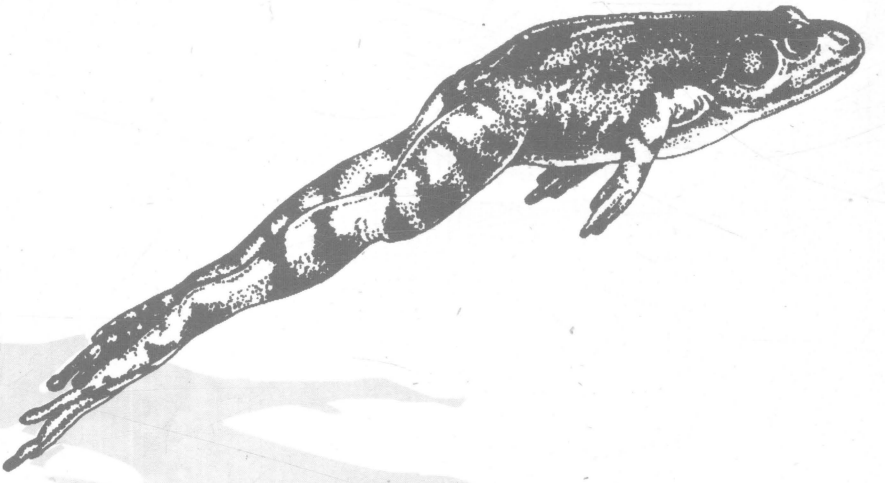
Bulletin 374

Ohio Pond Management

8th Edition



THE OHIO STATE UNIVERSITY EXTENSION

This bulletin has been prepared to serve as a guide for the small impoundment owner and/or manager. The practices outlined apply principally to the management of small impoundments for fishing and other recreational uses. They represent the best information available, although they may change as more research is done on the subject.

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Contents

Consider the Watershed

The water source for most ponds in Ohio is surface runoff from the surrounding land. That area of land is the watershed.

Many activities that occur throughout the watershed will affect the quality of the run-off water, which, in turn, will affect how successful you are in your pond management efforts. Common water quality problems of surface run-off come from improperly maintained septic tanks; industrial pollution; excessive nutrient run-off from crop and livestock production areas and intensively managed turf areas such as golf courses; acid mine drainage; and sedimentation from construction sites, cropland, and timber harvests.

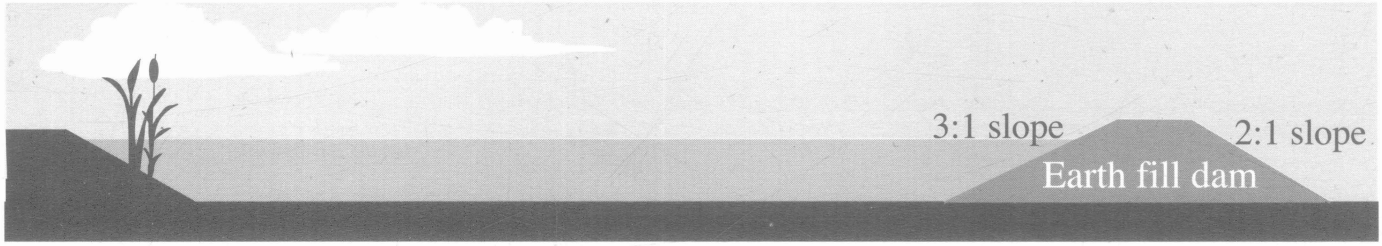
Landowners who own or control the entire watershed for the pond are best able to ensure good quality surface water runoff. When possible, divert poor quality runoff from entering the pond. If diversion is not possible or practical, place grass filter strips between the affected area and the pond.

Watershed size is also an important consideration. Because most of the water for the pond will come from run-off, a general rule of thumb is to have about three acres of watershed for every acre-foot of pond storage capacity. Watersheds that are too large may result in high sedimentation rates, turnover, and storage problems, while watersheds that are too small may not provide sufficient runoff, particularly during drought conditions. The local Soil and Water Conservation District (SWCD) office can assist you with watershed size and land-use determinations.

Requirements for a Good Pond

Proper site selection, design, and construction are essential to the success of a small impoundment. The USDA Natural Resources Conservation Service (NRCS), working with the county Soil and Water Conservation District (SWCD), can provide valuable information on pond construction. The county SWCD office is usually located in the county seat and should be your first stop as you begin to plan for a pond or small lake.

Ohio ponds should be at least eight feet deep if fish are to be stocked, and banks should be built with 3:1 slopes. A properly built pond, when full, will have a minimum of water less than three feet deep to discourage growth of aquatic vegetation. Water flowing into the pond should be free of pollution and sediment, and the pond banks should be protected with a good sod cover. Also, you may wish to allow adequate space around your pond for landscaping, wildlife cover, and a picnic shelter. If you intend to stock the pond, remember that ponds one acre or larger usually produce better fishing than smaller ponds.



Pond Measurements

Proper management of your pond requires that you know its surface area in acres and its volume. Fish stocking and some chemical applications are done using surface area; however, pond volume is often used to determine the amount of chemicals to be used.

If an NRCS conservationist or civil engineer designed and supervised the construction of your pond, that person should be able to provide you with these measurements. Your local USDA Farm Service Agency (FSA) office may have an aerial photo of your pond from which the surface area can be measured. The surface area of an existing pond may also be determined by a survey.

You can determine the surface area by making measurements and using one of the formulas given here. If your pond is rectangular, the surface acreage equals the length in feet times the width in feet, divided by 43,560.

You can usually regard an irregular-shaped pond as a rectangle or square and compute the area from straight boundary lines that approximate the actual shorelines.

If your pond is circular, measure the total distance in feet around the edge of the pond. Multiply this number by itself and divide by 547,390. The result is the surface area in acres.

This formula also works for ponds that are almost round. However, if your pond is more egg-shaped than round, this formula will give you a much larger acreage and will introduce errors in other computations.

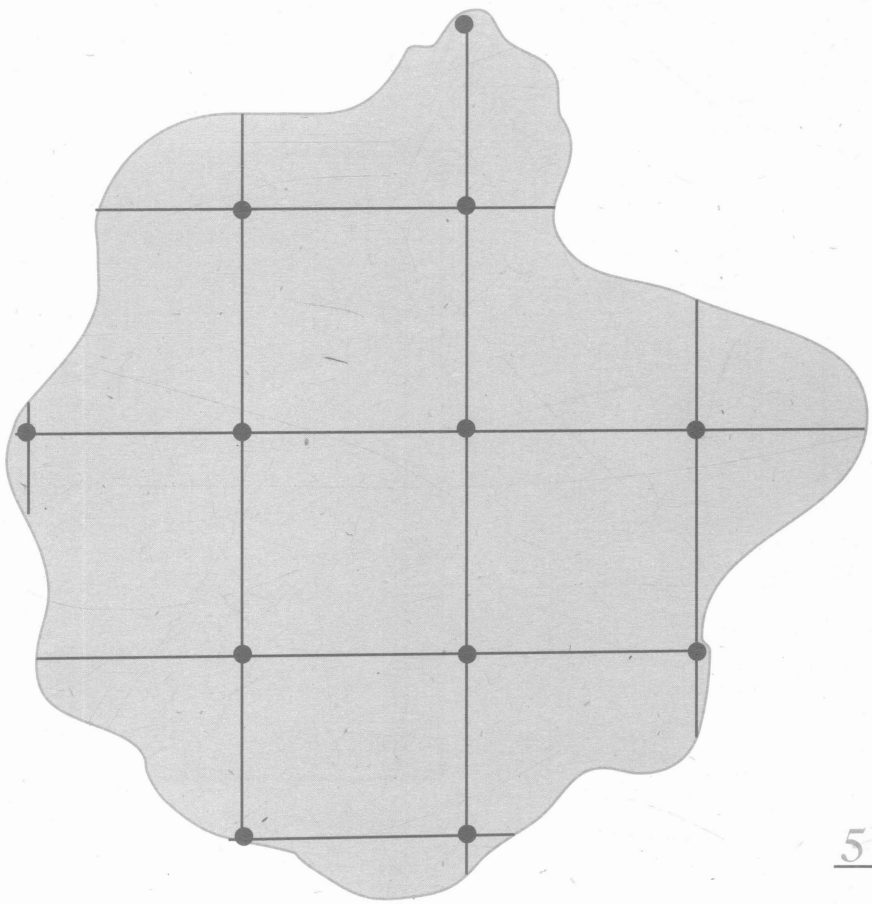
Next, you will need to determine the average depth of your pond in feet. Make soundings uniformly spaced over your entire pond surface. This can be done from a boat by using a weighted rope marked off in one-foot increments and lowered to the bottom of the pond. Average at least 15 such readings — this will be the average depth of your pond.

Now you have the measurements necessary to determine the volume of your pond in acre-feet. Simply multiply the surface area in acres by the average depth in feet (surface area in acres x average depth in feet = volume in acre-feet). One acre-foot equals 325,850 gallons.

Average Depth:
Take soundings at intervals along transects. Add the measurements and divide by the number of soundings to determine average depth.

Circular:
Surface acres = (total ft. of shoreline)^2 / 547,390

Rectangular:
Surface acres = length (ft.) x width (ft.) / 43,560



Physical and Chemical Properties of Pond Water

Many of the physical and chemical properties of water must be considered in its management. Some of these properties are temperature, pH, hardness, dissolved oxygen, source of the water in the pond, uses made of the water, and where it goes if it flows from the pond.

Temperature

Water temperature as it affects the spawning of fish is discussed in a later section (see page 12) as is the effect of temperature on the survival of trout (see page 11). Water temperature also must be considered when using chemicals in the management of a pond. As is mentioned in other sections of this bulletin, some fish toxicants and herbicides are more effective when the water temperature is above 60°F in the top two feet. Some herbicide labels discourage application when water temperatures exceed 75°F because there is an increased risk of oxygen depletion due to decomposition of dead vegetation, and a fish kill could result.

Finally, copper compounds used as algaecides may be safe for fish at recommended rates but may kill fish eggs or fry (newly hatched fish). Thus, temperature provides a clue as to when fish are spawning and may influence the timing of algaecide applications. Water temperature should be measured at a depth of one foot.

Dissolved Oxygen

The amount of dissolved oxygen (DO) in water is measured in parts per million (ppm) and is inversely related to water temperature. The chart presented here shows the decrease in dissolved oxygen as water temperature increases.

Amount of Dissolved Oxygen (ppm) in Pure Water at Different Water Temperatures (at sea level)

Temperature (F)	Approximate PPM
35	13.4
40	12.7
45	11.8
50	10.9
55	10.2
60	9.7
65	9.2
70	8.7
75	8.3
80	7.9

Pond water is not pure, nor are the Ohio ponds at sea level, so the amount of DO will be slightly different. Pond fish require about 4 ppm of DO, and other organisms in your pond, both plants and animals, also require dissolved oxygen.

When the dissolved oxygen level in the upper 4 feet of the pond drops to or below 4 ppm, fish and other organisms will start to show stress. Fish will come to the surface and appear to gulp air, and snails, crayfish, and other organisms may actually climb out on the bank or up on emergent objects.

Oxygen depletion can be caused by a number of factors, including the decomposition of aquatic plants that have died of natural causes, large decomposing masses of aquatic plants killed with a herbicide, run-off waters rich in nutrients and organic matter such as that from a livestock feedlot or a poorly maintained septic system, or from pond turnover.

Other Properties

Other pond water properties are also important, though less so than temperature and dissolved oxygen. Usually Ohio ponds have a pH (hydrogen ion concentration) from 7 (neutral) to 9.5 (alkaline). Most freshwater fish are able to survive and reproduce when the pH is between 5 and 10. Most Ohio ponds range from 75 to 200 parts per million in total alkalinity (hardness). The hardness of water may influence the effectiveness of some herbicides and is discussed on page 20 of this bulletin.

Finally, management of the watershed that contributes run-off water to a pond is important. Land uses that leave the soil surface unprotected may contribute large amounts of sediment. Some chemicals applied to crops in the watershed, especially insecticides, may be detrimental to the fish and other organisms in the pond as well as to water quality.

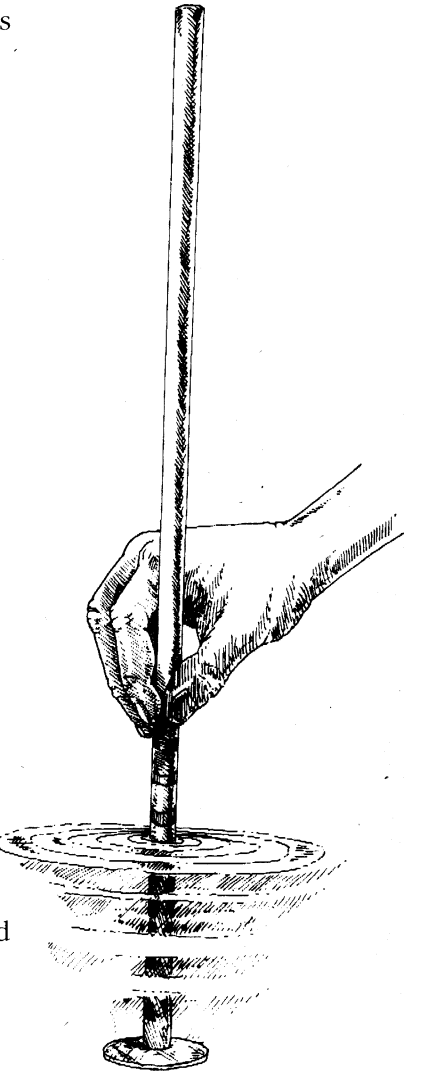
Fertility

Microscopic plants and animals, called plankton, are basic fish foods. The production of plankton is directly related to the fertility of the water. Plankton are eaten by small fish and other animal organisms such as aquatic insects and their larvae, which in turn are eaten by larger fish. If any link in this food web is weak or missing, an unbalanced condition will result and fish production will suffer. The density of the plankton population also determines the depth to which light will penetrate the water. This affects the growth of undesirable plants (weeds), which is discussed later.

The principal source of water for most Ohio ponds is run-off from the pond's watershed. This run-off carries fertile matter from soils into the pond. As a result, the fertility of the soils in the watershed determines fertility of the pond water and the density of the plankton population. Most Ohio ponds do not need additional fertilizer. An exception may be ponds where most of the watershed is forested. Also, where springs or water pumped into the pond from a ditch, a tile drain, or a well provides the principal source of water, low fertility may be a problem.

Determining Fertility

The "dipstick" method can be used to measure the fertility of a pond. You can make a dipstick by nailing a shiny can lid to the end of a stick at least three-feet long and marking one inch graduations on the stick. Immerse the dipstick vertically in the water until the image of the can lid begins to blur. You are actually measuring the depth of light penetration. A plankton population that permits light to penetrate 15 to 18 inches deep is an indicator of good fertility.



Should I Fertilize My Pond?

Pond fertilization is a common practice in the South and among people who raise fish commercially. However, due to the good fertility of most Ohio soils, ponds used for recreational fishing usually do not need to be fertilized. Owners prefer to improve the fertility of the watershed and let nutrients be carried into the pond with run-off water.

If you determine that your pond needs additional fertility and are willing to make the commitment a fertilization program requires, here's how to proceed.

Starting in late March or early April, apply 80 to 100 pounds of fertilizer per surface acre of water. Inorganic fertilizers balanced for the three main components (N-P-K) such as 10-10-10 or 12-12-12 are suitable. Avoid fertilizers that contain lime, gypsum, or tobacco dusts as "inert" ingredients, and supplemental ingredients such as herbicides or insecticides. The first application should produce a plankton "bloom" that is green or brown. Check depth of light penetration. If no bloom results, repeat the application in 10 days. Once you have achieved the desired level of fertility, make additional fertilizer applications as determined to be necessary by the dipstick test. Your pond may require fertilizer applications as often as every two to four weeks. Continue your program until mid-August. Do not apply fertilizer after August 15.

Over-fertility is possible. It can result from too much fertilizer or from the natural introduction of high-fertility materials such as barnyard run-off, silo drainage, or septic system effluents. Excessive fertility may exist if light penetration is less than 12 inches and can contribute to fish kills. Fertilize only when needed, do not over-fertilize, and do not start a fertilization program unless you plan to continue it. Improperly done fertilization may actually increase undesirable weed growth and contribute to other problems.

Should I Aerate My Pond?

Pond owners are frequently interested in providing artificial aeration in their ponds. The benefits of artificial aeration are:

- Increase in the amount of dissolved oxygen available to aerobic bacteria for decomposition of organic matter, such as dead aquatic vegetation and algae.
- Circulation of the pond water. This can eliminate the layering (stratification) that develops between the bottom oxygen-poor water and the top layer of oxygenated water. Good water circulation can create an isothermal (equal water temperature throughout) condition in the pond.
- Prevention of complete freezing of the pond surface. By circulating water and creating surface turbulence, complete freeze-over can be prevented. Open water allows for gas exchange between the pond and the atmosphere, permits sunlight to penetrate so that photosynthesis and oxygen production can occur, and provides some open water for waterfowl in the winter.
- Creation of an aesthetic benefit with water spraying into the air from a fountain head.

Natural Sources of Dissolved Oxygen

The two most significant sources of dissolved oxygen are the atmosphere and photosynthesis. The diffusion of oxygen from the atmosphere is slow, except under conditions of strong turbulence. Transfer of oxygen from the atmosphere into natural waters will occur when the water is undersaturated with oxygen. If the surface film of water is saturated with oxygen there will be no further diffusion until oxygen diffuses from the surface film into the overall body of water. Therefore, oxygen transfer is dependent on the amount of water turbulence at the surface.

The most important source of oxygen is that produced by aquatic plants during the process of photosynthesis. Some factors that control the rate of photosynthesis include temperature, light,

nutrient concentration, species of plants, abundance of plants, and water turbulence. Light penetration, to a large extent, is regulated by turbidity, and in many ponds the major source of turbidity is plankton. Therefore, the abundance of plankton is a primary factor affecting light penetration and the production of oxygen. Oxygen production by plankton is greatest near the surface and decreases with water depth because of self-shading. Ponds with high densities of plankton have higher rates of oxygen production near the surface, but ponds with lower densities of plankton have oxygen production occurring at greater depths. Therefore, ponds with low levels of plankton have more stable oxygen regimes, but are less productive because plankton is the base of the food chain in ponds.

Types of Aerators

Subsurface Aerators

Also known as diffusers, subsurface aerators consist of an onshore compressor that pumps air through a hose placed in the deepest part of the pond. This creates a column of air bubbles that are released at the bottom of the pond. As the column of bubbles rises to the surface, it moves water from the bottom of the pond to the surface where it is exposed to atmospheric oxygen which then dissolves into the water. The mixing of water moves oxygenated water to the bottom of the pond where it is used by aerobic bacteria to decompose dead organic material such as vegetation. The bubbles impart very little dissolved oxygen into the water. The primary benefit is the mixing effect.

Surface Aerators

Agitators such as paddlewheel devices and fountain sprayers can be used to create substantial turbulence which results in atmospheric oxygen dissolving into the pond. Fountains consist of a float, nozzle or sprayer head, and a pump that draws water from the pond and sprays it into the air. They are usually powered by an electric pump, or less commonly, by a windmill device. If the water is drawn from the bottom oxygen-poor layer of the pond, fountains can also reduce the layering that develops between oxygenated and unoxygenated water. Surface turbulence can also be created by paddlewheel devices powered by an electric motor or a power takeoff (PTO) from a tractor, or by churning the water surface with an outboard motor propeller.

The process of mixing:

- Provides oxygen for aerobic bacteria to decompose organic matter.
- Provides well-oxygenated water throughout the pond so that the pond is less likely to experience a fish-kill.
- Liberates dissolved gases, such as ammonia, carbon dioxide, hydrogen sulfide, and methane, into the environment instead of having them build to harmful levels in the pond.

Locating and Sizing an Aerator

In order to get the maximum benefit from an aerator, it should be properly located and sized. Recommendations for these specifications are based on practical experience. Research-based findings vary due to the wide range of conditions under which aerators have been used. In one study, three sizes (1/3, 3, and 5 horsepower) of electrical, spray-type surface aerators were used, and each failed to appreciably raise the dissolved oxygen concentration in the 1.4-acre study ponds within four hours. But a 1/3-horsepower aerator in a 1/10-acre pond quickly raised the DO concentration and prevented a fish kill. A rule of thumb suggested by one manufacturer is 1.5–2 horsepower per surface acre. In situations where water quality is especially poor, a minimum of 2 horsepower per acre should be provided.

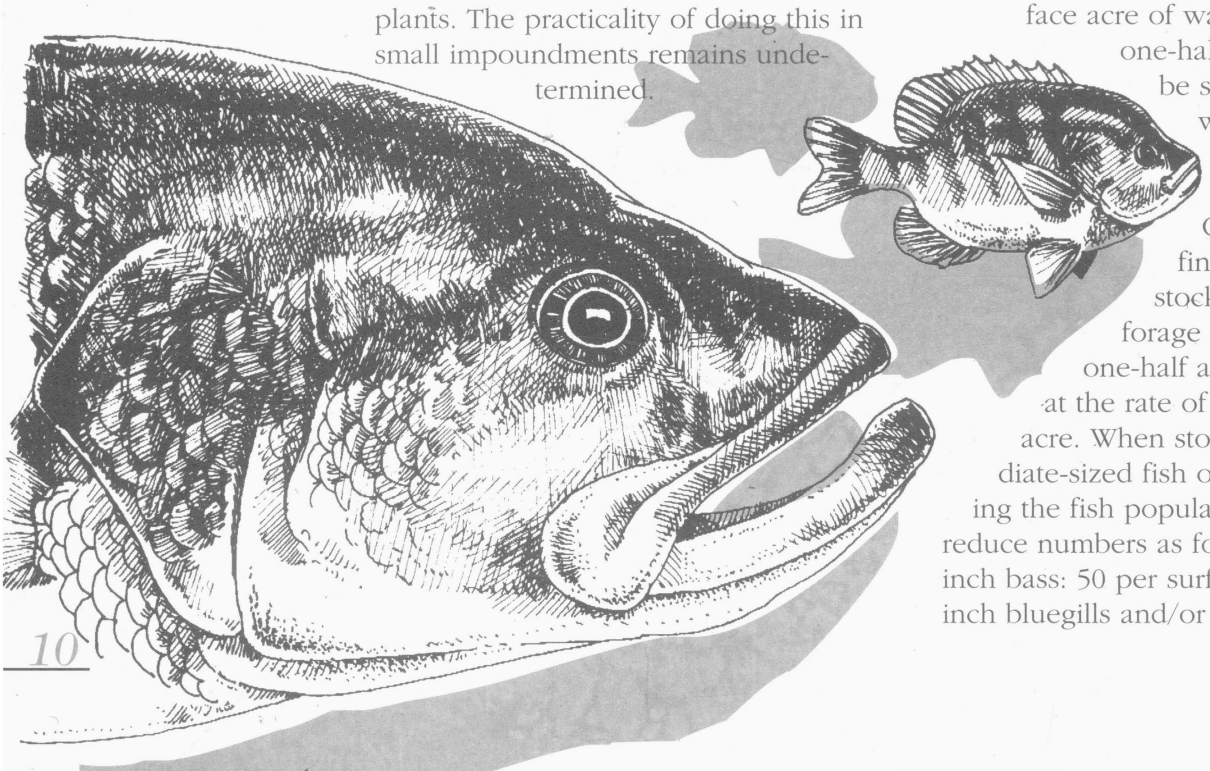
Considerations in sizing and locating aerators include:

- Depth of pond. The shallower the pond, the warmer the water, and the greater the potential for low dissolved oxygen.

- Water temperature. The warmer the water, the lower the concentration of dissolved oxygen. Algae growth is greater, as is the oxygen demand by bacteria for decomposition of dead algae.
- Age of pond. The older the pond, the more likely it is to contain large quantities of sediment, organic matter, and nutrients. The organic material is decomposed more rapidly by aerobic bacteria (bacteria that are only active in the presence of oxygen) than by anaerobic bacteria (bacteria that lives in the absence of oxygen).

Aerators and Vegetation Control

Pond aeration has been promoted as a method of aquatic vegetation control. To date, the benefits supposedly derived by aeration for controlling aquatic weeds or algae have not been fully demonstrated. Artificial aeration may be helpful in reducing algal blooms in ponds and lakes plagued by blue-green algae problems. Also, there may be some indirect benefit of aeration if nutrient-rich water in the bottom of a pond is moved to the upper layer where it serves to increase the density of the phytoplankton. This in turn increases the shading of the water which can then reduce the growth of aquatic vegetation. Research has shown that a well-oxygenated layer of water at the pond bottom can keep the mud oxidized. This can keep phosphorus in an insoluble form which is unavailable for plants. The practicality of doing this in small impoundments remains undetermined.



Stocking the Pond

The kinds and numbers of fish stocked in your pond will affect its success. Most ponds are stocked with a combination of a predator species and a forage species.

Fish for stocking usually are purchased from commercial producers. A list of the licensed commercial fish propagators in Ohio (Publication 196) may be obtained by writing to Publication Center, Ohio Department of Natural Resources, Fountain Square, Columbus, Ohio 43224. The offices of your county wildlife officer, county Extension agent, and the local Soil and Water Conservation District may also have a copy of this list.

Largemouth bass are the recommended predator species for stocking in Ohio ponds. Because bass feed almost exclusively on other fish, a forage species should be stocked as a food source. Bluegill and redear sunfish are the most commonly stocked forage species.

The least expensive size of fish for stocking is fingerlings, which are one to three inches long. When using fingerlings, stock 100 largemouth bass and 500 bluegills and/or redear sunfish per surface acre of water. Ponds less than one-half surface acre may be stocked at this rate or with 200 channel catfish fingerlings per acre only. Channel catfish fingerlings may be stocked with bass and a forage species in ponds one-half acre or larger. Stock at the rate of 100 per surface acre. When stocking with intermediate-sized fish or when supplementing the fish population in a pond, reduce numbers as follows: four to six inch bass: 50 per surface acre; two to four inch bluegills and/or redears: 250 per

surface acre. These stocking rates for bluegills and redear sunfish are designed to supply the food needed by the bass and provide enough survival of the forage species to ensure spawning for a sustained food source. The rates for both predator and forage species should also produce enough adult fish to provide good recreational fishing.

Care should be taken when moving fish from one water source to another so that the water temperature difference does not exceed 5°F. If the water temperature is greater than 5°F, slowly add pond water to the fish container so that the temperature change is not greater than 2°F per hour. If the fish are supplied to you in a plastic bag, float the bag in the pond for 30–45 minutes, then open and release.

Some pond owners want to fish for only largemouth bass and do not want bluegill or redear sunfish in their pond. For such a pond, golden shiners, bluntnose minnows, or fathead minnows may be stocked to provide food for the bass. These minnows should be stocked at the rate of 500 to 1,000 adults (2-1/2 to four inches in length) per surface acre.

Bass, bluegills, redear sunfish, and minnows will find suitable places to spawn in ponds without the addition of any special spawning structures. However, catfish require spawning structures that normally do not exist in a pond. If they do not reproduce, channel catfish must be restocked periodically to replace those harvested. In larger ponds, channel catfish may spawn if you provide eight inch or larger concrete tiles or rubber tires placed in areas where the water is two to five feet deep.

The Ohio Revised Code states that it is illegal to introduce exotic (not native) species of fish into public or private waters of the state. As a result, the stocking of vegetation-feeding fish was illegal until a triploid (not capable of reproducing) variety became available. Now triploid white amur (or grass carp) may be stocked in Ohio lakes and ponds for the control of aquatic vegetation. For more information on the triploid white amur, see "Biological Weed Control," page 18.

Pond owners often ask about the stocking of other fish species, particularly trout, in Ohio ponds. Most ponds will not support trout because the water gets too warm during the summer. Trout cannot survive in ponds where water temperatures exceed 75°F to 80°F for more than a few days. Ponds fed by springs may remain below these temperatures throughout the summer and may be suitable for trout. Crappie is another species many pond owners want to stock. This fish is unpredictable in ponds smaller than two acres. In larger ponds, crappie may be a desirable addition. As for perch and walleye, these lake species seldom do well and may compete with bass for forage. Finally, green sunfish, carp, rock bass, and bullheads are all undesirable. Their mistaken or accidental introduction into a pond from creeks or other impoundments can spoil your chances for good fishing. Years of experience by hundreds of Ohio pond owners suggest that a pond stocked with bass, bluegills and/or redear sunfish, and channel catfish provides the best fishing and the fewest problems.

Facts About Your Fish

One of the first questions pond owners ask is "How fast should fish grow?" Several factors affect the rate of growth, including fertility of water, availability of food chain organisms, and density of fish. The table on page 13 lists the length and weight of pond fish under average conditions.

Another often-asked question is "When should my fish spawn?" Largemouth bass are sexually mature when about nine to 10 inches long. It usually takes two full years after stocking for fingerlings to attain that size. Usually in May, when the water temperature reaches 60°F, bass will be observed fanning out shallow depressions on the bottom, called nests, in areas from one to several feet deep. The female deposits from 2,000 to 20,000 eggs, which the male guards and cares for during the three to 14 days required to hatch. Sexually mature bass only spawn once in a season and then only as the water warms to about 60°F in the spring.

Some forage fish will be sexually mature the first season after stocking as fingerlings. Within a few days to a couple of weeks after the bass have spawned, and when the water temperature reaches 70°F, bluegill and redear nests will be seen in shallow areas where the water depth ranges from six inches to three feet. From 10,000 to 60,000 eggs are laid in the nest; these hatch in a few days. Although bass spawning occurs within a few days, forage fish may be observed on spawning beds through much of the summer, and individuals may spawn several times in a season.

Maintaining Good Fishing

No two ponds are alike, and with present knowledge, it is impossible to predict the amount of harvestable crop in ponds. However, certain practices can make the difference between a good harvest and a poor one. To provide good fishing, your pond should contain between three and six pounds of forage fish (bluegills, redears, or minnows) for each pound of bass. Of these, about one pound should be small enough for the bass to eat. This means forage fish of 2.5 inches or less for the average bass.

Sixty to 85 percent of the total weight of fish in a pond should be harvestable size. A bluegill or redear is considered harvestable when it is five inches long, and a bass 12 inches. Ohio ponds that are well managed should produce an annual harvest of 50 to 100 pounds or more per acre.

Here are some practices to increase the chances of good fishing.

- Stock fish at the recommended rates (see "Stocking the Pond," page 10). If the proper number of forage fish is stocked, their offspring will be held to a small size long enough for the bass to thin them effectively. Those that reach 2.5 to 4.5 inches in length will have a better chance of growing to pan size.
- Start harvesting bass only after they have spawned for the first time. Bass reach sexual maturity when they are nine to 10 inches long. Some bass, stocked as fingerlings, may spawn in May or early June of the second year after stocking; however, most may not reproduce until the third season. This is particularly true in northern Ohio.
- Harvest fish at the rate of four to five pounds of forage fish for each pound of bass. This means 10 to 30 fish, depending on size. If you cannot maintain this harvest ratio by fishing, you may need to consider other population reduction means (see "Population Reduction," page 15).

Largemouth Bass	Bluegill	Channel Catfish
6.3 in. / .13 lb.	3.2 in. / .03 lb.	6.4 in. / .3 lb.
9.0 in. / .44 lb.	4.6 in. / .08 lb.	9.6 in. / .5 lb.
11.6 in. / .75 lb.	5.7 in. / .16 lb.	12.6 in. / .8 lb.
13.5 in. / 1.13 lb.	6.6 in. / .19 lb.	14.3 in. / 1.3 lb.
15.8 in. / 2.0 lb.	7.4 in. / .31 lb.	16.7 in. / 2.0 lb.
20.7 in. / 5.5 lb.	8+ in. / .5+ lb.	26.6 in. / 8.0 lb.

- Encourage year-round fishing by including ice fishing in the winter. It is very important to continue to harvest your pan-sized fish. A well-managed pond should support a harvest of up to 20 pounds of bass and 80 pounds of forage fish per acre per year. This may require help from your friends.
- Avoid the accidental introduction of undesirable fish in your pond (see "Stocking the Pond," page 10). Many pond owners do not permit the use of minnows as bait because the "minnows" may be small, undesirable fish.

Feeding Pond Fish

Feeding is not necessary to manage the fish population; however, the growth rate of some pond fishes may be accelerated through the introduction of additional food. Several animal food manufacturers offer fish-food pellets for sale. Such foods may be used to feed trout, catfish, bluegills, and redears. Pelleted fish foods should be fed sparingly at first. Feed only as much as the fish will eat at one time. Be careful not to use too much food as unused food may accumulate on the bottom where it will decompose and increase the risk of a fish kill. Feeding catfish and forage fish may result in larger fish but not necessarily better fishing. Bass do not take pelleted food readily.

Providing Structures for Fish

Any good angler will tell you that the best place to catch pond fish is around structures such as docks, submerged stumps and logs, and at the edges of weed beds. Pond fish use "structure" for a number of things. Forage fish hide in it to escape predators; they also feed on animal organisms such as snails and aquatic insect larvae found on the structure. Finally, most fish seek shaded, darkened areas during hot, sunny days.

Because living plants such as submerged and emergent aquatic plants are usually hard to limit and spread

rapidly, don't leave weed beds to provide structure. Non-growing structures such as bundles of tree branches weighted and submerged in five to six feet of water make good structure, as do piles of large rocks or several old tires wired together.

Discarded Christmas trees can also be used to provide structures for fish. Use wire and a concrete construction block to anchor the tree, and then group three to five trees in six to eight feet of water. Another method is to stand the tree in the center of an old tire, then fill the tire with concrete. The easiest method for submerging trees in a pond is to place them on the ice during the winter and let them sink when the ice melts.

Fishing over and around structures often will produce results when you cannot catch fish elsewhere, although fishing lures may become snagged on structures and lost. The location of structures should be marked so swimmers and boaters can avoid them. (For more information on structures, see *Placing Artificial Fish Attractors in Ponds and Reservoirs,* OSU Extension Natural Resources Fact Sheet A-1).

Correcting Poor Fishing

Several indicators can be used to monitor the balance of your fish population. A decline in fishing success may, but does not always, mean an unbalanced population. Observing the condition of fish you catch also can be an indicator. Are they healthy and full-bodied, or are they skinny and "bug-eyed"? If few bass are caught and forage fish are small, this, too, may indicate a problem. An absence of bass on spawning beds or new hatches of bass also may suggest a problem. The survival of large numbers of tadpoles is often an *indicator of a low bass population.*

A scientific way to determine the population balance in the pond is to sample it with a seine. Seine shallow water areas between July 1 and September 1 for an indication of the spawning success of your fish. Using a seine four feet wide and at least 12 feet long with a mesh no larger than 0.5 inch, make several sweeps in shallow areas of your pond. After each sweep, look at the contents of the seine. If the seine contains current reproduction of both bass and forage fish and some intermediate forage fish (2.5 to 4.5 inches), the pond is in balance and producing satisfactorily.

After July 1, any bluegill or redear less than one inch long has hatched that year. Fingerling bluegills and redears can be distinguished from fingerling bass by their deep body form. Bass have a more streamlined shape and a faint dark line running lengthwise along each side.

Your pond is over-populated by forage fish if the seine contains many intermediate-sized and some fingerling forage fish, but no bass fingerlings. Techniques discussed later in this section (see page 15) may be used to restore balance. If the seine contains mostly small intermediate-sized forage fish (three inches or less) and no fingerling bass or forage fish, your pond is unbalanced. Complete eradication of the fish population and restocking may be necessary to correct such a problem. For ponds that are forage-fish heavy, imposing a ban on bass harvest and the stocking of 20 to 30 bass, six inches in length or longer, per surface acre may correct the problem.

Do not be concerned if you do not catch large fish when you seine sample your pond. Larger fish will swim out of the seine. We are interested only in the smaller fish when

using this method for determining population balance.

Note: It is unlawful to transport oversized seines (greater than four by eight feet) off the property on which the pond is located. For information on transporting oversized seines, contact your ODNR county wildlife officer. Your county Extension agent or sheriff can help you locate this person.

Population Reduction

If observations or seine sampling indicates that your fish population is out of balance, you can try several methods to correct the problem. The first is to regulate harvest. Enforcement of a minimum length limit on bass harvested of 12 to 14 inches may help. You may even want to ban all bass harvest for a season. Encouraging forage fish harvest with all bluegills and redears caught being kept also may help.

The use of larger seines (at least 20 by four feet with 0.5 inch mesh) also may be used to reduce forage fish populations. Ponds should be free of obstructions such as stumps, brush, and large rocks. To seine the pond, make sweeps with the seine ending with moves to the shoreline. Lift the seine onto the bank, immediately remove all bass and large forage fish and return them to the water. Dump small forage fish on the bank or into containers for later disposal.

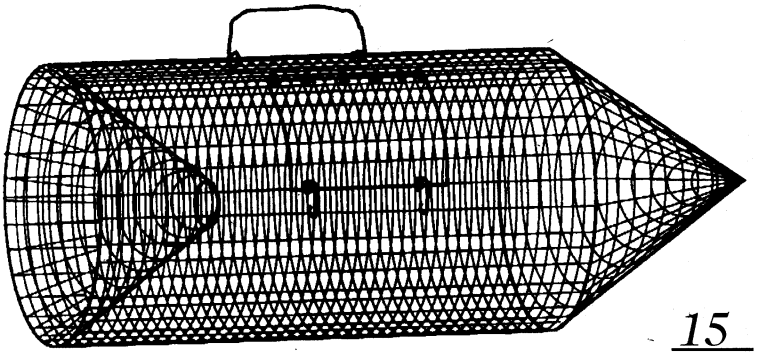
Fish traps can be used to accomplish the same thing as seining. These are commercially available, or you can build your own. To build a fish trap, use 0.5 inch mesh welded or woven wire or hardware cloth. The body of the trap should be cylindrical and about two feet in diameter and five feet long. Close one end of this cylinder with a cone made of the same wire and pointed away from the body of the trap. Construct a second cone or funnel with a 2.5 inch opening at the small end and attach this, point in, to the open end of the trap. Finally, cut an opening into the body of the trap and construct a trap door to cover it.

Bait fish traps with soybean or cottonseed cake, bread, or other foods that disintegrate slowly in water. Cottage cheese in a cloth mesh bag suspended inside the trap also will attract fish. Place the baited trap in two to four feet of water with the long axis parallel to the shoreline. Traps should be checked daily and desirable fish released and forage fish removed for disposal. Several traps may be used per acre depending on the number of fish you wish to remove.

It is impossible to be exact about how many small forage fish to remove. You will have to experiment in your own pond to determine when you have reached the right amount. With an overabundance of forage fish, removal of 50 to 100 pounds per acre may be necessary to reduce the numbers to a level where the bass can control them.

When seining or fish traps are not practical as population reduction methods, the forage fish population may be reduced using a fish toxicant. Rotenone, long used as an insecticide, is a common ingredient in fish toxicants. **Read and follow label directions for proper use of fish toxicants. Rotenone is a *restricted-use* pesticide. You must be *licensed* to purchase and use it. The information provided here is intended to clarify and supplement that which is found on the product label.**

In situations where the intent is to reduce, but not eliminate, the fish population, usually no more than half the shoreline should be treated at one time. The maximum safe length of shoreline to treat in a one-acre pond is 400 feet, 300 feet in a 0.75-acre pond, and 200 feet in a 0.5-acre pond.



Water temperature influences the effectiveness of rotenone. It acts more slowly at lower temperatures. Do not use rotenone when water temperatures are below 60°F.

Treat the pond at midday on a clear, sunny day with no wind and no prospect of a weather change. Under these conditions, most bass will be in cooler water and will be outside the area to be treated. On a windy day, you will be unable to control the rotenone and some of it may spread into deeper water, killing large fish. You may treat the leeward side of the pond with some safety if there is only a slight breeze.

Mix powdered rotenone with just enough water to form a stiff paste, or mix the emulsified form with about twice its volume of water. Next apply a line of the rotenone under the surface following the shoreline of the pond 10 to 15 feet out from the bank. The rotenone will settle downward and mix with the water on each side of the line of application. Most of the fish between the line of rotenone and the bank will be killed, while those outside the line are likely to move away. If weather conditions are right and care is taken with this method, only small fish will be killed.

Rotenone kills fish by affecting the gills and reducing their capacity to remove oxygen from the water. The end result is suffocation. Moderate amounts of rotenone are not harmful to warmblooded animals. The small amount of rotenone added to the pond in a partial treatment will mix with the total volume of water in the pond in 8 to 12 hours. After that time, water from the pond may be used as before the treatment.

It is difficult to know the poundage of fish killed by a partial rotenone treatment. Two or three treatments at intervals of a week or 10 days should correct a situation where forage fish but not bass were reproducing and where there were moderate numbers of intermediate forage fish.

Population Elimination

When a pond is overpopulated with stunted forage fish and neither bass nor forage fish are reproducing, removal of part of the fish population will seldom solve the problem. Complete elimination of all fish and subsequent restocking is recommended. Complete elimination of all fish is also recommended when undesirable fish are in the pond.

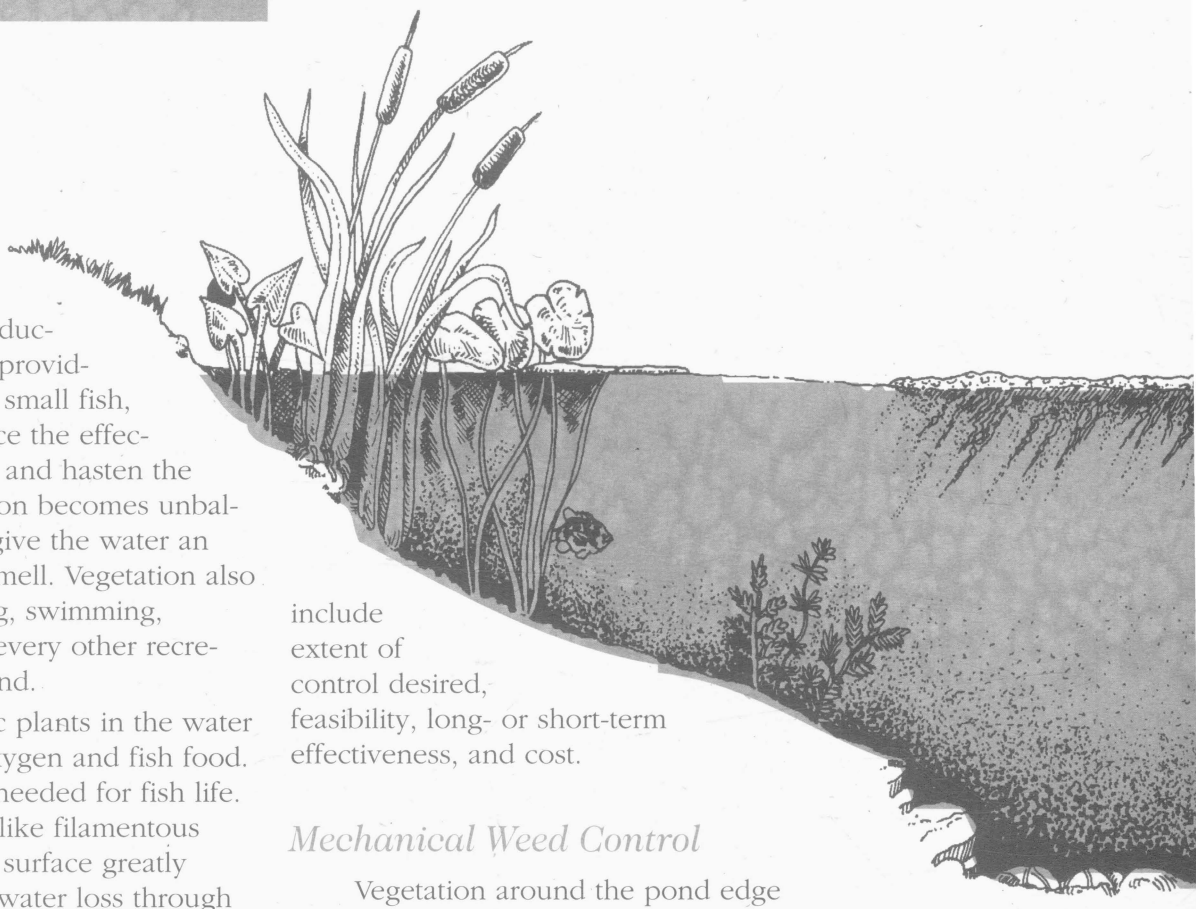
Draining the pond will allow you to save the desirable fish. Some ponds are constructed with a drain. Others may be siphoned using sections of fire hose, or they may be pumped down with a high-capacity pump such as that used for irrigation.

Commercially available fish toxicants contain complete directions on the label for total population elimination. Rotenone is a common ingredient in fish toxicants. **Read and follow label directions for proper use of fish toxicants. Rotenone is a *restricted-use* pesticide. You must be *licensed* to purchase and use it. The information provided here is intended to clarify and supplement that which is found on the product label.** Five percent rotenone applied at the rate of two pounds per acre-foot of water, or five percent emulsion at the rate of 1.3 pints per acre-foot of water, will eradicate fish in waters with temperatures above 60°F. To determine the volume of your pond in acre-feet, see the "Pond Measurements" section on page 5.

Small ponds may be treated entirely from the shoreline. In ponds larger than one-half acre, apply the fish toxicant from a boat to get better mixing and distribution. An outboard motor will be helpful on large ponds. Collection and disposal of larger fish killed in population eradication is recommended to reduce odor problems.

A pond that has had the population eliminated with a fish toxicant usually can be restocked within 10 days to a month. To make sure all of the toxicant has decomposed, place some minnows in a screen wire cage or a minnow bucket liner in the water. If the minnows live for four days, the water is safe for restocking. Follow the suggestions in this bulletin when restocking.

Controlling Weeds



Vegetation that grows under, on, or out of the water in a pond may be undesirable for a variety of reasons. It may interfere directly with fish production and harvest. By providing hiding places for small fish, vegetation may reduce the effectiveness of predators and hasten the day the fish population becomes unbalanced. Some plants give the water an unpleasant taste or smell. Vegetation also interferes with fishing, swimming, boating, and almost every other recreational use of the pond.

The microscopic plants in the water provide necessary oxygen and fish food. Large plants are not needed for fish life. Also, a mat of threadlike filamentous algae floating on the surface greatly increases the rate of water loss through evaporation.

Vegetation that grows in a pond may be divided into four general groups. The first includes the microscopic plants that, along with microscopic animals, are called plankton. Plankton are a vital link in the food web.

The other three groups are all undesirable from a management standpoint. The first and probably the most common vegetation problem affecting Ohio ponds is floating weeds. The second group is submerged weeds; they grow attached to the pond bottom with most of their leaf surface below the water's surface. The third group, emergent weeds, grows in shallow water and along the shoreline with the leaf surfaces above the water.

Undesirable vegetation in a pond can be controlled mechanically, biologically, or chemically. All three methods should be considered before making a decision to proceed. Factors to consider include extent of control desired, feasibility, long- or short-term effectiveness, and cost.

Mechanical Weed Control

Vegetation around the pond edge can be controlled by hand pulling, cutting, or mowing. This can be effective against emergent weeds such as cattails and some submerged weeds and should start in spring when leaves first begin to appear. By repeatedly removing the leaves on cattail plants, the food supply in the underground tuber will be depleted and the plant will eventually die. This method, requiring persistence on the part of the pond owner, can have noticeable results in one growing season.

A longer-lasting, but expensive, solution is to eliminate the shallow areas that are conducive to weed growth. A minimum water depth of three feet will prevent rapid establishment of aquatic vegetation. Shoreline edges can be steepened with a dragline to give the sides a 3:1 slope and a minimum of shallow water. The only exception should be swimming areas where steep dropoffs could be hazardous.

Biological Weed Control

Another method of control that should be considered is biological control. This involves disrupting plant growth by modifying the aquatic environment through natural manipulation, or it can mean the introduction of a living organism capable of controlling the weeds.

Biological control of weeds includes the maintenance of a level of fertility high enough to foster a good microscopic plant and animal population in the water (see discussion of fertility and fertilization in an earlier section, page 7). This plankton population will "cloud" the water and prevent the light penetration necessary for weeds to become established. This form of biological control requires intensive management and more time than the average pond owner normally devotes to the pond.

Inert Dyes

Another method by which light penetration can be reduced is through the use of inert dyes. Such dyes are commercially available and the color (usually blue) they impart to the water can reduce light penetration and help control both filamentous algae and submerged weeds. These dyes will not be effective in water less than two feet deep, or if weeds are on or above the water surface.

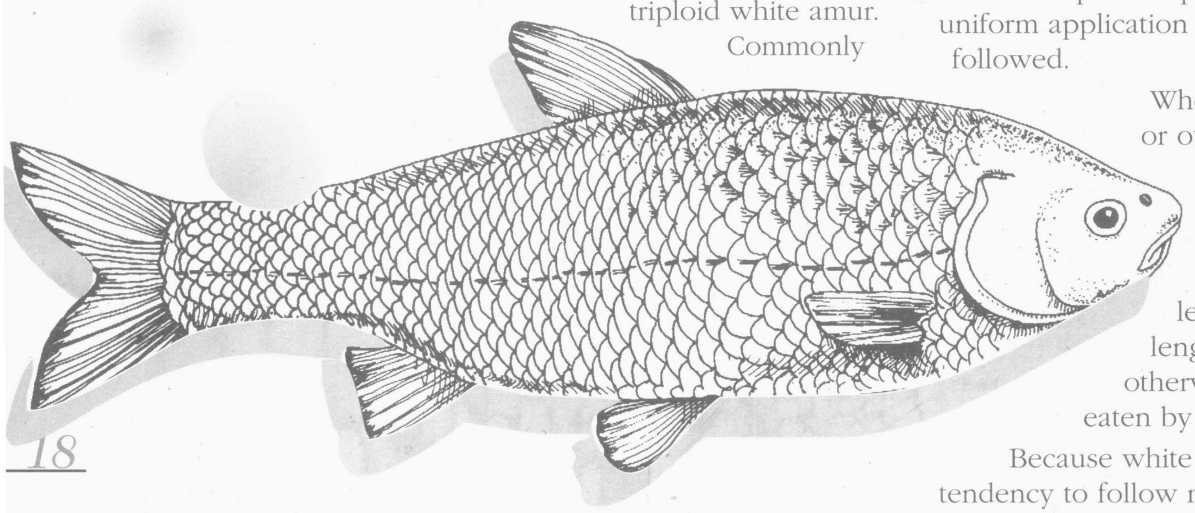
Triploid White Amur

Biological control can also be achieved through the introduction of a vegetation-eating fish, the triploid white amur. Commonly referred to as "grass carp," this fish is a member of the minnow family and may grow to 60 pounds or more in size and live up to 15 years. Possession of the natural form (diploid) of this fish continues to be illegal in Ohio due to concerns that it could escape from private ponds and lakes and become established in public waters. The triploid form is sterile and would not become established if it did escape.

The type and quantity of vegetation should be used to determine the number of triploid white amur to stock. If the vegetation is primarily milfoil, musk grass, pondweed, or naiad, these stocking rates are recommended:

Percent of pond covered by plants	Number of fish per surface acre
0 – 20	none
20 – 40	5
40 – 60	10
more than 60	20

If the vegetation is primarily coontail or elodea, the stocking rates should be doubled. In situations where filamentous algae is the only aquatic vegetation present, some control can be expected. However, since this is the least desirable food, other aquatic plants will likely be eaten first, and noticeable control of algae may not be evident. If copper sulfate is used to control algae in ponds where white amur have been stocked, strict observance of the recommended rate of 2.7 pounds per acre-foot and uniform application methods should be followed.



Where largemouth bass or other predatory fish are already present in the pond, triploid white amurs should be at least 8–10 inches in length when stocked; otherwise they may be eaten by other fish.

Because white amurs have a natural tendency to follow moving water, barriers

to prevent their escape can be installed in ponds with inflows and outflows (including high-water spillways). Care should be taken, however, to ensure that such barriers do not become clogged with debris.

This herbivorous (plant feeding) fish should be considered as another "tool" for aquatic weed control and not as the ultimate solution. White amur represents a biological control option that may reduce the need to use aquatic herbicides. This can be especially important for those who use their water for potable or livestock uses as well as for managers of larger private lakes where annual aquatic herbicide treatment costs are prohibitive.

Triploid white amur are available from dealers with permits from the Ohio Department of Natural Resources, Division of Wildlife. County wildlife officers can provide a list of these dealers. When purchasing triploid white amur, you should receive a receipt from the seller indicating the number and size of fish purchased and the seller's name. Save this receipt as documentation that you purchased and stocked sterile (triploid) fish.

Chemical Weed Control

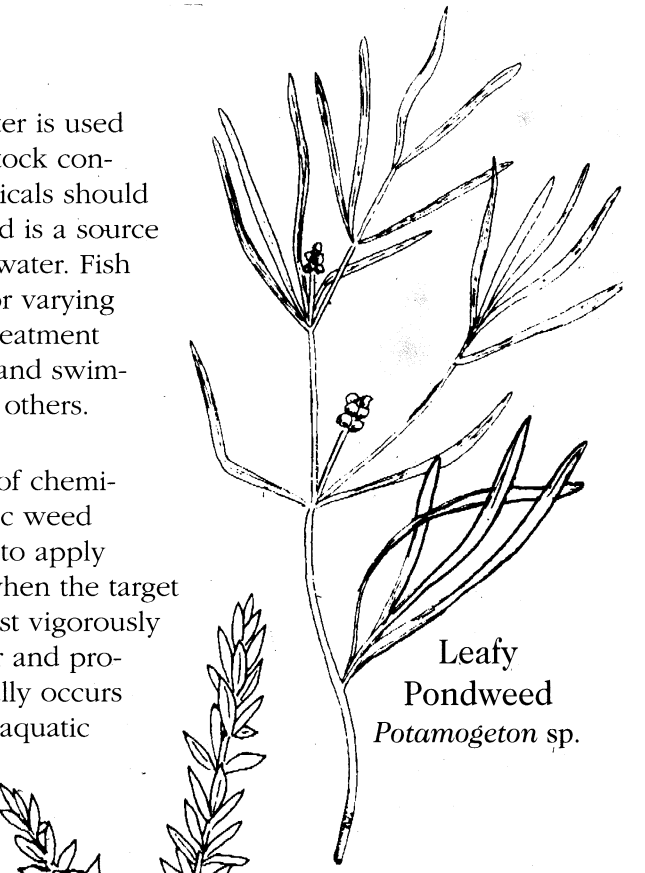
Chemical weed control, the third method available to the pond owner, is the one most often used. Three considerations are a must before starting a chemical weed control program. First, uses of the pond and the pond water will influence selection of the chemical. Second is the time of year when the chemical is to be applied. Finally, the kind of weeds to be controlled must be considered. Most herbicides recommended for aquatic weed control carry complete instructions for use on the container label. **Always read the entire label on any herbicide before applying.**

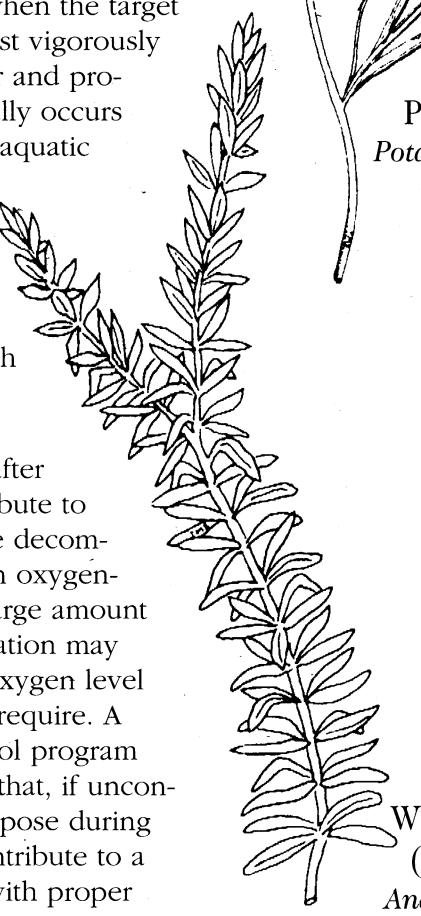
Read the label for restrictions on use of the water treated. Some chemicals are not suitable for use in ponds from which water is used for domestic and livestock consumption. Other chemicals should not be used if the pond is a source for irrigation or spray water. Fish should not be eaten for varying periods of time after treatment with some chemicals, and swimming is restricted with others. **Read the label!**

Application time of chemicals is critical in aquatic weed control. The best time to apply aquatic herbicides is when the target plants are growing most vigorously and before they flower and produce seed. This normally occurs before July 1 for most aquatic weeds in Ohio. Proper timing of herbicide applications produces better results and also reduces the hazard of fish kills.

Killing of heavy infestations of weeds after midsummer can contribute to a summer fish kill. The decomposition of weeds is an oxygen-using process, and a large amount of decomposing vegetation may reduce the dissolved oxygen level below that which fish require. A well-timed weed control program also eliminates weeds that, if uncontrolled, die and decompose during the winter and can contribute to a winter fish kill. Even with proper timing, the control of aquatic vegetation with herbicides is a maintenance measure usually requiring treatment each year.

Finally, selection of the chemical to be used and the amount to apply should be decided only after the weed or weeds have been identified. Some weeds are more resistant than others and require higher concentrations of an herbicide. Use only as much herbicide as is recommended and apply it as specified on the label.





Floating Weed Control

The most common type of floating weed in Ohio ponds is filamentous algae ("moss" or "pond scum"). This weed, which looks like a dense mat of hairlike fibers, starts to grow on the pond bottom and on submerged objects. It floats to the surface, often covering large areas of the pond.

Most species of this plant group can be controlled with very low concentrations of copper sulfate. The recommended rate is 2.7 pounds per acre-foot of water (see "Pond Measurements," page 5.) Double this rate for very hard waters (more than 12 grains or 200 parts per million of hardness).

Determine the size of the area to be treated and then calculate the amount of chemical needed. The application method will determine what grade of copper sulfate to purchase. For best results, dissolve copper sulfate in water and spray it on the surface of the algal mat or on the water surface over the algae. Finely ground, "snow grade" or "instant" copper sulfate dissolves easiest and is best for this method. Mix the desired amount of copper sulfate with enough water to cover the area to be treated.

In large ponds and when spray equipment is not available, it may be easier to treat with copper sulfate for algae control by placing the larger crystals of this chemical in a burlap bag and towing the bag through the water in the area to be treated until all of the crystals have dissolved.

If the algae is so abundant that it covers more than half the total pond surface, a complete treatment may result in an oxygen depletion and fish kill. This hazard is greatest during very hot, overcast weather. When these conditions exist, treat only half the pond and wait 10 days to two weeks before treating the other half.

Copper sulfate is corrosive to galvanized containers. The solution should be mixed in wooden, earthenware, plastic, stainless steel, or copper-lined containers. If a copper-lined, plastic, or stainless steel sprayer is not available, you may broadcast the solution with a bucket and dipper. Strive to treat the weeds directly. Contact is important.

When copper sulfate is applied at the recommended rate, it will be so diluted or inactivated after 12 hours that it will not present a hazard to livestock or swimmers. **Caution:** Do not apply any copper compound when fish are spawning unless you wish to kill the new hatch of fish.

Copper is also available in a buffered, or chelate, form (see "Aquatic Herbicide Table," page 24). This material contains complete instructions on the label for use in the control of filamentous algae. Several other herbicides recommended for the control of other weed problems will also control algae. Where a mixed problem of algae and submerged weeds exists, the chemical suitable for control of the submerged weed also may kill algae. Do not mix or apply different chemicals at the same time unless the label states clearly that this may be done. Some combinations may be ineffective and others may be toxic to fish.

There is another form of algae that grows attached to the bottom and resembles the submerged weeds discussed in the next section. This is *Chara*, commonly called muskgrass or stonewort. It usually grows in clumps in shallower areas. When crushed it may have a musky or skunky odor. Although *Chara* is a form of algae, copper sulfate applied at 2.7 pounds per acre-foot of water will not control it. Buffered formulations of copper will control *Chara* when applied according to the label, as will the amine salt of endothall (see the table on page 24 for trade names).

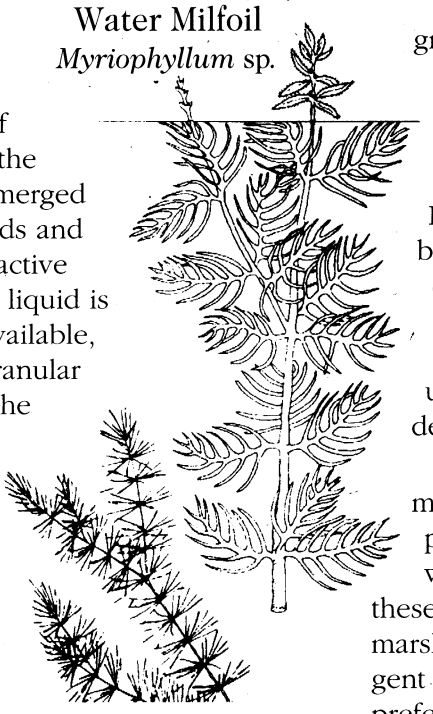
Submerged Weed Control

Many water weeds grow below the surface of the water. Some are loosely rooted and others are firmly rooted. Still others appear to be suspended fragments or clusters. Some have a few leaves that float on the surface, while many blossom and produce seed on a stem that extends above the water surface. This general

group is referred to as submerged weeds. They thrive in clear, calm, shallow waters.

Many species of submerged weeds are found in Ohio ponds. The common kinds include the large family of pondweeds *(Potamogeton),* coontail *(Ceratophyllum),* water milfoil *(Myriophyllum),* water weeds *(Elodea),* and naiads *(Najas).*

Water Milfoil
Myriophyllum sp.



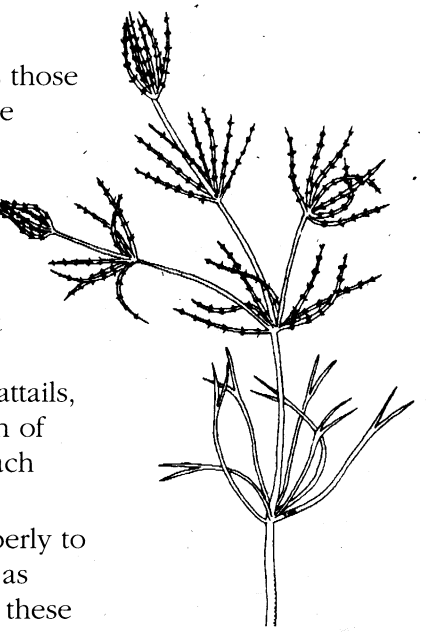
Coontail
Ceratophyllum sp.

There are two general formulations of herbicides for the control of submerged weeds — liquids and granules. The active ingredient in a liquid is immediately available, whereas the granular forms release the active ingredient slowly as the inert carrier breaks down. Granular herbicides are best suited for application early in the growing season and for spot-treating. The liquid forms may be used through midsummer. No aquatic herbicide is currently approved for submerged weed control that does not place some restriction on the use of the treated water.

Many herbicides on the market carry label recommendations for the control of submerged weeds, and new products are being introduced all the time. Therefore, it is impossible to discuss each of these. Several of the most common are described in a later section. Visit your local agricultural chemical dealer to see what is available. Each container will carry complete instructions on the label for the herbicide's use, a list of the weeds it will control, application rates, precautions, and restrictions. **Read each label completely and select the one that best fits your needs and your application equipment.**

Illustrations of some common submerged weeds that occur in Ohio ponds appear in this bulletin. They should help you identify most pond weed problems.

Muskgrass
Chara sp.



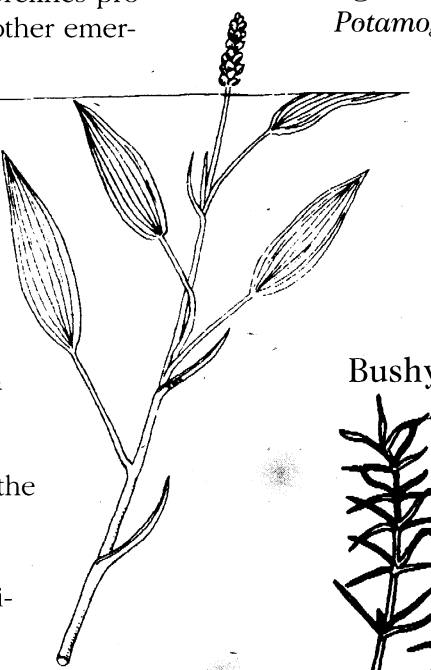
Emergent Weed Control

This group of weeds includes those growing along the margin of the pond as well as in other shallow waters. Their stems and leaves protrude above the water surface. Examples are cattails *(Typha),* bulrushes *(Scirpus),* arrowhead *(Sagittaria),* and spatterdock *(Nuphar).* Some, especially cattails, may spread rapidly by growth of underwater stems and may reach depths of three feet or more.

Constructing the pond properly to maintain as little shallow water as possible is the best control for these weeds. If you have shallow water, these weeds will turn your pond into a marsh unless they are controlled. Emergent weeds, especially cattails, are a preferred food of muskrats, which may result in the use of shorelines protected by cattails and other emergent weeds for their burrows. Mechanical deepening of shallow areas will reduce these problems. Control also can be achieved by cutting and pulling emergents if this practice is started soon after they appear. There are also several herbicides labeled for the control of emergent aquatic weeds.

Some of the herbicides labeled for submerged weed control are effective on emergent weeds, including diquat dibromide and

Floating-Leaf Pondweed
Potamogeton sp.



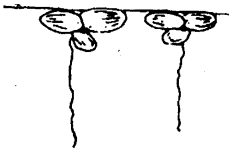
Bushy Pondweed
Najas sp.

granular 2,4-D. In addition, fluridone and glyphosate are approved for emergent weed control. Diquat dibromide and glyphosate are applied as sprays and will give better results when applied with a wetting or sticking agent. These agents are available commercially, or liquid household detergent may be used as a substitute. Add two tablespoons of liquid detergent to each gallon of spray mixture and spray on the exposed surfaces of the emergent weeds so that a thin film covers the leaves. Do not use kerosene or fuel oil emulsions as they can cause undesirable flavors in fish. To reduce the amount of herbicide falling on the water surface when spraying emergent weeds, apply from a boat, directing spray toward the shore.

Each aquatic herbicide has complete instructions for its use on the package label. **Read and follow label directions carefully.**

Another group of weeds occasionally occurs in Ohio ponds, especially very sheltered ponds that have little wind action on the surface. These weeds are duckweed *(Lemna)* and watermeal *(Wolffia)*. Although they float freely on the water surface, they are treated as emergent weeds. Duckweed has tiny, usually three-lobed leaves with rootlets that hang down in the water. Watermeal appears as minute green grains floating on the water. Dense populations of these weeds often form a green blanket on the water surface. Diquat dibromide and fluridone will provide some control of these weeds. Follow information on the label regarding its application.

Duckweed
Lemna sp.



Note: The use of herbicides for the control of submerged, emergent, and floating aquatic weeds is a maintenance measure and usually requires annual applications. Applications made early in the growing season usually will give better results and will reduce the hazard of oxygen depletion later.

Woody Plants

Woody plants may create problems on embankments and along the shoreline of a pond. Willows and cottonwoods are particularly troublesome in some areas. These can be controlled by cutting or pulling when they are seedlings, or with herbicides. Formulations of glyphosate are available for use as foliage spray, injection, or frill treatments. Frill treatments involve making notched cuts completely around the woody plant and then spraying an herbicide in the cut.

Aquatic Herbicides

Many chemicals may kill aquatic weeds; however, select only those approved for aquatic use by the U.S. Environmental Protection Agency and labeled for this use. Brief descriptions of several chemicals follow. These are identified by their chemical names. See the table on page 24 for trade names and manufacturers.

Copper Sulfate

This is the least expensive and most widely used material for the control of algae (except *Chara)*. It has little or no effect on other aquatic plants. Copper sulfate is a contact herbicide, so direct contact is required. In highly alkaline waters (greater than 250 ppm $CaCO_3$), copper sulfate forms an insoluble precipitate and becomes unavailable for algae control. Therefore, a higher concentration of copper sulfate must be used. Copper sulfate is toxic to fish eggs, so its use should be suspended during spawning periods. There are no restrictions on the use of the water following treatment, but it is desirable to wait 24 hours to let the metallic smell dissipate from the water.

Copper Chelates

The copper chelates (copper held in an organic molecule) are formulations that prevent copper from precipitating out of the water, especially in hard water. As a result they should provide somewhat longer-lasting results than copper sulfate. The chelates are formulated as liquids and granules, making them somewhat easier to apply.

Diquat Dibromide

This is a contact aquatic herbicide and is available in liquid form. It will kill most submerged weeds. It is applied by pouring directly from the container or by diluting with water and injecting below the water surface. For best results, it should be applied before weed growth has reached the surface. When sprayed on emergent weeds, the herbicide is mixed with water and a nonionic surfactant. Diquat dibromide should not be used in muddy water.

Endothall

This herbicide is available as an amine salt or a potassium salt and is available in both liquid and granular formulations. Fish are sensitive to the amine salt, but not the potassium salt. Endothall is a contact herbicide and is most effective in waters 65°F and above. It will control most of the common submerged weeds that grow in Ohio. The liquid form is mixed with water and sprayed on the water surface or injected below the surface. The granular form is best applied with a cyclone-type spreader. Tables for determining amounts required, application instructions, precautions, and restrictions are on the product label. **Read the label!**

Fluridone

Fluridone is a systemic aquatic herbicide that interferes with a plant's ability to make food. By inhibiting carotenoid synthesis, chlorophyll is gradually destroyed and the plant dies. This process takes 30 to 90 days to work so treatment early in the growing season is recommended. This aquatic herbicide is available in liquid and slow-release pellet formulations. **Read the label for application information and restrictions.**

Glyphosate

Glyphosate is a systemic herbicide that moves through the plant from the point of foliage contact into the root system. It is a liquid and produces the best results when applied after emergent plants have reached full growth. It gives good control of cattails and other emergent aquatic plants as well as woody plants growing on the shorelines.

Granular 2,4-D

This systemic aquatic herbicide is easily applied using a cyclone-type spreader. It should be applied to coincide with rapid growth of the root systems of submerged weeds for best results. Effective on most submerged weeds found in Ohio ponds, granular 2,4-D also may be used to control some emergent weeds. **Read the product label carefully for application rates, precautions, and restrictions.**

Warning!

Aquatic herbicides recommended for submerged weed control are safe for use in ponds stocked with fish unless otherwise stated on the label. Each has different restrictions on water use following treatment, so **read the entire label** on the product you select before applying it.

Although non-injurious to fish when applied at the recommended rate, an herbicide application can still contribute to a fish kill. If large amounts of floating or submerged weeds are killed at one time, their subsequent decomposition can result in an oxygen depletion and the death of fish from suffocation. To reduce the hazard of such a fish kill, treat weeds early in the growing season. When more than half of the pond is covered with weeds, treat half the pond and wait 10 to 14 days before treating the other half.

When applying herbicides along shorelines or spot-treating weed beds, it is best if applications are started along the shoreline or in the shallowest area and applied out to the deeper water. This will enable fish to move into deeper water to escape the chemical.

Aquatic Herbicide Table

This table is provided for the convenience of those who desire a source of products for aquatic weed control. References to commercial products or trade names are for educational purposes only. Ohio State University Extension does not assume any responsibility and intends no discrimination toward or endorsement of any of these products.

Chemical Name	Common or Trade Name	Manufacturer Name
Copper sulfate	Blue vitriol, bluestone, other	Many
Copper chelate	AlgaePro, Nautique Cutrine Plus	SePRO Corporation Applied Biochemists, Inc.
Diquat dibromide	Reward	Zeneca Professional Products
Endothall	Aquathol Super K Granular (potassium salt) Aquathol K (potassium salt) Hydrothol 191 (amine salt)	ELF Atochem North America, Inc. ELF Atochem North America, Inc. ELF Atochem North America, Inc.
Fluridone	Sonar	SePRO Corporation
Glyphosate	Rodeo	Monsanto Co.
Inert Dye	Aquashade, Aquashadow Lake Colorant WSP True Blue Others	Applied Biochemists, Inc. Becker Underwood, Inc. Precision Laboratories
2,4-D (granular)	Navigate	Applied Biochemists, Inc.

Fish Kills

Fish mortality in ponds has many causes. While little can be done to stop fish death once it begins, fish kills may be prevented by understanding the causes.

Oxygen Depletion

The most common cause of fish kills in Ohio is suffocation due to lack of oxygen. This can occur for several different reasons. However, the principle cause of oxygen depletion is the decomposition of organic matter, especially dead plant material. As aquatic vegetation decomposes, either as a result of herbicide use or natural die-off, the process uses oxygen. During the warm summer months, decomposition may use what little dissolved oxygen is in the water, resulting in an insufficient amount for fish.

Another cause of oxygen depletion is a phenomenon known as a turnover or inversion. During the late spring and summer, the pond water develops layers as a result of temperature and density differences. Rapid warming in the upper 8–10 feet results in water that is less dense and has a lower oxygen holding capacity than the colder and denser deep water. However, because of photosynthesis and contact with the atmosphere, there is normally enough oxygen to meet the minimum needs of fish.

The cooler layer of water in the bottom of the pond has the potential to hold more oxygen than the top layer because it is denser. But the lack of photosynthesis and the decomposition of organic matter actually results in a lower level of dissolved oxygen compared to the top layer.

A turnover results when a strong wind, rapid temperature change, or inflow of a large volume of cold water causes the upper layer of water to be replaced by the lower layer of oxygen-deficient water. Fish stay near the surface and, because they cannot get enough oxygen from this new water, die of suffocation.

Prevention

A good aquatic weed control program will prevent the accumulation of large masses of vegetation, which will use a large amount of oxygen when it decomposes.

The use of an aerator will help keep the pond water mixed so that layering is minimized and the surface water is well-oxygenated.

Natural Mortality

Although fish may die of natural causes at any time of the year, they are more stressed in the early spring and during spawning season. This makes them more susceptible to unfavorable environmental conditions and diseases. Large fish seem to be more susceptible. Mortality may also be due to old age. Some fish may live up to 10 years, but four to eight years is more common.

Prevention

Little can be done to prevent natural mortality. Year-round pond management practices will provide the best growth conditions for your fish.

Organic Pollution

Run-off from barnyards, cropland, feedlots, septic tanks, and intensively managed turf areas such as golf courses can introduce large quantities of organic matter and nutrients into a pond. The nutrients will contribute to increased growth of aquatic vegetation, which will eventually die and decompose, using oxygen in the process.

Prevention

Divert run-off from these sources so that it does not enter the pond. Use diversion ditches, tiling, embankments, and land grading as needed.

Agricultural Chemicals

Crop production practices commonly involve the use of chemicals to control weeds, disease, and insect pests. Some of these materials, particularly insecticides, may be toxic to fish and other aquatic organisms if they enter the pond in sufficient quantity. This may result from drifting spray or a heavy rain that washes recently applied chemicals into the pond. Only a very small percentage of fish kills in Ohio have been positively attributed to agricultural chemical poisoning.

Prevention

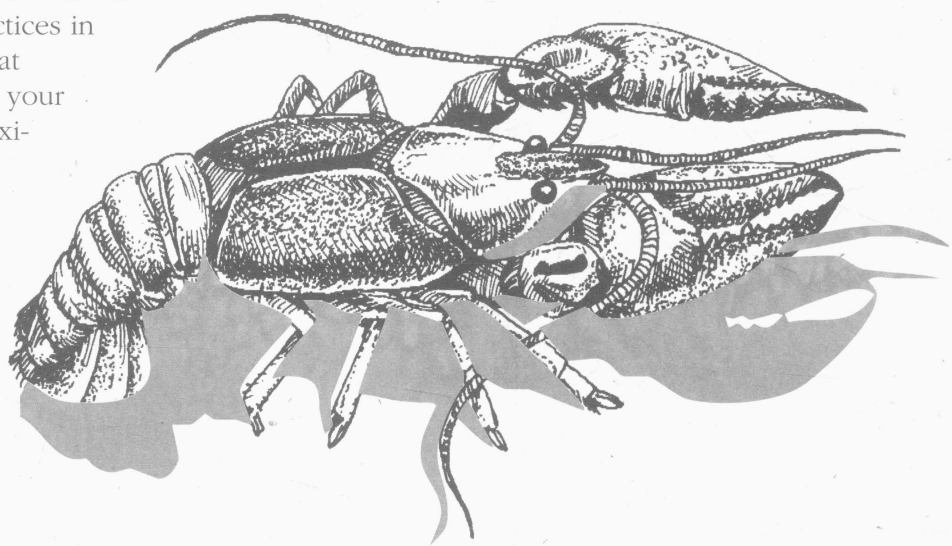
Preventing the introduction of agricultural chemicals is primarily a matter of diverting drain tile and runoff water away from the pond. This is often easier said than done, however, as it may require the mutual efforts of the pond owner and adjacent landowners.

If you are planning to build a pond, take time to find out about the land use practices in the watershed that would drain into your pond. To the maximum extent feasible, locate the pond so that it will not receive undesirable runoff.

Other Potential Pond Problems

Crayfish

Crayfish are important food organisms in the pond. They are on the food lists of birds, mammals, and most species of pond fish. Some species of crayfish may present a problem. These are the burrowers, which make vertical burrows two to six feet deep and pile the mud from their excavation in a "chimney" around the mouth of the burrow. Burrows in moist areas may have connecting tunnels, and in rare cases such tunnels have perforated the dams on ponds. There are currently no effective long-term control methods — cultural, chemical, or mechanical — for controlling these burrowers. High densities of largemouth bass will help keep a crayfish population in check.



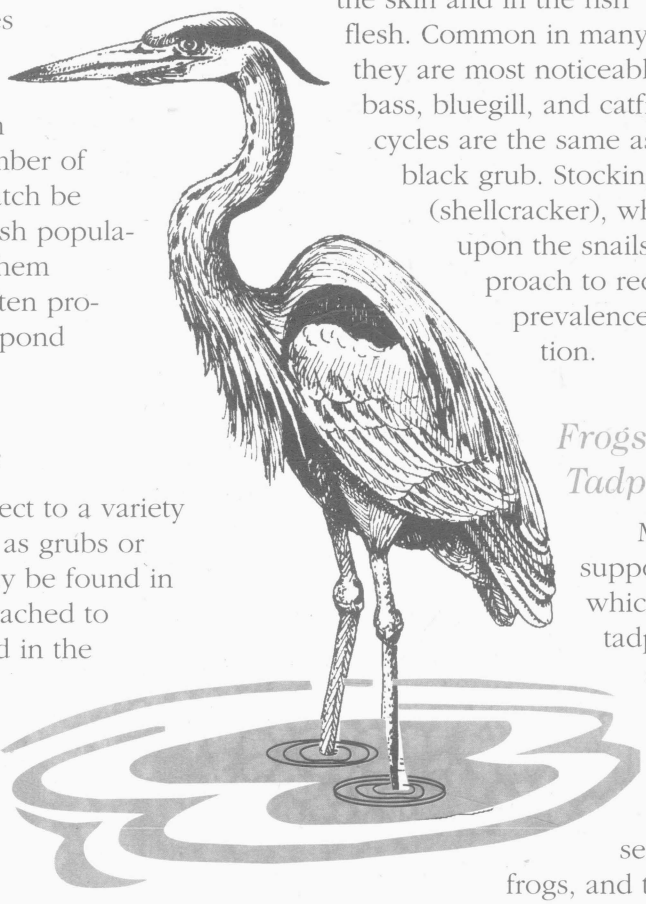
Ducks and Geese

Ponds and small lakes are attractive feeding and loafing areas for migrating waterfowl, and more natural-looking ponds may even attract nesting pairs of ducks and geese. In addition, many pond owners may keep domestic ducks and geese. Such waterfowl provide viewing pleasure, and their feeding habits may help to control some weed problems; however, they also can create problems.

Coliform bacteria thrive in water enriched with waterfowl droppings, especially when the ducks and geese use the pond year-round. For ponds used for swimming, maintenance of more than one pair of domestic ducks or geese per surface acre of water is discouraged. Domestic ducks or geese are not recommended for ponds used for domestic drinking water supplies.

Fish-Eating Birds

Several species of fish-eating birds may visit your pond. Large herons and kingfishers appear often on some ponds. If the pond is secluded, the smaller species of herons may even take up residence. Seldom will the small number of fish these birds catch be harmful to your fish population, and seeing them around a pond often provides pleasure to pond owners.

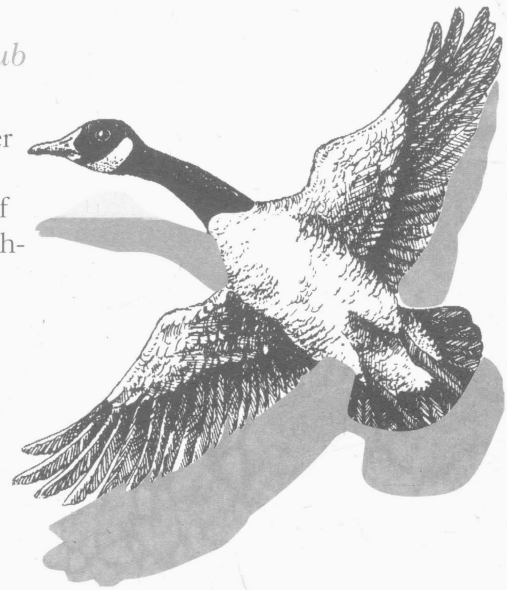


Fish Parasites

Fish are subject to a variety of maladies, such as grubs or worms, which may be found in or on the skin, attached to gills, or embedded in the flesh. Although aesthetically displeasing, none of these parasites presents a threat to human health provided the fish is thoroughly cooked before it is eaten. There are no practical methods to control these parasites in ponds. One aid to prevent their introduction is to stock the pond using only hatchery-raised fish. Parasites and diseases are prevalent in natural fish populations, and stocking a pond with "wildlings" infected with these organisms could result in their inadvertent introduction into the pond.

Black Spot or Black Grub

Small black spots, resembling ground pepper flakes, are visible in the fish flesh. The life cycle of this parasite includes a fish-eating bird and a snail. Sunfish and minnows are commonly affected.



White and Yellow Grubs

These parasites appear as small white or yellow spots under the skin and in the fish flesh. Common in many species of fish, they are most noticeable in largemouth bass, bluegill, and catfish. Their life cycles are the same as that of the black grub. Stocking redear sunfish (shellcracker), which will prey upon the snails, is one approach to reducing the prevalence of the infestation.

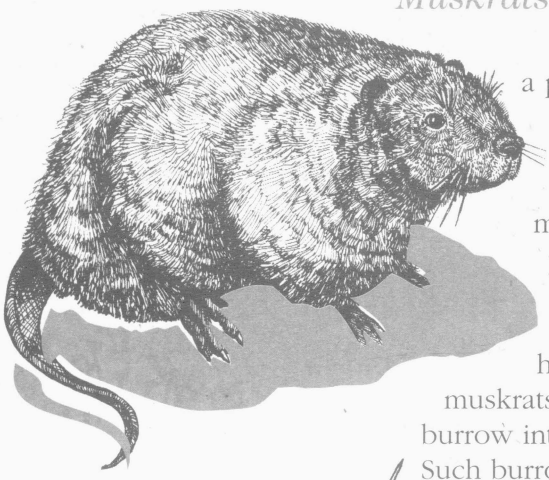
Frogs and Tadpoles

Most ponds will support a few frogs, which, along with tadpoles, provide another source of food for fish. Many pond owners enjoy seeing frogs, and they enjoy the "music" they provide on warm evenings. Because fish, especially bass, eat both frogs and tadpoles, frogs seldom become overpopulated except in ponds where the bass population has become severely depleted. Management for frogs is seldom successful in ponds that are stocked with predatory fish.

Leeches

Leeches present in Ohio ponds are usually small (less than one inch long), colorless, and opaque. They are not blood suckers, but feed on decomposing organic matter in the pond. They attach themselves to swimmers, fish, and the legs and feet of ducks and other water birds. Although harmless, leeches can be very frightening and thus detract from the recreational uses of a pond. There is no practical control method that can be recommended.

Muskrats



Muskrats often invade a pond, especially if it is near a creek or a ditch and there are areas of emergent and submerged weeds in the pond for food. Unlike muskrats found in marshes, which build houses from vegetation, muskrats in ponds usually dig a burrow into the bank as a den. Such burrows may present problems, especially if dug into the dam of a pond. If your pond was designed according to NRCS recommendations, the dam should be wide enough that a burrow is not harmful. However, if the dam lacks adequate width or height above water level, a problem may develop.

Since muskrats are furbearers and are protected by wildlife laws, the recommended method of control is to trap them heavily during the legal trapping season. As mentioned earlier, large areas of cattails and other aquatic plants also will encourage muskrat activity. Get rid of this vegetation, particularly near the dam, if you expect to reduce muskrat populations. Lining the shoreline with coarse stone (at least six inches in diameter) to a depth of three feet below the water level and two feet above will discourage muskrat burrowing.

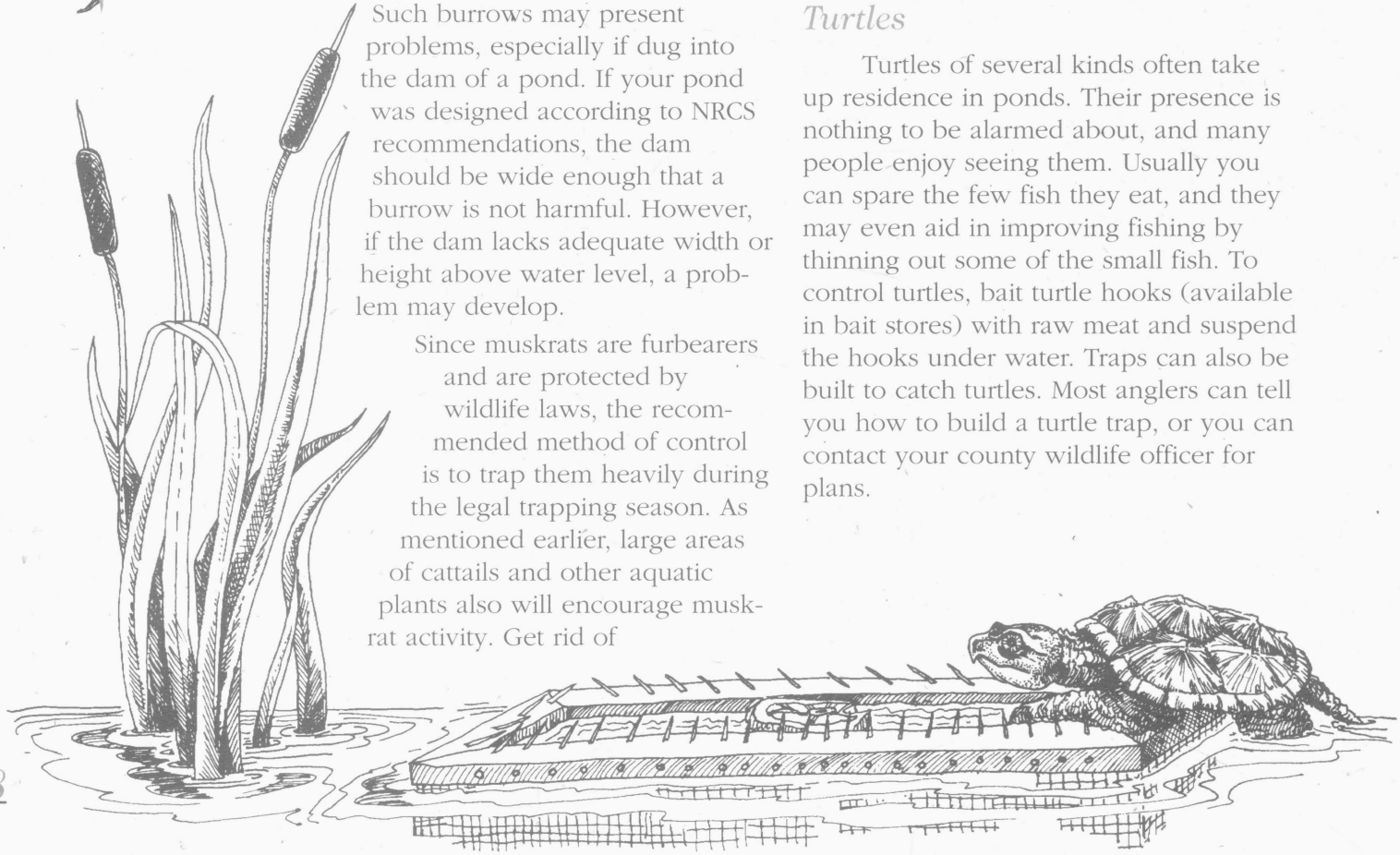
Swimmer's Itch

Although not common in Ohio ponds, this problem is occasionally reported. Swimmer's itch is caused by a free-swimming parasite that burrows into and irritates the skin of humans. The parasite develops in certain birds and snails before it becomes free-swimming.

Elimination of swimmer's itch means controlling the snails. One of the easiest methods of ridding a pond of snails is to stock redear sunfish. Also known as "shellcrackers," one of this species' favorite foods is snails. Redears can also serve as a prey species for largemouth bass and should be stocked with, or in place of, bluegills at the rates mentioned elsewhere in this bulletin.

Turtles

Turtles of several kinds often take up residence in ponds. Their presence is nothing to be alarmed about, and many people enjoy seeing them. Usually you can spare the few fish they eat, and they may even aid in improving fishing by thinning out some of the small fish. To control turtles, bait turtle hooks (available in bait stores) with raw meat and suspend the hooks under water. Traps can also be built to catch turtles. Most anglers can tell you how to build a turtle trap, or you can contact your county wildlife officer for plans.



Clearing Muddy Water

Water in a newly constructed pond is usually muddy. This should clear up as a good sod cover forms on the exposed soil around the pond. Several things may contribute to a new or an old pond's muddy state. These are erosion in the watershed; fine clays in the construction site; muskrats, crayfish, and certain fish; livestock within the pond area; and the action of wind on the shorelines.

The cause of the problem should be determined first. If removal of the cause is not effective, one of several chemicals may be tried. The broadcasting of 1,000 pounds of ground agricultural limestone (calcium carbonate), 740 pounds of hydrated lime, 1,000 pounds of agricultural gypsum, or 250 pounds of aluminum sulfate (commercial alum) per surface-acre is effective in clearing many muddy ponds.

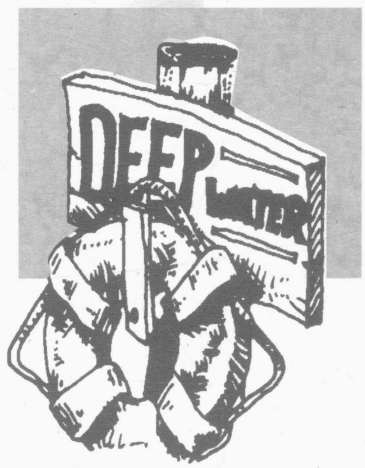
The first two chemicals should clear the pond and keep it clear up to two years. With gypsum it may be necessary to treat several times a year. In some cases, where the turbidity is caused by an excessive growth of microscopic organisms, periodic spray applications of copper sulfate at two pounds per surface acre have proven effective.

Winter Pond Management

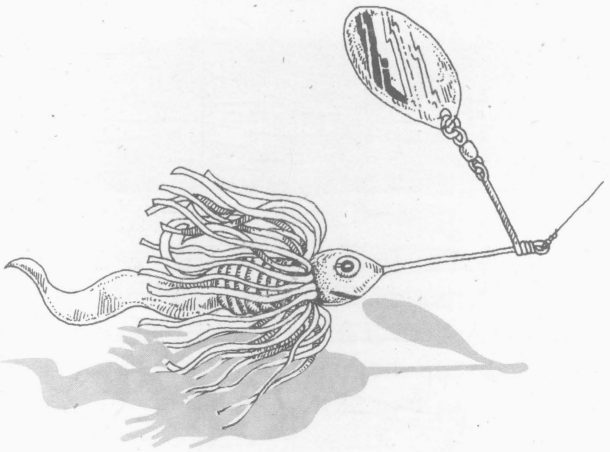
The arrival of winter does not mean you can ignore your pond. Properly constructed ponds seldom freeze deep enough to harm fish because aquatic plants, especially the microscopic plants, continue to produce oxygen as long as light penetrates the ice. However, snow blanketing the ice prevents this light penetration, and plants can no longer produce oxygen. When this situation exists and the decomposition of dead vegetation uses some of the available dissolved oxygen, there may be insufficient oxygen for fish, and they may suffocate. Removal of snow from at least one-tenth of the pond surface will greatly reduce the likelihood of this happening. Good weed control during the growing season and operation of an aerator in the pond during the winter also will reduce this hazard.

Pond Safety

Ponds, like any other body of water, attract people. Because of this, pond owners have an obligation to consider safety measures for their pond. Such considerations should start during the construction of the pond. Trees, stumps, and brush that may present a hazard to swimmers should be removed. Once built, the pond and area around it should be kept free of rubbish, cans, bottles, and other debris that may cause accidents. The placement of warning signs at known danger spots is advised. In addition, lifesaving devices such as ring buoys, ropes, or long poles placed at safety stations near the pond should be provided. Finally, rules should be established regulating the recreational use of the pond.



Tips for Pond Fishing



Largemouth Bass

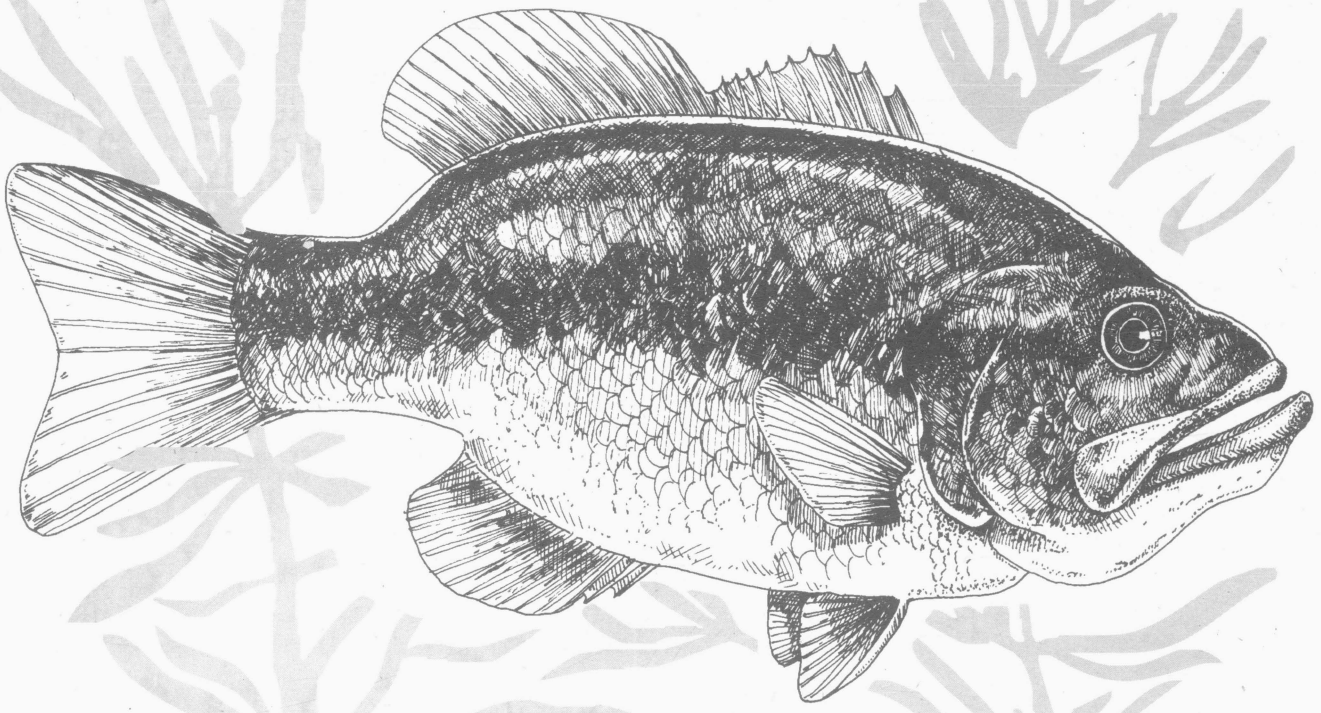
Bass fishing is at its best in Ohio ponds in the spring. Bass usually feed where small fish are numerous — around the edge of the pond or near the cover of water weeds. Feeding bass usually cruise within 20 or 30 feet of the shore.

Watch and listen for bass feeding. If you see one feed twice in the same place, move within reach and place your bait where it is feeding. If an hour of fishing produces no action, it's time to go home or try bluegill fishing.

Recommended baits include both artificial and live baits. Worms, small bluegills, frogs, and crayfish are good live bait. Take care not to introduce undesirable fish through the use of minnows.

Artificial baits used with casting or spinning equipment or fly rods also will catch bass. The secret of success with these baits lies in:

- Using a neat, accurate cast.
- Varying the retrieve by twitching the rod tip.
- Finding the bait that works best for you.
- Fishing the productive spots at productive times of day.

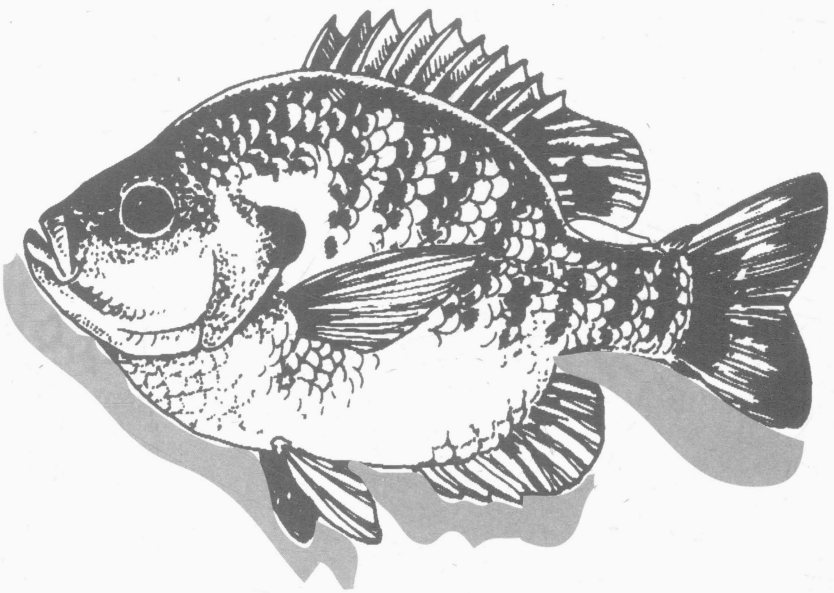


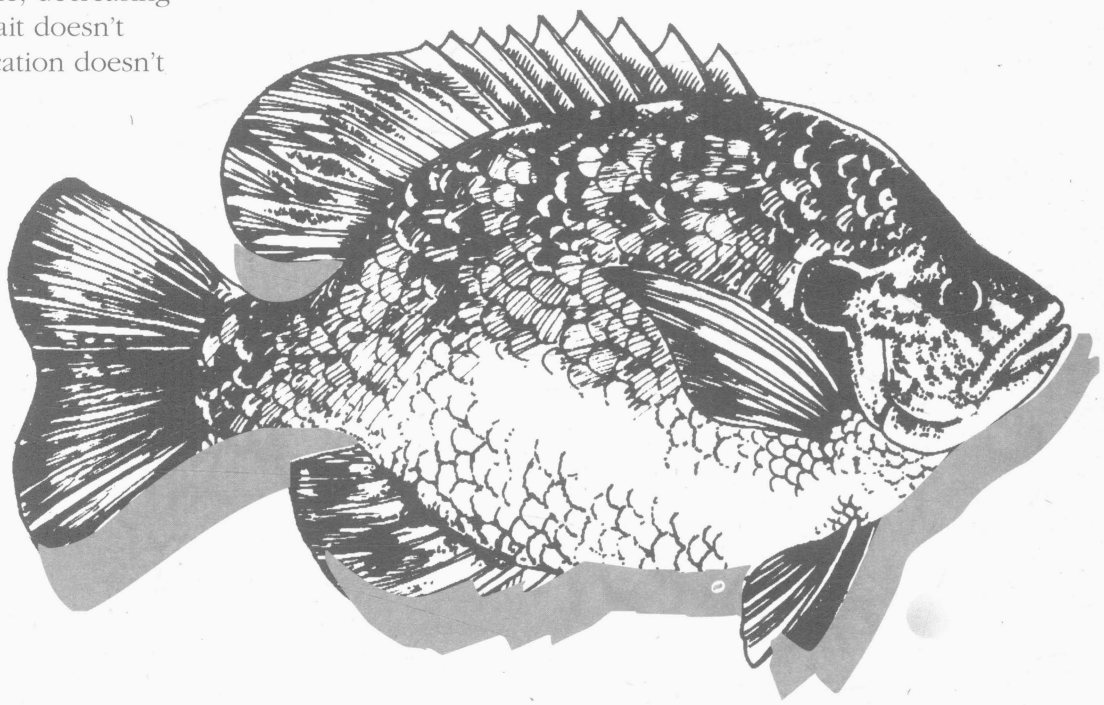
Bluegill and Redear Sunfish

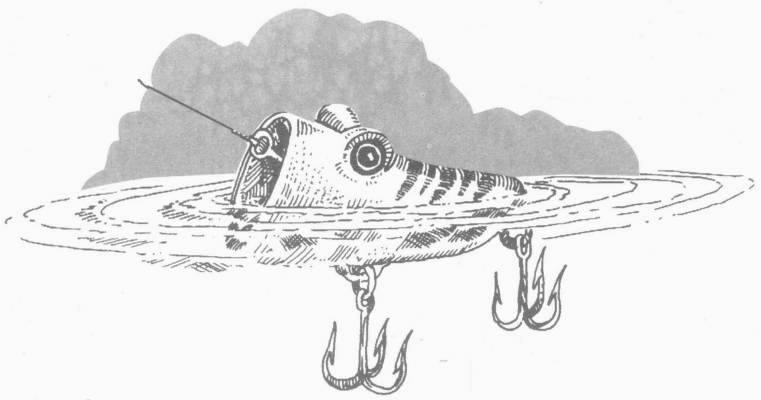
Forage fish (bluegill and redear sunfish) should furnish more than 75 percent of the poundage of fish taken from your pond. They provide summer fishing when bass fishing is slack and are often easy to catch when spawning.

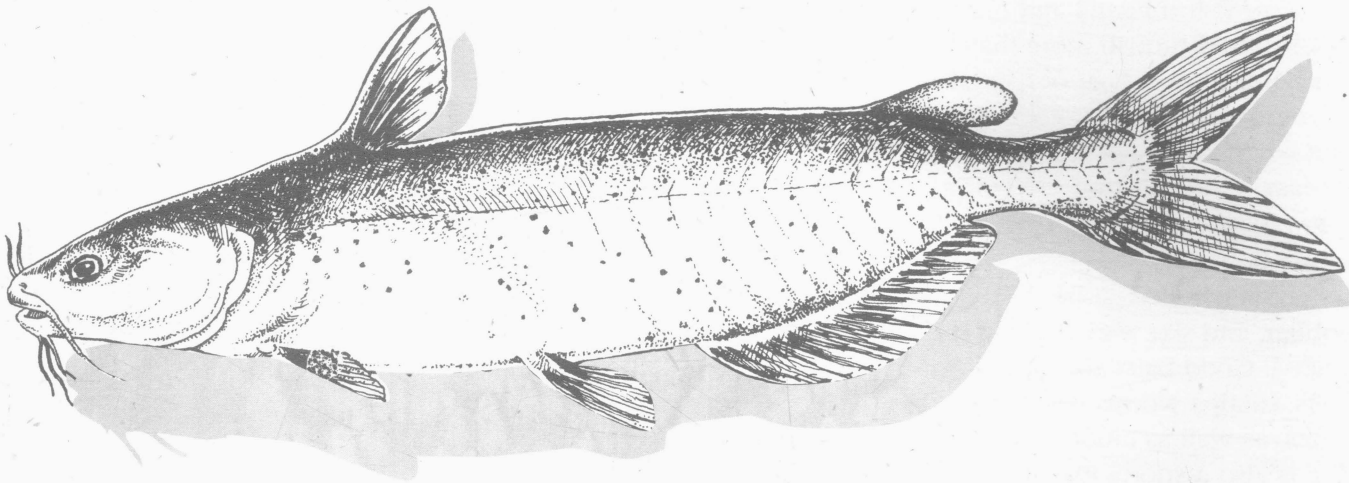
Equipment for catching forage fish need not be fancy. A limber cane pole with lightweight line, small sinker, cork or bobber, and size 8 to 10 hook are all you need. Good baits are earthworms, crickets, catalpa worms, leeches, and maggots, as well as artificial baits. Fly fishing is also a sporty way to take bluegills.

It is a good idea to start fishing for bluegills and redears a few inches off the bottom. For redears, jigging (twitching your line) often produces the best results. If one depth does not produce results, slide your float down the line, decreasing your fishing depth. If one bait doesn't work, try another. If one location doesn't work, move to another.









Channel Catfish

The channel catfish does not usually reproduce in ponds. Consequently, a stocking of this species can be fished out in three to four years and may need to be restocked. If channel catfish are to be stocked with the bass-bluegill combination, there are two factors to consider — the pond should be at least 0.5 acres, and catfish of the same size as the bass and bluegills should be stocked.

This species has a very good flavor and grows to a good pan size. You should be able to harvest catfish weighing 0.5 to 1 pound in the first year. If stocked alone and fished moderately the second year, 1.5-pound catfish may be harvested the third year.

Still fishing and bait casting are good ways to catch channel catfish. Worms, frogs, and crayfish make good bait, and for more sport, try a sinking plug. Allow the plug to sink to the bottom, then retrieve it slowly so it scrapes the bottom and causes a disturbance.

Enjoying Wildlife Around Your Pond

A pond can be made attractive to wildlife with some planning. Quail, rabbits, raccoons, songbirds, and other animals that are attracted to a pond will enrich the hours you spend there. The more secluded the pond, the more likely it is to attract wildlife.

You can increase wildlife use of your pond area in several ways. Plant and protect wildlife nesting cover such as grasses and legumes; plant fruit-bearing shrubs (dogwood, cranberry, autumn olive, bush honeysuckle) for food and landscaping; plant evergreens in clumps of 10 to 15 for winter cover and landscaping. Do not plant these trees close to the edge of the pond if you want to attract ducks. Cover that connects the pond area to cropland and woodland (travel cover) will also increase wildlife use of the pond area.

Fertilizing and liming the area will improve cover conditions as will the construction of a brush pile for additional cover. Predator-proof nesting boxes may also be erected for wood ducks.

Your county Extension agent, county wildlife officer, or NRCS/SWCD office can help you plan the wildlife area and tell you how to get shrubs and trees.

Laws and Regulations

Local

Some local units of government consider ponds to be "structures" and may require a permit, site review, fencing, or fee. Check with local (municipal, township, county) planning and zoning officials to determine what is required before beginning construction of a pond.

State

The state of Ohio has several laws that apply to impounding water. Those laws of interest to pond owners and the state agency responsible for them are noted here.

Aquaculture Products

Aquaculture is defined as "a form of agriculture that involves the propagation and rearing of aquatic species in controlled environments under private control, including but not limited to, for the purpose of sale for consumption of food." Persons who are producing aquatic organisms for sale as food fish must have a permit. Aquaculture permits are issued annually by ODNR Division of Wildlife. The division may be contacted at 614-265-6300.

Dams

A dam is an artificial barrier constructed across a stream channel to impound water. Most dams in Ohio are constructed of earth by farmers and private individuals to create a water supply for agricultural, domestic, or recreation uses. There are more than 50,000 dams in Ohio. Many of these are small and do not fall under the jurisdiction of Ohio's Dam Safety Laws. Dams that are exempt include:

- Dams less than 10 feet in height and having a storage capacity of not more than 50 acre-feet of water.
- Dams, regardless of height, that have a storage capacity of not more that 15 acre-feet of water.
- Dams, regardless of storage capacity, that are less than six feet in height.

Specific questions about dams, permits, and construction should be directed to the Ohio Department of Natural Resources Division of Water, 614-265-6717.

Drainage

Water-rights laws in Ohio are complex. Most decisions are based on civil case law. Landowners interested in constructing a pond should avoid creating these situations:

- Backing up surface or subsurface water onto neighboring property.
- Diverting a watercourse from its natural course or state in a way that injures or prejudices others.
- Diverting water from its natural drainage pattern.
- Unreasonable use, such that quantity and quality of water is degraded.

When constructing a pond, a good rule of thumb is to ensure that water continues to enter and leave your property at the same places as it did before the pond was built.

Fishing

Licenses are required when fishing in public waters, but there are several exemptions related to privately owned ponds, lakes, and reservoirs. A fishing license is not required of persons who are:

- Fishing on a private pond.
- Fishing on land and water which they or their parents own.
- Fishing on land and water where they or their parents are tenants on which they reside and from which they derive income from agricultural production on that land (except state-owned lakes).

Persons fishing in privately owned ponds, lakes, or reservoirs must have a license to take frogs and turtles.

Nuisance Wildlife

While one benefit of a pond is the wildlife that will be attracted to it, pond owners may be forced to address some of the problems associated with wildlife problems in and around their ponds. Because wildlife is a publicly owned resource, the state has passed laws that govern the management and taking of wildlife. Canada geese, muskrats, groundhogs, beavers, and various bird species may cause nuisance problems in and around the pond. If nuisance situations develop, pond owners should contact their county wildlife officer to determine what actions may be taken to resolve the problem. Contact the Ohio Department of Natural Resources Division of Wildlife, 614-265-6300.

Pesticides

The use of pesticides is regulated by the Ohio Department of Agriculture. Pond owners who purchase and apply pesticides (herbicides, algaecides, etc.) in their own ponds are considered "private applicators" and do not need a license unless the material is classified as ***restricted*** (such as rotenone). Purchase and use of restricted pesticides requires training, a test, and a license.

Pond owners, who hire someone to use pesticides in their pond, are employing a "commercial applicator" who has received training, passed a test, and has been issued a license. Pond owners should make sure that anyone they hire to treat their pond is, in fact, licensed to do so. Contact the Ohio Department of Agriculture, 614-728-6270, if you have questions about a particular applicator.

Triploid White Amur Fish

The triploid (sterile) white amur is an exotic fish species that has been specifically authorized for use in Ohio. Diploid (fertile) white amur remain illegal in Ohio. Pond owners wishing to purchase triploid white amur must do so from a dealer who has a valid White Amur Dealer Permit. Contact the Ohio Department of Natural Resources Division of Wildlife, 614-265-6300.

Additional Extension Publications

These publications are available from your county office of Ohio State University Extension:

Placing Artificial Fish Attractors in Ponds and Reservoirs, Natural Resources Fact Sheet A-1

Pond Measurements, Natural Resources Fact Sheet A-2

Controlling Filamentous Algae in Ohio Ponds, Natural Resources Fact Sheet A-3

Chemical Control of Aquatic Weeds, Natural Resources Fact Sheet A-4

Farm Pond Safety, AEX-390

This publication contains pesticide recommendations that are subject to change at any time. These recommendations are provided only as a guide. It is always the pesticide applicator's responsibility, by law, to read and follow all current label directions for the specific pesticide being used. Due to constantly changing labels and product registration, some of the recommendations given in this publication may no longer be legal by the time you read them. If any information in these recommendations disagrees with the label, these recommendations must be disregarded. No endorsement is intended for products mentioned, nor is criticism intended for products not mentioned. The authors and Ohio State University Extension assume no liability resulting from the use of these recommendations.

Visit the Ohio State University Extension website, *OhioLine,* to access more than 4,000 publications.
http://ohioline.ag.ohio-state.edu

Sources of Assistance

	Private Fish Hatcheries[1]	SWCD[2]	Private Consultant[3]	ODNR Division of Water/ Local Zoning Officials[4]	Construction Contractor[5]	ODNR Division of Wildlife[6]	Ohio State University Extension[7]	Agri-chemical Dealers[8]	Licensed Pesticide Applicators[9]
Planning		XXX	XXX		XXX				
Construction		XXX	XXX		XXX				
Vegetation management			XXX				XXX	XXX	XXX
Fish stocking and management	XXX	XXX	XXX			XXX	XXX		
Nuisance wildlife						XXX			
Herbicide/ algaecide applications			XXX						XXX
Fish kills						XXX	XXX		
Construction laws and regulations		XXX		XXX					
Purchase aquatic pesticides								XXX	

[1] Call ODNR Division of Wildlife (DOW) (614-265-6300) and ask for the publication *Fish and Fish Food Propagators*. This is a list, by county, of licensed fish propagators in Ohio.

[2] Look in the local phone book under "county government" listings.

[3] Contact your county OSU Extension or SWCD office to inquire about consultants in the area.

[4] Contact local zoning officials regarding local permits; contact ODNR Division of Water (614-265-6717) about dam laws and permits.

[5] Contact your local SWCD office for a list of private pond construction contractors.

[6] Contact your county OSU Extension or SWCD office for the name and phone number of the county wildlife officer, or contact ODNR Division of Wildlife (614-265-6300).

[7] Look in the local phone book under "county government" listings, or call the State Extension Office (614-292-4077).

[8] Look in the local phone book under "farm supplies" or "garden centers."

[9] Look in the local phone book under "farming services," "farm supplies," or "pest control," or call your county OSU Extension office.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