



Alabama Department of Conservation & Natural Resources

SPORTFISH MANAGEMENT IN ALABAMA PONDS

Fish Ponds: An Alabama Tradition



SPORTFISH MANAGEMENT IN ALABAMA PONDS

By Alabama's Pond Management Biologists

DIVISION OF WILDLIFE AND FRESHWATER FISHERIES

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Revised, 2003

INTRODUCTION

Small ponds and lakes represent a significant portion of Alabama's freshwater resources. Our state has an estimated 50,000 ponds that cover approximately 150,000 acres. Most ponds that have been stocked with largemouth bass and bream (bluegill and redear sunfish) can provide excellent recreational opportunities when properly managed.

Ponds are also important for wildlife, livestock watering, irrigation, swimming, fire protection, and erosion control. Man-made ponds also alleviate the fishing pressure on our public streams and lakes. In many areas of the state, ponds are the only local source of fishing; therefore, the Alabama Department of Conservation and Natural Resources, Division of Wildlife and Freshwater Fisheries is vitally interested in this resource.

The primary purpose of this booklet is to serve as a management guide for pond and small lake owners who desire a high quality largemouth bass and bream fishery. Many of the terms used in pond management are defined in the glossary.

ACKNOWLEDGEMENTS

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Thanks is also extended to the members of the Fisheries Section, Alabama Wildlife and Freshwater Fisheries Division, who provided photos, review, or comments. Special thanks to Johnie Crance who authored the original manuscript, which served as our pattern.

Mike Newman
Chairman, Revision Committee

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PRINCIPLES OF POND MANAGEMENT

Some basic biological principles must be understood before a pond can be properly managed. The pounds of fish that can be produced in a pond are limited and are affected by several factors: proper construction, nutrients, the quantity and quality of fish food, proper brood stock, elimination of unwanted competition, and efficient harvest of surplus fish.

A question often asked is "how many bream and bass should I harvest from my pond?" Carrying capacity and yield limit are terms often used by biologists to answer this question. Biologists define the carrying capacity of a pond as the maximum pounds of fish that can be maintained in the pond without depleting the food supply. Yield limit is defined as the maximum pounds of harvestable-size fish a pond will yield from year to year without causing detrimental effects to the balance of the fish population. Yield limit is dependent on the species of fish present, amount of food available to the fish, rate of harvest and other factors. Yield limit as used in this booklet refers to the harvest of bream and largemouth bass since this stocking combination is normally used in Alabama.

Nutrients are very important in the production of fish food organisms and therefore in the production of fish. Simply stated, nutrients increase the amount of food available to the fish, which results in greater fish production. Nutrients are needed to promote plankton, which are microscopic plants and animals that cause pond water to appear green, brown, blue, yellow or red. Plankton form the base of the food chain in bass and bream ponds. Plankton are consumed by small microscopic animals such as water fleas, insects, worms, and others which, in turn, are eaten by fish.

Plankton cannot grow without sunlight and adequate amounts of nutrients. Nitrogen, phosphorous, and potassium are the primary nutrients. However, they are not usually available in ponds in sufficient quantities to produce adequate plankton populations needed in the food chain of fishes. Therefore, nutrients must be added to ponds for maximum fish production.

Nutrients are usually applied in the form of inorganic, commercially produced fertilizers. Ponds that are fertilized and managed properly can yield about 175 pounds of bream and largemouth bass per acre per year. In comparison, unfertilized ponds will yield only 25 to 50 pounds per acre annually.

The total weight of fish that a pond supports may be comprised of many fish too small to be desired by anglers or of a lesser number of large fish that are appealing to sportsmen. A desirable bass-bream population is one in which 60 to 85 percent of the total weight is composed of harvestable-size fish. If a pond maintains such a population and provides satisfactory yields of fish from year to year, it is considered to have a balanced fish population.

The time of year the pond is stocked is critical in achieving a balanced fish population. Bream are stocked in the fall and winter months. Bass are stocked the following May or June. A bream-largemouth bass population normally attains a balanced condition 12 to 14 months after the bass fingerlings are stocked. During the first 20 months after bream are stocked, growth and reproduction rates are very high. The pond experiences a population explosion because large amounts of food are available. The fish reproduce and increase in weight until most of the food is utilized. At that time, their growth rates decrease or stop until some of the fish die, are caught, or otherwise are removed from the population. At this point (usually one year after the initial stocking of bass) the pond is ready for fishing. As fish are removed, competition for food decreases, growth rates increase, and the remaining fish reproduce to replace the older, larger adults that have been harvested.

The rate at which fish are harvested must be controlled, especially during the first few weeks of fishing. When the fish population first attains a balanced condition, the total weight is comprised primarily of harvestable-size adults (initial stock). Most of the remaining weight is composed of small (1- to 5-inch) fish that

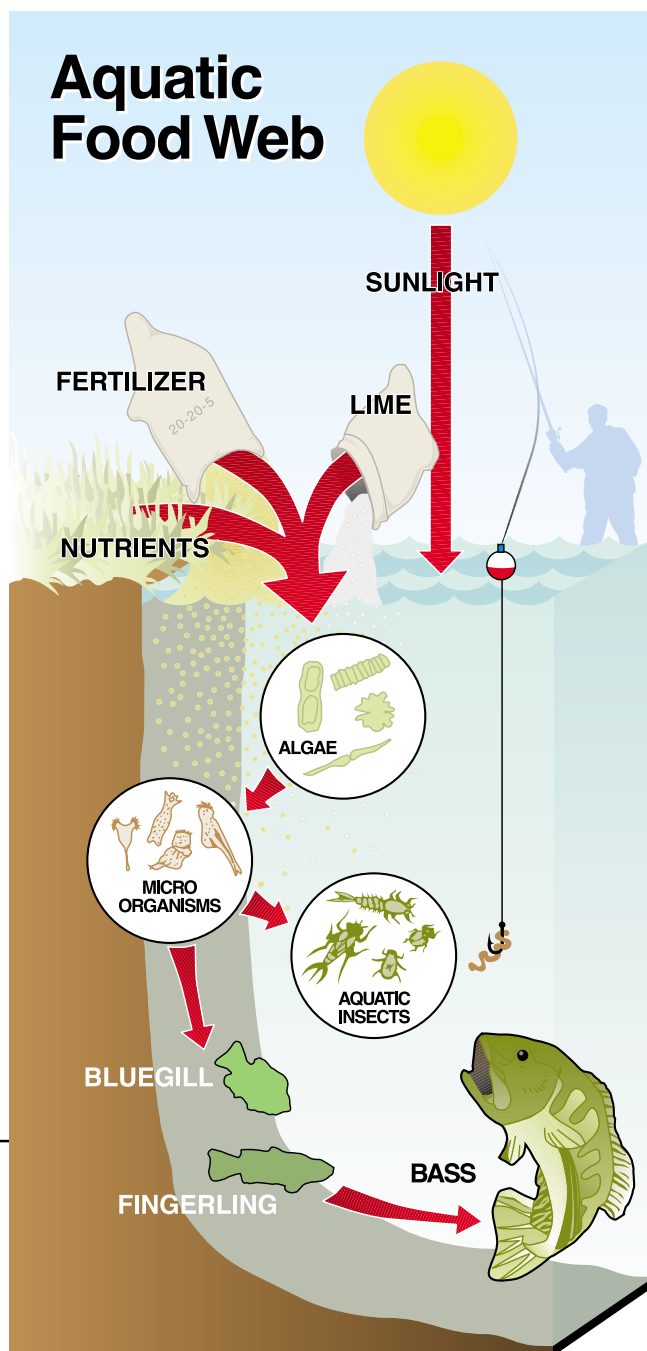
are offspring of the initial stock. Rapid harvest of adults can result in excessive numbers of small fish, which can lead to poor fishing.

A desirable yield from a properly managed pond is about 145 pounds of bream and 30 pounds of largemouth bass per acre per year. The catch should be distributed over the entire year rather than a few days or weeks. An accurate record of the numbers and weights of bass and bream removed from the pond is very important. A set of weighing scales and a notebook should be readily available to anglers to log in their catch after each trip. Proper pond management requires an understanding of harvest, both above, and even below, recommended rates.

Each pair of adult bluegill may produce over 5,000 offspring each season. Bluegill grow faster and spawn more abundantly when their food supply is increased. A sudden removal of too many pounds of adult fish will result in accelerated growth and reproduction by the bream that remain. The outcome may be a population of stunted bream that are too small to be desirable.

The diet of adult largemouth bass consists almost entirely of small bream; therefore, the removal of bass must be controlled. If bass are caught faster than they are replaced by natural reproduction, the result can also be an overpopulation of small, stunted bream.

Fertilizer produces more food for the fish and results in more fish and healthier fish.



POND CONSTRUCTION

Ponds are much easier to manage when properly constructed. A prospective pond owner should contact a representative of the U.S.D.A., Natural Resources Conservation Service (NRCS), which is located in each county. The NRCS can make recommendations regarding location, design, and proper construction. The owner should also utilize a reputable contractor (with references) that is familiar with design and construction of ponds which meets NRCS engineering specifications.

Selection of Site

A poorly planned pond will result in failure. Careful consideration should be given to the selection of a desirable site before the "ground breaking" or construction begins. A desirable site needs an adequate but not excessive water supply. The subsoil should contain sufficient clay to prevent excessive seepage. The topography (lay of the land) should lend itself to the economical construction of a pond which will maintain a minimum of 1/4 surface acre of water. In addition, access roads and location of the pond in relation to the owner's residence should be considered. A pond located near the home and with an all-weather access road is more likely to be cared for properly. Before construction begins, the U.S. Army Corps of Engineers and the Alabama Department of Environmental Management should be contacted to determine if environmental permits are needed.

Source of Water

A flowing stream is not essential when evaluating water sources. Rain and run-off from the watershed are usually adequate. The amount of watershed needed may vary from a ratio of 3 to 20 acres for each acre of pond (3:1 to 20:1), dependent upon the subsoil, the amount and type of vegetation, and the slope of the land. Cultivated or barren watersheds are undesirable because of rapid run-off and the accompanying silt load. The watershed should provide enough water to fill the pond and to maintain a water level that will not fluctuate more than 6 inches below or above the spillway. An excessive amount of water results in erosion, possible dam failure, loss of fish, and loss of nutrients needed for fish production. Ponds built on streams usually have excessive overflows and cannot be fertilized economically, nor can the streams be effectively poisoned



Poorly constructed ponds will result in failure.

to eliminate wild fish, which is essential before stocking hatchery fish.

Time to Build

Pond construction should be completed during the fall or early winter. At that time bream and largemouth bass are available from Alabama's Division of Wildlife and Freshwater Fisheries to stock fertilized ponds that are 1/4 surface acre or larger and that contain no

fish. Bream are normally delivered from December through March. Largemouth bass are delivered in May and June. If ponds are completed during the spring and summer, they are likely to fill with water and become contaminated with wild fish before hatchery fish are available. If contamination occurs, the added expense of renovation is necessary before hatchery fish can be stocked. In addition, ponds that are completed in the spring and remain full of water during the summer are likely to become infested with aquatic plants. If ponds are completed during January or February, they may not fill in time to meet stocking deadlines. For these reasons, timing is important when planning a pond.

Clearing Site and Digging Core Trench

While the site is being cleared, a fisheries biologist should be consulted regarding recommendations that would enhance the fishing. For example, brush piles or standing trees can be left in specified areas to serve as fish attractors. Advice can also be given regarding underwater contours (mounds or ditches), suitable sites for spawning substrate (gravel), or placement of docks and piers.

Coring the dam is vital to the success and safety of the pond. The core trench of a dam may be compared to the

foundation of a building. An earthen dam must have a clay core to bond the above-ground portion of the dam to the subsoil. The clay core should extend to the top of the dam. Coring prevents excessive seepage and loss of water. The core trench should extend a minimum of 3 feet into desirable subsoil, have a width of about twice its estimated depth, and should be filled with the best clay available. The NRCS should be contacted to determine if adequate clay is nearby and to periodically inspect the dam as it is being cored.

Drainpipe

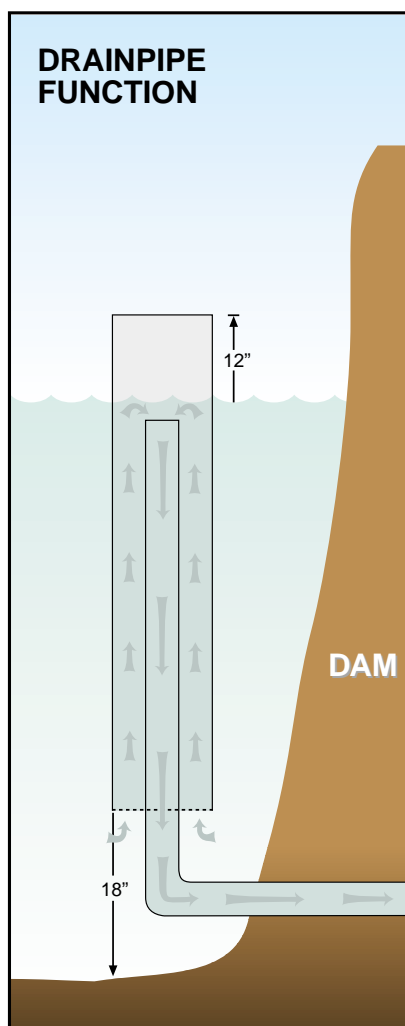
Drainpipes should be utilized in all ponds. Eventually a pond will need to be lowered or drained for reasons of management or repair. The drainpipe, with the use of a sleeve or trash rack, can also enhance fertilization by drawing water from the bottom of the pond and not from the productive upper layer. Several types of drainpipes and valves are available, and the NRCS should be consulted regarding the type, size, and placement of the pipe.

Dam

Professional assistance should be obtained when constructing dams. The above-ground portion of a dam, which impounds water less than 15 feet deep, should be constructed with good quality, well-compacted clay. Dams that impound water more than 15 feet deep must have porous material in the downstream slope to provide drainage or water pressure could build-up and cause sloughing. Adequate freeboard (distance between water level and the top of the dam) should be incorporated during construction to ensure that water does not flow over the dam during periods of heavy rainfall. Freeboard should be at least 3 feet or higher if the drainage area is large.

In large ponds or lakes, wind may create waves that could severely erode the face of a dam. Under such circumstances, the dam should be armored by laying filter fabric and cover-

ing with riprap (rock) or concrete rubble about 2 feet above and below the water level on the pond side, particularly if the dam is over 300 feet long. On most small ponds grass cover on the face of the dam should be sufficient to prevent erosion by wave action.



A drainpipe with trash rack should be utilized in all ponds.

Spillway

The width, length, and type of spillway best suited for a pond is determined by watershed area, average annual rainfall, topography, vegetative cover, and soil type. Consult an NRCS representative to determine the proper spillway for your pond. The spillway should be wide enough so that overflow will not exceed a depth of 6 inches, which will prevent excessive numbers of fish from being lost during heavy rainfall. The spillway should be constructed about 6 inches above the level of the overflow pipe. A barrier, as well as a 3-foot vertical drop, should be placed in the spillway to prevent entrance of wild fish from downstream and the escape of desirable fish from the pond. A barrier may be constructed from re-bar (3/8 inch) spaced approximately one inch apart. The barrier should not be constructed of hardware cloth or screen, which could become clogged and endanger the dam during floods. In general, the barrier should be 16 to 20 inches high, but never more than half the depth of the spillway. **A horizontal pipe through the dam is not a sufficient spillway for watershed ponds!**

Deepening Edges

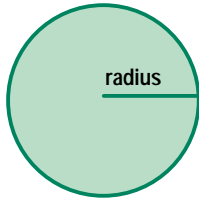
Pond edges should be deepened before the valve is closed to collect water. When the pond is full, all edges should be 2 to 3 feet deep. Serious aquatic plant problems will likely develop in areas less than 2 feet in depth. The soil that is removed can be used to create pond structure or earthen fishing piers.

Establishing Sod

Pond construction is not complete until grass is established on the dam, spillway, pond's edge, and watershed. Centipede, Bermuda, Zoysia, Bahia, Kentucky bluegrass, rye grass, or a combination of these grasses, will prevent erosion and siltation. Mulch or silt screens should also be utilized to hold the soil until the grass can become established. Pond owners should consult with the NRCS for the grass variety that is best suited for the pond's location and soil type.

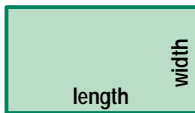
Pond Size

A reasonable estimate of the pond's surface area is needed if the pond is to be managed for optimum fish production. Stocking rates, application rates of fertilizer and lime, and harvest rates of fish are based on the pond's size (surface acres). The following formulas can be used to estimate size based on the shape of the pond:



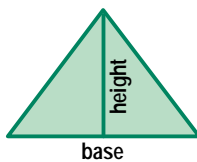
$$\text{CIRCLE} = 3.14 \times \text{radius}^2$$

CIRCLE: determine diameter (distance across the middle of the pond in ft.) and divide by 2. Multiply that number by itself, multiply by 3.14, then divide by 43,560.



$$\text{RECTANGLE} = \text{length} \times \text{width}$$

RECTANGLE or SQUARE: surface acres = length (ft.) x width (ft.) ÷ 43,560 (sq. ft. in an acre).



$$\text{TRIANGLE} = \frac{\text{base} \times \text{height}}{2}$$

TRIANGLE: surface acres = ? length of dam (ft.) x the length of the pond (ft.) ÷ 43,560.

Distances can be determined by a measuring tape, range finder, or by pacing.

Some contractors or technical personnel may have GPS capability to calculate pond size. Fisheries biologists with the Wildlife and Freshwater Fisheries Division can estimate the acreage when conducting a pre-stock or management check.

Acreage of old ponds can be determined by aerial photos from the local NRCS office.

MANAGEMENT PRACTICES

Without proper management, many ponds will not sustain adequate fishing. Fisheries biologists of Alabama's Division of Wildlife and Freshwater Fisheries have determined that most pond failures are due to the following reasons:

1. *Competition from wild fish that are not eliminated from the pond before it is stocked with hatchery fish or that enter the pond after it is stocked.*
2. *Improper harvest practices such as removing too many fish, too few fish, or fishing prior to the spawn of the originally stocked bass.*
3. *Improper lime and fertilization program.*
4. *Fish kills as a result of pesticides, low oxygen, or other causes.*
5. *Improper stocking.*

These five reasons account for the majority of pond failures in Alabama. Other reasons, but of lesser importance, are excessive amounts of aquatic plants, significant loss of fish over the spillway, and severe loss of water. Most pond failures can be avoided by utilizing the proven management practices that follow:



Rotenone is applied to a pond to eliminate wildfish.

failure is likely if wild fish are not eliminated.

The time of year that wild fish are eliminated is important. The work should be done after October 1, but before January 10, if fish are to be obtained from Alabama's Division of Wildlife and Freshwater Fisheries. If it is necessary to complete construction during the period of March to September, allow the valve to remain open until October or drain the pond at this time and treat all potholes and other water with rotenone to eliminate all fish. **Before treatment, the pond valve must be closed so that fish will not be killed downstream.**

Powdered or liquid formulations that contain 5% rotenone or its equivalent should be used to eliminate fish in the pond and watershed area. Rotenone is not dangerous to livestock when used as directed. Before application, mix the powdered material thoroughly with water until a "soupy" mixture is obtained. Liquid formulation of rotenone should be diluted with sufficient water to adequately treat all of the pond basin and watershed. The amount of rotenone to apply will vary widely depending upon the site. Therefore, label instructions should be followed closely regarding application rates.

Basically, all standing water should be treated with 10 pounds of powder or 10 pints of liquid rotenone per acre-foot of water (acre feet = surface acres X average depth). Ten pounds or 10 pints of material containing 5 percent rotenone should be applied for each 1/4 mile of stream that averages up to 1 foot in depth and 10 feet in width. A second treatment is often necessary to eliminate all fish. **Rotenone is a restricted use pesticide and cannot be purchased without a valid permit. The local county extension agent should be contacted to obtain current label information regarding the purchase and application of rotenone. Label instructions should always be followed when making a treatment.**

Eliminating Fish Prior to Stocking

When construction is completed, but before the pond is full, all **wild fish** should be eliminated from any water existing in the pond or watershed. Assume that fish are present even if none are seen. **The elimination of all fish from the pond and watershed is one of the most important steps toward successful fishing.** Suckers, shad, bullheads, green sunfish, shiners, and other fish will spawn in a pond and compete with stocked fish for food and space, much like weeds in a vegetable garden. The production of desirable fish will be greatly reduced, and pond

Stocking

The Division of Wildlife and Freshwater Fisheries operates three fish hatcheries, which are located at Marion, Eastaboga and Carbon Hill. Bluegill, redear sunfish and largemouth bass are provided to stock ponds that contain no fish and are at least 1/4 surface acre in size (1/2 acre if pond is not to be fertilized). An application for fish must be obtained from the local district fisheries office. The address of all district offices and district boundaries may be obtained from the back of this booklet, or go to <http://www.dcnr.state.al.us/agfd/staff.html>. Applications may be submitted at any time, but the deadline for receiving applications for each stocking year is February 1. After receiving the application, fisheries biologists of the Division of Wildlife and Freshwater Fisheries will visit the pond to advise the owner of proper management practices to follow and determine if the pond meets requirements for stocking. Pre-stocking inspections are conducted from September through the first week of February. Bream are delivered during the period of December through March and bass during May and June. No fish should be placed in the pond except those delivered from the hatchery unless recommended by a fisheries biologist. The number of fish provided by the Division of Wildlife and Freshwater Fisheries depends on the size of the pond and if fertilization will be conducted; therefore, it is important that a reasonable estimate be made of the pond's surface area. Ponds that are to be properly fertilized will be stocked with 1,000 bream (bluegill and redear) and 100 largemouth bass per surface acre. Ponds that are not to be fertilized will receive one-half these amounts. A nominal fee will be charged for pond stocking services. **Do not haphazardly stock fish from a neighbor's pond or nearby stream, as poor fishing will likely result. Money spent on proper stocking will be cheaper than trying to correct a pond with an unbalanced fish population.**

Liming

Liming is essential before most ponds can be effectively fertilized. Many times, ponds will not respond to fertilization if bottom muds are acidic. Under these conditions, agricultural limestone must be applied to correct the acidity. If the pond fails to develop a plankton bloom after repeated applications of fertilizer, mud samples should be taken from the pond's bottom. Samples should be taken from several different areas of the pond, then mixed together while wet to form a representative sample. The sample should then be spread on a piece of plastic or wood to dry. After drying, a soil test box (from the county extension office) should be filled with the dried mud and sent to: **Soils Testing Laboratory, Auburn University, Auburn, Alabama 36849**, for analysis. The sample box should be labeled "fish pond". A nominal fee will be



Biologists with the Alabama Wildlife and Freshwater Fisheries Division meet with all pond owners before stocking.

Alabama farm ponds should be stocked with largemouth bass, bluegill and redear sunfish. *These species are depicted below:*



BLUEGILL



LARGEMOUTH BASS



REDEAR SUNFISH

charged for each analysis. (Note: Many ponds in Alabama's Black Belt or those with limestone springs will not need lime. If in doubt, have a sample checked.)

When lime is required, agricultural limestone (calcitic lime) should be applied. Do not use slaked lime or builders' lime, which can be toxic to fish and dangerous to handle. Lime will have to be applied periodically (3-5 years) during the life of most ponds if effective fertilization is to be practiced. Lime must be applied evenly over the whole pond to make certain all of the bottom mud is covered. If the pond is new, it should be limed heavily by spreader truck or tractor before filling since liming is much more difficult after the pond collects water. Liming is labor intensive so many pond owners prefer to apply two to three times the recommended rate to increase the interval between applications. Some pond owners are physically unable to apply the weight of lime needed (tons); therefore, consultants are available that will apply the lime for a fee. A list of consultants is available from the district fisheries office.

Fertilizing

If pond owners wish to maximize fish production, fertilizer must be properly applied to increase natural fish food. Properly fertilized ponds normally produce three to seven times more pounds of bream and largemouth bass than unfertilized ponds. Fertilized ponds also have less weed problems due to the shading effect of darker water. The application of fertilizer does not prevent fish from biting and the water is safe for livestock and for swimming. Before stocking fish, pond owners should decide if a fertilization program will be part of their long-term management plan. Ponds cannot be fertilized economically if the water stays muddy, or if excessive amounts of water are flowing through the spillway during the spring and summer. In addition, if fish are not to be routinely harvested, the owner may elect not to fertilize.

Kind and amount of fertilizer: Fertilizers are typically labeled with percent composition of nitrogen (N), phosphorus (P), and potassium (K). For example, fertilizer labeled 20-20-5 is comprised of 20% N, 20% P, and 5% K. Phosphorus is normally the limiting nutrient in most ponds. Owners should purchase and apply formulations that will give approximately 8 pounds of phosphorus per acre per application. For example, a 40 pound bag of 20-20-5 contains 8 pounds of phosphorus (40 x .20). One of the following formulations of fertilizer should be used per acre per application:

- A. 50 pounds of 16-16-4 or 18-18-5.
- B. 40 pounds of 20-20-5.
- C. 3 to 4 quarts liquid fertilizer: 10-34-0 or 13-38-0.

- D. 4 to 6 pounds powdered fertilizer: 12-49-6 or 10-52-0.
- E. 25 to 40 pounds annual time-release fertilizer: 10-50-0.

When to fertilize: Fertilization should be initiated when water temperatures stabilize above 60° F, usually late February to early April, depending on the region of the state where the pond is located. Fertilization should begin each year at this time in ponds with established fish populations as well as in new ponds that have been stocked with bream but have not yet received largemouth bass fingerlings. Applications of fertilizer should continue throughout each spring and summer as follows:

1. Make the first application when water temperature stabilizes above 60° F (usually February to April).
2. Make the next two applications at two-week intervals.
3. Make the fourth and subsequent applications when the water visibility exceeds 18 inches (usually every 3 to 5 weeks)
4. Discontinue fertilization when the water becomes cold (below 60° F) in October or November.
5. Repeat the above steps each year. (Note: Some ponds cannot be effectively or economically fertilized because of excessive flow. Contact the local fisheries biologist, if in doubt.)

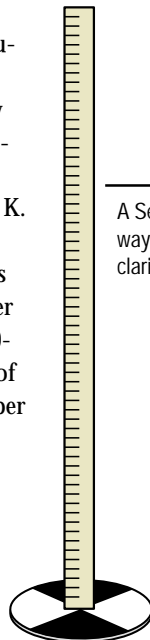
Most ponds in Alabama require about 10 to 12 applications of fertilizer each year; however, the time between applications may vary. Ponds with high lime content or those that receive run-off from a heavily fertilized watershed may require less fertilizer. Ponds that receive heavy rains or those on moderate streams may require more frequent applications to maintain a desirable plankton bloom. Therefore, ponds should be fertilized based on water visibility rather than a regimented time interval. Visibility refers to a green color from plankton growth, not a muddy color from run-off. If the green water visibility is over 18 inches, then additional fertilizer should be

added. A 12 to 18 inch green visibility is ideal. If visibility is less than 12 inches, the pond is too dark and fertilizer should not be added until the water clears to 18 inches or better. A simple method for checking vis-

ibility is with a Secchi disk. Attach a round white object (6 inches in diameter) to a yardstick. Submerge the object in the pond, then read the inches on the yardstick when the object disappears to determine the visibility.

Many ponds can be fertilized properly with phosphate fertilizers only. Ponds that have been properly fertilized two or more years with a complete fertilizer may be fertilized adequately at about one-third the normal cost by using 40 pounds of super-

A Secchi disk is a good way to measure water clarity in a pond.



phosphate (18-20% phosphate) or 18 pounds of triple super-phosphate (46-52% phosphate) per acre per application. A complete fertilizer should be used for the first two applications each year. After that, only phosphate should be used for the remainder of the year. If phosphate fertilizer does not maintain a desirable growth of plankton, then revert to the use of one of the complete fertilizers previously described.

Fertilizer types and application methods: **Granular fertilizer:** The use of a platform for granular fertilizer is usually less time consuming and more economical. Platforms are especially useful in ponds 10 acres or larger, but may also be used in smaller ponds. The fertilizer should be poured directly onto a submersed platform which allows nutrients to dissolve slowly in the surface water. The amount of fertilizer required to maintain a desirable growth of plankton may be reduced 15 to 25 percent when platforms are utilized. One platform is adequate to fertilize 25 surface acres of water. A platform 3 x 3 feet or 9 square feet will hold the fertilizer needed for a 3-acre pond. In larger ponds provide 3 1/2 square feet of platform for each surface acre of water greater than 3 acres. For example, a 10-acre pond needs 35 square feet of platform area or one platform measuring 5 x 7 feet. Two platforms with a total surface area of 140 square feet are needed in a 40-acre pond.

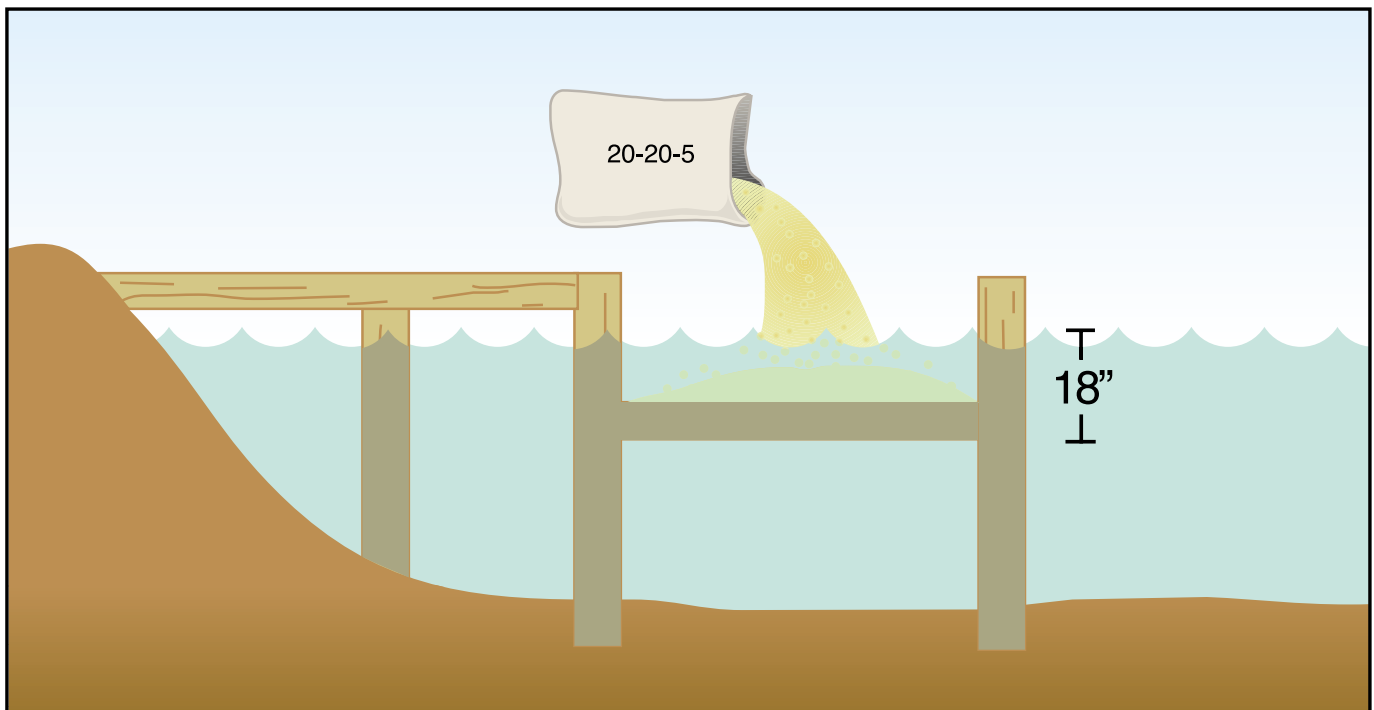
The platform should be placed in the upper end of the pond, about 10-15 feet from the bank, where wave action will provide good distribution of the dissolved nutrients. A walkway should lead from the bank to the platform or the platform may

be installed beneath a fishing pier. The floor of the platform should be 12 to 18 inches under the water and should be adjustable to allow for water level fluctuation. Platforms may be constructed of wood or concrete. If wood is used, it should be treated with preservative to improve longevity.

Granular fertilizer may also be applied by placing bags in water 2 to 3 feet deep along the shoreline in the upper end of the pond. The bags should be placed on the pond bottom and the topside of the bag removed. A layer of the bag should remain between the fertilizer and the pond bottom. The fertilizer should not be allowed to come in contact with the mud. Plywood or plastic sheets may also be used between the fertilizer and pond bottom. The shoreline method is similar to the platform in principle, but may not be as efficient.

Liquid fertilizer: It can be purchased in three forms, one is clear green and is made from new acids. The second form is gray because clay has been added to suspend phosphate in the liquid. Either of these forms is suitable for use in ponds; however, the clear green form (Poly N) is preferable. The third form is brown-black, formulated from used industrial acids, and may contain undesirable metals or chemicals. The brown-black type of liquid fertilizer is not recommended. If the fertilizer has less than 30 percent phosphorus (the second number on the label), apply one gallon per surface acre per application. If it has 30 percent or more phosphate apply 3 quarts per surface acre per application.

If the pond is less than two acres, the fertilizer may be



Platform for dispersion of granular fertilizer.

applied with a garden sprayer or diluted 10 to 1 with water and broadcast from the bank. It should be sprayed or broadcast along at least 1/4 of the shoreline. If the pond is larger, the fertilizer may be applied with a power or tractor sprayer if 1/4 of the surface area can be covered. If necessary, the fertilizer can be applied by boat by siphoning from a container into the propwash of a small outboard or electric motor. **Liquid fertilizer should not be poured directly into the pond. It is heavier than water and will sink to the bottom before it can go into solution.**

Liquid fertilizer can be obtained more economically by supplying your own containers and by purchasing a year's supply. Poly N should be stored in plastic drums since it can be corrosive to certain metals. The drum should be mounted horizontally and a plastic valve inserted so that each application can be easily withdrawn. A hole should be cut in the upper side of the drum so that the fertilizer can be stirred before each application.

In the summer, if the pond clears within two weeks following fertilization, apply more frequently (at two-week intervals) with one-half the recommended rate. Liquid fertilizer is so soluble that the planktonic algae can quickly consume it. Smaller, more frequent applications should solve the problem.

Powdered fertilizer: Powdered fertilizer is highly concentrated and very soluble in water; therefore, smaller quantities are needed. Application is accomplished by simply broadcasting from shore or trickling the recommended rate from a boat. Because the material is so soluble and quickly consumed by the plankton, more frequent applications may have to be made to maintain a desired color.

Annual time-release fertilizer: For pond owners who are too busy or do not live close to their pond, time-release fertilizer may be an option. An application is made once a year, and even though it is expensive, one bag will treat several acres. Plankton blooms may not be as consistent with this type fertilizer. Owners should visit their ponds occasionally to check the water visibility. If the pond is excessively green (visibility below 12 inches), then the fertilizer bags should be temporarily removed.

Feeding

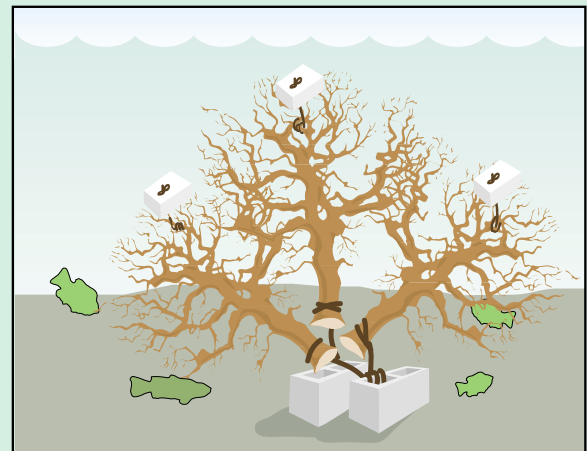
Bluegill respond favorably to a supplemental feeding program. Commercial fish rations (manufactured for catfish) are available from most feed and seed stores. Bream can be trained to take the pellets, which increases their growth and size considerably. Although bass do not actually consume the pellets they do benefit from improved bluegill reproduction. Bluegill should be fed about twice a day by hand or by automatic feeders. A small, floating, BB-sized pellet that the bream can easily consume should be used.

They should be given only what they can eat in a 10-15 minute interval. Feeding should be done in the warmer months (March - November), but can also be done on a smaller scale in the winter during mild weather. Usually, sinking feed is better in the winter. **(Note: Supplemental feeding of bream is not absolutely necessary to maintain a quality pond.)**

Habitat Improvement

Many pond owners like to add structure to attract fish and improve angling success. Trees, brush, limbs, or other woody material make excellent attractors and are readily available. Trees may be anchored in the pond bottom prior to impoundment or added later by attaching concrete blocks and sinking them. Three to five trees should be used per site and a styrofoam float should be attached to the top of each tree so that they will stand upright. Brush piles or limbs should also be anchored with blocks. If the pond has not filled, brush can be anchored by cables or dirt piles. Attractors can also be constructed of concrete rubble, PVC pipe or wooden stake beds, or most any material that is environmentally safe. No more than three attractor sites per acre are needed or their effectiveness will decline. The fish reefs should not be placed in water that exceeds 8-10 feet as low oxygen may deter fish from using them during the summer months.

Pea gravel is effective in attracting bream. The gravel beds should be 2-3 inches thick and should cover an area of around 100 square feet. The gravel should not be placed in water over 3 feet in depth and the site should be easily accessible by bank anglers. Usually no more than one gravel bed per acre is needed.



Many pond owners add structure to attract fish.

POND PROBLEMS

Aquatic Plants

Aquatic plants are not desirable in ponds for a variety of reasons, which include reduced fish production by removal of nutrients, interference with population balance, breeding habitat for mosquitoes, and interference with angling.

Aquatic plants can be classified into five basic categories: algae, floating, submergent, emergent, and marginal. Control measures differ for each group, and proper identification of the plant is necessary before the correct control measure can be selected.

Most aquatic plant problems can be prevented in a properly constructed pond by a good fertilization program. Plants need sunlight in order to thrive. If the water depth is a minimum of 2 feet and a satisfactory plankton bloom is maintained by fertilization, sunlight cannot penetrate to the bottom and rooted plants will not grow. For fertilization to be effective a bloom must be established early before nuisance plants begin to grow. Attempting to fertilize after the plants have become established will only worsen the problem.

In established ponds where the water is less than 2 feet deep, the most practical method of control may be to lower the water during the winter and deepen the shallow areas to a minimum of 2 feet in depth. Deepening the edges should be completed prior to February to allow sufficient time for the pond to refill before bass begin to spawn. Soil removed from the shallow areas may be used to make earthen piers for better bank access or to form underwater structure in the pond.

Many plants in the marginal or emergent groups may be removed by hand. It is a simple task to pull a few water lilies or cattails from the pond before they have time to grow, reproduce, and cause major problems.

Chemical control with registered herbicides is effective on most aquatic plants. The correct herbicide depends upon proper plant identification. To achieve the desired results, it is important that all label instructions be followed when an aquatic herbicide is used.

Some plants can be controlled by natural or biological methods. One such control agent is the white amur (grass carp). When stocked at the proper rates (see table), these fish can provide long-term control of aquatic plants and do not interfere with the sportfish population.



Ponds with aquatic plants cannot be managed for fish.

Stocking Rates for Grass Carp in Farm Ponds

<u>Weed density</u>	<u>Number per acre</u>
Slight	5
Moderate (less than 20% coverage)	10-15
Heavy (greater than 20% coverage)	15-20

In ponds with established bass populations, the amur should be at least 10-12 inches in length so that they will not be consumed by the bass. A spillway barrier should also be utilized to prevent the amur from escaping during periods of heavy rainfall. White amur will usually control aquatic plants for about 5 years. Older, larger amur become ineffective; therefore they may have to be restocked periodically.

Control of aquatic plants depends on correct identification followed by proper control. A fisheries biologist should be contacted for plant identification and control measures that

are best suited for your pond. **Aquatic plants from water gardens or ornamental ponds should never be placed in a fish pond. Many of these plants are not native to Alabama and can have serious environmental impacts on ponds or adjacent natural waters. Most are illegal to place in the public waters of Alabama.**

Watershed Care

The watershed is an integral part of a pond. Practically all water passes over or through the soil in the watershed before entering the pond. Proper watershed management will help regulate the rate and quantity of run-off, reduce siltation, and prevent pesticides or toxic chemicals from entering the pond.

The entire watershed should have a permanent cover crop. If it is necessary to plant row crops in the watershed, terraces should be constructed to drain fields away from the pond so that siltation will be held to a minimum. Row crops should not be planted in the watershed that will require the use of pesticides that are toxic to fish. Application of pesticides to nearby fields should only be done on calm days when rain is not forecast. Likewise, pesticide containers or equipment should not be cleaned or dumped into the pond or watershed.

Fish Kills

Fish kills may occur if toxic substances enter the pond, if dissolved oxygen is low, if parasites or diseases attack the fish, or for other reasons. When a fish kill occurs, a fisheries biologist should be contacted immediately to determine the cause and to develop a plan to reduce or eliminate additional losses.

The numbers, weights, and sizes should be estimated for each species of fish that dies. Mortality estimates will be helpful to a fisheries biologist in determining the severity of the kill and whether the fish population will recover.

Care should be exercised when using pesticides on or near the watershed of ponds. Pumps used to spray pesticides and then cleaned in the pond may contain enough toxic material to kill fish. In addition, cattle sprayed with pesticide should not be allowed to access ponds. Many pesticides are not toxic to fish and should be used when practical.

Low oxygen may result in fish kills, particularly during the hot summer months as warm water contains less oxygen. The primary source of oxygen in most ponds is from photosynthesis, a process through which phytoplankton (green algae) produce oxygen in the presence of sunlight. Since sunlight is required, oxygen production occurs during daylight hours. After dark, oxygen concentrations tend to decline as it is consumed by aquatic organisms (fish, insects, algae, etc.) through respiration. Oxygen level is typically 8-10 ppm (or higher) during the day. If concentrations fall below 2-3 ppm, fish mortalities may occur.

The decay of plant material is another common cause of fish kills. Since decomposition of organic matter consumes oxygen, chemical treatment of plants should be done in early spring when water temperatures are lower and plants are less abundant. No more than a third of the plants should be treated at a time. Several days of cloudy weather or a rapid change in temperature following a thunderstorm may also cause an oxygen deficiency through a sudden die-off of plankton. Over fertilization increases the likelihood of an oxygen problem. Symptoms of oxygen depletions may include a change in water color (from green to black or brown), a pungent odor, fish that suddenly stop biting or taking pelleted feed, or fish swimming near the surface and gulping for air. When any of these



Low oxygen can cause major fish kills

symptoms are noticed, the pond should be aerated immediately. Usually, a pump is the most practical method for aeration. The intake should be placed just beneath the pond's surface and the water sprayed into the air and allowed to fall back on the pond. The stream of water should be diffused so that it will collect more oxygen from the air. Aeration is especially critical at night when oxygen levels are the lowest. An application of 20 pounds per acre of triple superphosphate should also be made to quickly improve oxygen production by stimulating plankton growth. (**Note: In ponds greater than 3 acres, small pumps will have little or no effect in improving oxygen).**)

Fish parasites or diseases seldom cause extensive kills in bass-bream ponds. Symptoms may include external sores or bloody lesions. Chemical treatments, though expensive, are available for certain fish parasites and diseases. If the fish are taking a pelleted ration, many diseases may be treated with medicated feed. Consult a fisheries biologist or the Auburn University Fish Parasite and Disease Lab (phone 334-844-4786).

During the spring, kills may also occur when fish, primarily bream, gorge themselves on swarming fire ants. Fire ant kills can often be determined by examining the stomach contents of a dead or dying fish. Fire ants may also be suspected if large numbers of ants are seen floating on the pond.

Pond Leaks

Some water loss can be expected in new ponds until soils become saturated. Water loss through evaporation (6-12 inches) is also normal, particularly during dry months. If an excessive decline in water level is noticed and the area below the dam stays saturated, then a leak is probable. Leaks may be very difficult to locate since they can occur in the pond bottom through sand or rock seams. Usually the pond will have to be lowered and a layer of clay incorporated into the bottom. Other leaks can occur through the dam because it was not properly cored. When building the pond make sure a reputable contractor, with references, is employed. Normally, leaks through the dam can only be repaired by lowering the pond and re-coring the dam. Pond leaks can also develop through the drainpipe. A slight leak in the valve may be repaired by

Undesirable Fish Species

Pond owners should never stock any species of fish without first consulting a fisheries biologist. Species such as shad, crappie, shiners, bullhead catfish, or hybrid bream can cause problems to pond balance and are only advisable under specific circumstances. Wild fish may also enter the pond from the watershed through no fault of the owner. Once undesirable species have become established, the only remedies are to drain the pond or attempt to control their abundance by increasing the bass population if the wild fish can be eaten by the bass.



Bullhead Catfish



Crappie



Shad



Shiner

Freshwater Fish Illustrations By Duane Raver, USFWS

pouring wet sawdust along the outside of the standpipe. As the sawdust sinks, it is sucked into the leak, resulting in a seal. At times, new pipe can be inserted into old pipe for repair or divers can be employed to repair a faulty valve; however, in most cases the pond will have to be lowered and the valve replaced. If a leak is suspected, the contractor and the NRCS should be consulted regarding the best method of repair.

Muddy Water

Muddy water is the result of suspended soil particles. Ponds occasionally become muddy because of wave action or erosion of exposed soil in the watershed. Muddy water can limit plankton growth which results in lower pond productivity. Several treatments are available but are only temporary unless the source of the silt is eliminated. All bare areas around the pond or in the watershed should be seeded and mulched or sodded. Additional remedies include a mixture of cottonseed meal and superphosphate, lime, gypsum, alum, or routine fertilization under minor circumstances. Contact a fisheries biologist to determine which treatment is best for your particular problem.

Livestock

In addition to fishing, many ponds provide a source of water for livestock. Cattle may muddy the water, cause erosion of the dam and the shoreline, or their wastes may result in excessive nutrients, which may cause fish kills. Alternate sources of water should be used or the pond overflow pipe should empty into a trough below the dam. If the pond must be used, fences should be constructed which allow cattle to access only a small portion. Ponds that are heavily utilized by livestock should not be fertilized.

Muskrats, Beavers, and Otters

Although muskrats and beavers pose no problems to fish, they can be nuisances. Occasionally they will burrow or tunnel into the dam or shoreline just below the water level. Many times these tunnels collapse and create shallow areas where aquatic plants may grow. Muskrats and beavers will usually not tunnel through a properly constructed dam, but excessive tunneling can weaken the dam and cause serious leaks. In addition, beavers can stop up overflow pipes and spillways, which can lead to breaching of dams during heavy rains. The destruction of timber is also a concern to most pond owners.

Muskrats and beavers may be controlled by trapping or shooting. Contact local Conservation officers to determine legal means to trap or kill these animals. An electric fence is also an effective method to prevent muskrats and beavers from entering the pond.



Beaver may tunnel into dams, stop up overflow pipes and spillways, and destroy nearby timber.

Many pond owners are concerned about otters consuming their fish. Otters cause very little problems in bass-bream ponds due to the high reproductive rates of these fish species. Sufficient numbers of young fish are produced to more than replace those eaten by otters; however, if control is desired, the methods used on muskrats and beavers are equally effective. Otter species are protected so a Conservation officer should be contacted before control measures are taken.

Snakes

Snakes often cause concern for pond owners, but usually for unjustified reasons. Water attracts snakes, but most are harmless and they play important roles in nature. Snakes should just be left alone and viewed from a distance. If their presence is cause for concern, then simply clean up the shoreline and they will find other places to live.

Turtles

Turtles are present in most ponds. They are primarily scavengers and are not harmful to fish populations. They may be a nuisance by stealing bait or fish from stringers, but under most circumstances, should be left alone as some species are protected and should not be harmed or captured.



Turtles are primarily scavengers and are not harmful to fish populations.

Alligators

Alligators are becoming increasingly abundant in Alabama, and occasionally they may take up residence in a fish pond. Since alligators don't eat enough fish to adversely affect bass - bream balance, they should just be left alone. Do not feed or harass them. If they do become a nuisance by attacking ducks or pets, then a local Conservation officer should be contacted for removal of the alligator.

Mosquitoes

Mosquito populations can usually be controlled by bream and topminnows, which feed upon the larvae. Deepening pond edges and reducing aquatic vegetation will also reduce mosquito populations by eliminating breeding areas.

Midges, mosquito-like insects that live in and around ponds, are often mistaken for mosquitoes. Thousands of midges are sometimes present around fish ponds. They make a noise similar to mosquitoes but are usually larger than mosquitoes, have fuzzy antennae, and do not bite. The larval form of midges is a significant portion of the bluegill's diet.

Water Birds

A common belief among pond owners is that herons (cranes), kingfishers, and other water birds transport fish or fish eggs from one pond to another. Although this may be possible, it is not likely and has not been proven. While some water birds are the intermediate host of fish parasites and some eat fish, they generally pose no serious threat. Occasionally large flocks of fish-eating cormorants may take up long-term residence in a pond.

Under these circumstances significant fish losses can occur and control measures may be necessary. Practically all water birds are protected by law, so Conservation officers should be contacted before control measures are initiated.

FISHING PONDS

New ponds may be fished one year after the bass are stocked. Prior fish harvest can cause problems in pond balance because largemouth bass will not spawn until they are 1 year old. After the bass have spawned, there is usually no reason to delay fishing. If the pond has been managed properly, it will be supporting a maximum weight of fish one year after the initial bass stocking. Continued growth of the fish will be very slow until some are harvested. Bream normally average about 1/4 pound and largemouth bass about 1 pound when fishing begins. As harvest occurs, more food becomes available to the fish that remain, and their growth rates improve.

Efforts should be made to harvest a practical yield of fish from the pond, yet overfishing should be prevented. Overfishing occurs most often during the first few days or weeks after the pond is opened, but may occur at any time if excessive fishing pressure is exerted. Therefore, owners should use some restraint when harvesting fish.

Annual maximum harvests should be limited to about 125-150 pounds of bream and 25-30 pounds of largemouth bass per acre for a properly fertilized pond (less than half these limits for unfertilized ponds). The total catch should not be made during a 1- or 2-month period, but evenly distributed throughout the year. Sound harvest practices cannot be placed on a precise schedule, but as a general rule, no more than 25 percent of the maximum yearly harvest of bream and largemouth bass should be made during any one month. To maintain balance, fish should be harvested at about the same rate they reach a catchable size. Harvest records (weight and numbers for each species) should be documented to eliminate guesswork. If proper management and harvest is practiced, ponds will sustain a fishery indefinitely. Contrary to popular belief, ponds do not have to be drained every few years.

Bluegill are easiest to catch during their first spawning period. In Alabama, this is usually during May or June. Bluegill spawn periodically throughout the summer when the water temperature remains above 80° F and can be caught



New ponds may be fished one year after bass are stocked.

during any month of the year. Redear sunfish are caught more readily during April and May. Redear sunfish spawn when the surface water warms to about 75° F. Normally they do not continue to spawn throughout the summer, but may spawn again during September or October when the water temperature cools to 75° F again. Redear are not as prolific as bluegill; therefore they are less abundant and are not caught as often as bluegill.

Live earthworms are the most popular bait for bream. Other effective live baits include crickets, meal worms, cockroaches, grasshoppers, and catalpa worms. Bream will also take an assortment of artificial flies and small lures.

Largemouth bass usually spawn once each year when the surface water temperature reaches 65-70° F. Bass may go on nests as early as February or as late as May, depending on the

water temperature. Largemouth bass are not easily caught while nesting, but after they spawn, their feeding activity increases. Bass fishing success is usually at its peak from March thru May, but is also productive during fall and winter. Largemouth bass can be caught on an assortment of live baits and artificial lures; however, shiners or minnows should not be used as they may become established and pose problems to the gamefish populations.

A common problem in large ponds (over 5 acres) is inadequate bass harvest. Bass may become so abundant that they become stunted and skinny. If overcrowding occurs and owners wish to improve bass size, then they must fish heavily for bass and remove all that are caught. Owners may have difficulty removing enough bass to correct this problem in a large pond. Preventative measures are usually best by routinely harvesting a minimum of 25-30 pounds of bass per acre each year (beginning one year after the bass are stocked) so that overcrowding is avoided.

There is no "only way to fish." Fishing success may be improved by studying the habits of fish or by watching other anglers. The most successful angler fishes often, uses effective baits or lures, and is willing to experiment with new baits or techniques. If fish are not biting, simply try again another day.

DETERMINING POND BALANCE



Fisheries biologists use a seine to help determine pond balance.

Pond owners may become dissatisfied with the quality of fishing and wonder if their pond is in balance (correct ratios of bass to bream). Some times pond balance can be determined by the numbers and sizes of fish being caught. If a variety of sizes of both bass and bream are being caught (mostly harvestable size, but some smaller), then the pond is probably balanced. If the bream are large and healthy, but few in number, and the bass are small, skinny and abundant, the pond is usually overcrowded with bass and anglers should keep all bass that are caught. If the bream are small, skinny, popeyed, and very abundant, and the bass are few, but large (over 3 pounds)

and healthy, the pond is overcrowded with bream. Usually the quickest and least expensive solution is to drain the pond and restock. Other alternatives may include a reduction in bream numbers by a marginal rotenone treatment or by stocking adult bass (over 10 inches). If undesirable species are mostly caught (shiners, crappie, bullheads, wild sunfish, etc.) then the pond is being adversely impacted by a competitive species. Usually these ponds must be drained, the wild fish eliminated from the watershed, and the pond restocked with the correct numbers of bass and bream. If the status of the fish population is uncertain, biologists of the Division of Wildlife and Freshwater Fisheries may need to perform a management check, either in June or September. The local district fisheries office should be contacted to obtain an application. Applications must be submitted prior to June 1 to have the pond checked in June and prior to September 1 for the fall check. The pond will be visited by a qualified fisheries biologist and management recommendations will be made to improve fishing success.



ABOVE: Fisheries biologists conduct a balance check.

LEFT: Bass and bluegill reproduce well in a balanced pond.



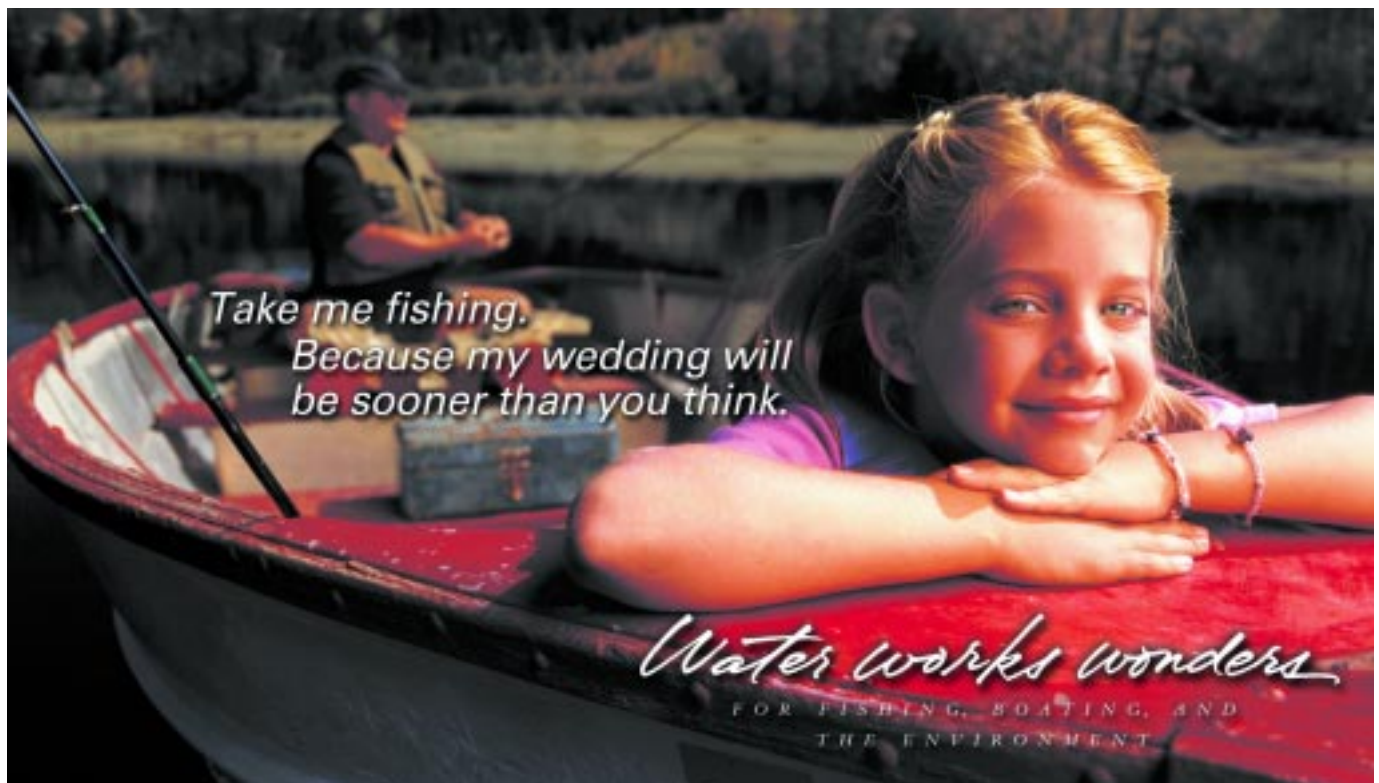


CHANNEL CATFISH

Channel catfish can be stocked in fertilized bass and bream ponds at the rate of 50-100 per acre. At higher stocking rates, channel catfish are very competitive with bream and can reduce bream growth and abundance. When catfish attain large sizes (over 15 inches), they may also compete with bass by preying upon bream. When bream numbers decline, bass growth is also affected. If more catfish are desired, or the pond is less than 1/2 acre, owners may wish to consider stocking only catfish. Information on catfish production can be obtained from the local county extension office, the Fisheries Department, Swingle Hall, Auburn, Alabama 36845, or the Alabama Fish Farming Center, P.O. Box 487, Greensboro, Alabama 36744. Channel catfish are not stocked in private ponds by the Alabama Department of Conservation and Natural Resources, but fingerlings may be purchased from commercial producers. A list of commercial producers is available upon request from the Division of Wildlife and Freshwater Fisheries, Department of Conservation and Natural Resources, 64 N. Union St., Montgomery, Alabama 36130 or from the local district fisheries office.



If pond owners desire, channel catfish can be stocked at low rates with bass and bream.



GLOSSARY

Acre-foot — One surface acre of water 1 foot deep or 43,560 cubic feet of water. The total acre-feet of water in a pond is determined by multiplying the number of surface acres by the average depth in feet.

Alkalinity — The total concentration of bases in water.

Balance — Fish populations capable of producing satisfactory annual crops of harvestable-sized fish.

Bass — Common name for several spiny-finned fishes. Used in this booklet to denote the largemouth bass.

Bluegill — Common name for *Lepomis macrochirus* (Rafinesque), also called bream. Stocked in ponds in combination with redear sunfish and largemouth bass.

Bream — Common name of several centrarchid fishes. Used in this booklet to denote bluegill, redear sunfish, or a combination of these two fish.

Carrying capacity — The theoretical maximum weight of fish that can be maintained in a pond without depleting the food supply.

Core trench — A trench dug into the soil at the base of dam site and later filled with clay to bond the above-ground portion of the dam to the subsoil of the pond bottom. This prevents excessive seepage of water through the porous soils between the surface and the subsoil.

Cube' powder — Powdered root of a shrub of the legume family. The powder contains rotenone which is used to kill fish.

Freeboard — Portion of the dam above spillway level to protect the dam against washout.

Harvestable-sized fish — A fish of a size normally kept by sport anglers. This size for bream is about 6 inches and larger and for largemouth bass it is about 10 inches and larger.

Largemouth bass — Common name for *Micropterus salmoides* (Lacepede), also called "trout," "green trout" "bass," and other names. Stocked in ponds in combination with bluegill and redear sunfish.

Mosquitofish — See topminnow.

Overpopulated (overcrowded) — A term that describes a fish population where

too many fish are present for the amount of available food. In such a population the fish are thin and undesirable to anglers.

Plankton — Collectively, all organisms (plants and animals) suspended in the water which are not independent of water movements. They are eaten by insects, worms, crustacea and small fish.

Plankton bloom — A dense growth of microscopic plants and animals (plankton) that causes the water to be green, brown, or soupy in appearance. Plankton blooms occur after ponds are fertilized.

Pond check — An analysis by a fisheries biologist of a fish population in a pond. A seine is used to catch fish, catch records are reviewed to determine angler success, and previous management records are studied to determine the present and past condition of the fish population.

Recruitment — The number of young fish that grow into the adult population during a specific time interval.

Redear sunfish — Common name for *Lepomis microlophus* (Gunther), also called shellcracker and bream. Stocked in ponds in combination with bluegill and largemouth bass.

Rotenone — A natural substance extract-

ed from the root of certain plants, which constricts blood vessels in a fish's gills and causes suffocation.

Shellcracker — See redear sunfish.

Spillway barrier — A barrier to block the entry or escape of all fish through the spillway during periods of overflow. A barrier is usually constructed so that water leaving the spillway will drop a vertical distance of at least 3 feet.

Topminnow — The common name of *Gambusia affinis* (Baird and Gunther). A small fish found in practically all ponds. Also known as mosquitofish. It reaches a size of up to 3 inches, inhabits shallow water and feeds on mosquito larvae and plankton.

Watershed — All land area from which run-off water may enter a pond or lake.

White amur — Common name for *Ctenopharyngodon idella*, also called "grass carp." Stocked in ponds for weed control.

Wild fish — Any fish not supplied by a fish hatchery.

Yield limit — The maximum pounds of harvestable-sized fish a pond will yield from year to year without detrimental effects to the balance of the fish population when normal management practices are applied.

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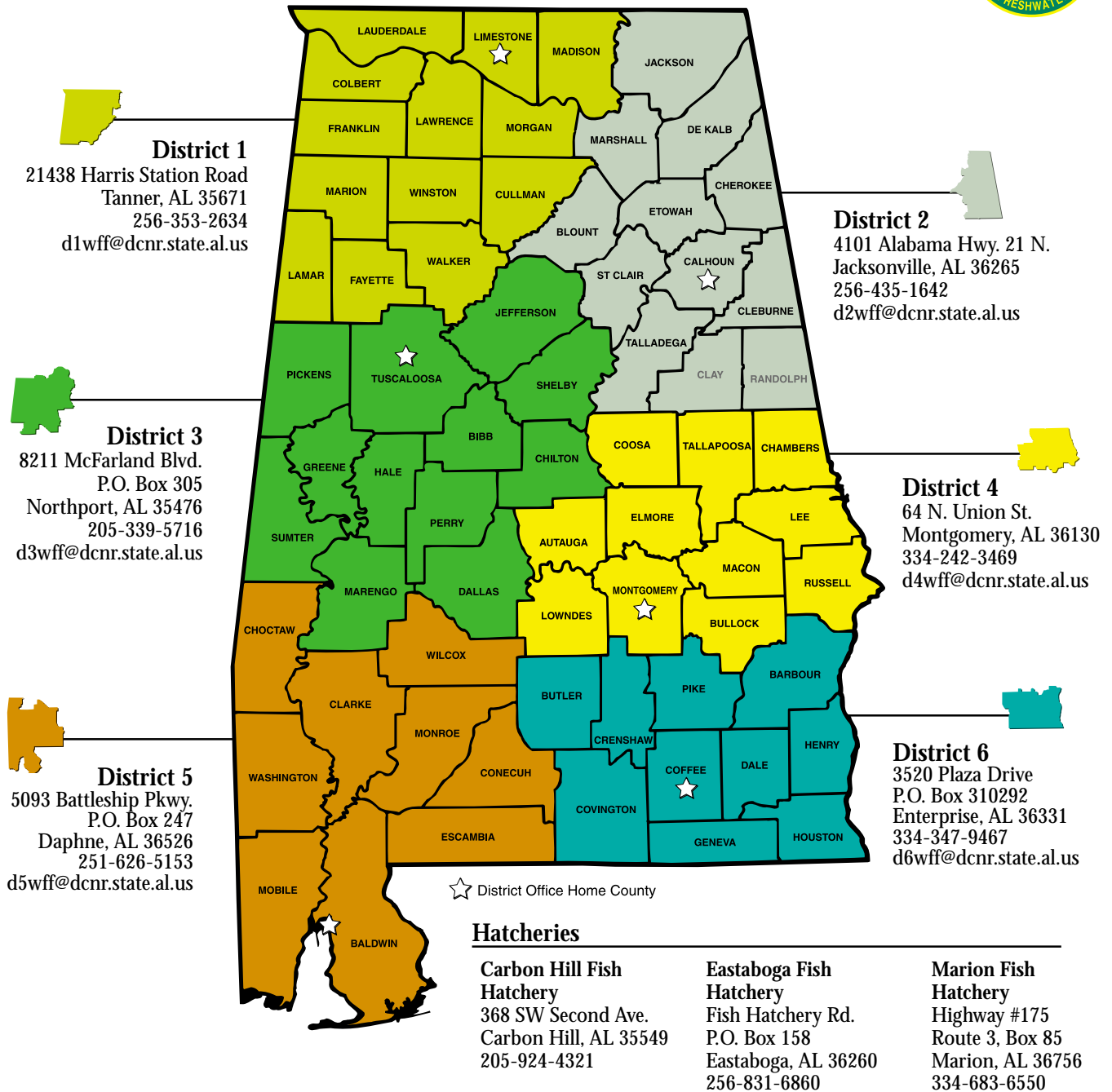
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