The first report concerning collections of Colorado fishes was published by Cope and Yarrow in 1875 from collections made during the years 1872 to 1874 as a part of the Wheeler Survey. Colorado collections made by Jordan and Evermann in 1889 for the United States Fish Commission were reported in 1891. A local list of Colorado fishes was published by Juday in 1903 from specimens collected at Boulder and Longmont. In 1908, a list of the fishes of the Rocky Mountain Region was compiled by Cockerell.

Three distinct river systems, the Mississippi, the Rio Grande, and the Colorado, are represented in the state of Colorado. The Missouri-Mississippi drainage system in Colorado includes all of the streams east of the Continental Divide excepting the Rio Grande and its tributaries and consists of the North Platte, the South Platte, the Republican, and the Arkansas, with their tributaries. The South Platte and its tributaries drain most of the northeastern quarter of the state. Coming from the Hoosier Pass area at an altitude of about 11,000 feet, the South Platte is joined by Clear Creek, St. Vrain Creek, Thompson River, and the Cache La Poudre River. The Cache La Poudre River begins in the area of Poudre Lake and Milner Pass at an altitude of about 10,000 feet. At a short distance beyond the Continental Divide are headwaters of the Colorado River.

Observations and collections were made in tributaries of the Cache La Poudre River near Fort Collins, Colorado, during August, 1961. Specimens collected included the plains sand shiner, *Notropis stramineus missuriensis* (Cope); northern fathead minnow, *Pimephales promelas promelas* Rafinesque; western white sucker, *Catostomus commersoni suckleyi* Girard; and central Johnny darter, *Etheostoma nigrum nigrum* Rafinesque.

FOOD AND GROWTH OF SIX CENTRARCHIDS FROM SHORELINE AREAS OF BULL SHOALS RESERVOIR

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ABSTRACT

Stomach contents were examined from 579 longear sunfish, 381 green sunfish, 173 bluegill, 206 largemouth bass, 264 smallmouth bass, and 328 spotted bass collected from the shoreline area of Bull Shoals Reservoir, April 1964 - March 1965. The food of the six species by seasons and size groups (0-1.9, 2.0-3.9, 4.0-7.9 and 8.0 plus inches) is presented.

Fish contributed 85 to 99% of the total volume of food of the black basses four inches or more in length. Threadfin and gizzard shad were the most common prey species (50% or more of the volume). Consumption of longear, green, and bluegill sunfish by the basses was also significant (19% of volume). Longear sunfish over four inches in length relied heavily on terrestrial insects (37%), green sunfish on crayfish (63%), and bluegill on terrestrial insects (23%) and filamentous algae (23%). Utilization of fish by the larger sunfishes was minor, except for heavy consumption of dead or dying threadfin shad during a winter mortality.

The same species of Entomostraca and aquatic insects found only in the littoral browsing area constituted the primary foods of all six species of centrarchids under four inches in length, with greatest utilization by those under two inches. Basses, two to four inches in length, included fish in their diets. All the sunfishes consumed large quantities of black bass eggs in May. Bryozoa were seasonally important in the diets of longear and bluegill sunfish.

Growth of these centrarchids in Bull Shoals Reservoir was slow compared with that of the same species in other U. S. waters.

INTRODUCTION

Study of the food habits of fishes is considered vital to reservoir understanding (Jenkins, 1964). Seaburg and Moyle (1964) emphasized the need for determining trends in feeding throughout a season; selective feeding and competition for food between different species and sizes of fish in the same population; and on relationships between food, feeding habits, and growth of the fish. The present study was designed to gather preliminary information of these kinds on the closely related longear sunfish (*Lepomis megalotis*), green sunfish (*L. cyanellus*), bluegill (*L. macrochirus*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieui*), and spotted bass (*M. punctulatus*) living together in shoreline areas of Bull Shoals Reservoir.

DESCRIPTION AND METHODS

Bull Shoals Reservoir is a 15-year-old, 45,440 surface-acre impoundment of the White River in the Arkansas-Missouri Ozarks. Principal physical characteristics of the reservoir at power pool level are: mean depth, 67 feet; maximum depth, 201 feet; shoreline length, 740 miles; average annual water level fluctuation, 16 feet; average Secchi disc transparency, >10 feet. The littoral area lacks rooted aquatics and breadth, and consists of gravel, chert, and block fragmented bedrock.

Fish were collected along the shoreline with a 220-volt A.C., boat-mounted electroshocker in 12-night samplings between April 1964 and March 1965. Stomach contents were pooled within species-size groups (Borgeson, 1963) of O-1.9, 2.0-3.9, 4.0-7.9 and 8.0 plus inches for each collection. Volumetric measures were made by water displacement in a calibrated centrifuge tube.

Fry and fingerling largemouth and spotted bass were differentiated using criteria described by Applegate (1966).

Growth rates were computed from scales of fish collected in May and June 1965. Age determinations and scale measurements were made with an Eberbach scale projector under a magnification of 80X. Total body length-scale radius relationships were described as polynomials and programmed for an IBM 7040 computer.

COMPARATIVE FOOD HABITS

Largemouth bass

Studies of the foods eaten by largemouth bass fry demonstrated an initial dependence on Entomostraca and Rotifera. Inclusion of aquatic insects occurs during growth from fry to fingerling, with the foregoing items diminishing in importance as the piscivorous habit develops between 2.0 to 3.0 inches, providing suitable forage fish are available (Bennett et al., 1940; McCormick, 1940; Dendy, 1946; Murphy, 1949; LaFaunce[1] (unpublished); Kramer et al., 1960; Ridenhour, 1960; Scidmore, 1960; McCammon et al., 1964; McConnell et al., 1964; Goodson, 1965).

Stomach contents of 0.8 to 1.9-inch, 2.0 to 3.9-inch, and 4.0 to 23.5-inch largemouth bass from Bull Shoals Reservoir revealed a diet succession within these size groups from Entomostraca (99%), to Entomostraca and aquatic insects (50% each), to fish (88-99%) (Table 1).

Smallmouth bass

The diet of the smallmouth bass has been found similar to that of the largemouth bass, except that the larger individuals may be less rigidly piscivorous (Tester, 1932; Dendy, op. cit.; and Harlan et al., 1956). Fish, aquatic insects, and Entomostraca were of primary importance to 2.0 to 3.9-inch individuals in Bull Shoals, with fish making up the bulk of the diet of specimens over 4.0 inches long (Table 1).

[1] LaFaunce, Don A. 1959. The food of fingerling largemouth bass (**Micropterus salmoides**) in Clear Lake, Lake County, during August 1958. California Inland Fisheries Administrative Report No. 59-8, (mimeographed). 9 pp.

Table 1.--Stomach contents of centrarchids collected from Bull Shoals Reservoir in 12 night electroshocker samples between April 1964 and March 1965

Length group	Species	Number examined	Number with food	Total volume (cc.)	Percent of total volume: Fish	Fish eggs	Terrestrial insects	Aquatic insects	Acari	Malacostraca	Entomostraca	Mollusca	Bryozoa	Filamentous algae	Detritus
0-1.9	Longear sunfish	186	183	1.06	-	7	-	42	5	t	44	t	3	-	-
inches	Green sunfish	23	23	0.49	-	24	12	46	1	-	14	t	-	2	-
	Bluegill	4	4	0.06	-	-	-	60	8	2	31	-	-	-	-
	Largemouth bass	10	10	0.17	-	-	-	1	-	-	99	-	-	-	-
	Smallmouth bass	0	0	0											
	Spotted bass	18	17	0.33	-	-	-	79	-	-	21	-	-	-	-
2.0-3.9	Longear sunfish	206	200	10.46	-	23	9	48	t	t	1	3	9	2	5
inches	Green sunfish	196	189	6.28	10	1	8	59	t	5	12	3	1	1	1
	Bluegill	70	69	6.60	-	3	26	26	1	t	4	t	25	13	t
	Largemouth bass	6	2	0.3	50	-	-	50	-	-	-	-	-	-	-
	Smallmouth bass	74	65	2.3	38	-	2	33	-	-	21	-	-	-	6
	Spotted bass	81	60	3.6	56	t	2	28	t	-	14	-	-	-	-

Table 1.--Continued

Length group	Species	Number examined	Number with food	Total volume (cc.)	Fish	Fish eggs	Terrestrial insects	Aquatic insects	Acari	Malacostraca	Entomostraca	Mollusca	Bryozoa	Filamentous algae	Detritus
					Percent of total volume										
4.0-7.9 inches	Longear sunfish	187	179	51.36	29	3	37	15	t	1	3	1	4	5	3
	Green sunfish	162	144	85.03	16	-	13	6	-	63	t	1	t	t	1
	Bluegill	99	92	74.53	6	19	23	8	t	3	t	t	16	23	1
	Largemouth bass	84	59	71.1	99	-	t	1	-	-	-	-	-	-	t
	Smallmouth bass	160	122	99.1	93	t	t	2	t	3	t	t	-	t	1
	Spotted bass	183	115	78.5	85	t	2	1	t	10	t	-	-	1	1
>8.0 inches	Largemouth bass	106	74	660.6	88	-	t	t	-	12	-	-	-	-	t
	Smallmouth bass	30	24	72.8	94	-	1	-	-	5	-	-	-	-	t
	Spotted bass	46	31	106.7	91	-	-	-	-	7	-	-	-	-	2

Spotted bass

Accounts of spotted bass food habits do not show any wide variation with diets reported for largemouth or smallmouth bass (Howland, 1932; Dendy, 1946; Rosebury, 1950; Viosca, 1952).

The predominant food items in stomachs of Bull Shoals spotted bass under 2.0 inches were aquatic insects (79%) and Entomostraca (21%). Individuals between 2.0-3.9 inches were less dependent on insects (30%) and Entomostraca (14%), with fish making up 56% of the diet. Spotted bass 4.0 inches or more in length were primarily piscivorous (Table 1).

Longear sunfish

No studies of the diet of longear sunfish are known to us. It is the most abundant inhabitant of the littoral zone of Bull Shoals Reservoir.

Aquatic insects and Entomostraca were equally important and made up 86% of the diet of fish smaller than 1.9 inches long. Aquatic insects (48%), fish eggs (23%), terrestrial insects (9%), Bryozoa (9%) predominated in the food eaten by longear sunfish 2.9-3.9 inches long. Longear (4.0 plus inches) evidenced a selectivity for terrestrial insects (37%) (Table 1).

Green sunfish

The green sunfish is insectivorous, but also utilizes crustaceans, small fish and other non-insect items (Harlan et al., 1956; Sigler et al., 1963). McCormick[2] (unpublished) reported that green sunfish fed mainly upon Chironomid larvae, with increasing inclusion of crayfish as they grew larger. Huish[3] (unpublished) and Clark[4] (unpublished) demonstrate a dependence of larger individuals on crayfish. Cornish (1940) reports a quarry-pit population subsisting on diet of plankton, aquatic beetles, and algae.

Green sunfish in this study heavily utilized aquatic insects, particularly mayfly naiads, until shifting to a crayfish diet at 4.0 inches in length (Table 1).

Bluegill

The diet of the bluegill has been exhaustively researched (Bennett et al., 1940; Moffet et al., 1945; Ball, 1948; Patriarche et al., 1949; Turner, 1955; Harlan et al., 1956; Huish, 1957; Gerking, 1962, 1964; Doxtater[5] (unpublished), Seaburg et al., 1964). The species shifts from a plankton to insect diet at about 2.0 inches, thereafter occasionally ingesting shrimp, crayfish, snails, fish, vegetation and other items. Plant material is generally acknowledged to represent substitute rations for animal foods (Ball, op. cit.; Patriarche et al., op. cit.).

The bluegill is the least abundant of the three sunfishes in Bull Shoals. Like individuals of the other two species, most of those examined contained food. Prominent items eaten by larger individuals were terrestrial insects, filamentous algae, fish eggs, and Bryozoa (Table 1).

SEASONAL FEEDING TRENDS BY MAJOR FOOD CATEGORIES

Largemouth, smallmouth, and spotted bass 4.0 inches or more in length were primarily fish eaters throughout the year, but fish consumption by smaller bass and the sunfishes tended to be seasonal (Figure 1).

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[2] McCormick, Elizabeth M. The food of four species of fish in Franklin County, Ohio. Master of Science thesis. Ohio State University. 1939.

[3] Huish, Melvin Theodore. The foods of the largemouth bass, the bluegill and the green sunfish. Master of Science thesis. University of Illinois, 35 pp. 1947.

[4] Clark, Clarence F., 1965. Personal communication. Assistant Supervisor Fish Management Section, Ohio Division of Wildlife.

[5] Doxtater, Gary D. 1964. Food habits of the bluegill as influenced by season and size class. 26th Midwest Wild. Conference, 14 pp. (mimeographed).

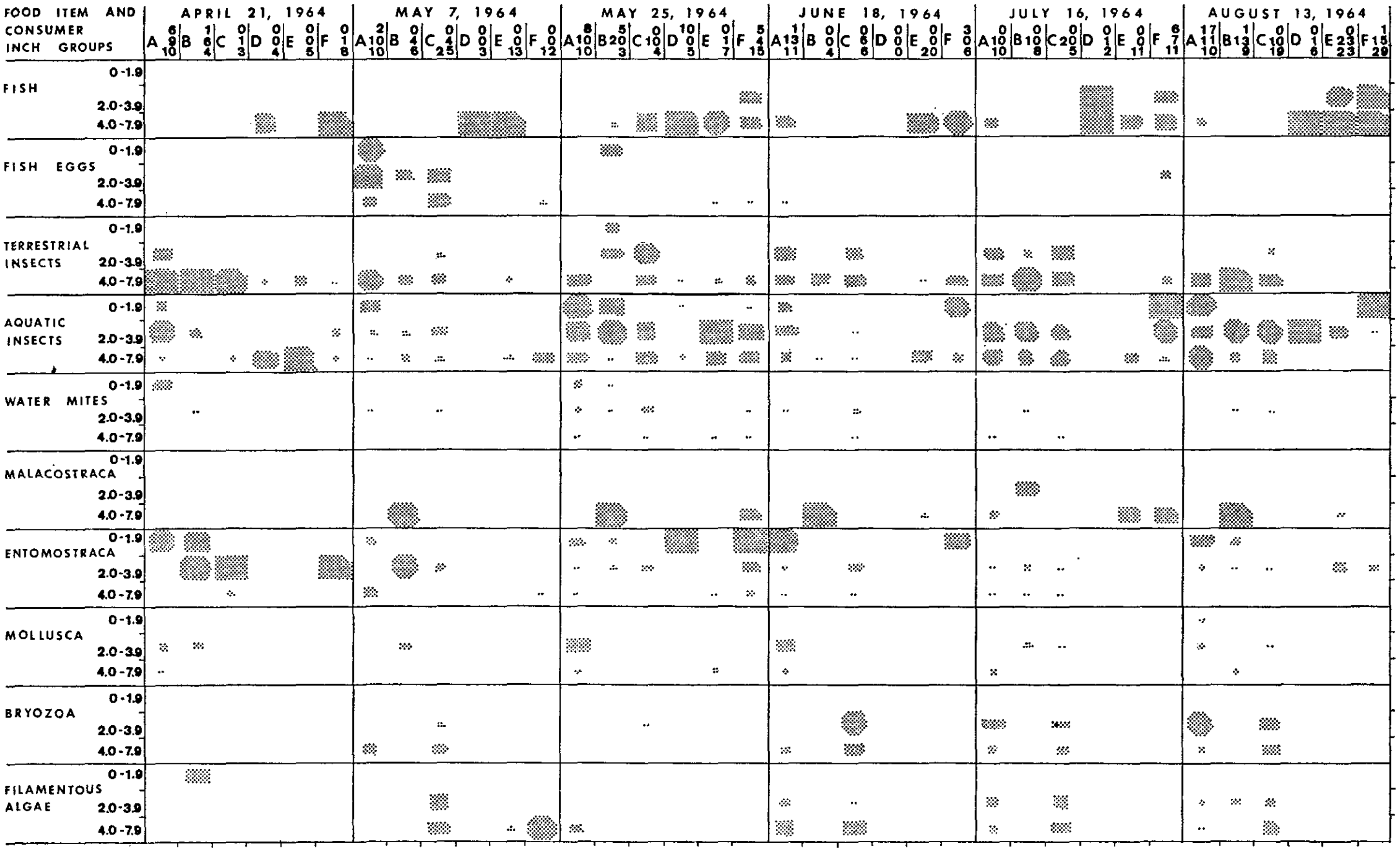

FOOD ITEM AND CONSUMER INCH GROUPS
APRIL 21, 1964
MAY 7, 1964
MAY 25, 1964
JUNE 18, 1964
JULY 16, 1964
AUGUST 13, 1964
A B C D E F
FISH
FISH EGGS
TERRESTRIAL INSECTS
AQUATIC INSECTS
WATER MITES
MALACOSTRACA
ENTOMOSTRACA
MOLLUSCA
BRYOZOA
FILAMENTOUS ALGAE
0-1.9
2.0-3.9
4.0-7.9

Figure 1 — Seasonal interactions within food categories by A — longear sunfish, B — green sunfish, C — bluegill, D — largemouth bass, E — smallmouth bass, and F — spotted bass from shoreline areas of Bull Shoals Reservoir, expressed as percent of total stomach volume (three dots = one percent and 102 dots = 100 percent) by size groups of 0-1.9, 2.0-3.9, 4.0-7.9 inches. Dietary overlap suggested by the degree of blackening between species-size divisions within each food-time rectangle. Numbers of stomachs examined within size groups follow species letter. Miscellaneous foods omitted.

Unidentifiable fish fry constituted 26, 15 and 7% of the food volumes of longear sunfishes 4.0 inches and longer in June, July and early August. In January and early March, threadfin shad (*Dorosoma petenense*) 1.5 to 2.3 inches long made up 13 and 91% of the food. Coincidently, a winter kill of threadfin shad began in January and reached its peak in early March.

Green sunfish 2.0-3.9 inches were found to have eaten threadfin shad only in January and March (12 and 27%). Within the 4.0 plus inch group, 63% of the March food volume consisted of threadfin shad; otherwise fish were found included in diets only during May (2%) and November (20%).

Large bluegill included fish in their diets in late May (43%), early August (1%), September (30%) and March (94%). Black bass fry were indentified as the fish eaten in May and threadfin shad in March.

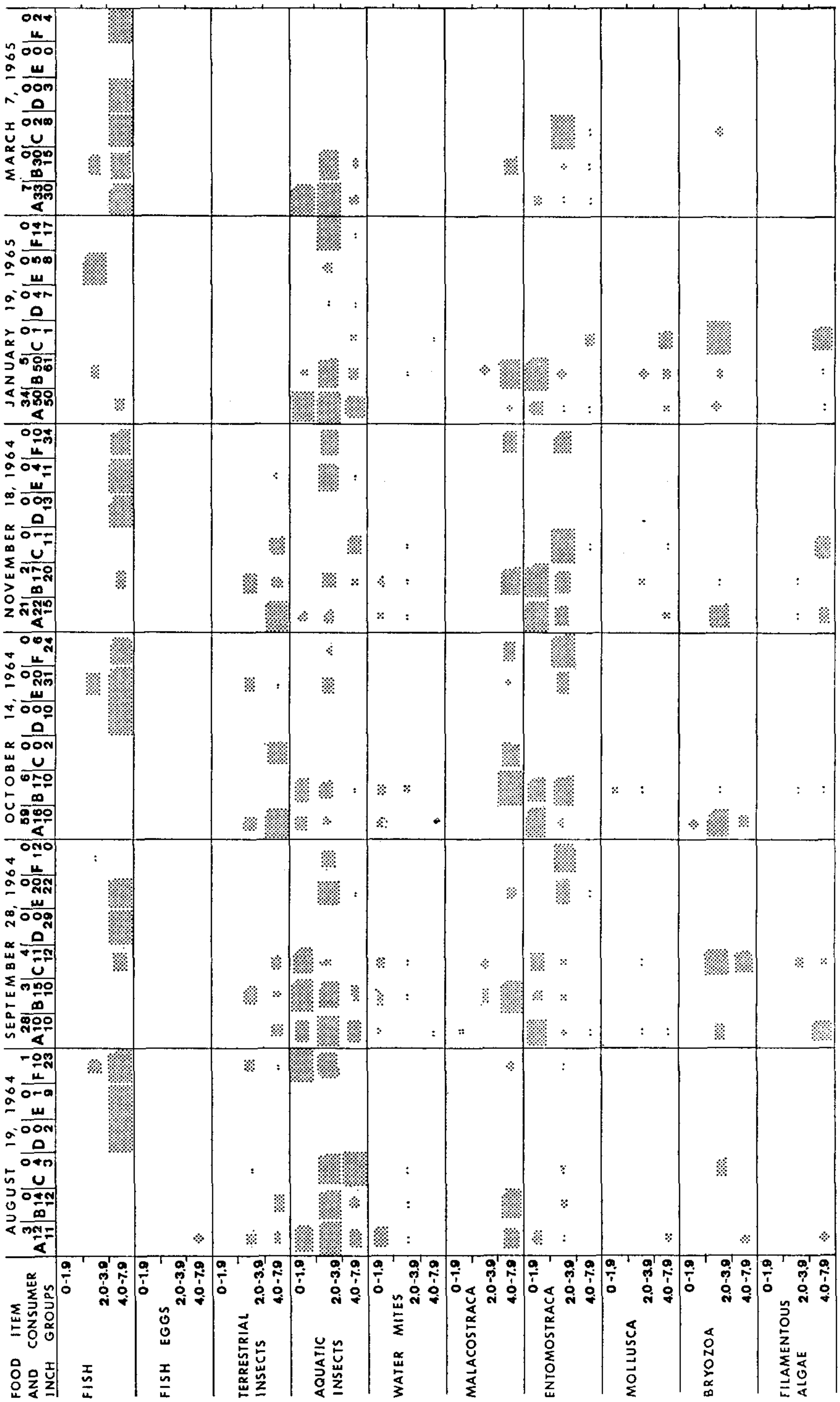
Shad were the principal prey found in stomachs (Table 2). Threadfin shad, introduced in 1962, apparently afforded an abundant food source during the summer, early fall and winter die-off. However, neither threadfin nor gizzard shad (*D. cepedianum*) appeared as regular inhabitants of the littoral, but rather as nocturnal transients and then primarily at water temperatures above 60 F. At cooler temperatures, threadfin shad were scarce or absent in night shoreline electrofishing samples, although trawl catches and echosounder monitoring identified vast numbers off shore. Heavy utilization of threadfin in winter is accounted for in that they began to die in pelagic waters, came to the surface, and then windrowed inshore where they became available to shoreline-dwelling centrarchids.

TABLE 2. TOTAL AND PERCENT OF TOTAL VOLUME OF VARIOUS FISHES FOUND IN STOMACH CONTENTS OF ALL CENTRARCHIDS EXAMINED FROM BULL SHOALS RESERVOIR.

Species	Total volume cc.	Percent
Unidentified fish remains	204.3	20.2
Threadfin shad	368.9	36.5
Gizzard shad	66.0	6.5
Shad spp.	111.6	11.0
Catfish	30.0[7]	3.0
Brook silversides	5.9	0.6
Spotted bass	4.5	0.4
Black bass fry	1.7	0.2
Black bass	23.2	2.3
Longear sunfish	147.3	14.6
Green sunfish	40.2	4.0
Bluegill	1.9	0.2
Log perch	5.0	0.5
Total	1010.5	100.0

[7] One fish

About three percent of the total fish eaten consisted of bass (Table 2), and the bulk of this represented bass eating bass. Only a fraction consisted of sunfish feeding on bass. Although this amounted



FOOD ITEM AND CONSUMER INCH GROUPS
AUGUST 19, 1964
SEPTEMBER 28, 1964
OCTOBER 14, 1964
NOVEMBER 18, 1964
JANUARY 19, 1965
MARCH 7, 1965
FISH
FISH EGGS
TERRESTRIAL INSECTS
AQUATIC INSECTS
WATER MITES
MALACOSTRACA
ENTOMOSTRACA
MOLLUSCA
BRYOZOA
FILAMENTOUS ALGAE
0-1.9
2.0-3.9
4.0-7.9

to a minute percentage, it may be of some importance in that it involved bass fry.

Predation by the basses on longear, green, and bluegill sunfish amounted to 19% of the total fish volume found in stomachs (Table 2). Young-of-the-year longear were particularly important in diets of 2.0 to 7.9-inch basses during the summer and fall. Kimsey[6] et al. (unpublished) previously noted the prominence of sunfishes as forage for largemouth bass in a situation offering an abundance of threadfin shad.

Brook silversides (*Labidesthes sicculus*) also contributed substantially to diets of 4.0-7.9-inch basses during the summer and fall. Catfish and log perch (*Percina caprodes*) were minor food items (Table 2). Silversides and log perch were the only other species abundant in electrofishing samples.

Fish eggs

Predation by centrarchid panfishes on the spawn of the black basses has been extensively documented (Bennett, 1962). All 55 longear, green and bluegill sunfish examined in early May had fed on black bass eggs. Sporadic ingestion of brook silverside eggs by green sunfish and spotted bass was also noted.

Terrestrial insects

All three sunfishes utilized terrestrial insects intermittently between April and November (Figure 1). The contribution ranged from a trace to 54% of the volume of food found in 2.0-3.9-inch fish. Heaviest use was by individuals over 4.0 inches. For example, 98, 100 and 90% of the April diet of large longear, green sunfish, and bluegill consisted of June beetles (*Phyllephaga spp.*). Much of the sustenance of large bluegills in a fluctuating reservoir in California was shown to be terrestrial in origin (Goodson, 1965).

Aquatic insects

Consumption of aquatic insects by 4.0-7.9-inch largemouth and smallmouth bass was moderate to appreciable during April, and by spotted and smallmouth from May through mid-July. Even though overall use by 4.0-inch plus longear, green and bluegill sunfish was low (Table 1), volumes ranged from 24 to 100% in late May, midsummer, and late fall through midwinter.

Aquatic insects were of major significance in the diet of all six species less than 4.0 inches, constituting from 26 to 79% of the total food, and contributing up to 100% of the diet during the three peak-use periods mentioned.

Tendipedidae larvae, pupae and adults dominated the spring peak of consumption. Ephemeroptera naiads, supplemented by Tendipedidae pupae, characterized midsummer usage. Midge pupae, supplemented by lesser quantities of Ephemeroptera, Libellulidae, and Neuroptera, primarily represented the aquatic insects eaten in the late fall through midwinter period.

The principal ephemeropteran eaten was *Stenonema spp.*, an inhabitant of wave-washed, rocky shorelines. Burrowing mayflies *Hexagenia spp.*, were only occasionally found. Other aquatic insects consumed in small quantities included *Chaoborus*, coleopterans, ceratopogonids, and odonates. Aquatic insects utilized by the fishes almost exclusively were representative of the littoral fauna of the reservoir.

Malacostraca

Crayfish were a regular minor item in the diet of the basses over 8.0 inches in length. They were consistently utilized by 4.0-7.9-inch spotted and smallmouth bass as well, seasonally forming 20 to 50% of the food

[6] Kimsey, J. B., Robert H. Hagy, and George W. McCammon. 1957. Progress report on the Mississippi threadfin shad, **Dorosoma petenensis atchafaylae**, in the Colorado River for 1956. Calif. Dept. Fish and Game, Inland Fisheries Admin. Rept. No. 57-23, 48 pp. (mimeographed).

consumed. While eaten by all the sunfishes, crayfish were of major value at all seasons to large green sunfish (Figure 1).

Entomostraca

Entomostraca were of primary importance to all species less than 2.0 inches, ranging from 14% in the green sunfish to 99% of total volume in the largemouth bass. Fish 2.0-3.9 inches long made less use of this food item (Table 1). Heaviest use occurred during fall through mid-spring. Cladocerans were most important, followed closely by copepods in the fall. Ostracods were of minor significance.

Peak abundance of zooplankton in the spring coincided with its maximum use by fish, but euplankton predominated in open water net samples and tychoplankton in centrarchid stomachs. Of the 23 species of cladocerans in the reservoir, 13 have been recorded only from fish stomachs and littoral bottom dredge samples. Of the 10 euplanktonic forms, only *Bosmina longirostris* was recorded in stomach contents, and Brooks et al. (1965), categorizes this species as basically a littoral inhabitant.

Bryozoa

Bluegill and longear over 2.0 inches included *Fredericella sultana* in their diets in trace to substantial quantities at all seasons (Applegate, 1966). Heaviest consumption, ranging to 75% for bluegill and 70% for longear, was recorded in 2.0 to 3.9-inch fish during the fall.

Filamentous algae

Filamentous algae were eaten primarily by intermediate and large bluegills (Table 1). Heaviest use, ranging from 23 to 56%, occurred in early May, June, July, early August, November, and January by 4.0 plus inch bluegill (Figure 1). Similar sized longear relied on algae mainly in June, September, and November (32, 47, and 18%, respectively).

GROWTH

Buck and Cross (1951) defined overpopulation as a stunted condition of various game and panfishes caused by reduction of growth to a point where overlapping size ranges of different age-groups introduced excessive interclass competition. Bennett (1962) pointed out the purely arbitrary nature of defining stunting, but emphasized extremes of below average growth as reflecting this condition.

Growth of these six centrarchids in Bull Shoals Reservoir was slow compared with that of the same species in other U. S. waters (Table 3). Whether all species were growing slowly enough to qualify as stunted is questionable. Pertinently, inter and intra growth comparison was best for largemouth bass, whose length-frequency distribution appeared most normal (Figure 2), and poorest for green sunfish, whose length frequency distribution typically reflected the excessive number of small fish within a narrow size range characteristic of stunted fish populations.

DISCUSSION

Dendy (1946) states that benthos, particularly aquatic insects, was neither sufficiently abundant to be important or necessarily vital in bridging the gap between zooplankton and fish diets of the game fish population of Norris Reservoir. These observations were predicated on the hypothesis that fluctuations of water levels practically excluded benthos production in shoreline areas, thereby effectively eliminating the normal role of the littoral as a nursery area for young fish as occurs in natural lakes. The littoral benthos in fluctuating Bull Shoals Reservoir contributed substantially to the diets of all six species under four inches in length.

While it is undoubtedly true that benthos is not necessarily vital in the transition to a piscivorous diet, a study of the foods eaten by young largemouth bass collected from Bull Shoals during May and June 1965 compared to a similar sample from newly impounded Beaver Reservoir reflects advantage in such succession (Applegate and Mullan, in press).

Bull Shoals largemouth 0.7 to 1.6 inches total length fed primarily on entomostracans, after which shad became the dominant food. The diet succession in Beaver Reservoir was entomostracans, midge larvae, and then shad when the largemouth attained 1.6 inches total length. Growth in length of largemouth bass in Beaver was twice that of Bull Shoals during the period, and largely attributed to the greater availability and utilization of midge larvae during the fry to fingerling transition.

TABLE 3. COMPARISON OF CALCULATED GROWTH OF SIX CENTRARCHIDS IN BULL SHOALS RESERVOIR (COLLECTED FROM SHORELINE AREAS BY ELECTROSHOCKING DURING THE FOURTEENTH YEAR OF IMPOUNDMENT) WITH THAT OF THE SAME SPECIES IN OTHER U. S. WATERS. CALCULATED GROWTH OF BULL SHOALS FISHES BASED ON SCALE SAMPLES FROM 116 LARGEMOUTH BASS, 190 SPOTTED BASS, 107 SMALLMOUTH BASS, 150 LONGEAR SUNFISH, 98 GREEN SUNFISH AND 124 BLUEGILL.

Species and reservoir(s)	Calculated total length (inches) at end of year				
Largemouth Bass	1	2	3	4	5
Lake of the Ozarks (Weyer, 1940)	7.7	10.5			
TVA reservoir average[8]	4.7	10.0			
Oklahoma reservoir average[9]	6.7	11.4			
Bull Shoals Reservoir	6.0	8.3			
Spotted Bass					
Norris Reservoir (Stroud, 1948)	4.9	10.3	13.2		
Cherokee Reservoir (Stroud, 1949)	3.7	8.6	11.2		
Douglas Reservoir (Stroud, 1949)	2.6	7.8	11.2		
Grand Lake, Oklahoma[10]	4.1	8.4	11.8		
Bull Shoals Reservoir	3.9	7.2	8.3		
Smallmouth Bass					
TVA reservoirs[8]	4.2	9.5			
Tenkiller Reservoir[11]	4.3	8.6			
Bull Shoals Reservoir	3.6	6.9			
Missouri streams[12]	3.7	6.7			
Longear Sunfish					
Oklahoma reservoirs[13]	3.0	4.0	4.9	5.4	
Tenkiller Reservoir[11]	2.4	3.4	4.4	5.0	
Bull Shoals Reservoir	1.7	3.2	4.1	4.5	
Green Sunfish					
Ohio average[14]	2.3	4.3	5.6	6.3	6.8
Oklahoma reservoirs[13]	3.9	6.4	7.0		
Bull Shoals Reservoir	1.8	2.8	3.6	4.3	4.8
Bluegill					
TVA reservoir average[8]	2.1	3.7	5.0	6.2	7.4
Oklahoma reservoir average[13]	3.5	5.2	6.3	7.2	
Ohio average[15]	1.6	3.6	5.1	6.0	6.8
Bull Shoals Reservoir	1.9	3.3	4.0	4.8	5.9

[8] Fitz, Richard B. 1965. Growth of fishes in eastern Tennessee Valley reservoirs. Tennessee Valley Authority. 1 p.

[9] Jenkins, Robert M., and Gordon Hall. 1953. Growth of largemouth bass in Oklahoma. Okla. Fish. Res. Lab. Rept. No. 30. 43 p.

[10] Jenkins, Robert M. 1953. Growth histories of the principal fishes in Grand Lake (O' the Cherokees), Oklahoma, through thirteen years of impoundment. Okla. Fish. Res. Lab. Rept. No. 34. 87 p.

[11] Hall, Gordon E., and Robert M. Jenkins. 1953. Continued fisheries investigations of Tenkiller Reservoir, Oklahoma, during its first year of impoundment, 1953. Okla. Fish. Res. Lab. Rept. No. 33. 54 p.

[12] Funk, John L. 1960. The Missouri smallmouth bass. Mo. Conserv. Comm. 22 p. (Spec. pub.)

[13] Jenkins, R. M., R. E. Elkin, and J. C. Finnell. 1955. Growth rates of six sunfishes in Oklahoma. Okla. Fish. Res. Lab. Rept. No. 49. 73 p.

[14] Roach, Lee S. 1948. Green sunfish. Ohio Conserv. Bull. 12(10):13.

[15] Roach, Lee S., and Irene Evans. 1947. Growth of game and pan fish in Ohio. Bluegills. Ohio Div. of Conserv. and Nat. Resources. Fish Mgt. Rept. No. 224 F. Reprinted 1955. 26 p.

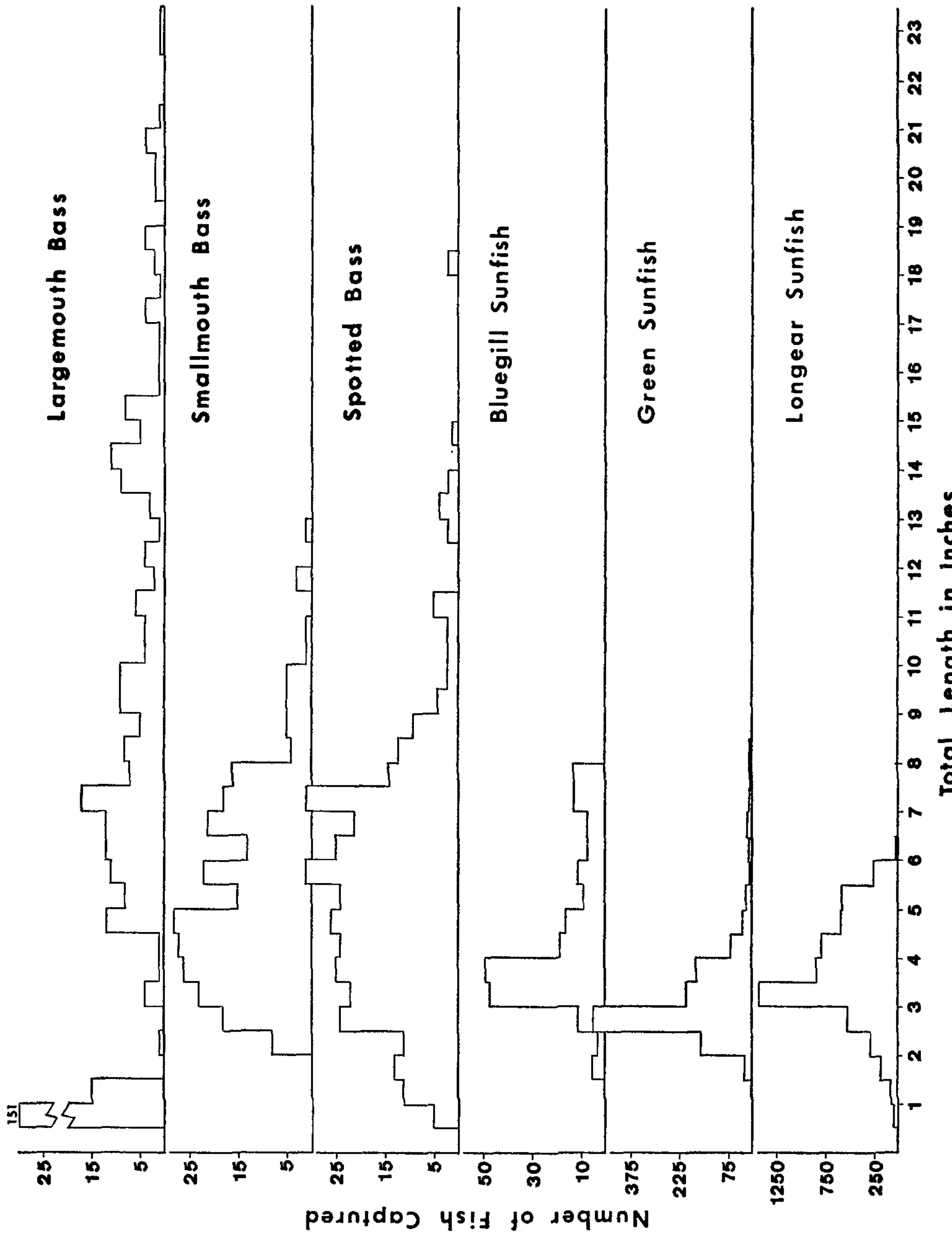


Figure 2. Length-frequency histograms of centrarchids from littoral areas of Bull Shoals Reservoir, April 1964 through March 1965, presented in 0.5-inch intervals.

Growth of fishes being density dependent cannot be used as sole evidence as to the role of foods consumed, nor as a measure of intraspecific and interspecific competition. Nevertheless, the rationale of a limited littoral, supporting six dominant centrarchids, whose growth is slow and foods similar while small, argues remarkable coincidence barring a lack of acute interactions.

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A NOTE ON THE ACCURACY OF THE SCALE METHOD IN DETERMINING THE AGES OF LARGEMOUTH BASS AND BLUEGILL FROM ALABAMA WATERS

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ABSTRACT

Photographic prints were made of scales taken from largemouth bass (*Micropterus salmoides* Lacepede) and bluegill (*Lepomis macrochirus* Rafinesque) of known ages by the use of a micro-projection machine. The image of each scale was projected directly upon photographic paper to produce, upon development, a permanent negative print.

In an examination of the prints of 272 largemouth bass scales, 80.1 percent were aged correctly when the ages were unknown to the technician. When the scales first aged incorrectly were re-examined after the technician knew the actual ages, an additional 3.7 percent was found to have the correct number of annuli although many were indistinct. A total of 16.2 percent of the bass scales did not possess annuli corresponding to the known ages.

In an examination of 264 prints of the scales of bluegill, 76.1 percent were aged correctly when the ages were unknown. When the scales first aged incorrectly were re-examined after the technician knew the actual ages, an additional 4.9 percent was found to have the correct number of annuli; however, many were not distinct. Of the total number of bluegill scales studied, 18.9 percent did not possess annuli corresponding to the known ages.

INTRODUCTION

Age determinations by the scale method have been used extensively in obtaining the rate of growth of fishes in natural waters. The method has been described in detail by Van Oosten (1928). Considerable doubt has been expressed concerning the accuracy of age determinations, especially of fish from southern waters.

A study of the scales of largemouth black bass (*Micropterus salmoides* Lacepede) and bluegill (*Lepomis macrochirus* Rafinesque) of known ages was made to test the accuracy of the scale method in determining the ages of these species of fish in Alabama.

Fish for study were taken from four fertilized ponds stocked at the rate of 1,500 bluegill and 100 largemouth bass per acre, and from one unfertilized pond stocked at the rate of 400 bluegill and 30 largemouth bass per acre. Records were kept on the dates of hatching, dates of stocking, dates when the scale samples were taken, and on lengths, weights, and ages of the fish. Thirty of the bass were taken from feeding experiments where they were fed different amounts and kinds of food from June to October. Scales, weights, and lengths were taken from these fish at monthly intervals. In both species the scales were removed from the area between the dorsal and pectoral fins, immediately above or below the lateral line. Usually a dozen or more scales were removed with a forceps from each fish and placed in an envelope.

Two or three of the dried scales from each fish were selected with the use of a binocular microscope for mounting. Care was exercised in the selection of the scales in order to obtain only typical, clear, nonregenerated specimens. The selected scales were cleaned by rubbing between moistened layers of cheese cloth. They were then mounted on a glass slide in a solution of water-glass and glycerin. This solution was used because it gave a sharper projected image than other mounting fluids. The water-glass-glycerin solution was prepared by dissolving 60 g. of sodium silicate in 100 ml. of water that had been brought to the boiling point. This solution was filtered through coarse filter paper. Ten