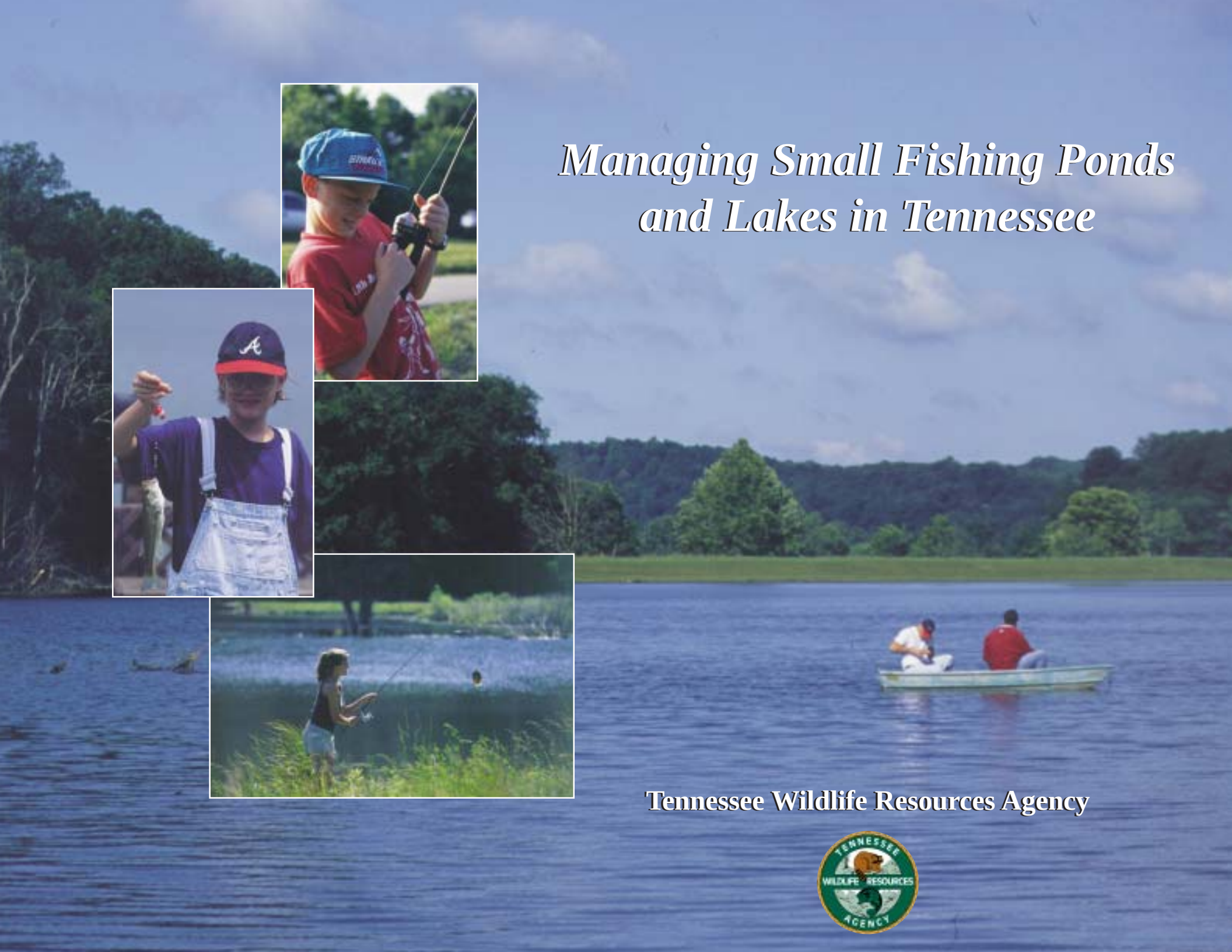


Managing Small Fishing Ponds and Lakes in Tennessee

Tennessee Wildlife Resources Agency

Largemouth bass

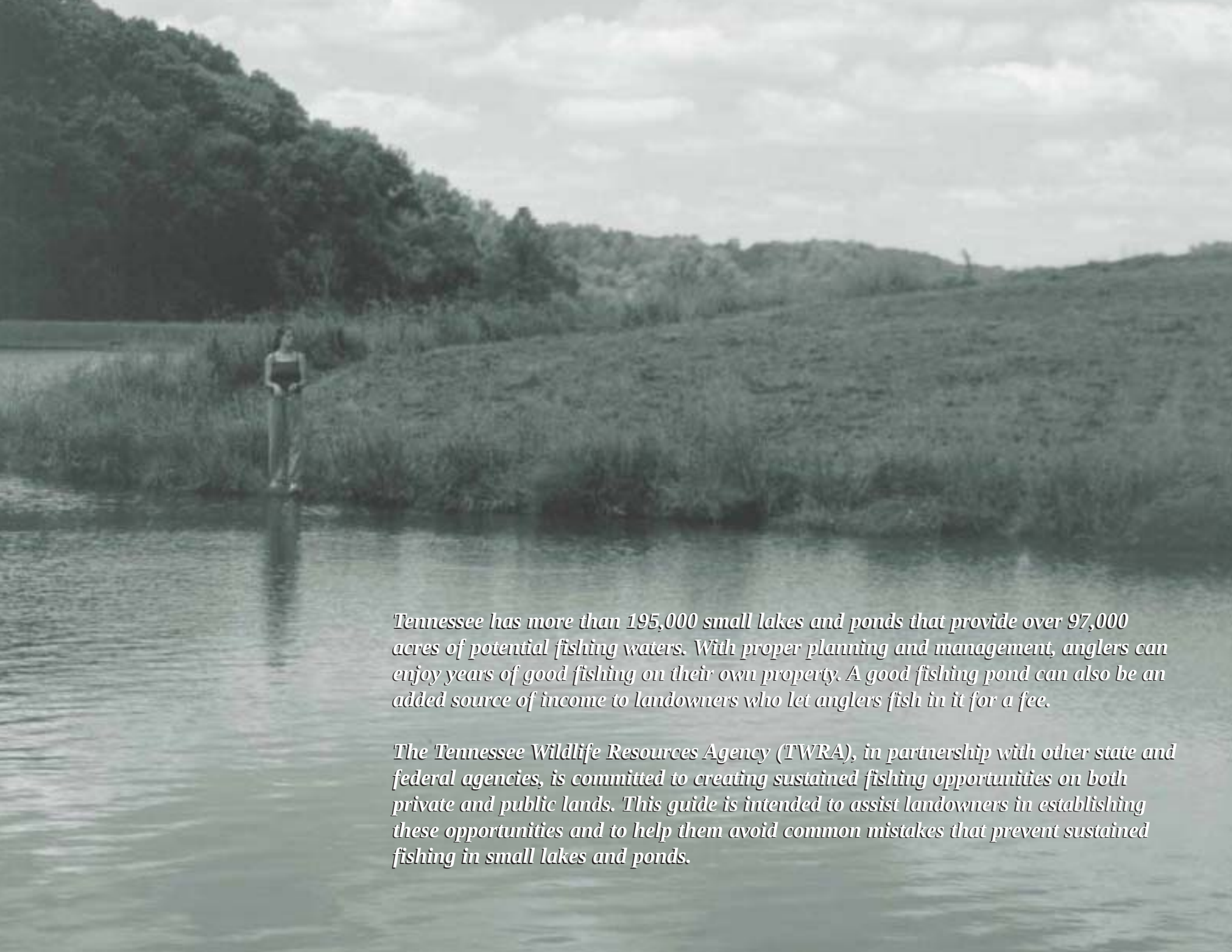
Bluegill

Redear sunfish

Channel catfish

(Art by Duane Raver/USFWS)

Tennessee ponds stocked with a combination of largemouth bass and bluegill (or bluegill and redear sunfish) offer better year-to-year fishing than any other combination. Channel catfish can also be successfully stocked with this combination of hatchery fish.



Tennessee has more than 195,000 small lakes and ponds that provide over 97,000 acres of potential fishing waters. With proper planning and management, anglers can enjoy years of good fishing on their own property. A good fishing pond can also be an added source of income to landowners who let anglers fish in it for a fee.

The Tennessee Wildlife Resources Agency (TWRA), in partnership with other state and federal agencies, is committed to creating sustained fishing opportunities on both private and public lands. This guide is intended to assist landowners in establishing these opportunities and to help them avoid common mistakes that prevent sustained fishing in small lakes and ponds.

Managing Small Fishing Lakes and Ponds in Tennessee by the Tennessee Wildlife Resources Agency Division of Fisheries Staff

Eighth Revision, 2000

Mr. Bobby Wilson, Mr. Mike Bramlett and Ms. Binney Stumpf, editors

Cover photograph by Doug Markham

This edition of the Tennessee Wildlife Resources Agency's guide to ***Managing Small Fishing Lakes and Ponds in Tennessee*** is a revision of earlier editions compiled by Mr. Eugene S. Cobb, who is now deceased, and previous Fisheries Division Staff members. Mr. Cobb's and current TWRA fisheries personnel's contributions to this edition are gratefully acknowledged.

This edition of the Tennessee Wildlife Resources Agency's guide to ***Managing Small Fishing Lakes and Ponds in Tennessee*** was produced by the Center for the Management, Utilization and Protection of Water Resources at Tennessee Technological University in Cookeville, Tennessee, under project 7304. Development of this guide was financed in part by funds from the Federal Aid in Sportfish Restoration (Public Law 91-503) as documented in Federal Aid Project FW-6.

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Photograph by Doug Markham

Photograph by Mike Bramlett

Photograph by Bobby Wilson

POND CONSTRUCTION

Seek assistance from experts at state and federal agencies when planning and constructing your fishing pond.

The Natural Resources Conservation Service provides pond construction information.

If you plan to stock with TWRA fish, your pond construction or renovation should be completed and water in the pond by October 1.

To maintain good fishing quality, your pond should be 1 acre or larger.

Drainage into lake or pond

By carefully planning the placement and construction of your fishing pond, you can enjoy years of fishing with a minimum of maintenance. The best pond sites are in open areas with a wooded watershed. Land previously used for row crops is less desirable because, unless there is a permanent ground cover, runoff is likely to deposit silt into the pond. Your pond site should receive enough stormwater runoff to maintain the pond's water level, but it should not be in an area that may flood. Determine the size pond you want and locate it in an area that will require the least amount of soil to build the dam and banks.

Duane Raver/USFWS

A watershed is the area of land that drains into a particular body of water.

A wetland is an area of land that stays saturated (wet) long enough and often enough throughout the year to support wetland vegetation.

Normally 1 surface acre of water requires a surrounding ***watershed*** drainage area of 6 to 15 acres. This varies depending on how the land in the drainage area is being used and the soil's capacity for seepage. For instance, more rainfall will run off grassy fields than off wooded land. Also, ponds intended as fishing ponds should be constructed away from streams or other ponds so fish from the other bodies of water cannot get into the pond during high flow periods.

Preserving streams & wetlands

Do not build a pond on a stream or a ***wetland***. Streams are protected as wetlands. *See Seeking Assistance pages 40 and 41 for Tennessee Department of Environment and Conservation Water Quality Division and the U.S. Army Corps of Engineers Regulatory Branch phone number.*

If you plan to construct a dam across a stream or a wetland, you must first contact the appropriate authorities.

Avoiding construction mistakes

To avoid costly mistakes when determining your watershed drainage area and constructing your fishing pond, contact the Natural Resources Conservation Service (NRCS) in your county for assistance and information. NRCS personnel can conduct soil surveys to determine whether soils will hold pond water. Although they do not build private ponds or lakes, they can provide a list of pond builders in your area. *See Seeking assistance page 41.*

Duane Raver/USFWS

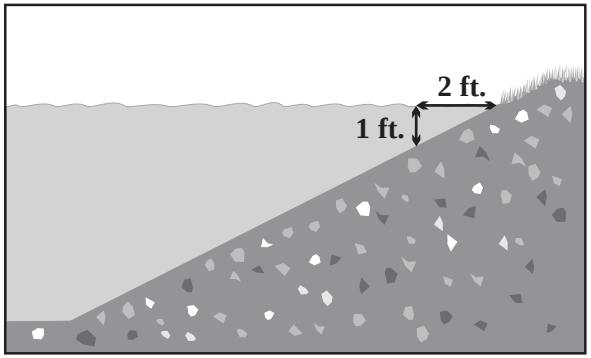
To avoid leaks in the pond, do not choose a rocky or sandy area for a pond site. It may also be necessary to add clay soil, bentonite, or soda ash (sodium carbonate) to the pond bottom. Compact the bottom using a sheepsfoot roller behind a tractor.

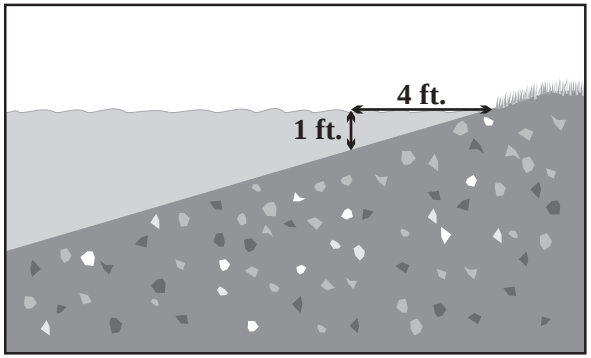
Avoiding livestock or crop fields

Livestock and crop production in the watershed of the pond should be avoided because the runoff can contain pesticides or fertilizers, and animal waste that can cause fish kills with heavy blooms of unwanted algae. Livestock should not have direct access to the pond. However, a gravity-fed water line can be run from the pond to a watering trough below the dam. *See Drain pipes page 3.*

Toxicants such as herbicides and pesticides should not be used in areas that can drain into streams, ponds or lakes.

***Slope** is the angle of the pond's edge from the shoreline to the bottom of the pond.*





The top illustration shows a pond with the correct shoreline slope of 2 to 1. This means that a 2 feet away from the shore, the water is 1 foot deep. The bottom illustration shows an incorrect shoreline slop of 4 to 1. This pond would have large areas of shallow water, which would result in poor fishing.

Tennessee Department of Environment and Conservation Division of Dams regulates and requires a permit for some dams that are over 20 feet high or that hold 30 acre-feet or more of water.

Pond depth & shoreline slope

The ***slope*** of the shoreline and pond depth should also be considered when constructing a pond. A pond with incorrect shoreline slope may end up with large shallow areas. Ponds with large areas of shallow water (less than 3 feet deep) rarely remain in balance, so fishing is usually poor. *See Fish population balance page 20.*

Shallow areas can cause a pond's fish population to become unbalanced because they give smaller fish a place to escape being eaten by larger fish. If the larger fish in a pond do not eat enough of the smaller fish, the pond will become overcrowded with smaller fish, and none of the fish will grow as well as they should. Shallow areas also encourage unwanted aquatic plant growth, which can provide too much escape cover for small fish. Unwanted aquatic plant growth can also raise water temperature. This lowers the amount of oxygen that the fish depend on for survival. *See Oxygen deficiencies 28.*

Shoreline slope

To avoid shallow areas of water, the pond should be constructed with at least a 2 to 1 (horizontal to vertical) shoreline slope. This means that 2 feet away from the shore, the water should be 1 foot deep. To ensure that nuisance weed infestations do not become a problem soon after the pond is filled (or become as severe), the pond banks may be sloped with a water depth of 3 feet near the shoreline.

Pond depth

A fishing pond should have a preferred maximum depth of no more than 10 to 12 feet. Deeper water does not mean more fish in your pond. The water in deeper ponds stratifies, or forms layers of water with different temperatures in the summer. The deepest, coolest layer does not mix with the upper, warm layer because the deepest layer is heavier. Fish may not be able to use the deepest layer because it usually does not have enough oxygen to support fish during the summer.

Dam construction

Each fishing pond should have a well built dam, or levee. To prevent seepage and possible cracks, the dam should have a solid clay core and should be 6 to 14 feet wide at the top depending on the dam height and the lay of the land. The dam should have slopes no steeper than 3 to 1 on either side.

A dam less than 10 feet high should be at least 6 feet wide across the top. The top width should be increased by 2 feet for every 5 feet of dam height over 10 feet. So, if the dam is 20 to 24 feet high, it should be at least 12 feet wide at the top. Contact your nearest NRCS office for further information on proper dam construction. *See Seeking assistance page 41.*

Trees and other woody plants should be removed from where the dam is going to be built and not be allowed to grow on or near the dam because their roots can cause seepage. They can also attract muskrats, which damage the dam by burrowing. Some trees or stumps can either be left in the pond or returned after construction to attract or concentrate fish.

After construction, the land directly surrounding the pond including the banks and dam should be fertilized and seeded with an appropriate perennial grass such as bermuda grass, bahia grass and fescue grass. To reduce runoff, trees, bushes or other permanent soil-retaining crops can be planted in the pond's watershed drainage area. Immediately after construction the entire pond basin should be planted in a fast growing annual such as wheat, rye, sudan or millet. This will reduce sedimentation and muddiness. It will also provide initial fertilization to begin the food web. *See Aquatic food web page 9.*

Drain pipes

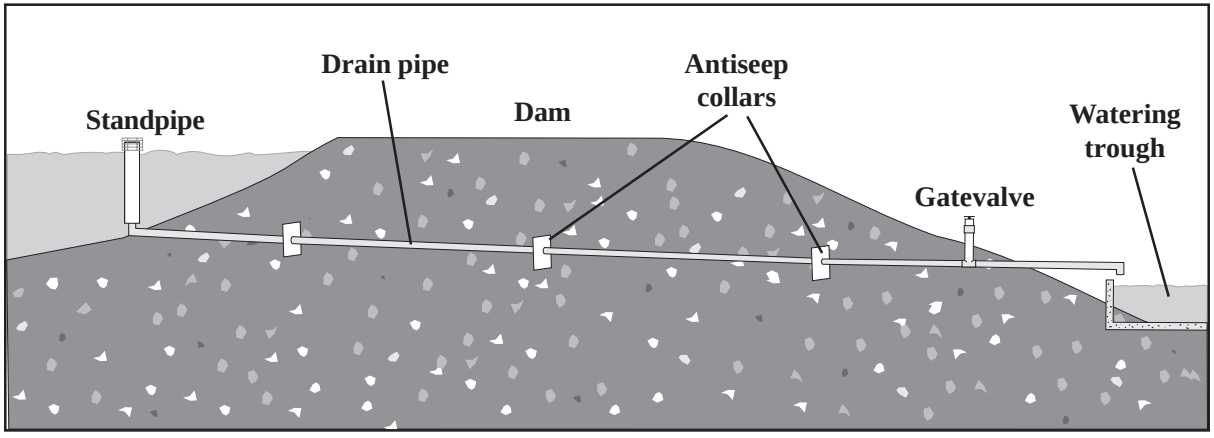
A fishing pond should be equipped with a drain so the owner can manage overpopulations of bream (bluegill/redear sunfish), control water levels, make repairs and help control unwanted aquatic plants. Although a drain pipe is not absolutely necessary, proper pond management is easier and more effective in a pond with a drain pipe. A drain pipe, if installed correctly, will serve as the outlet for most of the water that passes through the pond. ***Drain pipes*** are also called ***overflow pipes***. Drain pipes can be made out of cast iron, smooth steel, galvanized pipe or corrugated metal. However, those made out of cast iron will not rust out as quickly as corrugated or galvanized pipes will in fertilized ponds.

The drain pipe should include a gatevalve and, to maintain the water level, a standpipe with a grate (trash rack). Grate openings should be small enough to keep larger fish from escaping, but not small enough to trap debris such as leaves. The drain pipe allows the owner to manage for overpopulation of bream. By lowering the water level to concentrate the bream, bass can prey on them more easily. In ponds with severely unbalanced fish populations, a drain pipe can be used to completely drain the pond and start over with new fish. *See Reclaiming unproductive ponds page 26.*

Water quality can also be controlled, and occurrences of fish kills can be reduced if stagnant water with low oxygen levels can be drained from the bottom of the pond. Releasing excess water through the overflow pipe reduces the possibility of undesirable, wild fish entering the pond through the spillway. Drain pipes can also be designed to gravity feed pond water to a livestock watering trough below the dam. *See Livestock page 33 and Reclaiming unproductive ponds page 26.*

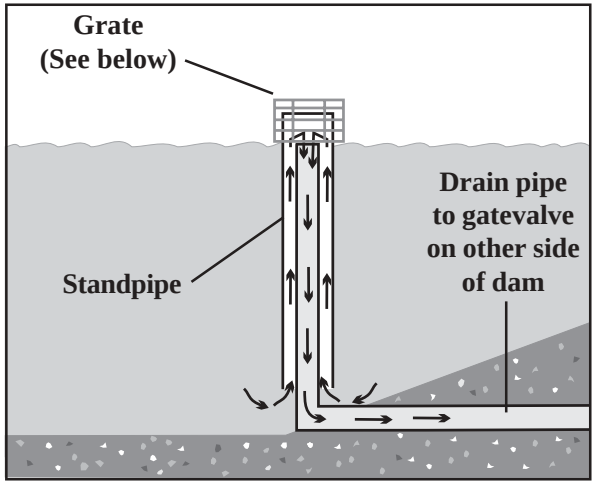
Spillways

A properly designed ***spillway*** is essential in all ponds, particularly in ponds not equipped with drain pipes. To prevent the loss of larger fish, the spillway should be wide and level enough that excess water flowing out of the pond is never more than 2 to 3 inches deep. The spillway for an average sized pond (½ to 1 acre) should be between 8 and 16 feet wide depending on the size of the watershed and how the land surrounding the pond is being used. Consult an NRCS agent or a University of Tennessee (UT) Agricultural Extension Service agent for information in designing a spillway. *See Seeking assistance page 40 and 41.*

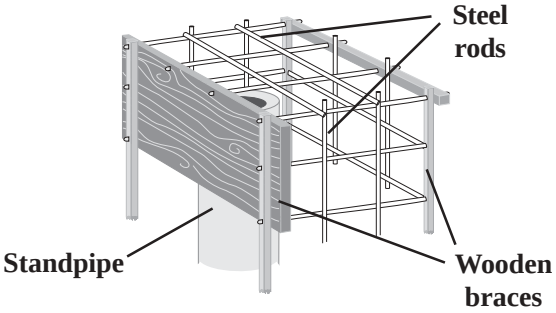


A drain pipe, also called an overflow pipe, should provide an outlet for most of the water that passes through the pond.

A spillway is a shallow channel that diverts excess water around the dam so it is not damaged when pond water rises.



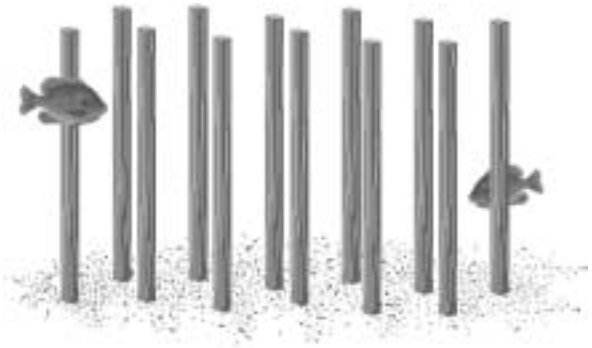
Drain pipe with a standpipe and grate



A grate (trash rack) over the standpipe keeps leaves and fish ou of the drain pipe.

Gravity-fed drain pipe carrying pond water to a watering trough on the other side of the dam

Stake beds are groups of wooden stakes that can be pounded into the pond bottom or nailed to a pallet, weighted and sunk.



Stake bed fish attractor

Fish attractors, habitat & fishing piers

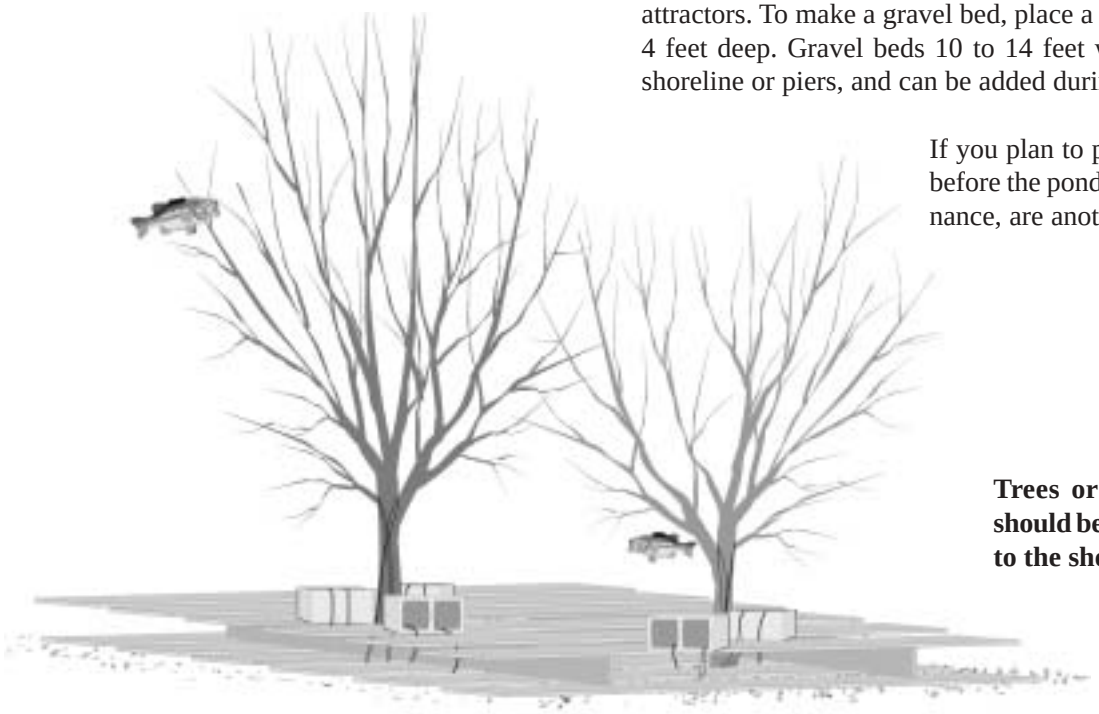
Using fish attractors to concentrate fish in certain areas to improve fishing success is a popular practice. It is easiest to add fish attractors right after construction, but they can be added after the pond has been filled with water. Fish habitat can be enhanced by building a pond with an irregular pond bottom with humps and channels. Fish attractors can be made from a variety of materials such as dead trees (discarded Christmas trees, cedar trees, willows or hardwoods), brush piles made of trees and branches anchored down with concrete blocks, ***stake beds*** (groups of wooden stakes driven into the pond bottom), rock piles or other structures. Combinations of any of these materials, such as brush piles with stake beds, can also be used.

When placing brush piles, the more upright (vertically) they stand, the better. Several trees grouped together work better than single trees. Stake beds can be made by driving 2 inch by 2 inch wooden stakes into the bottom or nailing them to a pallet or weighted frame, then sunk. Stakes used for stake beds, whether driven into the bottom or weighted down, should be placed 6 to 8 inches apart. All fish attractors should be open enough to allow fish to move easily in and around them. This will also make it less likely for hooks and lures to get hung up in them.

Fish attractors should be placed at 4 to 8 foot depths and should be within fishing distance of the shoreline or piers. They should never be constructed or placed where they could offer too much protection for small fish, which would promote overpopulation. Depending on the size of the attractors, 1 to 3 fish attractors per surface acre is adequate and combined should only take up between 10 and 25 percent of the pond area.

In some cases, gravel beds, which are attractive habitat especially for bluegill to spawn in, can be used as fish attractors. To make a gravel bed, place a 3 to 5 inch deep layer of ½ to 1 inch gravel into an area that is 2 to 4 feet deep. Gravel beds 10 to 14 feet wide are adequate. They should be within fishing distance of the shoreline or piers, and can be added during construction or after the pond is filled.

If you plan to place fishing piers in your pond, remember they are easier to build before the pond is filled with water. Earthen piers, which require almost no maintenance, are another option that should be considered during pond construction.



Trees or brush piles used as fish attractors should be placed as upright as possible and close to the shoreline or a fishing pier.

PLANNING & APPLYING FOR HATCHERY FISH

Only apply for hatchery fish for a new pond or for a reclaimed pond that does not contain other fish. Stocking additional small fish in a pond where fishing is already poor will not improve fishing.

Accurately measure your pond to the nearest 1/10 acre before applying for hatchery fish. See Pond Measurement page 37.

Stock only the species and numbers of fish recommended by a qualified fisheries biologist.

Applying & getting approval for hatchery fish

Currently, largemouth bass and bluegill are available by application to TWRA for stocking into newly constructed or renovated ponds that are at least 0.25 acres or larger. Applications must be post-marked by September 30 to assure fall delivery. *An application is available on page 46.*

Applications are also available from NRCS and UT Agricultural Extension Service.

If approved, you will receive a notice approximately 2 weeks prior to delivery telling you when and where to pick up fish, and what size containers to bring. Fish are distributed to central locations in each region for pickup. Therefore, pond owners must be prepared to make a trip to accept delivery of bluegill in the fall (October or November) and a trip in the spring (June) for largemouth bass.

Applications post-marked after September 30 will be considered for the following year. Those who miss the deadline but do not want to wait a full year can get their hatchery fish from a commercial producer. *See Pond Fish Suppliers page 41.*

Duane Raver/USFWS

Existing fish in pond

If new or existing ponds become contaminated with wild fish before hatchery fish are available, the wild fish should be eliminated either by draining the pond or with the proper chemicals. If the pond has been stocked previously, corrective action will be necessary before any benefit can be gained from stocking fingerling fish. *See Reclaiming unproductive ponds page 26 and Seeking assistance page 39.*

Measuring pond size

A common mistake made by many pond owners is overestimating the surface area of their pond when applying for fish. If the size of the pond is overestimated, too many fish would be stocked and few would grow to a desired size. If pond size is underestimated, too few fish would be stocked, and the fish population may never achieve proper balance.

Pond owners should always accurately measure their ponds before applying for fish.

An accurate measurement of pond size will also be needed if fertilizing, liming or controlling aquatic plants. *See Pond measurement page 37.*

FISH COMBINATIONS FOR STOCKING

Duane Raver/USFWS

Largemouth bass

Largemouth bass & bluegill/redear sunfish

Tennessee ponds stocked with a combination of largemouth bass and bluegill (or bluegill and redear sunfish) have provided better year-to-year fishing than any other combination. Bluegill and redear sunfish (bream) should be stocked from October through December. Bass should be stocked the following year, around June 1.

Stocking rates for Tennessee ponds are 500 bream and 100 bass per surface acre. This will establish pond balance with 3 to 5 pounds of bluegill (or bluegill/redear sunfish) to every 1 pound of bass in the pond.

Largemouth bass

Largemouth bass, among the most sought after game fish in North America, are well adapted to Tennessee ponds and lakes. They eat a variety of aquatic organisms including insects, tadpoles, frogs, crayfish and small fish. Larger bass have been known to prey on snakes, turtles, mice and ducklings. They must, however, have fish in their diet to grow to a satisfactory size.

Duane Raver/USFWS

Bluegill

Young bass grow rapidly if enough food is available. Under ideal conditions, a bass can grow 12 inches long in its first year. In most cases, however, they grow only 6 to 10 inches in their first year. They can grow to be relatively large by the time they are 6 to 8 years old. Largemouth bass will usually reach spawning maturity when they are from 10 to 12 inches long. They spawn in the spring when the water temperature reaches 63 to 68º F. The females are generally larger than the males and will produce from 2,000 to 7,000 eggs per pound of body weight.

Bluegill

Bluegill, the most commonly stocked bream in Tennessee, have also adapted well to ponds and small lakes. Not only do they provide food for largemouth bass, they provide many hours of angling pleasure and food for the table as well. Bluegill, which mainly eat zooplankton (microscopic animals) and insects, can weigh as much as a pound or more. Most weigh ¼ to ½ pound and grow to between 4 and 10 inches long. In Tennessee, bluegill begin to spawn in May and will continue spawning throughout the summer when the water temperature is 70 to 78º F. The female will deposit her eggs in a saucer-shaped nest, or bed, and the male will fertilize and guard them until they hatch. They will hatch in 2 to 4 days depending on water temperature. A bluegill will produce from 10,000 to 50,000 eggs, depending on her size.

Duane Raver/USFWS

Redear sunfish

Redear sunfish

Redear sunfish, sometimes called shellcrackers, are also good fish to stock in Tennessee ponds. They must be stocked with bluegill because their low reproduction will not support enough bass. They spawn in May through June and lay between 15,000 and 30,000 eggs. Redear sunfish are nicknamed shellcrackers because they feed heavily on snails. They also feed on zooplankton and insects. Most weigh ¼ to ½ pound and grow to between 4 and 11 inches long.

Channel catfish

Channel catfish adapt well to ponds and lakes. They eat fish, insects, worms, crayfish and some plants. Channel catfish growth is highly variable, but under favorable conditions will grow more than 1 pound per year.

They usually reach spawning maturity at about 3 years old and typically spawn in late May through July when water temperature is 72 to 85º F. They rarely reproduce in ponds without the addition of spawning structures, but when they do reproduce, they lay from 2,000 to 70,000 eggs per year, depending on their size. Ponds rarely become overcrowded with channel catfish when largemouth bass are present because the bass usually eat enough of them to prevent them from becoming overcrowded.

Catfish do not have to be stocked in ponds with largemouth bass and bluegill/redear sunfish to maintain pond balance. *(See "Catfish-only fishing ponds, page 36.)* However, if pond owners choose to stock channel catfish, they should stock at a rate of 50 to 100 per surface acre in combination with largemouth bass and bluegill/redear sunfish. When stocking channel catfish into an existing bass population, they should be at least 8 to 10 inches long so they will not be eaten by bass. *See Pond fish suppliers page 41.*

Grass carp

Pond owners with nuisance aquatic plants may want to stock grass carp to control the problem. Aquatic plant control is slower with grass carp than with chemicals, but can be more cost effective in the long run. *See Biological control page 18.*

Grass carp will not spawn in ponds or small lakes. They will not muddy the pond by rooting vegetation, and their diet is primarily aquatic vegetation. A grass carp can consume as much as 3 times its weight daily, can grow to over 50 pounds and is good to eat.

Fish you should NOT stock

Several species of game and forage fish that are popular in Tennessee reservoirs are not suitable in the controlled environments of small fishing ponds or lakes. For small fishing ponds and lakes, TWRA recommends ONLY the combinations of hatchery fish discussed on the previous pages. Any other combinations of fish could cause a pond to become unbalanced and would make it necessary to kill unwanted fish before proper balance could again be established.

Black and white crappie should not be stocked into ponds smaller than 50 acres because they will spawn before bass, they will eat the small fish that young bass need to grow and they will eat young bass. This can result in the pond becoming overcrowded with small crappie.

Duane Raver/USFWS

Channel catfish

TWRA does not supply catfish for stocking into private ponds.

Grass carp

Duane Raver/USFWS

White crappie

Duane Raver/USFWS

Black crappie

Ponds with heathy bass populations seldom have problems with unwanted species.

Another species that should not be stocked into fishing ponds is gizzard shad. Shad eat zooplankton almost exclusively, which depletes the supply needed by bluegill and young bass. This reduces bluegill growth and reproduction, and survival of young bass. These ponds may also become overpopulated with shad of a size that only the largest bass can eat. Similarly, golden shiners and green sunfish should not be stocked into ponds because they cause the same kind of problems as gizzard shad.

Bullheads (yellow and black), also called mudcats or polywogs, should not be stocked into ponds because they compete with bluegill and channel catfish for food, and they can make the water muddy when feeding. This reduces the feeding capability of sight-feeding largemouth bass and bluegill. Muddied water can also reduce the production of planktonic algae and zooplankton, which are basics in the food web of fish. Bullheads also reproduce and become overpopulated rapidly, which results in large quantities of small fish that never become large enough to harvest.

Duane Raver/USFWS

Golden shiner

Duane Raver/USFWS

Black bullhead

Duane Raver/USFWS

Yellow bullhead

FERTILIZING YOUR POND

A permit may be required before you fertilize if your pond or lake has water flowing out of it. Contact the Tennessee Department of Conservation at (888) 891-8332 for permit requirements.

Proper alkalinity of pond water is important for fertilizer to work properly in producing a planktonic algal bloom. See Liming page 14.

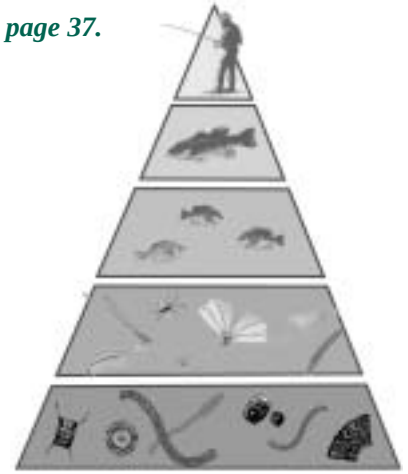
You must accurately determine the surface acreage of your pond before applying fertilizer. See Pond measurement page 37.

There is a greater risk of oxygen levels becoming too low and killing fish in fertilized ponds.

Some ponds should not be fertilized. See page 12.

Aquatic food web

Fertilizing pond water provides nutrients that increase the amount of food available for fish. This, in turn, increases the amount of fish a pond can support. Fertilizing a pond increases its planktonic algae, which are microscopic plants that give water a green color. These planktonic algae are eaten by zooplankton (microscopic animals), which are, in turn, eaten by small crustaceans, insects and other aquatic organisms. These insects and other, larger organisms are then eaten by bluegill and small bass, which are then eaten by larger bass. The amount of planktonic algae in a pond, therefore, determines the amount of food available to every organism in the food web, and ultimately the number of pounds of fish the pond can produce and support.



Aquatic food web

Fertilizing to produce more fish

Fertilized ponds have a higher ***carrying capacity*** and can produce up to 400 pounds of fish per surface acre per year. Adequately fertilized ponds have a light green color because they have a well nourished planktonic algal bloom. Fertilizing a pond can reduce unwanted aquatic plant growth as long as nuisance plants are not already present. The light green water in a fertile pond provides shade and prevents most types of unwanted underwater and emergent aquatic plants from growing. *See photograph on following page.* Fish in fertilized ponds are also less likely to be frightened away by anglers than in unfertile, clear ponds.

***Carrying capacity* of a pond refers to the maximum weight (in pounds) of fish that a pond will support during a set period of time.**

Unfertile ponds, which are usually clear because of a reduced amount of planktonic algae, have a much lower carrying capacity. They rarely produce more than 100 pounds of fish per surface acre per year. Unfertile ponds are also more likely to have problems with aquatic plants, which can be expensive and time consuming to correct. *See Aquatic plant control page 15.*

Small ponds that are adequately fertilized, therefore, can produce more fish than unfertilized ponds that are much larger. The carrying capacity for fish increases to 2 to 4 times as much when a pond is properly fertilized, so fish must be harvested much more frequently and in greater amounts from fertilized ponds. Pond owners should be aware that there is a greater chance of oxygen levels becoming too low for fish in fertilized ponds – especially during hot, cloudy weather. *See Oxygen deficiencies page 28.*

Watch for early signs of possible fish kills caused by low oxygen levels such as fish gulping for air at the surface of the water.

Photo by Bobby Wilson

Water in a (fertilized) pond with a heathy, planktonic algal bloom will be light green as shown above.

Photo by Bobby Wilson

This photograph shows excessive planktonic algai, which give water a "pea soup" green or brownish color. Ponds should not be fertilized when excessive or nuisance algae are present. See When not to fertilize page 12.

Do not pour undiluted, liquid fertilizer directly into the water. It will sink ot the bottom and become unusable.

Types of fertilizer

Pond fertilizers are available in granular, liquid and powdered forms and are usually available at farmers cooperatives, feed stores and general farm supply stores. Any of these can be used in Tennessee ponds to produce a planktonic algal bloom. Generally, the most available and least expensive liquid, granular or powdered fertilizer can be used. *To determine the surface acreage of your pond, see Pond measurement page 37.*

Granular fertilizer

Granular fertilizer can be applied (broadcast) evenly in areas 1 to 2 feet deep. If applied in deeper water, granular fertilizer settles to the bottom of the pond where it cannot be used by planktonic algae to produce the bloom. *See Table 1 on next page for general fertilization rates.*

A good method for applying granular fertilizer is the use of platforms. Fertilizer platforms can be installed to distribute fertilizer more easily and efficiently by wind and wave action. A 3 foot by 3 foot platform is adequate for each 3 to 4 surface acres of water. Platforms should have solid bottoms (no cracks) and should be 10 to 15 inches below the water surface. (See illustration on next page.) Platform(s) should be placed in the end of the pond opposite the drain pipe, 6 to 12 feet away from the shoreline. The required amount of fertilizer can then be poured out onto a platform or the entire bag can be laid on the platform.

If platforms are not used, the recommended amount of granular fertilizer can be poured along the shoreline, or left in the bag and laid along the shoreline so at least 4 inches of water covers it. Bags placed on platforms or on the shoreline should be cut open from top to bottom. Wave action will dissolve the fertilizer and distribute it throughout the pond.

A time-released granular fertilizer that can be applied once a year (instead of the 6 to 8 times a year required with most other fertilizers) is available. The granular pelleted, 10-50-0 (nitrogen-phosphate-potassium) formula should be applied in the spring at a rate of 25 to 40 pounds per surface acre. The fertilizer is slowly released from spring through fall, although seasonal variations in climate (sunlight, rainfall) can compromise the effectiveness of the initial application.

Fertilizing with phosphate alone

Some ponds, especially those that have been fertilized regularly with nitrogen-phosphate-potassium (N-P-K) fertilizer for 2 or 3 years, respond well to phosphate fertilization alone. Each application of phosphate fertilizer should consist of one of the following: 40 pounds superphosphate (0-20-0) per surface acre or 18 pounds of triple superphosphate (0-46-0) per surface acre.

If a good algal bloom (green water) cannot be produced and maintained with phosphate alone, the pond owner should resume a regular fertilization program with a granular, liquid or powdered (N-P-K) formula.

Liquid fertilizer

Liquid fertilizer will produce an algal bloom (green water) more quickly than granular fertilizer because it immediately dissolves in pond water. Use of liquid fertilizer is preferred in larger ponds and lakes over granular fertilizer because of its ease of use. *Fertilization rates are listed in Table 1 on the next page.*

Fertilizer Type	Formulation* (N - P - K)	Application Rate**
Granular	20-20-5	40 pounds per surface acre
	8-8-4	100 pounds per surface acre
	15-15-15	50 pounds per surface acre
	18-46-0	18 pounds per surface acre
Time released	10-50-0	25 to 40 pounds per surface acre
Liquid	10-34-0	1 gallon per surface acre***
	11-37-0	1 gallon per surface acre***
	13-38-0	1 gallon per surface acre***
Powdered	12-49-6	2 to 8 pounds per surface acre
	10-52-0	2 to 8 pounds per surface acre

Table 1.
General fertilization rates for ponds

* *These are just some of the more common formulations that are available.*

** *These are general fertilazation rates. Follow rates and application methods on product label.*

*** *These should be diluted with at least 5 to 10 gallons of water then applied evenly in the pond. Follow instructions on label.*

Do not use a clay-suspended, liquid fertilizer.

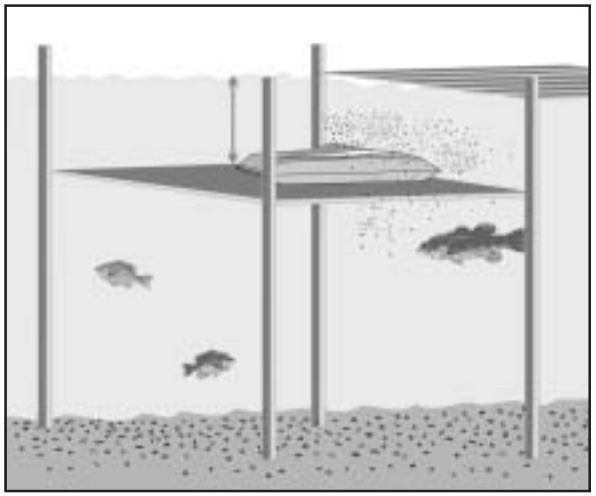
Liquid fertilizer works best when applied from a boat, ideally by being released near the prop wash of an outboard motor. If this is not possible, the liquid fertilizer should be diluted to 1 part fertilizer to 5 or 10 parts water. This solution should then be sprayed or spread as evenly as possible over the pond's surface. Unlike granular fertilizer, liquid fertilizer can be applied to shallow and deeper areas of the pond.

Powdered fertilizer

Powdered fertilizers, which are effective and easy-to-use, are also available. Formulas, such as 12-49-6 or 10-52-0, are typically applied at a rate of 2 to 8 pounds per surface acre. (Follow label instructions.) Powdered fertilizers can be broadcast, because they are highly water soluble and do not sink to the bottom and become unusable.

When to fertilize

Fertilization with liquid, granular or powdered fertilizer should begin in the early spring if the water is clear, not muddied from spring rains. Otherwise, fertilization should begin when the water starts to clear and the water temperature reaches 60° F. Recommended fertilizer mixtures per surface acre are shown in Table 1. Unless using a time-released fertilizer that only needs to be applied once a year, fertilizer will usually need to be applied 6 to 8 times per year. So, enough fertilizer should be purchased in the spring to last the entire season. Fertilization should be discontinued in the fall (usually late September) when the water temperature falls below 60° F. For advice about fertilizing your pond, contact your regional TWRA biologist or UT Agricultural Extension Service agent. *See Seeking assistance pages 39 and 40.*



Fertilization platform connected to a fishing pier

Photo by Dave Rizzuto

The second application of fertilizer should be made from 10 to 14 days after the first application. This usually establishes an algal bloom (green water) that should be maintained throughout the summer. Generally, once the algae bloom has been established, fertilizer should only be reapplied when it is possible to see more than 18 inches into the water. On the average, this occurs once every 30 to 45 days. If algal bloom is not established after the second application of the recommended fertilizer, alkalinity may be low. *See liming, page 14.*

A good way to tell if you can see 18 inches into the water is to attach a white or shiny object such as a pie pan to the end of a stick. Then put a mark on the stick 18 inches away from the white or shiny object. If the object on the end of the stick can be seen clearly when submerged into the pond to the 18 inch mark, another application of fertilizer is needed.

Some ponds require more frequent fertilization than others to maintain a good algal bloom. A record of the date and amount of fertilizer used should be kept. With proper record keeping, adjustments in the amount of fertilizer needed for best results can be made easily.

When NOT to fertilize

Successful fertilization requires regular treatments. If the pond owner is not willing to apply treatments at necessary intervals and continue fertilization efforts annually, all benefits of fertilization will be wasted, and fish populations may become unbalanced. Fish become dependent on the extra food produced as a result of fertilization. Stopping fertilization reduces available food for fish, and their growth slows or stops. Also, if fertilization is begun, then stopped, nuisance aquatic plants are likely to emerge.

Some ponds should not be fertilized. Do not fertilize in the following cases: (see following page for explanations)

1. Nuisance algae or aquatic plants are present
2. Fish population is not in balance
3. Pond is usually muddy
4. Pond is not fished often
5. Pond is in well managed pasture with many cattle
6. Fish are being fed
7. Heavy rain is expected

1. Unwanted aquatic plants and algae must be controlled before fertilizer is applied. Nuisance plants and algae are not only unattractive, they can use up nutrients that would otherwise be used by beneficial, planktonic algae, and they can lead to oxygen depletion and fish die offs. They can also be a nuisance when they get caught on hooks and lures. *See Oxygen deficiencies page 28.*

In Tennessee, excessive planktonic algae, which give water a "pea soup" green or brownish appearance, are common. *See photograph on page 10.* Filamentous algae, also known as pond scum, moss or slime, are also common in Tennessee. *See photograph on inside back cover.* For information about how to control nuisance algae and aquatic plants, *see Chemical control of nuisance algae page 16.*

2. Fertilization will not improve fishing in unbalanced ponds. Balance refers to the number and weight of predatory fish (bass) compared to the number and weight of forage fish (bluegill and sunfish) in the pond. *See Fish population balance page 20.* In ponds that are already overpopulated, fertilizing will produce more pounds of fish, but the average size of the fish will usually be very small.

The balance of the fish population in a pond should be determined before fertilization is begun. If a pond is overcrowded with bluegill or sunfish, fertilization should not be started. Thinning the bluegill population may be necessary to correct this situation and should be done in the fall. *See Avoiding overcrowding page 20.*

3. If a pond stays muddy most of the time, do not fertilize until the problem is corrected. *See Muddy water page 31*.

4. Ponds that are not fished often do not need fertilizer. Fish must be harvested (removed) frequently and in greater amounts from fertilized ponds.

5. Ponds in well managed pastures with high numbers of cattle usually do not need fertilization.

6. Pond owners who feed fish may not need to fertilize because the nutrients in the fish feed may produce the desired algal bloom.

7. Excessive water flow though the pond washes out the fertilizer, therefore, at least 30 to 40 days of water retention (without extremely heavy rain) is necessary for fertilization to be effective.

Photo by Dave Rizzuto

LIMING

To improve fishing, liming is necessary in Tennessee ponds with low total alkalinity. Ponds with total alkalinity below 20 milligrams per liter or parts per million are sometimes acidic with pH levels of 6 or below. Adding agricultural lime will increase water alkalinity and, in turn, raise the pH level of the water. Liming is not necessary in ponds with total alkalinity above 20 milligrams per liter.

Algicides containing copper compounds can kill fish in ponds with low alkalinity.

Recommended fertilization rates will not produce an adequate algal bloom in ponds with low alkalinity. *See below.* Algicides, especially those containing copper compounds, will not be effective and can kill fish in ponds with low alkalinity. *See page 17.*

Photo by Doug Markham

Water testing & liming in existing ponds

Water in existing ponds can be tested for total alkalinity using a kit purchased at swimming pool, aquarium or most hardware stores. Note that some test kits measure for alkalinity in milligrams per liter (mg/L) and some measure in parts per million (ppm), but they are equal measurements. Fishing ponds with a total alkalinity of 20 or less should be limed.

Soil testing & liming ponds

To know how much lime is needed for ponds that are under construction, soil samples should be taken from the pond bottom. For existing (filled) ponds, dip mud samples from the bottom in about 8-10 locations per acre with a can fastened to the end of a stick. Dry the mud and send some of it in a soil sample box obtained from the County Extension Office. The lime requirements for the pond will be determined and recommendations returned. For further instructions about soil testing, contact the UT Extension Service Soil Testing Center in Nashville. *See page 40.*

How & when to lime

Lime should not be added in the summer because the phosphate separates out in warmer temperatures and is unavailable to plankton as a nutrient.

Agricultural limestone, often called agricultural lime, should be added at the recommended rate in the fall or winter. For use in ponds, agricultural lime, which can be purchased in bulk or bags at farmers cooperatives, should be powdered, not pelleted. Either agricultural lime, which is calcium carbonate ($CaCO_3$), or dolomite, which is calcium magnesium carbonate ($CaMg(CO_3)_2$), can be used. Quick lime, hydrated, builder's or slaked lime should not be used, because they can cause fish kills.

In existing ponds liming can be done by building a plywood platform on the front of a boat and shoveling the lime out as evenly as possible as you move over the surface of the pond. For ponds under construction, a lime spreading truck, normally used to spread agricultural lime over crop fields, can be used on relatively flat ground.

Ponds with a history of low total alkalinity should be tested and limed as needed every 2 to 4 years.

AQUATIC PLANT CONTROL

A permit may be required before you apply herbicides or algicides to kill aquatic plants if your pond or lake has water flowing out of it. Contact the Tennessee Department of Conservation Water Quality Division at (888) 891-8332 for possible permit requirements.

Treating nuisance aquatic plants, especially during hot summer months, can be risky.

DO NOT fertilize a pond that has nuisance aquatic plants and algae present.

Excessive nuisance aquatic plants and algae must be controlled for a fishing pond or lake to maintain a proper ***balance.*** Nuisance aquatic plants and algae compete with desirable planktonic algae for nutrients. This results in a more limited quality of fish being produced in the pond. A more serious problem caused by an overabundance of aquatic plants and algae is the excessive cover they provide for small fish. Fish populations can become unbalanced when too much aquatic vegetation protects the small bluegill from the bass. Ponds choked with aquatic plants and algae almost always have large numbers of small fish, so the fishing is usually poor.

Pond balance refers to the ratio and weight of predatory (bass) and forage fish (bluegill/redear sunfish) in the pond.

Identifying nuisance plants

The first step in controlling aquatic plant growth is identifying the plants that need to be removed so you can select the most effective and economical herbicide and/or method. For assistance in identifying nuisance plants, pond owners should contact a TWRA biologist or UT Agricultural Extension Service agent. *See Seeking assistance pages 39 and 40.* If a professional cannot visit the pond, the pond owner should bring or mail a sample of the plant to the nearest TWRA biologist for identification and treatment recommendation.

Photo by Bobby Wilson

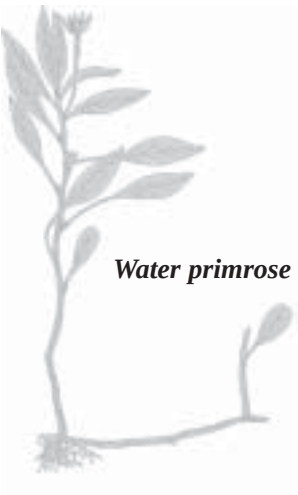
Many types of aquatic plants are found throughout Tennessee. In general, aquatic plants are emergent, which means they grow out of the water; submersed, which means they grow underwater; and floating. Emergent aquatic plants that commonly become a nuisance in Tennessee are water primrose, cattail and willow. Submersed aquatic plants that often become a nuisance in Tennessee are pondweeds and Southern naiads. Floating aquatic plants that commonly become a nuisance in Tennessee are duckweed and watermeal. Also, filamentous algae, which can be floating or submersed, are very common. *See page 45 for photographs of these common nuisance aquatic plants found in Tennessee.*

Avoiding nuisance aquatic plant growth

The best way to prevent unwanted aquatic plant growth is constructing a pond with proper depth and shoreline slope. *See Pond depth & shoreline slope page 2.* However, in an established pond, preventing submersed aquatic plant growth is the most practical solution. This can be done by deepening any shallow water areas (eliminating “feather edges”) and, in some cases, starting a regular fertilization program after plant growth is eliminated. Once desirable, planktonic algae produce a light green algal bloom, the shade it provides will suppress aquatic plant growth.

Duckweed
(See photographs on page 45.)

Watermeal



Water primrose

Southern naiads

Pondweeds

Cattail

Chemical control of nuisance aquatic plants

Only a few chemicals and herbicides are presently approved for use in ponds used for recreational fishing. The U.S. Environmental Protection Agency and the U.S. Food and Drug Administration rigidly control use of these chemicals and other herbicides that are capable of controlling aquatic plants.

Floating aquatic plants such as duckweed and watermeal have been controlled using Diquat, 2,4-D and Fluridone depending on the species. All members of the duckweed family can be controlled by mixing the appropriate chemical and applying it directly to the plants with a garden sprayer. A nonionic surfactant, normally available where herbicides are sold, should be added to the chemical before spraying. A surfactant is a soapy substance that helps chemicals stick to plants. Watermeal is more difficult to control, and at this time only Fluridone is recommended for treatment. Watermeal is very small, bright green in color and feels like tiny grains of sand when rubbed between the thumb and fingers.

For control of emergent plants such as water primrose, cattail and willow, chemicals such as Glyphosate or 2,4-D can be used effectively depending on the plant species. Results are improved when a nonionic surfactant is used. *See Table 2 on page 19.*

For control of submersed plants such as pondweeds and Southern naiads, chemicals such as Fluridone, Diquat, Endothall or 2,4-D (however 2,4-D works poorly on pondweeds) can be used effectively depending on the plant species. The use of surfactants is not recommended for submersed weed control treatments.

Chemical control of nuisance algae

There are three main types of algae that become a nuisance in excessive amounts. They are planktonic, filamentous and attached algae. These should not be confused with desirable planktonic algal blooms that give water a light green color and are desirable for a pond to be more productive for fishing.

The most common nuisance algae found in Tennessee are filamentous algae. Filamentous algae, often called pond scum, muck or moss, usually begin growing along the edges or bottom of the pond. Then, because of a buildup of oxygen in the plant, filamentous algae, which can be slimy, cottony or coarse, float to the surface. *(See photograph of filamentous algae on page 45.)* Excessive planktonic algae in a pond can give water a “pea soup” green or a brownish appearance instead of the desired light green produced by a healthy algal bloom. *See photographs of a healthy planktonic algal bloom and excessive planktonic algae on page 10.* The attached forms of branched algae, such as *Chara* (muskgrass) and *Nitella* (stonewort), grow from the pond bottom and are best identified by their musky odor, or gritty, bristly feel. Dense growths of this algal type occur primarily in clear water.

Most types of nuisance algae can be controlled with algicides (herbicides specifically formulated to kill algae). To select an algicide, it is helpful to know what type of algae needs to be controlled.

Copper compounds are the most common algicides, however, the alkalinity of the water in the pond should be determined before they are applied. One type of copper compound called copper sulfate, or bluestone, has been used with some success. In waters with low total alkalinity (less than 40 milligrams per liter), the rate of treatment with copper sulfate needed to control algae can be toxic to fish. In water with total alkalinity of more than 250 milligrams per liter, copper sulfate separates out and is not effective for algae control. The toxicity of copper sulfate to fish increases as water temperature increases, so pond owners should avoid using copper sulfate during the hot summer months. Another type of copper compound that is used is called a chelated copper compound. Chelated copper compounds do not readily separate out, however, they should not be used in waters with low alkalinity. The total alkalinity of the pond water can be determined by using a test kit, which can be purchased at swimming pool, aquarium and some hardware stores.

Algicides containing copper compounds can kill fish in ponds with low alkalinity.

Applying herbicides & algicides

Generally, recommended herbicides or algicides, when used as directed on the label, are safe to use, and the chemicals themselves will not harm fish or other aquatic life. However, herbicides and/or algicides should be applied at the correct time to ensure effectiveness. In most cases it is best to apply herbicides/algicides early in the growing season or after the water temperature has reached at least 65º F. At this time of the year, weeds are smaller and easier to control than during the hot summer months. Also, with fewer weeds present, less herbicide is required.

Herbicides and algicides should not be used in bodies of water that flow constantly into streams, or other ponds or lakes.

Treating nuisance aquatic plants, especially during the hot summer months, can be risky. Aquatic plants that are killed by herbicides/algicides undergo decomposition. The decomposition process consumes oxygen and can reduce the amount of oxygen available for fish, especially during the hot summer months when oxygen demand is greater. Although the chemicals used to treat nuisance plants will not directly harm the fish, the low oxygen levels in the pond can kill them. *See Fish kills page 28.* To reduce this risk, the pond owner should treat ***only*** 1/4 to 1/3 of the pond at 7- to 10-day intervals. *See Oxygen deficiencies page 28.* Spot treatments may be necessary throughout the growing season. In difficult cases, pond owners should contact a TWRA wildlife officer, fisheries biologist or regional office for advice.

Users of herbicides or algicides are always responsible for their effects if they drift or move to private or public property.

Chemicals must always be handled according to the instructions provided on labels, and manufacturer's instructions should be strictly followed when preparing, applying, storing and disposing of chemicals .

All state and federal regulations regarding chemical use must be followed.

Chemicals used to kill aquatic plants and algae are available at seed stores, farmers cooperatives and feed stores. New chemicals are continually being developed, so pond owners are encouraged to contact TWRA for up-to-date information about herbicide and algicide use prior to treating ponds. For additional information about using chemicals and algicides, contact a UT Agricultural Extension Service agent, a TWRA fisheries biologist or the TWRA regional office. *See Seeking assistance pages 39 and 40.*

Willow

Chara

Nitella

Biological control

Most aquatic plants can be controlled with grass carp. Native to southeast Asia, the grass carp was brought into the United States in the early 1960s as an experimental aquatic weed control method. Aquatic plant control is slower with grass carp than with chemicals, but can be more cost effective in the long run. *See Table 2, on the next page, for the relative effectiveness of grass carp for controlling aquatic plants and algae.*

Grass carp should not be stocked unless an aquatic vegetation problem develops.

Grass carp, also known as white amur, will not spawn in ponds or small lakes. They will not muddy the pond by rooting vegetation, and their diet is primarily aquatic vegetation. A grass carp can consume as much as 3 times its weight daily, can grow to over 50 pounds and is good to eat. However, consumption of aquatic plants will decrease as the fish grows. For example, by the the time a grass carp reaches 15 to 20 pounds their consumption rate will decrease to about 20 to 25 percent of body weight per day.

Photo by Bobby Wilson

Grass carp

Generally, for ponds containing largemouth bass, grass carp for stocking should be from 10 to 12 inches long to avoid being eaten by the bass. This is the size of fish that is generally available from commercial hatcheries. Ponds in their first year of being stocked with hatchery fish can use smaller grass carp. For ponds with slight aquatic vegetation coverage (15 to 30 percent of the water surface), 5 grass carp per surface acre are recommended. Ponds or small lakes with moderate vegetation coverage (30 to 50 percent of the water surface) should be stocked with 5 to 10 grass carp per surface acre. For ponds with excessive aquatic vegetation coverage (greater than 50 percent of the water surface), 10 to 15 grass carp per surface acre should be stocked. Stocking rates for controlling submersed aquatic plants are the same as for controlling algae.

Care should be taken to prevent the escape of grass carp from the pond during high water flows through the spillways and/or overflows. This can be accomplished by constructing a screen barrier across the spillway or overflow pipe. The screen openings should be small enough to keep grass carp from escaping, but not trap debris such as leaves, which can cause structural damage. Check the screen and remove debris regularly.

Time is required for grass carp to control aquatic weeds and the results are not usually obvious until their second year in the pond, depending upon the amount of plant infestation and stocking rates. To speed up removal of nuisance aquatic plants, herbicides or algicides can be applied before grass carp are stocked. Approximately 5 to 6 years after initially stocking grass carp, restocking may become necessary to continue the desired level of control because grass carp are less effective in controlling aquatic vegetation as they grow older, and some will die of natural causes.

Only triploid (sterile) grass carp are legal to stock.

Most feed stores and farmers cooperatives, and the TWRA have lists of commercial hatcheries where grass carp may be purchased. Because of concerns about the potential impact on the environment and native fish populations, some states restrict or prohibit their use. Other states, including Tennessee, only allow the use of a sterile grass carp known as a “triploid.” No special permit is required to stock grass carp into private Tennessee lakes and ponds at this time. However, pond owners should obtain verification from the seller that they are purchasing triploid (sterile) grass carp.

Aquatic group and weed	Grass carp	Copper compounds[1]	2-4-D	Diquat[2]	Endothall[3]	Fluridone	Glyphosate
Algae							
Planktonic		E	P	P	P	P	P
Filamentous	F	E	P	E	G[4]	P	P
Chara	E	E	P	G	G[4]	P	P
Floating weeds							
Duckweed	F	P	G[5]	G	P	E[6]	
Watermeal	F	P	P	P		F-G[6]	
Waterhyacinth		P	E	G		P	G
Submersed							
Coontail	G	P	G	E	E	E	P
Watermilfoil	P-F	P	E	E	E	E	P
Naiads	E	P	F	G	E	G-E	P
Pondweeds	E	P	P	G	E	E	P
Hydrilla	E	F	P	G	G	E	P
Emergent							
American lotus		P	E	P	P	P-F	G-E
Cattails	*	P	G	G	P	F	E
Smartweeds		P	E	F		F	G-E
Water primrose	*	P	E	F	P	P-F	E
Watershield	*	P	E	P-F	P-F	G	G
Willows		P	E	F		P	E

E = excellent control; G=good control; F=fair control; P=poor control

Table 2.
Relative effectiveness of grass carp and herbicides for control of common aquatic weeds in Tennessee ponds

Note: It is not intended that any suggested usage in this table be in violation with existing regulations or manufactures's label.

[1] *Use products containing copper with caution because its toxicity to fish and its effectiveness in controlling aquatic weeds depends on the total alkalinity of the water.*

[2] *Diquat has a 14-day livestock restriction. Use only in bright sunny weather. Do not use in muddy water.*

[3] *Aquathol and Hydrothol have a 7-day livestock restriction. Do not consume fish from treated water for a period of three (3) days.*

[4] *Hydrothol formulations only, but may be toxic to fish at application rates used for weed control*

[5] *Liquid ester formulations only*

[6] *Sonar A.S. formulations only*

* *Grass carp are not likely to reduce mature stand of these plants, but may eat new sprouts and help prevent further expansion by these plants.*

** *Use of trade names or brand names is for clarity and information purposes only. It does not imply endorsement of the product to the exclusion of others that may be of similar, suitable composition. Nor does it guarantee or warrant the standard of the product.*

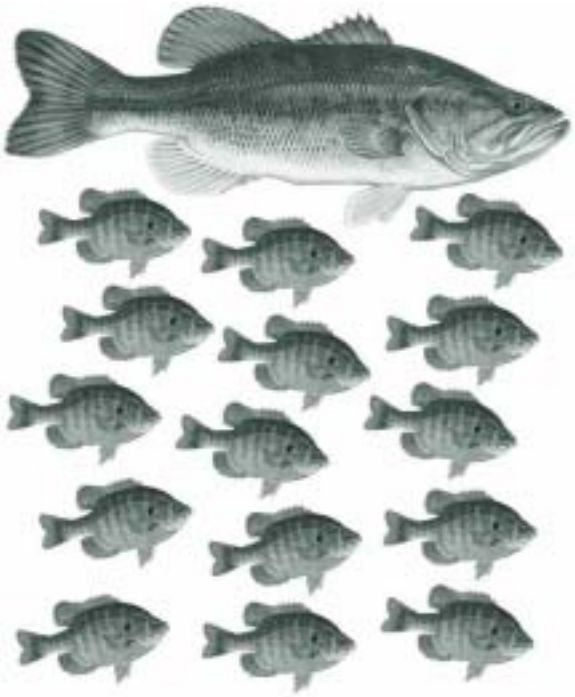
Chemical	Trade Names**
Copper Sulfate	Various trade names
Chelated Copper	Cutrine-Plus, Komeen, Earth-Tec, Stocktrine, K-Tea, Aquatrine, A&V Plus, others
2-4-D	Various trade names
Diquat	Reward, Weedtrine-D
Endothall	Aquathol, Hydrothol
Fluridone	Sonar, Avast
Glyphosate	Rodeo

MANAGING FISH POPULATIONS

Fish must be harvested regularly for the population to remain in balance.

This section explains how pond owners can achieve and maintain a balanced pond. First, a pond must initially be stocked at recommended rates. *See Planning & applying for hatchery fish page 5.* To keep a pond in balance, a pond owner must properly maintain the pond's dam, spillway and surrounding vegetation, diligently control aquatic plants and properly harvest fish. *See Pond construction page 1* and *Aquatic plant control page 15.* In managed ponds, sampling of the fish population should be routine. In managed ponds that have been stocked for 2 years or more, keeping a record of fish caught, harvested (kept) and released is also important.

***Balance** refers to the ratio and weight of predatory (bass) to forage fish (bluegill/redear sunfish) in the pond.*



Duane Raver/USFWS

Bass overcrowding often occurs in catch-and-release only ponds because few or no bass are caught and kept.

Fish population balance

To understand stocking and maintaining a pond so the quality of fishing remains high, you must understand pond ***balance***. Predatory fish (bass) primarily eat, or prey on, other fish. Forage fish (bluegill/redear sunfish) primarily eat insects and snails. To be in proper balance, there should be 3 to 5 pounds of bluegill/redear sunfish to every 1 pound of bass.

A balanced pond is more productive, which means it can support more fish, zooplankton and planktonic algae, which are eaten by insects and small fish. A balanced pond can be achieved by stocking fish at recommended rates based on the size of the pond. Maintaining pond balance requires proper construction, diligent aquatic plant control and sensible harvesting by anglers. When a pond becomes seriously out of balance, killing all remaining fish and completely restocking may be necessary.

Avoiding overcrowding

The best way to avoid overcrowding in a pond is to harvest fish regularly and in adequate numbers. *See Tables 4 and 5 on pages 21 and 22.* However, if the average size of bass or bluegill/redear sunfish is small, it is usually an indication of overcrowding, and the species that is small should be fished more heavily. The condition (plumpness) of the fish is also an indicator of population balance or imbalance. In bluegill-crowded ponds, bluegill will be abundant, small and/or skinny. In a seriously overcrowded pond, their eyes may be large and bulging. In bass-crowded ponds, bass will be abundant and will usually have small bodies and large heads.

When bluegill/redear sunfish are overcrowded, their reproduction slows or completely stops. Such a reduction in small forage fish seriously threatens pond balance because it limits the survival of young bass in the pond. Successful bass spawning is almost impossible in a bluegill/redear sunfish-crowded pond because the bluegill/redear sunfish eat bass eggs. Bluegill/redear sunfish also stop reproducing, so no forage is available for surviving bass fingerlings. Fishing exclusively for bass in a pond leads to bluegill overcrowding and results in a seriously out-of-balance fish population. Excessive removal of bass is one of the most common causes of fishing pond failure. Therefore, it is vital not only to stock fish at recommended rates, but to harvest fish species properly as well.

One solution to excessive removal of bass is for the pond owner to impose a minimum size limit of 12 to 14 inches for the first 12 to 24 months after stocking. This can provide excellent catch-and-release fishing and will maintain enough bass to help keep the bluegill under control. After this period it is essential for bass to be harvested regularly. *See Table 4 on the next page.*

Pond production & fish harvest

Most large ponds are underfished, and small ponds are frequently overfished to the point of becoming seriously unbalanced. To appropriately regulate pond harvest so balance can be maintained, pond owners should understand pond production potential, or ***carrying capacity.***

Carrying capacity refers to the maximum weight of fish (in pounds) that a pond can support during a set time period.

The weight of bass and bluegill (or bluegill/redear sunfish) that can be produced in Tennessee ponds ranges from less than 100 pounds of fish per surface acre in unfertilized ponds up to 400 pounds of fish per surface acre in fertilized ponds. In a pond that supports 70 pounds of bass, there may be 70, 1 pound bass; 140, ½ pound bass; or any combination of sizes that total 70 pounds. *See Table 3, below.* As with stocking fish at the appropriate rates, it is vital to know the surface acreage of your pond to harvest at appropriate rates. *See Pond measurement page 37.*

On the average, the pounds of fish harvested in a year should be no more than half of the pond's yearly carrying capacity.

For instance, as shown in Table 4 *(below)*, approximately 12 pounds of bass should be harvested from an unfertilized, 1 surface acre pond per year. According to Table 5, approximately 36 pounds of bluegill/redear sunfish should be harvested from an unfertilized, 1 surface acre pond per year. So, a combined total of approximately 50 pounds of fish should be harvested from an unfertilized, 1 surface acre pond per year.

Not harvesting fish can be as harmful to pond balance as overharvesting them.

For a pond to remain in balance, some fish must be harvested. Bass must be harvested at a much lower rate than bluegill/redear sunfish, and must be present in sufficient numbers to prevent bluegill/redear sunfish overcrowding. A good rule of thumb is: ***for every pound of bass harvested, 3 to 5 pounds of bluegill/redear sunfish should be harvested.***

	Fertilized ponds			Unfertilized ponds		
Surface acres	½	1	2	½	1	2
Total carrying capacity in pounds	200	400	800	50	100	200

Table 3.
Total carrying capacity[1]

[1]*Total carrying capacity of pond is the combined weight of bluegill/sunfish and bass*

	Fertilized ponds			Unfertilized ponds		
Surface acres	½	1	2	½	1	2
Yearly harvest in pounds	18	35	70	6	12	24
Monthly harvest in pounds	1½	3	6	½	1	2

Table 4.
Recommended harvest for bass

Table 5. Recommended harvest for bluegill/sunfish

	Fertilized ponds			Unfertilized ponds		
Surface acres	½	1	2	½	1	2
Yearly harvest in pounds	82	165	330	18	36	72
Monthly harvest in pounds	6½	14	29	1½	3	6

When to harvest

It is important to space fish harvesting out evenly throughout the year. An exceptionally high harvest in a short period of time will cause a pond to become unbalanced because the fish will be removed faster than they can replace themselves. To maintain high quality fishing in a balanced pond, fish should be harvested regularly and in moderate, balanced numbers. *See Table 4 on previous page and Table 5 above.* This will allow reproduction and harvest rates to maintain balance. Catch-and-release fishing can be enjoyed at any time without threatening pond balance, and catfish can be harvested whenever they reach edible size.

Photos by Dave Rizzuto

When seining, the net should be allowed to arch in a half-moon shape so fish cannot easily swim around it.

When to harvest after stocking

Bass should not be harvested for approximately 2 years after they have been stocked depending on the growth of the bass. Bream (bluegill/redear sunfish) may be harvested after the first year of stocking. This allows stocked fish the opportunity to spawn, which will bring the pond into balance so it will reach its carrying capacity sooner. This waiting period also allows fish to grow to harvestable size.

Harvesting channel catfish

Catfish can be harvested whenever they reach edible size. If the pond is overcrowded with catfish, they will have large heads and small bodies. If catfish overcrowding occurs, harvest more of them to allow for healthy growth of the remaining catfish. At proper stocking rates, channel catfish in a pond generally do not affect the balance of bass and bluegill/redear sunfish. If channel catfish reproduce, offspring usually do not survive because of bass predation. Restock with catfish when most of the originally stocked catfish have been removed.

Monitoring pond balance

To determine whether a fish population in a pond is in balance, the pond owner can either sample the fish present by shoreline seining (pronounced “sane-ing”) or by keeping track of the fish caught, harvested and released. When a pond is in balance, there should be 3 to 5 pounds of bluegill and sunfish to every 1 pound of bass.

Monitoring pond balance by seining

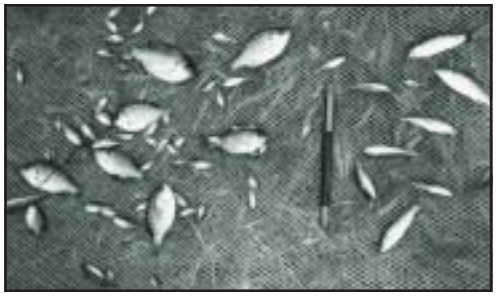
This method is effective for ponds with bass/bluegill populations that are at least 2 years old. Seining to monitor for pond balance is most effective during June and July because spawning has occurred by then. Using a 15 to 20 foot seine (4 feet deep with a ¼ inch mesh), make 3 to 5 passes (hauls) in shallow areas (4 feet deep or less) along the pond bank and record the catch. Allow the seine to arch (in a half-moon shape) so that the fish cannot easily swim around it. *See photographs at left.* The fish caught in the seine hauls provide

	Type of fish	Conclusion	Recommendations
1.	Many recently hatched bluegill, a few intermediate (3 to 5 inch) bluegill, and young-of-year (fingerling) bass	Fish population in balance *(See photograph at right.)*	Follow normal management practices.
2.	No recently hatched bluegill, numerous intermediate (3 to 5 inch) bluegill, and few or no fingerling bass	Bluegill crowded *(See photograph at right.)*	Remove intermediate bluegill by any method[1] and/or stock 20 to 30 adult bass (larger than 12 inches) per surface acre.
3.	Many recently hatched bluegill, no or few intermediate (3 to 5 inch) bluegill, and numerous fingerling bass	Bass crowded *(See photograph at right.)*	Harvest approximately 35 pounds of bass (50 bass, 12 inches or less) per surface acre over a 3 to 4 month period.
4.	No game fish present, no recently hatched bluegill, and no or few intermediate bluegill, unwanted species such as carp, bullheads, shad, crawfish, tadpoles, etc. present	Pond seriously out of balance *(See photographs on following page.)*	Eradicate fish by draining or rotenone, and restock[2].

[1] *See Removing fish from overpopulated ponds page 25.*

[2] *See Reclaiming unproductive ponds page 26.*

Table 6. Evaluating pond balance using seine contents



Sample results from a balanced pond. (See number 1 in table at left.)

Sample results from a bluegill-crowded pond. (See number 2 in table at left.)

Sample results from a bass-crowded pond. Bluegill fry are not visible in photograph. (See number 3 in table at left.)

information on the reproductive success of the fish in the pond and can also help determine if there are unwanted fish in the pond. *For more information about analyzing seine samples, see Table 6, above.*

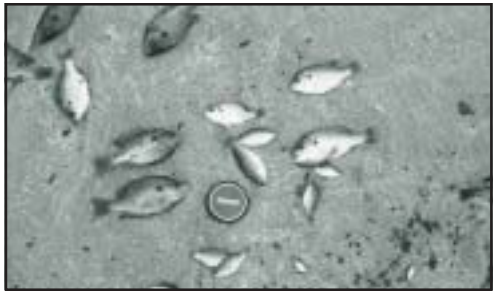
Monitoring pond balance by angling (fishing)

When pond owners are able to catch ample numbers of various sizes of bass and bluegill, the pond is probably in balance. Unbalanced ponds tend to provide poor fishing, which can be an indication that a problem exists.

If your pond has been stocked for 2 or more years, recording angler catch data is another way to look at the fish population and identify any problems. Keep a fishing log of what you catch, harvest (keep) and release with the fish sizes for each. Table 7 on the following page gives an example of possible catch combinations by rod and reel with fish condition and management recommendations.

Table 7. Evaluating pond balance by angling

	Fish caught	Condition	Recommendations
1.	Bass - various sizes (up to 1 to 2 pounds). Bluegill - various sizes (5 to 8 inches)	Fish population in balance	Follow normal management practices.
2.	Bass - few caught, but large (2 pounds or larger) (Bluegill - few harvestable size and few large: many 3 to 5 inches	Bluegill crowded	Remove excess 3 to 5 inch bluegill[1] by rod and reel, seining[2] or trapping. Do not harvest any bass.
3.	Bass - numerous, but many are small (less than 1 pound) and thin. some bass may have large heads and thin bodies. Bluegill - few, but larger (7 to 10 inches) and robust	Bass crowded	Fish more for bass, keep smaller sizes for more quality bass[3]. For quality bluegill, maintain this population.
4.	Few harvestable size bluegill (most 3 to 5 inches(. Unwanted species present (crappie, bull-heads, green sunfish, common carp, etc.). Few bass caught, but usually large (2 pounds or larger)	Unbalanced population dominated by unwanted species	Kill existing fish population and restock[4].



Sample results from an unbalanced pond with (undesirable) green sunfish and intermediate, stunted bluegill. (See number 4 in table on previous page.)

Sample results from an unbalanced pond with no bluegill fry or bass fingerlings. Frogs and crawfish are present. (See number 4 in table on previous page.)

[1] *The number of small bluegill that need to be removed from an overpopulated pond depends on the degree of crowding. If the fish average 5 inches in length, it may be necessary to remove only a few hundred per surface acre. If the fish average less than 4 inches in length, it may be necessary to remove more than 1,000 per surface acre. In extremely overcrowded ponds, complete elimination with rotenone and re-stocking may be necessary. See Reclaiming unproductive ponds page 26.*

Bluegill and sunfish should not be removed at too rapid a rate during summer months when a size increase alone is the objective. In crowded ponds where reproduction of bluegill has stopped and young bass are abundant, however, a quick removal of some bluegill will induce spawning and provide forage for bass.

[2] *See Partial removal with seines page 25.*

[3] *See Removing fish from overpopulated ponds page 25.*

[4] *See Reclaiming unproductive ponds page 26.*

Removing fish from overpopulated ponds

If results from seining or angling show that your pond is overcrowded, fish will have to be removed to restore pond fish balance. This can be done with chemicals, wire traps, seines or increased fishing effort. Another method for controlling overcrowded fish such as bluegill is to draw down the water level in the fall thereby concentrating the bluegill for bass to feed on.

The number of small bluegill that need to be removed from a bluegill-crowded pond depends on the degree of crowding. If the fish average 5 inches in length, it may be necessary to remove only a few hundred per surface acre. If the fish average less than 4 inches in length, it may be necessary to remove more than a thousand per surface acre.

Removing fish from a bass-crowded pond is not as difficult. Bass-crowded ponds are usually older, established ponds that are overpopulated with bass that are 7 to 12 inches in length. In these cases, removing 50 (12 inch or smaller) bass per surface acre over a 3 to 4 month period is the best solution. If remaining bass do not increase in size after about 6 months, an additional 25 (12 inch or smaller) bass per surface acre should be removed. *Once the size of bass increases, the harvest guidelines in Table 4, on page 21, should be followed.*

Partial removal with chemicals

Treatment with chemicals is relatively inexpensive and is the only practical method in larger ponds where sizable quantities of fish must be removed. In brief, the treatment consists of lowering the water several feet where possible and treating the remaining shallow water areas and shoreline with rotenone. Several treatments may be necessary to remove enough fish without endangering the entire fish population.

Ponds are often so severely overcrowded that thinning is impractical. In these cases, killing all of the fish in the pond and restocking may be the only solution. *See Reclaiming unproductive ponds page 26.*

For additional information about using rotenone, contact a TWRA wildlife officer, fisheries biologist or regional office. *See Seeking assistance page 39.*

Using too much rotenone can cause a complete fish kill, so for partial treatment it should be used with extreme caution.

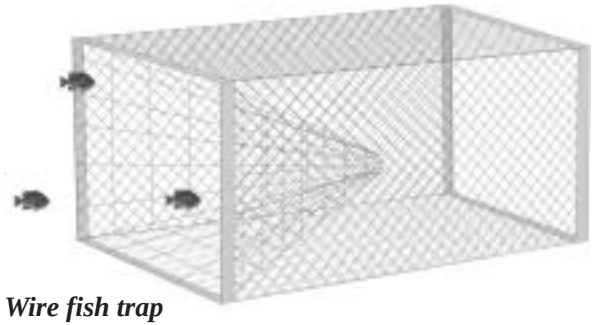
Rotenone should not be used in ponds that flow constantly into streams, ponds or lakes. Users of this chemical are always responsible for its effects if it drifts to other public or private property.

Chemicals must always be handled according to the instructions provided on chemical labels, and manufacturer's instructions should be strictly followed when preparing chemicals.

All state and federal regulations regarding chemical use must be followed.

Partial removal with wire traps

Wire traps may be used in private ponds, but they are not legal in public waters. Properly used, they are valuable for removing small bluegill from overcrowded populations and for removing adult fish when fishing has been light. Attach these to the bank by string or wire, and submerge the trap into the water, preferably around structure such as fish attractors in the pond.



Wire fish trap

Partial removal with seines

Using a 40 foot seine with a ½ inch mesh, make as many passes (hauls) as necessary to remove fish as recommended in Table 7. In waters no more than 5 feet deep, the seine should be allowed to arch (in a half-moon shape) so that fish cannot easily swim around it. Fish can be removed weekly in late summer and early fall. A smaller mesh size can be used to remove more fish in a haul.

RECLAIMING UNPRODUCTIVE PONDS

When ponds become unbalanced, poor fishing can be expected. Poor location, improper construction, excessive water flow, overstocking, stocking the wrong species, improper harvesting and failure to manage have resulted in hundreds of unproductive fishing ponds. However, occasionally even when good management practices are used, some ponds fail to produce satisfactory fishing.

Photo by Dave Rizzuto

Many ponds, regardless of their present use, are potentially good fishing ponds. With proper planning and care, ponds that have been used for other purposes as well as ponds that have previously been used primarily for fishing can be made into excellent fishing waters.

Physical characteristics

To reclaim a pond for fishing, its physical characteristics should first be evaluated. To avoid siltation and muddy water, the watershed that drains into the pond should be primarily pasture or woodland. It should also be in an area with the correct watershed ratio, so that runoff is not excessive. Otherwise, the pond owner should consider digging a diversion ditch around the pond. *For more information, see Drainage into lake or pond page 1.*

If a pond was not constructed properly for fishing or if the fish population has become unbalanced because of shallow water areas, the water should be lowered and the shoreline slope and/or pond depth corrected. *See Pond depth and shoreline slope, page 2.* Also, the spillway may need to be widened to drain excess water. Vegetation such as willows, buttonbush or nuisance aquatic plants should be removed from the dam and around the bank. *See Spillways page 3.*

Chemical removal of unbalanced fish populations

In ponds seriously overpopulated with bluegill or undesirable species such as green sunfish or bullheads, all fish in the pond should be killed and the pond restocked. The most economical way to kill, or eradicate, the fish is to completely drain the pond with a drain pipe, siphon or pump. If completely draining the pond is impractical, chemical removal is the only alternative.

If chemicals are used to kill fish, it is more efficient and economical to drain the pond to half its volume. This not only reduces the cost of treatment, it concentrates the fish into a smaller area. Unbalanced fish populations should be killed in the late summer or early fall, preferably in August or September. Water levels are usually lower in late summer and early fall. More importantly, any bluegill that may survive the treatment are not likely to spawn before the following spring. Even a single pair of bluegill that survive a summer fish eradication treatment can spawn heavily before the fall, creating an unbalanced population and ruining pond reclamation efforts.

Rotenone is a restricted-use pesticide.

Pond owners must contact the UT Agricultural Extension agent in their county to get a restricted-use pesticide card to purchase Rotenone. See Seeking assistance page 40.

Rotenone is the chemical most commonly used to kill fish populations. At concentrations used to kill fish, it is nontoxic to most wildlife and farm animals **except swine.** With a restricted-use pesticide card, available from your County Extension Agent, rotenone can be purchased at farmers cooperatives under several brand names. The cost and amount of rotenone treatment depends on the volume of water in the pond. So, before using chemicals to kill fish, pond owners need to know the water volume of their pond measured in acre-feet. *See Determining water volume page 38.*

Applying rotenone

Rotenone can be purchased in liquid or powdered form. The following application rates are general guidelines. Always follow application rates and instructions on the rotenone label. If using a liquid mixture with a 2½ percent rotenone content, 1 gallon of the mixture per 3 acre-feet of water should be applied. With a liquid mixture of 5 percent rotenone content, ½ gallon of the mixture per 3 acre-feet should be applied. Liquids are easier to get into solution and are more reliable for total fish kills.

If using the 2½ percent powdered formula, 8 pounds of the mixture per 3-acre feet of water should be applied. The 5 percent powdered formula should be halved to 4 pounds of the mixture per 3 acre feet of water.

All formulations must be diluted with water and ***evenly distributed*** throughout the water column. The chemical can be sprayed over and below the pond surface or dripped into the propwash of an outboard motor.

Rotenone treatment is most effective when the water temperature is above 70º F. The warmer the water, the faster the fish die. The best time is late summer or early fall. Killing fish at this time reduces the time between the kill and the restocking, which minimixes the chance the pond will be contaminated by unwanted fish before restocking. The dead fish may either be removed or left in the pond to decay and return to the food web.

For additional information about using rotenone, fish eradication and reclaiming ponds, contact a TWRA wildlife officer, fisheries biologist or regional office. *See Seeking assistance page 39.*

When to restock

After killing fish to reclaim a pond in the fall, the time to restock with new fish is extremely short depending on the water temperature. If the water temperature is 70º F or more, the pond can be restocked with bluegill in two to three weeks after rotenone treatment. If the water is below 70º F, it can take 4 to 6 weeks before restocking is safe. A simple test can help determine when it is safe to restock. Place a few fish (bream, minnows) in a small cage or minnow bucket into the pond or in a container with water from the pond. If the fish survive after 24 to 30 hours, it is safe to restock the pond. Bass caught within 2 years after they have been stocked should be released to ensure a sufficient first spawn. *For recommended harvest rates for bass and bluegill, See Table 4 on page 21 and Table 5 on page 22.*

Rotenone should not be used in ponds that flow constantly into streams, ponds or lakes. Users of this chemical are always responsible for its effects if it drifts to private or public property.

Chemicals must always be handled according to the instructions provided on chemical labels, and manufacturer's instructions should be strictly followed when preparing chemicals.

All state and federal regulations regarding chemical use must be followed.

FISH KILLS

Photo by Doug Markham

Most insecticides and pesticides used on agricultural crops are highly toxic to fish and even in minute quantities can kill fish populations. Therefore, insecticides and pesticides should be handled with extreme caution near fishing ponds. They should not be used at all if rainfall is expected.

Parasites or diseases

Fish with parasites or diseases may have sores or patches of fungus. Parasites or diseases seldom cause extensive fish kills in bass-bluegill ponds, and most are seasonal and will usually disappear after a short time. In most cases, chemical treatments for fish parasites and diseases are very expensive and unnecessary. Sometimes parasites or diseases can be an indicator of overcrowding, malnutrition or other stresses on the fish population. Never throw fish that have sores or patches of fungus back into the pond.

Occasionally bass or bluegill/redear sunfish with white or yellow grubs embedded in their flesh are caught. If the fish are properly cooked, these pose no threat to humans. So, although they are unpleasant to look at, the affected area can be cut away, and the rest of fish can be cooked and eaten.

Oxygen deficiencies

A major cause of fish kills in fertilized ponds is overfertilizing in July and August. Kills caused by a shortage or lack of oxygen sometimes occur after a heavy rain when the water becomes very muddy or during periods of drought. Filamentous algae (pond scum) or duckweed covering the entire surface of the pond can also lead to an oxygen deficiency. In a fish kill that results from a shortage of oxygen, the pond water may sometimes appear gray, brown or black.

Oxygen deficiencies that result from the pond water "turning over" can also cause fish kills. In the summer, deeper ponds stratify, or separate into layers of water with different temperatures. The warmer layer of water, which contains dissolved oxygen, will remain at the top. In the fall, the night air cools the warm, oxygenated upper layer of water, and it becomes heavier and mixes with the cooler, unoxygenated lower layer. This "turning over" of pond layers quickly reduces the amount of oxygen available to fish, which can kill them. "Turn overs" also occur after periods of hot, still, cloudy summer days and after summer thunderstorms, which mix the water layers. This problem can be reduced by not building the pond too deep or by installing an aeration system. *See Pond depth page 2 and Farm pond suppliers page 41.*

Oxygen can also be depleted from a pond when too much dead plant material decays in the water. So, if applying herbicides or algicides to remove nuisance plants or algae, treat only ¼ to a of the pond at a time. *See Applying herbicides or algicides page 17.*

A more thorough understanding of the cause of fish kills requires a greater understanding of the oxygen cycle within the pond. Basically, wherever life exists, oxygen is being used and must be replaced at a steady rate. Oxygen is replaced either directly from the atmosphere or as a result of photosynthesis by plants in the water during daylight hours. At night photosynthesis ceases, and plants as well as fish and other aquatic life use oxygen during respiration. As a result, oxygen levels are lowest just prior to sunrise. When more oxygen is being used than can be replaced, an oxygen deficiency results. Most fish kills caused by oxygen deficiencies

occur at night, in the early morning or during cloudy weather. Fish kills are more likely to occur in fertilized ponds that support a heavy crop of fish because the demand for oxygen is greater.

The first sign of oxygen deficiency in a pond is when fish appear to be gulping for air at the water surface. Adding enough oxygen to the water using one of the following methods may prevent or reduce the effects of a fish kill. In catfish ponds where fish are being fed, an early sign of oxygen deficiency can be the catfish not eating.

Chlorinated or "city water," which contains chlorine, should not be used in ponds because chlorine is toxic to fish.

If available, well water can be run into the pond but should first be aerated by spraying it into the air. Chorinated or "city water" should not be used. If possible, water from the bottom of the pond should be released through the drain pipe or pumped out.

Photo by Dave Rizzuto

Other options are pumping water from as close to the surface as possible while maintaining the prime and spraying it in fine droplets far out in the pond for several days. Angle the discharge somewhat parallel to the shoreline and establish a circular motion around the pond. Sprayers, pumps, paddle wheels or other types of aerators may be used for extended periods to stir oxygen into the water. Back a tractor-powered rotary mower into the pond and stir the water with the blades. (An outboard motor boat creating as much spray as possible for at least an hour per surface acre of water can also be used to aerate the water.) Also, there are several commercial aeration systems available that agitate the pond, or bubble air from the bottom. *For a partial list of distributers, see Farm pond suppliers page 41*. After the oxygen problem has passed, the pond management program should be reviewed and the causes of the low oxygen eliminated.

Maintaining balance after a fish kill

The severity of a fish kill determines what action is needed to restore the pond to a productive condition. If only a few large fish are lost, the pond balance may not be endangered. In many cases, a pond will return to a productive state if enough bass fingerlings survive to control the bluegill fry that will be spawned following a fish kill. If most of the bass do not survive, overpopulation of bluegill will be impossible to prevent. *See Table 6 on page 23.* When many fish are killed, particularly large numbers of bass, it is best to kill the remaining fish with rotenone in the fall, and restock. *See Reclaiming unproductive ponds page 26.*

For additional information about preventing fish kills, contact a TWRA wildlife officer, fisheries biologist or regional office. *See Seeking assistance page 39.*

FEEDING FISH

It is not necessary to feed fish in a fertilized bream and bass pond to produce good crops of fish. For ponds stocked with catfish only, feeding the fish is appropriate to increase growth. In small ponds with hybrid sunfish only, fish can also be fed. Feeding fish can increase the pounds of harvestable fish in a pond and increase fish size, but should be fed with caution, and the pond owner should be aware of the risks discussed below.

It is extremely important for pond owners who feed their fish to harvest some of the larger fish regularly.

Photo by ?????????????

Do not overfeed fish.

Risks of feeding

Feeding fish can cause conditions that threaten fish. It can cause oxygen to be depleted when uneaten food decays and when fish waste quantities increase. This decaying organic matter can also produce a heavy algal bloom, which can cause oxygen levels to drop at night or on cloudy days, and kill fish.

It is important for pond owners who feed their fish to harvest some larger fish regularly because increases of larger fish resulting from feeding will also put greater demand on oxygen in the pond, which could cause a fish kill. *See Oxygen deficiencies page 28.* Too many large fish being crowded may also become diseased and die. A permanent aeration device is recommended for all ponds where fish are fed regularly. *See Farm pond suppliers page 41.*

How to feed

Fish should be fed at the same time and location each day. It is best to use floating fish food to observe the amount of feed being eaten. As a general rule, only feed fish what they consume completely in 10-15 minutes. **Never feed more than 10 pounds per surface acre a day.** Also, do not double the feed after missing a day of feeding. If fish quit eating, stop feeding for a few days. Watch for fish gulping air at the surface or for signs of disease. Feeding can be done by hand or with either demand or automatic feeders.

Stop feeding fish when the water temperature falls below 55° F. Do not feed fish during prolonged periods of cloudy weather (summertime) or when fish are stressed for other reasons such as low oxygen in the water, or parasites and disease. *See Fish kills, page 28.* Commercial feed is available at some farm and feed stores.

Leaking ponds

All new ponds absorb water and appear to be leaking until the bottom soil becomes saturated. However, if the water level continues to stay lower than expected, the cause should be identified. Leaks can be stopped with several methods, but most are expensive and require extensive work.

The most effective method for fixing a leak is to use a clay material called bentonite. Bentonite expands and seeps into the pores of sand or soil when wet. To seal a leaky pond bottom, completely or partially draining the pond first is recommended. Bentonite works best when it is disked into a dry pond bottom at a rate of 1 pound of bentonite per square foot of bottom, then compacted. Bentonite can also form an effective seal if the pond is not completely drained. When water is present, 1 pound of bentonite should be applied to 2 square feet of bottom. When applying in areas over 10 feet deep, more bentonite should be used.

Another method that sometimes works if the leak is not too large and can be specifically located, is to punch holes into the unopened bentonite bag(s) then throw the bag(s) as close to the leak as possible. As water enters the bag(s) through the holes, the bag(s) will burst, and bentonite will flow into the leak, helping to stop the flow of water out of the pond.

Bentonite can be purchased at some farm supply stores, well drilling companies or construction companies.

A leaky pond could be sealed after draining by compacting the bottom with a sheepsfoot roller. Waterproof liners could also be installed. Proper planning and construction is the best way to avoid leakage problems. *See Avoiding construction mistakes page 1.* For more information about sealing leaky ponds, contact your NRCS or TWRA regional office listed in *Seeking assistance page 39 and 41.*

Muddy water

Many ponds become muddy easily and are sometimes difficult to clear up. Muddy water reduces the food organisms that can be produced in the pond and, therefore, reduces the crop of fish. Muddy water can also interfere with fish reproduction and fishing success.

Muddy water is usually caused by excessive runoff or by the cultivation of row crops in the same watershed as the pond. The solution in many cases is simply to dig a drainage ditch around the pond to divert excess water and to plant cover crops or trees in the watershed.

Muddy water can also be caused by aquatic organisms such as crayfish, turtles or bottom-feeding fish such as common carp or bullhead. One method for determining the cause of muddy water is to take a sample of the water in a clear glass jar and set it out of sunlight. If the muddy particles settle to the bottom in less than a week, the muddiness is probably caused by an aquatic organism in the pond. If the water is still muddy after a week, the problem is chemical.

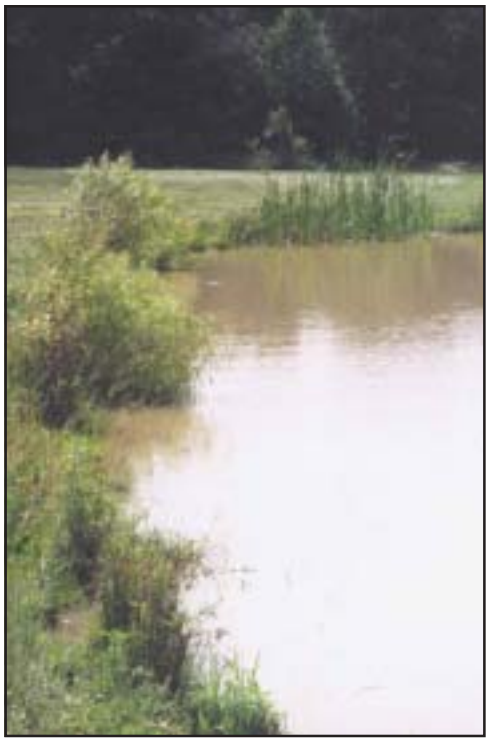


Photo by Bobby Wilson

Pond with muddy water

If aquatic organisms are the probable cause of muddy water, then controlling the organisms will be necessary. For bottom-feeding fish, the only remedy is killing the entire population, reclaiming the pond and restocking. *See Reclaiming unproductive ponds page 26.* Crayfish can be controlled with bass and catfish. *See Turtles page 35.*

If the probable cause of muddy water is chemical, one of the methods listed below should be used to correct the problem.

Photo by Doug Markham

1. Broadcast over the entire pond ***agricultural limestone or agricultural gypsum*** at a rate of 1,000 pounds per surface acre repeated weekly until the water clears. Agricultural limestone and gypsum can be purchased at farmers cooperatives and farm supply stores.

2. Spreading approximately ***4 square bales of good hay*** such as dry green alfalfa or clover (not wheat straw or weeds) per surface acre every 2 weeks. Bales should be broken apart and scattered around the pond. No more than 4 applications of hay per year should be applied. This method should not be used during hot summer months because it may lead to oxygen depletion and fish kills.

   An alternative to spreading hay is to anchor or stake solid bales of hay every 30 to 40 feet along the bank in the water. Replace and anchor new bales every 14 days until the water clears. As with the spreading method above, hay bale applications should not be used more than 4 times per year. This method should not be used during hot summer months because it may lead to oxygen depletion and fish kills.

3. Broadcast over the entire pond a ***cottonseed meal and superphosphate fertilizer mixture*** over the surface at a rate of 75 pounds of cottonseed meal and 25 pounds of superphosphate per surface acre every 2 weeks until the water clears. Cottonseed meal and superphosphate fertilizer can be purchased at farmers cooperatives and farm supply stores.

Contact your NRCS or TWRA office for further assistance. *See Seeking assistance pages 39 and 41.*

Livestock

Many farm ponds have been constructed primarily to provide water for livestock, and fish production is a secondary benefit. Some of the drawbacks to having a fishing pond with cattle and other livestock around are that they trample the edges of a pond and create problems with erosion, shallow-water areas, fish reproduction and increased muddiness. Livestock also encourage excessive fertility around pond edges, which promotes undesirable aquatic plant growth in shallow areas.

To properly manage a pond for successful fish production, access to the pond by livestock should be limited. Preventing the animals from having access to the pond would be ideal. A drain pipe leading to a gravity-fed water trough below the spillway could provide livestock with water and not harm fishing. *See illustration on page 3.* If this is not a realistic option, all but a small section of the pond should be fenced off to limit access to the pond by livestock.

Wild fish

Pond owners are usually surprised when bullheads, green sunfish or other fish they have not stocked are caught in their ponds. When rainfall is heavy and the excess water passing from a pond runs into nearby streams, drainage canals or other ponds, fish can easily swim into the pond through the spillway. They usually enter as small fingerlings and may go undetected for a year or more. A drop off of 1 foot or more at the lower end of the spillway can prevent fish from entering most ponds.

When a new pond is located below an old one, it is difficult to prevent fish from moving to the new pond. This can produce serious complications during initial stocking because untold numbers of bluegill, shiners and other species can enter the pond when water is passing around the spillway of the upper pond. This disrupts any planned stocking rates in the lower pond. Where wild fish may be a problem, the best procedure is to sample all new ponds with a minnow seine several weeks before stocking to identify the fish populations present. This should be done during early fall. *See Monitoring pond balance by seining page 22.* If any fish are found, they should be killed with rotenone at least 2 weeks prior to stocking with hatchery fish. *See Reclaiming unproductive ponds page 26.*

When fish can enter a pond from other bodies of water in the watershed, the bass populations should be maintained at a high level to safeguard against overpopulation of bluegill. When bass are present in sufficient numbers, the problem of wild fish from upper or lower bodies of water can be minimized.

Water birds

Water birds such as egrets, herons, kingfishers, cormorants and many other species are common visitors to Tennessee ponds, and they add much to the beauty of the ponds. Usually only small fish are eaten by most water birds, and, except for the possible introduction of parasites and disease into ponds, most water birds will not upset the fish balance or cause major problems in recreational ponds.

Photo by Jim Johnson

Most water birds are protected by state and federal laws, making it illegal to kill or capture them.

Photo by Doug Markham

Traps should not be used where domestic pets may be present.

Muskrats

Pond owners often become concerned when muskrats invade their ponds. When dams are narrow and covered with willows or other dense vegetation, this concern is justified because muskrats' burrowing can damage dams and pond banks. When dams are built with top widths of at least 8 feet and are free of dense vegetation, which could provide cover and food for muskrats, there is much less of a possibility for major damage. Removing excessive growths of cattail, willow and other plants will help force muskrats to leave the pond. *See Aquatic plant control page 15.*

Although muskrat burrows are usually long, they are seldom more than 2 feet below the surface of the ground. Burrows that are found should be plugged with riprap (6 inch or larger rock) or other fill material as this may discourage muskrats from staying.

When muskrats become a nuisance by burrowing into the pond dam or banks, they should be removed. Pond owners should check the *TWRA Hunting and Trapping Guide* to see whether muskrats are in season before shooting or trapping them. The most effective time to hunt or trap muskrats is early in the morning or late in the evening. If muskrats are not in season, pond owners can kill them if they are being a nuisance, but they must contact a TWRA wildlife officer before trapping muskrats out of season.

Muskrats are easily trapped, so this method is usually preferred. Traps that can be used for muskrats are available at hunting and sporting goods stores. Live traps can also be used. They should be well camouflaged and baited with bait such as apples. Traps should be placed at the entrance of burrows or on the trails created by muskrats. Before trapping, read current license, season and bag limit requirements. Pond owners may wish to contact a local trapper or animal control agent to remove muskrats. TWRA offices have lists of animal control agents. *See Seeking assistance page 39.*

Frogs

Frogs are present in most ponds, but tadpoles are usually not abundant in ponds with balanced fish populations. Tadpoles are readily eaten by bass, so a heavy crop of tadpoles in ponds more than 1 year old indicates a lack of bass. Ponds with abundant tadpoles are usually overcrowded and may offer poor fishing.

Beavers

Occasionally, beavers take up residence in ponds and can cause considerable damage. They often block drain pipes and dam spillways, and dig dens in pond banks or dams. As with muskrats, trapping is the best way to remove beavers, but pond owners should contact a TWRA wildlife officer before killing nuisance beavers. For advice about beaver removal, contact a TWRA wildlife officer or regional office for a list of animal control agents. *See Seeking assistance page 39.*

Otters

In some parts of the state, otters can invade ponds and small lakes. Their diet consist primarily of fish, so they can affect the balance of the fish population, especially in small ponds. They can also damage the pond dam and cause erosion. At present, otters can only be trapped in certain parts of the state. Please read current license, season and bag limit requirements in the *TWRA Hunting and Trapping Guide* available where licenses are sold. Pond owners who have problems with these animals or need further assistance should contact the nearest TWRA regional office. *See Seeking assistance page 39.*

Turtles

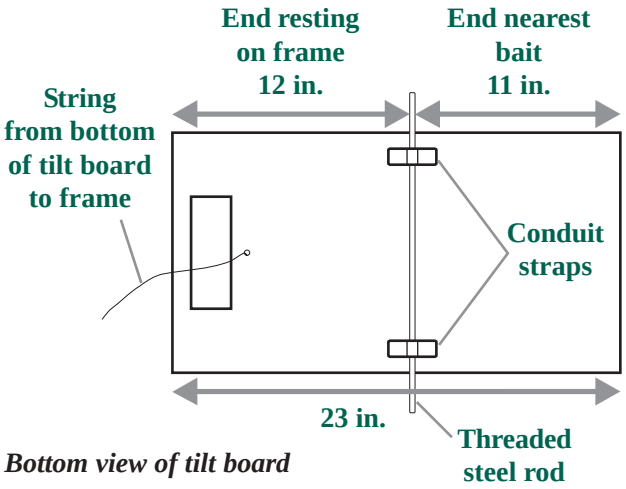
Turtles can become numerous in some ponds, but they are mainly scavengers and are neither good nor bad for overall fish production. They may cause problems by stealing bait or fish from stringers. If turtles are abundant in a pond, their activities on the pond bottom can make the water muddy. Snapping turtles are not as harmful to fish populations as is generally believed. Although they do prey upon small fishes and young ducklings, they prefer to eat dead or dying fish in the pond.

When turtles do become a nuisance they can be controlled by several methods. The box trap is effective for trapping some turtles. *See Building a turtle box trap below*. Turtles can also be captured using baited bank lines with stout hooks and no weights, trot lines and hoop-net turtle traps with part of the net above the water. *See net companies under Farm Pond Suppliers, page 41*. Fish, chicken necks or other fresh meat should be used as bait. Traps and lines should be checked daily, turtles removed, then transported to another location and released into their natural habitat.

Turtle traps or lines are most effective in shallow, weedy areas. Turtles should be trapped in spring, summer or fall because they are inactive in the winter.

Building a turtle box trap

Construct a 4 foot frame with pressure-treated 2 x 4s. This size is easy to handle and can still trap many turtles. The sides and bottom of the frame should be covered with chicken or web wire.



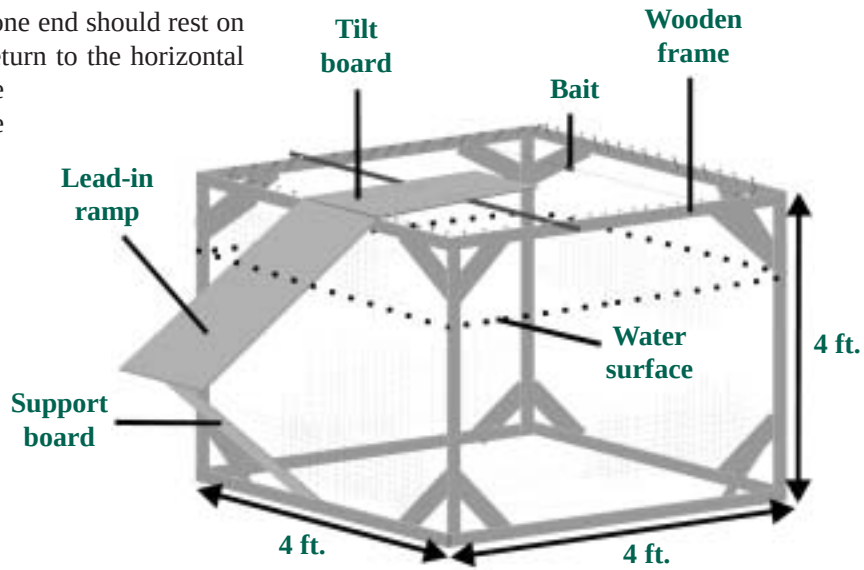
Bottom view of tilt board

Next install the tilt board. When a turtle crawls out onto the tilt board to get the bait, its weight will tip the board down, and it will fall into the trap. The tilt board should be a 1 x 12 cut to 23 inches. Attach 2, ½ inch conduit straps to the bottom of the tilt board with the center of each strap 12 inches from one end. Run a 4½ foot, ½ inch threaded rod through the conduit straps and secure the rod's ends to the top of the frame 12 inches from the end of the tilt board that will rest on the frame. (Use conduit straps, ½ inch nuts and washers to secure the rod.) The tilt board should revolve freely around the threaded rod and one end should rest on top of the frame. A counterweight may be added if the tilt board does not easily return to the horizontal position after it has been tilted. If a counterweight is needed, nail a block of wood to the bottom of the frame end of the tilt board. Also, nail a string from the frame to the bottom of the tilt board to keep it from flipping over completely.

The lead-in ramp, a 24 inch, 1 x 12 should have one end nailed to the top of the frame so it leads onto the tilt board. The end of the lead-in ramp that sticks into the water should be nailed to a 3 foot, 2 x 4 that is nailed to the bottom of the frame. The angle of the ramp should be 45º. If the angle is too steep, turtles will not be able to climb it. If the lead-in ramp is not steep enough they may not climb out onto the tilt board.

Long (20 penny) nails should be nailed every 4 inches along the inside of the frame near the top so turtles cannot climb out. Bait should be attached to a string or wire that is strung across the nails.

The box trap should be set on posts or attached to sealed PVC pipes so it sticks 1 foot above the water. Traps should be removed from the water, dried out and covered in the winter.



Turtle box trap

ALTERNATE STOCKING OPTION

Duane Raver/USFWS

Channel catfish

TWRA does not supply catfish for stocking into private ponds.

Catfish only fishing ponds

Pond owners may choose to stock channel catfish alone in ponds either because they prefer the species or because the "catfish only option" requires the least amount of management. Stocking channel catfish alone is also an excellent option for ponds that cannot support bass and bream because they stay muddy or are smaller than ¼ acre.

Catfish-only fishing ponds can be stocked at a rate of 150 per surface acre if fish are not going to be fed, or 300-500 catfish per surface acre in ponds where fish will be fed. Pond owners can harvest as many catfish as they like whenever the fish grow to an acceptable size. Channel catfish do not reproduce unless special spawning structures are provided, so there is little risk of overpopulation in catfish-only ponds. However, as a precaution, 50 largemouth bass fingerlings per surface acre should be stocked after the catfish have been stocked to control any undesirable fish species that may enter the pond.

Channel catfish will, however, need to be restocked every year or two to replace fish that have been harvested, so pond owners should keep track of how many fish they harvest. Catfish should be restocked in the fall or early spring and should be about 10 inches long if largemouth bass are present.

Catfish eat fish, insects, worms and some plants, but, to increase the size of the catfish, pond owners may choose to stock fathead minnows (also known as "tuffies") for forage at a rate of 10 pounds per surface acre or feed fish with commercial feed. *See Feeding fish page 30*. Catfish for stocking are available through commercial hatcheries. *See Pond fish suppliers page 41*.

POND MEASUREMENT

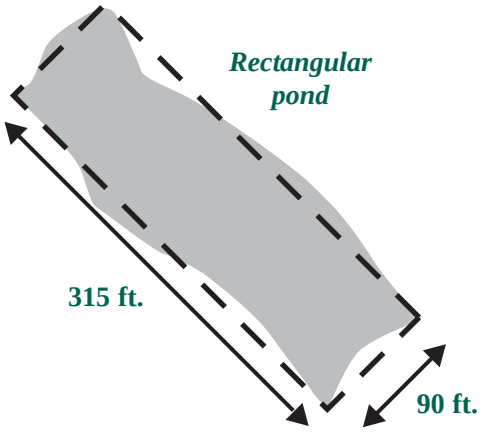
For proper stocking, fertilizing, liming or chemical application to control aquatic plants, you will need to determine the pond surface area, and average pond depth and volume as accurately as possible.

Determining pond surface area

If your pond is *basically square or rectangular*, measure the width of the dam and the length of the pond in feet. Multiply the dam measurement by the length measurement and divide by 43,560 (the number of square feet in an acre).

For example, 90 ft. (dam width) x 315 ft. (pond length) = 28,350 sq. ft.

28,350 ÷ 43,560 = **.65 surface acres (round up two decimal places)**

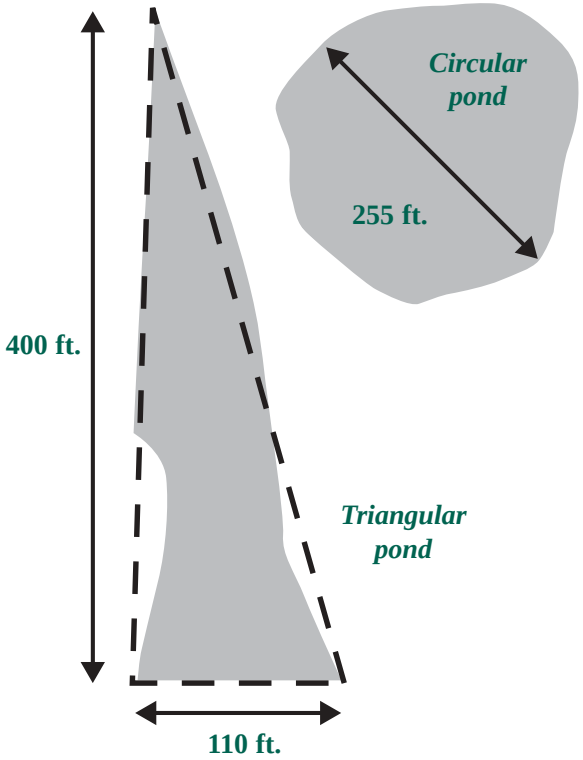


If your pond is nearly square or rectangular, you can approximate its size by "boxing it in" so the water outside the rectangle is about equal to the land inside the rectangle. Using this method to determine pond length and width, you can follow the formula above to determine the pond's surface acres.

If your pond is more *triangular*, measure the width of the dam in feet, then multiply by the length of the pond in feet. Divide this number by two, then divide by 43,560 to determine the surface acres.

For example, 110 ft. (dam width) x 400 ft. (pond length) = 44,000 sq. ft.

44,000 ÷ 2 = 22,000 ÷ 43,560 = **.51 surface acres (round up two decimal places)**

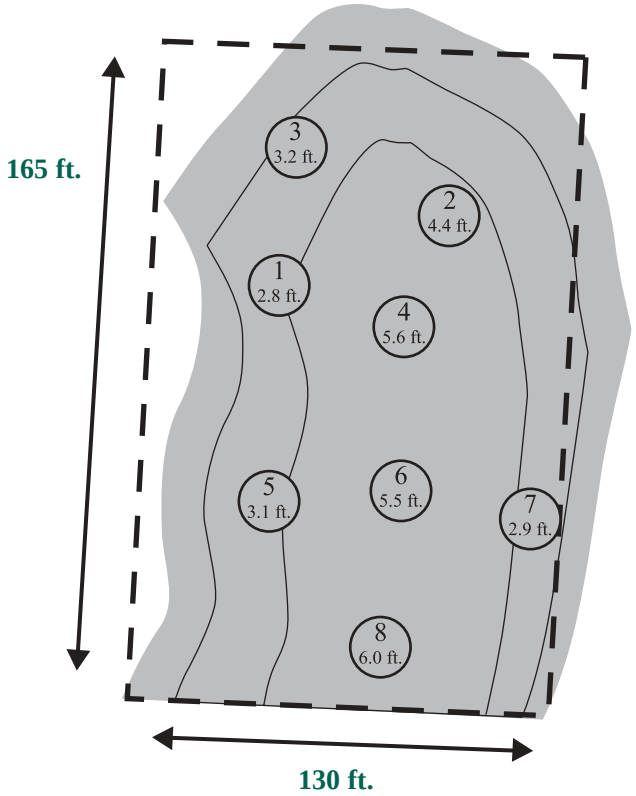


If your pond is *basically circular*, computing the surface acres is more complicated. First, measure the distance in feet from one side of the pond to the other across the center point of the pond. Divide this measurement by two to determine the radius of the pond. Multiply the radius measurement by itself, then multiply by 3.14. Then, divide this number by 43,560.

For example, 255 ft. (pond width) ÷ 2 (pond radius) = 127.5 ft.

127.5 x 127.5 = 16,256.25
16,256.25 x 3.14 = 51,044.625

51,044.625 ÷ 43,560 = **1.17 surface acres (round up two decimal places)**



Sample sites to determine pond depth

Determining average pond depth

To determine the average depth of your pond, you need to measure it in numerous, uniformly spaced locations. To make sure you get measurements both in shallow and deep areas, take measurements as you go from shore to shore several times in parallel lines. Then, add the depths of each of the sampled sites together and divide by the number of sites (in this case 8).

1.	2.8	**2.**	4.4
3.	2.3	**4.**	5.6
5.	3.1	**6.**	5.5
7.	2.9	**8.**	6.0

Total 32.6

32.6 ÷ 8 = **4.075 ft. average pond depth**

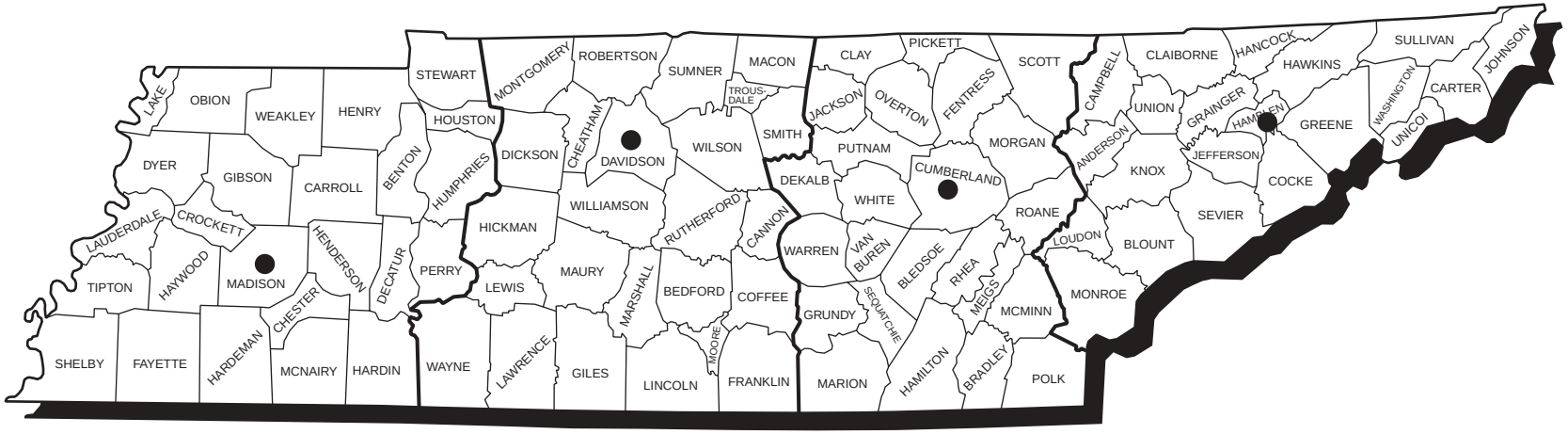
Determining water volume

The volume of water in a pond is expressed in acre-feet. To determine the volume of water in your pond, multiply the average pond depth (in feet) and surface area (in acres) together.

In the previous example, average pond depth was determined to be 4.075 ft. The same pond is 0.49 surface acres (130 ft. x 165 ft.).

4.075 ft. x 0.49 surface acres = **1.996 acre-feet.**

TWRA REGIONAL OFFICES



WEST TN OFFICE
REGION I
JACKSON

MIDDLE TN & CENTRAL OFFICE
REGION II
NASHVILLE

CUMBERLAND PLATEAU OFFICE
REGION III
CROSSVILLE

EAST TN OFFICE
REGION IV
MORRISTOWN

All offices open 8 a.m. to 4:30 p.m. (local time)
Monday through Friday

West Tennessee Region I
200 Lowell Thomas Drive
Jackson, TN 38301
Phone: 731-423-5725
Phone *toll-free*: 800-372-3928 (In State only)
Fax: 731-423-6483

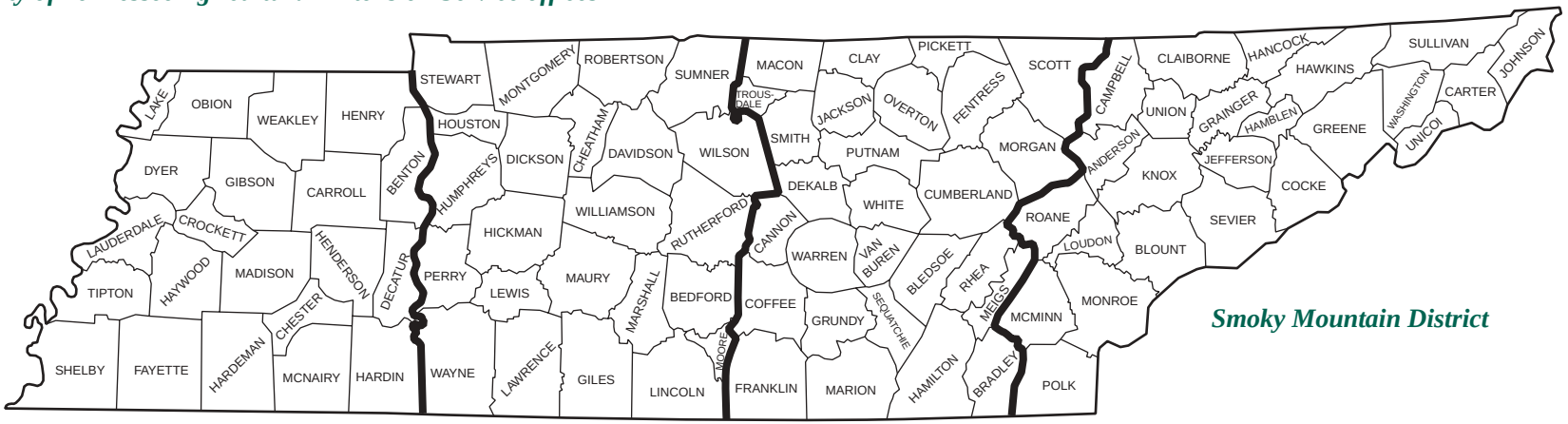
Middle Tennessee Region II
Ellington Agricultural Center
P. O. Box 41489
Nashville, TN 37204
Phone: 615-781-6622
Phone *toll-free*: 800-624-7406 (In State only)
Fax: 615-831-9995

Cumberland Plateau Region III
464 Industrial Blvd.
Crossville, TN 38555
Phone: 931-484-9571
Phone *toll-free*: 800-262-6704 (In State only)
Fax: 931-456-1025

East Tennessee Region IV
3030 Wildlife Way
Morristown, TN 37814
Phone: 423-587-7037
Phone *toll-free*: 800-332-0900 (In State only)
Fax: 423-587-7057

Visit TWRA's Web site at www.tnwildlife.org

University of Tennessee Agricultural Extension Service offices



Smoky Mountain District

Western District ***Central District*** ***Cumberland District***

Western District
605 Airways Boulevard
Jackson, TN 38301-3201
Phone: (731) 425-4725
Fax: (731) 425-4725
Email: WesternDist@cru.gw.utk.edu

Central District
5201 Marchant Drive
Nashville, TN 37211-5112
Phone: (615) 832-6550
Fax: (615) 832-0043
Email: CentralDist@cru.gw.utk.edu

Soil Testing Center (Nashville)
Phone: (615) 832-5850

Cumberland District
398 4-H Camp Road
Crossville, TN 38555-3969
Phone: (931) 788-1020
Fax: (931) 788-1073
Email: CumberlandDist@cru.gw.utk.edu

Smoky Mountain District
P. O. Box 1071
Knoxville, TN 37901-1071
Phone: (423) 577-6626
Fax: (423) 573-6626
Email: SmokyMtnDist@cru.gw.utk.edu

U. S. Army Corps of Engineers Regulatory Branch

Nashville District
Phone: (615) 736-7161

Memphis District
Phone: (901) 544-3005

Natural Resource Conservation Service

The telephone number for the central office in Nashville is (615) 277-2531.

For local offices, look in the telephone book under “United States Department of Agriculture.”

Tennessee Department of Environment and Conservation, Water Quality Division

Phone *toll-free*: (888) 891-8332

SUPPLIERS

Farm pond suppliers

Air-O-Lator Corp., Phone *toll-free*: (800) 821-3177

Aquacenter, Inc., Phone *toll-free*: (800) 748-8921

Aquatic Eco Systems, Inc., Phone *toll-free*: (877) 347-4788

Aquaculture Systems and Equipment, Phone *toll-free*: (877) 837-5580

Eager Aquaculture Products, Phone *toll-free*: (800) 423-6249

Keeton Industries, Phone: (970) 493-4831

Local farmers supply stores and cooperatives

Master Systems, Phone *toll-free*: (800) 533-6748

Memphis Net and Twine Co., Phone *toll-free*: (800) 238-6380

Miller Net Co., Phone *toll-free*: (800) 423-6603

Netco LLC, Phone *toll-free*: (888) 947-7750

Nylon Net Co., Phone *toll-free*: (800) 238-7529

Pond fish suppliers

Tennessee Department of Agriculture, Division of Marketing, Tennessee Aquaculture, Phone: (615) 837-5160 or www.picktnproducts

Local farmers supply stores and cooperatives

TWRA regional offices *(See page 39.)*

Water Analysis

Test America, Nashville, TN, Phone *toll-free*: (800) 765-0980 or 615-726-0177

INDEX

Cattail

Water primrose

Filamentous algae

Willow

Duckweed on pond surface

Watermeal

Willow

Duckweed on pond surface

TENNESSEE WILDLIFE RESOURCES AGENCY
POND FISH STOCKING APPLICATION
(FOR OBTAINING BLUEGILL AND LARGEMOUTH BASS)

Please read instructions below
Use separate application for each pond (please print in ink or type)

Applicant's Name _____

Mailing Address _____

City _____ State_____ Zip Code _____

Telephone Number - Daytime _____

Date of this request _____

County where pond is located _____

Date pond construction/renovation completed _____

Pond surface acreage* _____ x $100/acre = _____
*(Minimum acreage is 0.25) AMOUNT ENCLOSED(minimum $25)
See instructions for measuring acreage on page 37.

INSTRUCTIONS: *A charge of $100 per acre is required to defray costs. The minimum acreage for stocking is 0.25 acres. Multiply the acreage by $100 and write this amount on the AMOUNT ENCLOSED line above. Enclose a check or money order (made out to T.W.R.A.) for this amount along with the signed application to the address below. The pond should be empty of fish since those that we provide will be small, and if stocked with existing fish, will only be food for the fish already present. You are responsible for picking up the fish, with hauling containers, at the designated time and place and stocking them in your pond. To assure receipt of fish, applications must be post-marked by midnight* ***SEPTEMBER 30****. Bluegill will be stocked first in the fall (OCT or NOV) at 500 per acre, followed by largemouth bass the following spring (MAY or JUNE) at 100 per acre. You will be notified by mail approximately 2 to 3 weeks prior to delivery as to when, where and what to bring to pick up your fish. If you fail to pick up the bluegill and/or bass when notified, your application will be voided, and your money forfeited. These fish cannot be resold or stocked into public waters. For further questions regarding the pond stocking program call 615/781-6577. For questions regarding payment call 615/781-6525.*

_____

APPLICANT'S SIGNATURE -By signing, you have read, understand and agree to the stipulations in the instructions above.

MAIL APPLICATION AND CHECK OR MONEY ORDER TO:
Pond Fish
Sales Division
Tennessee Wildlife Resources Agency
P.O. Box 41729
Nashville, TN 37204

WR-0637(Rev. 6-01)