An Eleven-Year Growth History of White Crappie in Grand Lake, Oklahoma[1]

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Grand Lake was impounded for hydroelectric power and flood control purposes in March, 1940, and by artificial lake standards may now (1953) be termed "old." This reservoir, located on the Grand River in northeastern Oklahoma, is bordered on the east by the rugged Ozark hills and on the west by tall grass prairie. At normal level (745 feet above sea level) it covers 46,000 acres and extends 60 miles upstream from the dam, with about 1,000 miles of shoreline, a maximum depth of 120 feet, and an approximate average depth of 30 feet. The water level, which normally fluctuates about 15 feet annually, reached an all-time low of 27 feet below power pool level in September, 1953.

The white crappie, *Pomoxis annularis*, is the most commonly sought game fish in Grand Lake, and angling success has been relatively good since impoundment. The present study attempts to establish the growth history of this important species from 1942—the third year of impoundment, through 1952—the thirteenth year of impoundment. The calculation of growth is based on a method developed by Weese (8) which eliminates discrepancies created by the existence of different scale length-body length relationships between the various age-groups.

Materials and Methods

This growth-history is based on 1,408 white crappie scale samples collected between 1948 and 1953. Dates of collection, method, and number of fish were as follows:

Dates of collection	Sampling method	Number of fish
June 1-26, 1948	gill nets	48
Aug. 12—Sept. 9, 1949	rotenone	186
Dec. 7, 1949—April 15, 1950	gill nets and angling	715
August 6-19, 1953	rotenone	459

Growth of the crappie collected in 1948 and 1949 has been previously reported by Thompson (6). Fish from these two years' collections were lumped into age-groups in his data, and growth calculated from a single regression line.

Total-lengths of the fish were measured in millimeters in the first three collections, and in tenths of inches in the 1953 collection. All lengths were

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converted to millimeters for growth calculations of the entire sample, and reconverted to inches for presentation in the tables and in Figure 2.

Three scales from each fish were placed between glass slides (water mount) and "read" on a standard micro-projection scale reading machine at a magnification of 45 diameters. The distance from the focus to each annulus and to the anterior edge of the scale was measured to the nearest millimeter.

Age determination was relatively easy, although some false annuli did occur irregularly and the annulus formed in the winter of 1948-49 was indistinct on many scales. Overlap in length between age-groups was not extensive, and the majority of the fish could be properly aged by examination of a plotted length-frequency diagram.

Growth Calculation

Calculated lengths were computed by averaging the scale measurements for each year of life and the lengths of the individuals employed as suggested by Van Oosten (7), which is an accurate and much shorter method than the customary one of computing lengths for each individual fish.

Fish from the entire sample were grouped into year-classes, and growth calculated by direct proportion with an assumed intercept of zero

TABLE I

*Eleven-year (1942-1952) Growth History of 1,408 Grand Lake White Crappie**

Year-class	Average calculated total-lengths at end of year of life, based on direct proportion method					
	1	2	3	4	5	6
1952	2.3 (386)					
1951	1.8 (48)	6.4 (48)				
1950	1.9 (23)	6.5 (23)	8.8 (23)			
1949	3.0 (26)	5.8 (1)	9.0 (1)	10.9 (1)		
1948	2.1 (221)	5.7 (81)	7.0 (1)	10.3 (1)	12.9 (1)	
1947	2.0 (253)	5.3 (225)	8.6 (197)			
1946	1.7 (398)	4.4 (398)	7.9 (392)	10.3 (383)		
1945	1.7 (39)	4.7 (39)	7.6 (39)	10.1 (33)	12.2 (32)	
1944	1.3 (11)	4.1 (11)	7.7 (11)	10.3 (11)	12.9 (5)	14.1 (5)
1943	1.8 (2)	3.9 (2)	7.9 (2)	10.8 (2)	12.2 (2)	
1942	1.1 (1)	3.7 (1)	8.2 (1)	10.8 (1)	13.4 (1)	14.6 (1)
Grand average calculated length	2.0	5.0	8.1	10.3	12.3	14.2
Grand average calculated annual increment of length	2.0	3.0	3.2	2.2	2.1	1.2
Number of fish	1,408	829	667	432	41	6

* Based on growth calculated by assuming a direct body-scale proportion. Data are combined for all age-groups, expressed as weighted average calculated total lengths attained at end of year of life by each year-class. Number of fish in parenthesis.

(Table I). Average total-lengths of fish at the end of the first two years of life calculated by this method were below actual lengths at capture. The average calculated total-lengths of 1,408 fish at the end of their first year of life was 2.0 inches. However, eight young-of-year collected August 25, 1949 averaged 3.1 inches, total-length; nine young-of-year collected January 15, 1950, 3.3 inches; and 150 young-of-year collected August 15, 1953, 2.3 inches.

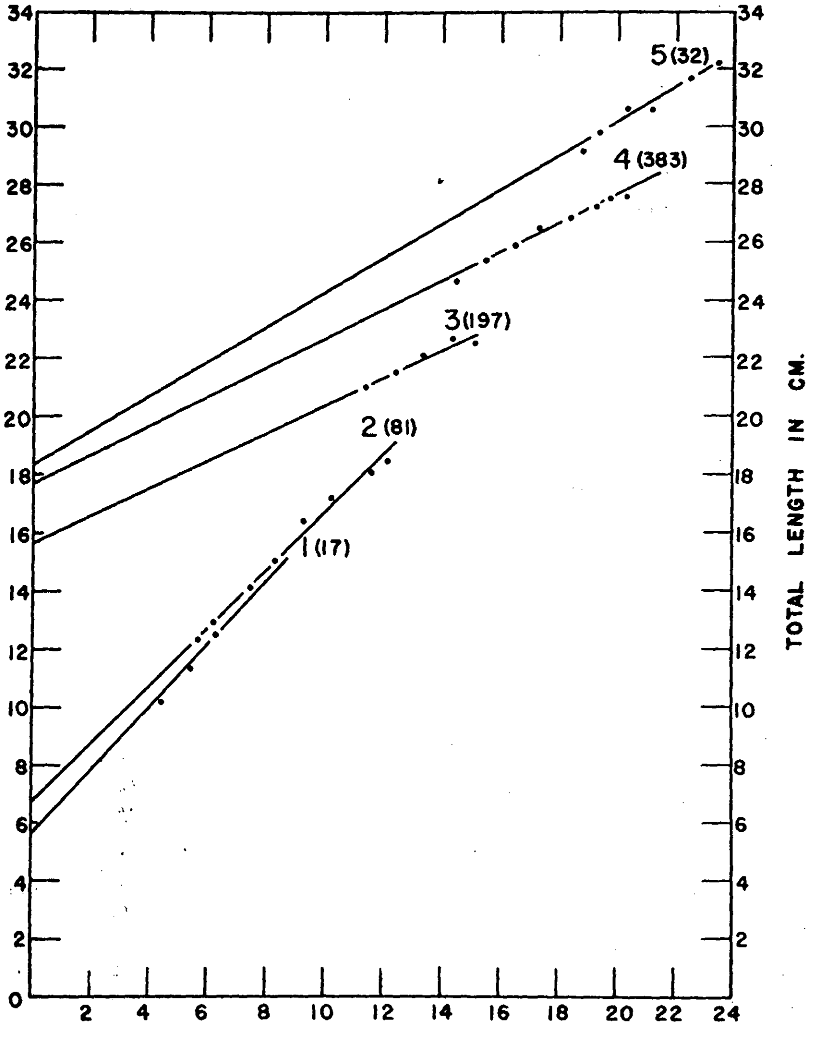

FIGURE 1. The Relation Between Scale Length and Body Length for Five Different Age-groups of Grand Lake White Crappie Collected Jan.-April, 1950. Numbers in parentheses indicate number of individuals represented in determining the respective regression lines. Straight lines are regression lines of body length on scale length. (10 mm. arrays).

To correct this error, the method employed by Weese (8) in calculating growth of Lake Texoma white bass was applied to the 1950 collection of 715 scale samples. All fish were collected between the time growth in length had ceased in 1949 and before annulus formation in the spring of 1950. (Scales of 29 crappie taken on May 8, representing age-groups I to IV, all possessed an annulus near the anterior edge. No annulus was visible on scales taken before April 15.) Fish were divided into age-classes and a regression line representing body length on scale length (10 mm. arrays) calculated for each class (Figure 1). The regression formulae for the respective age-classes are as follows:

General formula	$L = a + bS$
One-year-old fish	$L = 56 + 1.07S$
Two-year-old fish	$L = 67 + 0.99S$
Three-year-old fish	$L = 156 + 0.47S$
Four-year-old fish	$L = 177 + 0.49S$
Five-year-old fish	$L = 183 + 0.59S$

where L is the total-length in mm., S is the length of the anterior field of the scale in mm. (x45), a is the intercept in mm. on the ordinate axis, and b is the regression coefficient.

The intercept value increases and the slope of the regression line decreases with age. All of the fish were collected during a period when growth in length was not detectable. Calculated lengths derived by this method show much closer agreement to actual lengths of fish in the various age-groups than did the direct proportion method (Table II).

TABLE II

Comparison of Actual Lengths of Age-groups of Grand Lake White Crappie at Capture and Lengths Calculated by Direct Proportion and by the Weese Method. (1950 collection).

	Average length at end of year of life				
	1	2	3	4	5
Actual length of age-groups at capture	3.7	5.8	8.6	10.3	12.2
Grand average calculated length					
Weese method	3.5	5.8	8.6	10.4	12.4
Direct proportion method	1.9	4.9	8.1	10.3	12.3

Formulae derived by the Weese method for the various ages were applied to corresponding age-groups of the remaining collections. Growth calculations of six-year-old fish (6 individuals) were based on the regression line established for five-year-old fish. All fish were then placed in their proper year-classes (Table III) and a growth history diagram of the first three years of life drawn (Figure 2) depicting the results of both calculation methods. Growth during the fourth, fifth, and sixth years of life is omitted from the figure as there was no significant difference in lengths obtained by the two methods of calculation (Tables I, III).

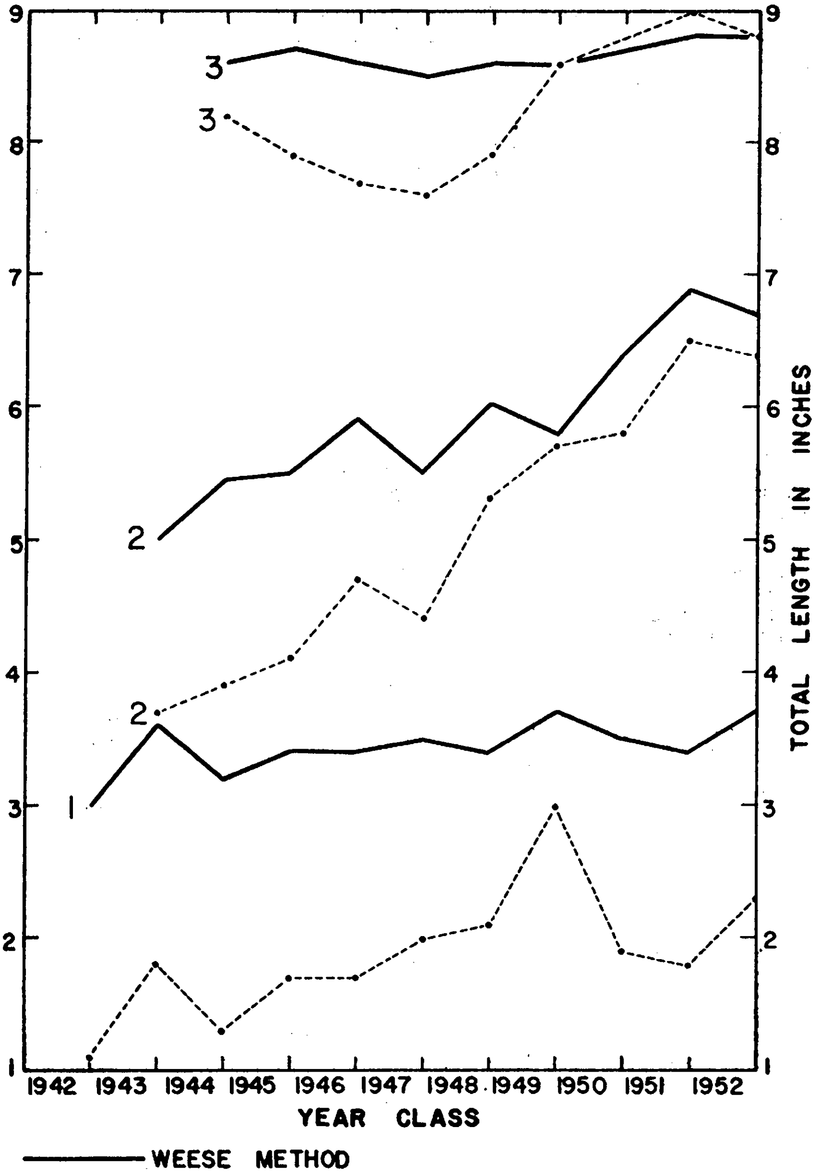

FIGURE 2. Elven-year Growth-history of Grand Lake White Crappie for the First Three Years of Life. Lines connect points representing lengths attained at ages indicated by numerals at left. Solid lines are based on calculations by the Weese method, broken lines on the direct proportion method.

TABLE III
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Discussion

An analysis of the growth history based on lengths calculated by direct proportion would indicate that growth during the first three years of life has steadily increased during the eleven-year period (Table I, Figure 2). The increase might be explained in terms of "Lee's phenomenon" which postulates an apparent decrease in the calculated growth for any given year of life of fish of successively older age-groups. Correction for the changing body-scale relationship by the application of separate age-group regression lines, however, virtually eliminates this tendency, except during the second year of life (Table III, Figure 2). On the basis of recent crappie growth studies in newly-impounded Tenkiller and Fort Gibson reservoirs it is probable that growth of the 1940 and 1941 year-classes was appreciably faster.

Increased second-year growth suggests that an over-populated condition may have existed for age-group-I fish in the earlier years of impoundment and that this situation is being gradually alleviated. Average annual increments of growth had assumed more normal proportions by 1952 (Table IV). The gradual increase in the second-year growth increment might also be explained by the occurrence of a parallel increase in mortality rate during that period, resulting in lessened intra-specific competition, or by an error inherent in the method of growth calculation.

Growth of Grand Lake white crappie is slightly lower than that exhibited in other large Oklahoma reservoirs (Table V). Most of the growth-rates stated, however, represent a period of accelerated growth typical of the first three years of impoundment, and are not directly comparable to growth in older lakes. Growth in Grand Lake and Lake Texoma (Texoma was five years old at time of collections) is very similar, with a slightly faster rate occurring in Grand Lake during the crucial fourth year of life. (Four-year-old fish comprised about 75 percent of the fisherman's take-home catch during the winter of 1949-50 at Grand Lake.) Differences in calculated lengths of the two Lake Texoma studies are due to collection methods and times of sampling (9).

TABLE IV

Comparison of Grand Average Calculated Annual Increment of Growth, 1942-1952, and Average Annual Increment, 1952.

	Average calculated annual increment of growth (inches) at end of year of life 1	2	3	4	5
Grand average 1942-52	3.5	2.3	2.8	1.7	1.9
Average for the year 1952	3.4	3.3	1.9	1.6	2.0

The marked similarity in rate of growth over the 11-year span in Grand Lake strongly suggests definite regularity in spawning success, and relative constancy in the availability of food, severity of competition, length of growing season, and rate of mortality, which has been little influenced by water-level fluctuations and angling pressure. The data do not indicate any cyclical trends in growth or population fluctuation. Effects of low water levels, high water levels, the introduction of white bass in 1948, and intensified commercial fishing, are not reflected in the growth of this sample of white crappie.

An unprecedented spawning failure or greatly increased angler's take might bring about an acceleration in rate of growth in future years, but there will probably be no serious declines. "The operation of certain natural biological controls acting to limit the density of the population in larger reservoirs" (4) is the premise on which this prediction is based.

TABLE V

Comparison of Growth of White Crappie in Grand Lake and in Other Oklahoma Reservoirs.

Reservoir	Authority	Average total-length in inches at end of year of life 1	2	3	4	5
Grand Lake	Jenkins, This study	3.5	5.8	8.6	10.3	12.3
Lake Texoma	Wilson (9)	3.8	5.6	7.3	8.9	10.0
	Sneed & Thompson (4)	3.6	5.9	9.3	10.0	12.5
Canton Reservoir*	Buck & Cross (1)	4.1	7.8	10.4		
Wister Reservoir*	Latta (3)	4.1	7.9	10.6	13.0	
Fort Gibson Reservoir*	Hall & Jenkins (2)	6.3	9.3	11.3		
Tenkiller Reservoir*	Hall & Jenkins (2)	5.0	11.0	12.4		

*Impounded three years or less.

New and improved methods of concentrating and harvesting crappie are needed and present the greatest challenge to fishery management. Winter angling success has been improved in recent years on Grand Lake by the installation and annual refurbishing of marked brush shelters, and the introduction of "crappie docks", where for a nominal fee, the fisherman may recline in a deck chair within a heated, floating boat house, and reel in his limit of 25 fish between sips of coffee. The total catch of white crappie could be increased many fold without detrimental effect to future fishing success, and greater angler take is accordingly encouraged.

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