An Estimate of the Fish Population in a Forty-five-year-old Oklahoma Pond[1, 2]

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Farm pond fish management has been of great importance to fishery biologists throughout the nation during the past two decades, and has received considerable attention in Oklahoma. The bass-bluegill combination advocated by Swingle (8) and others is the stocking policy most commonly employed because the resulting population tends to remain in "balance" for a longer period and produces greater numbers of desirable-sized fishes than do other species combinations. This brief study was undertaken to determine the population composition of a 2.15-acre pond which was built and stocked with bass, bluegill, warmouth, and white crappie forty-five years previously. Information concerning the standing crop (in pounds per acre) of ponds in the south-central region of the state was an additional aim.

DESCRIPTION

The pond, owned by Mr. Wirt Franklin, is located two miles north of Ardmore, (Township 4 South, Range 2 East, Section 18), in the Caddo Creek drainage, a tributary of the Washita River. It drains about 80 acres of pastureland, which was originally tall grass prairie underlain by Arbuckle limestone. Surrounded by tall willow and cottonwood trees, and adjacent to a post oak woodland, it was formerly a popular recreation area, and a street car transported swimmers and picnickers from the city of Ardmore to the site until its discontinuance in 1930. The earthfill dam was completed in 1909, and at present impounds 2.15 acres at spillway level, with an average depth of 3.5 feet, and a maximum depth of 9 feet. The pond was about 2 feet below spillway level at the time of sampling, which reduced the surface area to 1.7 acres. The bottom is mud and silt from 6 to 24 inches thick, covered with decaying fallen limbs and leaves, and dense growths of *Chara* occur in water less than 2 feet deep. Sparse stands of water willow grow around the water's edge.

The pond is divided into two sections connected by two channels about 30 feet wide, which creates an irregular shoreline approximately 900 yards in length. The north section comprises 1.35 acres, and the south section, 0.80 acres.

A thermocline was present from a depth of 5 feet to the bottom at the time of sampling. The water temperature was 85° F at the surface, 80° F at 4 feet, and 66° F at the bottom. Oxygen deficient waters existed below 5 feet, but less than 10 percent of the pond area exceeded this depth. The pH at the surface was 7.5 and a Secchi disc was visible at a depth of 14 inches.

MATERIALS AND METHODS

On 15 June, four seine hauls were made by the Fisheries Research Laboratory summer survey crew with a one-half-inch mesh seine, 100 feet long, and 8 feet deep. All fish captured were measured, marked by clipping the right ventral fin, and returned to the water (Table I). On 16 June, emulsifiable rotenone was sprayed on the north section of the pond in a concentration of 1.5 ppm., in an effort to kill about 75 percent of the total fish population. Stirring by an outboard motor and wind and wave action spread the poison over most of the south section, and the actual kill was probably nearer 90 percent. Complete pick-up of dead fishes was accomplished on the 16th, and on the following day. Each fish was measured to the nearest

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0.1 inch, and representative scale samples were taken from bluegill, *Lepomis macrochirus;* largemouth bass, *Micropterus salmoides;* warmouth, *Chaenobryttus coronarius;* and white crappie, *Pomoxis annularis.* The only other species present was *Gambusia affinis.*

Standard methods of scale analysis were used in determining calculated growth (Table II), and a nomograph used in computation, with an assumed intercept of zero. Population estimates (Table I) are based on the Peterson formula (4) and 95 percent confidence limits established by the method presented by Chapman (3).

BLUEGILL

Bluegills dominated the population, outnumbering the other species combined by more than 10 to 1. The estimate is $\hat{P} = \frac{(3{,}047)\ (227)}{112} =$ 6,176 ± 20.8 percent. Examination of the data (Table III) showed a much smaller percentage of recaptures (24 percent) of marked fish below 4.5 inches total length than in the larger fish (58 percent). This is attributable to the fact that the distressed fish dived into the matted *Chara* beds, and only the larger ones bloated sufficiently to break loose and float to the surface. Predation by turtles and crayfish was also a factor in reducing small fish recovery. Therefore, the data were regrouped according to two size classes: Group A — 0.9-4.4 inches; Group B — 4.5-8.1 inches. The two estimates are

$$\text{Group A}\quad \hat{P} = \frac{(987)\ (33)}{8} = 4{,}063 \pm 30\%$$

$$\text{Group B}\quad \hat{P} = \frac{(2060)\ (194)}{112} = 3{,}568 \pm 19\%$$

$$\text{Total}\quad 7{,}631 \pm 24.7\%$$

Using this total estimate, a length frequency histogram (Figure 1) showed an abnormal size distribution, with relatively few fish represented between 4 and 6 inches total length. Age and growth data (Table IV) indicated that this was within the length range of Age-Group I (3.1-5.3 inches), and that the dominant age-groups were III and II.

The length-weight relationship calculated from a sample of 58 bluegills (2.3-7.9 inch range) resulted in the equation log W = — 4.0750 + 2,9242, log L. The condition factors C(TL) for these fish ranged from 64 to 60, decreasing slightly with growth in length. The larger individuals were obviously in poor condition, as the body tapered sharply posteriorly into the caudal peduncle, creating a spindle-shaped appearance, rather than the rectangular shape of normal adult bluegills. Specimens 7 inches long weighed only 3.36 ounces as compared to 4.96 ounces in nearby Ardmore City Lake. Carlander and Moorman (2) found a C(TL) range of 56 to 77 over the same length range in Iowa ponds, increasing with an increase in fish length.

Based on calculated weight, there were about 315.8 pounds of bluegill per surface acre, 80 percent of which was represented by fish over 5 inches in length. There were an estimated 525 individuals per acre weighing over 0.2 pound, which is arbitrarily considered as the minimum desirable weight.

Growth in length had been relatively fast (Tables II, IV), especially during the first year of life, in spite of the poor weight condition. This is unusual in that rapid growth is normally associated with excellent condition. It is possible that a limited survival of the 1950, 1951, and 1952

year-classes resulted in accelerated first year growth, but that growth slowed as individual food demands became greater, and the maximum carrying capacity of the pond was neared. Age-group 1 fish were few in number, and had experienced slow first year growth, which might be attributed to competition and predation by the preceding three dominant year-classes, or that spawning was successful only in late summer in 1953. Young-of-the-year fish (1954 year-class), although present in relatively small numbers, had attained a length of 2.5 inches on 16 June. This year-class might conceivably have attained dominance following the expected heavy mortality of the 1951 and 1952 year-classes in their fourth winter. No fish older than four years were collected, and this evidently represents the maximum length of life in this habitat. Bennett (1) cites similar growth-rate, except during the first year of life, and longevity data for this species in his study of a heavily-fished two-acre lake in Illinois. He stated that fishing intensity was so great that most of the fish were caught before they reached the age of 3 years. However, angling pressure has been negligible in Franklin Pond in recent years, and there are no other known causes of unnatural mortality.

LARGEMOUTH BASS

The largemouth bass population was unsatisfactory in terms of numbers of legal-sized fish, reproductive success, and condition factor. Only 8 individuals over 10 inches in length were recovered, and 7 of these weighed less than 0.8 pound. One bass weighing approximately 5 pounds was picked up, but was 'spirited away' before scale samples could be taken.

Pre-rotenone seining yielded 39 fish between 5.0 and 6.8 inches, 22 of which were recovered (Table V). As these individuals all belonged to age-group I, a realistic estimate of the other age-groups is not available. The estimate in Table I is based on the assumption that recovery of all age-groups was proportionate to Age-Group I recovery, which tends to over-estimate the numbers of fish over 10 inches, and under-estimate Age-Group 0 abundance. However, a diligent search was made for young-of-the-year fish, and it is believed that spawning success or survival in 1954 was low.

An estimate of the total population, based on the foregoing premise, is $\hat{P} = \frac{(323)\ (39)}{22} = 573 \pm 13.6$ percent. Examination of length frequency data and 40 scale samples revealed no overlap between age-groups, and all fish which were collected were used in the summary of calculated lengths (Table VI). Bass in Franklin pond required nearly three complete growing seasons to reach 10 inches, which is well below the state average for ponds (Table II). Growth was average for the first year of life, but was sharply retarded thereafter, indicating a lack of available forage fishes, and severe competition from larger bluegills for other food materials. The age frequency distribution (Table VI) suggests an extremely high mortality rate, and only one fish collected was over three years old.

The length-weight relationship, determined from 42 fish, is described by the equation $\log W = -4.6500 + 3.1330 \log L$. The condition factor (TL) ranged from 37.3 to 43.1, averaging 40.2, which is below the state average. A 10-inch individual weighed 6.61 ounces in Franklin pond compared to the state average of 7.78 ounces. There was an estimated total of 13 legal-sized bass in the pond, weighing 12.3 lbs., or 5.7 lbs. per acre. The entire bass population comprised 10.2 percent of the estimated weight of all fish present. Bass-fishing was reported to have been extremely poor in past years, the only catches being of sub-legal size.

WARMOUTH

Fifty-five warmouth, including the single marked individual (Table I), were recovered following poisoning, but an accurate estimate of total numbers is not possible, as seining two months later produced young-of-the-year hatched subsequent to 16 June. However, it is believed that the major portion of the warmouth population was picked up following rotenoning.

Growth data (Table VII) indicated, 1) a maximum age of four years, 2) a weak 1953 year-class, and 3) fast growth during the first two years of life in comparison with Lake Onized warmouth (Table II), — characteristics also evident in the bluegill population. Apparently the two species responded similarly to environmental conditions in spite of the great difference in numerical abundance.

WHITE CRAPPIE

Fourteen white crappie were recovered from Franklin pond, including 9 yearlings, 4 two-year olds, and 1 marked four-year-old. No young-of-the-year were observed. Growth in length was very rapid (Table II), but the fish were in poor condition. C(TL) values averaged 41.7 as compared to a state average of 47.7 over the same length range, and the larger individuals were extremely thin. Bennett (1) recovered only 22 crappie from eight-year old, 2-acre Onized Lake, in Illinois, and attributes the low population to inter-specific competition, and not to fishing mortality. The present study substantiates this assumption, as anglers' catches had been of no consequence in the past decade. It is surprising that this species and warmouth maintained extremely small populations over a period of years without suffering extinction.

SEINING FOLLOWING POISONING

On 23 June, one week following poisoning, two one-half-inch mesh seine hauls yielded 5 bluegill ranging from 2.7 to 6.9 inches in length. Four seine hauls on 25 August, 70 days after rotenoning, produced 195 young-of-the-year bluegill, ranging from 0.7 to 2.1 inches, with an average of 1.3 inches, and two larger individuals, 5.3 and 7.3 inches, in length. Four young-of-the-year warmouth were also taken, averaging 1.8 inches. Therefore, some adult bluegill and warmouth survived and reproduced following the poisoning. On November 15, five months after treatment, the pond was stocked with 300 six-inch largemouth bass, and the development of the population is to be followed.

DISCUSSION

The preceding evidence demonstrates the complete dominance of bluegill over largemouth bass, warmouth, and white crappie in a forty-five year old pond which has received little fishing pressure in recent years. The standing crop of this 2.15 acre body of water was estimated as 357 pounds per acre, 88.5 percent of which was represented by bluegill. There were an estimated 8,273 individuals in the pond, of which 13 largemouth bass, 5 white crappie, 8 warmouth, and 1,130 bluegill were of desirable size.

All species except bass grew exceptionally fast during the first two years of life, suggesting that only the most rapidly growing individuals survived, due to severe food and space competition. The observed fast growth was accompanied by early mortality, and only one fish was past its fifth summer of life. All fish were in poor condition, a phenomenon not generally associated with fast growth in length. A normal decrease in condition during the summer months, and a water level drawdown of two feet are not considered to be factors of enough magnitude to have effected the uniformly emaciated, deformed body shape of the entire population.

The estimated standing crop of 357 pounds per acre at spillway level is somewhat below that found in other states. Bennett (1) states an

average of 446.5 pounds per acre for 21 small Illinois lakes. Swingle (7) found carrying capacities of from 137 to 522 pounds per acre in Alabama ponds with a similar species composition. However, if the standing crop of Franklin pond is computed on the basis of the total surface area at the time of sampling, — 1.7 acres, — the weight per acre is 450 pounds, which is very close to the Illinois average.

Although data from other ponds are lacking and badly needed, the present study indicates that a stocking combination of bluegill, bass, warmouth, and white crappie in Oklahoma ponds where no further management is attempted will become completely dominated by bluegills, and poor fishing will result. Some method of controlling the bluegill population must be devised if bass fishing is to be maintained beyond the initial years of impoundment.

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TABLE I.

Number of fishes marked and recovered, and estimated number and weight of fishes in 2.15-acre Franklin pond, 15-17 June, 1954.

	NUMBER OF FISH				WEIGHT IN POUNDS		
	15 June	16-17 June	16-17 June		16-17 June		
SPECIES	Marked	Returns	Re-covered	Esti-mated	Re-covered	Esti-mated	Estimated lbs/acre
Bluegill	227	112	3,047	7,631	362.0	679.0	315.8
Largemouth bass	39	22	323	573	48.0	78.0	36.3
Warmouth	1	1	55	55?	6.6	6.6?	3.1?
White crappie	1	1	14	14	3.8	3.8	1.8
	Totals		3,439	8,273	420.4	767.4	357.0

TABLE II.

Calculated growth of fishes in Franklin pond, 16 June 1954, compared with the Oklahoma average (5; 4) or Onized Lake, Illinois (1).

SPECIES	LOCATION	No. of fish	Calculated length in inches at end of year			
			1	2	3	4
Bluegill	Franklin Pond	50	4.2	5.9	6.6	7.5
	Onized Lake 1938 (1)	53	1.4	5.2	6.6	7.4
Largemouth bass	Franklin Pond	277	5.3	8.1	10.7	
	Oklahoma pond average (5)	—	5.2	9.2	12.0	
Warmouth	Franklin Pond	42	3.0	4.8	6.2	7.5
	Onized Lake 1941 (1)	101	1.4	4.0	6.1	
White crappie	Franklin Pond	14	5.6	9.0	10.2	11.6
	Oklahoma pond average (4)	—	2.8	5.7	7.9	10.1

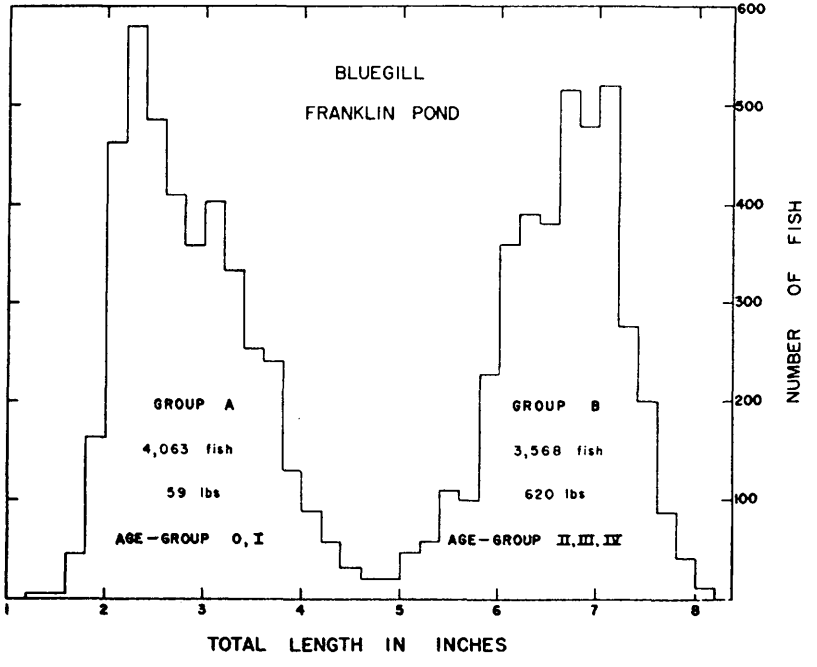

FIGURE 1. Length-frequency histogram of the estimated population of bluegill in 2.15-acre Franklin pond, 16 June, 1954. Fish are grouped in 0.2 inch length intervals.

TABLE III.

Number of bluegill marked, and number of marked and unmarked individuals recovered and measured from Franklin pond 15-17 June, 1954, grouped in one-inch length intervals.

Total length range	Number marked 15 June	Number recovered 16-17 June	
		Marked	Unmarked
0.0-0.9	0	0	2
1.0-1.9	0	0	53
2.0-2.9	16	0	554
3.0-3.9	11	4	327
4.0-4.4	6	4	41
4.5-4.9	0	0	24
5.0-5.9	25	14	276
6.0-6.9	109	57	1,083
7.0-7.9	59	33	570
8.0-8.9	1	0	5
Totals	227	112	2,935

TABLE IV.

Summary of average calculated lengths of bluegill in Franklin Pond, 16 June 1954.

Year Class	Age Group	No. of Fish	Av. T. L. (inches)	Length Range (inches)	Average calculated total lengths in inches at end of year			
					1	2	3	4
1954	0	8	2.5	2.1-2.7				
1953	I	10	4.2	3.1-5.3	2.5			
1952	II	20	6.3	5.7-7.0	4.6	5.9		
1951	III	19	6.9	6.4-7.5	4.6	5.8	6.6	
1950	IV	1	7.8	-	4.1	6.0	6.7	7.5
Average					4.2	5.9	6.6	7.5
Number of fish					50	40	20	1

TABLE V.

Number of largemouth bass marked, and number of marked and unmarked individuals recovered from Franklin pond 15-17 June, 1954, grouped in 2-inch length intervals.

Total length range	Number marked 15 June	Number recovered 16-17 June	
		Marked	Unmarked
1.0-2.9	0	0	45
3.0-4.9	0	0	2
5.0-6.9	29	22	186
7.0-8.9	0	0	44
9.0-10.9	0	0	40
11.0-12.9	0	0	5
Total	39	22	322
Percent recovery — 56.4			

TABLE VI.

Summary of average calculated lengths of largemouth bass in Franklin Pond, 16 June 1954.

Year Class	Age Group	No. of Fish	Av. T.L. (inches)	Av. Wt. (lbs.)	Length Range (inches)	Average calculated total lengths in inches at end of year		
						1	2	3
1954	0	45	1.6	—	1.2-2.5			
1953	I	204	6.0	0.08	4.6-7.8	5.5		
1952	II	66	9.1	0.31	8.2-10.0	4.6	8.0	
1951	III	7	11.3	0.61	10.6-12.3	5.3	9.1	10.7
Average						5.3	8.1	10.7
Number of fish						277	73	7

TABLE VII.

Summary of average calculated lengths of warmouth in Franklin pond, 16 June, 1954.

Year Class	Age Group	No. of Fish	Av. T.L. (inches)	Av. Wt. (Gms.)	Length Range (inches)	Average calculated total lengths in inches at end of year			
						1	2	3	4
1954	0	13	2.5	4	2.0-2.9				
1953	I	7	3.3	12	3.0-3.8	2.3			
1952	II	13	4.3	28	4.1-4.8	3.1	3.9		
1951	III	14	6.2	85	5.5-6.7	3.3	5.0	5.8	
1950	IV	8	7.8	161	7.6-7.9	3.1	5.7	6.9	7.5
Average						3.0	4.8	6.2	7.5
Number of fish						42	35	22	8