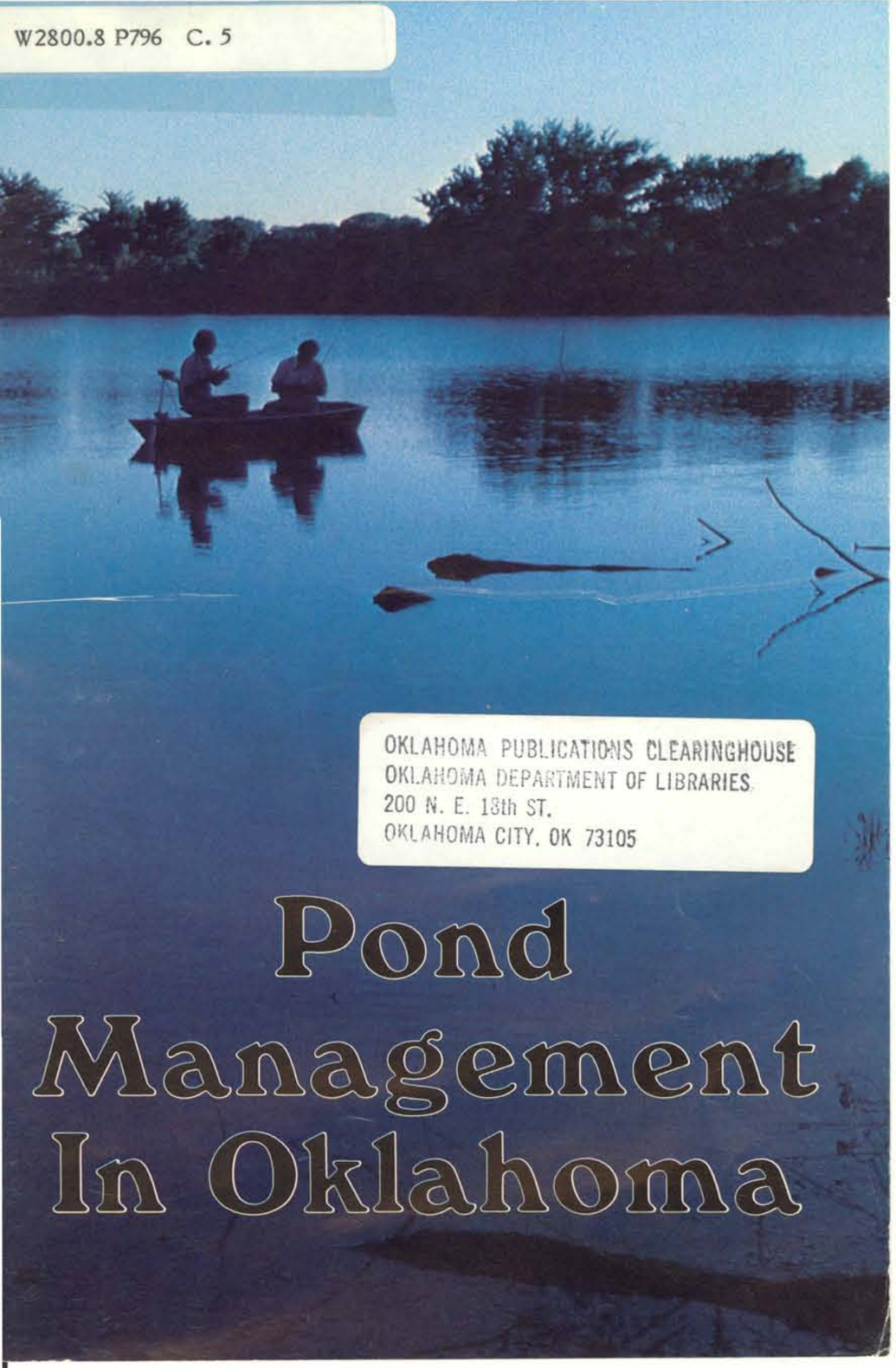
W2800.8 P796 C. 5



OKLAHOMA PUBLICATIONS CLEARINGHOUSE
OKLAHOMA DEPARTMENT OF LIBRARIES
200 N. E. 18th ST.
OKLAHOMA CITY, OK 73105

Pond Management In Oklahoma

Pond Management In Oklahoma

A Fish Pond Management Handbook
by
Fish Division
Oklahoma Department of Wildlife Conservation

1981

Financial support for this publication was provided by the Anglers of Oklahoma through the purchase of fishing licenses, and by the Oklahoma Conservation Commission.

INTRODUCTION

Oklahoma has more than 200,000 ponds which cover about 500,000 acres. Most ponds can potentially produce fish. The water and fish populations in ponds are easily managed if these small impoundments are planned and designed carefully. A successful pond which consistently produces good catches of fish depends on proper planning prior to building a pond. The pond's location, design and construction will combine to optimize fish production.

After the pond is completed, the success or failure of the pond depends on the pond owner's efforts to implement and carry out management practices necessary to establish and maintain good fish populations. These practices include proper stocking ratios, balanced harvest, water management and weed control.

Through proper management, the pounds of fish produced annually in a pond can be increased tenfold, compared to an unmanaged pond situation. In addition, the increased numbers of harvestable fish provide many hours of recreation as well as a nutritious food supply for the family, friends and neighbors.

After reading this booklet, you may have some specific questions. For additional information contact:

- Fish Division, Oklahoma Department of Wildlife Conservation, 1801 North Lincoln Blvd., OKC 73105 or phone 405/521-3721.
- Soil Conservation Service, Agriculture Center Building, Stillwater, OK 74074 or phone 405/624-4437.
- Wildlife Specialist, Room 017 Agriculture Hall, Oklahoma State University, Stillwater, OK 74074 or phone 405/624-5515.

TABLE OF CONTENTS

INTRODUCTION 3

PLANNING A POND

- Site Selections 3
- Water Supply 3
- Topography 3
- Soil Quality 3

POND CONSTRUCTION

- Fishing Ponds 4
- Pond Dams 4
- Pond Banks 5
- Seepage Problems 5
- Clearing 5
- Fish Shelters 5
- Basin Preparation 5
- Completion Time 5

STOCKING A POND

- Fish available from Oklahoma Department of Wildlife Conservation 8
- Largemouth Bass 8
- Bluegill 10
- Channel Catfish 11
- Other Sources 12

POND MANAGEMENT

- Harvest Guidelines 12
- Vegetation Control 14
- Fertilization 16
- Muddy or Turbid Ponds 17
- Feeding 18
- Drawdown 19
- Habitat Development 19
- Fencing 19

POND RENOVATION 21

ROTENONE 22

PLANNING A POND

Site Selection

Consider the following points when selecting a pond site.

Water Supply should be adequate but not excessive. The water supply may be from springs, artesian wells, irrigation runoff or natural drainage. Natural drainage ponds in Oklahoma should have from five acres (in the east) to 20 acres (in the west) of drainage area for each surface acre of pond. A small yet adequate drainage area for fish ponds is best because: (a) the pond water will be changed much less often, meaning runoff will not frequently flush nutrients and animal life out of the pond; (b) less silt will wash in; and (c) potential erosion of the spillway will be reduced.

A successful pond requires a quality water supply. The water must not be contaminated with industrial wastes, feedlot runoff, pesticides, herbicides or excessive silt. Drainage areas completely covered with grasses or woody vegetation provide the best water source for fish ponds. Properly grazed pasture land provides the second best drainage area coverage, while heavily fertilized, cultivated land provides the least desirable cover.

Topography of the pond site can help reduce construction costs. If natural features of the land form three sides of the pond you'll move less earth and save money. Select a site so the finished pond area is as flat and wide as possible. This obtains greater water volume in relation to the dam height, but doesn't sacrifice adequate depth. Generally, avoid damming creeks or large deep draws unless excess water can be easily diverted. These type ponds usually become muddy, silt in rapidly, and eventually develop unwanted fish populations. They also lose valuable nutrients when they overflow.

Another consideration is the prevailing wind direction. Don't build a pond so the wind constantly blows across the water towards the dam. Wind-caused waves destroy shoreline fish habitat and damage dams.

Some deficiencies found at less than optimum pond sites can be overcome by diverting water with terraces either towards or away from a pond, or by installing shoreline protection measures such as rock riprap or artificial reefs made from logs or tires.

Test coring before construction starts determines the pond site's **Soil Quality.** Look for impervious clay or clayloam soils which provide more leak-resistant construction. If adequate clay is not available, consider another site or truck in enough clay to core (plate) the dam and pond basin. If the clay in the pond area is less than 15 feet deep, do not remove dirt from the pond basin for building the dam. Instead, bring clay in from another location for the dam.

Anyone planning to build a pond can obtain free technical assistance from the U.S. Department of Agriculture, Soil Conservation Service. Cost sharing may be available for pond construction through several government programs. The SCS District Conservationist will inform landowners of what funding is available and how to apply for such

financial assistance. Also through SCS, pond site soils will get checked for water holding properties. Pond topography, water source and other design features, as well as laws and regulations concerning dam safety and pond construction, will be determined and complied with.

POND CONSTRUCTION

Fishing ponds should be at least 1/2 acre and at least 10 feet deep in one-fourth of its area. Smaller ponds may produce many hours of fine fishing, but they are more susceptable to overharvest and require more intensive management.

Larger ponds are more dependable for other uses (water supply, irrigation, hunting, swimming, and boating) and are less susceptable to water fluctuations and overharvest which adversely affects pond fishes. Small ponds, however, can provide enjoyable fishing if good planning and management guidelines are followed.

Pond Dams should be at least 10 feet wide (or six feet plus 1/5 of the dam height) at the crest, and have a 3:1 slope (three feet of width for every one foot of height). The dam should have these water control structures: an overflow pipe to handle normal runoff, a spillway of sufficient size to handle extreme runoff and a drainpipe.

Build the spillway at least three feet below the top of the dam. If the spillway is a vertical concrete structure, it should have a lip overhang. Earthen spillways should have adequate fall so unwanted fish don't move upstream into the pond. So the stocked fish don't get swept downstream during heavy overflow, construct the spillway wide enough so the water spreads into a thin sheet only a few inches deep.

A drainpipe extending through the dam is the most important management device for any pond. No pond should be built without a drain-

Careful planning before the bulldozer starts working is the first step for a productive fishing pond.

pipe. It permits water level drawdowns for vegetation, nutrient and water quality control. Drainpipes also allow partial or complete drainage for renovation or repair work. Ponds three acres or less need a four to six inch diameter pipe capable of draining a six to eight foot deep, one acre pond in 60 to 120 hours. Ponds up to 15 or 20 acres need a 12-inch diameter pipe. Drainpipes should have a one foot drop per 100 linear feet. Use pipes made of asbestos-cement, cast iron, or plastic with tight connecting joints. Place concrete cutoff collars 10 to 15 feet apart to prevent tunneling along the pipe. Use pipes equipped with valves or an adjustable trickle (riser) tube.

Pond banks should also be on a 3:1 slope extending at least three feet below the waterline. Try to keep the water at the shoreline at least three feet deep. Excess dirt removed from the shoreline can be used on the dam banks or as peninsulas or berms. Shallow shorelines encourage excessive plant growth, reduce bank fishing access and limit spawning habitat.

New ponds often develop **seepage** problems. The solution calls for draining the pond completely, letting the bottom dry and working the soil with a disc or plow up to the permanent water level. Then apply bentonite (one pound per square foot) or soda ash (one pound per five square feet) evenly over the area to be sealed. Disc or rake the top three or four inches, then pack the bottom with a sheepsfoot or plain roller.

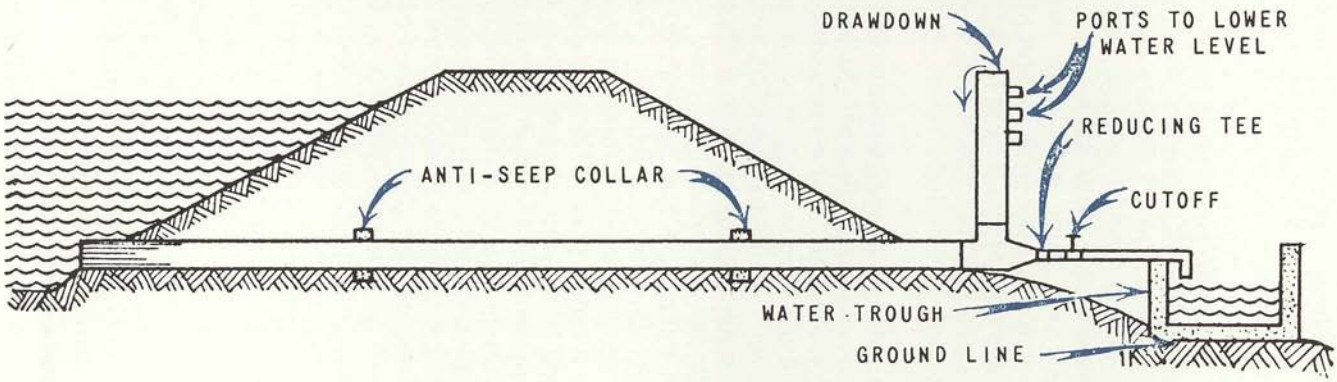
The amount of **timber and brush** you need to clear from the pond basin depends upon the pond's size and its planned uses. For producing maximum harvestable fish populations, smaller ponds (less than three acres) should be cleared of all trees, stumps and brush. The only exception would be a small pond where only a few large fish are desired. In larger ponds leave some brush, yet a few well-placed, man-made shelters are more effective than a congested stand of timber which only restricts the pond's uses. Too much timber and brush usually results in an underharvestable fish population.

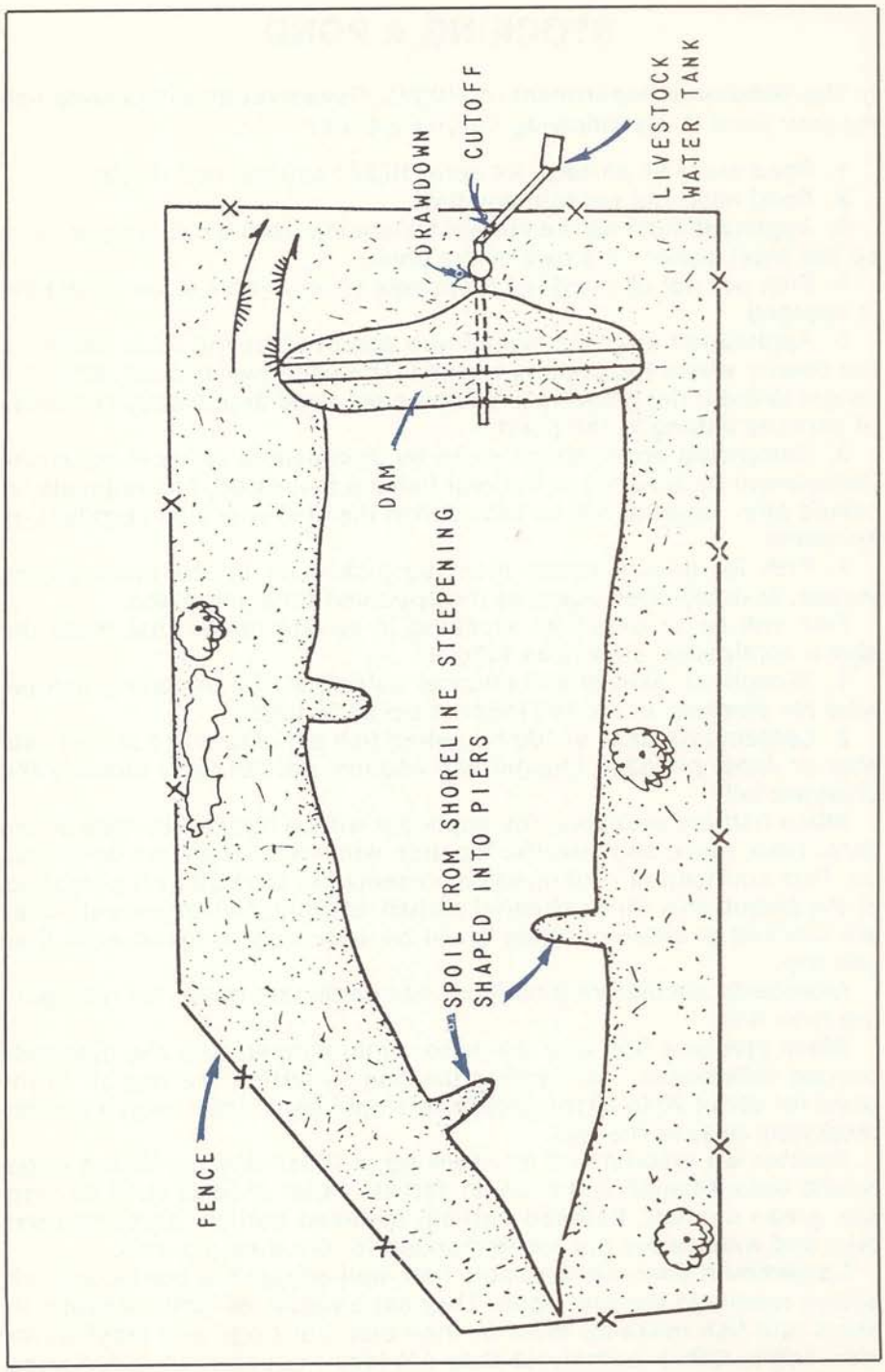
Place **fish shelters,** such as automobile tire modules, brush piles, stake beds, large trees, culvert pipes, milk or cream cans, drain tiles, and gravel or rock beds, in three to six feet of water. These not only promote fish harvest, growth and reproduction, but help reduce turbulence and shoreline erosion. Man-made habitat is much easier to install during the construction phase than after the pond fills.

Preparing the **pond basin** for filling requires planting fast growing crops (rye, wheat, oats) at 100 pounds per acre, or sudangrass at 25 pounds per acre. These plants provide nutrients plus control erosion prior to impoundment. Shorelines may be protected from erosion by planting Japanese millet in a five to ten foot wide strip around the shoreline, establishing good sod-forming grasses around the shore, or placing rock riprap along the shores.

Complete any pond construction in early fall so a two stage filling process (1/2 in fall, remainder of water in early spring) can be employed. This process promotes excellent fish reproduction, growth and young fish survival.

POND WITH COMBINATION DRAWNDOWN, DRAIN, PORTS, AND WATER TROUGH




FENCE
SPOIL FROM SHORELINE STEEPENING
SHAPED INTO PIERS
DAM
DRAWDOWN
CUTOFF
LIVESTOCK
WATER TANK

STOCKING A POND

The Oklahoma Department of Wildlife Conservation will provide fish for your pond if the following criteria are met:

1. Pond must be at least 1/4 acre (10,870 square feet) in size.
2. Pond must not contain any fish.
3. Applicant must have a current Oklahoma fishing license and must be the legal owner or lessee of the pond.
4. Fish will not be provided for private ponds where a fee for fishing is charged.
5. Application must be signed and approved by the local ranger in the county where the pond is located. The pond owner must allow the ranger to enter the property to examine the pond and to check licenses of persons fishing in the pond.
6. Completed applications must be postmarked or received at the Department by June 1st of the year fish are requested. Any requests received after June 1st will be included in the next year's fish production schedule.
7. Fish for private ponds must be picked up by the pond owner, lessee, or designated agent at the specified time and place.

Fish will be provided for stocking in private ponds that meet the above application criteria as follows:

1. Bluegill at 200-500 and channel catfish at 100 fingerling fish per acre for stocking in the fall (September or October).
2. Largemouth bass at 100 fingerling fish per acre in the spring (late May or June) provided bluegill and channel catfish were stocked the previous fall.

When fish are available, the applicant will be notified by mail of the date, time, town, and specific location where their fish can be picked up. This notification card must be presented to the hatchery personnel at the pickup site. Since channel catfish, bluegill, and largemouth bass are stocked at different times it will be necessary to make more than one trip.

Applicants should bring medium size cardboard boxes for transporting their fish.

When stocking fish into the pond, avoid temperature and dissolved oxygen differences. Acclimatize the fish by letting the bag sit in the pond for about 20 to 30 minutes before opening it, then open it and immediately release the fish.

Species we recommend for stocking in Oklahoma ponds are largemouth bass, bluegill and channel catfish. Other species such as crappie, green sunfish, flathead catfish, bullhead catfish, carp, northern pike and walleye are not recommended for Oklahoma ponds.

Largemouth Bass are desirable fish, well adapted to ponds, and will spawn readily in shallow water. They eat a variety of foods. Aquatic insects and fish make up most of their diet, but frogs and crayfish are also eaten. Other animal life they eat less frequently includes mice,

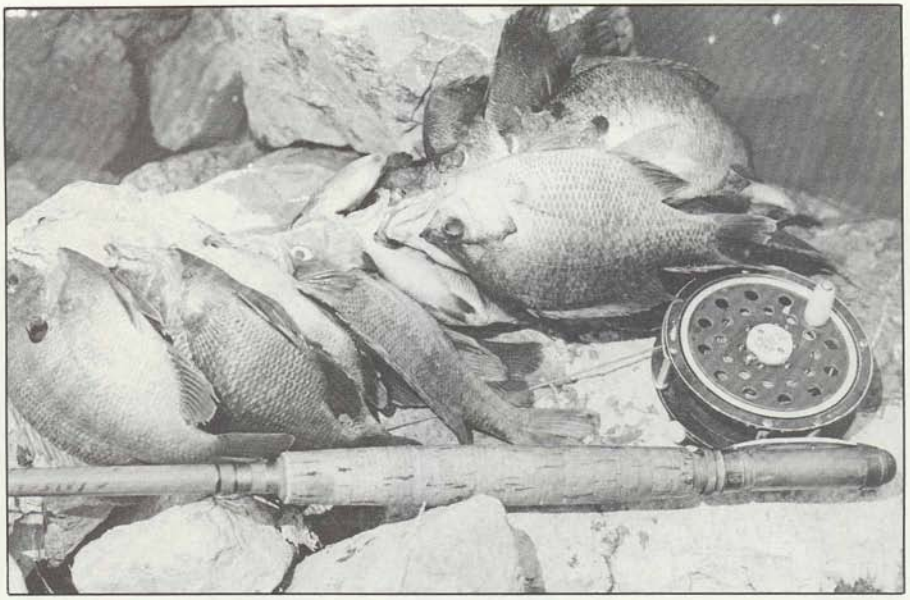
The Department provides fish for stocking in new or reclaimed ponds. The fish are free to pond owners or lessees holding valid fishing licenses, who apply for the fish and whose pond has been approved by the local Game Ranger.

moles, leeches and even ducklings. Adult bass feed day or night, but their main feeding periods are early morning and evenings.

Young bass grow rapidly when food is plentiful. In old ponds, with good growing conditions, they may reach a length of three to five inches in their first summer. It usually takes three years to grow a 12-inch bass from an egg. Largemouth bass can reach 15 years of age, but their normal maximum age is usually six to ten years.

Largemouth bass mature (10- to 12-inches long) in the spring beginning their third summer in a pond. The males fan out depressions with their body and fins, then entice females over the nest to deposit eggs. Nesting begins when the water temperature reaches 60° to 65°F. Large females, up to seven years of age, produce the most eggs in proportion to body weight. Approximately 2,000 to 7,000 eggs are produced per pound of fish. The male largemouth bass guards the eggs during the 45 to 96 hour incubation period.

Bass survive well in ponds, but their relatively large size, and preda-



Proper bluegill harvest is the key to maintaining quality fishing in a pond.

tory instincts require that other fish make up a part of their diet. Stocked alone, bass usually overpopulate and do not reach a large size.

Bluegill The bluegill is another fish well adapted to pond life. They are particularly suited for stocking with largemouth bass, since they serve not only as a food source for bass, but provide a lot of angling and eating pleasure. They provide most of the fishing in a pond because they are the most abundant fish taken from properly managed ponds. Bluegills bite in the middle of the day (when bass fishing is usually poor) so anglers both young and old with tackle ranging from a hook and string to the most expensive fly rod can expect success. The bluegill looks like several other members of the sunfish family and has been called many names including sunfish, perch, pond perch, bream, brim and numerous others.

Young bluegill feed on tiny microscopic plants and animals, then gradually change to larger animals such as aquatic insects, snails, small crayfish, fish eggs and small fish as they mature. Adult bluegill feed mainly on aquatic insects and insect larvae, but plant material is also eaten in late summer when animal food becomes scarce. Bluegill rarely exceed a pound with most adults weighing between 1/4 to 1/2 pound (six to eight inches in length).

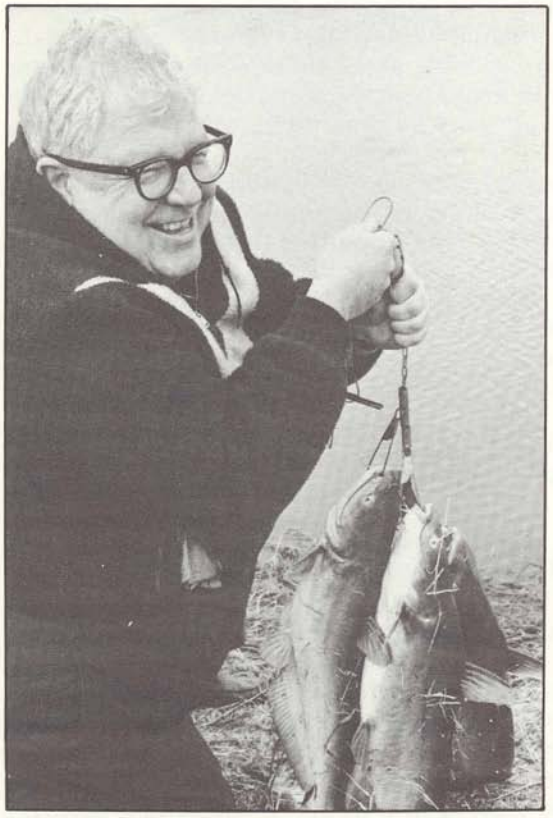
Bluegill growth depends on the amount of food available, temperature, and the number of fish in a pond. On the average it takes three or more growing seasons to produce a "keeper" bluegill. They usually live about five years, but maximum age is eight to ten years. When over-

crowded, they seldom live more than four to five years and may never reach a desirable size.

Bluegill spawn from early April to August. They become sexually mature their second year or when they are about three inches long. The male fans out a saucer-shaped nest in early spring when the water temperature reaches 70° to 75°F. The female deposits the eggs, the male fertilizes them, then the male guards the nest. A four ounce female may deposit 12,000 eggs while larger females produce up to 60,000. The eggs hatch in 1-1/2 to 3 days, depending upon water temperatures. Spawning beds consist of many nests close together. A pond may contain only two or three spawning beds, but these locations offer excellent fishing during the spawning season.

Channel Catfish Channel catfish also grow well in ponds and are stocked in combination with largemouth bass and bluegill. This stocking combination offers the catfish as a bonus fish, adding additional sport as well as food. If stocked by themselves in a pond, they usually overpopulate and grow slowly.

Channel catfish eat a wide variety of foods ranging from fish to de-



Channel catfish, stocked along with bass and bluegill, makes another fine eating fish available to the angler.

caying organic material and aquatic plants. Opinions differ greatly about how many bluegill or other fish channel catfish eat. Usually, fish do not appear in the diet until catfish are 12- to 14-inches long. Small catfish feed mostly on aquatic insect larvae, crayfish and frogs.

Under average conditions channel catfish stocked in a new pond in the fall, using the standard largemouth bass - bluegill combination, will grow to 11- to 12-inches in one year, 14- to 15-inches after two years, and 16- to 18-inches after three years. Channel catfish may live to be 12-to 15-years old, but normally few live more than six to eight years.

Channel catfish can and do reproduce in ponds especially when suitable spawning facilities such as milk cans, specially built boxes, concrete or clay pipes or other suitable nesting devices are provided. However, in clear water ponds, the eggs and young are usually eaten by bass and/or bluegill, thus the population gets controlled. For this reason, if channel catfish are stocked alone, the population requires special management such as feeding, thinning, or removing a portion of the young to maintain healthy, vigorously growing individuals. Otherwise, with too many fish in the pond, the available food can't support the fish and slow growth results.

Since young channel catfish survive poorly in ponds stocked with bass and bluegill, restocking is necessary. Catfish for restocking should be a minimum of ten inches in length, preferably larger, so the bass won't eat them. For good growth, stock no more than 40 per acre of this size catfish. You should avoid building population levels greater than 60 to 70 channel catfish per acre by keeping good records of those removed and those stocked.

Contact **other sources** such as commercial fish farmers if you want to purchase larger fish or species other than what the Oklahoma Department of Wildlife provides free. The Department maintains a listing of commercial fish hatcheries and you may obtain this list by contacting the Fish Division office, 1801 N. Lincoln, Oklahoma City, Oklahoma 73105. However, keep in mind that crappie, bullheads, carp, green sunfish, northern pike, walleye and trout have been stocked in ponds, but these attempts have failed to produce successful fisheries in Oklahoma.

Stocking any fish from creeks, lakes and other ponds is not recommended because you increase the chances of introducing undesirable species or diseases.

POND MANAGEMENT

Small ponds are notorious for their short life span of good fishing. The first three years of life in the pond for largemouth bass, channel catfish and bluegill are the most important. Proper management begins with the initial stocking. Remember, good fishing ponds require more time and effort than a comparable amount of agricultural land. Even though good fishing can never be guaranteed, proper management improves the chances for good fishing in a pond. Management revolves

The bass harvest from a pond must be closely monitored so the main predator population is not depleted.

around three general procedures: first and most important is a systematic harvest, second is to control water quality and water levels, third is to prevent excessive aquatic vegetation. The following guidelines will assist you in managing your pond.

Most small ponds are harvested excessively and this contributes to poor fishing in the future. Avoid overharvesting the predator species (largemouth bass). Most harvestable bass in a one-half acre pond can be caught and removed in one afternoon of fishing. To maintain a stable bass population in a small pond (1/2 acre or less), remove no more than three to ten bass per year.

You may start fishing for bluegills the first summer after stocking or whenever you think they are a desirable size. Begin harvesting channel catfish during the second season, but don't harvest more than ten channel catfish per acre per year. Don't fish for largemouth bass until one full year after stocking and do not remove any largemouth bass until the third summer after stocking. You may catch and release them prior to this time. After the third summer, **never** harvest more than 20 bass per acre per year. Remember, the stocked largemouth bass must support all bass harvest for three years after the first spawn (five years after the initial bass stocking).

For each pound of bass harvested remove eight to ten pounds of bluegill from the pond. To insure a proper harvest, be sure that all anglers know about your harvest system. Develop a pond harvest log for recording lengths, weights and numbers of each species removed from the pond. Make sure fishermen enter their catches at the end of each trip so your harvest system can control the pond's fish populations.

The largemouth bass-bluegill fish community will provide the best fishing in Oklahoma ponds. In a pond with bluegill and bass, you may manage the fish harvest for quality bluegill fishing or quality bass fishing. If you prefer quality bluegill fishing, you need to manage for an overabundant bass population. This can be achieved by never harvesting (catching-and-releasing) any bass or by catching and removing only those bass greater than 14 inches. The fish community in this pond will be made up of too many small (10 inches or less) bass and many (6 inches or longer) bluegill.

If you desire quality bass fishing and you are not interested in bluegill fishing, you will need to manage the pond for fewer bass and an overabundance of bluegill. You can achieve this by removing all bass caught under 14 inches and then releasing back into the pond all bass over 14 inches, or by catching and removing only those bass below 12 inches and above 15 inches. This 12-15 inch "slot" length limit will not work unless all fish caught under 12 inches are removed and there is a good supply of bluegill for bass forage.

Vegetation Control All vegetation is not bad. Some vegetation is needed for good fish growth, shoreline protection from wind and wave caused erosion, cover for young fish, wildlife food and nesting habitat. Total vegetation removal is not desirable. However, when aquatic plants cover more than 25 percent of a pond's surface, problems start to develop.

Aquatic weeds, particularly submersed types, rarely become established in deeper waters. However, once established in shallow areas, they gradually spread to deeper areas. So the best vegetation method is to construct ponds so that no water is less than two feet deep.

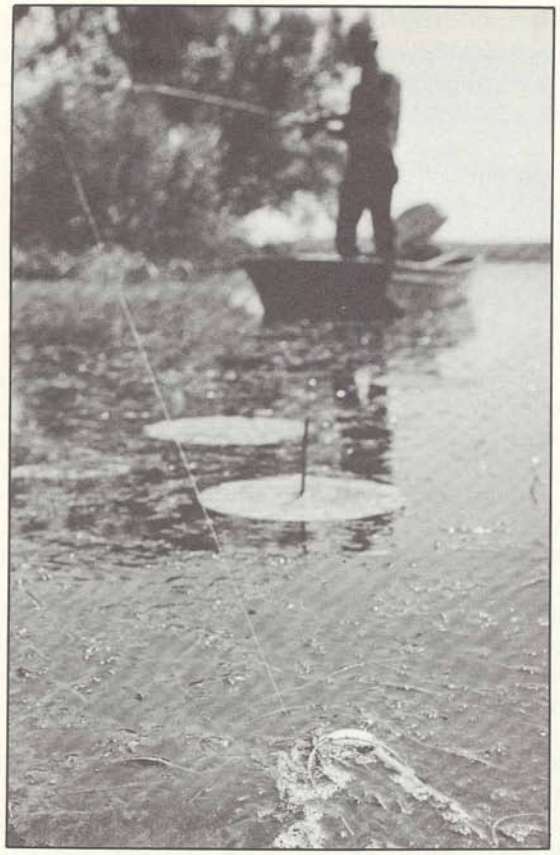
Plants found in ponds include: algae, floating vegetation, emersed rooted vegetation and submersed rooted vegetation.

Algae (commonly called moss) includes microscopic plants, either single-celled or filamentous, which can be free-floating or attached (periphyton). Chara (commonly called stonewort or muskgrass) is a large form of algae.

Examples of free-floating aquatic plants are duckweed and water meal.

Emersed aquatic plants are rooted in the pond bottom but grow above the water's surface. These include cattails, sedges, rushes and arrowheads.

Submersed aquatic plants are usually rooted to the bottom and grow beneath the water surface or a few leaves may float on the surface. These include pond weeds, coontail, milfoil, elodea, stargrass, Eura-



Aquatic vegetation can easily develop into a serious problem. Preventing conditions favorable to weeds is easier than combating the over-abundant vegetation after it grows.

sian water milfoil and water lillies.

Before any attempt is made to control aquatic vegetation, there are certain conditions which must be identified.

1. Reasons for heavy growth: If excessive nutrients are flowing into the pond from feedlot, septic tank, or heavily fertilized watershed, the source should be corrected before any treatment begins.

2. Use of the water: If humans use the water for drinking, copper sulfate can be used, and if the pond water is used for irrigation, herbicides should not be used.

3. Identification of the problem plant species: Different plant types require different mechanical or chemical controls.

4. Preferred control method: You may wish to avoid putting chemicals in your pond and instead choose a mechanical or alternative control method which requires more individual effort.

Available vegetation controls come under three categories: mechanical, biological and chemical.

Mechanical control may be sufficient in smaller ponds. This includes

pulling, digging, cutting, raking, or covering the problem plants with a material such as dark plastic. Aquatic weeds grow rapidly and must be removed or treated frequently throughout the growing season. Mechanical aquatic weed harvesters are available but they are extremely expensive.

Biological control in Oklahoma is limited to fertilizing the water. This promotes microscopic plankton growth thereby reducing the light transmitted to the bottom. This limits the growth of higher aquatic vegetation. The disadvantages of this method are that: (1) additional nutrients may cause a more serious weed problem, and (2) an even more serious side effect may be oxygen depletion.

Chemical control is the most popular method for controlling aquatic weeds in Oklahoma waters. No single all-purpose chemical controls all aquatic weeds, so you must select the best chemical for the specific problem vegetation. This is why proper identification of the plants is so important. Chemicals work most effectively on many plants in spring or early summer when plants are growing rapidly. However, most treatments are temporary and must be repeated annually.

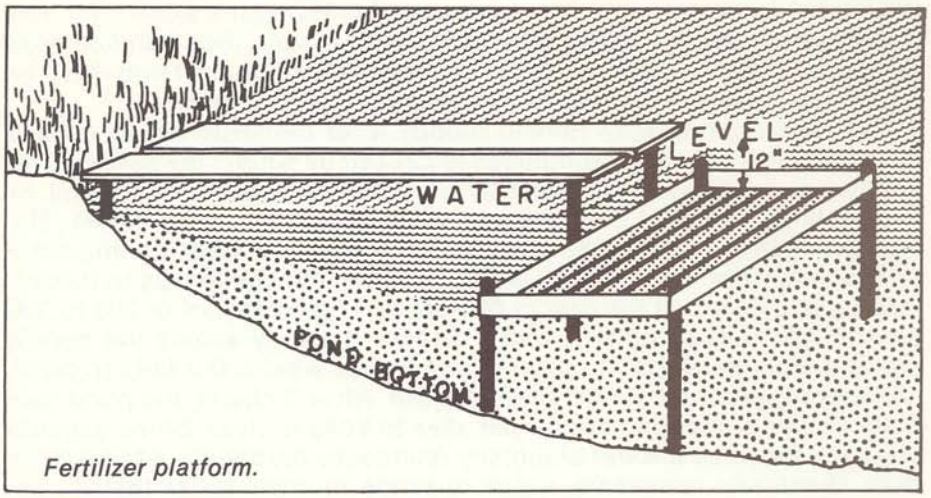
The treatment to control aquatic plants depends on the plant species, water quality, and use of the water. Recommendations for control should be made only after positive identification of the plant has been made and other factors have been considered. Wildlife Department personnel, OSU Extension Agents, or SCS District Conservationists will provide current information and recommendations for chemical vegetation control.

Fertilization can increase the poundage of fish produced in a pond. If the soil in the watershed is nutrient poor, the pond water will be infertile. Therefore, fertilization may increase fish production. It may also prevent growth of unwanted vegetation, as mentioned earlier. Regardless of the benefits, excessive or ineffective fertilization may produce dense growth of undesirable plants, reduce the quality of water and cause fish kills. Fertilization is more likely to produce undesirable excessive plant growth if the pond has excessive shallow water.

Fertilization is expensive, time-consuming, accelerates the natural aging process (eutrophication) of a lake, and once started it must be continued on a regular schedule.

Begin fertilizing when the water temperature reaches 65°F and continue until water temperature falls below 65°F. In general, apply fertilizer anytime you can see 22 inches or deeper into the water. In Oklahoma you may have to fertilize up to 12 times per year ranging from every 10 days to every 6th week. For most Oklahoma ponds, the proper application rate is 80-100 lbs. of 10:20:10 fertilizer per surface acre of water. Fertilizer is readily available in bags of 10 percent nitrogen, 20 percent phosphorous and 10 percent potassium.

Never put fertilizer in a muddy pond, a pond with an algae bloom, or a pond with alkalinity less than 20 mg/liter of calcium carbonate. Always have your pond water checked by a water chemist for both alkalinity and hardness before you fertilize.



Fertilizer platform.

After a pond has been fertilized three to five years, it is better to quit applying the nitrogen and potassium, and just continue using phosphorous. Apply 18 pounds of triple-super-phosphate (0-46-0) to each acre of water, or 40 pounds of super-phosphate per acre.

Apply fertilizer using a platform placed about 6-12 inches below the surface near the pond's edge. Place the sacks of fertilizer on the platform and slit them open. Wave action and water currents will mix the fertilizer throughout the pond. One platform is enough for 15 acres of pond surface if placed at the upwind edge of the pond.

Other methods for applying fertilizer are pouring it from a boat or scattering it by hand over the water around the pond shoreline. You need not scatter the fertilizer over the entire pond. It is best to place it in water no deeper than three feet.

Fertilization increases fish production by increasing the production of microscopic phytoplankton (plants). These plants are eaten by microscopic zooplankton (animals) which in turn are eaten by larger zooplankton, aquatic insects and small fishes. Larger fishes prey on the small fish. Fertilization **does not** prevent crowding and stunting of fishes. It can also cause several other undesirable side effects. **Therefore, fertilization is not recommended for most Oklahoma ponds.**

Muddy or Turbid Water decreases the transparency of the water which in turn prevents microscopic plant growth and the subsequent growth of fish food organisms and fishes. Bass grow better in clearer waters because in muddy water, less fish food grows, plus the adult bass must battle reduced visibility to feed.

Visibility should be 18- to 22-inches deep. You have adequate visibility if you can see your fingers after sticking your arm vertically in the water up to your shoulder. For older ponds, it is important to maintain good plant cover on the entire watershed. Before you attempt to clear a muddy pond, erosion on the watershed should be stopped which will

reduce the large amounts of muddy runoff entering the pond. The Soil Conservation Service agent or county agent in your area can help you select the proper vegetative cover, or help develop a diversion ditch or terrace to prevent sediment from flowing into your pond.

Oklahoma ponds may remain muddy after construction or after a large inflow of silt. This muddiness is caused by small clay particles remaining suspended in the water by wave action, aquatic organisms, or by repelling action of negatively charged colloidal clay particles. The problem is how to get these clay particles out of suspension and settled to the bottom. The solution is adding either gypsum or hay to the water. Apply gypsum at the rate of 500 pounds per acre foot or 200 to 300 pounds per surface acre of water. Scatter it evenly across the pond's surface. Your pond should clear in one to four weeks. If it fails to clear, add more gypsum at 1/4 the original dose. After it clears, the pond may need an additional bag or two per year to keep it clear. Since gypsum changes the pond's water chemistry (increases hardness), add no more than absolutely necessary. Gypsum tends to clear water faster than hay but it is more expensive, makes the water harder and it changes the chemical nature of the pond.

Hay is less expensive and even has some beneficial side effects (adds organic fertilization) when used to clear a pond. Hay should be applied at the rate of three to ten bales (or 200 to 500 lbs.) per acre. Use less hay in late summer because of the increased chance for oxygen depletion. At 10- to 14-day intervals add more hay until the pond is clear, but use four applications per year at most. Break up the bales and scatter the hay loosely on the pond surface.

In addition, two or three applications of barnyard manure at one ton per acre at three-week intervals will clear a pond as will 75 pounds of cottonseed meal and 25 pounds of super-phosphate per acre at two- to three-week intervals.

If bottom feeding fish such as carp, buffalo or bullheads muddy your pond, the best control is to kill all fish in the pond with rotenone (see later section) and restock the pond with non-bottom feeders (bass, bluegill and channel catfish).

Feeding is not recommended in fishing ponds. Most sport fish species do well enough on naturally produced food. Yet, if you are managing the pond as a food source, or you are commercially raising channel catfish, bullheads, carp or other fish species, supplemental feeding may be practical. Keep in mind that uneaten food may actually pollute the water, causing oxygen depletion and fish kills. Some other important things to remember when feeding fish are:

1. Feeding is not recommended for largemouth bass or other game fishes.
2. Never feed any more than the fish will eat in five to ten minutes.
3. Feed at the same time and location each day.
4. Do not feed when water temperature is below 70°F or above 90°F.
5. If the fish do not readily accept the feed, stop feeding.

6. Feed only in the shallow (less than four feet) water areas of the pond.

7. Feed only a floating feed so that feeding activity can be observed.

Drawdown of the pond water level is one of the most beneficial management activities. It will:

1. Help control excessive vegetation.
2. Remove excessive nutrients.
3. Reduce the water volume for more economic and effective removal of all fish by rotenone.
4. Concentrate forage fishes and undesirable species into a small area so they can be eaten by predatory sport fishes. This method controls excessive sunfishes and bullheads, and promotes growth of largemouth bass.
5. Provide an opportunity for repairing the dam, spillway, drawdown structure or seepage areas.
6. Provide an opportunity for building fish habitat such as brush piles, tire reefs, shoreline deepening, etc.
7. Provide an opportunity for installing boat ramps, docks, fishing piers, etc.
8. Provide an opportunity for planting wildlife habitat and food crops such as millet, rye, oats, etc., in parts of the pond.

Drawdowns are possible if a drainpipe is installed when the dam is built, and is not possible in dams without drainpipes unless a siphon is used. Early fall drawdowns extending until early March work the best in Oklahoma. The drawdown should reduce the pond surface by at least 50 percent, and should be included as a regular fisheries management activity implemented once every three to five years. Due to infrequent rainfall, drawdowns may not be feasible in the drier parts of Oklahoma.

Habitat Development for fishing ponds should include: (1) spawning substrate, (2) fish shelter, and (3) fish attractors. These may be brush piles, tire reefs, stake beds, gravel beds, sewer (concrete) tiles, cream cans, cedar (Christmas) trees, bricks or masonry blocks properly placed and secured to the pond bottom. Many Oklahoma ponds lack adequate fish habitat. Natural or artificial, man-made habitat provides an area where fishes can hide from predators, rest, find food or spawn.

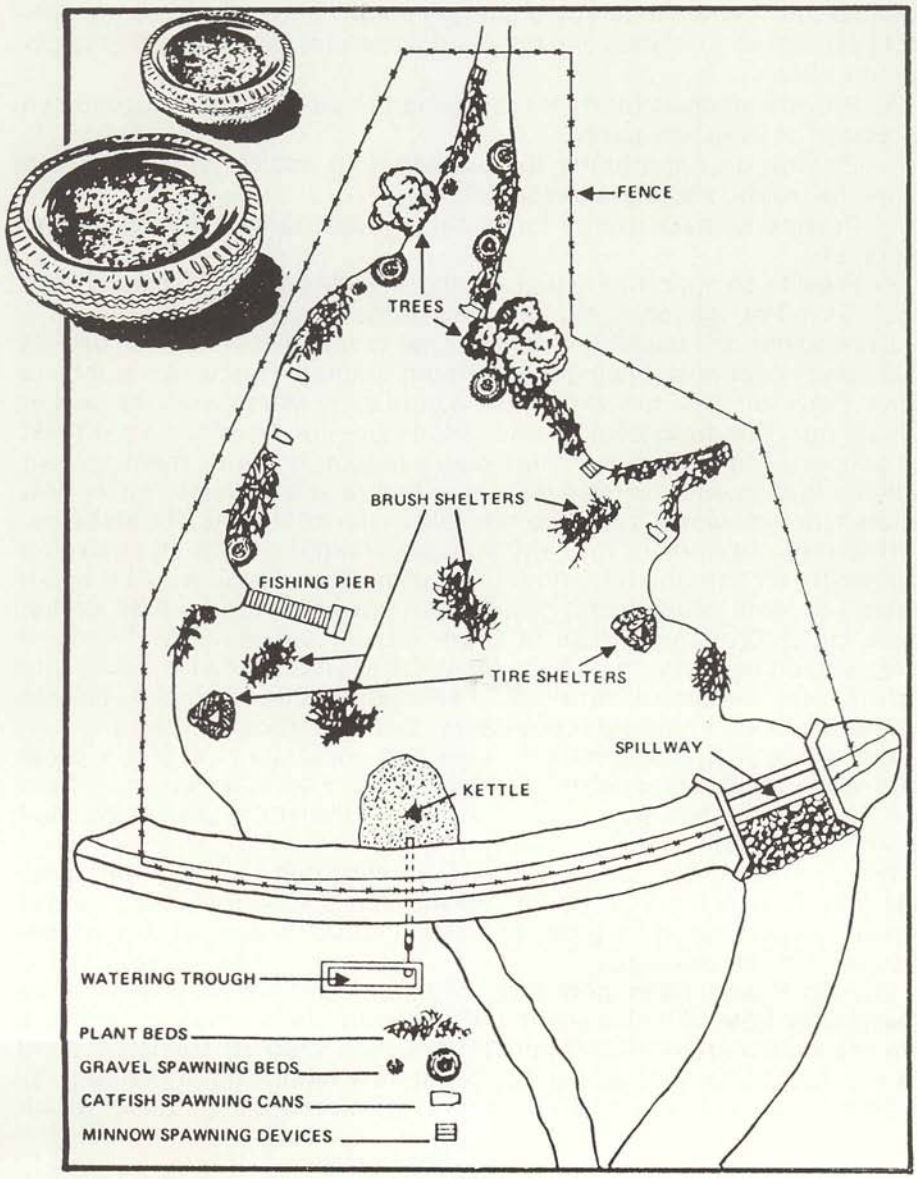
Place fish shelter and attractors on firm substrate near shore, drop-offs, or old channels at depths of 10 to 20 feet. Fish spawning substrate such as gravel beds should be placed near the shoreline in less than ten feet of water.

Fencing prevents livestock from trampling pond banks. Trampling not only causes banks to erode, leaving shallow water where excess aquatic vegetation may grow, but also increases turbidity which decreases fish production.

Livestock also harm ponds by causing fish kills that result from chemically treated cattle wading in the water; by shortening a pond's life through increased siltation from waves eroding trampled pond banks; and by creating unsightly, constantly muddy pond perimeters.

Fencing the entire pond area eliminates one of the benefits for which

the pond was built. Generally, if the majority of the pond perimeter is fenced and the pasture or range is not overstocked with livestock, the pond will still provide good fishing and still provide livestock water. Another alternative is to fence the entire pond and install a freeze proof stock tank below the pond for watering livestock. This arrangement not only increases fish production by eliminating the trampled pond banks, but if properly constructed, the watering tank provides a permanent source of water which livestock can use during winter when the pond is frozen.



POND RENOVATION

Your pond may have been neglected for several years. You are now concerned about this pond, and your first question is what should I do? The following steps should assist you:

Step 1. Look at the pond. Is it muddy? Is aquatic vegetation excessive? Do you have a drainpipe in the dam? How big is the pond? How deep is the pond? Are there extensive areas shallower than two feet deep? Is there pollution or contamination running into the pond?

All these questions should be answered first and if an obvious problem such as vegetation, turbidity, or contamination is influencing the pond's fishing potential, these problems must be solved first. Answering these questions will also help you in the overall management of your pond.

Step 2. Examine the fish population. This can be done by: (a) fishing the pond with various types of bait and artificial lures, fishing it at various times of the day and fishing all areas of the pond, or (b) by seining your pond.

This gives you information about the fish community and its general well-being. The following possible hypothetical situations may help you interpret these results:

Situation 1: Your catch consists of largemouth bass, bluegill and a few channel catfish, but few if any other species. Then you may have one of the three following possibilities:

(a) The bluegill caught were primarily six inches or longer (at least 50 percent of those caught) and the bass averaged one to two pounds (12 to 15 inches long), yet some smaller and longer ones were caught. The diagnosis would be that you have a desirable fish population. The recommendation would be to follow a good harvest plan to remove no more than 20 bass, 200 to 300 bluegill, and 10 channel catfish per acre per year and implement any of the other management activities discussed earlier whenever you feel they are appropriate.

(b) The bluegill caught were primarily three to five inches long. Few bass were caught and they were larger than two pounds. This would be an undesirable population with overcrowded bluegill. Recommended management would be to stop harvesting bass until the situation is corrected, lower the pond (drawdown) water level during July and August (or October through March) from 1/2 to 2/3 of its usual surface area to allow the few bass to remove more bluegill. At the same time you may buy some 10- to 12-inch bass and stock them at the rate of 10 to 40 per acre. If vegetation is excessive, you may remove some at this time. Another alternative is to completely kill off (with rotenone) all fish in the pond and restock with bass, bluegill and channel catfish.

(c) The bluegill caught are quite large but the bass average less than a pound (9 to 10 inches long), and they are in poor condition. In this case the bass are overcrowded. Recommendations are to fish for and remove 25 to 30 small bass per acre while returning all bass larger than 12 inches until the bass overabundance is corrected.

Situation 2: Your catch consists of many species such as green sunfish, crappie, bullheads and carp, as well as a few bass and bluegill. The recommendation here depends on what you want from your pond.

If you catch only a few large green sunfish or bullheads in a pond consisting primarily of bass and bluegill, then there is probably no problem.

If you catch only three- to six-inch green sunfish or bullheads or have mainly six- to eight-inch crappie in poor condition, then you need to check the bass and bluegill.

If the majority of the bluegill are six inches or larger and in good condition, you may not have a serious problem. Yet if the bass and bluegill are in poor condition with only a few bass and the bluegill primarily three to five inches, the recommendation would be a complete renovation (with rotenone) followed by restocking with bass, bluegill and channel catfish.

Situation 3: Your catch is almost entirely species other than bass and bluegill. The pond is undesirable for fishing purposes. Even though you may catch fish, they are undesirable sizes and/or species. The best recommendation is a complete renovation with rotenone followed by restocking bass, bluegill and channel catfish.

Situation 4: You catch no fish. Recommendations are to determine if pond has ever been stocked, determine if pond depth is adequate to support fish, determine if pond goes dry during a drought, determine if some contaminant such as salt, pesticides, etc., can enter the pond and kill fish.

ROTENONE

Rotenone is a fish toxicant derived from the derris or cube plant. Available in liquid forms of either 2.5 percent or 5 percent active ingredient solutions, it kills fish by acting on the respiratory system, preventing oxygen uptake by the fishes' gills, and is effective on all Oklahoma fish species. It does not harm man or other nongill breathing animals.

Rotenone should be applied in water 70°F or warmer at the rate of one gallon (2.5 percent solution) to three acre-feet of water (approximately 1-2 parts per million). Rotenone loses its toxic qualities faster in warm water than in cold water. In water 70°F or above, it detoxifies within 14 days after application.

(Note: This is an ideal time to take advantage of a drainpipe and reduce the size of your pond, thus decreasing the cost and effort.)

To determine how much rotenone to apply in a pond, estimate the acre-feet (volume) by multiplying the length by the width of your pond and divide by 43,560 (number of square feet per acre). The result is the number of acres in your pond. Then determine the average depth of your pond by measuring the depth at various places along transects across the pond with a pole or weighted line (divide the sum of all depths by the number of depths taken). Multiply the area (acres) already determined by the average depth (feet) to obtain the acre-foot value.

The computation guidelines will work for most Oklahoma ponds:

Rectangular Pond:

$$\frac{\text{length in feet X width in feet}}{\text{43,560 square feet/acre}} \text{ X average depth in feet = acre feet}$$

Triangular Pond:

$$\frac{\text{1/2 length of dam in ft. X length of pond in feet}}{\text{43,560 square feet/acre}} \text{ X average depth = acre feet}$$

Round Pond:

$$\frac{\text{3.14 X radius in feet X radius in feet}}{\text{43,560 square feet/acre}} \text{ X average depth = acre feet}$$

(Radius = 1/2 distance across pond)

Once the acre-foot value is determined, divide it by three to find the number of gallons of 2.5 percent rotenone needed.

To apply rotenone, mix the required gallons with pond water (ten parts pond water, one part rotenone) and apply it by spraying or pouring the solution into propeller wash of outboard motor. For small ponds on windy days, you may pour the mixture in the water along the upwind shoreline and the wind action will spread the chemical.

If there are deep holes in your pond, it is best to pump the mixture through a weighted hose to the bottom.

It takes less than 30 minutes to treat a two acre pond. In water 70°F or warmer, fish will begin to surface in minutes, but some may die near the bottom and surface several days later.

Renovating a pond using rotenone should be completed in August or early September. The time lapse between renovation and restocking should be as short as possible because wild fish may repopulate the pond prior to stocking. This, of course, would interfere with restoring a desirable population balance to the pond.

If renovation becomes the only alternative to restoring your pond to a desirable state, you should contact your local ranger or regional fisheries for technical assistance. The local Wildlife Department ranger will supply you the quantity of rotenone you need at the same cost paid by the Department. However, the local ranger must be present when the rotenone is applied. The ranger can also supply the pond owner or lessee with an application form for restocking if desired.

ACKNOWLEDGEMENTS

This pond management information was prepared by the Oklahoma Department of Wildlife Conservation, Fish Division Staff, with technical assistance from the U.S. Soil Conservation Service and the Oklahoma State University Cooperative Extension Service. Some information was obtained from the following sources:

Missouri Pond Handbook, by Joe G. Dillard
Missouri Department of Conservation

"New Life for Old Ponds," by Charles Bennett
Outdoor Oklahoma, July-August, 1972
Oklahoma Department of Wildlife Conservation

Managing Kansas Ponds for Fish and Wildlife, by Don Gablehouse
Kansas Fish & Game Commission

Ponds for Nebraskans, by Phil Gipson, Darrell Fiet, and Larry Morris
Nebraska Game and Parks Commission

Construction Hints and Preliminary Management Practices for New Ponds and Lakes, by C.R. Inman
Texas Parks and Wildlife Department

"Warmwater Fish Ponds," by Olan W. Dillon, et al
Farmer's Bulletin, No. 2250
U.S. Department of Agriculture

"Managing Farm Ponds for Fishing," by Don Driscoll
Outdoor Oklahoma, December 1978
Oklahoma Department of Wildlife Conservation

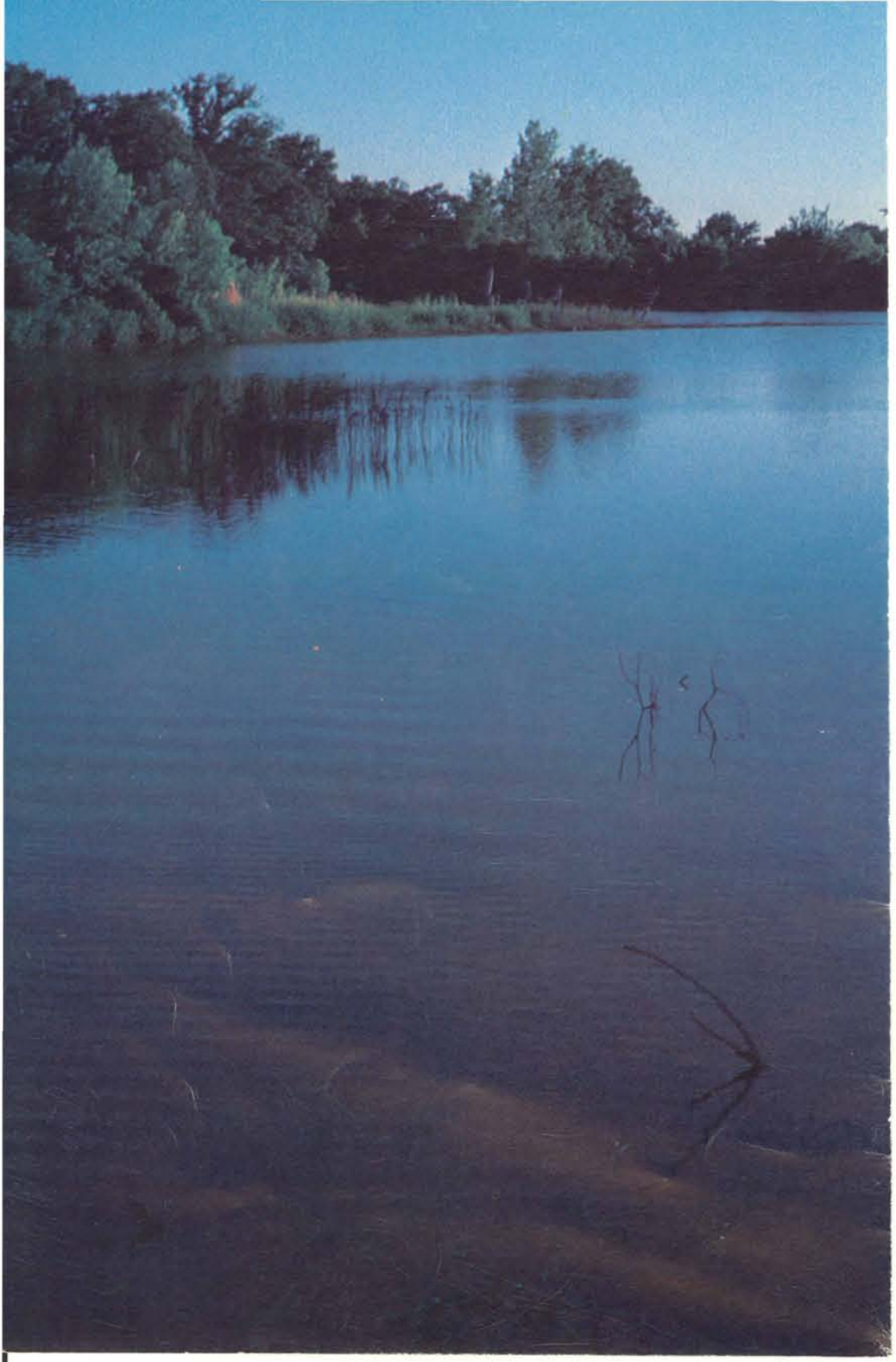
Fish Habitat Improvement in Reservoirs, by A.A. Forshage and K.R. Moore
Texas Parks and Wildlife Department

Aquatic Weed Control, by James R. Whitely
Missouri Department of Conservation

Fertilizing Farm Fish Ponds, by Claude Boyd and Jack Snow
Leaflet 88
Agricultural Experiment Station, Auburn University, 1975

Liming Farm Fish Ponds, by Claude Boyd
Agricultural Experiment Station, Auburn University

Weed Control in Lakes and Farm Ponds, by Ted Whitewell and David Bayne
Circular ANR-48
Agricultural Experiment Station, Auburn University

Water Quality Management in Pond Fish Culture, by Claude Boyd and Frank Liehtkoppler
Research and Development Series, No. 22
Agricultural Experiment Station, Auburn University, 1979

Relationships and Dynamics of Balanced and Unbalanced Fish Populations, by H.S. Swingle
Agricultural Experiment Station, Auburn University, 1950