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Jim Satterfield

FINAL REPORTS

INVESTIGATIONS PROJECTS

STATE OF MISSOURI

PROJECT NO. F-1-R-20, STUDY NO I-13, JOB NO. 1

TITLE OF JOB: A review of literature on bluegills in ponds

PREPARED BY: Larry K. Graham

DATE: July 1, 1971

APPROVED BY:

Superintendent
Fisheries Research

Study No. I-13, Job No. 1. A review of literature on bluegills in ponds.

Larry K. Graham, Project Leader

Abstract

Seventy-one references were located and reviewed for this report. Many other papers were reviewed but were not reported on since they did not specifically involve the mentioned characteristics. The scope of this literature review was limited to stocking size and rate of stocking bluegills in ponds.

Stocking rates for bass-bluegills in ponds most generally fit into two categories; the northern and southern rate, with only minor differences from state to state. Fertilized ponds in the south are commonly stocked with 100 bass and 1,000 - 5,000 bluegill per acre. About one-half this number of fish are stocked in unfertilized waters. In the northern area of the United States, common stocking rates include 100 bass and 300 - 500 bluegill per acre.

Fingerling bluegills are most commonly stocked in all areas, however, fry and adult stocking are mentioned. Most authors feel fingerlings have better survival than fry and their chances of producing a balanced pond fish population are usually better than stocking adults.

Most papers were quite general when referring to the size of stocked bluegill. Most indicated, however, that fall-stocked fingerlings would spawn the following summer. Three-inch bluegill, under favorable conditions will spawn in Alabama.

Length of growing season, as well as water fertility, appears to be one of the most important considerations for establishing stocking rates and ratios in ponds. Midwestern states have undergone more change in their stocking policies than have the northern and southern states.

Stocking Rates for LMB-BG

1. "Southern" rate - 1:10-15
2. "Northern" rate - 1:3-5

Study No I-13, Job No. 1. A review of literature on bluegills in ponds.

Larry K. Graham, Project Leader

Introduction

The largemouth bass - bluegill is a widely accepted fish pond combination, however, the rates and ratios of stocking and the size of bluegill at stocking varies from region to region. Standard stocking for Missouri ponds is 100 largemouth bass, 500 bluegills and 50 channel catfish per acre. All fish are stocked simultaneously in the fall of the year. The bass and catfish usually range from 2 to 3 inches total length, while the bluegill are more variable in size and usually average 1 inch in length, with few exceeding 1½ inches. Previous studies show survival of initial stock bluegills as low as 20 per cent, doubtless due to bass predation.

It is hoped that the following literature review will reveal stocking rates and sizes of bluegill that have produced desirable results for other states in their farm pond program. The scope of this literature review was limited to stocking size and rate of stocking of bluegills in ponds.

Seventy-one references were located and reviewed for this report. Many other papers were reviewed but not reported upon since they did not specifically involve the mentioned characteristics.

Literature Review

Aldrich, A. D., F. M. Bumgartner, and W. H. Irwin. 1944. Fish production in farm ponds. Okla. Agric. Exp. Sta. Cir. C-115:8.

Oklahoma is following recommendations that are being used in Alabama. In fertilized ponds, stock 1,500 fingerlings bluegills and 150 bass fingerlings per acre. If white crappie are desired, stock 12 fingerlings and reduce the number of bass to 38. If bullheads are desired, stock 100 and reduce the number of bluegills to 1,100.

For unfertilized ponds, they recommend stocking 30 fingerling bass per acre and 400 fingerling bluegills per acre. If white crappie are wanted for stocking, then add 8 fingerling crappie and reduce the number of bass to 22. If bullheads are desired, stock 25 bullhead fingerlings and reduce the number of bluegills to 300.

Ponds should be stocked in late summer or fall in order to give the fingerlings time to develop and spawn the following spring.

Allan, P. F. and C. N. Davis, 1941. Ponds for wildlife. U. S. Dept. Agric., Farmers Bull. 1879:46.

Farm ponds should be stocked with 50 bass and 400 bluegill per acre. All fish should be the same size at stocking (1-2 inches). Never should adult or large fish be stocked into a pond.

Almand, J. David. 1968. Six keys to fish pond management. Univ. Ga. Coop. Ext. Ser. and Coll. Bull. 669:26.

Fertilized ponds in Georgia are stocked with 100 bass and 1,000 bream per acre. The 1,000 bream are made up of about 800 bluegills and 200 redear sunfish. In unfertilized ponds, Almand recommends half the previously mentioned stocking rate. Bream should be stocked in the fall and bass should be stocked in the spring. 1:10

Ayers, H. D., H. R. McCrimmon, and A. H. Berst. (no date). Construction and Management of Farm Ponds in Ontario. Ont. Dept. Agric. & Food:41.

Warm-water ponds in Ontario can support bass and bluegills if bottom water exceeds 71° F. Recommended stocking rates for largemouth bass are 100 fingerlings (one to three inches), 25 yearlings (five to seven inches), or 100 adults per acre. Stocking of bluegills if desired, should be with fish of approximately the same age as the bass and at a rate of 1,000 fingerlings (one inch), 50 yearlings (three to five inches), or 25 adults (five to seven inches, per acre.) If bass and bluegills are mixed, there is a good possibility the populations will become unbalanced and pond reclamation will be necessary within a few years.

Ball, Robert C. 1952. Farm Pond Management in Michigan. J. Wildl. Mgmt. 16(3): 266-269.

Bass and bluegills commonly do not reach sexual maturity until their third summer in Michigan. In ponds stocked with fingerling bass and bluegills, there will be two growing seasons before the bluegills spawn, consequently, there are two growing seasons before small bluegills are available for bass forage. When adult bluegills produce young the first year, Ball states that fingerling bass stocked with adult bluegills weighed

twice as much at the end of the second year and three times as much at the end of the third year as bass stocked at the same time with fingerling bluegills.

He also states that there is strong evidence that in Michigan's hard water ponds, with accompanying dense beds of submerged aquatic vegetation, predator bass are not able to crop bluegills sufficiently to prevent their overpopulation and stunting. Michigan recommends stocking new ponds with 100 bass fingerlings and 10 adult bluegill per acre.

Ball, R. C. and H. D. Tait. 1952. Production of bass and bluegills in Michigan ponds. Mich. State Coll. Agric., Exp. Sta. Tech. Bull. 231:24

Bass and bluegills take three years to reach a size that they would normally reach in one year in Alabama. When fingerling bass and bluegills are stocked, growth of bass is extremely slow because, Ball and Tait theorized, the bass had no small bluegills to eat until the bluegills grew to a large enough size to spawn.

To increase bass growth, fingerling bass were stocked with adult bluegills and bass growth was much faster. It should be noted that other bass forage such as aquatic insects and crayfish were present in these ponds.

Ball and Tait recommended stocking 150 fingerling bass with 10 adult bluegills. They state that this combination will give good initial bass growth and produce at least one crop of fast-growing bluegills, however, there is not assurance that this combination will result in a population that will be stable for any considerable length of time, particularly if there is selective fishing for larger bass. Ball and Tait were not satisfied with this combination but, state, however, that ponds would continue to be stocked with bass-bluegill until a more desirable pond combination is found.

Bennett, George W. 1943. Management of small artificial lakes. Ill. Nat. Hist. Surv. Bull. 22(3): 357-376.

Bennett states that under moderate fishing pressure, bass are unable to control numbers of bluegills. Therefore, in stocking new or renovated lakes, it is unnecessary and possibly undesirable to stock more breeder bluegills than breeder bass. In Illinois, bass spawn at the age of two years and bluegill at one year, so it would be better to stock

both adult bass and bluegills rather than stocking adult bluegills and bass fry or fingerlings.

Bennett, George W. 1952. Pond management in Illinois. J. Wildl. Mgmt., 16(3):249-253.

Pond stocking should be done in a way that bass become dominant immediately, otherwise the bluegills will quickly overpopulate, become stunted and curtail bass reproduction. Early dominance by bass is needed because bass in Illinois do not become sexually mature until 2 years of age, whereas, bluegills spawn at one year. In ponds 1 to 15 acres, stocking rates of 50 to 100 fingerling bass per acre have been generally successful. An equal number of bluegills may be stocked simultaneously with the bass or at any time later. Bennett also states that nearly all impoundments quickly develop populations of crayfish which are selected by bass as forage in preferences to bluegills. Even when a pond is stocked initially with a dominant population of bass, bluegill populations may expand excessively and fishing may become poor within 6 to 10 years.

Bennett, George W. 1954. Largemouth bass in Ridge Lake, Cole County, Illinois. Ill. Nat. Hist. Surv. Bull. 26(2):217-276.

Ridge Lake, an 18-acre lake was stocked with bass (22 to 110 fish per acre) and bluegills (3 to 98 fish per acre). The bass used for stocking were a minimum of 6 inches in length and bluegills were 0.2 pounds a piece or larger. In addition, other species such as black bullheads and green sunfish were present in the lake.

Bennett, George W. 1962. Management of Artificial lakes and ponds. Reinhold Publ. Corp. New York:283.

Bennett states that generally the bass-bluegill combination is more successful in the southeastern states. Further north, results may be good, however, desirable results are not necessarily a certainty. He also mentions that many mid-continent biologist stock 100 fingerling bass and 100 fingerling bluegills per acre. During the first season, the bass prey upon the bluegills reducing their numbers not so low as to preclude enough survival for a spawn the next summer. Furthermore, the pond will not be overcrowded with bluegills the second season to interfere with bass spawning.

Brown, C. J. D., and N. A. Thoreson. 1952. Ranch Fish Ponds in Montana. J. Wildl. Mgmt., 16(3):275-278.

The bass-bluegill combination has not been a satifactory pond combination in Montana except in a few instances. However, recommended stocking rates include 100 bass and 500 bluegills per surface acre. Stocking at a rate of 1 bass to 10 bluegills will result in large numbers of stunted bluegills.

The writers feel the bass-bluegill combination is not suited for Montana since the growing season is so short. Bluegills commonly do not reach 6 inches in total length until their fifth summer and largemouth bass do not reach 10 inches until their fourth summer.

Brown, William H. 1951. Results of stocking largemouth black bass and channel catfish in experimental Texas farm ponds. Trans. Am. Fish. Soc., 80:210-217.

Ponds at San Marcos, Texas were stocked with fry and fingerling bass and fingerling bluegills. Numbers of bass per acre ranged from 100 to 150 and bluegill numbers ranged from 100 to 1,500. The duration of the experiment was about one year.

Yields from the ponds indicate that the weight of edible bass per acre is decreased as the stocking ratio of bluegill is increased. Average weight of adult bass varied inversely with the survival rate of fingerlings. Average weight of adult bluegills varied inversely with the number of bluegills stocked.

Brown states that a fertilized pond stocked with a ratio of 150 bass and 100 bluegills (all fingerling) produced the most pounds of edible bass. The most pounds of edible fish were produced in a fertilized pond by stocking 100 fingerling bass and 1,500 fingerling bluegills.

Carter, Bernie. 1968. Farm pond fish stocking procedure. Farm Pond Harvest. 2(3):4-6.

In the early days of pond stocking in Kentucky, emphasis was placed on producing a bass-bluegill population that was high in numbers of bass, since bass fishing was a popular sport. Stocking rates at that time were 40 adult bluegills and 100 bass fry per acre. This combination did produce good initial bass fishing, however, the exceptionally fast growth

usually attained by stocking fingerling bluegills was lost. Also, the potential carrying capacity of harvestable-size bluegills was never attained. Since 1958, new ponds are stocked with 120 bass fry and 400 bluegill fingerlings per acre. Bluegills are stocked in March and the bass are added in May.

Clark, Monor. 1952. Kentucky's farm fish pond program. J. Wildl. Mgmt., 16(3): 262-266.

The largemouth bass-bluegill combination is the only pond combination to be used successfully in Kentucky. Success, measured in terms of continued good fishing year after year, has been limited to stocking 30 adult bluegills and 100 bass fry. Adult bluegills are stocked from October through the following June, with bass fry being stocked in May of the same year. Clark states that at the end of the first five months, the growth rate of bass averages from 1½ to 2 inches per month, while the first spawn of bluegills has grown at a rate averaging from 3/4 to 1 inch per month. Bass and bluegills both spawn heavily early in the first summer after stocking. At this time, the bluegill population consists of all sizes and young bass are in excellent condition.

Other experiments have been conducted stocking 100, 200, 300 and 500 adult bluegills per acre in conjunction with 100 bass fry. All, by the end of the second summer were overcrowded with 3-inch bluegills. Other variations of stocking included stocking 30 adult bluegills per acre prior to the middle of September and 100 bass fingerlings planted the following July. This stocking variation resulted in bluegill overpopulation. The bass did not spawn the second summer in these ponds, while the bluegill spawned at least once in the first year stocked. A number of ponds were stocked with 100 bass fry in May and 30 adult bluegills the following fall. Both bass and bluegills spawned the next summer. Such ponds have always resulted in balanced populations in the third summer when fished after the first bass spawning period.

Since 1949, practically all Kentucky farm ponds have been stocked with bluegill fingerlings in late fall or early spring followed by bass fry plantings in May. The ratios for unfertilized waters of 50 bass and 500 bluegills, 60 bass and 500 bluegills and 80 bass and 500 bluegill have consistently produced poor fishing. All become overcrowded with bluegills.

Cobb, Eugene S. 1963. The management of Tennessee Farm ponds. Tenn. Game and Fish. Comm:83.

Largemouth bass and bluegills are recommended for stocking Tennessee farm ponds. Bluegills should be stocked in fall or early winter followed with bass the next spring. Present stocking rates are 750 bluegills and 75 bass per acre for unfertilized ponds. 10:1

Crance, Johnnie 1969. Alabama fish ponds., Ala.Dept. Conserv:43.

Stocking recommendations in Alabama follow very closely to those proposed by Swingle. Stocking rates in fertilized ponds are 1,000 bream and 100 bass per acre. In unfertilized ponds, stock one-half these numbers. Bream (bluegills) are stocked during the period of November through March each year, and bass are stocked during May.

Davis, R. K. 1955. Farm Pond Management. Ohio State Univ. Agric. Ext. Ser. Bull. 336:8

Ohio stocks farm ponds with largemouth bass and bluegill at the rate of 100 fingerlings of each per acre.

Davison, Verne E. 1955. Managing farm fishponds for bass and bluegill. U. S. Dept. Agric. Farmers Bull. 2094:18.

A good stocking rate for bass and bluegills in ponds is 1,000 to 1,500 bluegills and 100 to 150 bass per acre in fertilized ponds. For unfertilized ponds, stock 500 bluegills and 50 bass per acre. With these stocking rates, 4 pounds of bluegills should be produced for each pound of bass produced. After 12 to 18 months, bluegills should weigh from 3 to 6 ounces each and the bass should weigh about 12 ounces to 1 pound. This stocking rate should give the useable size fish 75 per cent or more of the pond's fish food, thus, preventing an overpopulation of smaller fish in the succeeding years.

Dillard, J. G. and M. Hamilton 1969. Evaluation of two stocking methods for Missouri farm ponds. Mo. Dept. Conserv. D-J Series 7:17.

In 1965, 52 ponds that had been stocked with largemouth bass in the summer of 1962 and stocked with bluegill and channel catfish in the fall were seined. In 1966, data was similarly collected from 41 ponds that were stocked with all three species simultaneously in the fall of 1963. Stocking rates were 100 bass, 500 bluegills and 50 catfish per acre.

All species stocked were young-of-the-year, usually less than 3.0 inches total length.

The variation in stocking method appeared to have little effect on the size attained by the various year-classes of bass, bluegills and catfish. Ponds stocked by the split-stocking method appeared to have better fish population structures than when all three species were simultaneously planted. However, this was only true if pond owner negligence in stocking bluegills was disregarded.

Fuller, Jefferson C. Jr. 1963. Management of farm ponds in South Carolina. S. Carolina Wildl. Res. Dept:16.

South Carolina recommends stocking ponds with the bass-bluegill combination. For fertilized ponds, 1,000 bluegills and 100 bass should be stocked per acre. Unfertilized ponds should be stocked with 400 bluegills and 30 bass per acre. All fish stocked should be fingerlings. Bluegills are stocked in the fall followed by the bass the next spring.

Fuqua, Charles L. 1949. Analysis of Farm Ponds in Oklahoma, Texas, and New Mexico. Prog. Fish. Cult., 11(3):179-184.

Fuqua states that the Fish and Wildlife Service recommends stocking bass-bluegill ponds at a ratio of 1 bass for every 10 bluegills. These early stocking recommendations were more or less rule of thumb ratios and did not consider the water fertility and the physical characteristics of the ponds, or how the fish crop was intended to be utilized.

Gasaway, Charles R. 1968. Comparison of bass-bluegill and bass-redear sunfish stocking. Okla. Acad. Sci., 47:397-406.

The objective of this study was to evaluate present and past stocking policies in Oklahoma. Ponds chosen for study in 1964 were selected from a list of pond stocked prior to 1958. Usable samples were collected from 38 farm ponds. In making comparisons between the two groups of ponds, only those ponds stocked 4½ to 7½ years prior to the study were used. At the time the ponds were studied, 12 usable bass-redear ponds that had been stocked an average of 6.2 years and 12 usable bass-bluegill ponds that had been stocked an average of 6.18 years were located.

Bass-bluegill ponds had been stocked at the average ratio of 1.55:1, while bass-redear had been stocked at an average ratio of 1.06:1. Bass,

in both groups of ponds, had been stocked in a range of 34 to 100 fish per pond, while bluegill ranged from 17 to 100 per pond and redear ranged from 30 to 100 per pond.

There was a tendency for the numbers of bass to decline as the ponds aged when stocked with redear sunfish, however, this decline was not evident when bass were stocked with bluegills. Bluegills had reproduced in 60 per cent of the ponds in which they had been stocked.

The author states that these studies indicate that in ponds stocked at an approximate 1:1 ratio of bluegills or redear to bass and in quantities of somewhat less than 75 fish of each species per acre, the bass-bluegill combination is capable of providing more satisfactory fish populations.

Gentry, Glenn, 1951. Management of farm ponds. Univ. of Tenn. Agric. Ext. Ser. Publ. 333:22-28.

Recommends new pond stocking rates in Tennessee of 100 largemouth bass fingerlings and 1,000 to 1,500 fingerling bluegills per surface acre. If the pond is not fertilized, then the stocking rate should be cut down to 30 bass and 400 bluegills per acre.

Gowder, M. T. and D. P. Schwab. 1951. Farm Ponds. Univ. of Tenn. Agric. Exp. Ser. Publ. 333:28.

The authors recommend that fertilized ponds in Tennessee be stocked with 100 bass fingerlings and from 1,000 to 1,500 bluegill fingerlings per acre. In unfertilized waters, stock 30 bass and 400 bluegills per acre.

Gulish, William J. 1970. Bluegill predation by three fish species. Proc. Ind. Acad. Sci., 79:139-147.

Since bluegills tend to overpopulate in farm ponds, an experiment was set up to evaluate the ability of three predacious species, northern pike, white catfish and largemouth bass to control bluegill populations.

One pond was stocked with 100 bass and 1,000 bluegills per acre. The bass ranged from 6.0 to 7.0 inches in length and bluegills were from 1.0 to 2.0 inches. All fish were stocked in the spring of 1967 and the ponds were drained in the falls of 1967 and 1968.

At the end of two growing seasons, the bass-bluegill pond developed an overpopulation of bass. Bass predation kept the bluegill population far below carrying capacity.

Gulish states that it is extremely difficult 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 bluegills stocked. This would slow the growth rate somewhat, and reduce the recruitment to a more manageable level.

An alternative is to decrease the bluegill survival by increasing the number of bass stocked. It is not known which method would produce the highest fishing yield over an extended period of time.

Hall, John F. 1958. Final report on the success of largemouth bass-bluegill and largemouth bass-shellcracker rates and ratios in Kentucky farm ponds. Proc. Conf. S.E. Assoc. Game, Fish Comm., 12:91-116.

A total of 574 farm ponds were stocked with bass and bluegills to evaluate their performance in various stocking ratios. Ponds were stocked at the following rates per acre: fry bass and fingerling bluegills, 30:400, 50:500, 80:500 and 100:500; fry bass and adult bluegills, 100:30, 100:50 and 100:70. Ponds were tested for balance or unbalance by seining a series of the ponds yearly for a period of 3 to 6 years. Results indicate that bass fry-bluegill fingerling ratios of 80:500, 100:500 and bass fry-adult bluegill ratios of 100:30, 100:50, and 100:70 gave about the same results.

Hall recommended stocking ponds using 80 bass fry with 500 fingerling bluegills per acre or 100 bass fry and 50 adult bluegills per acre. He noted that bluegills have a tendency to overpopulate, therefore, ponds should be made deep to decrease the amount of spawning area. An adequate number of bass must be stocked to keep the bluegills in check, however, too many bass and not enough bluegills can cause the bass to overpopulate.

Holloway, Ancil D. 1951. An evaluation of fish pond stocking policy and success in the southeastern states. Prog. Fish-Cult., 13(4):171-180.

Recommended stocking rates in the southeastern states is 50 bass and 500 bluegill per acre in unfertilized ponds and double that figure for fertilized ponds. Bluegills are stocked in the fall and bass are added the following spring. Of a total of 612 ponds stocked, a sample of 323 were chosen at random and were examined after fish populations were well reestablished. Factors that appeared to influence balance for future years was faulty pond construction, wild fishes, improper stocking rates

and aquatic vegetation. The stocking rate in relation to the carrying capacity and weeds that reduce bass predation on the bluegill are two primary factors that permit or prevent development of a balanced fish population. Carrying capacity can be increased by proper fertilization. The author states that not much more than 10 per cent of the pond bottom should be covered with vegetation if overcrowding of bluegills is to be prevented.

Krumholz, Louis A. 1950. New Fish Stocking Policies for Indiana Ponds. Trans. Am. Wildl. Conf., 15:251-267.

The author concludes that the bass-bluegill combination should not be used in Indiana. This conclusion is based on results gathered from his own stocking of private ponds and pond stocked by other agencies. He bases these conclusions on the fact that bluegills have a strong tendency to overpopulate. In Indiana, female bluegills reach maturity and reproduce during their second summer of life, while female bass, even though they may reach a length of 10 inches during their first full year of life, will seldom reproduce before they are two years old. If it is imperative that bluegills be stocked, he recommends no more than 50 fingerling bluegills along with at least 100 fingerling bass and either 100 rock bass or crappie fingerlings per acre. It must be kept in mind that rock bass are primarily stream fish and are not particularly well-suited for pond life and crappies do well only in deep ponds. It may be that stocking bowfin with bass and bluegills will aid the bass in keeping predatory pressure on the bluegills.

One interesting statement by Krumholz was fish stocking ratios are not important as long as one of the fish is not stocked in excessive greater numbers than the other fish in the combinations. He contends that the results of stocking depends more on the species stocked than the numbers of fish stocked.

Krumholz, Louis, A. 1952. Management of Indiana Ponds for Fishing. J. Wildl. Mgmt., 16(3):254-257.

Largemouth bass (100 to 500 fingerlings per acre) and bluegills (10 to 1,000 fingerlings per acre), were tested in conjunction with bass and various other forage species. Of this series of combinations, the

largemouth bass or spotted bass.

The combination of bass and bluegills usually results in an overpopulations of bluegills within a few years. The apparent reasons for such an overpopulation are the abilities of the bluegill to produce many young and the inadequacy of the bass as a predator on the bluegill. The actual number of fingerlings of either species did not seem to have any effect on the future success of the pond fish populations unless one or the other was stocked in overwhelmingly large numbers.

The bass-bluegill pond combinations is not recommended for initial stocking, however, if they are stocked, only enough individuals of each species concerned should be introduced to get the population established. Another method more satisfactory than stocking bass-bluegill only is adding some other predator species such as rock bass, black crappie or white crappie to assist the bass control of the bluegills.

Leedy, Donald J. (no date). Tips on pond stocking. Ind. Dept, Conserv. 8:4

Leedy states that Indiana ponds over 1 acre, but under 1.5 acres , should be stocked with 200 channel catfish per acre or with 200 bass and 1,000 bluegills per acre. In ponds larger than 1.5 acres, stock 200 bass per acre the first year, then add 1,000 bluegills per acre the following year.

Lopinot, A. C. 1967. Pond fish and fishing in Illinois. Ill. Dept. Conserv., Fish. Bull. 5:62.

The stocking of correct numbers and sizes of recommended pond fish species is very important. The stocking of correct numbers of fingerlings will produce faster sport fishing than stocking small numbers of adult fish. By stocking fingerlings, all fish will grow at a rapid rate and fishing can begin the second summer.

Recommended bass-bluegill stocking rates in Illinois are 100 bass per acre stocked with from 100 to 400 bluegills depending upon pond and watershed fertility. Lopinot recommends stocking 100 bluegills per acre in fairly fertile ponds, 200 in ponds of average fertility, 300 in ponds with good fertility and the maximum rate of 400 bluegills per acre in ponds with high fertility.

Redear sunfish may be stocked in conjunction to the bluegills. When this is done, the forage population should contain about 30 per cent redear sunfish and 70 per cent bluegills.

Lopinot, A. C. 1971. New Illinois Dept. of Conservation Fish Stocking Procedure. Ill. Dept. of Conserv. (mineo), 1 p.

The Illinois Department of Conservation is presently stocking 100 largemouth bass and 1,000 bluegills per acre. The bluegills will be stocked in the fall and bass will be added in early summer the following year. The author states it is extremely important to stock both fish species to insure good fishing.

McCarraher, D. B. 1959. The northern pike-bluegill combination in north central Nebraska farm ponds. Prog. Fish-Cult., 21(4):188-189.

A northern pike-bluegill combination was stocked in two small impoundments (5.5 and 7.1 acres) in Nebraska. The 5.5 acre pond was stocked with 648 pike fingerlings and 144 adult bluegills while the 7.1 acre pond received 800 pike fingerlings and 22 adult bluegills. All fish were stocked in the spring. Bluegills, in both ponds, reproduce the first summer and provided abundant pike forage throughout the year.

Meehan, O. Lloyd. 1952. Problems of Farm Fish Pond Management. J. Wildl. Mgmt., 16(3): 233-238.

Stocking rates for bass and bluegills in new ponds normally consist of 100 bass and from 750 to 1,500 bluegills. Whenever, 1,500 bluegills are stocked, they will be somewhat smaller when stocked. In unfertilized waters, approximately one-half that number is recommended. Most stocking rates recommended by state biologists are 100 bass and 200 bluegill per acre, 200 to 200, or other similar ratios.

Moorman, Robert B. 1957. Some factors related to success of fish populations in Iowa Farm ponds. Trans. Am. Fish Soc., 86(1956): 361-370.

A total of 60 farm ponds in Marion County, Iowa that had previously been stocked with largemouth bass-bluegill and largemouth bass-bluegill-bullhead were sampled to determine reproductive success of all fish and relative balance.

The ponds had been stocked with a bluegill-bass ration ranging from 4:1 to 10:1. Numbers of bluegills stocked per acre ranged from 200 to 2,500. The majority of fish stocked were fingerlings, however, one pond received fry stocking.

The author found that 15 of 26 ponds stocked with bass-bluegills-

bullheads were successful. There was no discernible correlation between the stocking ratio of bluegills to bass and ultimate success of the pond. The author also found no apparent relationship between rates of stocking and future success within the stocking range for the ponds.

Moorman, Robert B. 1957. Reproduction and growth of fishes in Marion County, Iowa, farm ponds. Ia. State Coll. J. Sci. 32(1):71-88.

Pond fish populations from 19 farm ponds in Marion County, Iowa, were examined. Bluegills were collected by seining, angling and renovation with rotenone. Swingle (1943) reports that in Alabama bluegills have been reported as spawning at one year of age, if, at that time, they weigh at least ½ ounce. Moorman states that in Iowa, bluegills of that weight would be approximately 3.5 inches in total length. He also states that this size would probably be reached the summer following initial stocking. The minimum size was not normally reached by yearling bluegills in other ponds where stockings were several years old.

In Iowa ponds, young bluegills could usually be taken with a minnow seine by late June or early July, however, in four of the ponds checked, young-of-the-year bluegills were not taken by seining until August. Lower than normal water temperatures (less than 80°F) and overcrowding may have attributed to the late spawn of bluegills in these four ponds.

Morgan, George D. 1958. A study of six different pond stocking ratios of largemouth bass, Micropterus salmoides (Lacepede), and bluegill, Lempomis macrochirus (Rafinesque); and the relation of the chemical, physical and biological data to pond balance and productivity. Dennison Univ, J. Sci. Lab. 44(11):151-202.

This study was set up to test six stocking ratios of bass and bluegill in twelve, 1-acre ponds in Ohio. The following is a list of numbers and sizes of fish stocked.

Ponds	Stocking Date	Fish	Number/Acre	Size in inches
2	7/18/53	bass	200	2-2 1/8
	9/4/53	bluegill	1,000	2-2 1/8
2	7/28/53	bass	100	2-2 1/8
	9/17/53	bluegill	1,000	2-2 1/8
2	7/7/53	bass	100	2-2 1/8
	11/11/52	bluegill	30	Adult breeders

2	9/23/53	bass	100	2-2½
	11/9/53	bluegill	100	2 1/8 - 2½
2	8/26/53	bass	200	2 1/8
	9/4/53	bluegill	200	1 7/8 - 2 3/8
2	9/22/53	bass	100	2¼ - 3
	9/22/53	bluegill	1,000	2 - 2 3/8

At the end of the experiment, all ponds were drained and their fish populations analyzed. Based on Swingle's ratios (1950), and the best F/C, Y/C, A_c, A_f, S_t ratios was the 200 bass and 1,000 bluegills stocked on 7/18/53 and 9/4/53, respectively. Second best was the 200 bass and 200 bluegills stocked on 8/26/53 and 9/4/53, respectively. The third and fourth best ponds were stocked with 100 bass and 1,000 bluegill in July and September, respectively.

In terms of pounds of harvestable fish and balance, ponds stocked with 200 bass and 1,000 bluegills were best. Ponds stocked with 100 bass and 1,000 bluegills were rated second. It is interesting to note that these ponds were stocked with bass in July and bluegills were added in September.

Nine of the 12 ponds were in balance after five years. One of the unbalanced ponds was stocked with 30 adult bluegills in September, 1952, and 100 bass were added in July, 1953. The other two ponds out of balance were stocked with 100 bass and 100 bluegills in September and November, respectively.

Neely, W. W., Davison, V. E. and L. V. Compton. 1965. Warm-water ponds for fishing. U. S. Dept. Agric. Farmers Bull. 2210:16.

The authors recommend pond stocking rates established by southern workers in the early 1940's. These rates include 50 bass and 500 bluegill per acre for ponds of average fertility. In fertilized ponds, stock from 100 to 150 bass per acre with 1,000 to 1,500 bluegills. They point out that it is a serious mistake to stock at the higher rate if the pond is not adequately fertilized year after year.

Padoll, Erling, 1958. Wisconsin farm ponds., Wis. Conserv. Bull. 23(8):4.

Wisconsin stocking recommendations include planting 100 fingerling bass and 500 fingerling bluegill per acre. The author states that this ratio may not be the best for Wisconsin ponds but, because of lack of investigation for better ratios, the present recommendations will be used.

Untried stocking methods that may have merit include planting 100 fingerling bass and 20 adult bluegill per acre.

Price, Ora M. 1963. 1963 Farm Pond Survey. Ill. Dept. Conserv. Spec. Fish. Rpt. 5:20.

In 1952, a total of 249 water areas (0.5 to 1.5 acres in Illinois were stocked with largemouth bass-bluegill. Stocking rates for bass ranged from 85 to 104 fingerlings per acre and from 84 to 103 fingerlings bluegill per acre.

In 1963, these ponds were sampled to access their relative performance in terms of providing fishable populations. It was learned that 41 per cent of the ponds received additional stockings of fish other than those stocked by the Illinois Department. Bass and bluegill fishing was best in those ponds supporting only those two species.

Regier, Henry A. 1960. Bass, bluegills, shiners, - and farm ponds, N.Y. Conservationist, June-July:18-20.

Regier points out that a pond owner in New York stands a considerably better chance of getting some satisfactory sport fishing with the largemouth bass-golden shiner combinations than with largemouth bass-bluegill. In the bass-bluegill combination, there is a strong tendency for the bluegills to reproduce too successfully. This causes young bluegills to run out of food, consequently, stunting their populations. When this occurs, fishing becomes poor.

However, bass and bluegills are provided to the pond owner. Recommended stocking rates are 100 bass and 1,000 bluegills per acre.

Regier, Henry A. 1963. Ecology and Management of Largemouth Bass and Bluegills in Farm ponds in New York. N. Y. Fish and Game J. 10(1);89.

Bass and bluegills were stocked in ponds at various rates: 100 bass and 500 bluegills, simultaneously; 100 bass and 1,000 bluegills, simultaneously; 100 bass and 1,000 bluegills, staggered.

Fingerlings were used. With simultaneous stocking both species were planted the same summer, with staggered stocking bluegills were introduced the year following bass. Stocking was usually done in late summer. After four years, composition of the bass-bluegill populations was similar in all three categoris. Regier stated that perhaps staggered

populations would have fewer cases of bluegill crowding and more of bass crowding than simultaneous populations, and if this is the case, then staggered stocking may have an advantage over simultaneous stocking in this respect. On the other hand, bluegill harvests would usually be higher in the 100 - 1,000 simultaneous than in the 100 - 1,000 staggered category. The author feels that bluegills probably will become crowded somewhat more frequently in a 100 - 1,000 simultaneous population.

Regier recommends 100 bass fingerlings, and 1,000 bluegill fingerlings be stocked simultaneously, however, there is a tendency for overpopulation by bluegills.

Saila, Saul B. 1952. Some Results of farm pond management studies in New York. J. Wildl. Mgmt., 16(3):279-282.

In the early 1950's, New York stocked 100 bass fingerlings and 1,000 bluegill fingerlings per acre in ponds, however, the overall results of such stockings have been unpredictable. This stocking rate was described by Swingle (1950) and probably cannot be used in the northern states. In New York, water temperatures appears to be the primary reason for lack of success with the bass-bluegill combination. Bass will not spawn until they are two years old, whereas, bluegill can spawn one year after stocking. Variable stocking ratios of bass and bluegills ranging from 2:5 t o 1:10 produced no observable differences in angling success.

Smith, E. V. and H. S. Swingle, 1940. Winter and Summer growth of bluegills in fertilized ponds. Trans. Am. Fish. Soc. 70(1941):335-338.

Experiments were conducted to study winter and summer growth of bluegills in fertilized ponds. In December, small ponds were stocked with 1,750 bluegill fingerlings per acre. These fish averaged 3.8 grams in weight. Three months later, their weight had increased to 11.4 grams, an increase of 200 per cent. Water temperatures during this time ranged from 37.4° F. in January to 59°F. in March. Another fertilized pond was stocked in March with 1,500 bluegill fingerlings per acre and averaged 4.5 grams in weight. In June, samples of these fish averaged 80 grams or an increase of 1,700 per cent. Water temperatures during this period of time ranged from 66.2° F. to 75.2°F.

Smith and Swingle point out that growth during the winter months is so slow that fertilization during the winter is generally not practical, however, ponds stocked during fall or winter should be fertilized lightly

to produce sufficient food so as to insure good fish health until spring.

Smith, E. V. and H. S. Swingle. 1943. Percentages of survival of bluegills (Lepomis machrochirus) and largemouth black bass (Huro salmoides) when planted in new ponds. Trans. Am. Fish. Soc., 72(1942): 63-67.

Smith and Swingle stocked both fertilized and unfertilized and unfertilized ponds with varying numbers of bluegill fingerlings alone and bluegill and advanced bass fry to determine survival rates for newly stocked bluegills.

In order to obtain maximum utilization of food produced, five fertilized ponds were stocked with 13,000 fingerling bluegills per acre. When these ponds were drained in the fall, survival of 76 to 90 per cent was found, but identical stocking in five unfertilized ponds yielded only 29 and 30 per cent survival. Two fertilized ponds stocked with 2,600 bluegills per acre, yielded 95 per cent survival, whereas two fertilized ponds stocked with 1,300 bluegills had 1,000 per cent survival. In 2 fertilized ponds, when the stocking rate was increased to 1,500 bluegills per acre, survival was 75 and 91.7 per cent.

One fertilized pond was stocked with 1,500 bluegills per acre and 98 bass fry. In the fall, 85.3 per cent of the bluegills survived and 74.8 per cent of the bass were alive. In another fertilized pond, bluegills were again stocked at 1,500 per acre but bass were increased to 100 per acre. Survival in this pond was 76.6 per cent for the bluegills and 90 per cent for bass. Survival of bass and bluegills was measured in an unfertilized pond. Bluegills were stocked at 400 per acre and bass were planted at 28 per acre. In the fall, survival for the bass was 82.1 per cent and bluegill survival was 83.5 per cent.

Smith, W. A. Jr., J. B. Kirkwood, and J. B. Hall. 1965. A survey of the success of various stocking rates and ratios of bass and bluegill in Kentucky farm ponds. Ky. Dept. Nat. Res., Fish. Bull.16:42.

A total of 872 ponds were selected from the files of stocked ponds to be used for this survey. Many of these ponds were eliminated for various reasons. Common problems were some ponds were dry, others were contaminated with undesirable fish species, while others could not be sampled because of extreme depth or physical obstructions. Of the almost 900 originally selected ponds, 113 were sampled to evaluate the relative success of various

stocking rates and ratios of fingerling or fry bass stocked with either fingerling or adult bluegills.

Sixty-three ponds were used for comparing various rates and ratios of fingerling or fry bass and fingerling bluegills. Stocking ratios of bass to bluegills in these ponds ranged from 1:3 to 1:12 and stocking rates for bass ranged from 80 to 250 per acre, while bluegills were stocked from 250 to 2,500 per acre. Fifty ponds were used for comparing various rates and ratios of fingerling or fry bass to adult bluegills. Stocking ratios of bass to bluegills in these ponds ranged from 1:1 to 10:1. In these same ponds, stocking rates of bass ranged from 50 to 750 per acre, while adult bluegills ranged from 20 to 150 per acre.

Three and four years after stocking, the ponds were sampled. In many cases, one replication was all that could be used to compare results, however, one rate and ratio was documented in 12 ponds. The highest percentage (87 per cent) of balanced ponds were produced by a fingerling ratio of one bass to eight bluegills. The highest significant percentage (46 per cent) of balanced ponds resulting from adult bluegill stocking was produced by a ratio of three bass to one bluegill. The authors state the most useful ratio for stocking bass and adult bluegills appears to lie between 2:1 and 6:1, whereas, the best appearing ratio for stocking bass and fingerling bluegills is above 1:12; the best range appears to be 1:10 to 1:6, inclusive.

The authors state that in adult stocking, the tendency for overcrowding by bluegills appears to increase as the ratio of bass to bluegills is increased. Conversely, the tendency for overcrowding by bass appears to increase as the ratio of bass to bluegills is decreased. They also state that in fingerling stocking, the ratio of one bass to eight bluegill fingerlings produced a maximum number of balanced populations. Either increasing or decreasing this ratio seemed to result in an increasing tendency for overcrowding by bluegills.

Stockdale, Thomas M. 1967. Farm pond management. Ohio State Univ. Coop. Ext. Ser. Bull. 374:16.

The Ohio Extension Service recommends stocking small ponds ($\frac{1}{4}$ to $\frac{1}{2}$ acre) with 200 largemouth bass and 1,000 bluegills per acre. For larger ponds, use the same numbers of bass and bluegills per acre, only stock 100 channel catfish per acre with them. All species of fish stocked

should be fingerling size.

Summers, Max W. 1963. Managing Louisiana fish ponds. La. Wildl. and Fish Comm:64.

Recommended pond stocking rates in Louisiana follow very closely to those recommended by Dr. H. S. Swingle. They recommended stocking 10 bluegill fingerlings for every one bass fingerling. The actual number of course, depends upon the fertility of the individual pond. Unfertilized ponds should be stocked at the rate of 50 bass and 500 bluegill per acre. In fertilized ponds, the recommended rate of stocking is 100 bass and 1,000 bluegill per acre.

Surber, Eugene W. 1949. Results of varying the ratio of largemouth black bass and bluegills in the stocking of experimental farm ponds. Trans. Am. Fish. Soc., 77(1947):141-151.

Fertilized ponds at Leetown, West Virginia were stocked with various ratios of bass and bluegill fingerlings per acre. Bass fingerlings ranged from 50 to 100 per acre, while fingerling bluegills ranged from 100 to 640 per acre. Results from this study show that regardless of the stocking ratios used, standing crops of fish were about the same. Surber recommends stocking 100 bass fingerlings and 800 bluegill fingerlings because this ratio will produce more desirable-size fish than higher rates. He does comment that data indicates edible fish production is about double in the deep south. This difference may be due to a longer growing season.

Swingle, H. S. and E. V. Smith, 1939. Increasing fish production in ponds. Trans. N. Am. Wildl. Conf., 4:332-338.

Swingle and Smith state that stocking with large fingerlings has recently been tried since poor results have so often been obtained from stocking with smaller fish. The use of larger fish has proved of little value when stocking with bluegills bream. Where the food supply was sufficient, half-ounce bream reached a size of 4 ounces within a four-month period in ponds, while under less favorable food conditions, 2-ounce bream actually decreased in weight during the same period. If food was abundant, small bream rapidly became large bream, while if food was not

abundant, large bream just maintained or even lost weight.

Heavy stockings of ponds did not result in increasing the pounds of fish produced per acre, but did decrease the average size of fish.

Swingle, H. S. and E. V. Smith, 1940. Experiments on the stocking of fish ponds. Trans. N. Am. Wildl. Conf., 5:267-276.

Swingle and Smith recommend stocking fingerling bass (100 per acre) and fingerling bluegill (1,500 per acre). Inorganic fertilizer was added to most ponds to increase production. They stocked a 1.3 acre pond by this method. The results indicated that bass can effectively balance a pond containing bluegills when stocked with fingerlings at the same time. When this pond was drained in the fall, the number of small bluegills left was approximately sufficient to carry the bass through the winter and replace any bluegills removed by fishing. At fall draining, over 89 per cent of the total weight of bluegills was in the form of legal-size fish.

Swingle and Smith state that when a pond is stocked in the above manner, the bass should be as small as, or smaller than, the bluegills so that the bluegills cannot be eaten. The bass will then be unable to feed upon bluegills after spawning occurs.

Swingle, H. S. 1949. Experiments with combinations of largemouth black bass, bluegills, and minnows in ponds. Trans. Am. Fish Soc. 76(1946): 46-62.

Swingle conducted experiments stocking largemouth bass and various forage species in fertilized ponds. Species of forage fish tested included, Gambusia, golden shiners, gizzard shad, and goldfish. Bluegill fingerlings (200 per acre) were stocked in the fall and followed by 200 bass fingerlings the next fall. One year after the bass were stocked, this combination produced 103.2 pounds of bass and 251.6 pounds of bluegill per acre. In another experiment, 200 bluegill fingerlings per acre were stocked in the fall followed with 200 fry bass the next spring. That fall, the pond contained 62.4 pounds of bass and 82.2 pounds of bluegill per acre.

Swingle concluded that the bluegill appears to be the most desirable forage fish of the species tested for a long time basis. Golden shiners yielded higher bass production for about three years, then were lost to predation.

Swingle, H. S. 1949. Some recent developments in pond management. Trans. N. Am. Wildl. Conf., 14:295-310.

According to Swingle, bluegills make most of their growth when surface water temperatures range between 60° and 80°F. Above 80°F., the bluegill spends most of its energies spawning and grows very little. No young are produced until surface water temperatures reach at least 80°F. As a result, the bass-bluegill combination is unsuitable for use in ponds where water temperatures at surface do not exceed 80°F. Waters carrying heavy loads of suspended silt seldom exhibit good bluegill populations.

Swingle, H. S. and E. V. Smith. 1950. Management of farm fish ponds. Ala. Agric. Exp. Sta., Bull. 254:30.

Swingle and Smith recommend stocking 1,500 bluegill fingerlings in late summer, fall or winter and 100 bass fingerlings per acre the same fall or winter or 100 bass fry the following spring. These recommendations are for fertilized ponds which can support 400-600 pounds of fish per acre.

In unfertilized ponds, which have carrying capacities ranging from 40-200 pounds of fish per acre, they recommend stocking 400 bluegill fingerlins per acre in late summer, fall or winter and 30 bass fingerlings the same fall or winter. Fry bass can be substituted for fingerlings, however, they should not be stocked until the following spring.

Swingle, H. S. 1950. Relationships and Dynamic of Balanced and Unbalanced Fish Populations. Ala. Agric. Exper. Sta., Bull.274:74.

Swingle described the dynamics of a balanced pond fish population. The delicacy of the balance involved may be illustrated by the results in a simple bass-bluegill combination. Where bluegills are stocked in a fertilized pond at the rate of 1,500 per acre, approximately 1,000 will survive to be a harvestable size of 4 ounces within one year and will completely utilize the food available for large bluegills. Each pair of bluegills then produce an average of 5,000 young during the first summer. In successive years, 4-ounce bluegills can be caught only if the young fish are reduced by predation and natural deaths to approximately the number removed by fishing plus the number of old fish that die annually. In that case, if both the adult parents are lost from these combined causes, there is room in the pond for two replacements to grow to a

4-ounce size; the predatory fish and natural mortality must, therefore, remove, 4,998 and leave two replacements in the family group. Actually, for various species in various aquatic environments and for different rates of harvest, from one to five or more years will be required for the reduction in numbers of a brood to the correct number of replacements for the adult fishes lost from these combined causes. This gives rise to the various "year-classes" and "length-frequency" groups below the size of the harvestable fish in a population.

In order to determine what the proper relationship between carnivorous and forage fish should be, Swingle removed the fish populations from 89 ponds. All fish were weighed, measured, and classified as either carnivorous or forage fish. He was then able to characterize the ponds as having balanced or unbalanced fish populations. One relationship was the weight ratio of forage fish to carnivorous fish (F/C ratio). A carnivorus fish or ("C" species) was defined as a fish which feeds primarily upon other fish. All other fish were considered forage fish or "F" species. The crappies were found to be "F" species up to and including 4 ounces and all crappie over 4 ounces in weight were considered "C" species. All sizes of largemouth bass were considered "C" species, since Swingle considered fish to be a major part of the diet of bass regardless of size. Many people think of a forage fish as one that furnishes food for a carnivorous fish; however, as Swingle uses the term, diet is the only criteria. Because of this, a 15-pound carp and 0.1 pound bluegill would both be considered a forage fish based on feeding habits. Swingle states that the most favorable range for the F/C ratio in balanced ponds was found to be 3:1 to 6:1.

The F/C ratio, the carrying capacity of the body of water, the expected mortality of the stocked fish during the first year, and the weight desired for the individual of each species of fish a year after stocking were used by Swingle to calculate the number offingerlings of each species to stock. He used the following example to illustrate a calculated stocking rate: If the pond will support 400 pounds of fish per acre, then the number of bluegill fingerlings desirable for stocking to achieve a F/C ratio 4, will be: 4/5 x 400 = 320 pounds.
320 x 4 = 1,280 bluegill fingerlings.

Swingle also believes that the best weight of a bluegill after one year is 4 ounces; therefore, the number of bluegills was obtained by

multiplying the desired number of pounds (320) by 4. No correlation was made for expected mortality of bluegills since they will spawn the first summer and that loss will be replaced by the young fish.

Swingle states the number of bass to be stocked will be: 1/5 x 400 = 80 pounds or 80 one-pound bass, mortality rates have shown that about 70 per cent of bass fingerlings or advanced fry stocked will survive. If 80 bass are to be present a year after stocking, this must be taken into consideration:

$\frac{100}{70} \times 80 = 114$ advanced bass fry or fingerlings.

Swingle states that if the above numbers of each species are used, balanced populations will usually result, barring excessive mortality among the stocked fish.

Swingle, H. S. and E. V. Smith. 1950. Factors affecting the reproduction of bluegill bream and largemouth black bass in ponds. Ala. Agric. Exper. Sta. Cir. 87:8.

In Alabama, bluegills may spawn at less than one year of age. Blue gills which hatched during early June were removed to separate ponds where food was plentiful. Some of these fish reproduced the following September, at which time they weighed from 1 to 2 ounces and were approximately 4 months of age. Swingle and Smith point out that spawning at such an early age rarely occurs. Most generally, they spawn at about one year of age, if, at that time, they weigh ½ ounce or more. In properly balanced ponds, spawning occurred at intervals during each month from April to October.

Swingle and Smith found that large adult bass were not able to obtain enough food to spawn successfully in the absence of small fish. This problem arose when adult bass were stocked with adult bluegill. Bluegills spawn after the bass which denies the bass small fish prior to spawning.

Swingle, H. S. 1951. Experiments with various rates of stocking bluegills Lepomis macrochirus Rafinesque, and largemouth bass, Micropterus salmoides (Lacepede), in ponds. Trans. Am. Fish Soc., 80(1950): 218-230.

Swingle lists three methods of stocking bass and bluegill in ponds that should result in balanced populations. (1) Stock small numbers of adult or fingerling bass and bluegills and depend upon subsequent reproduction and predation to yield the correct numbers of each species. (2)

Stock 100 bass fry or fingerlings per acre and a small number of adult or fingerling bluegills. Again, subsequent reproduction and predation must yield the correct numbers of each species. (3) Stock small bass and small bluegill fingerlings in such a way that one year later the pond will be balanced.

Be stocking adult fish, Swingle concluded bass in the 6 to 8-ounce size range were able to obtain enough food from insects and tadpoles to spawn. In an experiment using this size bass (8 per acre) and bluegills weighing 4 ounces each (8 per acre) the bass averaged only 0.45 pounds 1 year after stocking. Swingle concluded, this stocking method usually requires two or more years to establish balance, then would be uncertain because of two major factors, reproduction and predation. Since so few fish are stocked per acre, there is a chance fish of all the same sex might be stocked. Also, producing 6-ounce bass and 4-ounce bluegills for stocking purposes might place an undue burden on the hatcheries.

Swingle stocked 100 bass fingerlings and three adult bluegills per acre in a pond containing cover and in a pond with no cover. Results showed an overpopulation of bluegills in both ponds. In another experiment, he stocked 200 bass fingerlings and about one adult bluegill per acre in a pond with cover. In this case, the bass controlled the bluegills adequately but they themselves were undersized due to a shortage of food. He states that in this case, reproduction of and subsequent predation upon the bluegills must furnish the correct numbers of bluegills to achieve balance. Swingle considers this stocking technique unreliable because cover and shallow water makes it more difficult for bass to prey upon the bluegills.

Swingle found that stocking fingerling bass and bluegills in such a way that a balanced population results in one year was the most reliable stocking technique. He recommends stocking 100 bass fingerlings and between 750 and 1,000 bluegill fingerlings per acre in fertilized ponds. It seems illogical that the fewer bluegills that are used, the more likely overpopulation will occur. If the number of bass and bluegills stocked is such that in about one year they will reach harvestable size and there are enough of these fish so that their expected combined weight is over 40 per cent of the carrying capacity of the pond, then balance is probable. If a small number of bluegills are stocked, there is less control over the number of bluegills from the subsequent spawn which will combine to

make up the carrying capacity of the pond. It is likely there will be too many harvestable-sized fish for the food supply.

Swingle, H. S. 1952. Farm pond investigations in Alabama. J. Wildl. Mgmt., 16(3):243-249

For fertilized ponds, Swingle recommends that 100 bass fingerlings stocked with 1,500 bluegill fingerlings per acre yielded the greatest harvest of bass and bluegills, however, 100 bass fingerlings and 1,000 bluegill fingerlings per acre resulted in the greatest yield of bass.

Swingle, H. S. 1956. Appraisal of Methods of Fish Population Study. Part Iv. Determination of balance in farm fish ponds. Trans. N. Am. Wildl. Conf., 21:298-322.

Swingle states that there is a size below which bluegills do not spawn. A 0.3-ounce (3-inch) fish that is making rapid growth has been found to spawn if conditions are favorable. As the size of brood fish increases, so does number of young produced. In an experiment, Swingle found a 1-ounce bluegill female produced 70 young, whereas a 4-ounce fish produced 2,560 young.

Toole, Marion, 1950. Utilizing stock tanks and farm ponds for fish. Texas Game, Fish and Oyster Comm., Bull. 24:53.

Stocking recommendations for Texas ponds include stocking 150 fingerling bass and 100 bluegill and redear fingerlings per acre. If crappies are desired rather than redear, stock 100 bass with 100 bluegill and 50 crappie fingerlings per acre.

Toole mentions that adult fish should never be stocked in small ponds. He also states that one or two years after stocking, an additional 1,000 bluegill fingerlings per acre can be added if you notice large numbers of small bass and few bluegill.

Ward, H. C., E. M. Leonard and J. M. Martin, 1954. Farm Ponds for Fish in Oklahoma. Okla. Game, Fish Dept. Publ:31.

These authors recommend stocking 100 largemouth bass and 75 bluegill or redear sunfish per acre in small ponds in Oklahoma. They feel that since bluegill reproduction is high, this small number stocked will prolong the time before they overpopulate.

Wenger, Alan G. 1968. Bass stocking techniques, Job Completion Rpt. Texas Parks and Wildl. Dept. D-J Project, F-12-R-13, Job 42.

Stocking rates per acre of (1) 100 bass fingerlings and 1,500 bluegill fingerlings, and (2) 100 bass fingerlings and 50 bluegill fingerlings were tested in experimental ponds in Texas. Bluegills were stocked in January and February and the bass were added in March.

Results were that the stocking recommendations of Swingle and Smith (1950) for bass and bluegill give about the same results in Texas as they did in Alabama. Wenger states that this stocking ratio probably wouldn't work as well in Texas since most people prefer bass fishing and the bluegill population would be neglected more than in Alabama. The 100 bass - 50 bluegill resulted in a population that was dominated with bass. These ponds produced about the same yield of harvestable bass as those stocked with 1,500 bluegill, however, the total yield of all harvestable fish was much less.

Wingard, Robert G. (no date). Fish in your farm pond. Penn. State Ext. Serv. Circ. 452:21.

Recommended pond stocking rates for Pennsylvania are 100 bass fingerlings and 1,000 bluegill fingerlings per acre. These fingerling fish range between 1 and 3 inches in total length. Regardless of the number of acres stocked, the bluegill to bass ratio should be kept at 10:1. Bass should be stocked from July through September and bluegills should be stocked at the same time or later in the season - September to November.

Wingard states that it is important that the bluegills are not put in the pond early in the summer, since it is not desirable for them to reproduce during the same season they are stocked.

Winkleblech, Carl S. 1962. Farm ponds in New York. N. Y. State Coll. Agri. Cornell Ext. Bull. 949:32.

New York is conducting experiments for pond stocking recommendations, however, until information is available, they will utilize recommendations developed for more southern regions. This recommendation is to stock 1,000 fingerling bluegills and 100 fingerling bass per acre.

Additional information of the stocking rates and ratios of bluegills in small ponds and reservoirs was collected from several states neighboring Missouri from the following individuals in letters to Dr. Richard O. Anderson, Leader, Univ. Mo. Coop. Fish. Unit.

Bennett, Charles D., Okla. Dept. of Conserv. 1971.

Oklahoma stocks bass, bluegill and channel catfish in new or reclaimed waters only, and only in waters over ½-acre in size. Advanced fry of all three species are stocked during the same season (April to July). The stocking rate of each species is 100 per acre, which is a carryover figure from the fingerling stocking period, and will soon undergo change.

Collins, James L. Ark. Game and Fish. Comm. 1971.

Collins states that 50 to 100 bass, 250 to 500 bluegill, and 50 to 100 channel catfish per acre are stocked in Arkansas. Arkansas also recommends that only catfish be stocked in ponds smaller than one acre.

Hanten, Robert L. So. Dak. Dept. of Game, Fish and Parks. 1971.

South Dakota reports that largemouth bass, bluegill and channel catfish are stocked in new and reclaimed lakes in July and August. Bass (100 per acre), bluegill (300 per acre), and catfish (100 per acre), are fingerling-size when stocked.

Lopinot, A. C. Ill. Dept. of Conserv. 1971.

In a letter, Lopinot states that all new and reclaimed waters are stocked with 100 bass, 100 bluegill or redear, and 50 channel catfish per acre. Illinois plans to change their stocking program to a 5 or 10:1 ratio of bluegill and bass.

Nichols, Hudson M., Tenn. Game and Fish Comm. 1971.

Tennessee recommends stocking farm ponds with bass, bream and channel catfish. In fertilized waters, they recommend 750 bream (75% bluegill, 25% shellcracker), 100 bass and 50 catfish per acre. In unfertilized waters, they stock 500 bream, 75 bass and 50 catfish. Bream and catfish are stocked in fall or winter and bass are planted the following June.

Schoonover, Roy E. Forestry, Fish and Game Comm. 1971.

Kansas recommends stocking farm ponds with 100 largemouth bass, 50 to 100 bluegill and 100 channel catfish per acre. All fish stocked are 2 to 4-inch fingerlings and are fall stocked.

Thomas, Robert. Nebr. Game and Parks Comm. 1971.

Nebraska lists nine fish species for stocking new and reclaimed lakes and reservoirs. Among these 100 bass and 100 bluegill per acre are mentioned. These fish when stocked in the fall fingerling size, bluegills range from 1+ to 2 inches in length and the bass are from 3 to 4 inches.

Summary

In reviewing the literature, it was found that there are primarily two stocking rates of bass - bluegill being used; the southern and the northern rate, with only minor variations from state to state. The southern method involves stocking 100 bass and 1,000 - 1,500 bluegill fingerlings per acre in fertilized ponds that can support approximately 400 - 600 pounds of fish per acre. In unfertilized ponds that normally support about 40 - 200 pounds of fish per acre, the recommended stocking rate is near 30 bass and 400 bluegill fingerlings per acre. This stocking method had its origin with Swingle in Alabama and most southern states recommend these stocking rates or close variations to them.

In the northern areas of the United States where fertilization is normally not needed, stocking rates commonly mentioned are 100 bass and 300 - 500 bluegill fingerlings per acre. There is some variation in the numbers of bluegills to be stocked, however, most authors recommend stocking from 300 - 500 bluegill fingerlings per acre.

The size of bluegill stocked is usually fingerling, however, adults and fry were mentioned by several authors. Most authors feel that fingerling bluegills (in most cases no size mentioned) have the best survival and give a better chance for pond balance than do fry. Most authors feel the stocking of adults will produce an unbalanced situation very quickly.

Swingle (1956) was the only paper to specifically mention size of bluegill at spawning. He felt that under favorable conditions, a fingerling bluegill of 3 inches will spawn, however, the number of eggs produced will be small as compared to a larger fish. Most authors state

that when fingerling bluegill are stocked in the late summer or fall, they will spawn the next year.

One very important aspect to consider when stocking any fish combination is the length of growing season. Ball (1952) mentions that it normally takes three growing seasons to produce a sexually mature bluegill in Michigan, whereas Swingle (1950) reports sexually mature bluegills in one year in Alabama. Many authors from the northern areas of the United States and Canada recommend stocking adult bluegill to insure reproduction and forage for the bass.

Stocking rates and ratios have generally remained constant in the extreme northern and southern states, however, states in the midwest have tended to modify their stocking programs over the years to produce a more desirable pond fishery. In the early 1940's, the U. S. Department of Agriculture was recommending that ponds be stocked with 50 bass and 400 bluegills per acre. Soon after fertilization, an important management tool in the southern states for increasing total production and stocking rates were changed accordingly. In 1965, the U.S.D.A. recommended two stocking rates for farm ponds. If the pond was being fertilized, they recommended stocking 100 to 150 bass and 1,000 to 1,500 bluegills per acre. In unfertilized ponds, the stocking recommendation was set at 50 bass and 500 bluegills per acre. Present day U.S.D.A. pond stocking policies follow closely the 1965 guidelines. The midwestern state of Illinois shows typically the changing stocking rates for ponds over the years. Early stocking rates recommended 50 to 100 bass and equal numbers of bluegills per acre. By the late 1960's, Illinois recommended stocking 100 bass and from 100 to 400 bluegills per acre, depending upon the fertility of the water. Recently, Illinois has changed their stocking recommendations to stocking 1,000 fingerling bluegills per acre in the fall, followed by 100 fingerling bass per acre early the next summer. Back to Swingle!