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ESTIMATED GROWTH AND STANDING CROP OF LARGEMOUTH BASS *(MICROPTERUS SALMOIDES)* FROM LAKE ELMDALE

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ABSTRACT

Electro-fishing gear was used to make shoreline population estimates of largemouth bass *(Micropterus salmoides)* in Lake Elmdale, Washington County, Arkansas, during September 1979. The population density was estimated to be 1541 bass/Km² with a standing crop of 30.4 kg/ha. The length-weight relationship was calculated as $W = 0.00001504L^{2.97}$, and the total length-scale radius relationship as $L = 41.75 + 1.23S_r$. The average condition coefficient(K) was 1.31. In comparison with four other Arkansas lakes the population density of largemouth bass was highest in Lake Elmdale while the growth rate was lowest.

INTRODUCTION

The largemouth bass is an important game fish in the United States and Arkansas (Bryant and Houser, 1971). In order to better manage populations of largemouth bass in reservoirs and lakes, studies on the growth, population size, and feeding are necessary. Numerous studies on Arkansas largemouth bass populations have been conducted (Aggus and Elliott, 1975; Applegate et al., 1966; Kilambi et al., 1978; Olmstead, 1974) as well as studies on bass populations in other areas of the country (Bennett, 1950; Byrd and Moss, 1957; Hooper, 1975; Ridenhour, 1960; Swingle and Smith, 1942; Von Geldern and Mitchell, 1975). With this wealth of information on bass populations, it is unfortunate that some smaller lakes such as Lake Elmdale have never been studied. This paper represents the first published study of this small reservoir which has some interesting features.

Lake Elmdale, owned by the Arkansas Game and Fish Commission, is located on Bush Creek in Washington County, Arkansas, about four miles west of Springdale. It was impounded in 1953 and contains underground deficiencies. The limestone formations beneath the dam allow leakage, which causes a wide fluctuation in the water level (Kaffka, 1967). This was evident during the study, when after two weeks a return trip to the lake showed that the water level had fallen 15 to 20 cm. The surface area is about 80 ha with a shoreline of 5.8 Km.

METHODS AND MATERIALS

Largemouth bass were collected by a boat-mounted 230 volt AC electroshocker on six nights from 11 to 20 September, 1979. All bass were measured for total length to the nearest millimeter, and scale samples from all fish were removed from the body at the tip of the apposed left pectoral fin. Bass for the length-weight analysis were collected only on the last trip. The bass were weighed to the nearest gram. Scales were pressed in plastic and read by use of an Eberbach scale projector with a magnification of 40x. For the population estimate the bass were caught and released after marking them by clipping the anal fin.

RESULTS

The length-weight relationship was calculated as:

$$W = aL^b$$

where W = total weight in grams, L = total length in millimeters, and a and b are constants. Based on 211 largemouth bass this relationship was described by the equation:

$$W = 0.00001504L^{2.97}$$

The slope of 2.97 was not significantly different from 3.0 ($t_{210} = 1.45$) indicating isometric growth.

The condition coefficient ($K = W/L^3 \times 10^5$), for Lake Elmdale largemouth bass ranged from 0.95 to 1.48 with an average value of 1.31. This value was similar to Crystal Lake largemouth bass (Kilambi et al., 1978) and higher than the bass from Lake Fort Smith, 1.19 (Olmsted, 1974). The coefficient was highest (1.54) for largemouth bass from Beaver reservoir (Bryant and Houser, 1971).

For the total length-scale radius analysis, a total of 96 bass were used. The relationship was estimated by the linear regression equation:

$$L = 41.75 + 1.23S \ (R = 0.95)$$

Lengths attained at earlier ages were calculated using the total length-scale radius relationship (Table 1). Comparison of growth of Lake Elmdale largemouth bass with those of other bodies of water in Arkansas (Table 2) indicated a lower growth rate for the bass in Lake Elmdale.

Growth data were fitted to the von Bertalanffy growth equation (Ricker, 1975):

$$L_t = L_\infty(1-e^{-k(t-t_0)})$$

where L_t = length at age t, L_∞ = maximum attainable size, k = rate constant (coefficient of catabolism), and t_0 = age at which the length is zero. The Bertalanffy model describing the growth of the Lake Elmdale largemouth bass was expressed as:

$$L_t = 650(1-e^{-0.08t + 2.4})$$

The lengths calculated by the Bertalanffy growth formula and by back calculation from the total length-scale radius relationship when fitted to a linear regression were in agreement (r = 0.99) indicating the suitability of this growth model to describe the growth of largemouth bass.

A total of 1,934 bass were marked, and 13.1% were recaptured. The population size was estimated by the Schnabel Method (Ricker, 1975) to be 8,937 with 95% confidence limits of 7,835 and 10,037. Of the total population, 47% of the bass were less than 150 mm.

The biomass of largemouth was estimated to be 30.4 kg/ha with bass less than 250 mm in length being 23.4 kg/ha and bass more than 250 mm in length making up 6.9 kg/ha. The estimated standing crop for Lake Elmdale largemouth bass was much greater than those of Beaver Reservoir or Bull Shoals (Table 4).

Population density expressed as number of largemouth bass per kilometer of shoreline was compared with four lakes in Arkansas (Table 3). The densities are comparable since the population estimates were obtained by the Schnabel Method. Population density was highest in Lake Elmdale and lowest in Lake Fort Smith. In Lake Elmdale and Crystal Lake the population densities were higher than in Beaver Reservoir and Lake Fort Smith. The higher densities in Lake Elmdale and Crystal Lake were likely due to frequent stockings by the Arkansas Game and Fish Commission and better survival of young-of-the-year bass.

A comparison of largemouth bass average annual length increments during the first six years of life (Table 2), and population density in five Arkansas Lakes (Table 3) by linear regression showed a significant decrease at the 0.05 level in growth with increasing density ($R = 0.92$). However, the length increment of 74 mm for Lake Fort Smith with the lowest density was smaller compared to Beaver (79 mm) and Bull Shoals (82 mm) Reservoirs having greater densities of largemouth bass population. Growth increments of 54 and 62 mm for bass from Lake Elmdale and Crystal Lake, respectively, were less than in bass from the other three lakes. The observations indicate that factors other than population density may also influence growth.

DISCUSSION

Lake Elmdale had the highest population density and slowest growth rate for largemouth bass of five Arkansas lakes. Availability of suitable forage fish is an important factor influencing growth. The diet of Lake Fort Smith bass was predominantly bluegill, *Lepomis macrochirus*, with young gizzard shad, *Dorosoma cepedianum*, occurring in early summer diet (Olmsted, 1974). In Beaver and Bull Shoals Reservoirs, gizzard shad and threadfin shad, *D. petenense*, are abundant (Houser and Dunn, 1967; Houser and Netsch, 1971) and were the most common forage fishes in the diet of largemouth bass (Applegate et al., 1966; Applegate and Mullan, 1967; Aggus and Elliott, 1975). Fish, especially bluegill, was the major food item for the Crystal Lake bass less than 170 mm, and above this size crayfish and fish, predominantly bluegill, were most important (Wickizer, 1978). In Crystal Lake, bluegill was the most abundant of all lepomids (Kilambi et al., 1976). Based on the number of fish observed during the period of bass population estimation, bluegill is the dominant lepomid in Lake Elmdale and is presumed to be the primary forage for Lake Elmdale bass.

In Beaver and Bull Shoals Reservoirs and Lake Fort Smith, the population density of largemouth bass was low, with Lake Fort Smith being the lowest. However, the growth of the Lake Fort Smith bass is lower than in Beaver or Bull Shoals Reservoirs. One difference is that the main forage fish for bass in Lake Fort Smith is bluegill which has been shown to be less suitable forage than other fishes for largemouth bass (Dendy, 1946; Bennet, 1950; Lewis and Helms, 1964; Aggus, 1972; Olmsted, 1974). While bluegill is not considered to be suitable forage for bass, largemouth bass feeding on threadfin shad exhibited improved growth (von Geldern and Mitchell, 1975). It appears that even though largemouth bass are more dense in Beaver and Bull Shoals Reservoirs than in Lake Fort Smith, the forage of bluegill is less suitable for the growth of largemouth bass than shad.

In Lake Fort Smith, Crystal Lake, and Lake Elmdale the forage fish is largely bluegill. However, the population density is highest in Lake Elmdale, intermediate in Crystal Lake, and lowest in Lake Fort Smith. The population density is inversely related to the growth rates which is poor in Lake Elmdale, intermediate in Crystal Lake, and good in Lake Fort Smith. The extremely high density of largemouth bass in Lake Elmdale was probably due to fertilization. The Arkansas Game and Fish Commission periodically applies inorganic fertilizer to the lake and further, the run off from the surrounding poultry industry adds organic fertilizer. It has been shown that fertilization of ponds will increase fish production (Swingle, 1949; Swingle and Smith, 1942; Byrd and Moss, 1957). In Lake Elmdale largemouth bass

Table 1. Back-calculated total lengths of Lake Elmdale largemouth bass.

Age group	Number of fish	Total length (mm) at each annulus 1	2	3	4	5	6	7
I	16	138						
II	18	160	210					
III	4	148	180	223				
IV	10	162	193	236	266			
V	11	159	195	230	263	282		
VI	2	144	204	232	256	279	300	
VII	2	165	189	250	280	306	327	352
Weighted mean		153	195	234	266	289	313	352

Table 2. Growth (mm) comparisons of largemouth bass from different lakes in Arkansas.

Locality and reference	1	2	3	4	5	6	7	8	9	10
Lake Elmdale (Present study)	153	195	234	266	289	313	352			
Lake Fort Smith (Olmsted, 1974)	149	243	307	360	394	445	452			
Crystal Lake (Kilambi et al., 1978)	100	198	259	300	335	373	403	424	455	484
Beaver Reservoir (Bryant and Houser, 1971)	152	277	333	396	462	474				
Bull Shoals Reservoir (Bryant and Houser, 1971)	176	297	277	427	457	492	519	524		

Table 3. Comparison of largemouth bass population density among five Arkansas lakes.

Lake and reference	Shoreline (Km)	Population density (n/Km)
Lake Elmdale (Present study)	5.8	1541
Crystal Lake (Kilambi et al., 1976)	4.2	756
Beaver Reservoir (Bryant and Houser, 1971)	723	323
Bull Shoals Reservoir* (Bryant and Houser, 1971)	1,192	199
Lake Fort Smith (Olmsted, 1974)	11.8	120

*Petersen estimate

Table 4. Comparison of largemouth bass standing crop among 3 Arkansas lakes.

Lake and reference	Standing crop (kg/ha)
Lake Elmdale (Present study)	30.4
Beaver Reservoir (Bryant and Houser, 1971)	10.8
Bull Shoals Reservoir (Bryant and Houser, 1971)	5.6

less than 150 mm comprised 47% of the total number of bass collected, and bass less 250 mm in length were responsible for a standing crop of 23.4 kg/ha of the total 30.4 kg/ha. Lake Elmdale then has a predominance of small bass which probably feed heavily on entromostracans (Applegate et al., 1966; Goodson, 1965; Ridenhour, 1960; Olmsted, 1974). Also, studies have shown that fish production is directly related to plankton production (Hooper, 1975). The high bass population density of Lake Elmdale was attributable to survival of young bass due to availability of zooplankton.

CONCLUSIONS

Lake Elmdale largemouth bass have the highest population density and lowest growth rate of five Arkansas lakes. The standing crop of the lake is higher than that of two other Arkansas lakes with 77% of the weight composed of fish less than 250 mm. Lake Elmdale is a good example that fertilization will increase the yield of fish in a lake, but the increased production led to more small fish which caused an increased density that probably caused the lowered growth rate. It would appear that management measures should be taken to decrease the inorganic fertilization and prevent the runoff from the poultry industry. Then the largemouth bass population can be monitored for signs of improved growth.

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