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# Management of Farm Fish Ponds

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# Management of Farm Fish Ponds

## PART I. PRINCIPLES OF POND MANAGEMENT

**T**HOUSANDS of ponds have been built in the Southeastern States for the production of fish. Unfortunately, many of these ponds either have never given good fishing or the fishing has deteriorated within a few years. One of the main reasons for failure is the fact that most people do not understand the principles underlying the management of water areas for fish production. It is believed, therefore, that it should be helpful to review briefly some of the more important of these principles in order that the pond owner may understand more fully the problems involved in the successful management of his pond.

### **1. The weight of fish which an unfertilized pond can support is dependent upon the fertility of the watershed.**

Unfertilized ponds in Alabama have been found to support from 40 to 200 pounds of fish per acre of water. The lower weight occurred in poor land areas, and the higher in the best land areas. The number of pounds of fish which can be supported in a pond depends upon the amount of food for fish which the pond can produce. The materials (nitrogen, phosphorus, potassium and other elements) in the water which cause the growth of fish food are the same as those which cause the growth of field crops, such as corn and cotton. Since these materials do not occur in appreciable amounts in rain drops, they must be dissolved from the surrounding land. Many land areas in Alabama are too poor to grow good farm crops without fertilization; unfertilized ponds in these areas are also too poor to raise large crops of fish.

2. The productivity of a pond can be increased by the use of fertilizers.

Pond-fish have been found to feed mainly on microscopic water-animals, water-insects, and small fish; most of these small animals, in turn, use microscopic plants either directly or indirectly for food. These plants are so small that they cannot be seen unless highly magnified; they are present in most waters but the number is usually so small that they are not noticed. When the pond is fertilized, however, these plants grow and multiply so rapidly that they cause the water to appear green or sometimes brown. Thus, the reasons for fertilizing a pond and a pasture are essentially the same; both are fertilized to produce more plants to produce more animals, but in one case the animals are fish and in the other they are cattle or other livestock. In contrast to the low productivity of unfertilized ponds, properly fertilized ponds in Alabama support 500 to 600 pounds of fish per acre. (Fig. 1).

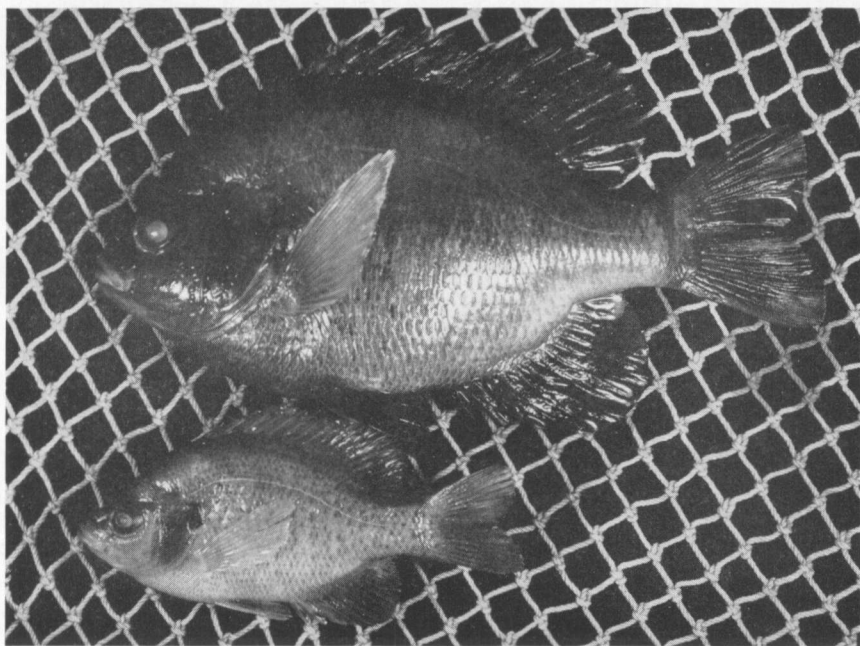


FIGURE 1.—Effect of fertilization on size of fish.

Upper — Average size (4.0 ounces) in a fertilized pond.  
Lower — Average size (1.1 ounces) in an unfertilized pond.  
Both ponds were stocked with 1500 bluegills per acre.

3. Fish grow rapidly if they have plenty of food — but very slowly if food is scarce.

Where food was plentiful, fish in ponds at Auburn made the growth illustrated in Figures 2 and 3.

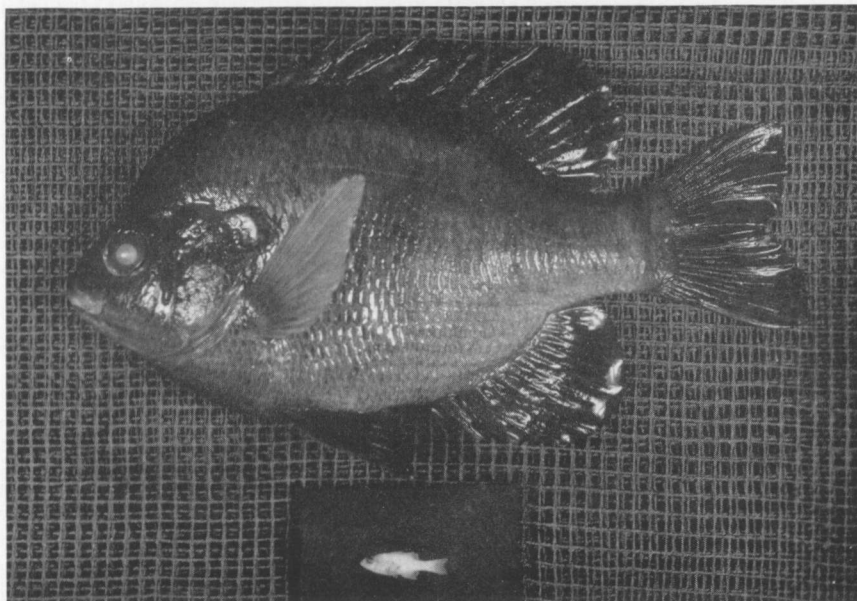


FIGURE 2.—Growth of bluegill bream (*Lepomis macrochirus* Raf.).

Lower — Size (0.007 ounce) of a week-old bluegill hatched May 1938.

Upper — Maximum size (6 ounces) reached when 1 year old, May 1939.

The extremely rapid growth of bluegills illustrated by Figure 2 is not desirable, however, since it indicates that there are too few bluegills to utilize all of the food available. Where ponds are adequately stocked with fingerlings, the bluegills should weigh 4 ounces within 1 year after stocking. The average rate of growth of bluegills in Alabama ponds and streams is 4 ounces in 4 years.

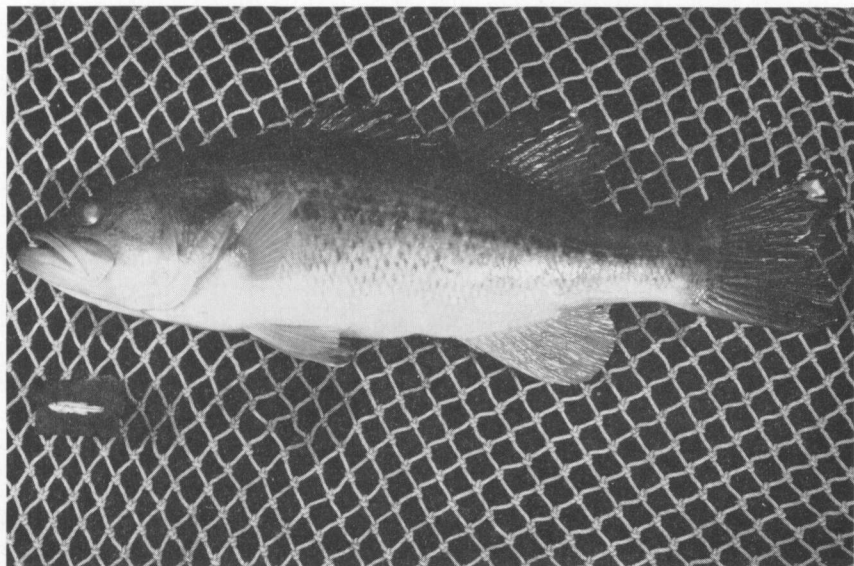


FIGURE 3.—Growth of Largemouth black bass (*Huro salmoides* Lac.).

Lower — Size (0.0008 pound) of a week-old bass hatched May 1941.

Upper — Size (1 pound) reached when 6 months old, October 1941.

The extremely rapid growth of bass illustrated by Figure 3 is not desirable, since it indicates that there are not enough bass present to utilize the available food. In properly stocked ponds, the bass should reach a weight of 1 pound within a year after stocking. The average rate of growth of bass in Alabama ponds and streams is 1 pound in 3 years.

**4. Too many fish in a pond cause small undersized fish and poor fishing.**

Since a pond can support only the weight of fish for which food is available, it can support either a large number of very small fish or a smaller number of large fish in each acre of water (Fig. 4). The former condition results in very poor fishing; the latter gives good fishing. It is very important, therefore, to stock a new pond with the correct number of fish.

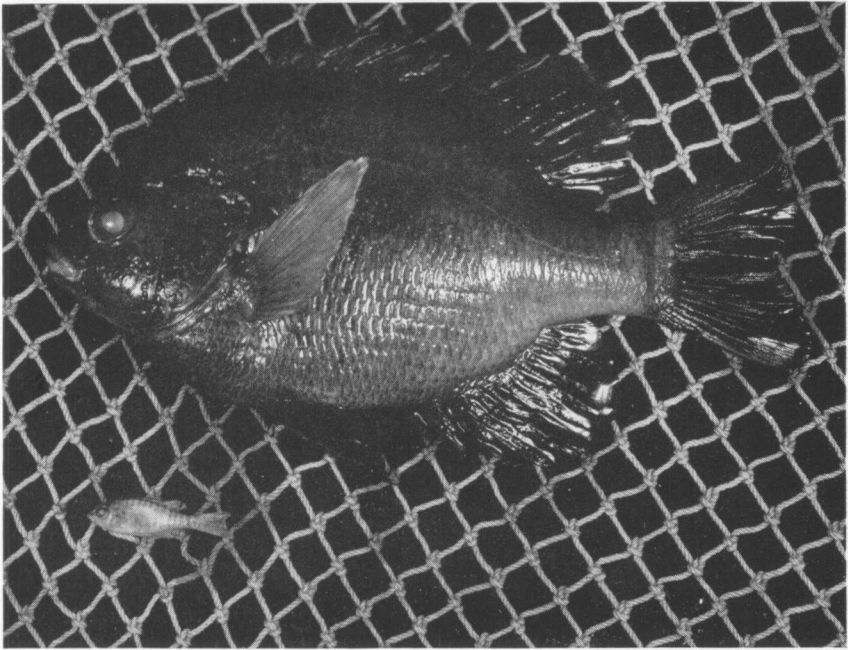


FIGURE 4.—Effect of rates of stocking on size of bluegills.

Upper — Average size (4.0 ounces) 1 year after stocking with 1500 bluegills per acre.

Lower — Average size (0.02 ounce) 1 year after stocking with 180,000 bluegills per acre.

5. **Within one year after stocking, a pond is usually supporting close to the maximum weight of fish for which food is available.**

After the fish used in stocking have spawned once, more small fish are present than can be adequately supported by the food which the pond is producing. Hence, a pond rapidly reaches its maximum carrying capacity, usually within one year. If the number of fish in a pond remains the same after the first year, an increase in the average size of these individuals is impossible unless the food supply is increased (Fig. 5).

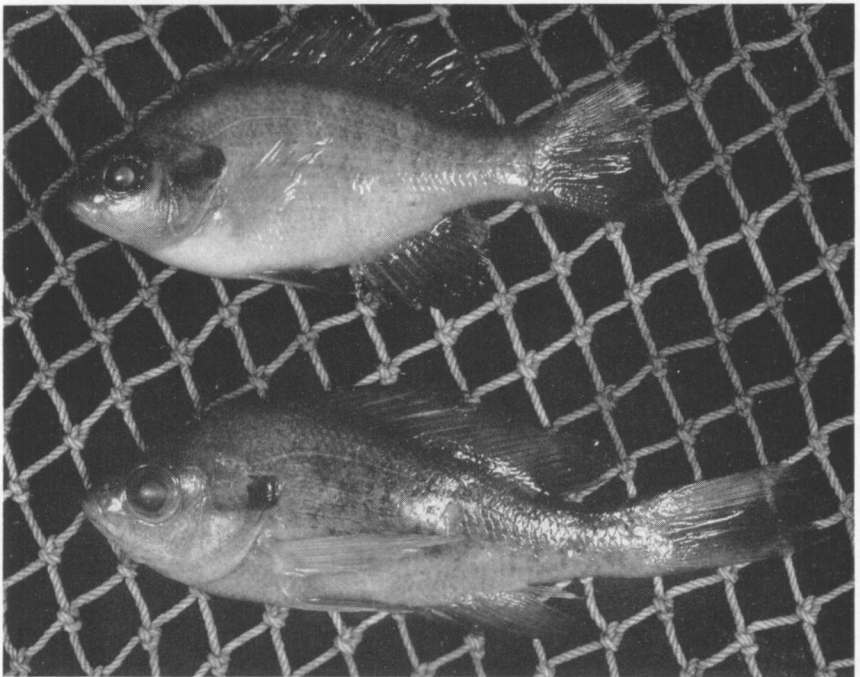


FIGURE 5.—Rate of growth in a pond stocked with 6500 bluegills per acre.

Above — Average size (0.8 ounce) 6 months after stocking.

Below — Average size (0.9 ounce) 2 years later.



6. If the number of fish in a pond is reduced, the average size of those remaining increases.

If nothing is done to increase the food supply in the pond, increases in the size of the fish after the first year can occur only when the food available for each fish is increased by reducing the number of fish present. In an experiment, 3 ponds were originally stocked with 6500 bluegills per acre. Two and one-half years later the number of fish in one pond was reduced to 3200 per acre and in another to 1300 per acre. The relative average sizes of the fish in the ponds 6 months later are shown in Figure 6.

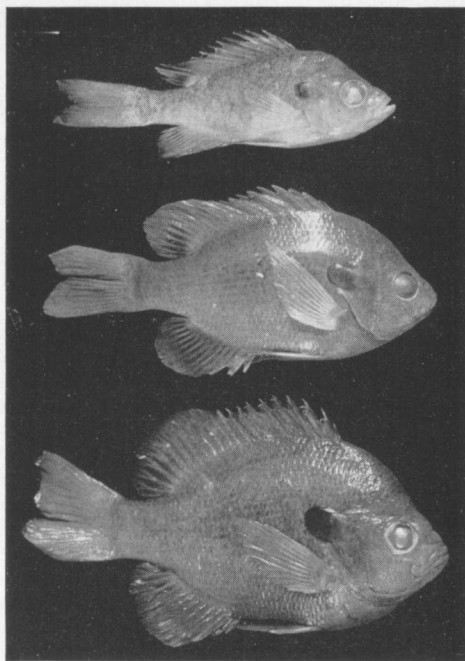


FIGURE 6.—Result of reducing the numbers of fish in ponds.

Top — 6500 per acre, average weight 0.9 ounce.

Center — 3200 per acre, average weight 1.8 ounces.

Bottom — 1300 per acre, average weight 3.7 ounces.

**7. Bluegill bream cannot be raised successfully in ponds containing only bluegills.**

Bluegill bream are excellent pond fish and should be raised in all farm ponds in the Southeastern States. However, they cannot be raised successfully alone in ponds because each pair may produce 4000 or more young fish the first year. Since they feed largely on insects and will not eat an appreciable number of their own young, the pond becomes so overcrowded with small fish that none are able to grow (Fig. 7).

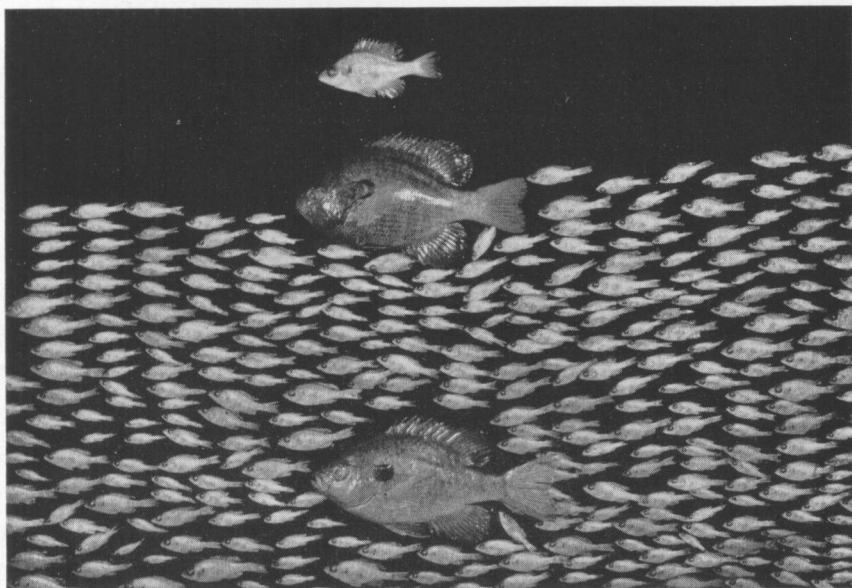


FIGURE 7.—Result of stocking with bluegills only.

Top — Average size (0.2 ounce) stocked March 1938.

Center — Average size (2.7 ounces) reached by June 1938, when spawning occurred. Each pair of bream produced an average of 4000 young.

Bottom — When pond was drained November 1938, the large bream weighed two-thirds as much (1.9 ounces) as in June, because the pond was overcrowded with their own young.

**8. Largemouth black bass should be used in ponds with bluegill bream.**

Since there is no feasible way to control the reproduction of bluegill bream, it is necessary to add some other fish to the pond to eat most of the young bream produced. The only fish which has proved satisfactory for this purpose in experiments at Auburn is the largemouth black bass (Fig. 8). This species of fish, when stocked in the proper numbers, effectively reduced the numbers of young bream and young bass in ponds so that both species made satisfactory growth.

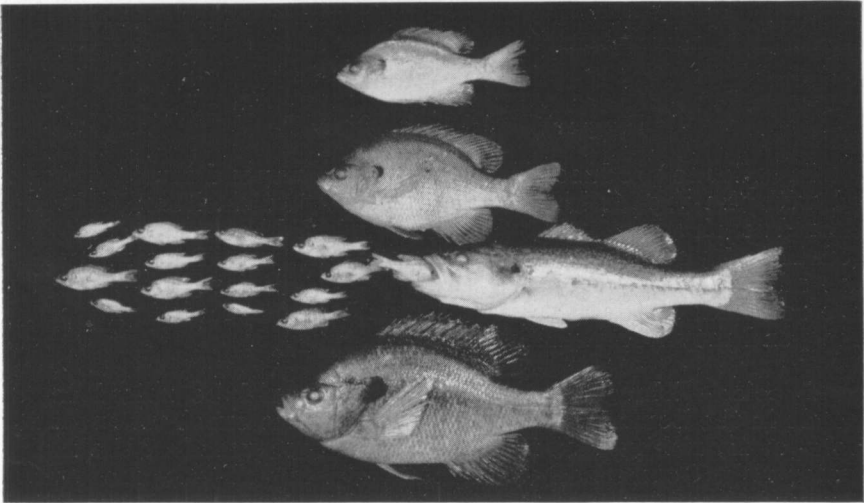


FIGURE 8.—Results of stocking with bluegill bream and largemouth black bass.

Top — Average size (0.5 ounce) of bream used in stocking February 1939.

Center — Average size of bream (1.8 ounces) in June 1939, when spawning occurred. Most of the young fish produced were consumed by the bass.

Bottom — Average size of bream (4.2 ounces) in November 1939. Since the bass had reduced the number of young fish, the bream more than doubled in weight after spawning.

From a consideration of the above principles, it is evident that the main problems involved in raising fish in ponds are the production of food and the management of the fish population so that the correct number of animals is present to utilize efficiently the food produced. These are also the main problems involved in the production of cattle or other farm animals, and many of the principles applicable to livestock production on farms are directly applicable to fish production. Although many of the principles are the same, the actual practices by which these principles are put into operation to produce animals in water differ considerably from those used to produce animals on land.

## PART II. MANAGEMENT OF PONDS

In the following pages, detailed directions are given for the management of fish ponds. The primary purpose of such management is to produce good fishing. In order to accomplish this purpose, ponds must be stocked and managed in such a manner that the maximum number of fish will be large enough to catch; the fertility of the ponds must be increased and maintained so that a large total weight of fish can be produced per acre; pond weeds must be controlled; and the ponds must be fished adequately to remove the maximum yearly crop of fish. The control of mosquitoes is necessary to prevent the spread of mosquito-borne diseases and for the fullest enjoyment of the pond by fishermen.

### Proper Stocking for New Ponds

In order to produce good fishing, a new pond must be stocked with the proper kinds and numbers of fish. Bluegill bream should reach a size of one-fourth pound and bass a size of three-fourth to 1 pound within 1 year after stocking. If too many fish are added, 3 to 5 or more years may pass before these weights are reached. If the correct combination of species is not used, the pond may never produce good fishing.

**Species.**—Bluegill bream (Fig. 2) should be raised in all ponds in the Southeastern States. It provides excellent sport for pole- or fly-fishing and is one of the best flavored of the fresh-water fish. Occasionally bluegills weighing slightly more than 2 pounds have been caught in ponds, but such large size is exceptional. In most ponds bluegills weighing in excess of 1 pound are seldom caught, the majority varying from 3 to 8 ounces. Bluegills feed mainly upon insects which live in the water, but occasionally feed upon small fish, including their own young. When overcrowded, they will eat their own eggs, as well as those of other species of fish. Bluegills as small as one-half ounce have been known to spawn when 1 year old; where food was extremely plentiful, young bluegills weighing 2 ounces spawned when 5 months old. In Alabama, egg-laying usually begins in April or May and is continued at intervals until frost. The beds have been found in water varying from 6 inches to 12 feet in depth. Nests, varying in number from 4 or 5 to several hundred, are usually swept out side by side. The fine dirt is removed by "fanning" until small pebbles or a hard bottom are exposed. After spawning the eggs adhere to the pebbles or to the firm bottom until they hatch. Bluegills are very prolific, one pair producing from 2,000 to 10,000 or more young.

Largemouth black bass (Fig. 3) should also be raised in all ponds in the Southeastern States since its presence has been found necessary to prevent a pond from becoming overcrowded with small fish. This species, often locally called "trout" or

“green trout”, is usually considered one of the gamest of the fresh-water fish. It has an excellent flavor if properly prepared for cooking. Large specimens often have a strong musky odor and taste. This objectionable taste may be largely eliminated by skinning the bass and removing the backbone and belly meat. Largemouth black bass weighing in excess of 10 pounds are seldom caught in ponds in Alabama; the majority of those caught vary in weight from 12 ounces to 2 pounds. Small bass, up to several inches in length, feed upon water fleas, water insects, and similar small animals; larger bass feed mainly upon small fish, crayfish, and frogs. Bass as small as 6 ounces have been known to spawn when 1 year old. Eggs are laid in April, May and June in Alabama. Nests have been found in water varying from 6 inches to 4 feet in depth. They resemble the nests swept out by bluegills, but are considerably larger and do not occur in groups.

The crappie (Fig. 9) is a somewhat less desirable species, but can be raised very successfully in ponds. This species apparently prefers deep water, but has been raised in ponds having a maximum depth of 4 feet. Except when caught on a flyrod or a very limber pole, the crappie puts up a poor fight. The meat is soft, but of good flavor. In shallow ponds some are caught every month of the year, but the peak of the crappie fishing comes in the early spring. The maximum size found in ponds is between 4 and 5 pounds, but most of those caught vary from 8 ounces to 1½ pounds. Crappie as small as 2 ounces have been known to spawn when 1 year old. Beds have been found in water varying in depth from 1 to 6 feet.

Catfish are desired by some pond owners because they can be caught easily on poles or in baited traps and will bite when the pond is too muddy for bream- or bass-fishing. Part of their popularity is due to the fact that they have relatively few bones and hence are easy to eat. The flavor of those species which can be raised in ponds is generally considered inferior to that of bluegill bream or bass. The channel cats (*Ictalurus* sp.) and the yellow or Appalaca cat (*Pilodictus olivaris* Raf.) usually fail to reproduce in ponds and consequently cannot be recommended. The yellow bullhead (Fig. 10) and the speckled cat (*Ameiurus nebulosus marmoratus* LeS.) are the best suited for use

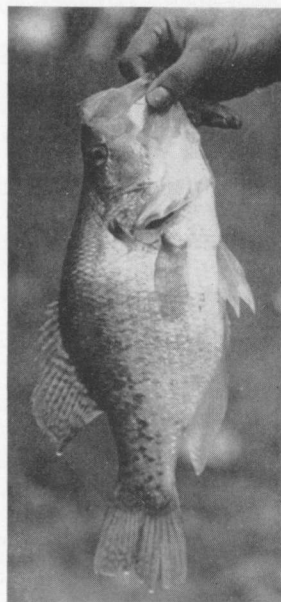


FIGURE 9. — Crappie (*Pomoxis annularis* Raf.) compete with bass, and to a lesser extent with bluegills, for food. When crappie are raised, less pounds of bass can be produced per acre.



FIGURE 10.—The yellow bullhead (*Ameiurus natalis* LeS.) reaches a maximum size of 2 pounds. It furnishes good fishing for 2 to 3 years in new ponds, but eventually disappears from ponds containing largemouth bass.

in ponds of the species so far tested. These cats have proved less satisfactory than bluegills in farm ponds and are not ordinarily recommended.

Top minnows (*Gambusia* sp.) are required in most ponds in the Southeast by State Health Department regulations to assist in the control of mosquitoes. These small minnows feed upon water fleas and various aquatic insects, including mosquitoes. In the presence of floatage or weeds lying on the surface of the water, they are ineffective for the control of mosquitoes. When the surface is kept free of weeds and trash, they are of some benefit in mosquito control. Top minnows are valuable for use in new ponds because they reproduce rapidly, giving birth to living young throughout the warm months of the year. The thousands of young produced in the early spring eat insects, including mosquitoes, which would otherwise not be utilized in the pond. As soon as the bass added to the pond become large enough, they begin to feed upon the top minnows, eventually eliminating all except those in the extremely shallow water. After the first summer, sufficient young bream and bass have hatched in the pond to utilize all the food available, including the mosquitoes, and large numbers of top minnows are then unnecessary.

**Methods of Stocking.**—For best results the number of fish added to a pond should actually be counted. This can be done without injury to the small fish by using a dipper and counting the fish as they are poured into the pond. Since small fish have a tendency to go over the spillway and to be lost, the spillway of the newly stocked pond should be screened with a quarter-inch mesh hardware screen. This screen should extend about 6 inches above the normal water level in the spillway but should not reach within 1 foot of the top of the dam. Trash should be removed from the screen periodically and especially after rains. The screen may be removed after the fish used in stocking have become adults; the adult fish normally do not go over the spillway in appreciable numbers, and so many small fish are produced that the pond balance is not upset if some of them are lost.

The correct stocking rates **per acre of water** are given below for both fertilized and unfertilized ponds. Small unfertilized ponds, however, have proved to be unsatisfactory fish ponds in the Southeastern States because they support a relatively small number of legal-sized fish and usually become filled with weeds within a few years. A combination of bluegill bream and largemouth black bass is usually recommended, but combinations including crappie or catfish are also given for those who desire to raise these fish.

**Combination A. Bluegill bream and largemouth black bass.<sup>1</sup>**

Fertilized pond:	1500 bream fingerlings <sup>2</sup> added in the late summer, fall, or winter.
	100 bass fingerlings added in fall or winter or 100 fry <sup>3</sup> the following spring.
Unfertilized pond:	400 bream fingerlings added as above.
	30 bass fingerlings or fry added as above.

**Combination B. Bluegill bream, white crappie<sup>4</sup>, and largemouth black bass.**

Fertilized pond:	1500 bream fingerlings added as in the previous section.
	75 bass fingerlings or fry added as in the previous section.
	25 crappie fingerlings or fry added at the same time that bass are added.
Unfertilized pond:	400 bream fingerlings added as above.
	20 bass added as above.
	10 crappie added as above.

**Combination C. Bluegill bream, bullhead catfish<sup>5</sup>, and largemouth black bass.**

Fertilized pond:	1200 bream fingerlings added as in previous sections.
	75 catfish fingerlings added in the fall or an equal number of fry the following spring.
	100 bass added as in previous sections.
Unfertilized pond:	300 bream fingerlings added as above.
	25 catfish added as above.
	30 bass added as above.

Stocking with adult fish is not satisfactory because this method usually results in certain species becoming overcrowded while others may fail to reproduce (Fig. 11).

<sup>1</sup>Top minnows (*Gambusia*) should be added to all ponds in the South at the rate of 50 to 100 per acre when the ponds begin to fill. They should be secured from neighboring ponds.

<sup>2</sup>Fingerlings are young fish more than one inch long.

<sup>3</sup>Fry are newly hatched fish.

<sup>4</sup>Also known as white perch.

<sup>5</sup>Bullhead catfish need not be stocked in ponds built on streams that already contain this fish.

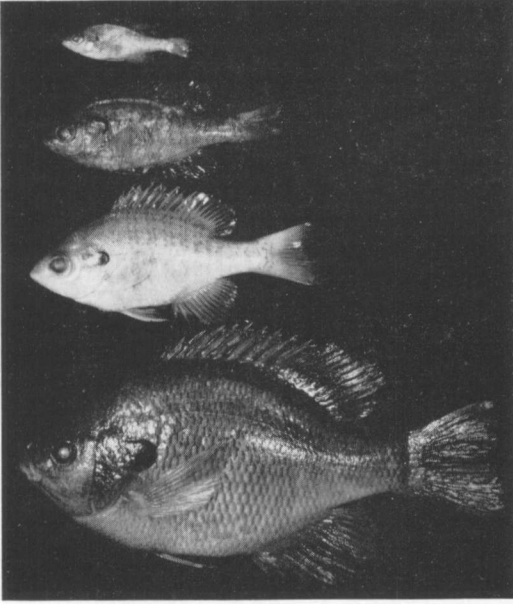


FIGURE 11.—Stocking with adult fish *vs.* stocking with fingerlings. The 3 bluegills at the top represent the relative average sizes after 1 year (0.06 ounce), 2 years (0.4 ounce), and 3 years (0.8 ounce) in a pond stocked with adult bluegills, crappie, and bass. The fourth bluegill shows average size (4 ounces) reached in 8 months when the pond was stocked with the correct number of fingerling bluegills and bass.

should be used in combinations that include adult crappie. If catfish are desired but cannot be obtained from the hatchery, schools of fry may be found in some neighboring pond in the spring and taken by dip net or minnow seine. Catfish need not be stocked in ponds that are built on streams containing this fish.

### Management of Old Ponds

After a pond has been properly stocked with fish, it should not need restocking. A number of old ponds in Alabama, varying from 3 to 30 years in age, have been drained and all fish present counted and weighed. In each instance sufficient numbers of small fish were present to utilize all the food the pond was producing, even if all the large fish had been removed. It is apparent that restocking with more fish from a hatchery would be useless under such conditions. Restocking seldom would

**Sources of fish for stocking.** — Bluegill bream and largemouth black bass can be obtained from state or federal hatcheries; some hatcheries also supply crappie and bullheads or other catfish. Alabama pond owners should address requests for fish for stocking new ponds to the State Department of Conservation, Montgomery, Alabama; fish can be obtained also from federal hatcheries by application through local congressmen. Fingerlings are distributed by hatcheries in the late summer, fall, and early winter, and ponds should be stocked as early as fish can be obtained. Fry are distributed in the spring.

If crappie fingerlings are not available, a few adults may be placed in the pond the first winter. Bass fingerlings, but not fry,



appear necessary since experiments at Auburn have shown that in one year a pair of bass, bream or crappie can produce more small fish than an acre of water can support.

Poor fishing in most old ponds is not due to insufficient brood stock, but usually results from the following causes:

1. Water too poor to support many legal-sized fish.
2. Fish stunted due to improper stocking.
3. Water weeds growing so densely as to render the pond unfit for fishing.

Lack of sufficient fertility in the pond water is the most common cause of poor fishing. Under such conditions, experiments have shown that if the pond already contains both bluegills and largemouth bass, excellent fishing can be obtained by proper fertilization of the water. If fertilization is begun in the early spring, improvement in the fishing can be readily noticed by the middle of the summer. Increasing the food by fertilization increases the hatch of young fish so that sufficient numbers are produced to utilize the increased food and the addition of hatchery fish is unnecessary and undesirable. When natural reproduction is relied upon, the forage and carnivorous fish apparently increase in the correct proportion to maintain the proper balance in the pond.

If most of the fish caught from an old pond are small and thin, this indicates that the pond is overcrowded. This condition is usually caused by improper initial stocking. In most ponds of this type, bluegill bream and similar fish are stunted and the pond contains either no largemouth bass or only a very few large individuals. This condition is caused by either failing to stock with bass or adding an insufficient number when the pond was first stocked; in the latter case the pond becomes so overcrowded with small bluegills that the bass added are unable to reproduce successfully. If no bass are present in the pond, 100 bass fingerlings per acre should be added. If bass are present, the overcrowded condition can be corrected within a few months by proper fertilization to increase the food for the fish and heavy fishing for bream to reduce their numbers. Due to an increase in food for the bream, the bass are then able to reproduce successfully.

When most of the bluegill bream caught are large and most of the bass are thin and under legal length, this condition is usually caused by originally overstocking with bass and understocking with bream or by failing to remove sufficient bass by fishing. Such a condition is hard to correct. It can best be done by heavy fishing or seining to reduce the number of bass in the pond, followed by fertilization to increase the food supply.

Where fertilization is impractical, fishing in an old pond often can be improved by draining the pond, removing the large or otherwise undesirable fish, and restocking with the correct number of small fish.

Dense growths of water weeds are undesirable for various reasons and must be controlled if good fishing is desired. Methods of controlling pond weeds are described in a later section.

### Fertilization of Ponds

The fertilization of pond waters is the only practical method known by which the weight of fish that the pond can support may be materially increased. Fertilized ponds in Alabama support 4 or 5 times as great a weight of fish as unfertilized ponds, and, consequently, fertilized ponds give much better fishing.

In spite of the general desirability of fertilizing ponds, 2 types of ponds cannot be fertilized economically — those that stay muddy, and those through which excessive amounts of water flow during the growing season. Ponds of the latter type can often be fertilized during dry periods. For best results, there should be little or no overflow water from the pond.

Fertilized ponds may be used for watering livestock as the amount of fertilizer applied is so small in comparison to the amount of water in the pond that it will not injure animals which drink the fertilized water. They may also be used for swimming, and are frequently preferable to unfertilized ponds for this purpose since they are less likely to be choked with weeds.

**Kinds and amounts of fertilizers per acre.**—The following amounts of fertilizers should be added to an acre of water at each application:

100 pounds of 6-8-4 (N-P-K)  
10 pounds of nitrate of soda<sup>1</sup>

These may be applied separately or mixed before applying.

Where the 6-8-4 fertilizer is not available or where large amounts of fertilizer are required, the following mixture is recommended per acre of water:

40 pounds sulfate of ammonia  
60 pounds superphosphate (16%)  
5 pounds muriate of potash  
15 pounds finely ground limestone

These materials may be mixed before applying, and used immediately or stored several months before using.

**Time and frequency of application.**—If the pond does not receive flood-water, the first application of fertilizer should be made during the first warm weather of spring (usually March in Alabama). When a pond receives appreciable amounts of flood-water, fertilization should be delayed in the spring until danger of floods is past (usually April or May in Alabama).

<sup>1</sup>If nitrate of soda is not available, it may be omitted although the fertilizer is not quite so effective without it.

Within a few days after an application, the water should become murky and appear green or brown due to the growth of microscopic plants. Subsequent applications should be made whenever the water begins to lose this green or brown color and becomes clear enough for the bottom to be seen in  $1\frac{1}{2}$  or 2 feet of water; this usually requires an application every 3 or 4 weeks. The last application should be made in September or October, the ponds thus receiving between 8 and 14 applications per year. The annual cost per acre will vary from \$11 to \$20.

The use of only 1 or 2 applications of fertilizer per year will not give good results. One application of fertilizer results in an increase in fish food lasting for approximately 1 month. This causes a temporary increase in the weight of fish which the pond carries. If the pond is not again fertilized, the food supply gradually decreases, and the weight of fish which the pond can carry decreases accordingly. For best results, a pond must be fertilized periodically throughout the growing season in order to maintain an adequate food supply during this period. Ponds having the least amount of over-flow water require the least fertilizer; similarly, those receiving water from fertile land require less fertilizer than those receiving water from poor land.

**Method of applying fertilizer.**—For small ponds, the fertilizer should be broadcast from the bank over the shallow parts of the pond (Fig. 12). No attempt need be made to cover



FIGURE 12.—Applying fertilizer to a small pond.

the pond completely as wave action may be depended upon to distribute the microscopic plants produced. For large ponds, the sacks of fertilizer should be carried in a boat equipped with a motor. The fertilizer should be poured slowly from the sacks as the boat is moved back and forth over the areas where the water is from 1 to 6 feet deep.

### Fishing

Fishing is the principal method by which the yearly crops of fish produced in ponds are harvested. Adequate fishing is as necessary to proper pond management as proper stocking or fertilization. New ponds are stocked at such rates that bream will reach a size of 4 ounces and bass a size of 1 pound within 1 year or less, and fishing should be begun as soon as the fish reach these sizes. If part of these fish are removed by fishing, those remaining become larger. If none of the fish are removed, the old fish remain practically the same size year after year, and young fish produced in the pond have little chance to secure enough food to grow to maturity.

Experiments have indicated that only approximately 50 per cent of the legal-sized fish can be removed from a pond each year by fishing. When the number of fish in the pond is reduced, the food for those remaining increases, and as the food per individual increases, the fish bite less often. During this period of poorer fishing, the fish grow rapidly; as the maximum weight which the pond can support is approached, the fish bite more and more readily, and fishing once again becomes "good". Alternating periods of good and poor fishing are therefore to be expected in all ponds which are adequately fished. One of the primary purposes of pond management is to reduce to a minimum the frequency and length of these periods of poor fishing.

When fish refuse to take one type of bait, they will often bite readily on another. The good fisherman therefore varies the bait used, determining the most successful by trial and error. Some of the more successful baits for the various species of pond-fish will be discussed.

Bluegill bream may be caught on a wide variety of artificial dry and wet flies. Earthworms<sup>1</sup>, or "fishworms", are the most commonly used live bait and are good bait most of the year, but especially in the spring; during the late summer and fall, bream often refuse to take this bait and may be caught more readily on wasp grubs and crickets. When available, the following baits are often very effective: catalpa worms, corn ear worms, cotton leaf worms, cutworms, grasshoppers, and cockroaches. These live baits are usually fished on the bottom, and better results are secured if no sinkers are used on the line. Bluegills may occasionally be caught on small minnows.

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<sup>1</sup>Directions for raising earthworms are given in a mimeographed leaflet "Raising Fishworms For Bait", obtainable from this Station.

Largemouth black bass are caught more or less readily with various flyrod and casting outfit lures. Among the live baits used, live minnows of various kinds are usually most effective. Bass are also occasionally caught on earthworms, catalpa worms, crickets, grasshoppers, crayfish and frogs.

Crappie are caught largely with small minnows, but may also be caught on chunks of fresh fish. They will occasionally take any of the live baits listed for bluegills. Small spinners and spoons, slowly retrieved, are among the most effective crappie lures for either the flyrod or casting outfit.

Catfish will take any of the live baits listed for either bluegills or bass. Earthworms, crickets, minnows, and chunks of fresh fish are among the most effective baits. Catfish are very seldom caught with artificial lures.

### Pond Weeds and Their Control

Weeds usually begin to appear in a new pond within a year or two after it is built. Water weeds grow so rapidly that they soon fill shallow clear-water ponds, and old unfertilized ponds of this type usually are choked with them. Weed-filled ponds are generally poor fish ponds. The weeds form such a tangled mass of vegetation that it is difficult or impossible to fish and it may be difficult to paddle a boat in the pond. They protect



FIGURE 13.—Submerged weeds fill the pond from bottom to top and leave only small areas in which fishing is possible.



FIGURE 14.—Spatterdock, waterlilies, and similar weeds are not desirable.

small fish from larger ones so well that the pond may become overcrowded and the fish stunted. Weed-filled ponds are objectionable also because they offer suitable breeding places for mosquitoes.

Pond weeds are of 3 types: submerged, emergent, and floating. The submerged weeds are rooted in the bottom and their stems and leaves may fill the pond to the surface of the water (Fig. 13). This type is commonly called "moss" or "grass" and includes such plants as *Najas*, *Myriophyllum*, *Elodea*, certain species of *Potamogeton*, and *Chara*. The emergent type of plant is rooted in the bottom and its leaves either stand above or float on the surface of the water (Fig. 14). This type includes spatterdock or yellow waterlily, common waterlily, lotus or water chinquapin, watershield, and the floating-leaf pondweeds. In addition to these, cattails, bulrush, and spikerush often form dense growths in shallow water along the edges. Water hyacinth may root in shallow water or float in deeper water.

Ponds that are muddy during much of the growing season usually are not badly infested with weeds since the muddy water tends to prevent plant growth. Such ponds, however, are undesirable as fish ponds; the muddy water retards the development of organisms furnishing fish food and the clay particles in the water absorb phosphorus and make fertilization impractical.

### Prevention of the establishment of weeds in new ponds.—

Underwater weeds usually cannot become established in properly fertilized ponds, except in the shallowest water. The fertilizer causes so many microscopic plants to grow that the water appears green or brown and the dense shade formed by these small plants usually prevents the establishment of under-water weeds.

The establishment of waterlilies, spatterdock, and similar plants can be prevented by removing these weeds as they appear in the pond.

**Destruction of weeds in old ponds.**—Many old, shallow, clear-water ponds in the South are filled with underwater weeds. A method for the destruction of such weeds by fertilization has been developed at Auburn. *Najas guadalupensis*, *Potamogeton pusillus*, *Potamogeton angustifolius*, *Chara* sp., *Nitella* sp., and one species of *Myriophyllum* have been controlled by this method. The recommended procedure follows: use 100 pounds of 6-8-4 (N-P-K) fertilizer and 10 pounds of nitrate of soda per acre at each application<sup>1</sup>; broadcast the fertilizer over the pond and especially over the weed beds, instead of applying it only in shallow water as recommended for weedless ponds; make the first application in December or January and then apply the fertilizer at intervals of 2 to 4 weeks until the weeds become wrapped with filamentous algae ("pond scum").

The filamentous algae cover the weeds and shade them so that they become weakened. Their stems break near the base and large masses of floating, decaying weeds and "scum" are present in the pond during the spring and early summer. **Fertilizer must not be applied while most of the weeds are decaying rapidly.** If fertilizer is applied at this time, it may cause such rapid decay that the oxygen in the water may be depleted, causing the fish to die. The weeds usually decompose and disappear from the pond by the middle of the summer. The decaying plants release nutrients into the water, and these cause a heavy growth of microscopic plants, turning the water green or brown. Very little fertilizer is required during the remainder of the year but it should be applied if the water clears enough for an observer to see deeper than 18 inches into it. Unless the pond is fertilized in subsequent years, underwater weeds will reappear.

Several other methods were tried for the eradication of underwater weeds. Control of the weeds by draining the pond and allowing the bottom to dry out before refilling was unsuccessful. Periodic removal of the weeds with hand rakes and by dragging cables through the weed beds proved costly and relatively ineffective. Within a few weeks to a few months the weeds were as bad as before these treatments were applied.

<sup>1</sup>A mixture of 40 pounds of sulfate of ammonia, 60 pounds superphosphate (16%), 5 pounds muriate of potash, and 15 pounds ground limestone per acre may be substituted for the 6-8-4 and nitrate of soda.

The use of fertilizer for weed control serves several important purposes. The weeds are destroyed and it is easier to fish in the ponds. The hiding places for small fish are destroyed by the decomposition of the weeds. Consequently, the carnivorous fish are able to reduce the excessive numbers of small fish so that rapid growth is possible. The decaying weeds furnish large quantities of food for the organisms upon which many of the fish feed. As a result, there is a tremendous increase in the abundance of these organisms.

Spatterdock, waterlilies, lotus, and watershield can be destroyed by removing the leaves several times during the summer. A scythe can be used for cutting the leaves. The first cutting should be made early in June and later ones every 2 or 3 weeks until no new leaves appear. Usually 5 or 6 cuttings will be necessary to destroy the plant. These weeds can be kept out of the pond thereafter if new plants are pulled whenever they appear. If nothing else is done, however, the part of the pond originally occupied by weeds with emergent or floating leaves may soon become filled with underwater weeds. Normal fertilization after the emergent plants are destroyed will prevent the growth of submerged weeds in all except the shallowest water. Bulrushes and similar plants can be controlled by frequent removal of the leaves or by pulling. Water hyacinths can be eradicated from small ponds by raking them out.

### Mosquito Control

It is very important in the Southeast that fish ponds be managed so that they will not produce malarial and pest mosquitoes. It has been found that trash floating in the water and practically all water weeds which emerge above the surface of the water furnish places for mosquitoes to breed. Under such conditions *Gambusia* and other "mosquito-eating" minnows will not control mosquitoes and, in fact, will eat very few of them.

For effective mosquito control, therefore, it is very necessary that pond weeds be controlled and that the pond edges be kept free of trash and floatage. If this is done, the breeding places for mosquitoes will have been eliminated and the pond will produce practically no mosquitoes.

From the previous discussion on weed control, it is apparent that if weeds are to be kept out of clear-water ponds with the minimum of effort, these ponds must be fertilized. This, therefore, is the first step in a mosquito control program for farm ponds.

In addition, the edge entirely around the pond should be examined once every 2 weeks and floatage and pond weeds should be removed. Weeds growing at the water edge and hanging over into the water should also be cut at this time (Fig. 15). In addition to controlling mosquitoes this improves the appearance of the pond, aids in preventing the establishment of obnoxious water weeds, and maintains a clean pond edge from which to fish.



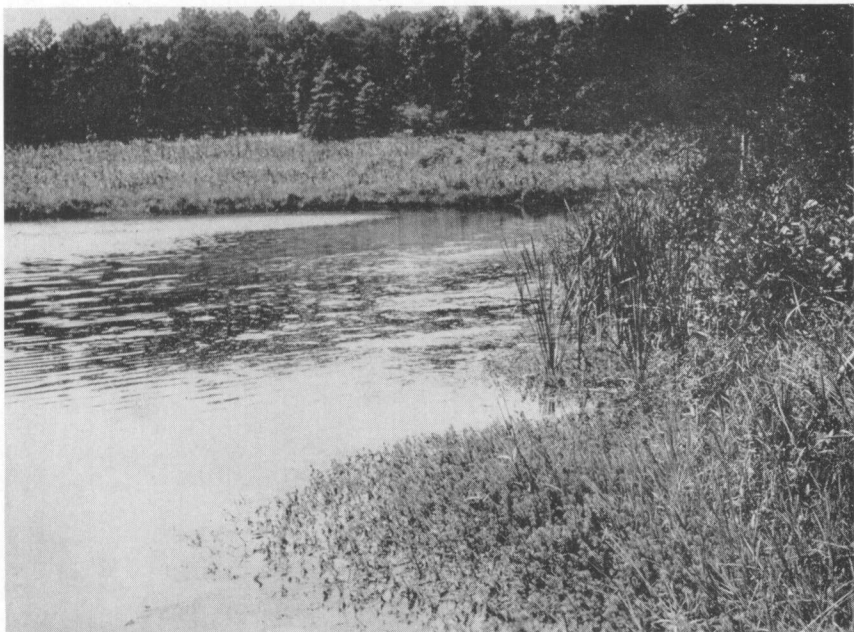


FIGURE 15.—Weeds in the edge of a pond form places for mosquitoes to breed, and should be removed periodically.

