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THE EFFECT OF BLACK BULLHEAD CATFISH AND BLUEGILL REMOVALS ON THE FISH POPULATION OF A SMALL LAKE

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ALFRED HOUSER AND BOB GRINSTEAD
Oklahoma Fishery Research Laboratory

ABSTRACT

The effect of removing various amounts of bluegill and black bullhead catfish from a small lake on the remaining fishes were studied. Estimates of population size by mark and recapture, numbers of desirable size fish, condition indexes and age and growth rates reveal some improvement in certain species but it was concluded that removals alone may not always produce greatly improved fish populations.

INTRODUCTION

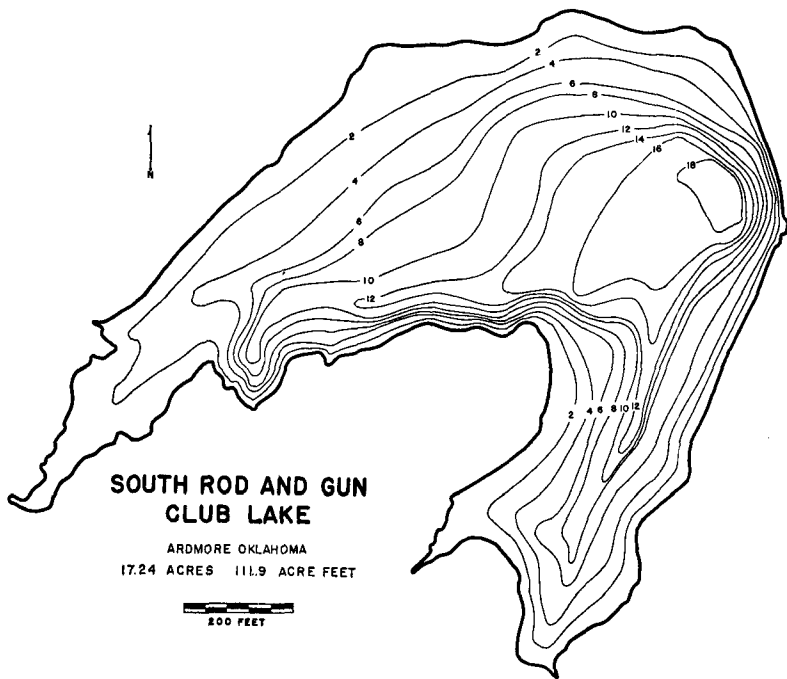
An attempt was made to determine the effects of removing various amounts of fish upon the remaining population of a small lake in southern Oklahoma.

The reduction of overcrowded populations in small lakes and ponds has previously been demonstrated to be beneficial for improving growth rates and proposed as a means for restoring a better balance between desirable and less desirable species.

The Ardmore Rod and Gun Club South Lake was treated with rotenone in 1955 to reduce the excessive populations of gizzard shad and carp. A partial-kill treatment eradicated both species. Population statistics on that date were reported by Jenkins in 1955 in a study of the effect of gizzard shad on the population. From that date through 1960 continued studies have been conducted for the purpose of observing further population changes.

During the summer study of 1958 it became evident that large populations of black bullhead catfish (*Ictalurus melas*) and bluegill (*Lepomis macrochirus*) had developed. Since neither species was considered desirable and few were ever harvested by the club members, it was agreed that both would be removed during subsequent studies. Mark and recapture estimates of population size were conducted in 1958, 1959 and 1960 when various amounts of both species were removed.

Ardmore Rod and Gun Club South Lake was constructed in 1896 for recreational purposes. It has an area of 17.24 acres and a capacity of 111.9 acre feet when full. It has a maximum depth of 18 feet (Figure 1). Cattails and bulrush surround the lake in shallow water. *Ceratophyllum demersum* and *chara sp.* occur in dense growth to a depth of 8 feet. The water is clear and the lake has a smooth mud bottom.



METHODS

Double funnel cylindrical nylon traps 3 feet in diameter, 6 feet in length with five steel hoops and covered with $\frac{5}{8}$ inch mesh, square measure, webbing were used to capture fish for population studies. All fish were measured, weighed and marked by fin clipping before release.

Estimates of population size for fish released were calculated by maximum likelihood method (Schnabel 1938) and estimates for those removed were calculated by linear regression based upon decreasing catch per unit of effort according to DeLury 1951.

The number of days spent in each period of trapping varied from 9 to 25 and the number of trap lifts varied from 131 during the summer of 1958 to 655 in the winter of 1960. In all estimates, except the last, efforts to randomize the sampling were made by constantly moving traps and scattering fish as they were released. In the concluding estimate a random trap station selection technique employing 74 100-foot square grid was used in conjunction with a table of random numbers to determine daily trap locations in the manner described by Cooper and Latta in 1954.

RATE OF REMOVAL

When, in 1958, it became evident that black bullhead catfish and bluegill comprised a major part of the standing crop of the lake an opportunity was presented which would permit a study of the effects of removing large portions of the standing crop upon the remaining population. During the following winter, the summers of 1959 and 1960 and in the winter of 1960, bullheads were removed (Table I). Bluegill were removed during the summer and winter of 1960. The largest amount removed for a single species was in 1958 when 42 pounds per acre of bullheads were taken out of the lake. In the winter of 1960 the largest combined removal rate was reached when 50 pounds per acre were removed.

FISH POPULATION ESTIMATES

The mean estimate of 55,965 for the numbers of individuals in the total lake population in the summer of 1958 was remarkably near the estimate of 53,583 obtained in the 1960 winter estimate. Although

TABLE I.
 RATES OF REMOVAL FOR BLUEGILL AND BLACK BULLHEAD CATFISH.

	Bluegill			Black Bullhead			Total Pounds per acre	
	Number of Fish	Pounds	Percent of p	Pounds per acre	Number of Fish	Pounds		Percent of p
1958 W	.....	....	....	..	3256	720	96.4	42
1959 S	.....	....	....	..	180	125	...	7
1960 S	3842	364	31.0	21	391	304	51.0	18
1960 W	9556	470	84.5	27	588	402	95.2	23

some of the intervening estimates exhibited rather wide variations (Table 2), the fluctuations cannot be wholly attributed to the removals. The influence of undetermined sampling error originating from too few days of trapping, gear selectivity and possibly homing behavior is recognized, however these data would not permit precise determination of their magnitudes. Since all of the estimates except the last were conducted in the same manner, population trends which were evident should be reliable.

TABLE 2.
FISH POPULATION ESTIMATES FOR ARDMORE ROD AND GUN CLUB
SOUTH LAKE THROUGH THE YEARS 1958 - 1960.

Species	Number Marked	Number Recap	Population Estimates 95% confidence limits			Total Weight Pounds
			Lower	Mean	Upper	
<i>1958 Summer</i>						
Largemouth bass	55	5	155	306	11,111	151
White crappie	1,130	18	23,636	33,546	57,787	2,717
Redear	275	13	2,835	3,005	3,197	637
Warmouth	18	3	27	68		22
Bluegill	1,722	100	15,181	18,460	23,546	2,621
Black bullhead	245	75	468	580	775	230
Totals	3,445	214	45,302	55,965	96,416+	6,379
<i>1958 Winter</i>						
Largemouth bass	156	26	371	522	883	108
White crappie	347	42	1,394	1,830	2,662	256
Redear	528	37	2,917	3,896	5,861	645
Warmouth	104	21	207	296	526	53
Bluegill	2,079	75	19,171	25,171	34,171	3,738
Black bullhead				3,220		747
Totals	3,214	201	24,788	35,036	44,059+	5,537
<i>1959 Summer</i>						
Largemouth bass	67	8	150	275	1,650	58
White crappie	539	5	12,500	25,550		2,437
Redear	564	72	1,808	2,307	3,194	268
Warmouth	72	4	278	605		61
Bluegill	2,032	263	7,092	8,143	9,523	822
Black bullhead				180		125
Totals	3,274	352	21,828	37,060	14,367+	3,371
<i>1960 Summer</i>						
Largemouth bass	73	5	287	560	12,500	179
White crappie	172	2	2,214	7,911		846
Redear	1,492	201	5,788	6,681	7,900	601
Warmouth	109	6	548	1,027	8,253	82
Bluegill			8,642	12,347	30,947	1,173
Black bullhead			561	766	1,538	595
Totals	1,846	214	18,040	28,292	62,138+	3,476
<i>1960 Winter</i>						
Largemouth bass	36	16	37	56	120	8
White crappie	273	10	2,174	3,608	10,946	416
Redear	3,028	116	32,050	38,375	47,813	2,504
Warmouth	170	6	1,235	2,296	17,068	258
Bluegill			7,484	8,688	10,922	556
Black bullhead			515	560	627	470
Totals	3,507	148	43,495	53,583	87,496	4,211

The greatest numbers and weight of the total population existed in the summer of 1958. In the winter of that year the population numbers decreased sharply while the weight decreased considerably. Since no fish had been removed before this date the reduction could only be attributed to natural mortality and angling. Population numbers alternately increased and decreased in later estimates but the weight continued to drop until the winter of 1960. At the end of the period the total population numbered approximately the same as it had in the

beginning but the weight, which had begun to increase by this time, was still one-third less than it had been originally.

With very few exceptions, all fish were measured during each estimate. Length and weight frequencies were used to separate each species into populations of small and desirable or harvestable size fish according to those values presented by Swingle 1950 (Tables 3,4). The A_t value, (the percent of the population which is harvestable size), was 41 in the summer of 1958. It increased to 63 by that winter but dropped sharply after the first removal. Only a few fish were removed in 1959 and the A_t value increased to 55 in the summer of 1960. At that time 668 pounds of bluegill and bullheads were removed. In the winter of 1960 the A_t value had decreased to 35.

CONDITION INDEX

The condition index $C(TL)$ expressed as the ratio of the weight in pounds times 10^6 to the length in inches cubed was calculated for each half-inch interval and averaged for identical length ranges of each species for each period (Table 5). Both largemouth bass and bluegill exhibited decreasing indexes. There was no change in redear except during the summer of 1960 when that decrease was attributed to spawning. White crappie, warmouth and black bullheads showed increases which could be attributed to environmental improvement resulting from the removals.

AGE AND GROWTH

Scales have been collected from fish of Rod and Gun Club South Lake every year since 1955. Samples were chosen from these collections and read to determine ages and rates of growth for all species. The growth history was determined for a period extending from several years previous to any removal through 1960 (Table 6). Growth rates for largemouth bass were determined for a small sample since only limited numbers were available. The growth rate for this species was decreasing.

White crappie growth decreased sharply when removals began and no improvement has since been observed through the winter of 1960.

Redear sunfish had experienced a decrease in rate of growth by the summer of 1958. First year growth increased but older fish grew slower throughout the removal period. Warmouth had been growing slow until removals began but the rate increased steadily since that time.

TABLE 3.
ESTIMATED TOTAL POPULATION NUMBERS OF SMALL (S) AND OF
DESIRABLE (D) SIZE FISH.

		1958		1959	1960	
		Summer	Winter	Summer	Summer	Winter
Largemouth bass	S	170	492	245	396	52
	D	136	30	30	164	4
White crappie	S	33,546	1,733	25,315	6,689	3,354
	D	...	97	235	222	244
Redear	S	2,811	2,122	1,262	3,993	34,752
	D	194	1,874	1,045	2,688	3,623
Warmouth	S	...	128	259	658	1,386
	D	68	169	346	369	910
Total small fish		36,527	4,475	27,081	11,736	39,544
Total desirable size		389	2,170	1,656	3,443	4,781
Total desirable and small		36,925	6,645	28,737	15,179	44,325
Bluegill	S	5,980	10,842	2,842	7,270	7,416
	D	12,480	14,329	5,301	5,077	1,272
Black bullhead	S	405	2,794	5	8	22
	D	175	426	175	758	566
Total all small fish		43,912	18,111	30,028	19,014	46,982
Total all desirable size		13,053	16,925	7,032	9,278	6,619
Total all fish		56,965	35,036	37,060	28,292	53,601

Bluegill growth rates generally declined since 1958.

Black bullheads show mixed growth rates. First year growth declined sharply in 1958 but gained very slowly thereafter. During 1959 two and three-year-old fish grew slower but older fish grew faster. In

TABLE 4.
ESTIMATED TOTAL POPULATION WEIGHT OF SMALL (S) AND OF
DESIRABLE (D) SIZE FISH.

		1958		1959		1960	
		Summer	Winter	Summer	Summer	Winter	Winter
Largemouth bass	S	28	86	36	73	6	
	D	123	22	22	106	2	
White crappie	S	2,717	232	2,405	783	342	
	D		24	56	63	73	
Redear	S	444	153	88	260	1,946	
	D	43	482	180	341	558	
Warmouth	S		9	18	39	64	
	D	22	44	43	43	194	
Total small fish		3,189	480	2,547	1,155	2,358	
Total desirable fish		188	572	301	553	827	
Total desirable and small		3,377	1,052	2,848	1,708	3,185	
Bluegill	S	395	1,030	207	407	378	
	D	2,221	2,708	615	766	178	
Black bullhead	S	63	542	1	1	3	
	D	167	205	124	594	467	
Total all small fish		3,647	2,052	2,755	1,563	2,739	
Total all desirable size		2,576	3,485	1,040	1,913	1,472	
Total all fish		6,223	5,537	3,795	3,476	4,211	

TABLE 5.
COMPARISON OF AVERAGE CONDITION INDEX FOR THREE PERIODS DURING THE
PERIOD OF BLUEGILL AND BULLHEAD REMOVAL OPERATIONS.

	Length ranges Compared	1958	1960	1960
		Winter	Summer	Winter
Largemouth bass	6.0-11.0	43	44	42
White crappie	7.5- 8.5	43	41	46
Redear	4.5- 5.5	66	62	66
Warmouth	4.5- 8.0	77	63	79
Bluegill	3.0- 8.5	67	64	59
Black bullhead	6.5-12.0	47	50	50

1960 two and three-year-old fish growth rates declined sharply. In 1960 fish older than three years had apparently been eliminated.

DISCUSSION AND CONCLUSION

When the removal of black bullhead catfish and bluegill from this small lake began it was anticipated that a general improvement of growth rates, condition index and increased numbers of desirable size fish would be experienced. Removal rates as high as 42 pounds per acre failed to produce any immediate or exceptional improvements. For some species, the results were actually detrimental. The standing crop in both numbers and pounds for the lake had actually decreased. The numbers of small fish increased while their weight decreased. Both numbers and weight of desirable size fish decreased. Considering the remaining populations, aside from bluegill and black bullhead catfish, the numbers of small fish increased slightly and there was a significant decrease in weight. Although the numbers and weight of these desirable size fish improved considerably, there were still too few to perceptibly improve the quality of fishing.

There is little doubt that the largemouth bass population was inadequately sampled to obtain good estimates, as evidenced by the broad confidence limits, but it does appear obvious that there were no laudable gains either in numbers or size of fish during the course of the study.

While there were wide fluctuations in the estimates of white crappie population size there is sufficient evidence to conclude, there was little benefit to this species as a result of removal. No reproduction was seen after 1958. The standing crop in both numbers and pounds decreased considerably, the numbers of desirable fish was not greatly improved and

TABLE 6.
GROWTH HISTORY OF FISHES FROM ROD AND GUN CLUB SOUTH LAKE.

Species	Year Class	Number of Fish	Average Calculated Total Length at the end of each year of life						
			1	2	3	4	5	6	
Largemouth bass	1960	8	4.8						
	1959	9	6.6	8.7					
	1958	3	6.9						
	1957								
	1956	2	6.1	10.7	12.7				
	1955	5	7.7						
	Average			6.3	9.0	12.7			
White crappie	1958	22	2.8	5.8	6.5				
	1957	51	3.3	6.4	6.3				
	1956								
	1955	8	3.7	9.5					
	1954	1	2.2	10.1	11.8				
	1953	1	3.0	7.0	10.7				
	Average		3.2	6.6	6.5				
Redear sunfish	1960	4	3.9						
	1959	11	3.7	4.5					
	1958	59	3.6	5.0	5.2				
	1957	5	3.2	5.8					
	1956	2	4.2	5.6	6.6				
	1955	10	5.5	7.1	7.0	7.6			
	Average		3.8	5.2	5.8	7.6			
Warmouth	1960	10	3.7						
	1959	6	2.8	5.1					
	1958	13	2.6	5.3	6.4				
	1957	9	2.1	4.9					
	1956	3	5.0						
	1955	11	4.0	6.1					
	Average		3.2	5.4	6.4				
Bluegill	1960	3	3.4						
	1959	33	3.6	4.7					
	1958	71	4.0	5.3	6.2				
	1957	57	4.7	6.3					
	1956	19	4.5	6.1	7.6				
	1955	31	2.5	6.5					
	1954	1	2.5	7.6					
	Average		3.9	5.8	7.3				
Black bullhead	1960	3	3.6						
	1959	3	3.2	5.3					
	1958	7	2.8	5.7	6.8				
	1957	42	4.0	8.5	10.3				
	1956	3	3.7	7.9	12.0	13.8			
	1955	20	6.0	7.5	10.0	11.9	14.1		
	1954	10	4.5	8.7	10.0	11.8	13.4		
	1953	10	3.7	7.7	9.8	11.9	12.4	14.4	
	1952	1	4.0	7.6	8.9	9.9	11.8		
	Average		4.3	8.0	9.6	11.9	12.9	14.4	

growth rates continued to drop. The only real benefit appears to be in a slightly improved condition index.

Redear sunfish was the only species which made truly important gains during the removal period. Growth rates improved for young fish but no change was seen in the condition index. Reproduction was high in all three years and the total population increased sharply both in numbers and weight. Small fish had become conspicuously more numerous and desirable sizes were also more common at the close of the study.

Warmouth increased in number, grew faster, exhibited a higher condition index and produced more desirable size fish, however the population continued to remain too small to noticeably improve angling.

The black bullhead demonstrated a remarkable ability to recover from losses due to removals. Although 3827 fish that weighed 1149 pounds had been removed prior to the last estimate, and as much as 96 percent of the estimated population had been removed in the winter of 1958, the population numbers remained almost unchanged from that of 1958 when the 1960 winter estimate was made. The winter estimate in 1960 indicated 8688 bluegill in the lake. This amount was almost identical to that remaining in the summer estimate after the removal but the population weight had decreased by 253 pounds. Declining growth rates and condition index, increased numbers of small fish and fewer of desirable sizes indicate that bluegill have been most seriously affected by the removals.

Both good and bad effects have been demonstrated when bluegill and black bullhead catfish were removed to the extent of 42 pounds per acre and the total standing crop was reduced by as much as 19 percent. While there appears to be a definite trend toward some improvement in the redear and warmouth populations, largemouth bass and white crappie exhibited more detrimental than beneficial effects. Although redear and warmouth populations did improve, the net effect within the space of three years failed to materially improve fishing. Apparently the removal of large amounts of less desirable fish did not, in itself, provide sufficient environmental improvement to stimulate greater production of either the largemouth bass or white crappie. Other factors, such as the abundance of aquatic plants as well as the fertility of the water, probably assert equally important influences on the environmental conditions which provide for greater production of these species. In order to achieve favorable results, it would seem wise to employ additional measures which may include one or all of weed control, fertilization and corrective stocking. At any rate it can be said that the reduction of populations of less desirable species of fish in ponds and small lakes by trapping will not immediately produce greatly improved populations of the more desirable species.

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TOXAPHENE AS A FISH ERADICANT IN FLORIDA

MELVIN T. HUISSH

*Florida Game and Fresh Water Fish Commission
Leesburg, Florida*

ABSTRACT

Experiments to determine concentrations of toxaphene lethal to fishes in a variety of lake types and to discern selective fish-killing properties of the material were conducted. Concentrations ranging from 1 to 85 parts per billion were placed in fourteen bodies of water varying in size