# Bluegill Predation by Three Fish Species

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*Abstract*

Seven ponds at Driftwood Experimental Station were used to evaluate the ability of three species of predaceous fish to control bluegill populations. These were the largemouth bass, northern pike and white catfish (*Ictalurus catus*). The ponds were stocked in April, 1967, with 100 predators and 1,000 bluegill per acre. Two control ponds were stocked only with bluegill at 1,000 per acre. Four ponds were drained in October, 1967, and the populations evaluated. Three of the ponds were refilled and the fish returned. All ponds were drained in August, 1968, and the populations evaluated.

The largemouth bass was the most effective bluegill predator followed by the northern pike and white catfish. The effects of intraspecific competition on the dynamics of the bluegill populations and its relation to the predator population is discussed.

## Introduction

The tendency of the bluegill to overpopulate has long been a major problem for the fisheries manager. The problem is particularly acute in farm ponds, as the stocking of bluegill in these bodies of water is widespread. This study was conducted to evaluate the ability of three species of predaceous fish to control bluegill populations.

## Methods

Seven ponds at the Driftwood Experimental Station were used in the experiments. The ponds range from 0.62 to 2.05 acres in size, have maximum depths of 5 feet and are supplied with water from Starve Hollow Lake. Screens placed over the inlet valves to prevent the entrance of lake fish were not completely effective. While contamination did occur, it was not serious in most of the ponds.

Three species of predaceous fish, white catfish, northern pike and largemouth bass were used. Two ponds each of white catfish-bluegill and northern pike-bluegill were stocked while one pond with largemouth bass-bluegill and two ponds with only bluegill were used as controls. The ponds were stocked during April and May, 1967. A rate of 100 predators to 1,000 bluegill per acre was used in all the ponds. Stocking is summarized in Table 1.

Ponds 2, 4, 6 and 7 were drained during October, 1967. Pond 7 contained a large bass (1.2 lbs.) and a large number of green sunfish and crappies so the data were discarded. All predaceous fish and bluegills from the three remaining ponds were counted, weighed and measured. Both the white catfish and largemouth bass had spawned, but the young were easily separated from the original stock by size. The same was true for bluegill in all ponds.

All bluegill were separated by year class. The survivors of the original bluegill stock (age 1) were counted and lengths and weights

TABLE 1. *Stocking of seven experimental ponds at Driftwood Experimental Station, April 19-May 11, 1967.*

| Pond | Area (Acres) | | Bluegill | Northern Pike | White Catfish | Largemouth Bass |
|---|---|---|---|---|---|---|
| 1 | 0.62 | No. | 620 | | | |
| | | Size | 1.0-2.0" | | | |
| 2 | 1.07 | No. | 1070 | | 107 | |
| | | Size | 1.0-2.0" | | 2.5-7.0" | |
| 3 | 1.07 | No. | 1070 | | 107 | |
| | | Size | 1.0-2.0" | | 2.5-5.0" | |
| 4 | 1.23 | No. | 1230 | 123 | | |
| | | Size | 1.0-2.0" | 1.5-4.0" | | |
| 5 | 2.05 | No. | 2050 | 205 | | |
| | | Size | 1.0-2.0" | 1.5-4.0" | | |
| 6 | 1.37 | No. | 1370 | | | 137 |
| | | Size | 1.0-2.0" | | | 6.0-7.0" |
| 7 | 1.40 | No. | 1400 | | | |
| | | Size | 1.0-2.0" | | | |

were recorded. Young-of-the-year bluegill were bulk weighed and the total number calculated from counts of weighed random samples.

After processing, all fish (except for Pond 7) were returned to the refilled ponds. As many as possible of the contaminating species, such as green sunfish, were sorted out and discarded. Handling mortality among the large fish was quite low. A high percentage of the young-of-the-year bluegill were lost, however.

TABLE 2. *Species composition and standing crop of fishes in six ponds at Driftwood Experimental Station, August, 1968.*

| | | Pond 1 | Pond 2 | Pond 3 | Pond 4 | Pond 5 | Pond 6 |
|---|---|---|---|---|---|---|---|
| White Catfish | No./A. | | 117 | 7 | | | |
| | Lbs./A. | | 31.4 | 1.7 | | | |
| Northern Pike | No./A. | | | | 10 | 10 | |
| | Lbs./A. | | | | 14.0 | 15.4 | |
| Largemouth Bass | No./A. | | | | | | 274 |
| | Lbs./A. | | | | | | 87.1 |
| Bluegill | No./A. | 72,684 | 29,147 | 8,923 | 13,429 | 17,914 | 8,054 |
| | Lbs./A. | 368.2 | 109.6 | 131.1 | 330.6 | 177.5 | 52.3 |
| Other Sunfish | No./A. | 5 | 2 | 1,785 | 2,776 | 6,183 | 2 |
| | Lbs./A. | 1.1 | 0.3 | 17.4 | 14.5 | 54.0 | 0.7 |
| Crappies | No./A. | | 1 | 186 | | 4 | |
| | Lbs./A. | | | 14.9 | | 1.1 | |
| Bullheads | No./A. | 2 | | | | 1 | |
| | Lbs./A. | 0.6 | | | | 0.9 | |
| Total | No./A. | 72,691 | 29,267 | 10,901 | 16,215 | 24,112 | 8,330 |
| | Lbs./A. | 369.9 | 141.3 | 165.1 | 359.1 | 248.9 | 140.1 |

In August, 1968, all ponds were drained. All bluegill of 4 inches total length or longer were sorted into 1-inch groups, counted and weighed. A minimum of 100 fish from each 1-inch group were measured to the nearest 0.1 inch. The relative abundance of bluegills below 4 inches was calculated from random samples because of the high numbers of these fish. A minimum of 100 fish from the 2 and 3-inch groups were measured to the nearest 0.1 inch. The remaining bluegills were then bulk weighed. No measurements were taken from fish in the 1-inch group, which included all fish less than 2.0 inches long. However, average weights of the 1-inch group fish were determined by counting and weighing a minimum of 500 fish. All predaceous fish were sorted into inch groups, weighed and measured.

It was possible to separate the different year classes by their length distributions. Scale samples taken as cross checks showed this method to be sufficiently accurate.

## Results

### Bluegill Mortalities

Mortality rates for the original stock of bluegill in the study ponds were calculated from the tables in Ricker (4) and are given in Table 3. These rates were similar in both white catfish ponds. The same was true in both northern pike ponds.

TABLE 3. *Survival, seasonal mortality rate (a) and instantaneous rate of natural mortality (i) for the original bluegill stock in six ponds at Driftwood Experimental Station, 1967-68.*

| | Predator | | | | | |
|---|---|---|---|---|---|---|
| | None | White Catfish | | Northern Pike | | Bass |
| | Pond 1 | Pond 2 | Pond 3 | Pond 4 | Pond 5 | Pond 6 |
| No./A. stocked | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |
| No./A. 10-67 | | 936 | | 751 | | 140 |
| a (4-67 to 10-67) | | 0.064 | | 0.249 | | 0.860 |
| i (4-67 to 10-67) | | 0.07 | | 0.29 | | 1.97 |
| Days (4-67 to 10-67) | | 183 | | 174 | | 184 |
| No./A. 8-68 | 884 | 861 | 951 | 347 | 444 | 104 |
| a (4-67 to 8-68) | 0.116 | 0.139 | 0.049 | 0.653 | 0.556 | 0.896 |
| i (4-67 to 8-68) | 0.12 | 0.15 | 0.05 | 1.06 | 0.81 | 2.26 |
| Days (4-67 to 8-68) | 475 | 470 | 467 | 454 | 453 | 490 |
| a (10-67 to 8-68) | | 0.080 | | 0.538 | | 0.257 |
| i (10-67 to 8-68) | | 0.08 | | 0.77 | | 0.30 |
| Days (10-67 to 8-68) | | 287 | | 280 | | 306 |

Table 3 indicates that there was little predation by the white catfish on the original bluegill stock. Change in bluegill mortality rate in Pond 2 between drainings was negligible, indicating a uniform predation rate over the study period.

A *Saprolegnia* infection in March, 1968, drastically reduced the white catfish population in Pond 3, since 41 were found dead from March 19 to 23. When drained in August, 1968, only seven white catfish were found in the pond. Several white catfish also died of the infection in Pond 2 along with a few bluegills in both ponds. The fungus infection probably caused the decrease in the 6-inch bluegill group in Pond 2 (Table 4).

The lack of Age I fish in Pond 2 (Table 5) is a result of the 1967 draining which almost completely eliminated the 1967 bluegill year class.

TABLE 4. *Length distribution of white catfish and bluegill from Ponds 2 and 3, 1967-68.*

| | Pond 2 | | | | Pond 3 | |
|---|---|---|---|---|---|---|
| | 10-19-67 | | 8-2-68 | | 7-30-68 | |
| Inch Group | Catfish | Bluegill | Catfish | Bluegill | Catfish | Bluegill |
| 1 | | 6,500 | 33 | 30,260 | | 7,541 |
| 2 | 7 | | 6 | | | 17 |
| 3 | 1 | 129 | | 6 | | 379 |
| 4 | | 768 | 1 | 500 | | 1,162 |
| 5 | 6 | 54 | | 402 | | 354 |
| 6 | 9 | 50 | 10 | 18 | 1 | 92 |
| 7 | 14 | | 5 | 1 | 1 | 3 |
| 8 | 17 | | 15 | | 3 | |
| 9 | 19 | | 20 | | 1 | |
| 10 | 17 | | 17 | | 1 | |
| 11 | 6 | | 5 | | | |
| 12 | 8 | | 10 | | | |
| 13 | | | 3 | | | |

TABLE 5. *Number per acre, average length and percent total weight of bluegill year classes from six ponds at Driftwood Experimental Station, 1968.*

| | Age II | | | Age I | | | Age 0 | | |
|---|---|---|---|---|---|---|---|---|---|
| Pond | No./A. | Ave. L. | % Wt. | No./A. | Ave. L. | % Wt. | No./A. | Ave. L. | % Wt. |
| 1 | 884 | 5.3 | 24.7 | * | * | * | * | * | * |
| 2 | 861 | 5.0 | 73.7 | 6 | 3.2 | 0.1 | 28,280 | 1.3 | 26.2 |
| 3 | 951 | 5.1 | 68.3 | 925 | 4.1 | 29.9 | 7,048 | 1.3 | 1.8 |
| 4 | 347 | 5.9 | 16.4 | 10,938 | 3.4 | 82.3 | 2,143 | 1.3 | 1.3 |
| 5 | 444 | 5.0 | 21.1 | 12,817 | 2.7 | 74.4 | 1,325 | 1.3 | 4.5 |
| 6 | 104 | 7.1 | 56.9 | 102 | 5.4 | 28.3 | 7,853 | 1.3 | 14.8 |

* Not separable with available data.

Total bluegill production in the white catfish ponds (Table 2) was the lowest in any of the ponds except Pond 6, which was overpopulated with bass.

Despite a high level of mortality, the northern pike significantly reduced the original bluegill stock. This stock declined from 55 to 65% over the study period. However, data from Pond 4 indicate that predation did not occur at a uniform rate (Table 3). Pike predation on the original bluegill stock shows a marked increase with time. Early in the study, the small size of the pike made the bluegills relatively invulnerable to them. However, the pike grew faster than the bluegill, increasing the latter's vulnerability accordingly. Beyerle and Williams (1) reported that northern pike fed in aquaria showed a preference for the smaller size groups of centrarchids. Results from Pond 4 indicate the opposite. Pike in this pond appeared to feed selectively on the larger sizes of bluegill, despite the fact that the pond contained a huge quantity of smaller size bluegill (Table 6). Total weight of the original bluegill stock decreased from 75 to 68 lb. in the time between the first and second drainings. Average increment in length of the original stock in this same time period was only 0.9 inch.

Despite impressive predation on the original bluegill stock, northern pike are poorly adapted for controlling bluegill populations. This is particularly true in ponds, where their spawning requirements are unlikely to be met. A major problem in the pike-bluegill combination is the difference in hatching dates between the two species. The pike is an early spawner. The young-of-the-year become piscivorous (in this area) in late April or early May.

There are seldom young-of-the-year bluegill available for forage before June. During this interval the young pike must feed on the

TABLE 6. *Length distribution of northern pike and bluegill from Ponds 4 and 5 at Driftwood Experimental Station, 1967-68.*

| | *Pond 4* | | | | *Pond 5* | |
|---|---|---|---|---|---|---|
| | 10-31-67 | | 8-7-68 | | 8-5-68 | |
| Inch Group | Pike | Bluegill | Pike | Bluegill | Pike | Bluegill |
| 1 | | 22,218 | | 2,636 | | 9,540 |
| 2 | | | | 1,515 | | 22,980 |
| 3 | | 31 | | 11,603 | | 3,294 |
| 5 | | 537 | | 274 | | 365 |
| 6 | | 16 | | 150 | | 39 |
| 7 | | | | 3 | | 3 |
| 8 | | | | | | 1 |
| — | | | | | | |
| 13 | 5 | | | | | |
| 14 | 2 | | | | | |
| 15 | 5 | | | | 1 | |
| 16 | | | 4 | | 1 | |
| 17 | | | | | 2 | |
| 18 | | | 4 | | 4 | |
| 19 | | | 2 | | 10 | |
| 20 | | | 1 | | 3 | |
| 21 | | | 1 | | | |

preceding year class (age I) of bluegill. As is indicated by Table 3, vulnerability of this size bluegill to the pike is low. As a result, where other forage species are not available, the size of a given year class of pike may well be determined by the abundance and size of the preceeding year class of bluegill. Where other species are present, pike seem to feed on them in preference to the bluegill (5).

TABLE 7. *Length distribution of largemouth bass and bluegill in Pond 6, 1967-68.*

| | 10-25-67 | | 8-27-68 | |
|---|---|---|---|---|
| Inch Group | Bass | Bluegill | Bass | Bluegill |
| 1 | | 60,463 | | 10,718 |
| 2 | | | 112 | 31 |
| 3 | | | 1 | 10 |
| 4 | | 3 | | 25 |
| 5 | 88 | 87 | | 107 |
| 6 | 85 | 102 | | 69 |
| 7 | | | 18 | 84 |
| 8 | | | 121 | |
| 9 | 26 | | 23 | |
| 10 | 72 | | 22 | |
| 11 | 5 | | 73 | |
| 12 | | | 6 | |

In terms of both bluegill control and size of fish produced, the largemouth bass-bluegill combination provided the best results (Table 7). Because of the relatively large size of the bass in relation to the bluegill at stocking (Table 1), the vulnerability of the bluegill was high. The result was a high mortality rate among the bluegill and good growth by both species. Total bluegill production in this pond was low (Table 2) as a result of a large bass overpopulation (274 bass/acre) coupled with the destruction of a large portion of the 1967 bluegill year class during the fall draining in 1967.

**Bluegill Dynamics**

In most cases, the bluegill carrying capacity of a body of water is determined by the food supply. The degree of intraspecific competition within the bluegill population is determined by the difference between the standing crop and the carrying capacity (2).

The amount of recruitment into a bluegill population is a function of the degree of food competition. If carrying capacities were uniform, many problems could be solved easily. Unfortunately, in addition to the differences in basic fertility among bodies of water, carrying capacity for bluegill may be influenced by relationships within the population. Swingle (6) reported an inverse relationship between the percentage of large fish in largemouth bass-bluegill populations and the standing crop.

Gerking (3) has shown that small bluegill are more efficient in using protein for growth than are large bluegill. This gives the smaller bluegill an advantage over the larger one in food competition. It also suggests that the potential carrying capacity is greater for small bluegill than larger ones, increasing the likelihood of overpopulation.

## Evaluation of Results

Pond 1 is a good example of what happens in the absence of predation and all bluegill control is intraspecific. No length frequency distribution or scale samples were taken from the 1-inch group bluegill, making positive year class assignment impossible. However, the length distribution curve from the 2-inch group, if extended, reaches a peak between 1.5 and 2.0 inches. The large average individual size of the 1-inch group bluegill (321/lb.) indicates that most of them were members of the 1967 year class. Intraspecific competition appeared to severely limit bluegill reproduction in Pond 1 in 1968.

The difference between the standing crop and the carrying capacity in Pond 1 was originally very large, resulting in the production of a large 1967 year class. This year class expanded to fill the carrying capacity, thereby limiting further reproduction or growth.

The results from Ponds 2 and 3 indicate that the white catfish is more of a bluegill competitor than a predator. Both catfish ponds remained turbid throughout the growing season. This probably reduced the carrying capacity for bluegill. If white catfish do, in fact, reduce the carrying capacity for bluegill, the difference between the standing crop (original stock) and carrying capacity was much lower than in Pond 1 resulting in less recruitment.

The northern pike mortality in Ponds 4 and 5 was so high that they never achieved a population level capable of controlling the bluegill. As in Pond 1, the difference between the standing crop and carrying capacity was large, resulting in high bluegill recruitment. The apparent selectivity of the pike for larger bluegill tended to aggravate the problem.

Since northern pike rarely reproduce in ponds, their applicability for bluegill control in ponds seems very limited. With sufficient effort, a pike population might be maintained at a level that would control the bluegill population. However, this can be said of almost any predator. At present, it appears that the largemouth bass is the best adapted species for controlling bluegill population in ponds.

Pond 6 developed an overpopulation of bass. Bass predation kept the bluegill population far below carrying capacity. The standing crop of bluegill actually decreased slightly between 1967 and 1968. While the production of bluegill recruits under these conditions had to be high, there were sufficient bass present to limit their survival to a very low level.

## Discussion

Since recruitment into the bluegill population is such an important component of population dynamics, the effect of various management procedures on it should be kept in mind. Preoccupation with growth rate often results in failure to consider the effect of various procedures on the entire system.

A case in point is the stocking rates used for farm ponds. A commonly used rate is 100 fingerling largemouth bass and 100 fingerling bluegill per acre. In ponds of average fertility, the original bluegill stock will rapidly grow to a large size. They will spawn at age I, producing a tremendous number of young. This very high level of bluegill recruitment results in good growth of the original bass population. However, it exceeds the ability of the bass to reduce the number of bluegill recruits enough to maintain good bluegill growth. If the bass are unable to reduce the numbers of the first bluegill year class sufficiently, this single year class will tie up most of the ponds carrying capacity causing low bluegill recruitment the following year. The young bass produced at this time find very few bluegill of a vulnerable size and a high degree of competition with the bluegill for other food organisms. Since the original bass stock will have reached desirable size at this stage, they are subject to fishing harvest, reducing the number of effective predators on the oversize bluegill year class. While the original stock of bluegill has also reached desirable size and are being harvested, they make up a relatively small portion of the total standing crop and their removal does not appreciably increase the growth of the remaining bluegill.

This stocking rate (100 to 100) results in good growth of the original fish but makes a bluegill overpopulation likely in short order. Since a population that will maintain a high equilibrium yield is desirable, stocking rates must be adjusted so that the bulk of the standing crop will be composed of harvestable fish. If a situation producing a high level of recruitment is set up, there should be enough predators stocked to control it.

It is nearly impossible to recommend a good stocking rate without some knowledge of the carrying capacity of the body of water involved. However, if a single fingerling stocking ratio is to be used, it would be advantageous to increase the number of bluegill stocked. This would slow the growth rate somewhat, and reduce recruitment to a more manageable level.

An alternative is to decrease the survival of bluegill recruits by increasing the number of bass stocked. Which method would produce the highest fishing yield over an extended time period cannot be predicted.

Another area where factors affecting recruitment are important is that of partial kills. Nothing seems more ridiculous to me than attempting to destroy nests or young-of-the-year in a stunted bluegill population. Since recruitment into a stunted population is low to begin with, the food made available by their destruction will not appreciably alter the growth of the remaining fish. Besides, this reduces the supply (low anyway) of vulnerable fish to the young-of-the-year predators.

A more common practice is the large scale reduction in the bluegill population concentrated on the smaller size groups. It should be remembered here that the same factors that increase growth also increase recruitment. Where a large reduction in standing crop is made, precautions against the recruitment of a massive bluegill year class should be taken. This, again, could take different forms. One way would be to increase the predator population to accommodate the higher level of bluegill recruitment. The other would be to replace the destroyed year class(es) with a number of bluegill more suited to the carrying capacity.

## Literature Cited

1. BEYERLE, GEORGE B., and JOHN E. WILLIAMS. 1968. Some observations of food selectivity by northern pike in aquaria. Trans. Amer. Fisheries Soc. **97**(1):28-31.

2. CARLANDER, KENNETH D. 1966. Relationship of limnological features to growth of fishes in lakes. Verh. Internat. Verein. Limnol. **16**:1172-1175.

3. GERKING, SHELBY D. 1962. Production and utilization in a population of bluegill sunfish. Ecol. Monogr. **32**:31-78.

4. RICKER, W. E. 1958. Handbook of computations for biological computations of fish populations. Fisheries Res. Board Canada Bull. 119.

5. SEABURG, KEITH G., and JOHN B. MOYLE. 1964. Feeding habits, digestive rates and growth of some Minnesota warm water fishes. Trans. Amer. Fisheries Soc. **93**(3):269-285.

6. SWINGLE, H. S. 1961. Some relationships within fish populations causing fluctuations in productions. Proc. Pacific Sci. Cong. **10**:43-45.