Ohio Pond Management HANDBOOK

a guide to managing ponds for fishing and attracting wildlife

OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WILDLIFE

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Pond Management Handbook

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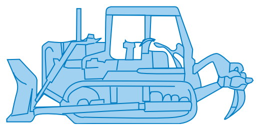
Table of Contents

Introduction 4

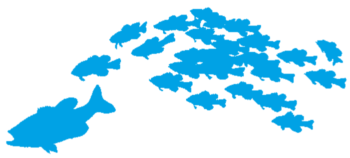


Chapter 1

Pond Construction 5

Chapter 2

Stocking the Pond 9



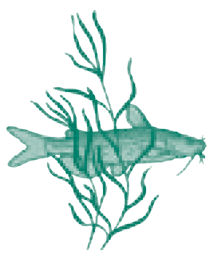
The Most Popular Pond Fish 9
How Many and What Sizes of Fish to Stock 11
When and How to Stock Fish 11
Stocking Other Types of Fish 11

Chapter 3

Management Practices for the Best Fishing 13

Assessing Fish Populations 14
Management Options Based on Selective Harvest 14
Increasing Fish Production 19
Adding Fish Habitat Structures to the Pond 20

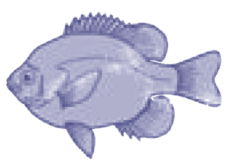
Chapter 4



Managing Aquatic Vegetation 23

Plant Identification 23
Methods for Control of Aquatic Vegetation 27
Before Applying Control Measures 29

Chapter 5



Fish Health 31

Common Fish Diseases 31

Chapter 6

Pond Problems and Solutions 35

Fish Kills 35

Undesirable Fish 38
Muddy Water 39
Leaky Ponds 40
Problems Caused by Animals 40
Fish Kill Problems – A Troubleshooting Guide 43

Chapter 7

Wildlife Habitat Enhancement Around the Pond 45

Wildlife Plantings Around the Pond 45
Wildlife Nesting Structures 45

Glossary 47
Appendix A: Sources of Information 49
Appendix B: Ohio Division of Wildlife Publications 49
Appendix C: Sources of Equipment and Supplies 50
Index 51

Introduction

Ohio farm ponds provide important recreational, domestic, and agricultural uses that range from fishing, swimming, and wildlife viewing to water sources for humans and livestock, irrigation, and erosion control. Ponds can be very beneficial to both people and wildlife. People benefit from the recreational opportunities and agricultural uses, as well as the added aesthetics of having a pond on their property. Ponds benefit wildlife by providing feeding and nesting habitat, resting areas, and water sources. Ponds that are constructed, maintained, and managed with these uses in mind are a valuable part of Ohio's natural resources.

This manual is intended for owners of new ponds, owners of old ponds, or landowners who plan to build a pond. Managers of small private lakes will find useful information in this manual as will anglers who wish to be informed on pond management matters. The information contained in these pages is intended to educate as well as to guide. Where appropriate, basic biological information behind management practices has been included to help pond owners understand why certain practices work and others don't.

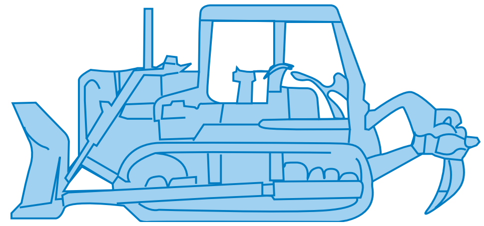
Many of the recommendations in this manual appear to be very cookbook-like in the way they are described. However, because no two ponds are identical, it should be noted that many of the rates suggested for fish stocking or chemical use are simply averages derived from ranges recommended for ponds in this part of the country. The idea here is to suggest techniques that should be effective in most ponds, and to describe the technique's relation to the range of potential results. Our intent is to have the reader gain enough insight into what might happen, and why, to realize that pond management is as much an art as it is a science. The pond owner should seek to make use of the general principles of management contained within this manual, but also be aware that other sources of information are available, and make use of them when circumstances warrant.

The organization of this manual was designed to achieve these purposes. In Chapter 1, the topic of pond construction is presented to place the importance of all the factors that go into a quality pond in the proper perspective. Chapter 2 addresses the idea of stocking fish in the pond in terms of the proper kinds and numbers of fish to stock, as well as kinds to avoid. In Chapter 3, the concept of management practices to create a desired type of fishing is covered. Whereas the first two chapters are intended primarily for new ponds, the management practices chapter is applicable to both new and existing ponds. The idea of managing aquatic vegetation, rather than simply eliminating it, is presented in Chapter 4. The idea here is that the pond can be viewed as a garden where certain types and amounts of vegetation are beneficial, whereas others are not and may require some type of control. Fish health concerns are addressed in Chapter 5, with the intention of providing the reader with an understanding of potential threats to fish health as well as preventative measures that can be taken. After presenting information about construction, stocking, management for fishing, aquatic vegetation, and fish health, the concluding chapter comes to grips with all of the things that can go wrong or cause problems for the pond owner. Again, the intent here is that by understanding the conditions that can lead to problems, the reader can be better prepared to prevent them in the first place.

In presenting each of these topics, no attempt has been made to avoid technical matter, although use of technical terminology has been kept to a minimum. For the convenience of the pond manager who will be using this manual, important terms and concepts are defined the first time that they are presented. More complete definitions of important terminology can be found in the glossary at the back of this manual. Additional sources of information, products, or publications are referenced throughout the text and are contained in one of the three appendices. A thorough index of all topics covered has also been added to quickly direct the reader to any information desired.

It is our sincere hope that the information presented in this manual will contribute significantly to the understanding and enjoyment of your pond. A properly constructed, maintained, and managed pond will be an asset rather than a liability, and can enhance your quality of life through the years of recreation and enjoyment it provides.

Chapter 1: Pond Construction



Proper planning and construction are the keys to building a pond that will meet owner needs whether they are primarily recreational, aesthetic, or agricultural. Prospective pond owners should obtain technical advice from government agencies for guidance concerning pond design. These agencies offer the necessary experience to recommend the pond size, depth, location, and dam and spillway construction that are best suited to the landowner's desires and the watershed and soil characteristics.

On-site advice from natural resource professionals is the first step for building a pond that will provide years of satisfaction and require minimal maintenance. Prospective pond builders should seek advice from the USDA Natural Resource Conservation Service. Their agents provide help with soil surveys, site selection, pond design and construction. Further assistance may also be obtained from your county Soil and Water Conservation District (SWCD) and local office of The Ohio State University Extension Service (Appendix A).

Watershed. The entire land area that drains into a pond is called the watershed. A landowner needs to consider the size, use, ownership and slope of this drainage basin before building a pond because ponds receive most of their water from surface runoff, rainfall and groundwater. These factors may limit the size and type of the pond that is practical to build. Generally, a one-acre pond should have a 10- to 15-acre watershed, or approximately three to five acres of drainage area for each acre-foot of water storage. If the drainage area is too large, large and expensive spillway structures must be built to prevent the dam from washing out when large inflows of water follow heavy storms. Too much inflow may also cause sedimentation and other water quality problems. On the other hand, if the watershed is too small for a pond's capacity, then proper water levels may not be maintained during droughts. The pond's water level should not fluctuate more than two feet during drought conditions. Groundwater should make up for losses from evaporation and normal seepage of water through the pond bottom. Achieving the proper watershed size to pond size ratio is one reason that technical guidance is important in building a pond.

Land use practices on the watershed will also affect water quality in a pond. Significant industrial, pesticide, acid mine drainage, or septic pollution sources on the watershed should be corrected before pond construction, or an alternative pond site should be chosen. Drainages with high agricultural land use should be avoided if possible. Forested or non-agricultural grassland watersheds provide the best protection against sedimentation and water quality problems.

Soil. A landowner needs to identify the type of soil at the prospective pond location during the planning and design process. Soil type is important to consider when selecting a pond site because the capabilities of soil to hold water differ between soil types. Soils must contain at least 20 percent clay by weight to prevent excess seepage. When clay soils absorb water they swell and seal the bottom of the pond. Three feet of high clay content soil is usually needed below the excavation level to prevent excess seepage. If porous soils such as sand and gravel underlie the pond basin, then either an alternative site must be considered, or an impervious layer of soil should be compacted over these areas to prevent excess seepage or leaks. If only a small portion of the pond basin has undesirable soils, it may be possible to haul in good clay soil from a nearby area without significantly increasing construction costs.

Although county soil survey maps can be very useful for determining the type of soils present and their suitability for a pond, thorough site investigation is essential prior to construction. Call your local Natural Resource Conservation Service agent for information on soil test pits and soil type testing.

Pond Size, Depth and Location. Pond size and depth may be dictated by the intended uses of the pond. Ponds designed for sportfishing should not be smaller than one surface acre because smaller ponds tend to be more difficult to manage. Large ponds are generally more cost effective to build and offer better and more sustainable fishing. A minimum depth of eight feet or more should be maintained in at least 25 percent of the pond basin. Deeper water may be necessary in the extreme northern part of Ohio where winter snow and ice may prevail for long periods of time. Greater volume and depth may be required to prevent of a winter fish kill (see Chapters 4 and 6). In such cases, 10 to 12 foot depths should be maintained in at least 25 percent of the pond basin. However, ponds constructed with depths much over 12 feet are often a waste of money for they create no additional benefits to fish. Local soil conditions may also dictate the exact depth that can be achieved within these recommended ranges.

Shoreline areas should be constructed with slopes adequate to prevent excessive growth of aquatic vegetation, yet provide quality fishing. A slope that drops one foot in depth for every three feet of distance towards the center of the pond, or a 3:1 slope, should be maintained along most of the shoreline areas. This will create the best conditions for spawning areas, provide cover and feeding areas for largemouth bass and bluegills, and minimize pond maintenance. Extensive areas of water less than three feet deep often become choked with aquatic vegetation and algae.

Prospective pond owners also need to consider pond location in their planning. Convenient access for recreation and maintenance is important to most pond owners. Others, however, may want to locate their ponds where more privacy is provided.

Dam Construction. A dam should be located where it is least expensive to build. Construction costs can be minimized by selecting a site that requires minimal soil movement and easy access to construction equipment. Keeping the length and size of the dam at a minimum will also reduce costs. Sites which have steep to moderately sloping terrain, tapering off to a relatively level basin are best for embankment ponds (Figure 1.2). Excavated ponds are preferred over embankment ponds in flat or gently sloping terrain and may not require an expensive dam. Floodplains should be not be selected as sites for either type of pond because the dam may be eroded by floods.

Dams should be designed and constructed by experienced professionals to ensure reliable service. Improperly installed dams present safety hazards and are an economic liability to the landowner if a dam fails. Properly designed, constructed, and maintained dams help stabilize water levels during periods of heavy rain, minimize loss of water during drought, and permit pond draining. The exposed slopes of the dam should be graded with topsoil and seeded immediately with a combination of perennial grasses to prevent soil erosion. If the dam is completed in the fall, annual rye grass, wheat, or oats should be planted to provide erosion protection until spring when the area can be reseeded with perennial grasses. Regular mowing and maintenance are necessary to prevent trees from growing on the dam. This is important because tree root systems may cause leakage problems and attract burrowing animals. Rock riprap can be added to the slope on the water side of the dam to further prevent erosion and burrowing by nuisance animals.

Excavated Ponds. Dug or excavated ponds are constructed in areas of flat or gently sloping land not suited for ponds with dams. As the name implies, dug ponds are created by removing soil and allowing water to fill in the dug out area. Most of the water supply comes from ground water seepage or natural springs. Soils are usually made up of materials that allow free movement of water through the pond bottom.

Embankment Ponds. Embankment ponds are more common in areas with moderate to steep sloping terrain. They are created by building a dam between two hillsides to collect and hold water from overland runoff. The pond bottom and dam must be made up of soil that prevents excess seepage. Embankment ponds should not be built by damming permanent flow streams, no matter what size they are. Small streams are a source for silt, sediment, debris, excess nutrients, and undesirable fish, all of which can degrade water quality and reduce chances for good fishing.

Combination. In many instances, a combination of digging and impounding (damming) is used to create a pond. A dam is built to hold water and some digging is used to finish the basin to the desired slope and depth.

Spillways. The principal spillway is usually located along the face of the dam at the normal water level. It is designed to maintain the water level under normal inflows from snow melt, spring flow, and rain. Drop inlet and hooded inlet trickle tubes are two of the more common

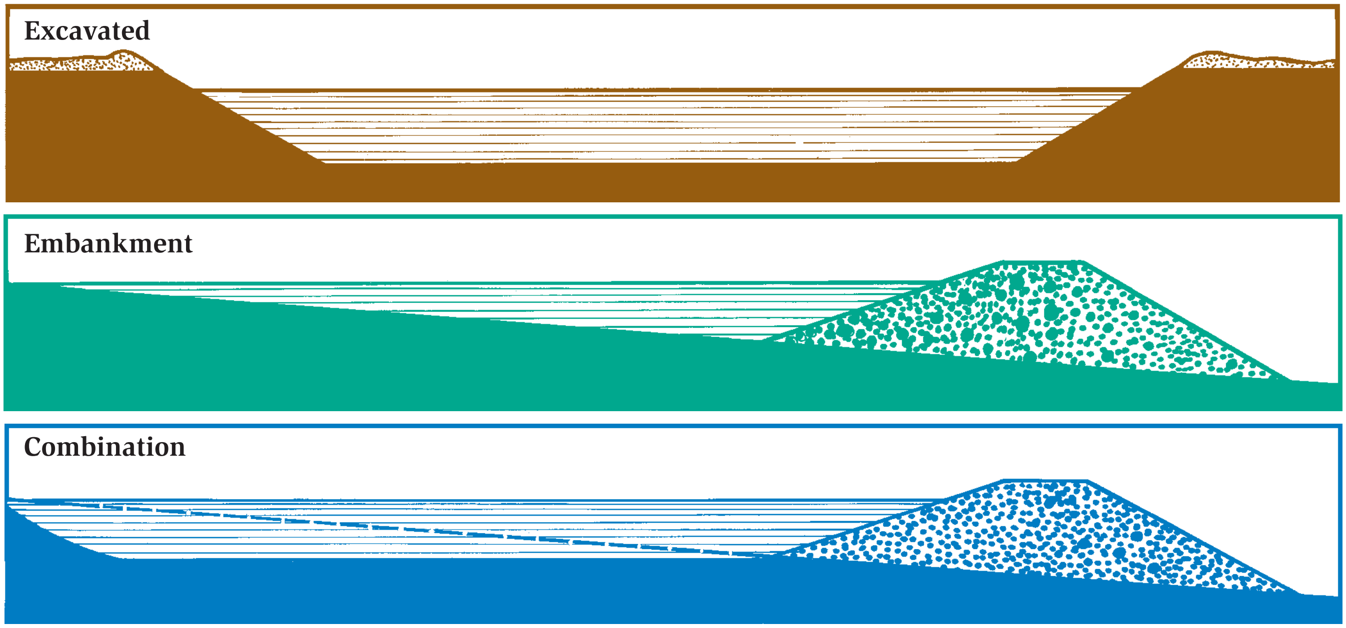


Figure 1.2. Pond types: excavated, embankment, combination.

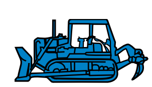
overflow pipes used in farm ponds. Hood inlet tubes pass at an angle through the center of the dam and drop inlets pass underneath the dam. Drop inlets are more expensive to install than hooded inlets, but can be designed to allow the pond to be drained. This is an important feature to have in ponds managed for fishing. All pipes that pass through the dam must be installed with anti-seep collars to prevent leaks from developing along the pipe as it passes through the dam.

Embankment ponds should have both a principal and emergency spillway. The emergency spillway provides an exit point for excess water. During periods of high rainfall, it routes water around the dam to prevent excess storm runoff from flowing over and eroding the dam. The emergency spillway should be cut into undisturbed terrain adjacent to one end of the dam where the overflow will fall into the natural drainage.

Drain Pipe. When possible, a drain pipe should be installed in ponds managed for fishing. This allows the pond to be drained to eliminate undesirable fish populations, or drawn down for management of nuisance aquatic plants, maintenance of banks, or repair of the dam. A drain pipe may also facilitate livestock watering (see Chapter 6 for details about livestock watering and pond construction concerns).

Principal spillway

Dry Hydrants. Dry hydrants can be installed in just about any pond as a readily available source of water for fire fighters. This is an especially nice feature in rural areas that lack public water supplies. Dry hydrants can be installed into new or old ponds, but are usually more convenient to install during construction. Personnel from the county Natural Resources Conservation Service office can provide material specifications and construction and cost information for installing dry hydrants.

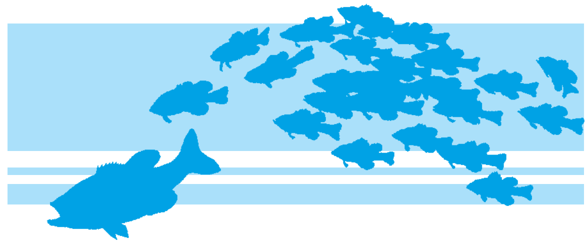


Dry hydrant

A completed farm pond

Aerial view of excavated ponds

Chapter 2: Stocking the Pond



Some of the finest fishing in Ohio for largemouth bass, bluegills, and channel catfish can be found in farm ponds that have been properly stocked and managed. New ponds are usually stocked with fingerling largemouth bass, bluegills, and channel catfish, whereas ponds with established fish populations may periodically be supplemented by stocking larger fishes. Successful stocking is as easy as determining the type of fishing a pond owner desires and the current condition of the pond.

A properly stocked and managed pond will provide years of quality fishing. Stocking the proper kinds, sizes, and numbers of fishes will start a pond in the right direction. Most Ohio ponds are ideal for largemouth bass, bluegills, and channel catfish, and all three provide excellent fishing and fine eating. An initial stocking of a combination of these fishes is usually recommended for new or renovated ponds. Properly managed largemouth bass and bluegills will produce self-sustaining populations, whereas channel catfish usually require periodic restocking. Channel catfish are often considered "bonus fish" because they don't interfere with the other pond fish, but provide extra fishing and harvest opportunities. Redear sunfish can also be stocked as a "bonus fish" in combination with bluegills and are popular because they rarely become overabundant and often grow to large sizes. However, they can be more difficult to catch than bluegills.

Another fish which is occasionally stocked in farm ponds is the triploid grass carp, or white amur. Unlike largemouth bass, bluegills, redear sunfish, and catfish, grass carp are not stocked for sport or to eat, but to control or eliminate nuisance aquatic vegetation. Additional information about grass carp is available in Chapter 4.

The Most Popular Pond Fish

Largemouth Bass. The largemouth bass is the top predator in Ohio ponds. It is the largest member of the sunfish family, which also includes the bluegills and redear sunfish. In Ohio, most largemouth bass begin spawning at age three when they are 10 to 12 inches long. Spawning starts during May when water temperatures reach 60°F and is usually completed by mid-June. The male builds a nest by using his tail to fan out a saucer-shaped depression on the bottom in one to six feet of water. After the female deposits eggs in the nest, the male fertilizes them and guards the nest until the eggs hatch in 4 to 14 days.

Young largemouth bass leaving the nest eat tiny microscopic animals, called zooplankton. As largemouth bass grow, they switch to a diet of insects, crayfish, and small fish. Adult largemouth bass in ponds usually eat bluegills and small largemouth bass, although their diets can be quite variable.

Growth of largemouth bass is also rather variable, depending on food availability and habitat suitability. Average growth rates of bass in Ohio farm ponds can be found in Figure 2.1. Most largemouth bass live from four to six years, but some may live to 10 years old or more. Even though the average size of an adult largemouth bass is only one or two pounds, fish up to five pounds or larger are not uncommon in Ohio ponds. In fact, the current Ohio record largemouth bass of 13 pounds, 2 ounces was caught from a farm pond in 1976.

Bluegills. Bluegills are not only important as food for largemouth bass, but are also very popular among anglers for both sport and the table.

Largemouth bass

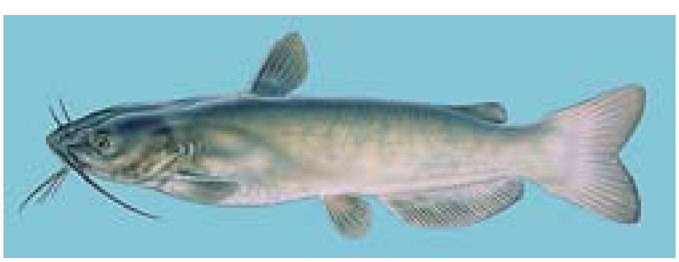
Bluegill

Bluegills are usually the pond fish most eager to bite and put up a good fight on light tackle despite their small size.

Most bluegills can spawn by age two when they are about three inches long. Spawning begins two to four weeks later than for largemouth bass when the water temperature reaches 70°F. Even though the spawning period usually begins in late May, it often continues through the summer. Bluegills build nests similar to, but smaller than those built by largemouth bass. Many nests are built close together in a relatively small area one to four feet deep. However, male bluegills rarely guard nests for more than three to five days.

Young bluegills feed on tiny microscopic plants, called phytoplankton, and zooplankton. The diet of adults often includes insects, snails, small crayfish, fish eggs, and very small fishes. Bluegills can grow to six inches in two to four years when plenty of food and space are available (Figure 2.1). This is the size that most anglers begin to keep for eating, although bluegills can grow to over 10 inches long.

Redear Sunfish. The redear sunfish, or "shellcracker," is the southern cousin of the bluegill. The name "shellcracker" came about from this fish's frequent eating of snails, which it can crush with specialized teeth in its throat. Since their introduction into Ohio during the early 1930s, redear sunfish have been widely stocked into lakes and ponds.

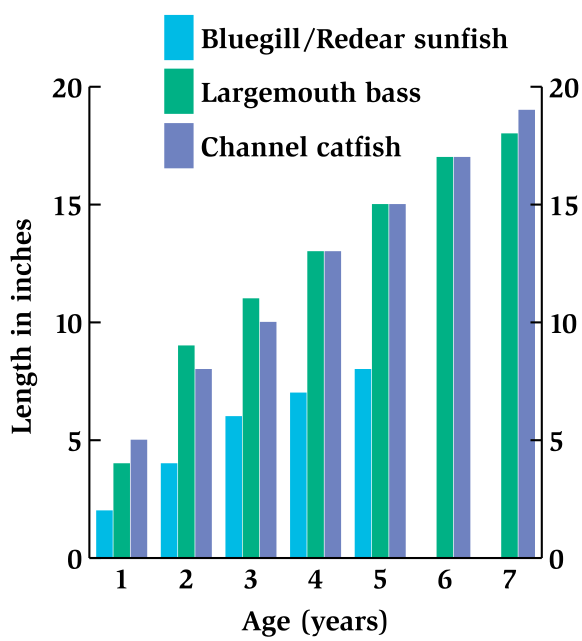


Channel catfish

Redear sunfish spawning is similar to that of bluegills, but they produce fewer offspring. Redear sunfish are usually stocked in combination with largemouth bass and bluegills because they rarely provide enough food for largemouth bass by themselves. Growth of redear sunfish is similar to that of bluegills.

Channel Catfish. Channel catfish are most at home in large streams, lakes or reservoirs, but they also survive and grow very well when stocked in ponds. These fish are primarily bottom feeders, preferring live or dead insects, crayfish, fish, and occasionally aquatic plants. They can also be easily trained to feed on commercial food pellets. Pond owners who stock channel catfish should be aware that in some shallow ponds these fish may stir up the bottom and cause the water to become muddy. Since channel catfish rarely reproduce in ponds, if they become a problem by creating muddy water, the pond owner can harvest the catfish in the pond and simply stop stocking them. Ohio anglers typically catch channel catfish in the 14- to 16-inch size range, although larger fish up to 26 inches are not uncommon.

Figure 2.1. Typical growth of fish in Ohio farm ponds.



How Many and What Sizes of Fish to Stock

Stocking the recommended sizes and numbers of fish is very important for good fishing. Fingerling fish one to three inches long are recommended for stocking new or renovated ponds. Starting a pond off by stocking larger fish is tempting, but can lead to an "unbalanced" pond with too many fish of one kind and too few of another. Stocking larger fish can also be very expensive. Table 2.1 shows how many fish of each kind to stock depending on the desired combination.

Whereas stocking fingerlings is recommended for new or renovated ponds, occasional stockings of larger fishes, or periodic restocking of channel catfish may be necessary in ponds with established fish populations. Stocking intermediate size fishes is recommended at reduced rates compared to fingerlings. For example, if largemouth bass or bluegills need to be supplemented, stocking four- to six-inch largemouth bass at the reduced rate of 50 per acre, or two- to four-inch bluegills at the reduced rate of 250 per acre may be appropriate. Channel catfish should be at least eight inches long for periodic restocking so they are not eaten by adult largemouth bass. Stocking these larger channel catfish is recommended at the reduced rates of 25 to 50 per acre.

When and How to Stock Fish

Stocking fishes need not be delayed once a new or renovated pond has filled. Although stocking during cooler seasons is a little easier on the fish, the time of year a pond is stocked is not all that important. Ponds are often stocked in the fall because fish tend to be more available from commercial fish dealers at that time.

Fish stocked in ponds need to be in the best possible condition. The person stocking the pond should try to avoid rough handling or extreme water temperature changes when transporting fish to the pond. Fishes must be carefully acclimated if the water temperature in the hauling container differs more than 5°F from the pond water. This is often done by placing the hauling container, usually a sealed plastic bag, into the pond and allowing the water in the bag to reach the same temperature as the pond. Another method is to gradually add pond water to the container until the temperatures are similar. With either method, acclimation time should be about 30 minutes.

Fishes for your pond should be obtained from a licensed commercial fish propagator. This is recommended over obtaining your own fish from local streams, rivers or lakes because you may accidentally introduce undesirable types of fish, parasites, or even diseases. A list of licensed fish propagators located in Ohio is available from the Division of Wildlife (Publication 196, Appendix B). The Ohio Division of Wildlife does not provide fish for private ponds; Division hatcheries only provide fish for public fishing waters.

Table 2.1. Recommended stocking rates of fingerling fish for new or renovated ponds.

	Number of fish to stock per acre			
Stocking combination	Bass	Bluegill	Redear	Catfish
Bass-bluegill	100	500		
Bass-bluegill-catfish	100	500		100
Bass-redear	100		500	
Bass-bluegill-redear	100	350	150	
Bass-bluegill-redear-catfish	100	350	150	100

Stocking Other Types of Fish

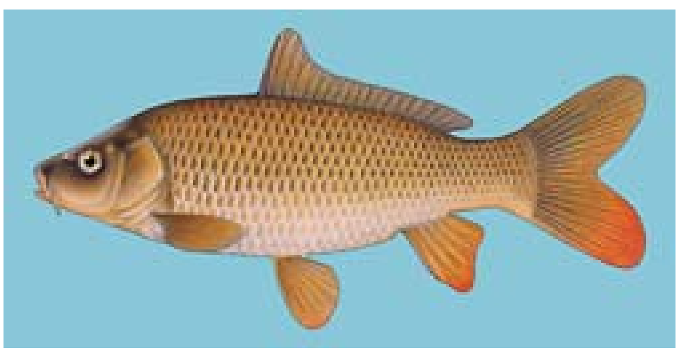
Largemouth bass, bluegills, redear sunfish, and channel catfish are the most appropriate fishes for stocking the majority of Ohio ponds. Experimenting with other types is not recommended if the pond owner is interested in easy and inexpensive maintenance of a quality fishing pond. Very few ponds are exceptions to this rule because few ponds have the unique conditions that make stocking other fishes possible. For example, spring fed, highly oxygenated ponds that remain below 75°F through the summer may support trout, but are very rare in Ohio.

Undesirable fishes for a pond include green sunfish, hybrid sunfishes, white crappies, black crappies, yellow perch, bullheads, common carp, and gizzard shad (Figure 2.2). Each of these types of fish can take over a pond, compete with the desirable fish for food and space, and ruin the quality of fishing. They are usually introduced into ponds by accident, or by well-intended "stockings" from a neighbor. Once they become established, undesirable fishes can be difficult to eliminate.

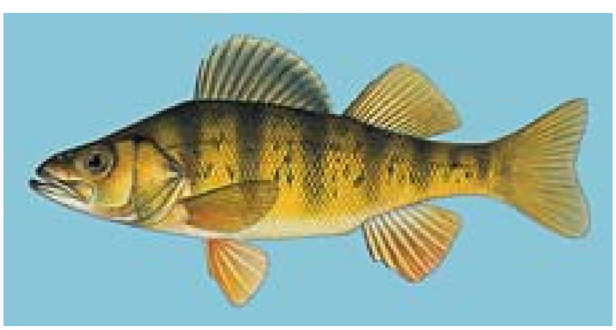
Figure 2.2. Fishes that are not desirable to stock in Ohio farm ponds.

White crappie

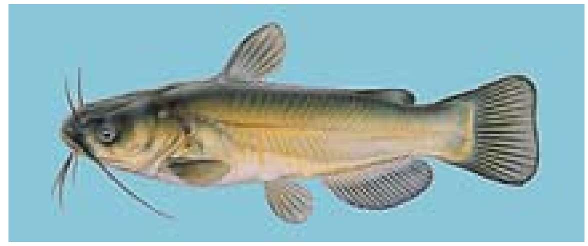
Black crappie



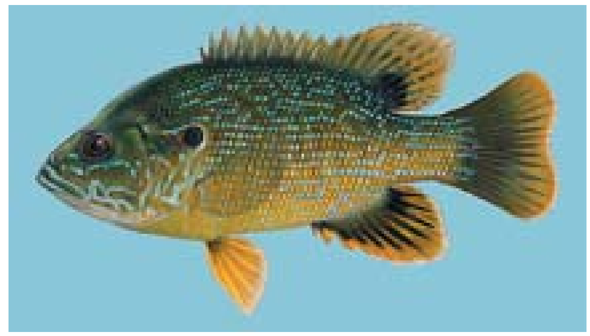
Common carp



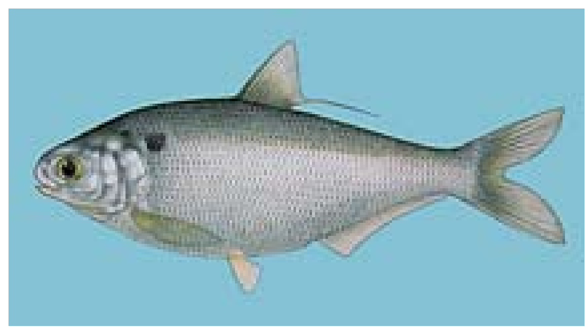
Yellow perch



Bullhead



Green sunfish



Gizzard shad

Chapter 3: Management Practices for the Best Fishing

Creating and maintaining good fishing in a pond that has been properly constructed and stocked doesn't have to be a lot of work. In fact, it can be as simple as a pond owner deciding what he likes to catch most and then following the management recommendations contained in this chapter. Some pond owners may simply want to catch as many fish as possible, regardless of their size. Others may want to catch fewer, but bigger largemouth bass and bluegills. Still others may prefer to catch mainly trophy largemouth bass or channel catfish. Each option is possible with little more effort than it takes to simply control the kinds and sizes of fish harvested from the pond.

Pond fishes are a renewable resource and sustained harvest is an important tool for creating and maintaining good fishing. However, pond owners need to carefully control how much of the catch is removed from their pond because overharvest can cause a variety of problems. Fish abundances should be low enough to allow for good fish growth, yet high enough to provide good fishing. Adjusting fishing and harvest practices is the easiest and most enjoyable path to good fishing. Each year a portion of a pond's fish population dies of natural causes. Keeping a few fish for the table puts them to good use and can actually increase the number of large fish in a pond by helping to prevent overcrowding. Other management practices that can contribute to good fishing are fertilization, artificial feeding, and the addition of habitat structure. However, these management practices alone will not overcome the problems caused by overharvest.

New pond owners are often anxious to fish their newly stocked ponds. Unfortunately, harvesting too soon from a new pond may ruin future fishing. Largemouth bass and bluegills should not be removed from a new or renovated pond for the first three years to allow the initial stock to grow and reproduce. During this time, fishing can be allowed as long as anglers release their catch.

After the three-year waiting period, a pond owner should decide what type of fishing he desires and how much effort will be committed to achieve good results. If fishing is not a high priority, then only a minimal amount of effort is required to ensure that the pond produces average fishing. On the other hand, very high quality fishing for a particular kind of fish requires a bit more effort. Management practices can begin immediately in a new or renovated pond, but population assessment will first be necessary in an established pond.

Assessing Fish Populations

An owner of a new or renovated pond can generally follow the basic steps in a management plan right from the start if the pond has been properly stocked. However, in established ponds, assessment of the fish population may first be necessary. A pond's fish population can be assessed with a combination of shoreline seining and the practice of keeping angler diary records. These methods provide an idea of the kinds and sizes of fishes present in the pond. Seines are relatively inexpensive and can be purchased from a variety of sources (Appendix C).

Seining. Determining the status of a pond's fish population is easy with a seine. Seining is used to determine the spawning success of largemouth bass and bluegills, so capturing large fish with the seine is not important. The seine should be as least 12 feet long with 1/4-inch mesh. During late June or July, pull the seine along the shoreline in at least three different areas of the pond to capture small fish hatched earlier in the year. The presence or absence, and abundance of fish collected with the seine tell a lot about the status of the pond's fish population. Ideally, a seine sample should contain many small bluegills that range from one half to two inches long and fewer numbers of young largemouth bass. This would indicate the presence of both species, and that both are successfully spawning. The absence or very low numbers of either young largemouth bass or small bluegills in the seine usually indicates that the pond's fish population needs help. The kinds, sizes, and numbers of fishes caught by anglers will usually tell the rest of the story.

Angler Diaries. Angler diaries are another source of information that can be used to assess the quality of pond fishing and the status of the fish population. It can be very important to take a few moments to write down the kind, number, and approximate lengths of fishes caught, and indicate whether they were released or harvested. These notes are the best way to document the quality of the fishing and the numbers of fish harvested from the pond. Anglers can help a great deal by recording this information periodically, or even for each trip, on index cards or in a notebook. Other notes that may be of interest include date, hours fished, or weather conditions. A sample angler diary form is provided in Figure 3.1. Diaries not only provide a written historical record of the pond's fishery, but can be entertaining and informative to read as the years go by. The information contained in the angler diary can be used to help develop a management plan to achieve the quality of fishing that the owner desires. Table 3.1 demonstrates how to use angler diary information to develop the desired type of fishing based upon the five primary management options.

Management Options Based on Selective Harvest

Sustaining a type of fishing and harvest for preferred sizes and kinds of fishes is easiest by selectively harvesting the catch. In the past, pond owners were told that the best ponds were "balanced" ponds. Fish populations in balanced ponds tend to offer moderate fishing quality that provides anglers with consistent catches of 10- to 15-inch largemouth bass and five- to seven-inch bluegills. However, this kind of fishing may not be for everyone. Many pond owners are not satisfied with average largemouth bass and bluegill fishing. Instead, they may prefer to manage their ponds for either bigger bluegill or trophy largemouth bass. Although it is nearly impossible to have an abundance of both in the same pond, tipping the traditional balance toward one type of fishery is rather easy. Five primary management options with different expectations for numbers and sizes of fish harvested are commonly used: 1) no restrictions on harvest, 2) all-purpose fishing (balanced pond), 3) large bluegill fishing, 4) trophy largemouth bass fishing, and 5) channel catfish fishing (Figure 3.2). The average annual sustained harvest that can be expected from a pond under each management option is described in Table 3.2.

ANGLER DIARY: Pond owners should ask anglers to record information about their fishing trip. If no fish are caught, record a zero (0) under the species of fish you fished for.

Date	Number Fishing	Time Fishing		Largemouth Bass								Bluegill								Channel Catfish			Other Species			Initials
		Start Time	End Time	< 8"		8-12"		12-15"		> 15"		< 3"		3-6"		6-8"		> 8"		Lengths			Lengths			
				K	R	K	R	K	R	K	R	K	R	K	R	K	R	K	R	↓	K	R	↓	K	R	

K – Number of fish kept

R – Number of fish released

Figure 3.1. Sample angler diary page

Table 3.1. Recommended steps to achieve the all-purpose, large bluegills, or trophy largemouth bass management options based on angler diary records. Numbers of fishes to be harvested or stocked are on a per acre per year basis. To use the table, first decide which catch scenario in columns one and two best fits the angler diary records. Then read across that row to the harvest recommendations for achieving the desired type of fishing under columns three, four, or five.

If the bass caught are: AND	If the bluegills caught are: THEN	To achieve the all-purpose management option:	To achieve the large bluegills management option:	To achieve the trophy large-mouth bass management option:
Mostly less than 12 inches in length	Mostly more than 5 inches in length	Harvest largemouth bass less than 12 inches, and do not harvest bluegills	Follow the large bluegills management option 3 on page 17-18	Harvest bass less than 12 inches, and harvest bluegills
Mostly 12 to 15 inches in length	Mostly 3 to 6 inches in length with some larger than 6 inches	Population is balanced, follow all purpose management option 2 on page 17	Harvest all bluegills less than 6 inches, harvest 50-75 bluegills 6-10 inches, harvest no largemouth bass	Harvest bass less than 12 inches, and harvest bluegills
Mostly 12 to 15 inches in length	Mostly less than 5 inches in length	Increase harvest of bluegills and do not harvest bass less than 15 inches in length	Harvest all bluegills less than 6 inches, harvest less than 25 bluegill 6-10 inches, harvest no largemouth bass	Harvest bass less than 12 inches, and harvest bluegills
Few caught, but most are over 15 inches in length	Mostly less than 5 inches in length	Increase harvest of bluegills, do not harvest bass, stock 50 4-6 inch bass	Harvest all bluegills less than 6 inches, do not harvest bass, stock 50 4-6 inch bass	Follow the trophy large-mouth bass management option 4 on pages 17-18
Mostly less than 12 inches in length	Mostly less than 5 inches in length	Increase harvest of bluegills, do not harvest bass	Harvest all bluegills less than 6 inches, do not harvest bass, treat vegetation if overabundant	Harvest bass less than 12 inches

Table 3.2. Average numbers of fishes per acre that can be harvested from Ohio farm ponds each year under the five management options; the lengths of fishes are in parentheses. These harvest numbers apply to ponds that have been stocked according to recommendations in Chapter 2 and have fish populations that are at least three years old.

	Average Harvest per Acre per Year		
Management Option	Largemouth Bass	Bluegills (and Redear)	Channel Catfish
No restrictions	10 (8-12") 1 (15")	500 (3-5")	10 (15-20")
All-purpose (balanced)	10 (8-12") 1-5 (15+")	300 (5-7")	20+ (18-20")
Large bluegill	0 (12-15") 1-3 (15+") 10[a] (8-12")	100-150 (6-10")	20+ (18-20")
Trophy largemouth bass	3-5 (15-20") 10 (8-12")	300 (5-7")	15 (18-20")
Channel catfish	0[b]	0[b]	30 (15-20")

[a] Selective harvest of 8- to 12-inch largemouth bass may be necessary every three to five years if largemouth bass appear thin and growth appears very slow.

[b] Only channel catfish have been stocked under this option.

***Management Option 1:* No Restrictions on Harvest.** Harvest without restriction requires no management effort on the part of the pond owner, but will rarely provide more than a year or two of good fishing. With this approach, anglers may keep as many bluegills and largemouth bass as they catch unless the pond is located on public land where state fishing regulations apply. During the first few years of fishing, anglers may catch several nice largemouth bass and bluegills, but the catch in succeeding years usually consists of a few small largemouth bass and an abundance of small bluegills. When bluegills become too abundant, their growth slows and few reach the sizes that fishermen like to catch and harvest. This approach is the best choice for pond owners who find that simply catching fish is more important than the size of each fish caught. However, it is usually not desirable for anglers who want to enjoy and maintain catches of larger fish for sport and the table.

***Management Option 2:* All-Purpose Fishing (Balanced Pond).** The all-purpose approach allows anglers to catch fishes in a variety of sizes. Most of the catch and the harvest will be five- to seven-inch bluegills and 8- to 12-inch largemouth bass, although an occasional trophy largemouth bass may be harvested. A few 8- to 12-inch largemouth bass should be removed each year to allow for good growth of those that remain. Careful harvest will enable some largemouth bass to reach larger sizes. Largemouth bass 12 to 15 inches long should be protected by a "slot length limit." This special regulation permits anglers to only harvest largemouth bass less than 12 inches or more than 15 inches long. Protecting largemouth bass in the 12- to 15-inch "slot" ensures adequate predation on small bluegills. Bluegills are very prolific and can easily become overabundant if too many largemouth bass are harvested, or if too much vegetation covers the pond and prevents the largemouth bass from capturing bluegills. In both cases, this happens because largemouth bass cannot eat enough bluegills to control their abundance. The best solutions to bluegill overpopulation are to maintain an abundance of 12- to 15-inch largemouth bass and control aquatic vegetation. Anglers are free to harvest many of the bluegills and channel catfish they catch under this all-purpose management option.

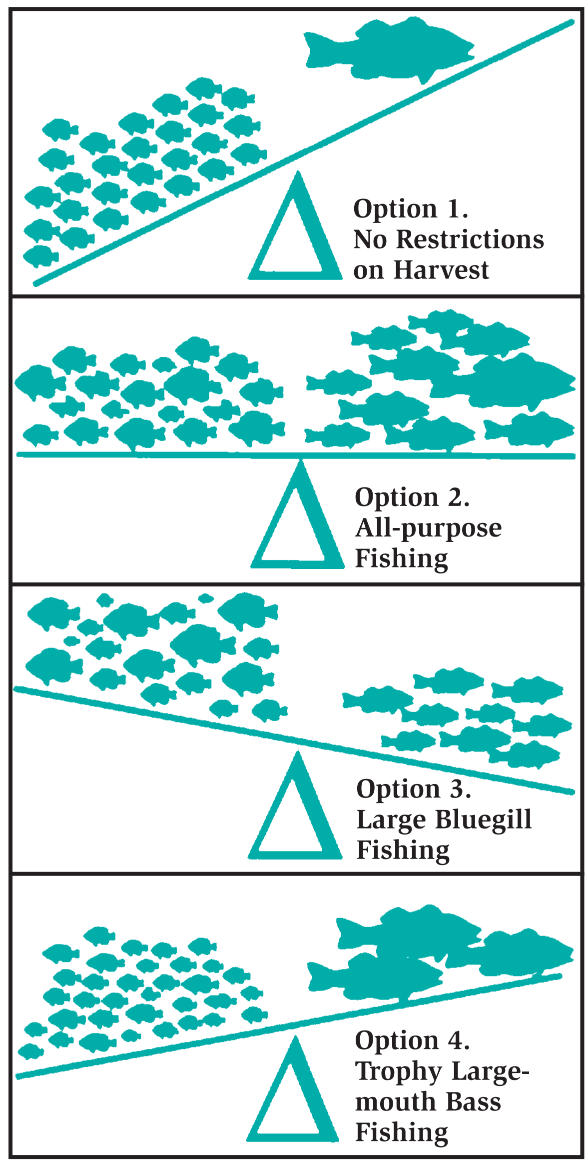
***Management Option 3:* Large Bluegill Fishing.** Managing a pond for quality bluegill fishing is a matter of limiting the harvest of largemouth bass. A dense population of largemouth bass will directly control bluegill abundance by eating them. Bluegills that escape being eaten by largemouth bass will have the food and space they need to grow more quickly to large sizes. This management option works best if largemouth bass less than 15 inches long are not removed from the pond, although anglers can still fish for them by practicing catch and release. If largemouth bass become skinny, or appear to be "all head" and a decline in catches of 12- to 15-inch fish results, then selective removal of some 8- to 12-inch largemouth bass may be necessary. Annual harvest of only 10 largemouth bass per acre that range from 8 to 12 inches long is generally sufficient. Under this management option, anglers may harvest moderate numbers of larger bluegills and as many channel catfish as desired. Bluegills in these ponds should weigh two or three times more than bluegills of the same length in ponds managed for all-purpose fishing.

Management Option 4: **Trophy Largemouth Bass Fishing.** Managing a pond to produce many trophy largemouth bass is more difficult than managing for big bluegills. Harvest must be carefully restricted because the number of largemouth bass produced in the pond is relatively low. Selective harvest of small largemouth bass will improve the growth of those that remain and eventually increase the number of trophy fish available. Under this management option, largemouth bass are managed similarly to the all-purpose option, which limits harvest of largemouth bass under 12 inches and prohibits harvest of 12- to 15-inch largemouth bass, except for those larger than 15 inches. Expect to harvest only three to five largemouth bass over 15 inches per acre each year in most Ohio ponds. Although the harvest is not much higher with this approach than with the other management options, the number of big fish caught and released should be noticeably higher. As with the all-purpose option, anglers can harvest many of the bluegills and channel catfish that they catch.

Management Option 5: **Channel Catfish Fishing Only.** As described above, the number of channel catfish harvested from a pond does not have much of an affect on bluegills or largemouth bass in the other four management options. With this management option channel catfish are stocked alone in ponds, and artificially fed in order to maximize growth and harvest. Since channel catfish do not reproduce naturally in most ponds, fish that are removed will need to be restocked. Once an adult population of channel catfish is established, annual or biannual stocking is necessary to offset harvest and maintain quality fishing.

Results of the large bluegill management option

Figure 3.2. Management Options



Increasing Fish Production

Pond owners should view their ponds as self-sustaining bodies of water that are capable of providing all of the ingredients necessary for good fish production. The amount of fishes that can be harvested depends upon a pond's ability to produce them, and this amount varies from pond to pond. Ohio ponds can often support up to 250 pounds of fish per acre, although this amount is generally less for ponds that are smaller than one acre. If a pond's normal fish production is less than what the pond owner deems acceptable, it may be possible to enhance production. The most effective methods to artificially increase fish production are pond fertilization and fish feeding. However, each of these methods can also cause pond problems, so pond owners should consider them only after carefully weighing the trade offs associated with trying to increase fish production.

Fertilization. Fertilization can improve fish production by increasing the production of tiny plants and animals at the bottom of the food chain, the phytoplankton and zooplankton. This increase in production at the bottom of the food web may ultimately translate into improved growth and production of sport fish. However, negative impacts from fertilization can also result if the added nutrients stimulate growth of undesirable types of aquatic vegetation and algae. Whereas excess vegetation can be a problem to anglers and swimmers during warm weather months, it can also make the pond more susceptible to fish kills due to a build-up of dead and decaying plant material (see Chapter 6). The pond owner may find that the cost of fertilizer, effort to maintain a fertilization program, and risk of fish kills outweigh the benefits of the increase in fish harvested.

Most ponds in Ohio are adequately supplied with nutrients from the surrounding watershed and should not require artificial fertilization. In fact, many ponds receive so many nutrients from the watershed alone that problems develop with growth of excess vegetation and reductions in water quality. The following criteria should be met if a pond is to be considered for fertilization: 1) the watershed to pond ratio is less than 20 acres of watershed per surface acre of pond, 2) the watershed consists primarily of woodland acreage with soils that are low in fertility, and 3) the pond has a minimal amount of shallow water and most of the shoreline has the recommended 3:1 slope to discourage the growth of aquatic vegetation. Ponds without these characteristics should not be fertilized.

If fertilization is appropriate, then the pond owner needs to proceed with the proper treatment applied on a careful schedule. The recommended procedure is monthly applications of liquid fertilizers 10-34-0 (N-P-K) applied at the rate of two gallons per surface acre. These treatments should begin when water temperatures reach 60°F in the spring, and stop when water temperatures drop below 60°F in the fall. Fertilization should be temporarily halted when water temperatures exceed 80°F during the summer. Dilute each gallon of fertilizer with 10 gallons of water and spray the mixture evenly over the pond surface. Water clarity is a simple and convenient way to measure the progress of a fertilization program. The water clarity should be monitored twice each month throughout the fertilization season. This is easily accomplished by simply lowering a white object into the pond, such as a coffee mug on the end of a string. The white object should be visible to at least 18 inches below the water's surface. If the object is not visible down to 18 inches, overfertilization may be a problem. In this case, postpone the next fertilizer treatment until the water has cleared somewhat and remeasure water clarity.

Artificial Feeding. Feeding is the most direct and reliable method to increase production of bluegills and channel catfish in ponds that are less than five acres. Proper artificial feeding will increase fish growth and provide larger fish for anglers. Unlike fertilization, with artificial feeding all of the nutrients go directly into fish production rather than the complex food chain. For ponds less than five acres, feeding is a feasible

Pelleted feed can easily be thrown from shore.

way to increase fish production. Bluegills and channel catfish will readily eat pelleted feeds that are available at agricultural feed stores. Pellet feed containing at least 25 to 32 percent protein will produce the best growth. Largemouth bass prefer live natural foods and will seldom eat pelleted feed.

Training fishes to accept artificial pellets may take a few days. When bluegills are feeding on the surface in the evening, tossing a few floating pellets into the areas where they are feeding will teach them to eat pelleted food. Begin an artificial feeding program by feeding fish about two pounds of pellets per acre per day. This amount may be increased to 15 pounds per acre per day after they have become accustomed to being fed. The feeding rate should be adjusted in the summer according to how much the fish are eating. Feeding may slow or even cease during the summer if water temperatures get above 85° F.

The best guide to feeding fishes is to give them no more than they can eat in 15 to 20 minutes. Using floating pellets in a feeding ring is a good way to monitor how much food they are eating. A feeding station approximately three feet in diameter can be constructed by sealing the ends of a piece of corrugated field tile. Connect the ends after sealing to form a three-foot circle and place the tile in an area of the pond that can easily be reached to fill with food (Figure 3.3).

A pond owner should be willing to make a long-term commitment to continue feeding before a feeding program starts. Feeding should begin in the spring when water temperatures reach 60° F and should stop in the fall when water temperatures drop to 60° F. Fish should be fed daily at approximately the same time and in the same place. Missing a few days of feeding while on vacation will not cause problems if feeding is consistent during the remainder of the summer.

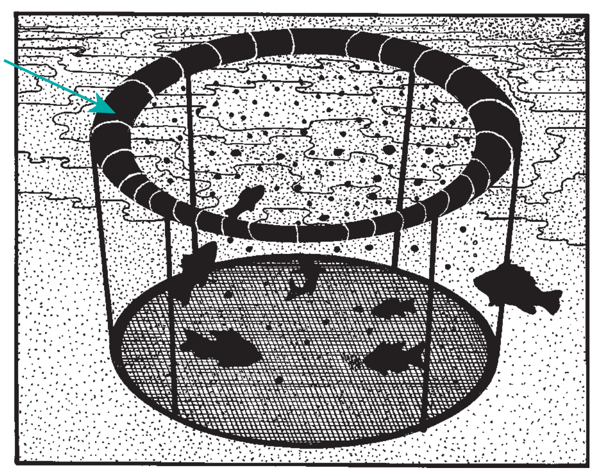


Figure 3.3. Feeding station

It should be noted that overfeeding fish can cause many of the same problems as overfertilization. Food that is not eaten by fish will decompose and use up the pond's dissolved oxygen (see Chapter 6 on fish kills). Decomposing food can also release nutrients into the water that may promote the growth of aquatic vegetation and algae.

Adding Fish Habitat Structures to the Pond

Habitat structures –"fish shelters," or "fish attractors"– are primarily designed to concentrate fish and increase an angler's chances of success. Depending upon the size and type of materials used, structures can provide cover, resting areas, and feeding areas. Habitat structures can act as substitutes for natural cover in ponds where these types of areas are lacking.

Habitat structures can be constructed from many different natural and man-made materials. Easily obtained materials such as discarded Christmas trees can be banded together, weighted and sunk, although trees such as oak, hickory, and cedar work best due to their resistance to decay. Man-made materials such as PVC pipe, field tile, concrete block, and wooden pallets can also be fashioned into fish attracting devices.

Brush pile

Habitat structures can be placed into the pond from the bank if the structures are not too large and there is relatively deep water near the shore. Larger structures can be placed from a boat to allow access to deeper water. Winter ice cover provides an excellent opportunity to build and place structures too large to install from the shore or by boat. These structures can be built on the ice, or built on shore and dragged out onto the ice. In either case, the structure is placed on the ice and allowed to fall into the desired location when the ice melts.

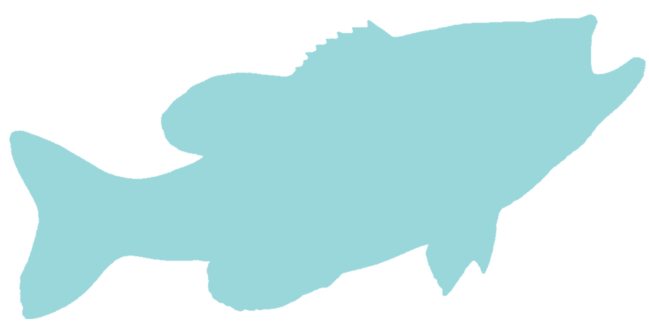
Fishes and anglers alike will make the best use of habitat structures that are distributed carefully in the best locations. These structures are best placed in water that is within reasonable casting distance from shore and two to eight feet deep to allow consistent fish use. Habitat structures should not be placed in the deepest part of the pond where low dissolved oxygen levels (common during summer) can make them inaccessible to fish.

Habitat structure constructed from concrete blocks

Brush piles placed upon the ice during winter

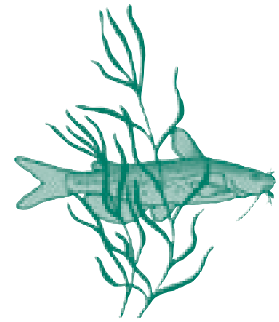
Habitat structure made from old tires

Stake-beds make good fish attractors.



Farm ponds are great places for novice anglers, especially children, to experience the thrill of fishing.

Chapter 4: Managing Aquatic Vegetation



All pond animals depend on aquatic plants, either directly or indirectly. Many different kinds of plants grow in and around ponds, ranging from tiny microscopic algae to large woody shrubs and trees. They are the basis of the food chain, because they use the sun's energy to make food from simple inorganic materials in a process known as photosynthesis. This process produces most of the dissolved oxygen in the pond. Aquatic plants also provide food and cover for fish and wildlife, improve water quality by filtering excess nutrients and reduce sedimentation. Some species of aquatic plants, such as pickerelweed, iris, and waterlily produce flowers that can also beautify a pond.

Although aquatic vegetation is an essential part of a pond, it can become overabundant and even detrimental. Identification and treatment of problem vegetation are discussed in this chapter.

At some point in time, aquatic plants become established in almost every lake or pond. Once this happens, the pond owner often has several questions about what actions, if any, need to be taken. Questions such as "What is it?" "Is it good or bad?" and, "If it's bad, how do I control it?" need to be answered before a proper course of action is chosen.

Plant Identification

Aquatic vegetation is often improperly called "seaweed," "grass," or "moss," but can be any one of a number of plants that are adapted to live either partly or totally in water. In a pond, you can find three basic types of aquatic vegetation: 1) submerged, 2) floating, and 3) emergent. Proper plant identification is important for selecting the proper herbicide or alternative treatment. Simply knowing whether a plant is a submerged, emergent, or floating type is not enough. Many common pond plants are identified in this manual. Other plants can be identified and appropriate control methods selected with the help of biologists from the Ohio Division of Wildlife, personnel from the county Extension Service, or the Natural Resources Conservation Service.

Submerged Plants. Submerged plants are usually rooted in the pond bottom with all, or nearly all, of the plant's stems and leaves under water. They may have flowers that protrude from the water on short stems at certain times of the year. Examples of submerged plants are coontail, milfoil, and najas.

Water Milfoil. There are several species of water milfoil in Ohio, but they are similar enough that for identification and control purposes in this manual, they are treated as one. Water milfoil is a hollow stemmed annual with leaves that are usually arranged in whorls of four. The leaves resemble feathers with delicate rays coming off of a mid-rib. A small flower stalk may project above the water in late summer. Water milfoil has the ability to grow in water up to about 10 feet, if the water is clear enough to allow sufficient light penetration.

Coontail. Coontail is a submergent annual that is relatively unique in that it doesn't grow attached to the bottom by a root system, but rather is freely adrift in the water. Its leaves are

Milfoil

Coontail


Floating-leaf pondweed


Elodea


Chara


Curly-leaf pondweed


Sago pondweed


Najas


Small pondweed

in whorls with each leaf having a distinct fork in it. Each leaf is also curved back toward the stem. This, and the whirling, gives each stem a bushy appearance, hence the name coontail.

Elodea. Elodea is a submerged plant that is more common to hard water ponds, especially in the northern part of the state. This is not as common and well distributed as milfoil, coontail, and the pondweeds. Elodea has wide, oval leaves, usually in groups of four, arranged in whorls around the stem. Spacing between whorls is more compact toward the end of the stem than at the base.

Chara. Chara is a form of algae that grows attached to the bottom, often covering large areas of the bottom with a layer several inches thick. It resembles najas, but has a more yellow-green color. Leaf-like projections occur in whorls around the hollow stem, nearly the same distance apart. When crushed between the fingers, chara feels gritty and has a distinctive musky odor.

Najas. As with the water milfoils, there is more than one species of najas in Ohio. Najas identification and control, like the milfoils, are treated as one. Najas are opposite leaved, although they may sometimes have leaves in whorls of three. The leaves have small spines along their edges. Najas often grow in clumps on the bottom and can be quite fragile. They can be fairly difficult to control with herbicides unless the treatments are applied properly.

Pondweeds. "Pondweed" is not a generic name for any type of vegetation that grows in a pond. Rather, it is the most diverse group of aquatic vegetation in Ohio comprised of many of different plants. While these plants can be quite different, they have certain things in common that allow us to lump them together, and they also tend to respond to herbicides in the same manner. Pondweeds have their leaves arranged alternately along the stem. The leaves are parallel veined and tend to be much longer than they are wide. They grow rooted to the bottom, but can grow several feet high.

Floating Plants. These are plants that float on the surface of the water and are not rooted in the pond bottom. The most common of these are duckweed and filamentous algae. Some plants, such as lotus and some pondweeds, are rooted in the bottom but have leaves that float on the surface. These are not true floating plants, but actually combine the characteristics of submerged plants and floating plants.

Filamentous Algae. Filamentous algae is most often seen as a slimy yellowish green mat on the surface of the pond. This mat is made up of tiny hairlike algae filaments. These filaments grow attached to the bottom of the pond and can often be seen early in the year as green “fuzz,” or “hair” on the bottom. When filamentous algae produce oxygen it is trapped in their filaments. At some point in time, enough oxygen is trapped to make the mat buoyant and the entire mass floats to the surface. The mat then remains there until it is broken apart by heavy wind or rain, or until the algae dies.

Planktonic Algae. This type of algae consists of microscopic plants, usually suspended in the upper few feet of water or floating on the surface. Water appears pea soup green, brown, or may have the appearance of bright green paint spilled in the pond. A sudden die-off may cause summerkill of fish due to oxygen depletion. Some forms of planktonic algae may be toxic to livestock, wildlife, and humans, and it may impart taste or odor to the water. Although uncommon in most ponds, nutrient-rich ponds are especially vulnerable and may become plagued with dense plankton blooms.

Duckweed and Watermeal. Duckweed and the closely related watermeal have the distinction of being the smallest flowering plants in the world. Both plants can cause big problems in ponds. Duckweed generally has one to three oval leaves that seldom measure more than a quarter of an inch in size. These leaves may have one or two hairlike roots hanging down into the water from the underside of the leaf. Watermeal looks like very small green grains floating on the surface of the water. It is often mistaken for seeds. No roots are visible. These plants can be extremely abundant in ponds where they are often are piled up by the wind until several layers high. This makes them extremely difficult to control because it is next to impossible to get good herbicide coverage over all the plants.

Filamentous algae

Planktonic algae

Duckweed and watermeal

Pond lilies

Pond Lilies. There are many species of plants that can loosely be called pond lilies. They are all perennials with relatively large leaves that lay flat on the surface of the water, distinguishing them from spatterdock (a lily-like emergent plant). Depending on the species, these leaves can be round or elliptical and may or may not have a slit in one side of the leaf. Like spatterdock, pond lilies have large root systems that send up shoots. In most cases, pond lilies do not become abundant enough to cause problems, however, some species can become quite dense under the right circumstances.

Emergent Plants. Emergent plants grow with their roots and lower stems in the water, but most of the plant is above the water's surface. Cattails are a familiar example. The category also includes irises, pickerelweed, water lilies, and bulrushes.

Cattails. Cattails are tall, erect perennials that grow in shallow water. Their long narrow leaves have characteristic twists that make identification easy from a distance. Also, a brown lower head, the "cattail" is usually present.

Iris. Irises are perennials that resemble cattails because they have long leaves and grow near the edge of the pond. Unlike cattails, they usually grow in the soil at the edge of the water instead of in the water. Instead of being flat, their leaves have a shallow "V" shape. Irises also produce beautiful purple or yellow flowers, depending on the species.

Iris

Spatterdock

Bulrush. Bulrushes are annuals that grow in shallow water. They have round stems that are dark green and reach three to five feet in height. A flower head is often found several inches from the top of the plant.

Spatterdock. Spatterdock is a perennial that grows in water ranging from several inches to several feet deep. It has erect, relatively heart-shaped leaves that stand above the surface of the water on thick, stiff stems. These leaves have veins that are

Cattails

Bulrush

Pickerelweed

perpendicular to a stiff mid-rib. Spatterdock is often called yellow pond lily due to the yellow flowers it produces in the summer. Spatterdock has large, thick roots that can be up to several inches in diameter. New shoots grow up from these roots in the spring.

Pickerelweed. Pickerelweed is a perennial that grows in shallow water around the edges of the pond. Its heart-shaped leaves stand erect above the surface of the water on thick stiff stems like spatterdock. However, unlike spatterdock, pickerelweed leaves have veins that parallel the leaf edge instead of branching off of a rib. Pickerelweed produces beautiful blue flowers in the summer and new shoots grow up from thick roots.

Methods for Control of Aquatic Vegetation

Although aquatic vegetation can provide a variety of benefits to both a pond and pond owner, it can also be a nuisance when it becomes too abundant. The point at which plants become a problem depends on the primary use of the pond. What one pond owner finds undesirable may be just what another pond owner is looking for. In most cases, vegetation problems result from too much of a good thing.

Overabundant vegetation can prevent good fishing, inhibit domestic or agricultural water uses, and ruin the appearance of a pond. Excessive algae can lead to summer fish kills and dense stands of submerged vegetation can contribute to winter fish kills . Decomposition of plants can cause water to smell or taste bad. Dense vegetation can attract insects such as mosquitoes and unwanted animals such as muskrats. Fish production can be reduced when thick vegetation prevents effective predation of small fish by larger fish. Swimming, boating, and fishing also become restricted if plants become too thick.

Methods for controlling aquatic vegetation can be lumped into three groups: 1) mechanical, 2) biological, and 3) chemical.

Mechanical Control. Mechanical control is simply the physical removal of plants. It consists of either pulling the plants out at the roots, or cutting the actively growing part of the plant. Pulling can be done by hand or with elaborate equipment. All it takes to pull plants is elbow grease. Since most plants grow in water less than five feet deep, this can often be accomplished by wading into the water and scooping them up by hand. A garden rake may expand your reach. Extensive mechanical control involves using heavy equipment to remove plants and is usually expensive. These extreme measures are only necessary for heavy concentrations of plants with strong root systems, such as cattails or spatterdock. Cutting is a mechanical control method that has limited application in most situations. Emergent vegetation can be cut with tools such as garden shears, weed whips (rakes), and gasoline powered trimmers (weed whackers) equipped with brush-cutting blades. Gasoline trimmers are a very good choice for this type of work. **Remember, never use electric-powered equipment around the water. Use of electric-powered equipment in wet areas can result in electrocution.**

Biological Control. Biological vegetation control reduces the amount of aquatic vegetation by stocking plant-eating fish. The fish most often stocked to control vegetation is the grass carp, sometimes called the white amur. Certified triploid grass carp were legalized for stocking in 1988 specifically for this purpose. These fish are incapable of reproducing in your pond.

Adult grass carp

Aquatic herbicide application

Grass carp stocking rates vary depending on the amount and kind of vegetation in the pond. For ponds with a surface covered by more than 60 percent vegetation, stock them at 10 fish per acre, but reduce the rate to 5 fish per acre for ponds with 40 to 60 percent vegetative cover, and to 2–3 fish per acre for ponds with 20 to 40 percent vegetative cover. Grass carp are not recommended for less severe problems. More fish can be added if these stocking rates do not provide adequate control. Wait at least three years after your initial stocking before deciding if you need more fish. Grass carp may not be effective for controlling milfoil, water meal, filamentous algae, or pond lilies.

There are a couple of things to remember about grass carp. First, pond owners should not expect them to solve a vegetation problem overnight. The fish will eat more as they grow older and bigger, and it may take them a year or two to reduce plant growth. Second, it's much easier to put grass carp into a pond than it is to remove them. Grass carp should not be stocked in a new pond until there is a vegetation problem, and applications should start at low initial stocking rates and be increased later as necessary.

Chemical Control. The most commonly used method of controlling vegetation is the application of chemical herbicides. This approach has both good and bad points. On the good side, herbicides often provide quick and effective vegetation control, are easily obtained and applied, and safe when properly used. They must also undergo rigorous testing to be labeled for aquatic use. On the negative side, herbicide use is becoming more and more controversial due to growing concerns about accumulation of chemicals in the environment. Herbicides can be dangerous to both the applicator and the environment when improperly used. To ensure that the herbicide chosen will be effective, proper plant identification, herbicide selection, and herbicide application are essential. Failure to do this can waste money on a product that simply cannot do the job. **The most important aspects of using herbicides are reading the product label, carefully following application instructions, or contracting a licensed applicator to select and apply the appropriate chemicals.**

Herbicides can be categorized by the way they kill plants. The most commonly used products are contact herbicides, systemic herbicides, and shading products. The type of product needed depends upon each situation.

Contact Herbicides. A contact herbicide only kills the plant parts that it touches. This is why effective cover of the plants is imperative for successful treatment. Contact herbicides usually work within a few days. Plants that grow from seeds each year (annuals) can be readily controlled with one application of a contact herbicide. However, plants that grow from the same rootstock each year (perennials) will require a number of treatments because contact herbicides will not kill the root system.

Copper sulfate has long been the contact herbicide of choice for the control of filamentous algae. Many people know it by the name "bluestone," which comes from its color. Copper sulfate is available in a variety of sizes, from relatively large, gravel-sized chunks to finely crushed granules that resemble refined sugar. The smallest size, commonly called "snow," is the easiest to work with. This is usually applied by dissolving the required amount in water and spraying or pouring the solution over and around the treatment area. Another commonly used method for applying copper sulfate is to place the needed amount of bluestone in a burlap bag and drag it around the pond, either behind a boat or by wading. This can be very difficult if the filamentous algae is thick. Copper sulfate by-products can be toxic to fish eggs and newly hatched fry, so avoid using it during spring spawning periods.

One of the problems with copper sulfate is that it can bind to organic materials and suspended clay particles in the pond. This reduces its effectiveness in controlling algae. A number of companies have developed more effective variations of the same chemical compound that allow the copper to remain in solution and stay active longer. These herbicides are more effective than plain copper sulfate, but they are also more expensive. Be sure to use stainless steel or plastic equipment for application of copper products because they are extremely corrosive to most metals. As with copper sulfate, timing the applications of modified copper products is important because they are also toxic to fish eggs and newly hatched fry.

Systemic Herbicides. A systemic herbicide travels through a plant and eventually reaches all parts of the visible plant and its roots. Systemics are usually slower acting than contact herbicides, but provide good control of perennials with only one application. Systemic herbicides tend to be more expensive than contact herbicides, which makes them a somewhat less desirable option for controlling annuals.

A pond owner's choice between contact or systemic herbicides may depend upon the plant. At this point, it becomes necessary to balance the high initial cost of the systemic herbicide against the need for repeated applications of a contact herbicide. The total cost of vegetation control from each type of herbicide often balances out.

Shading Products. Shading products work by reducing the amount of light available to aquatic plants. If shading is done properly, it can totally prevent weed growth in some areas of the pond by slowing down photosynthesis and retarding plant growth. Several commercial products are available that reduce plant growth by shading. These contain safe dyes that color the water blue. The dye pigments absorb sunlight and prevent light penetration. These products are not licensed for water that will be used for human consumption. In addition to shading chemicals, other shading products are available that are constructed from fabric screens and are placed on the pond bottom. They prevent sunlight from reaching the bottom and prevent plants from rooting.

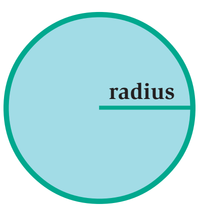
Before Applying Control Measures

In order to select and use aquatic herbicides or other chemicals effectively and safely, a pond owner needs to know the: 1) volume of water in the pond, 2) use of the water, 3) temperature of the water, and 4) type of vegetation that needs to be controlled.

Determining the Volume of Your Pond. The easiest way to determine the volume of a pond is to check with the people who built or designed it and ask to see their records. Without this information the volume will have to be calculated by the pond owner with the formula: volume = surface area (acres) x average depth (feet).

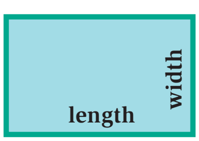
The first step is for the pond owner to determine the surface area of the pond. If the pond is a circle, rectangle, triangle, or some other standard geometric shape, estimating surface area is pretty straightforward. If the pond is irregular in shape, the best thing to do is divide it into workable shapes and then add the areas of the smaller units to get the area of the whole. The length and

Table 4.1. Formulas for calculating the surface area of a pond. Pick a shape that most closely resembles the pond and measure the necessary distances in feet. Put these measurements into the appropriate equation and multiply to find the total surface area in square feet.



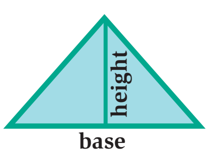
CIRCLE = 3.14 x radius²

EXAMPLE: pond radius 85 feet **x** 85 **x** 3.14 **=** 22,686.5 square feet total surface area (÷ 43,560 **=** ½ acre surface area)



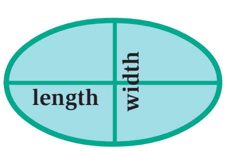
RECTANGLE = length x width

EXAMPLE: pond length 145 feet **x** width of 75 feet **=** 10,875 square feet total surface area (÷ 43,560 **=** ¼ acre surface area)



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

EXAMPLE: pond base 200 feet **x** height of 50 feet **=** 10,000 square feet ÷ 2 **=** 5,000 total surface area (÷ 43,560 **=** $\frac{1}{10}$ acre surface area)



ELLIPSE = length x width x 0.8

EXAMPLE: pond length 200 feet **x** width of 90 feet **x** 0.8 **=** 14,400 square feet total surface area(÷ 43,560 **=** ⅓ acre surface area) width, or diameter of the pond, or the divisions of the pond should be measured to the nearest foot. Formulas in Table 4.1 can be used to determine the pond's surface area in square feet. Surface area in acres is simply obtained by dividing the surface area by the number of square feet in an acre (43,560).

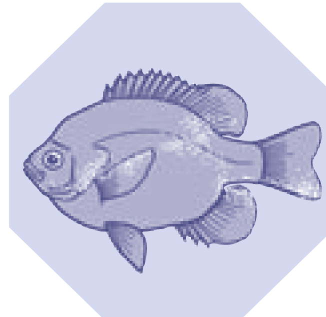
A pond owner can estimate average pond depth by measuring the depth of the water in a number of places throughout the pond, adding these measurements, and then dividing the total by the number of measurements. Measurements can be acquired with an electronic depth finder, sometimes called a "fish finder," or simply with a weight that is attached to a string marked in feet. Use a ruler to measure how many inches there are above the last foot marker and record the depth at this location. A reasonably accurate estimate can be made with 10 to 15 measurements for every acre of water. Measurements should be randomly scattered over the entire surface of the pond to provide the best estimate. Pond volume is then determined by plugging the estimated average depth into the formula.

Water Use. Before using herbicides, a pond owner must consider the use or anticipated uses of the pond's water on his property and the uses of the same water by downstream neighbors. Most herbicides carry use restrictions for treated water that may range from hours to months. Many problems can be avoided by selecting herbicides that are compatible with water uses and considerate of downstream neighbors. A product that is unsafe for animals would be inappropriate if a downstream neighbor uses the water for livestock. **Pond owners should carefully read product labels before they buy or use a chemical.**

Temperature. The water temperature of a pond should always be checked before using herbicides. This will protect fish and ensure chemical efficiency. Some chemicals will not work below certain temperatures, whereas others may kill fish eggs or newly hatched fry. To reduce the chance of killing fish eggs or fry, simply avoid herbicide applications during spring spawning periods. In addition, higher water temperatures mean lower dissolved oxygen concentrations, therefore it is a good idea to treat vegetation before the hottest part of summer. Sometimes conditions will force a pond owner to treat their pond well after the water has warmed in the summer. If this is the case, the chances of a fish kill due to oxygen depletion can be greatly reduced by treating no more than one fourth to one third of the pond at any one time and then waiting about two weeks before further treatment. Only smaller areas of thick vegetation should be treated at any one time.

White pond lily

Chapter 5: Fish Health



Fish, like humans, are subjected to many types of disease. Disease is more likely to become a problem in a fish hatchery where fish live in crowded conditions compared to those in a farm pond. This is fortunate since disease treatment can be difficult. Very few chemicals are available as treatments and they are usually too expensive to use in a private pond. In farm ponds, accurate diagnosis and proper identification of the cause of the disease is important, but prevention is the most critical step to avoiding disease problems. Pond owners can actively prevent most disease problems by making sure they obtain their stock from commercial fish propagators rather than wild populations. Maintaining good water quality and keeping feed fresh, if catfish and bluegills are being artificially fed, can also help.

Signs of fish health problems are indicated by fish behavior or appearance. Sometimes a symptom as obvious as death indicates an infection or parasite problem. Usually, however, the symptoms are less obvious. Infected fishes may appear sluggish, lethargic, turn quickly and repeatedly in circles (flashing), or even stop eating feed that they have been trained to eat. There are also a wide range of visual symptoms that might be observed on a fish's body. These include the excessive buildup of mucus on skin, emaciation, discolored areas, eroded areas or sores, swelling of the body or gills, bulging eyes, hemorrhages, cysts or tumors, or an obvious accumulation of fluid in the body cavity.

Fish diseases common to Ohio ponds pose no threat to humans who eat infected fish if the fish are cooked properly. Many fish are unnecessarily discarded by anglers because of unsightly sores, growths, or parasites, but none are harmful to man. For example, parasites such as tapeworms can only be transmitted to humans if infected fish are eaten uncooked, or not cooked thoroughly.

Common Fish Diseases

Fish diseases can be broken down into six major categories: 1) environmental, 2) nutritional, 3) viral, 4) fungal, 5) bacterial, and 6) parasitic (Figure 5.1). Environmental factors have a tremendous influence on fish health. Maintaining a clean environment, or good water quality, is important for reducing the susceptibility of fish to disease. Nutritional diseases are rare in fishes unless they are artificially fed. Commercially available feeds are formulated to meet the dietary requirements of a specific type of fish. Only fresh feed specifically formulated for the type of fish being fed should be used. Bagged feed should be stored in a cool and dry area to maintain freshness.

Viral. Viruses are the worst types of fish disease. They cannot be treated and may suddenly kill an entire population. Although most viruses affect only trout and salmon, viruses can be avoided by stocking only fish obtained from a fish dealer that is certified free of Channel Catfish Virus Disease (CCVD) and Golden Shiner Virus Disease (GSV). If you stock trout, you need to obtain fish certified free of Infectious Pancreatic Necrosis (IPN), Infectious Hematopoietic Necrosis (IHN), Erythrocytic Inclusion Body Syndrome (EIBS), and Viral Hemorrhagic Septicemia (VHS).

Fungal. Fungi are unavoidable and always present in ponds. Saprolegnia is a common fungal disease that affects all freshwater fish and fish eggs. Saprolegnia attacks injured or dead tissue and produces a cotton-like growth.

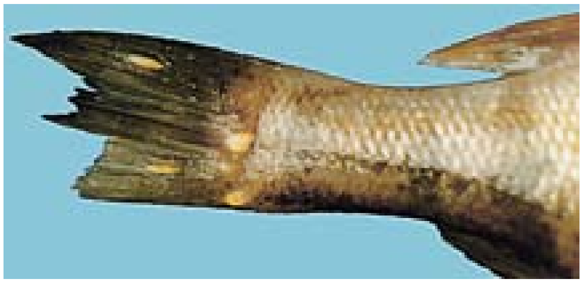
Bacterial. Bacteria are normally present in ponds and only become a problem when fishes become stressed. Bacteria can infect a single fish and multiply rapidly to cause a substantial fish kill in a few days or weeks. They are often identified by their damage to fish tissue since they are not visible to the naked eye. Some common bacterial diseases are listed on the following page.

Disease	***Symptoms***
Columnaris (*Flexibacter columnaris*)	On scaleless fish, lesions begin as small circular erosions that have a gray-blue center and red margins. On scaled fish, lesions begin at the outer margins of the fins and spread inward toward the body. It also attacks the gills of both scaleless and scaled fishes, and in advanced cases the internal organs.
General Septicemia (*Aeromonas hydrophila*)	Ulceration of the skin, distended abdomen, and inflamed fins and fin bases.
Bacterial Gill Disease *Flauobacteria* sp. *Cytophaga* sp.	Produces clubbing and discoloration of the gills.
Furunculosis (*Aeromonas salmonicida*)	Hemorrhages in the lining of the body cavity and visceral fat, cherry-red swollen spleen, inflamed pericardium, inflamed intestine and anus, and large lesions filled with dead cells and bloody colored fluid in the muscle or skin.

Parasitic. A parasite is an organism that lives in or on another organism. Fish often have parasites attached to gills, skin, inside the gut, or as tiny grub-like worms in their muscle tissue. Most are barely visible to the naked eye and often go undetected. A few of the most common parasites are described below.

Parasite	***Symptoms***
Whirling Disease (*Myxobolus cerebralis*)	Infects trout and to a lesser extent salmon. Causes abnormal swimming behavior, darkening of the caudal fin and peduncle and skeletal deformations.
Bass Tapeworms (*Proteocephalus ambloplitis*)	Can infect many species of freshwater fish and are commonly found in largemouth bass and smallmouth bass. Infections can reduce growth, inhibit spawning, and result in death. Humans can be infected by eating raw or undercooked fish.
Anchor Worm (*Lernea* sp.)	Small thread-like parasite (less than ½ inch long) that attaches itself to the fins and body of fish. Attachment point often develops into a lesion which is surrounded by a white-gray patch of fungus.
Ich (pronounced "ik") (*Ichthyophthirius multifilis*)	White "pimple-like" parasites that burrow under the skin. Individuals are normally the size of a pinhead. Fish may be covered with just a few individuals, or in severe cases parasites may be scattered all over the body and gills.
Black Spot (*Neascus* sp.)	Probably the most common parasite known by anglers and the easiest to detect. Small black spots (smaller than a pinhead) that appear on the fins and body. Caused by a larval fluke which burrows under the skin. May also be found in the flesh. Life cycles of this "worm" parasite usually involve a fish-eating bird and snail.
Yellow and White Grub (*Clinostomum* sp.) (*Hysterbmorpha* sp.)	Light colored (yellow or white) grublike "worms" less than 1/4-inch long encapsulated in a cyst in the flesh. Caused by a larval fluke that burrows through the skin and into the muscle tissue. Life cycles of this "worm" parasite usually involve a fish-eating bird and snail. Often noticed when filleting largemouth bass or bluegills. The smaller white grub is found more often in catfish. Severe infestations may have up to 2,000 "worms" on a single bluegill.

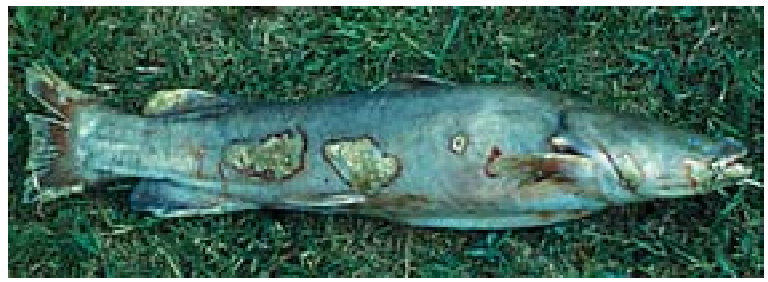
Figure 5.1. Examples of fish diseases.



Yellow grubs encysted in the tail of a perch

Yellow perch with black spot

Anchor worms attached to the underside of a channel catfish



Catfish with columnaris

Chapter 6: Pond Problems and Solutions

Most pond problems can be prevented by proper pond construction, management, and maintenance. However, not all pond owners are lucky enough to have participated in the design and construction of their pond, or in its management and maintenance through the pond's entire history. Common pond problems include fish kills, undesirable fish, muddy water, pond leaks, and animal damage. Each of these problems has a solution than can put a pond back on track in almost every case.

Ponds managed to provide good fishing need regular maintenance to prevent problems from developing. Minor pond related problems can usually be dealt with as they arise. However, major problems like fish kills often require additional effort. Common problems pond owners might encounter are addressed in this chapter. Having a thorough understanding of the conditions that lead to problems can help in preventing them before they start. Solutions to ongoing pond problems are also presented.

Fish Kills

Most fish kills can be attributed to one of three major causes: 1) fish suffocation due to lack of oxygen, 2) poisoning, or 3) disease outbreak. In most cases, dead fish are the only sign of a problem. Unfortunately, little can be done to reverse a kill once it has started. This is why understanding and preventing pond conditions that increase the chances of a fish kill are so important.

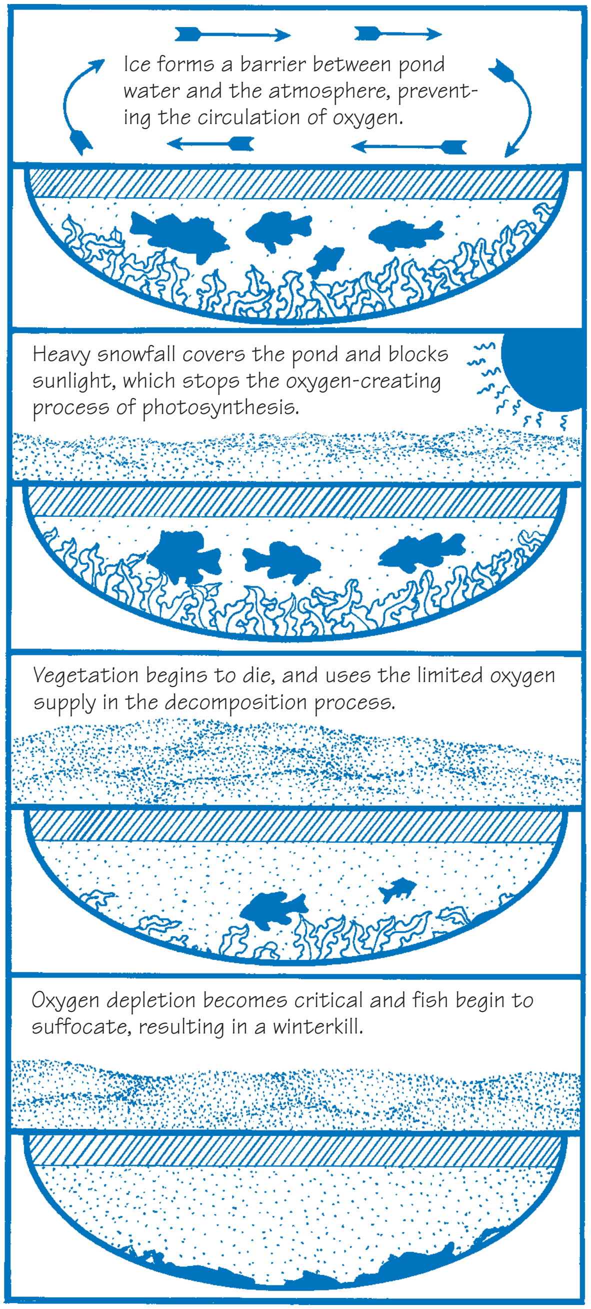
Water quality testing can be useful in determining the cause of a fish kill if tests are run during or immediately after the kill. This is rarely practical since summerkills often go unnoticed for several days and winterkills may go unnoticed for several months. If a pond owner can document the general water quality and weather conditions during a fish kill, its cause can frequently be determined with reasonable accuracy. Determining the cause of a fish kill is the best way to prevent future fish kills. Table 6.1 on pages 43 and 44 summarizes the symptoms, problems, and solutions to the most common types of fish kills.

Fish Kills Due to Suffocation. Ponds receive about 80 percent of their dissolved oxygen through plant photosynthesis. The rest of the dissolved oxygen is obtained by absorption through the water's surface caused by wind and wave action. A good supply of dissolved oxygen is necessary to support fish and other aquatic animals, but levels in a pond can vary greatly within a 24-hour period and throughout the year. The terms "winterkill" and "summerkill" are generally used to describe fish kills that result from critically low levels of dissolved oxygen in the water. Although the results of each type of kill are the same, understanding the differences between the two is the first step in prevention.

Winterkill. During severe Ohio winters, ice forms on ponds and creates a seal between the water and the atmosphere. This prevents a pond from obtaining dissolved oxygen from the atmosphere. At this point, photosynthesis by aquatic plants, the other pathway for dissolved oxygen to enter the pond, becomes even more important.

Clear ice or even cloudy ice allows enough sunlight penetration for plants to photosynthesize and produce sufficient dissolved oxygen to support fish. However, very little sunlight can reach the plants when ice becomes blanketed with snow. This reduces or stops photosynthesis and dissolved oxygen production. Under these conditions there is not enough dissolved oxygen produced during the day to compensate for normal daily uses by fish and other aquatic animals, aquatic plants, and bacteria. If this continues for an extended period of time, fish will eventually suffocate. Dissolved oxygen can become depleted within days or over the course of the entire winter depending on the severity of these conditions. The northern-most counties in Ohio are susceptible to winter fish kills because of colder temperatures and more frequent snows. Winterkill is most common in shallow, nutrient rich ponds that have high accumulations of organic material.

The winterkill process.



Summerkill. As is the case with winter fish kills, summer fish kills can usually be attributed to a loss of dissolved oxygen that results in total or partial death of the pond's fish population. Summerkill is also most common in shallow ponds that are heavily vegetated and have high accumulations of decomposing organic matter. Four events, singly or in combination, can result in the loss of dissolved oxygen in ponds and lead to summer kill: 1) cloudy, hot and still days in the heat of summer, 2) large-scale die-offs of tiny microscopic plants, or phytoplankton, 3) sudden thermal turnover or inversions caused by dramatic weather changes, and 4) chemical treatment of algae or aquatic weeds that result in excessive decay.

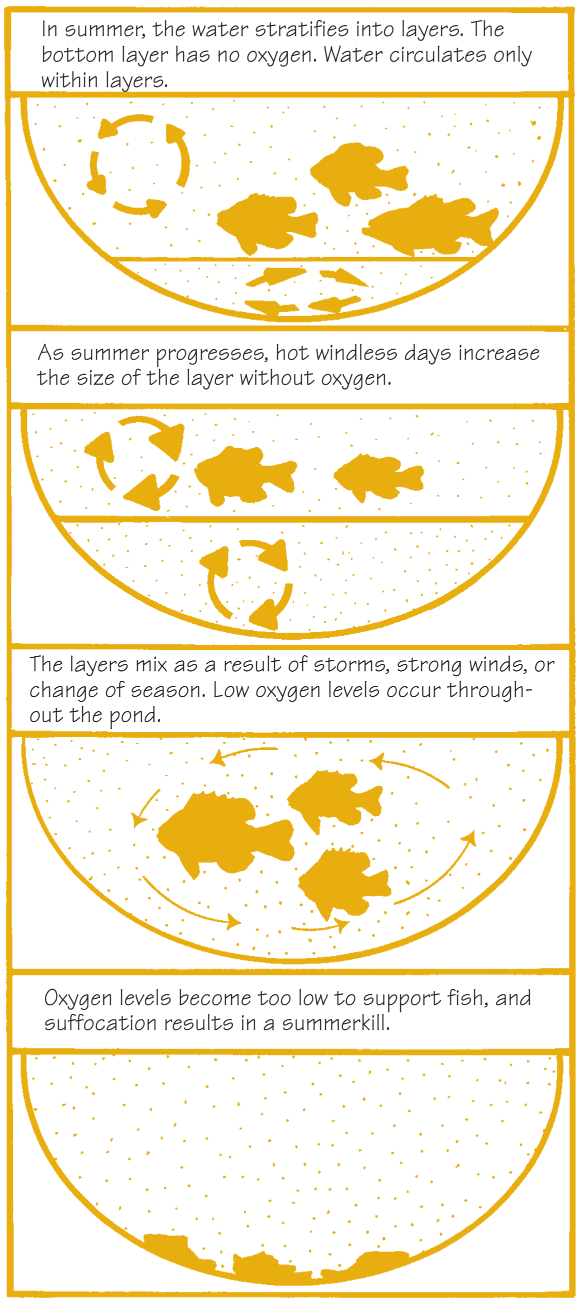
Cloudy weather during the heat of the summer can cause gradual reductions in the amount of dissolved oxygen in a pond. Under sunny conditions, ponds have the highest dissolved oxygen levels late in the afternoon following a long period of plant photosynthesis. During the night, oxygen production stops, but oxygen consumption continues, thereby reducing dissolved oxygen supplies that were "built up" during the day. When cloudy skies prevail for several days in a row, the rate of photosynthesis is reduced and a gradual reduction of dissolved oxygen results. These conditions are made worse by air and water temperatures greater than 80°F and calm winds that often prevail in July and August. These conditions set the stage for any event that would cause a further loss of dissolved oxygen.

Ponds that receive excessive amounts of phosphorus and nitrogen from the surrounding watershed can produce dense "blooms" of microscopic algae (phytoplankton). These blooms may give the water an appearance of pea soup or green paint floating at the surface. A sudden phytoplankton die-off and the decomposition of dead plankton that follows can reduce dissolved oxygen to levels lethal to fish.

Layers of pond water often stratify by temperature during the summer or winter. Water stratifies because water density differs according to temperature. Summer stratified ponds are characterized by having very warm surface waters that may be 10 to 15° F warmer than bottom water. The surface water usually has enough dissolved oxygen to support fish life. Bottom waters often have little or no oxygen because it is being used up by bacteria breaking down organic matter. This is especially true in heavily vegetated ponds. Once a pond is stratified, any event that causes the oxygen deficient bottom water to mix with the warmer surface water can result in a fish kill. Mixing of these layers during summer is most often caused by a thunderstorm that produces heavy cool rain and strong winds. The rapid inflow of cool surface runoff coupled with strong wind and wave action can lead to what is commonly referred to as an "inversion." Small ponds which have large watersheds with steep slopes can be especially susceptible to inversions due to high runoff rates.

Summerkills can also be caused by over-treating a pond with aquatic herbicides, or runoff of animal waste products into the pond. Treating ponds with aquatic herbicides to control nuisance vegetation can cause large amounts of decomposing plant matter resulting in oxygen deficiencies. Chapter 4 describes uses and precautions for application of aquatic herbicides. Another factor is waste products from livestock, which can "overfertilize" a pond and cause dense blooms of undesirable algae. Large-scale die-offs of these algae can trigger summerkill.

The summerkill process.



Reducing the Likelihood of Winterkill and Summerkill. The single most important preventative measure that can be taken to prevent winterkill and summerkill is proper pond construction. Ponds should be constructed at least 8 to 10 feet deep and have a 3:1 shoreline slope to prevent excessive growth of aquatic vegetation (Chapter 1). Unfortunately, pond owners are often living with the consequences of a previous owner's pond design. Small shallow ponds that "kill" frequently may be better off managed as wetlands for wildlife rather than fishing. Managing these ponds for fishing by repetitive stocking is expensive and unproductive. In some cases, the likelihood of fish kills can be reduced by diligent snow removal or artificial aeration.

The most practical method to increase oxygen production and prevent winterkill is snow removal. Snow accumulations of less than two inches usually melt soon after a storm passes and do not warrant removal. However, heavy snowfall accumulations that persist should be removed as soon as possible. Removal of at least 30 percent of the snow usually provides adequate light transmission. Pond owners should concentrate on removal in shoreline areas if only a portion of the pond is to be cleared.

Commercially available aeration and circulation systems can be used to prevent both winterkill and summerkill. Some systems actually transfer a significant amount of oxygen to the pond, whereas others circulate the water to permit oxygen exchange, prevent complete ice-over and reduce buildup of organic matter. There are many models of commercially available aerators and artificial circulators designed to fit most ponds. Some of the more common aerators and

Pond snow removal

circulators on the market are aspirators, paddle wheels, compressed air injectors, fountain aerators, and wind-powered aerators. See Appendix C for a list of aerator manufacturers.

Fish Kills by Poisoning. Chemicals found in or used on a pond's watershed can enter the pond and cause fish kills. Runoff following a heavy rain can transport a variety of unwanted chemicals into the pond including pesticides, herbicides, fertilizers, petroleum products, and mine drainage. Proper siting of the pond during construction is the best prevention. Avoid areas where the likelihood of chemical runoff is high and avoid using chemicals on the watershed.

Fish Kills by Disease. Fish kills can also be caused by disease and parasite infestations. Although more than 1,000 species of parasites and bacteria inhabit the freshwater of North America, only a few ever become a problem in Ohio ponds. Improper catch and release fishing can increase the fish's vulnerability to disease if released fish are mishandled. Also, prolonged periods of low dissolved oxygen levels, low pH, high temperatures, or sudden and drastic changes in water quality can stress fish and lower resistance to disease. Chapter 5 provides additional details about fish diseases.

The Consequences of Fish Kills. Fish kills seldom result in the death of the entire fish population. The extent of a fish kill depends upon the conditions and type of kill. For example, fish kills that involve chemicals or toxic substances are more likely to kill every kind of fish, whereas kills caused by low dissolved oxygen might not affect more tolerant species such as bullheads and carp. The completeness of the kill may also be influenced by the size, shape, and depth of the pond. The adverse conditions may not be uniform throughout the entire pond, thus providing a refuge for certain fishes to survive until conditions change for the better. A good illustration of this is seen in a partial kill caused by pesticide or fertilizer run-off from nearby fields. In this situation, toxic effects may be noticed in the vicinity of the inlet area, but may not affect the entire pond because of dilution.

Evidence of a fish kill

A partial fish kill can have very negative effects upon the remaining fish population. Surviving fishes often show rapid changes in growth and the remaining population may not easily return to the desired level for fishing. In addition, if undesirable fishes were present, they may overpopulate the pond due to reduced competition and lack of predation from largemouth bass. These examples indicate some of the problems that develop from drastic changes in the type of fishes present and their relative abundance after a partial fish kill. Ponds that have undergone a partial kill will probably never produce satisfactory fishing unless corrective measures are taken. In most situations, it is probably best if the entire fish population was killed to allow complete restocking. Fish populations in ponds that have lost fish to die-offs need to be assessed before deciding which corrective measures must be taken to return them to satisfactory fishing (see Chapter 3 on assessing fish populations).

Undesirable Fish

It is not unusual for fishes other than the kinds stocked to show up in a pond. Simply not releasing these back into the pond may be all the control that is necessary. Undesirable fishes become a problem when they become abundant enough to affect water quality or ruin fishing for preferred fish. When this happens, the pond owner has little choice other than to literally start over. Draining the pond or chemical eradication of the entire fish population are recommended if undesirable types of fish become a problem. The pond can be drained completely if an outlet structure exists, or pumped dry. After draining, allow the bottom a few weeks to dry before refilling. Chemical treatment becomes necessary when the pond cannot be drained. Five percent emulsified, or 2.5 percent synergized rotenone is effective in killing undesirable fishes. **Prior to treatment, a permit from the Ohio EPA is required if the pond has an outflow into public waters. Rotenone is a restricted chemical, so only licensed, certified applicators can use it to treat ponds**. See Appendix C for information on rotenone treatments.

Muddy Water

Most pond owners would probably agree that having clear water adds to the aesthetics of their pond. The clarity of pond water is primarily influenced by the abundance of microscopic plants (phytoplankton), animals (zooplankton), and suspended soil particles. Phytoplankton and zooplankton abundance will influence the water clarity to varying degrees depending primarily upon the time of year, time of day, and fertility of the pond. Generally, these tiny plants and animals do not influence water clarity as significantly as suspended soil particles. "Muddy" water is the result of tiny soil or clay particles suspended in the water.

Muddy water can have negative effects other than detracting from the aesthetics of the pond. Muddy water can hinder the feeding ability of largemouth bass, bluegills, and redear sunfish and even reduce their growth. Additionally, phytoplankton growth and abundance is reduced in muddy water. This may compound the problem of poor fish growth in muddy ponds by reducing the amount of food available through the entire food chain.

The first step in correcting a persistent problem with muddy water is to determine the cause. To do this, collect a jar full of pond water, cover it with a lid and allow it to sit undisturbed for one week. If the water appears clear after one week and sediment is noticed at the bottom of the jar, chances are that something in the pond is stirring up the sediments. However, if the water is still cloudy, then there is a good chance that suspended particles of clay soil are the cause of the muddy water. The problem may also be a combination of disturbed sediments and the presence of clay soils in the watershed.

If disturbed sediments are determined to be the problem, one or more of the following suggestions may help remedy the situation:

1) Remove undesirable rough fish from your pond. Bullheads and common carp have a habit of "rooting around" in pond sediment while feeding. Channel catfish may also cause the same problem.

2) Fence livestock away from the pond and avoid pasturing them on the pond's watershed. Livestock trample and compact pond banks causing them to erode.

3) Establish moderate vegetative growth of rushes, sedges, and cattails to protect pond banks and shoreline areas from wave erosion.

4) Keep domestic ducks and geese away from the pond. Their feeding activity may destroy shoreline vegetation and resuspend soil particles from the pond bottom.

5) Maintain good vegetative cover throughout the watershed. If you do not have ownership of the entire watershed, then establish buffer strips of vegetation around the pond.

6) Plant windbreaks to prevent wind from causing excessive wave action and disturbing sediment in shallow water.

These suggestions offer the best long-term protection against muddy pond water. It is much easier and cost effective to prevent soil particles from eroding into a pond than it is to remove them once they become a problem.

If the previous methods prove unsuccessful, it is likely that the muddy water problems are caused by colloidal clay particles that stay in suspension for a long time. Since colloidal clay particles do not settle out easily, other techniques are necessary to improve water clarity.

Several techniques are effective at removing colloidal clays from pond water. Each technique requires the addition of various materials to the pond that cause clay particles to settle out. These additives include organic matter (hay), aluminum sulfate (alum), calcium sulfate (agricultural gypsum), and hydrated lime. Each of them work through a chemical reaction that causes suspended clay particles to "clump together." These "clumps" of particles are heavier than individual particles and therefore sink rather than stay suspended. Most of these additives can be purchased from local agricultural supply stores.

Hay Bales. Application rates of dry hay are recommended at 540 pounds per acre-foot of water (see Chapter 4 to calculate acre-foot volume of a pond), which is roughly equivalent to 7 to 10 dry bales depending upon weight of each bale. Hay bales should be broken up and scattered evenly along the shallow nearshore areas of the pond. Applications should not be made for the entire volume of water at one time. Instead, apply treatments equivalent to one acre-foot of pond water at a time and monitor clearing. Each treatment should be separated by a two-week period. This method should not be used during July and August when water temperatures are high and dissolved oxygen levels in the pond can fluctuate widely from day to day. The best time for treatments is in the spring or early summer when oxygen levels are consistently higher. This method is not recommended for ponds that have a history of fish kills.

Aluminum Sulfate (Alum). Alum is the most effective treatment for clearing muddy water caused by colloidal clays. Application rates for alum are recommended at 25 to 50 pounds per acre-foot of water depending upon the concentration of suspended clay particles. The first treatment should be made at the rate of 25 pounds per acre-foot. Clay particles should settle and the water should clear within a few hours after mixing the alum. If there is little noticeable change after one day, then a second application should be made at 25 pounds per acre-foot. Alum should be applied during calm weather to avoid wind mixing that prevents clay from settling out. It is most effective when dissolved in clear water and sprayed over the surface from shore or a boat. In large ponds, a dissolved solution of alum can be poured into the outboard motor wash of a small boat.

Alum can reduce the pH and alkalinity of pond water due to a strongly acidic reaction in water. For this reason, pH and alkalinity need to be tested before treatment with alum to prevent harmful effects to fish. Alkalinity should not be below 75 mg/l and pH should not be below 7.0. If readings are found to be below these levels, then hydrated lime should be added in the same manner as alum at the rate of 50 pounds per surface acre. This will help buffer the acidic effects of alum treatment and protect fish. Alum is only toxic to fish under these conditions or when used at very high concentrations for a long period of time. Hydrated lime will also help remove suspended clay particles.

Agricultural Gypsum. Agricultural gypsum ($CaSO_4$ $2H_20$) can also be effective at removing colloidal clay suspensions from ponds. Application rates range from 100 to 522 pounds per acre-foot of water depending upon the amount of suspended clay. It is best to first apply gypsum at the most conservative rate of 100 lbs/acre-foot, and allow a few days to pass while monitoring water clarity. If the pond has not cleared, apply additional gypsum until transparency reaches 18 inches or meets owner satisfaction. Gypsum should be applied by the same methods described for alum, although it has a neutral reaction in water and does not require simultaneous lime treatment. Another advantage of gypsum is that it does not affect the use of water for livestock and will not affect plant and animal life. However, gypsum is less effective at removing suspended clay particles than alum or hydrated lime.

Hydrated Lime (Calcium Hydroxide). Hydrated, or slake lime, can also be used to reduce muddy water. Application rates are suggested from 35 to 50 pounds per acre-foot with application methods similar to alum and gypsum.

Leaky Ponds

If a pond's water level drops much more than 6 to 12 inches in one month, it may have a serious leak. Summer drought conditions should be taken into consideration when determining whether or not a pond leaks. Fortunately, pond leaks can often be sealed by adding clay material to pond soil or using a plastic liner. Bentonite clay is a product commonly used to seal leaky ponds that is commercially available at farm and drilling equipment stores. It is sold as a dry powder and it expands more than other clays when wet. Bentonite should be applied to dry pond soils at a rate of one to three pounds per square foot of pond basin. Bentonite is most effective when incorporated into the pond's soil using a rototiller or disk and then compacted using a sheep's foot roller, dozer blade, or soil compactor. If it is impractical to drain a pond, a slurry may be added uniformly across the surface of the pond. However, this method is often less effective because of uneven settling onto the pond bottom.

Geomembranes and other plastic liners can also be used to seal leaky ponds, although they are much more expensive solutions than bentonite. Geomembranes are thick plastic sheets drawn across the pond basin and covered with a thick layer of sand and soil to hold them in place and protect them from punctures.

Problems Caused by Animals

One fringe benefit of owning a pond is viewing wildlife that is attracted to the pond. However, both visiting wildlife and domestic livestock can occasionally cause problems. Sometimes pond owners have unfounded concerns about the extent of problems these animals cause, and sometimes there is a serious need for concern. Animals that damage a pond may need to be controlled or removed.

Livestock. Agricultural livestock is the most common source of animal damage to ponds. Cattle and other livestock cause damage by trampling banks, muddying water by wading, and excreting directly into ponds. These problems can shorten the life of a pond and promote fish kills.

Fortunately, this problem can be remedied by fencing livestock away from the pond, and installing pond plumbing for livestock watering prior to pond construction. Agricultural extension agents can recommend the best ways to water livestock from a pond without compromising the pond's health. Approaches to livestock watering should be considered before the pond is built.

Crayfish. Burrowing crayfish may become established in ponds and in extreme cases cause structural damage and water leaks. In such rare cases, burrowing can become so severe that the pond banks appear honeycomb-like. These conditions can become a particular problem in ponds with large and frequent water level fluctuations. However, ponds with established fish populations rarely become plagued with burrowing crayfish to the extent where control measures are needed. In fact, the majority of ponds in Ohio do not have crayfish in them. Ponds with crayfish usually have such low numbers due to the predation of fish and other animals, that crayfish are not a problem. If crayfish burrowing does become a problem, maintaining high densities of largemouth bass in the pond (see Chapter 3 on the large bluegill management option) can be effective in reducing crayfish densities. Crayfish numbers can also be reduced by seining for them or trapping them with modified minnow traps; these methods do not provide a long-term solution however. Although it is not recommended that you introduce crayfish into your pond, they do provide supplemental food items for largemouth bass, bluegills, and channel catfish.

Crayfish burrow

Turtles. Turtles are often thought of as pests in fish ponds because they occasionally steal an angler's bait or fish from a stringer. However, turtles pose little threat to fish populations. In fact, most types of turtles feed almost exclusively on plant matter and pond problems due to turtles are rare.

The snapping turtle is the most common turtle found in Ohio ponds, but the less common painted, musk, and soft shell turtles may also be found there. Snappers and soft shell turtles offer good eating and may be trapped or caught by angling, bank lines, trotlines, and specially designed traps. For more information on methods of capture and food preparation techniques, refer to Division of Wildlife Publication 332 (Appendix B).

Muskrats. Muskrats are members of the rodent family with partially webbed hind feet and water-resistant fur that make them well suited for an aquatic life. They are typically 18 to 24 inches long with small front feet used for digging and feeding, and a long and narrow tail. Muskrats cause problems when they burrow into pond banks and dams to make their dens. Pond banks can be damaged and dams can be weakened when their tunnels and dens collapse. You can identify the presence of muskrats by trails or "runs" they make through aquatic vegetation, freshly cut cattails floating on the water's surface, or large piles of vegetation rising out of the shallow water. If vegetation is lacking, small pockets of muddy water adjacent to the pond bank often mark the den entrance and recent digging activity. Sitting quietly on the bank in the evening is a good way to confirm the presence of muskrats.

Muskrat burrow

Muskrats may need to be removed from your pond. The best method of muskrat control is a trapping program conducted annually during the state's trapping season in the fall and winter. Leghold traps, conibear body-gripping traps, and various box traps are all suitable for muskrat trapping.

Barriers placed along shorelines can be used to keep muskrats from burrowing. Materials used include a layer of rock riprap that is at least six inches in diameter, chicken wire, or hardware cloth that is two-inch mesh or smaller. The materials should be placed from one foot above the normal water line, to three feet below the water line. Aquatic vegetation control may also deter some muskrats, but it is no guarantee that they will avoid the pond completely.

Beavers. Like the muskrat, beaver are rodents that are well adapted to life in the water. Adult beaver can weigh from 35 to 50 pounds. Their thick brown fur is oiled by glands that make it water-resistant. The tail is broad, flat, and dark brown to black in color. The hind feet are very large and fully webbed. The front teeth are large and well adapted for cutting vegetation and wood.

Beaver cause problems to pond owners by cutting down trees and shrubs around the pond. The cuttings are sometimes used to block the flow of water through outlet pipes and emergency spillways. This can result in valuable land, plants, or structures being flooded. Like muskrats, beaver can also cause damage by digging bank dens. They will also feed on nearby garden vegetables and crops and cut cornstalks to use in the building of their dens and dams.

Beaver signs include cut sticks without bark that are lying in and around the pond, partially girdled or debarked trees, stumps of trees and shrubs cut by the beaver, bank dens, lodges within the pond built from cut trees and mud, and outlet pipes and spillways plugged with sticks and mud.

Beaver can be legally trapped in Ohio during the winter trapping season. As with muskrats, trapping is the best means of control and leghold traps or conibear body-gripping traps can be used. Much larger traps are needed for beaver than for muskrats. Disturbing dens, lodges and dams does not discourage beavers. They will repair the damage and cut more trees and shrubs to complete their job.

Groundhogs. Groundhogs, or woodchucks, are rodents that grow to be 16 to 20 inches long. They have fur that is a combination of brown, gray, and black hairs, front feet with long curved claws that are well adapted for digging, and a four- to seven-inch long tail. Groundhogs can damage ponds by digging burrows into the banks and dam. Burrow openings and mounds of excavated soil can be dangerous to recreational users walking around the pond.

Hunting can be a very effective means of control and groundhogs can be hunted year-round in Ohio except during deer gun season. Another control method is the use of commercial gas cartridges. The gas cartridges are ignited and placed in the burrow after all burrow entrances have been sealed. The gasses produced are lethal to groundhogs. Cartridges are available from local farm supply stores.

Livetrapping Nuisance Animals. Muskrats, beaver and groundhogs can also be livetrapped as a means of control. The Division of Wildlife maintains a list of nuisance animal trappers who have special permits for trapping, removing, and relocating wild animals. Contact the nearest Division of Wildlife district office for a list of nuisance animal trappers and for more details on controlling wildlife-related pond problems.

Canada Geese. Waterfowl commonly use ponds as resting and breeding areas. Most pond owners enjoy seeing ducks and geese swimming across the water or resting at the water's edge. A pair of Canada geese is often welcomed. However, if they raise young on the pond and their presence attracts additional geese to the site, their numbers can increase dramatically and cause problems.

Adult male geese defending nesting females can become aggressive toward humans. They have been known to strike humans with their wings and pinch with their beaks. The droppings from a family of geese will foul the pond and its banks, making it unpleasant for recreational users. Geese will move into adjacent crop fields, garden areas, and lawns to feed. Also, the honking of several disturbed geese can be annoying.

If a pond is isolated from the home site and infrequently used by residents, then the presence of Canada geese may not be a problem. But if geese are a problem, then the pond owner needs to take action. The best method of control is to prevent Canada geese from becoming established on the pond. Harass the geese from the moment they first land and be persistent. If they are allowed to initiate nesting activities then they will be more difficult to frighten away. Frequent loud noises and visual scare devices can be used to deter geese. However, the geese, their nests, and their eggs are legally protected and cannot be harmed.

Table 6.1. A guide to troubleshooting fish kill problems in Ohio farm ponds.

Cause of fish kill	*Symptoms*	*Problem*	*Recommended Solution(s)*
Summerkill	Cloudy, hot, still days and nights. Low oxygen levels in pond water. Fish found dead and/or gasping for air at the surface.	Water temperature reaches very high levels (> 85° F) in shallow ponds; very warm water does not hold as much oxygen. Cloudy skies prevent plants from producing oxygen and calm winds keep oxygen from mixing into surface water. Shallow, weedy ponds are especially vulnerable.	Deepen pond and/or install aeration system.
Inversions	Low oxygen levels in pond water. Dead or gasping fish found after a violent thunderstorm which produces heavy downpours and high winds.	Large sudden inflows of cool rainwater and strong winds cause bottom water (low in oxygen) to upwell and mix with the surface water resulting in critically low oxygen levels. More likely to occur in shallow, weedy ponds with large, steep drainage areas which produce high runoff.	Deepen pond and/or install aeration system to circulate and aerate bottom water that lacks oxygen.
Phytoplankton die-off	Low oxygen levels in pond water. Fish found dead and/or gasping for air. Pond water with a green cast prior to or during fish kill. Phytoplankton may look like green paint floating on the water surface.	Nutrient enriched ponds produce dense blooms of phytoplankton (algae) which can suddenly die-off and decompose causing an oxygen shortage.	Reduce nutrient inputs by diverting overland runoff that is rich in nutrients (animal feed lots, crop fields, etc.).
Dead Vegetation	Low oxygen levels in pond water. Fish found dead and/or gasping for air within a few days after large amounts of aquatic vegetation was treated with herbicide.	Mass die-off of aquatic vegetation from natural causes or herbicide use. Large amounts of rotting vegetation will use up oxygen supply in the pond.	Pond banks should have 3:1 slope to reduce excess vegetation growth. Treat no more than 25% of the pond with herbicide at one time.

Continued on next page

Table 6.1. A guide to troubleshooting fish kill problems in Ohio farm ponds (continued).

Cause of fish kill	*Symptoms*	*Problem*	*Recommended Solution(s)*
Winterkill	Fish die from low oxygen levels. Dead fish seen floating along shoreline soon after ice melts. Few, if any, fish caught in the spring compared to numbers caught the previous season.	Snow covered ice stays on pond for an extended period of time keeping sunlight from reaching plants to produce oxygen.	Shovel snow if it is greater than 2 inches deep, removing at least 30% of the coverage and/or install aeration system to prevent complete ice cover.
Organic Pollution	Fish die from oxygen shortage. Look for large sources of organic matter which entered the pond, especially after heavy rains.	Excess animal wastes, leaves, decaying vegetation, and other matter consumes oxygen as it decays. Large amounts of decomposing matter deplete oxygen supply.	Prevent organic matter from entering or building up in pond. Cut trees back away from pond. Divert animal waste runoff around the pond. Use aeration to speed up the decay process and reduce buildup.
Toxic Substances	Fish die from direct exposure to toxic chemicals. May cause complete or partial fish kill depending on the amount and dilution rate as the chemical enters the pond. Toxins will often kill other aquatic life (insects, tadpoles), while oxygen shortages will not.	Pesticides, herbicides, mining wastes, petroleum products, fertilizers, and other toxic chemicals enter the pond via surface runoff from nearby land. Often occurs after heavy rains wash recently applied insecticides or fertilizer into the pond.	Levee the pond or divert runoff originating from potentially toxic sources (crop fields, golf courses, etc.). If possible, avoid using potentially toxic substances within the pond's watershed.
Natural Causes	A few fish found dead along the shoreline in early spring.	After a long stressful winter, a fish's natural resistance to disease is lowest in early spring. Spawning stress may also cause a few fish to die. Larger and older fish seem to be more likely to die of natural causes than smaller fish.	None: let nature take its course.

Chapter 7: Wildlife Habitat Enhancement Around the Pond

A pond owner can gain additional benefits by establishing and maintaining wildlife habitat around the pond. Good habitat will attract a variety of wildlife to the pond site, providing the owner with wildlife viewing opportunities, as well as increased opportunities at game animals during the legal hunting seasons. Other activities such as wildlife photography can be enjoyed as well.

Wildlife Plantings Around the Pond

Establishing a permanent border of vegetation around the pond helps maintain the water quality of the pond by filtering sediment from runoff and stabilizing pond banks. This vegetation will also provide food and cover for wildlife. It is important to protect this border of vegetation from disturbance. Fencing will keep livestock out of this important buffer area as well as out of the pond. If grasses are the only vegetation planted around the pond, the fence should be placed a minimum of 50 feet from the water's edge. If trees and shrubs are planted in addition to grasses, the fence should be built 100 feet from the water's edge.

Grass Buffer Strips. Grasslands are valuable wildlife habitat. They provide important nesting cover, shelter, and food for a variety of wildlife. Information about grass seeding mixtures that are best for wildlife habitat can be obtained from the nearest Division of Wildlife district office (Appendix A). Fescue grass is not recommended because it is of little value as wildlife food or cover. After grass buffer strips have become established, occasional mowing may be necessary. Grasses should be mowed in sections in different years so that some undisturbed grasses will always be left for wildlife. When a section is mowed, it should be done after July so as not to disturb nesting grassland birds and other wildlife.

Woody Plantings. Food and shelter requirements of many wildlife species can also be provided by planting trees and shrubs around the pond. These woody plantings can also serve as windbreaks, sight and sound barriers, shade producers, and erosion control structures. In general, the greater the habitat diversity, the greater the variety of wildlife that will be attracted to the pond vicinity. Diverse habitat will provide for the needs of wildlife on a year-round basis. Information about trees, shrubs, and vines that can be planted around a pond site for wildlife can be obtained from the nearest Division of Wildlife district office (Appendix A).

Where plants are located can be as important as the species that are planted. Never plant woody plants on the dam or spillway. They can damage the structure and may attract burrowing animals. Also, planting trees at least 30 feet from the water's edge will keep the grasses from being shaded out and keep the pond banks open for recreation.

Wildlife Nesting Structures

Mallards. Mallard ducks do not take to nesting structures as readily as wood ducks, but will use these structures if they are properly placed and maintained. A nest cylinder is easy to build and maintain, and is relatively inexpensive. Contact your nearest Division of Wildlife district office for a publication describing how to construct these nesting structures. The nest cylinder should be placed in the pond away from shorelines and at least three feet above the highest water level expected in the spring.

Wood Ducks. Wood ducks are the most abundant nesting waterfowl in the state of Ohio. Wood ducks are adapted to forested wetlands and swamps. Artificial nesting structures on ponds, when properly constructed and placed, are readily used by "woodies." Ohio Division of Wildlife Publication 109 (Appendix B) describes the construction and placement of these nesting structures.

Purple Martins. Purple martins can be beneficial to have around a pond because they prey on flying insects such as mosquitos. Because martins are colony nesters, a purple martin house should contain 12-20 individual nest compartments. The house should be light in color to help reflect the sun's rays and keep the compartments from overheating. Placement of the house is also important. Martins need a clear open space where insects can be pursued and flight to and from the nest is unobstructed. The nest structure therefore should be placed at least 30 feet from trees or buildings. Contact your nearest Division of Wildlife district office for a publication describing the construction and placement of purple martin houses.

Eastern Bluebird and Tree Swallow. Bluebirds and tree swallows are two other insect eaters that can be beneficial to have around a pond. A nesting box may be used by either bluebirds or tree swallows because of the similarities in size and habitats used by these two birds. The nest box should be located on the pond's dam or along the shoreline in open grassy areas. Ohio Division of Wildlife Publication 339 (Appendix B) describes how to construct and place bluebird nest boxes.

Bluebird

Purple martins

Checking a wood duck nest box

White-tailed deer

Glossary

Acre-foot–A unit of measure for water that would be equivalent to the volume of water contained in one surface acre of water one foot deep.

Algae–An aquatic plant found in ponds that can range in size from tiny microscopic phytoplankton to large floating green mats that surround the shoreline.

Alkalinity–The quantity and kinds of compounds present (usually carbonates or bicarbonates) in water that shift the pH to the alkaline or basic side of neutrality (i.e., pH > 7.0).

Annual plants–Plants that grow from seeds and live only one year.

Bacterial infection–A fish disease caused by tiny microorganisms (bacteria) found in water.

Balanced pond–A pond with a fish population composed of moderate numbers and a variety of sizes of largemouth bass and bluegill that is relatively stable from year to year.

Commercial fish propagator–A business person who grows, sells, or transports fish for profit.

Dissolved oxygen–Oxygen molecules that are in solution with water.

Emaciation–Severe weight loss in fish.

Embankment pond–A pond that is formed by the creation of a dam across a natural valley.

Excavated pond–A pond which has been dug out of the ground.

Fingerling–The name given to any small young fish, usually only an inch or two in length.

Fish production–An increase in the total amount of fish in a pond. This can be an increase in numbers or an increase in fish size as a result of growth.

Food chain–All plant and animal life in a pond that is interconnected through predator-prey relationships. For example, tiny plants are eaten by insects, which in turn are eaten by small fish, which in turn are eaten by larger fish, and so on.

Fungal infection–An infection on a fish, usually secondary to something else injuring the fish, caused by fungus that gives the area a cotton-like appearance.

Groundwater–Water located within or below the surface of the soil.

Harvest–Removal of fish from a body of water for the purpose of consumption.

Nutrients–A substance used either directly or indirectly by an organism as food.

Organic materials–Materials of any kind that occur naturally; not man-made. In ponds this is usually plant and animal matter.

Parasite–An organism that for all or part of its life gets its nutrition from another living organism or host, by living in or on the body of that organism, usually causing some type of harm to that organism.

Pelleted food–Commercially formulated feed for fish. This type of feed is typically used for channel catfish, bluegill, and trout.

Perennial plants–Plants that grow from extensive root systems where although the visible part of the plant may die each year, the root system survives and produces more plants the next year (example - cattails).

pH–A measure of the concentration of free hydrogen ions in water which determines the acidity or alkalinity of the water. Water with a pH below 7.0 is acidic, and water with a pH above 7.0 is alkaline.

Photosynthesis–The process whereby plants in the presence of sunlight produce simple sugars and give off oxygen as a by-product.

Phytoplankton–Microscopic aquatic plants that form the base of the food chain.

Predator–An animal that feeds on other animals.

Prey–A food item of a predator.

Renovated pond–A pond that has had its fish population removed either by draining or poisoning, so that the pond can be refilled or restocked and started over again.

Riprap–Pieces of broken rock, usually six inches to one foot in diameter, that are used to protect pond banks from erosion and burrowing animals.

Runoff–Water and its contents as it flows across the soil surface.

Seining–Pulling a small rectangular net (seine) through the water in a pond for the purpose of capturing young fishes.

Slot length limit–A special fishing regulation that permits anglers to keep fish larger than, or smaller than a specified length range.

Soil survey–A study of the soil type used to determine potential land use practices.

Solution–A mixture of two or more substances.

Storage–The capacity of a pond to hold water.

Triploid grass carp–A genetically altered fish ("triploid" fish have three sets of chromosomes to prevent reproduction) commonly used to control aquatic vegetation. Grass carp are often referred to as white amur.

Turbidity–The loss of water clarity due to suspended particles of soil or microscopic plants.

Unbalanced pond–A pond with a fish population where the abundance of one or more kinds of fish is too high or too low relative to the other kinds of fish in the pond. Examples would be ponds with too many small bluegills and too few bass, or high abundances of undesirable types of fish.

Viral infection–A fish disease caused by some type of virus, similar to what happens when humans get the flu, except that viral infections in fish are often fatal and untreatable.

Water quality–Any number of water characteristics such as clarity, pH, chemical makeup, or dissolved oxygen content.

Whorl–A circle of flowers or leaves arising from one point on the stem.

Zooplankton–Microscopic aquatic animals that rank just ahead of phytoplankton in the food chain.

APPENDIX A: Sources of Information

Natural Resource Conservation Service and County Soil and Water Conservation Districts: Local NRCS and SWCD offices are listed in the telephone directory under county and federal government listings.

The Ohio State University Extension Service: County offices are listed in the telephone directory under the county government listings.

District Offices of the ODNR Division of Wildlife:
Wildlife District One, 1500 Dublin Road, Columbus, OH 43215
(614) 644-3925
Wildlife District Two, 952 Lima Avenue, Box A, Findlay, OH 45840
(419) 424-5000
Wildlife District Three, 912 Portage Lakes Drive, Akron, OH 44319
(330) 644-2293
Wildlife District Four, 360 E. State Street, Athens, OH 45701
(740) 594-2211
Wildlife District Five, 1076 Old Springfield Pike, Xenia, OH 45385
(937) 372-9261

Other Pond Publications:
Lake Smarts. Terrene Institute, 1717 K Street, NW, Suite 801, Washington, DC 20006 (telephone: 202-833-8317)

Management of Lakes and Ponds. George W. Bennett. Van Nostrand Reinhold Company, 135 West 50th Street, New York, NY 10020

Ohio Pond Management. Bulletin #374, The Ohio State University Extension Service. Columbus, Ohio.

APPENDIX B: ODNR Division of Wildlife Publications

The following additional information can be obtained by writing: ODNR Division of Wildlife, 1840 Belcher Drive, Columbus, Ohio 43224. The first five items ordered will be mailed at no charge. For each additional 10 items (or fraction thereof) please include $1.00 for postage and handling. Please order by publication name, NOT number.

Fish Publications

Black Crappie (Publication 13)
Bluegill Sunfish (Publication 69)
Bluntnose Minnow (Publication 192)
Bullheads (Publication 123)
Carp (Publication 130)
Central Longear Sunfish (Publication 173)
Channel Catfish (Publication 65)
Flathead Catfish (Publication 116)
Gizzard Shad (Publication 185)
Grass Carp (Publication 364)
Green Sunfish (Publication 161)
Largemouth Bass (Publication 6)
Northern Creek Chub (Publication 311)
Pumpkinseed Sunfish (Publication 102)
Yellow Perch (Publication 169)

Wildlife Publications

Beaver (Publication 97)
Eastern Bluebird (Publication 359)
Great Blue Heron (Publication 70)
Hit the Trail for Bluebirds (Publication 339)
Mallard (Publication 324)
River Otter (Publication 384)
Waterfowl Identification Key (Publication 50)
Wood Duck Nest Box; Canada Goose Nesting Tub (Publication 109)

Miscellaneous Topics

Publication List (Publication 1)
Aquaculture Law Digest (Publication 61)
Filleting Your Fish (Publication 72)
Fish and Fish Food Propagators (Publication 196)
Fish Identification (Publication 334)
Fishing FUNdamentals (Publication 9)
Turtle Catching & Cooking (Publication 332)

APPENDIX C: Sources of Equipment and Supplies

Aerators

Aeration Industries, 603 Lake St., Excelsior, MN 55331

Airo-Lator, 8100 Passea, Kansas City, MO 64131

Aquatic Eco-Systems, Inc., 1767 Benbow Ct., Apopka, FL 32703

Aquatic Management, 6354 Low Rd., Lisbon, OH 44432

EnviroQuip International Inc., 8506 Beechmont Ave., Cincinnati, OH 45255

Fresh-Flow Corp., W6915 Highway 28, Cascade, WI 53011

Freshwater Farms of Ohio, 2624 N US Rt. 68, Urbana, OH 43078

Gen Airator, GROVHAC, INC., 4310 N. 126th St., Brookfield, WI 53005

Hedlund Aquaculture, P.O. Box 305, Medford, WI 54451

Lakecraft Corporation, 1010 W Lakeshore Dr., Port Clinton, OH 43452

Mineau Machine Co., 825 S. Baird St., Green Bay, WI 54301

Ohio Windmill & Pump Co., 8389 SR 534, Berlin Center, OH 44401

Ridgeview Fin Farm, 20-533 Co. Rd. X, Box 246, Ridgeville Corners, OH 43555

Aquatic Herbicides

See your local agricultural herbicide dealer or farm supply store.

Chemicals for Clearing Muddy Ponds

For alum, gypsum, and lime, see your local farm and feed supply store.

Fish Food

See your local farm and feed supply store.

Livestock Watering Devices

Farm'Trol Equipment, 409 Mayville St., Theresa, WI 53091

Net and Seine Supplies

Nichols Net and Twine Co., Rt 3, Bend Road, East St. Louis, IL 62201
(telephone: 618-876-7700)

Nylon Net Co., Box 592, Memphis, TN 38101
(telephone: 201-783-9800)

Sterling Net & Twine Company, 18 Label St., Montclair, NJ 07042
(telephone: 201-783-9800)

Rotenone

"Chemfish," Tifa (CI) Ltd., Tifa Square, Millington, NJ 07946

Cygnet Enterprises, Box 248, 1014 N. Bridge St., Linden, MI 48451

"Noxfish," Roussel Bio Corp., P.O. Box 1077, 400 Sylvan Ave., Englewood Cliffs, NJ 07632

"Prentox," Prentiss Drug and Chemical Co., Inc., 21 Vernon St., Floral Park, NY 11001

Trapping Supplies for Nuisance Animals

Sterling Fur & Tool Company, 11268C Frick Road, Sterling, OH 44276
(telephone: 330-939-3763)

Water Quality Testing Equipment

Hach Company, Box 907, Ames, IA

Heathkit Company, Benton Harbor, MI 40922

LaMotte Chemical Products, Chestertown, MD 21620

Water Testing Laboratories

Stilson Laboratories, Inc., 6121 Huntley Rd., Columbus, OH 43229-1003
(telephone: 614-848-4333)
Also, check your local telephone directory for other listings.

Index

Aeration
- benefits 37
- types of 38

Algae
- as food 19
- control of 27, 28
- problems associated with 20, 36, 43
- types of 24, 25

Angling
- angler diaries 14, 15
- catch & release 13, 18
- overharvest 13
- selective harvest 13, 14, 16–18
- to assess fish populations 14

Animal problems
- beaver 42
- Canada geese 42
- crayfish 41
- groundhogs 42
- muskrats 41
- turtles 41

Aquatic vegetation
- before applying control measures 29, 30
- biological controls of 27, 28
- chemical controls of 28, 29
- control by fishes 27, 28
- floating 25, 26
- identification of 23–27
- importance of 23
- mechanical control of 27
- reduces production of fish 19, 27
- rooted, emergent 26, 27
- rooted, submergent 23, 24
- sudden die-offs 25, 36, 37

Artificial feeding 19–20

Balanced pond 16, 17

Bank erosion 6, 39, 40

Bass, largemouth
- as a predator 9
- diet 9
- growth rate 9, 10
- harvest of 14, 16, 17–18
- management options for 14, 16, 17–18
- spawning 9, 14
- stocking of 9, 11

Beavers (see Animal problems)

Bluegill
- as prey 9
- diet 10
- growth rate 10
- harvest of 14, 16, 17–18
- management options for 14, 16, 17–18
- spawning 10, 14
- stocking of 9, 11
- supplemental feeding of 19–20

Bulrush (see Aquatic vegetation)

Canada geese (see Animal problems)

Cattails (see Aquatic vegetation)

Channel catfish
- diet 10
- growth rate 10
- harvest of 17–18
- management options for 14, 17–18
- stocking of 9, 11
- supplemental feeding of 19–20

Commercial fish propagators 11

Coontail (see Aquatic vegetation)

Copper sulfate (see Herbicides)

Crayfish (see Animal problems)

Dam
- construction 6, 7
- maintenance 6, 7
- problems from burrowing animals 6, 41, 42
- safety and liability 6
- seeding slopes 6, 45

Drawdowns
- for aquatic plant control 7
- for fish removal 7, 38

Duckweed (see Aquatic vegetation)

Erosion (see Bank erosion)

Evaporation 5, 40

Extension Service, The Ohio State University 5, 23

Feeding station 20
Fertilization 19
Fish diseases
  bacterial 31–32, 33
  environmental 31
  fungal 31
  nutritional 31
  parasitic 31, 32, 33
  viral 31
Fish kills
  consequences of 38
  disease 38
  poisoning 38
  reducing the likelihood of 37–38
  summerkill 35, 36–37
  winterkill 35–36, 37
Fish population
  assessment of 14, 16
  removal of 38
Fish propagators (see Commercial fish propagators)
Fish toxicants
  rotenone 38
Fishing (see Angling)
Food chain 19
Grass carp 9, 27–28
Groundhogs (see Animal problems)
Growth in fishes
  artificial feeding effects on 19–20
  bluegill (see Bluegill)
  channel catfish (see Channel catfish)
  largemouth bass (see Bass)
  redear (see Redear)
  relation to population density 19
  relation to water quality 20, 39
Habitat structures
  addition of 20
  types of 21
Harvest (see Angling)
Herbicides
  contact herbicides 28
  copper sulfate 28
  shading products 29
  systemic herbicides 28, 29
Hybrid fishes 11
Ice cover
  snow removal 37
Inversion 36, 37, 43
Leaking ponds
  sealing 40
Livestock 39, 40, 41
Management, for fishing
  all-purpose fishing 14, 16–17
  channel catfish fishing 14, 18
  large bluegill fishing 14, 16, 17–18
  no restrictions on harvest 14, 17
  trophy largemouth bass fishing 14, 16–18
Muddy water
  alum 40
  causes of 39–40, 41
  clearing muddy ponds 39–40
  effects on fish 39, 40
  gypsum 40
  hay bales 39
  hydrated lime 40
Muskrats (see Animal problems)
Natural Resource Conservation Service 5, 23
Organic material 36, 37, 44
Oxygen
  loss of 20, 35, 36, 37
  importance to fish 23
  sources of 23, 35, 36
Pelleted feed 19–20
pH 40
Photosynthesis 23, 29, 35, 36
Phytoplankton 10, 19, 36, 43
Pickerelweed (see Aquatic vegetation)
Poisoning
  for fish removal 38
  fish death from 38, 44
  restocking after 11, 38
Pollution
  animal waste products 40–41
  chemicals 5, 38
  sediment 5, 39, 40

Pond construction
- dam 6
- drain pipe 7
- dry hydrants 7, 8
- pond depth 6
- pond location 5, 6
- pond size 6
- slope 6
- spillways 6, 7

Pond types
- combination 6, 7
- embankment 6, 7
- excavated 6, 7

Pond volume
- calculation of 29, 30

Pondweeds (see Aquatic vegetation)
Predator-prey relationships 9, 10
Production of fishes
- increase of 19, 20

Recreational uses 13, 45
Redear sunfish
- diet 10
- growth rate 10

Renovated pond 9, 38
Reproduction (see Spawning)
Restrictions on angling
- numbers of fish 13, 17–18
- sizes of fish 13, 17–18

Rotenone (see Fish toxicants)
Seining 14
Slot-length limit 17
Soil and Water Conservation District 5
Soil types
- clay 5, 39, 40
- gravel 5
- sand 5

Spawning
- by bass 9, 14
- by bluegill 10, 14
- by channel catfish 10
- by redear 10
- determination of 14

Spillway (see Pond construction)
Stocking
- how to stock 11
- kinds of fish to stock 9–11
- number of fish to stock 9–11
- when to stock 11

Stratification 35, 36, 37
Summerkill
- causes of 36–37
- definition 35
- prevention of 37–38, 43

Temperature
- acclimation to 11
- for artificial feeding 19–20
- for fertilization 19
- for spawning (see Spawning)

Trapping nuisance animals 41, 42
Turbidity (see Muddy water)
Turnover (see Stratification)
Turtles (see Animal problems)
Undesirable fish 11, 12, 38
Vegetation (see Aquatic vegetation)
Volume measurement (see Pond volume)
Water
- clarity (see Muddy ponds)
- levels 5, 6, 40
- quality 5, 39
- supply 5

Water milfoil (see Aquatic vegetation)
Watermeal (see Aquatic vegetation)
Watershed 5
Winterkill
- causes of 35–36
- definition 35
- prevention of 37, 44

Zooplankton 9, 10, 19

Notes

Notes

Bob Taft, Governor • Samuel W. Speck, Director • Steven A. Gray, Chief
(R0502)