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COMPARISON OF GROWTH RATES OF GAME FISH IN LAKE CATHERINE, LAKE HAMILTON, AND LAKE OUACHITA, ARKANSAS

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Studies of the fishery resources of three lakes located in series on the Ouachita River in West Central Arkansas were conducted during the summers of 1955, 1956 and 1957. Lake Catherine, the lower lake, is a 3000-acre lake that was impounded in 1923 by the Arkansas Power and Light Company. Lake Hamilton, created just above Lake Catherine in 1931, by the same company, consists of 7200 acres. Lake Ouachita, which covers approximately 40,000 acres, was impounded in 1952 by the Corps of Engineers and is located just above Lake Hamilton.

The pattern of high original reservoir productivity followed by gradual decline (in terms of angling success and desirable fish production) has been evidenced in these lakes. Reports from residents and fishermen on Lake Catherine have indicated that fishing was excellent for the first few years following impoundment, but has declined in recent years. Many believe that the same course is true in Lake Hamilton. On the other hand, Lake Ouachita, since it has been constructed, has attracted hundreds of thousands of fishermen as a result of the angling success that can be had in this new lake.

The Arkansas Game and Fish Commission recognized that here was an unusual opportunity to study factors pertaining to fish production and fishing success in three lakes of widely different ages, all located in the same watershed. Therefore, in June, 1955, the Game and Fish Commission inaugurated a Dingell-Johnson Federal Aid To Sport Fish Restoration Project (F-5-R) which was a three-year comparative fisheries study of Lake Catherine, Lake Hamilton and Lake Ouachita. The objectives of this study were to investigate and compare fishing resources of these lakes of different ages and to make recommendations for management.

Since the growth rates of fish reflect the nature of the environment, one segment of this inves-

tigation consisted of a study of the age and growth of the important game species. This paper deals with data obtained from the analysis of scale samples collected during the summers of 1955, 1956 and 1957.

Methods

Scales were collected from fish during periods of rotenone population sampling and from fishermen's creels. Extensive population sampling with rotenone was conducted in all lakes every summer and, in order to obtain representative samples for each month, these periods were staggered for each lake during the three summers. The data obtained from the three summers' collections were combined so as to have composite age-growth characteristics of each species of fish from each lake for comparison.

Scale collections, taken over the three summers, were grouped together and analyzed as to year classes. Scales from each fish were soaked in water to soften and remove the dried mucous after which they were placed between glass slides and magnified 45 times by a standard scale reading microprojector for examination. During the first year of study, tabulations of the age versus the total length at the time of capture were made. Scales collected during the summers of 1956 and 1957 were further analyzed in that the length of the fish at the time of each annulus formation was determined. For comparative purposes, all calculated lengths were based on the assumption that the body-scale relationship is that of a straight line.

The term "age-group" refers to completed years of growth plus the period to time of capture. Approximately an equal number of scales were collected each month during June, July and August over the three-year period. Since these scales were grouped together, it appears possible to assume that the average lengths represent growth as of July for each age group. A young-of-the-year fish was placed in age-group 0, and fish with one annulus plus growth to the time of capture, in age-group 1, etc.

Comparison of Growth Rates

The average age at which a fish reaches a har-

vestable size is of significance in fisheries management. Another index that may be used is the average length at the end of a selected year of growth. Since the rate of growth per year is directly related to the available food and space, it should be possible to modify, or "thin," the population so that the game fish will reach harvestable size in a shorter period of time.

Table I gives a comparison of the total lengths of the different age groups of largemouth bass, Micropterus salmoides, spotted bass, Micropterus punctulatus, smallmouth bass, Micropterus dolomieu, and white bass, Lepibema chrysops, taken from the three lakes. No smallmouth bass scales were collected from Lake Catherine or Lake Hamilton, and white bass were absent from the Lake Ouachita collections.

Largemouth bass showed a more rapid rate of growth in Lake Ouachita during the first year than in the other lakes. Young-of-the-year fish, at the time of capture, averaged 3.5 inches, 4.0 inches and 5.9 inches, and fish in their second summers' growth averaged 7.4 inches, 8.5 inches and 10.3 inches in Lake Catherine, Lake Hamilton and Lake Ouachita, respectively. During the third summer (age-group 2) largemouth bass averaged 10.0 inches in Lake Catherine, 11.9 inches in Lake Hamilton and 12.5 inches in Lake Ouachita. Fish captured in their fourth summers' growth (age-group 3) averaged 12.4 inches, 13.6 inches and 15.3 inches respectively in the three lakes. There appeared to be a decrease in growth increment of this age group in Lake Hamilton. Those of age-group 4 in Lake Hamilton appeared to have grown quite rapidly during the preceeding growth period. However, scales from only three fish in this age group were analyzed. Largemouth bass in Lake Ouachita showed a steady rate of growth.

Spotted bass showed a slower rate of growth than largemouth bass in all lakes. Only a slight difference was noted among the fish in the three lakes in the first two summers. However, the growth increments were greater in Lake Ouachita. Age-group 2 showed an average length of 8.9 inches in Lake Catherine, 9.7 inches in Lake Hamilton and 10.9 inches in Lake Ouachita.

White bass grew faster than largemouth or spotted bass in Lake Catherine and Lake Hamilton, averaging 4.1 inches and 4.5 inches, respectively. During the second summer, white bass averaged 8.9

Age-Growth Comparison of Largemouth Bass, Spotted Bass, White Bass and Smallmouth Bass Collected from Lakes Catherine, Hamilton and Ouachita. (Average Time of Collection, July. Total Length in Inches. Number in Parentheses Indicate Number of Fish.) Years 1955 through 1957

Species	Age Group	LAKE CATHERINE			LAKE HAMILTON			LAKE OUACHITA		
			Average Total Length	Growth Increment		Average Total Length	Growth Increment		Average Total Length	Growth Increment
Largemouth Bass	0	(19)	3.5	3.5	(30)	4.0	4.0	(37)	5.9	5.9
	1	(54)	7.4	3.9	(61)	8.5	4.5	(86)	10.3	4.4
	2	(21)	10.0	2.6	(23)	11.9	3.4	(44)	12.5	2.2
	3	(11)	12.4	2.4	(10)	13.6	1.7	(13)	15.3	2.8
	4	----	----	---	(3)	20.9	7.3	(3)	18.0	2.7
	5	----	----	---	(8)	21.5	0.6	----	----	---
	6	----	----	---	(2)	22.0	0.5	----	----	---
Spotted Bass	0	(2)	3.5	3.5	(3)	3.5	3.5	(14)	3.7	3.7
	1	(10)	6.4	2.9	(14)	6.5	3.0	(25)	6.9	3.2
	2	(5)	8.9	2.5	(9)	9.7	3.2	(13)	10.9	4.0

(Continued)

TABLE I (Continued)

Species	Age Group	LAKE CATHERINE		LAKE HAMILTON		LAKE OUACHITA	
		Average Total Length	Growth Increment	Average Total Length	Growth Increment	Average Total Length	Growth Increment
White Bass	0	(3) 4.1	4.1	(5) 4.5	4.5	---- ----	---
	1	(18) 8.8	4.7	(9) 9.1	4.6	---- ----	---
	2	(13) 12.0	3.2	(2) 11.8	2.7	---- ----	---
	3	(8) 13.1	1.1	---- ----	---	---- ----	---
	4	(4) 14.5	1.4	---- ----	---	---- ----	---
Smallmouth Bass	0	---- ----	---	---- ----	---	---- ----	---
	1	---- ----	---	---- ----	---	(7) 7.4	---
	2	---- ----	---	---- ----	---	(9) 11.5	4.1
	3	---- ----	---	---- ----	---	(1) 12.5	1.0
	4	---- ----	---	---- ----	---	(5) 16.1	3.6

inches and 9.1 inches in the two respective lakes. During the third summer, age-group 2 showed 12.0 inches in Lake Catherine and 11.8 inches in Lake Hamilton. The greatest growth rate occurred during the first two summers.

No young-of-the-year smallmouth bass scales were collected from Lake Ouachita. Age-group 1 averaged 7.4 inches; age-group 2, 11.5 inches; age-group 3, 12.5 inches and age-group 4, 16.1 inches. The growth increment of age-group 3 was small, but this data is not considered significant since only one fish in this age group was collected.

Table II gives a comparison of the age and length of crappies collected in the three lakes. No white crappie, Pomoxis annularis, were captured in Lake Ouachita, and it is possible that some of the black crappie, Pomoxis nigromaculatus, scales recorded from fishermen's creels from Lake Catherine may have been white crappie.

White crappie showed little difference in rate of growth in Lake Catherine and Lake Hamilton with the exception of a slightly larger growth increment of those in Lake Hamilton between age-group 0 and 1. In age-group 2, the average length was 8.3 inches and 8.4 inches respectively. It appeared that white crappie in these lakes were not of practical harvest size until they reached their fourth summer (age-group 3). White crappie in age-group 3 were 9.7 inches in Lake Catherine and 9.2 inches in Lake Hamilton. In age-group 4, fish averaged 11.6 inches in both lakes.

Little difference was noted in the rate of growth of black crappie as compared with white crappie in Lakes Catherine and Hamilton. The lengths of black crappie in age-group 3 were 9.6 inches and 9.7 inches, respectively, as compared with white crappie of 9.7 inches and 9.2 inches of the same age-group. The growth increment between age-group 3 and age-group 4 was 1.3 inches in Lake Catherine and 1.1 inches in Lake Hamilton, which was smaller than other age-group increments and also smaller than growth increments of the same age-group of white crappie. The average total lengths of black crappie in age-group 4 were 10.9 inches and 10.8 inches in these two lakes, as compared with white crappie of 11.6 inches in the same age-group. Black crappie grew faster in Lake Ouachita than in the other lakes. Age-group 2 black crappie were 9.4 inches, with the greatest growth increment occurring between age-group 1 and age-group 2. Black crappie

TABLE II

Age-Length Comparison of Crappies Collected from Lakes Catherine, Hamilton and Ouachita. (Average Time of Collection, July. Total Lengths in Inches. Numbers in Parentheses Indicate Number of Fish.) Years 1955 through 1957

Species	Age Group	LAKE CATHERINE		LAKE HAMILTON		LAKE OUACHITA	
		Average Total Length	Growth Increment	Average Total Length	Growth Increment	Average Total Length	Growth Increment
White Crappie	0	(2) 3.3	3.3	(3) 3.2	3.2	----	---
	1	(9) 5.6	2.3	(5) 7.8	4.6	----	---
	2	(21) 8.3	2.7	(11) 8.4	0.6	----	---
	3	(10) 9.7	1.4	(4) 9.2	0.8	----	---
	4	(7) 11.6	1.9	(2) 11.6	2.4	----	---
Black Crappie	0	(1) 3.0	3.0	(7) 3.2	3.2	(13) 3.3	3.3
	1	(6) 5.7	2.7	(28) 5.9	2.7	(24) 5.7	2.4
	2	(4) 7.5	1.8	(18) 8.6	2.7	(33) 9.4	3.7
	3	(2) 9.6	2.1	(9) 9.7	1.1	(25) 10.7	1.3
	4	(5) 10.9	1.3	(8) 10.8	1.1	(19) 11.3	0.6

in this lake reached a harvestable size in their third summer, or one year earlier than those in the other lakes. Those in age-group 3 averaged 10.7 inches and in age-group 4, 11.3 inches.

Table III presents the growth rates of bluegill sunfish, Lepomis macrochirus, redear sunfish, Lepomis microlophus, and longear sunfish, Lepomis megalotis.

Age-group 1 of bluegill sunfish were of a harvestable size (5.0 inches) in Lake Hamilton, whereas, those of the same age-group were 4.1 inches in Lake Catherine and 4.3 inches in Lake Ouachita. However, bluegill in Lake Ouachita of age-group 2 were 7.1 inches, surpassing those in Lake Hamilton which averaged 6.0 inches and in Lake Catherine, 5.7 inches. The growth increment of bluegill in Lake Ouachita was high (2.8) between age-group 1 and 2 as compared with increments of 1.6 inches in Lake Catherine and 1.0 inches in Lake Hamilton. Bluegill in Lake Catherine and Lake Hamilton in general appeared to grow at about the same rate. Growth in Lake Ouachita was faster. A comparison of age-group 4 showed lengths of 7.3 inches in Lakes Catherine and Hamilton and 8.6 inches in Lake Ouachita.

Redear sunfish showed faster rates of growth than bluegills in all lakes. Age-group 1 were of usable size in Lake Hamilton (5.0 inches) and Lake Ouachita (5.8 inches). Age-group 1 redear (4.5 inches) in Lake Catherine were slightly small for harvesting. Age-group 2 showed continued growth in all lakes with the largest growth increment exhibited by those in Lake Ouachita. Age-group 2 averaged 6.8 inches in Lake Catherine, 7.0 inches in Lake Hamilton and 8.5 inches in Lake Ouachita. Age-group 3 showed the highest growth increment in Lake Hamilton. This age group averaged 8.2 inches, 10.1 inches and 10.6 inches in the three lakes respectively.

The number of scales obtained from longear sunfish was relatively small and significant conclusions cannot be made. It appears from the data, however, that they are not of usable size until their third summer (age-group 2). Age-group 2 showed lengths of 5.3 inches in Lake Catherine, 5.0 inches in Lake Hamilton and 6.5 inches in Lake Ouachita.

Table IV gives the calculated length at the end of indicated years of growth, as determined by the

TABLE III

Age-Length Comparison of Bluegill, Redear and Longear Sunfish Collected from Lakes Catherine, Hamilton and Ouachita. (Average Time of Collection, July. Total Lengths in Inches. Numbers in Parentheses Indicate Number of Fish.) Years 1955 Through 1957

Species	Age Group	LAKE CATHERINE			LAKE HAMILTON			LAKE OUACHITA		
			Average Total Length	Growth Increment		Average Total Length	Growth Increment		Average Total Length	Growth Increment
Bluegill Sunfish	0	(13)	2.4	2.4	(9)	2.9	2.9	(10)	3.2	3.2
	1	(22)	4.1	1.7	(24)	5.0	2.1	(26)	4.3	1.1
	2	(10)	5.7	1.6	(16)	6.0	1.0	(17)	7.1	2.8
	3	(18)	6.8	1.1	(6)	7.3	1.3	(17)	8.0	0.9
	4	(9)	7.3	0.5	(4)	7.3	0.0	(7)	8.6	0.6
	5	(4)	8.5	1.2	----	---	---	----	---	---
Redear Sunfish	0	(5)	2.2	2.2	(6)	2.4	2.4	----	---	---
	1	(16)	4.5	2.3	(13)	5.0	2.6	(3)	5.8	---
	2	(14)	6.8	2.3	(9)	7.0	2.0	(10)	8.5	2.7
	3	(11)	8.2	1.4	(3)	10.1	3.1	(10)	10.6	2.1
	4	(3)	8.3	0.1	(4)	10.0	---	----	---	---
Longear Sunfish	0	----	---	---	(3)	2.3	2.3	(4)	2.6	2.6
	1	(2)	3.1	---	(2)	3.8	1.5	(5)	3.7	1.1
	2	(2)	5.3	2.2	(2)	5.0	1.2	(6)	6.5	2.8
	3	----	---	---	(6)	5.6	0.6	(3)	6.8	0.3

direct proportion scale measurement method, for the six most important game fish found in the three lakes. Terminal lengths for any period were not as large as those obtained by direct measurement. Direct measurement values, however, were those from fish where the average time of collection was July for each age group. These calculated values represent a closer indication of length at the end of each growing season. The number of fish listed in the first column refers to the total number of fish aged by calculation. As previously stated, calculated lengths were not determined for the fish collected in the summer of 1955.

Largemouth bass show the same general trend as was observed from direct measurement of different age groups. Fish at the end of their third year showed a length of 14.3 inches in Lake Ouachita, 13.1 inches in Lake Hamilton and 10.3 inches in Lake Catherine. Growth of largemouth bass in Lake Hamilton indicated fairly even growth rates. Growth rates in Lake Ouachita appeared to drop below those in Lake Hamilton between the third and fourth years, which may indicate the relative population density of these particular age-groups in the two lakes.

Growth rates of spotted bass in the three lakes were approximately the same for the first year. The second year, fish showed a steady and greater growth in Lake Hamilton, averaging 9.1 inches. Length of spotted bass at the end of their second year averaged 7.0 inches in Lake Catherine and 8.0 inches in Lake Ouachita.

The number of scales collected from white bass in Lake Hamilton was small. From those analyzed, however, the first year's growth of 7.9 inches was greater than white bass (6.4 inches) in Lake Catherine. Growth rates in Lake Catherine showed a steady increase reaching 14.1 inches at the end of their fourth year.

White crappie grew more rapidly for the first two years in Lake Hamilton. Their calculated length at the end of three years was approximately the same in Lake Catherine (8.4 inches) and Lake Hamilton (8.3 inches).

Black crappie grew most rapidly in Lake Ouachita, followed by those in Lake Hamilton and Lake Catherine during their first three years. Calculated growth rates at the end of three years showed lengths of 7.9 inches in Lake Catherine, 8.5 inches in Lake Hamilton and 9.0 inches in Lake Ouachita. Lengths

TABLE IV

Comparison of Calculated Growth Rates. Total Length of Fish, in Inches, at End of Each Annulus Formation. Years 1956 and 1957 Only

Species	Lake	No. of Fish	Average Calculated Length				
			First Year	Second Year	Third Year	Fourth Year	Fifth Year
Largemouth Bass	Catherine	49	4.9	8.0	10.3	----	----
	Hamilton	75	5.9	9.9	13.1	17.6	20.7
	Ouachita	108	6.6	10.7	14.3	16.9	----
Spotted Bass	Catherine	13	4.8	7.0	----	----	----
	Hamilton	9	5.0	9.1	----	----	----
	Ouachita	14	4.9	8.0	----	----	----
White Bass	Catherine	32	6.4	10.1	12.9	14.1	----
	Hamilton	5	7.9	----	----	----	----
	Ouachita	---	---	----	----	----	----
White Crappie	Catherine	47	2.5	5.8	8.4	10.6	----
	Hamilton	20	3.5	6.4	8.3	----	----
	Ouachita	---	---	----	----	----	----
Black Crappie	Catherine	17	2.6	5.6	7.9	9.3	----
	Hamilton	62	3.1	6.2	8.5	9.3	----
	Ouachita	75	4.3	6.8	9.0	9.7	----
Bluegill Sunfish	Catherine	42	2.5	4.5	6.0	7.1	8.2
	Hamilton	45	3.0	4.6	6.1	6.9	----
	Ouachita	54	3.3	5.8	7.4	8.1	----

at the end of four years' growth showed a smaller increment for those in Lake Ouachita and the total lengths almost equal (9.3 inches, 9.3 inches and 9.7 inches).

Bluegill sunfish grew most rapidly in Lake Ouachita. The growth rates of bluegill sunfish were fairly uniform during the first four years in all lakes. However, growth increments of those in Lake Ouachita were the greatest. At the end of three years' growth, the average lengths were 6.0 inches in Lake Catherine, 6.1 inches in Lake Hamilton and 7.4 inches in Lake Ouachita. At the end of the fourth growing season, lengths were 7.1 inches, 6.9 inches and 8.1 inches in the three lakes respectively.

Summary and Conclusions

Composite age-growth studies were conducted on certain game fish collected from Lake Catherine, Lake Hamilton and Lake Ouachita during the summers over a three-year period. Evaluations were made on the basis of comparing the lengths of similar age-groups of each species from the three lakes. Total lengths in inches of fish at the time of collection were recorded and later the fish were placed in an age-group as determined by scale analysis. In addition, lengths of a number of fish for each year of life were calculated and these values recorded.

Largemouth bass in Lake Ouachita showed a steady and more rapid growth pattern than in the other lakes. At the end of their second year of growth, calculated lengths were 8.0 inches, Lake Catherine; 9.9 inches, Lake Hamilton; and 10.7 inches in Lake Ouachita.

Greatest calculated growth of spotted bass was exhibited in Lake Hamilton, with a length of 9.1 inches at the end of the second year, followed by those in Lake Ouachita with 8.0 inches and Lake Catherine with 7.0 inches.

Calculated lengths of white bass revealed more rapid growth at the end of the first year in Lake Hamilton (7.9 inches) as compared with Lake Catherine (6.4 inches). Measured lengths of white bass in their third summers' growth showed growth rates approximately the same (12.0 inches, Lake Catherine, and 11.8 inches, Lake Hamilton).

Measured lengths of smallmouth bass in Lake

Ouachita were 7.4 inches, 11.5 inches, 12.5 inches and 16.1 inches during the second, third, fourth and fifth summers' growth.

A correction factor needed to be used on calculated lengths of crappie. Values obtained, however, gave a comparison of growth rates in the three lakes. Measured lengths of white crappie revealed that harvestable size was not reached until the fourth summer. During the fourth summer, measurements of 9.7 inches in Lake Catherine and 9.2 inches in Lake Hamilton were obtained. Black crappie grew more rapidly in Lake Ouachita than in the other lakes. They were of harvestable size in Lake Ouachita (9.4 inches) during the third summer. Comparisons during the fourth summer revealed lengths of 9.6 inches, Lake Catherine; 9.7 inches, Lake Hamilton and 10.7 inches in Lake Ouachita.

Growth of bluegill sunfish was the most rapid in Lake Ouachita. Calculated lengths showed more consistent growth patterns than measured lengths. Calculated lengths indicated a harvestable size was reached in Lake Ouachita during their second summer. Those in the other lakes, however, were slightly undersize. At the end of the second year of life, calculated lengths were: 4.5 inches, Lake Catherine; 4.6 inches, Lake Hamilton and 5.8 inches in Lake Ouachita.

Measured lengths of redear sunfish indicated those in Lake Hamilton and Lake Ouachita were of harvestable size during the second summer (5.0 inches and 5.8 inches). Comparisons during the third summer showed lengths of 6.8 inches in Lake Catherine, 7.0 inches in Lake Hamilton and 8.5 inches in Lake Ouachita.

Measured lengths of a limited number of longear sunfish show the slowest growth in these of all fish checked. Harvestable size is not attained until the third summer. Measured lengths during the third summer were 5.3 inches, Lake Catherine; 5.0 inches, Lake Hamilton; and 6.5 inches in Lake Ouachita.

The data show that, generally speaking, the fish in the old lake (Lake Catherine) grew the slowest, and those in the newest lake (Lake Ouachita) exhibited the most repid growth.

The rate of growth of fish in these lakes was found to be in inverse relationship to the standing crop measured in total pounds per acre and more specifically to the total pounds of so-called "for-

age and rough" fish per acre. This indicates that the forage and rough fish, when too plentiful, compete with the sport species for food and space. In addition, the individual fish making up the bulk of the poundage of forage and rough fish found in Lake Catherine and Lake Hamilton were too large to be available as food for the predaceous sport species.

Since this age-growth study was a part of a larger investigation to determine why fishing was better in the newer lake and poorer in the older lakes, it stands to reason that management designed to increase the growth rate of the fish in the two older lakes would result in improved sport fishing. In this connection, a "selective fish thinning operation" was carried out in Lake Hamilton on October 31, 1957,(1) during which an estimated 650,000 pounds of fish were killed. Most of the fish killed were gizzard shad and drum.

The above paper deals only with length of fish versus age of fish and does not take into consideration the condition, or "plumpness," of the fish. Due to the limited nature of the study, data on plumpness was not recorded. Field observations indicate, however, that the fish in Lake Catherine were the poorest and those in Lake Ouachita the fattest.

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