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AGE AND GROWTH OF THE BLUEGILL *LEPOMIS MACROCHIRUS* RAFINESQUE FROM AN UNMANAGED WATERSHED LAKE IN NORTHEAST ARKANSAS WITH OBSERVATIONS ON LAKE ECOLOGY

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ABSTRACT

Age and growth data were compiled on 114 bluegill, *Lepomis macrochirus* Rafinesque, taken from floodwater retarding structure #15 of the Big Creek Watershed project in Craighead and Greene counties of northeast Arkansas. This project was completed in the early 1960's by USDA-SCS. The 73 surface acre lake has not been managed for fish production and has been subjected to unscheduled water level manipulations during dry weather periods. These manipulations have maintained the bluegill population in healthy condition. The oldest bluegill collected were age class IV+. Average condition coefficient K(TL) declined from oldest to youngest individuals (2.96 in age class IV+ - 2.20 in age class I+), while numbers in age class declined from the youngest to the oldest within the sample (age class IV+ = 1[0.8%]; age class I+ = 74 [64.9%]). The length-scale radius relationship was L = 9.51 + 46.92S, with a correlation coefficient (r) of 0.96. The length (60-178 mm)-weight (4.7-155.9g) relationship (Log W = 1.4 Log L - 1.37) indicates that weight has not increased as the cube of length. The utility of drawdown as a fishery management technique is discussed.

INTRODUCTION

Age and growth studies have long been used to determine fish health and condition, to compare the capabilities of water bodies for the fish production, and to assess fish management strategies (Lagler, 1956). The bluegill sunfish, *Lepomis macrochirus* Rafinesque, has been used as the subject species in numerous age and growth studies throughout the United States and as being representative of similar sunfishes (Carlander, 1977; Lewis, 1983). This paper describes the age and growth of bluegill in floodwater retarding structure (FWRS) #15 of the Big Creek Watershed project in Craighead and Greene counties, Arkansas (Figure 1). This project was completed in the 1960's by the USDA-Soil Conservation Service (SCS) under the authority of the 1954 Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress) (USDA-SCS, 1961). These flood water retarding structures are impoundments designed with flood control as their primary purpose. Some fish and wildlife benefits typically result from the construction of these structures, though often incidentally (Nord, 1963; Dillon and Marriage, 1973; Grizzel, 1960; Hatcher, 1973). FWRS #15 has a sediment pool which covers approximately 73 surface acres (29.2 hectares) with a designed flood pool of 256 surface acres (102.4 hectares) (USDA-SCS, 1961) and supports an estimated 1500 recreational activity occasions (person-days) per year (USFWS, 1980).

Site #15 drains 2,855 acres (1142 hectares) of the upper Big Creek Watershed on Crowleys Ridge. Soils within the area are dominated by Collins, Calloway and Loring silt loams. These soils are considered to have fair to very poor suitability for supporting wetland plants (Ferguson, 1979) and comprise the bulk of the water-borne sediments covering the bottom of the sediment pool of Site #15. Bottom depths within the site range from 0.3 - 7.0m. Substrates are typically either silty mud (as a result of water-borne sediment load and parent materials) or detritus from the upper watershed and decay of former forests within the site. Topography of the area is characterized by ridges with narrow winding tops, short side slopes and narrow valleys between ridges (Robertson, 1969). The structure was partially drained (50%) during the summer of 1979 and has not been managed for fisheries. Over 370 such structures, averaging 13.64 hectares in size and incorporating

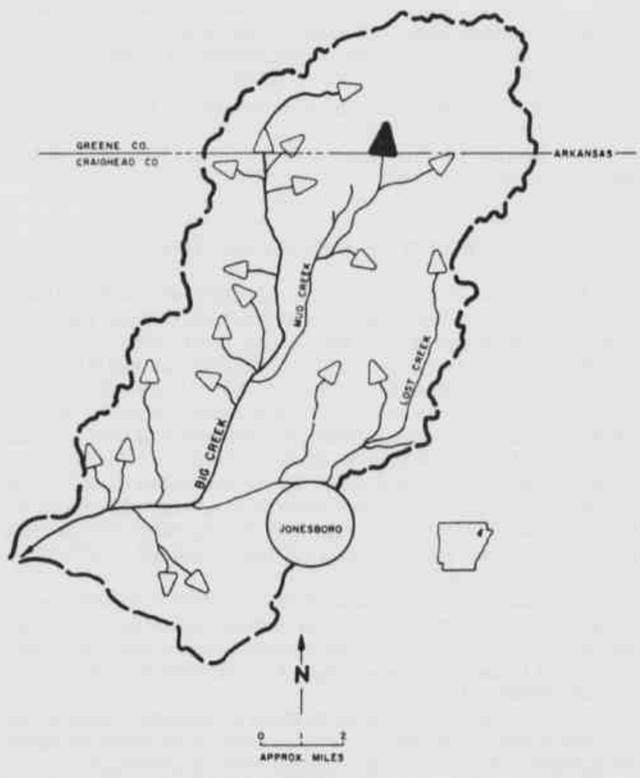

Figure 1. Location of Site #15 (shaded) in the Big Creek Watershed, Craighead and Greene counties, Arkansas.

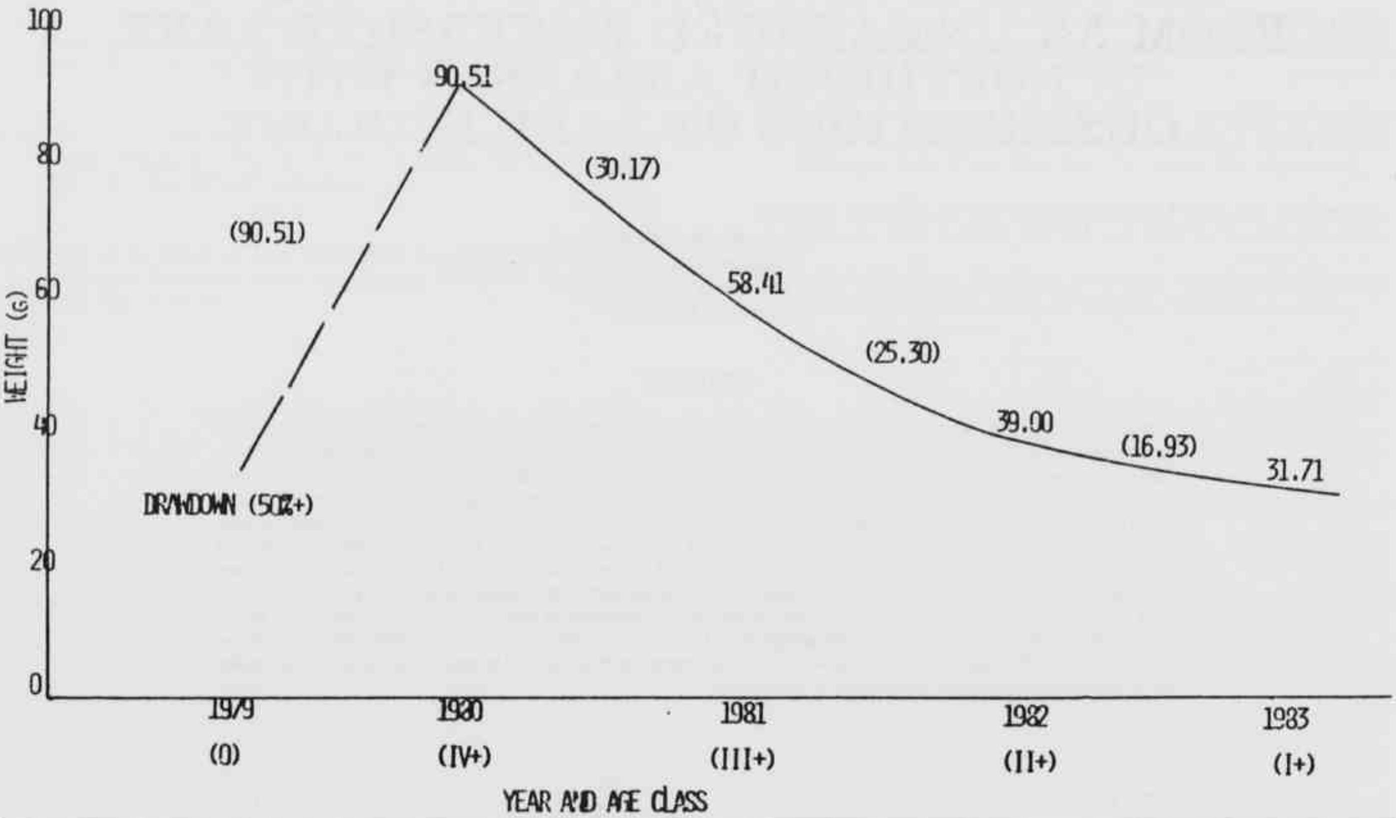

Figure 2. Average weights during each year since drawdown (1979) of bluegill sunfish from Site #15, Big Creek Watershed, Craighead and Greene counties, Arkansas. Absolute weight gain (w2-w1, Ricker, 1975) shown in parentheses between years.

various levels of management, have been built by SCS in Arkansas (Bates, 1985).

The remainder of this report will deal only with Site #15 as described above.

METHODS AND MATERIALS

One hundred and fourteen bluegill were collected from Site #15 during routine rotenone sampling by the author and Arkansas Game and Fish Commission personnel at the request of one of the landowners (Dr. Bill R. Cato, Jonesboro, AR). The sample area was a representative acre along the southwestern bank of Site #15 and included a section of the borrow pit for dam construction. Several species of fish were collected from the site and will be discussed further in later publications. Scales for study were selected by the "Key Scale" method suggested by Lagler (1956). Key scales were designated as those from an area approximately 10 scales back from the head and 5 down from the lateral line along the right side of the fish. Approximately 20 scales were collected from each fish, with the total length recorded in millimeters, and weight recorded in grams.

Scale annuli counts were made by the use of an American Optical dissecting microscope in conjunction with an American Optical light source. Measurements on each scale were made using Helios dial calipers from focus to each annulus and from focus to scale margin along the anterior median of each scale.

Age determinations were made by direct annuli count. Since collection was made in mid-summer, the age referred to herein represents the number of the last complete annulus plus any growth after formation (e.g. III+).

Measurements of individual fish were manipulated according to the basic mathematical formulae discussed and displayed in Lagler (1956), Ricker (1975) and Carlander (1977). These are discussed and compared with other data summaries (Allen and Aggus, 1981; Noble and Steinbach, 1981) as appropriate.

A limited amount of physicochemical and biological (macroinvertebrate) water quality data was collected in conjunction with fish collections. A Hach DR/EL-2 portable water quality laboratory was used to develop physicochemical data. Standard nets were used to sample macroinvertebrates.

Soils data discussed herein were taken directly from published soil surveys for Craighead and Greene counties, Arkansas (Robertson, 1969; Ferguson, 1979).

RESULTS

The length (60-178mm) - weight (4.7 - 155.9g) relationship as calculated using Le Crens (1951) proposal was Log W = 1.4 Log L - 1.37. The correlation coefficient 1.4 was significantly different from 3.0 ($a = .10$) indicating that weight did not increase as the cube of length. Figure 2 illustrates the trend in absolute (weight) increases (w2-w1) observed within the site by indicated year classes.

The coefficient of condition K(TL), was calculated for each bluegill from the expression K(TL) = W/L3 x 100. The K(TL) for individual fish varied from 1.96 to 3.34 with an average of 2.31 (Table 1). This average which exceeded the average reported by Trenary (1958) from Lake Fort Smith, Arkansas, would be rated "good" by Illinois standard (Bennett, 1948) and approaches "excellent" by Minnesota standards (Carlander, 1944). This average K(TL) (2.31) was similar to that found in other temperate waters reported by Carlander (1977), and was not significantly different from ponds in North Carolina, Tennessee or New Mexico.

Table 1. Average coefficient condition K(TL) for bluegill sunfish from Site #15, Big Creek Watershed, Craighead and Greene counties, Arkansas.

K(TL)

Yr.	Class	mK(TL)	# Fish
IV+	(1980)	2.96	2
III+	(1981)	2.79	8
II+	(1982)	2.42	30
I+	(1983)	2.20	74

Table 2. Average calculated total length (mm) of bluegill sunfish at the indicated annuli from Site #15, Big Creek Watershed, Craighead and Greene counties, Arkansas.

	Annulus Number			
YEAR CLASS	1	2	3	4
IV+ (1980)	103	137	160	173
III+ (1981)	74	115	143	---
II+ (1982)	61	105	--	---
I+ (1983)	34	--	--	---
Average	68	119	152	173
Number of Fish	74	30	8	2

The total length (L) - scale radius (S) relationship for Site #15 was $L = 9.51 + 46.92S$ with a correlation coefficient (r) of 0.96. The average calculated lengths at the time of annuli formation are displayed in Table 2. Comparison of lengths of age groups I - IV reveals a steady decline in length at comparable annuli during the period 1980 through 1983. Comparison of the length data shown in Table 2 with equivalent data from other Arkansas impoundments (Table 3) indicates that Site #15 bluegill grew in length like Lake Catherine and Lake Hamilton bluegill. Length gain at each annulus was significantly higher than Bull Shoals Lake and significantly lower than Lake Ouachita ($a = .10$).

DISCUSSION

Periodic major drawdown has been used effectively by fish and wildlife managers (Allen and Aggus, 1983) and usually depends on naturally or artifically increased hydrophyte growth for success in either wildlife or fisheries management (Dillon and Marriage, 1973; Grizzell, 1960; Hatcher, 1973).

Table 3. A comparison of total length (mm) at indicated annuli of bluegill sunfish from Site #15, Big Creek Watershed, Craighead and Greene counties, Arkansas, with other Arkansas studies. (* = significantly different at a = .10).

		Annulus Number			
	# Fish	1	2	3	4
Present - Site #15	114	68	119	152	173
Bull Shoals[1]	124	49*	84*	102*	122*
L. Catherine[2]	42	64	114	152	180
L. Hamilton[2]	45	76	117	155	175
L. Ouachita[2]	45	84*	147*	188*	206*

[1] Applegate, et al, 1967.

[2] Hulsey and Stevenson, 1958.

Within Site #15, soil fertility may be a limiting factor to effective drawdown for hydrophyte increases. The Callaway, Collins and Loring silt loam soils are not well suited to hydrophyte establishment. These soils are not only dominant in the upper watershed, but are also the chief constituents of substrates within the site. Water-borne sediments have also increased turbidity levels slightly (39 NTU) and may have contributed to slightly high total dissolved solids (540 mg/1), but water quality within the site is generally satisfactory for fish production (State of Arkansas, 1981). As a result, the average observed fish condition K(TL) is surprisingly good in Site #15 considering the lack of management.

Carlander (1977) noted that condition of bluegills increased after drawdown of Bear Camp Lake, Georgia, in a study by Pierce, et al. (1965). Cichra and Noble (1980) found that summer drawdown caused increases in clarity, alkalinity, hardness, and improved fish condition. Roland (1970) found that increased hardness increased the average condition of bluegills.

Following a partial drawdown (50%) of Site #15, average condition coefficient K(TL), improved initially but slowly declined as population size increased (Table 1). Schmittou (1968) noted that a higher population density resulted in a lower condition factor. Average condition improved for two years after 90 percent removal of an Oklahoma population (Jenkins, 1959). In Site #15, drawdown acted to concentrate the ichthyofauna along the dam where water remained. Under these conditions, natural mortality and predation were presumably greatly increased. Bluegill populations were reduced sufficiently to avoid the severe stunting which could be expected in an impoundment of this age and size without management.

The similarity of the results of drawdown, whether good management or mismanagement, is noteworthy. Cichra and Noble (1980) noted several positive effects of approximately 50 percent summer drawdown in six flood prevention lakes in central Texas. While not appreciably increased, growth and condition of bluegill in Site #15 were main-tained at a high level by a summer drawdown of greater than 50 percent. In the former case, drawdown was accompanied by hydrophyte establishment. In the latter case, hydrophyte establishment was very insignificant or substrates unsuited to hydrophytes, but fishery benefits accrued regardless. Drawdowns may provide a lost-cost fishery management technique for floodwater retarding structures not otherwise managed to support a fishery. Stable shallow reservoirs of the size (100 ac/40 ha) most often constructed in flood control projects can benefit greatly from extensive (> 50%) drawdowns, if properly timed (Allen and Aggus, 1983). Previous studies (Allen and Aggus, 1983) have pointed out that annual dewatering through summer months can lead to an unproductive littoral zone resulting in poor growth and survival of fish, particularly young-of-the-year. A five to six year drawdown frequency was suggested. Based on the observations on Site #15 presented herein, a three to five year drawdown cycle can produce significant low cost benefits to an unmanaged recreational fishery in flood control watershed lakes.

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