sible the use of such highly productive fishes as the gizzard shad and threadfin shad.

At present it is our opinion that crayfish and probably other invertebrates are the only animal forage that is reasonably vulnerable to the channel catfish. Further investigation may demonstrate the fathead to be reasonably satisfactory. On basis of the present data the policy of permitting the build-up of dense populations of sunfishes, bullheads, and similar fishes is of questionable value and may encourage oxygen depletion during critical periods.

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TWO-YEAR STUDY OF A BASS, SUNFISH, CHANNEL CATFISH POPULATION EXPOSED TO FLOODING AND ANGLING [1]

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Introduction

Methods of raising channel catfish have reached a degree of development where it is possible to stock farm ponds with this species. Therefore, it is pertinent to know the effects of introducing this species into the bass-bluegill-redear stocking combination. This study was designed to evaluate a particular bass-bluegill-redear-catfish stocking combination in detail.

A flood occurred midway in this study period, causing a large amount of escapement of fish over the spillway. This circumstance provided an opportunity to evaluate the effects of such a large removal of fish from the original population.

To accomplish these objectives, records were kept of the initial stocking. plus all fish removed by angling. Extensive sampling by seining, trapping, angling, and electric shocking was done throughout the study period, June 1960 through October 1961, to follow trends in the fish population. The experiment was concluded with draining the pond.

Pond S-6, built in 1946, has an area of 25.5 acres, a maximum depth of 15 feet, and a dam 742 feet in length. S-6 used in several earlier experiments, was drained in the fall of 1959 before the present investigation was begun. Management of the pond during the period of this study consisted of standard fertilization (Swingle and Smith, 1947) and *Microcystis* control with copper sulphate.

During normal conditions, water flowing out of S-6 passed over a cement apron that was screened. Flow over the spillway from normal rainfall was no deeper than 2 inches. Flooding on February 24 and 25, 1961, was the greatest in the history of farm ponds investigations at Auburn. Rainfall at Auburn in the month of February in 1961 was 20.5 inches, and 8.0 inches fell February 25, 1961 (Annual Report, Farm Ponds Project, Auburn University, 1961). At the peak of the flood, water flowed over the emergency spillway at a depth of about 6 inches and a width of 200 feet.

[1] Presented as a thesis to the Graduate Faculty of Auburn University in partial fulfillment of the requirements for the Master of Science Degree.

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Stocking Rates

Results from a previous experiment to evaluate use of channel catfish in farm ponds indicated that the sunfish were crowded when 200 catfish were added to the stocking combination of 100 bass, and 1,500 bluegill and redear (Annual Reports, Farm Ponds Project).

Consequently Pond S-6 was stocked during the period February 18 to 23, 1960, with 1,000 fathead minnows, 212 redear, 471 bluegill, and 200 channel catfish.[3] The sunfish were all in the 1- through 3-inch groups, with 91 per cent by weight in the 1- and 2-inch groups. The catfish were in the 3- through 8-inch groups, with 50 per cent by weight in the 4-inch group. On May 3, 1960, S-6 was stocked with 100 largemouth bass about 0.7-inch long.

Collection of Fish

Standard seining techniques developed and described by Swingle (1956) were used in the present study to follow changes in balance within the fish population. Samples were taken with a 15-foot seine once a week during the period of June 29, 1960, to January 14, 1961. From that date until October 10, 1961, hauls were made at biweekly intervals. Also throughout the study period, hauls with a 50-foot seine were taken at biweekly intervals.

Location of sites for seining samples was determined by dividing the shoreline of the pond into 11 segments of equal length. Samples with the 15-foot seine were taken along the shore near the center of each segment. Because of stumps in shallow water and because of water too deep to seine, samples with the 50-foot seine were taken in only four of the 11 segments. Seine haul samples were supplemented with occasional angling catches by project personnel, wire basket trap samples, and electric shocker collections.

On June 21, 1961, S-6 was opened to public fishing. All fishermen trips were censused and the time fished and amount of fish caught were determined. In the latter part of June and all of July, 1961, S-6 was open to public fishing from 7:00 a.m. to 5:00 p.m. every day except Sundays. However, in August and September the pond was only fished 14 days because of insufficient numbers of fishermen. There were 40 man-days of fishing per acre during the public fishing period. Of this total, 32 man-days were logged in the period of June 21 through July 5, 1961.

In order to complete the experiment and determine the composition of the fish population, S-6 was drained in the fall of 1961. The fish were placed in tanks on trucks and hauled to holding tanks in a processing building. All bass and catfish, and sunfish over 5.4 inches in total length were sorted into inch groups, counted, and weighed. The remaining fish were weighed and subsampled for composition by species and inch groups. Numbers and weights of the different species recovered on draining are included in Table 1. In order to reduce the size of the table, 87 fathead minnows, 137 golden shiners, and two brown bullheads have been excluded.

Dynamics of the Fish Population in 1960

In late June 1960 when sampling was begun the fish population in S-6 was expanding. Bluegill and redear of the initial stock were growing at a rate lower than expected in new ponds in Alabama, and by fall they were only in the six-inch group. In addition, the condition factor for these species decreased as the season progressed. Since the redear and bluegill stocking rate had been reduced to avoid both inter- and intra-specific competition, the reduced growth rate could not be attributed to crowding by these species. Reproduction by bluegill in S-6 as judged by the 15-foot seine haul samples, was considered inadequate for ponds at the Auburn Station and did not produce extremely large numbers of small fish until early fall. Seining samples indicated that most of the 1960 year class of bluegill and redear were only in the 1- and 2-inch groups in the fall of 1960. Green sunfish were far from being numerous enough in the seine hauls to have

[3] All data in this paper are reported on a per acre basis unless otherwise noted.

caused crowding. By a process of elimination, the presence of the channel catfish appeared to be the reason for the slow growth of bluegill and redear. Apparently the catfish competed for Chironomids, the main invertebrate food available in S-6. The few stomach analyses made of catfish in S-6 support this view as well as additional data from other ponds on the Auburn Station (Annual Reports, Farm Ponds Project).

Bass grew rapidly in the early summer of 1960, but the growth rate began to decline in late summer and fall. Fathead minnows provided abundant forage until the middle of August 1960, when this species ceased to be a major component of the fish population. Young-of-the-year bluegill became available as the summer progressed. However, these bluegill essentially never passed the 2-inch group in 1960. Bluegill spawning was apparently delayed by slow growth, and young-of-the-year fish were not present in sufficient numbers to offset the decrease in fathead minnow until September. Most of the abundant September reproduction of bluegill overwintered as 1-inch group fish. Bass grew slowly on this food supply. The average length of 142 bass measured in the period November 1 through 4, 1960, was 10.2 inches.

The decrease in food available for optimum bass growth was also suggested by a decrease in condition factor with time in 1960. Thus, it appeared that crowding bluegill by catfish resulted in insufficient numbers of young-of-the-year bluegill needed for optimum growth of bass in the 10-inch group. Therefore, the catfish were also probably indirectly responsible for the slower than expected bass growth in S-6.

Catfish were first sampled in sufficient numbers to estimate size during the latter part of December 1960, and early January 1961. Considering all samples of catfish taken in S-6, the size attained in the first year of growth was about 14.5 inches. This growth was similar to that of catfish in ponds stocked with 500 catfish and 100 bass, which were not fed (Annual Reports, Farm Ponds Project). The growth of channel catfish did not suffer from the inclusion of sunfish in the stocking combination. It also was apparent that catfish did not benefit from the forage that young-of-the-year sunfish provided, since growth in S-6 was no better than that in ponds without bluegill and redear on

TABLE 1 COMPOSITION OF THE FISH POPULATION IN S-6 AT DRAINING ON OCTOBER 31, 1961.
Number and Weight of Each Species

Inch	Channel Catfish		Largemouth Bass		Bluegill		Redear Sunfish		Green Sunfish	
Group	No.	Pounds	No.	Pounds	No.	Pounds	No.	Pounds	No.	Pounds
1					654,533	635.8			6,370	9.0
2					147,934	413.3	290	2.2	18,308	83.4
3					43,152	555.8	3,439	44.5	3,211	47.2
4					12,022	393.6	248	9.7	689	28.4
5					5,166	346.9	1,057	76.4	375	33.0
6	1	0.1			5,765	764.0	1,764	208.1	108	14.9
7	2	0.3	10	1.7	1,364	288.4	409	85.5	1	0.3
8	7	1.1	46	9.9	30	9.7	312	91.6		
9	6	1.2	146	48.7						
10	5	1.9	164	65.8						
11	20	10.0	4	2.3						
12	40	28.4	2	2.1						
13	35	29.5	8	9.7						
14	18	16.6	61	90.2						
15	68	65.6	41	69.1						
16	217	242.4	1	2.3						
17	177	218.3								
18	34	43.9								
19	1	1.7								
20	1	2.2								
Totals	632	663.2	483	301.8	869,966	3,407.5	7,519	518.0	29,062	216.2

the Auburn Station. Although catfish competed with sunfish for food, they did not convert any of this food to reproduction that would serve as forage for bass.

Dynamics of the Fish Population in 1961

Since flooding on February 24 and 25, 1961, changed the fish population in S-6 quite drastically, an estimate of the amount of fish lost in terms of weight was attempted. This estimate, of course, was only approximate, but it did give an indication of the magnitude of the loss. A mark and recapture experiment in November 1960, gave an estimate of 60 bass per acre. This value was used as the estimate of the February, pre-flood, population. At the time of flooding, bass were estimated to weigh 260 grams each and to be 10.6 inches in length. Using these values, the estimated weight of bass prior to flooding was 34 pounds. A minimum bass population at the start of fishing of seven bass was estimated by adding the catch to the number recovered at draining. Using this value for the number of bass remaining immediately after the flood, an estimated 53 fish weighing 30 pounds were lost during the flood.

Channel catfish are usually considered to suffer an approximate mortality of 10 per cent of the stocked population in their first year in ponds on the Auburn Station (Annual Reports, Farm Ponds Project). Using this natural mortality value, there was an estimated 180 catfish just prior to the flood. These were estimated to be 14.5 inches in length and weight 350 grams each. On the basis of these values, there was a total of 141 pounds of channel catfish at the time of the flood. The approximate number remaining after the flood (92) was obtained by adding the angling catch to the population recovered at draining. These calculations indicated that 70 pounds were lost during the flood.

Undoubtedly, other fish besides bass and catfish left the pond during the flood. However, the number of bluegill and redear of the initial stock harvested and recovered at draining did not indicate an unusual loss.

These estimates of weight loss led to the assumption that at least 100 pounds of fish per acre left S-6 during the flood on February 24 and 25, 1961. However, the loss of this large weight of fish did not result in a significant increase in growth rate of the original stock of catfish or sunfish.

After the flood only the 1960 year class of bluegill began to grow appreciably. These fish started to move from the 1-inch group into the 2- and 3-inch groups. Their growth, however, was not rapid. The numbers of 2- and 3-inch groups in the seine haul samples did not increase greatly until early May 1961.

The length measurements of bass showed that in 1961 this species did not begin to increase in length until late May and early June. This growth coincided with the cessation of bass spawning, but also occurred at the time forage in the 2- and 3-inch groups of bluegill became available. Very few fingerling bass were taken in the seine hauls in 1961.

There were approximately seven bass per acre remaining after the flood. This low number was not sufficient to adequately reduce the number of bluegills moving into the intermediate group. Consequently, the fish population began to approach a crowded forage condition.

On June 21, 1961, when S-6 was opened to public fishing, another drastic change in the fish population took place. By July 5, 1961, 74 pounds of fish per acre had been harvested. Assuming that all natural mortality occurred before June 21, 1961, the estimated population in terms of numbers of the initial stock of fish remaining on July 5, 1961, consisted of 30 catfish, 233 bluegill, 27 redear, and five bass. As a result of their small size the fish hatched in S-6, the 1960 year class, did not contribute significantly to the angling catch throughout the 1961 fishing season. Consequently, only the initial stock minus the fish lost to flooding and natural mortality were available to the fishery in 1961. After July 5, 1961 only an additional 10 pounds was harvested.

With the removal of 74 pounds by angling, the fish population responded with increased growth. As there were no large intermediate fish available, immediate recruitment to the harvestable size groups was not possible. The first result of this growth was a large increase in the number of 3-inch bluegill that caused the pond to go into the unbalanced classification, based on 50-foot seining samples (Swingle, 1956).

Crowding in the 3-inch group did not cause growth of the intermediate sunfish to stop altogether, but it was early fall before the surviving 3-inch fish began to move into the 4- and 5-inch groups.

Condition factors for bluegill increased in early spring, then decreased in midsummer when crowding was the heaviest only to increase slightly again in the fall when crowding was reduced. Despite the movement of some of the 1960 year class of bluegill into the 4- and 5-inch groups, at draining, 66 per cent of these I+ fish were still in the 3-inch group and only four per cent were in the 6-inch group. Although the total number of intermediates decreased in the 50-foot seine hauls in the fall of 1961, the numbers were still higher than desirable.

The 1961 year class of bluegill also grew very slowly in 1961. Although the 1- and 2-inch group catches in the 15-foot seine hauls increased as the season progressed, only 0.6 percent by number of the O+ fish recovered at draining was in 3-inch group.

The initial stock of bluegill essentially ceased to reproduce in the summer of 1961 after early July. In late September and October, reproduction increased slightly but could not be considered heavy. The condition factor decreased during most of the summer for this year class, but it increased slightly in the fall when crowding was lessened. This was the same pattern noted in 1960 year class.

Redear were not sampled in enough numbers in 1961 to follow growth closely. However, judging by the size attained at draining, all year classes of redear grew poorly in 1961. The competition from the 3-inch bluegill was probably or at least partly responsible.

Catfish in S-6 did not increase in length in 1961 prior to the start of public fishing. There was no drastic change in the average weight of catfish caught in the first two weeks of fishing. Growth began after that period, since on draining catfish averaged 15.3 inches in length and 1.08 pounds in weight. This was about an inch longer and 0.3 pounds heavier than at the start of public fishing. The reduced number of catfish was able to compete successfully with the large numbers of 3-inch group bluegill and to grow in the summer of 1961. How much the presence of catfish aggravated the crowding of bluegill and redear is not known. The condition of catfish in S-6 at draining was equal to that of catfish of equal size in ponds on the Auburn Station receiving supplemental feeding. This good condition was evidence that catfish in S-6 were able to maintain themselves in a satisfactory state despite competition from other species.

Largemouth bass of the initial stock in S-6 grew well in the summer of 1961 on an abundant supply of 2- and 3-inch group bluegill. They reached an average length of 14.1 inches and weight of 1.5 pounds at draining. Bass hatched in 1961, grew slowly in their first summer. There was considerably less forage available for these bass than for those of the initial stock bass in 1960 since fathead minnow were rare and bluegill reproduction was poor in 1961. At draining the average length of the 1961 year class of bass was 9.3 inches. The F/C ratio (Swingle, 1950) was 15.9 considering only bass as predator species. An F/C ratio of this magnitude indicates unbalance resulting from too few bass in the population.

Conclusions

Results of this study point up four main conclusions with respect to the fish population in S-6. They are: (1) Trends in the dynamics of this fish population could be followed with periodic seining; (2) a stocking rate of 200 catfish per acre was too high to be used in a bass-bluegill-redear stocking combination, even though the number of sunfish was reduced to about 700 per acre; (3) that removal of a large number of predatory fish upset the balance, but that the population in time tended to balance itself since the loss of predatory fish was not great; and (4) rapid reduction in the proportion of harvestable fish in the population by angling led to an unbalanced condition.

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COOPERATION BETWEEN ENFORCEMENT AGENCIES

BY LT. COL. CARL L. MILLER

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It is a pleasure to appear before this law enforcement section of the Southeastern Association of Game and Fish Commissioners. I feel like I am more familiar with your problems as Game and Fish Enforcement Officers than the average police officer because of my earlier close association with the Arkansas Game and Fish Commission which dates many years back, and while we are talking about many years ago, I am reminded of an early experience that brought about a better understanding between my own agency, the State Police, and the Game and Fish Enforcement Officers.

If Orville Swope is here he will bear witness to this story and I am ashamed to tell exactly how long ago it has been, but it was back when the Game and Fish Commission first started trapping deer in the overstocked area of the Scylamore Forest and transferring them to other sections of the State. The Scylamore Forest, as some of you know, is located up near the North Ozark section of Arkansas and back in those days, was pretty much of a wilderness. The natives living in the area of the Scylamore Forest at that time resented the Game and Fish Agents coming in there and trapping *their* deer as they called them. Today, of course, we would wonder why the people would feel that way about the matter of conservation, but then we can go back when our forefathers came into the wilderness of this country and were few and far between and usually wanted to move on whenever they saw the smoke rising from the next settlement camp. Every man was on his own and every man as good as every other man and a whole sight better in those days—they had to be in order to survive. He was a law unto himself until neighbors with the same idea moved in close enough to cross each other's paths, step on each other's toes and get into each other's hair. At this point the law for one had to become the law for all and liberty within the law became the slogan for survival.

It is not strange that men with this pioneering background would oppose the taking of the deer from the lands they called their own, even though it belongs to their government, because they had been shooting them any part of the season as the need arose. It is not strange that they should oppose conservation when they had been making cider out of their own apples and wine out of their own grapes and lightening out of their own corn. They opposed the transfer of these deer because they lived in a land of plenty and probably didn't want the rest of the people in the State to share the wildlife that they considered theirs.

This resentment grew and they posted signs in the Forest warning the Wardens to stay out. They even chopped up a number of the deer traps and took some random shots at some of the Agents.

I was sent up into the Forest to work with the Game and Fish Commission in resolving their difficulties. Orville Swope and myself camped out in the Forest for about 10 days and finally one morning found where some deer had been killed and the investigation developed