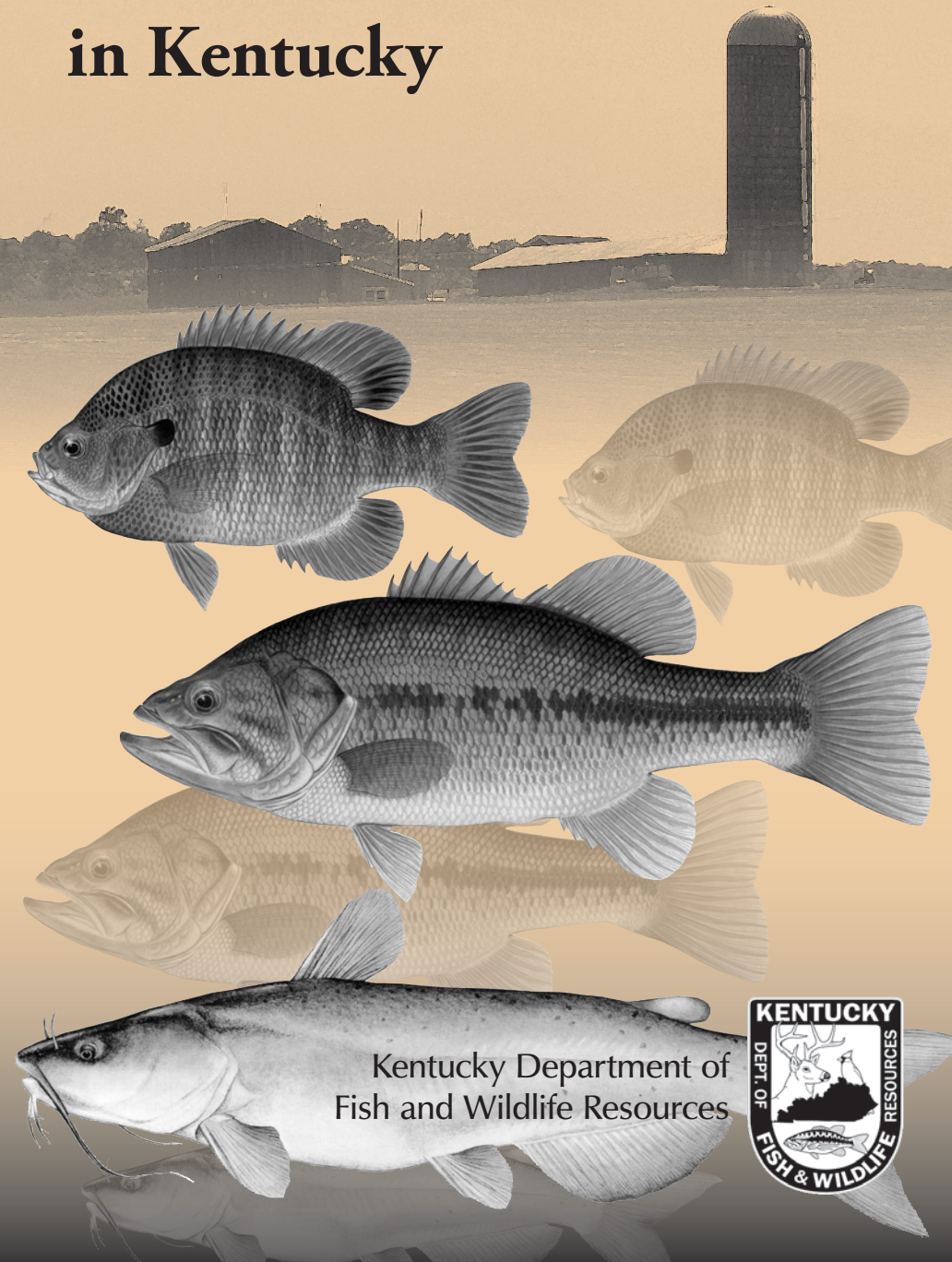
# A Management Guide for Ponds and Small Lakes in Kentucky



Kentucky Department of
Fish and Wildlife Resources

# Federal Aid Project

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# A Management Guide for Ponds and Small Lakes in Kentucky

Third Edition
2004

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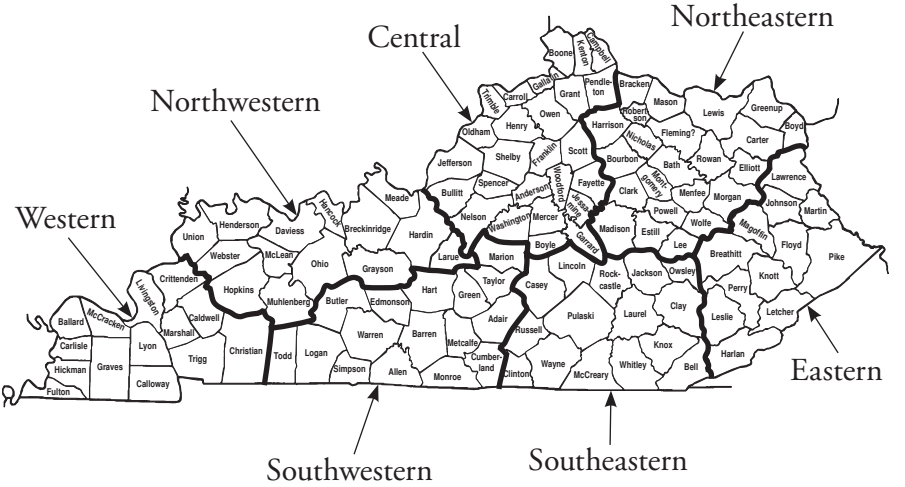
# KENTUCKY FISHERY DISTRICTS

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# INTRODUCTION

Fishing is a legacy in Kentucky and most of us began our fishing experience on a farm pond. Ponds and other small privately-owned lakes remain a significant aquatic resource in Kentucky. Traditionally, they have been important for agricultural use such as fire control, livestock watering, and irrigation. Equally important, small landowners are now enhancing their property values by constructing ponds strictly for their recreational use.

Ponds are some of most productive aquatic systems in terms of fish production. A simple and short food chain composed of largemouth bass, bluegill, redear sunfish, and channel catfish can provide a life time of enjoyable fishing, especially with a small amount of management effort. This booklet provides a quick reference for management techniques to both solve and prevent problems. You may also utilize the Fisheries Division Technical Guidance Program and call one of our fisheries offices listed in this booklet to obtain more information.

Your pond will provide you many hours of enjoyment whether you are a fishing enthusiast or a wildlife watcher. We encourage you to allow others to utilize your pond and help maintain the fishing tradition in Kentucky.

GO FISHING !

Benjy Kinman
Director of Fisheries

# POND CONSTRUCTION

The actual location of your pond may be the most important decision you make when planning pond construction. The benefits as well as the potential dangers from adjacent surroundings should be considered. In the event of failure of the dam, nearby buildings, highways, railroads or utilities could be affected. The uses for a well-designed pond may include domestic water supply, irrigation, fire protection, terrestrial wildlife habitat, livestock watering, recreation, and of course, fish production. Possible inflow of materials which may cause poor water quality or fish kills should be determined. Livestock wastes, ensilage, sewage or other by-products may lead to oxygen depletion or contamination.

According to the Natural Resources Conservation Service (NRCS) you should locate your pond where the largest storage volume can be obtained with the least amount of earth fill. For fishery management purposes the department recommends a minimum average depth of 6 feet and a maximum depth of 12 to 15 feet. It's best if construction funds are directed toward maximum surface acreage rather than excessive depth construction. The soil types of the area must be considered in site selection of the pond. A good pond site will have a sufficient depth of clay in the soil for construction of the levee, core of the dam, and excavated basin of the pond. Experienced local contractors with pond building experience should be contacted during the early planning stage for advice and suggestions on pond construction. The local NRCS agent can meet on site with the landowner and contractor to discuss watershed drainage area, pond capacity, runoff rates, spillway requirements, soil evaluation, dam construction, bottom drain standpipe, trickle tubes, and other engineering aspects.

The size of the pond to be constructed will depend on the amount of water runoff in the watershed. Normally, 10 to 15 acres of surface drainage are required to fill and maintain a one acre pond. Excessive watershed runoff into the pond can increase siltation and turbidity, reduce fish production, and cause dam failure. Plans for excavation of the pond basin should include shoreline depths of at least two to three feet to retard aquatic weed growth and improve angling. The most suitable (but less fertile) watershed cover is woodlands, followed by grasslands and pasture. The least suitable is row crops which can increase fertility but produce siltation. All ponds should have grass waterways leading into them to retard quick runoff and decrease the silt load. Special attention should be given to agriculture practices on adjacent lands and to the use of pesticides and herbicides. Nearby ponds that tend to overflow that contain undesirable fish species should also be considered. To maintain a quality fishery, pond owners should construct ponds of at least one acre, but two acres or larger are preferred. Ponds of less than one surface acre are more difficult to manage for a balanced fish population.

An important feature of any well designed and constructed pond is the capability to control water levels. A bottom drain standpipe installed with

anti-seep collars during the construction phase of the dam will maintain water quality and be beneficial in managing fish populations. The standpipe allows the water to be maintained at a constant level, with overflow water coming from the lower unoxygenated layer. Decreased water levels, or drawdowns, in the fall is a management tool that allows control of an overpopulation of bluegill by the bass population. Control valves are necessary for complete drainage of the pond, for total catfish harvest, or to dredge the pond if excessive siltation occurs. Drain pipes can also be installed which will provide water to livestock tanks below the dam. The NRCS will be able to provide more information on these structures.

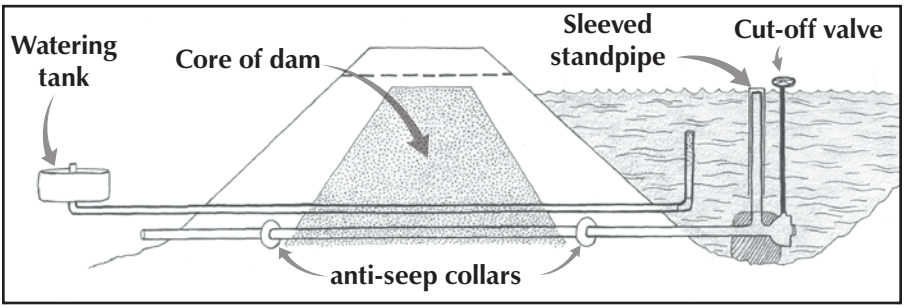


***Figure 1.*** *Profile of pond dam construction*

The final step following pond construction should be to fence the pond to prevent access by livestock. The fence should extend a minimum of 60 feet from the pond bank and completely enclose the pond, in-flowing grass waterway, and dam area. Wildlife habitat development within the fenced buffer area around the pond can be unlimited. The planting of grass and legume mixtures along with shrubs, hedges, and evergreens can enhance wildlife habitat. The shoreline, dam, and spillway areas should be mowed on a regular basis. Annual mowing of the adjacent wildlife areas should be delayed until late August following small game nesting.

# FISH STOCKING

## New or Renovated Ponds

For a nominal handling fee the Kentucky Department of Fish and Wildlife Resources (KDFWR) will supply small fish for stocking new or renovated ponds. Ponds with existing fish populations are not eligible for this stocking program. Pond owners can contact their county Wildlife & Boating officer, district fishery biologist, or call 800-858-1549 for a stocking application. The surface acreage should be determined to calculate the number of fish needed for stocking or the amount of rotenone needed for renovation, if the existing fish population is to be eradicated. The completed stocking application is then forwarded to the Fisheries Division office in Frankfort. The deadline for accepting stocking applications each year is Sept. 1. The pond owner is charged a minimal fee for the

fish to cover transportation costs. Rotenone is not available through KDFWR. Contact your district Fishery biologist for available sources.

The Fisheries Division has experimented with various fish stocking combinations for ponds and has found largemouth bass and bluegill to be the best combination for Kentucky waters. Channel catfish, a highly desirable game and food fish, are also available through the pond stocking program. The number of fish stocked depends on the pond size (surface acreage), as over-stocking or under-stocking can cause an unbalanced population, curtail pond productivity, and make fish management difficult. Fingerling bluegill and channel catfish (if requested) are stocked in the fall at rates of 400 and 50 per surface acre, respectively. Largemouth bass fingerlings are stocked the following May at the rate of 120 per acre. When these fish are ready for stocking, the Fisheries Division will notify the pond owner as to the time and place the fish may be picked up. The meeting place is usually a well-known location in the county in which the pond is located. The actual stocking of the new fish is the responsibility of the pond owner. (Note: Channel catfish do not normally reproduce successfullyin ponds as they require a cavity to nest in; it is best to restock them as they are removed; nesting structures or cavities may be added to encourage reproduction.)

Many new pond owners will stock their ponds with fish caught when fishing. This type of action is highly unadvisable and will usually result in an unbalanced or undesirable fish population in a new pond. If a pond owner is determined to personally stock his pond, the district fishery biologist should first be contacted for advice. The Department of Fish and Wildlife Resources' fingerling stocking program was developed through years of research and experience. To help ensure the development of a quality fishery in a new or renovated pond, it is recommended that this program be used.

## Redear Sunfish or "Shellcracker"

Redear sunfish is an optional species suitable for Kentucky farm ponds. The suggested stocking rate is to replace 40 percent of the bluegill stocked with redear sunfish. Redear sunfish alone will not support a bass population. These fish are available through commercial dealers. At least some aquatic vegetation is required for a successful redear sunfish population.

## Older Ponds

Certain ponds may be under-populated or over-populated with largemouth bass, bluegill, or another species. If the pond owner thinks that his pond is in this category, the district fishery biologist may be contacted so that existing fish population can be determined. Harvest, and or length limits, complete eradication and restocking, or the remedial stocking of largemouth bass or other species may be recommended to improve the fishery.

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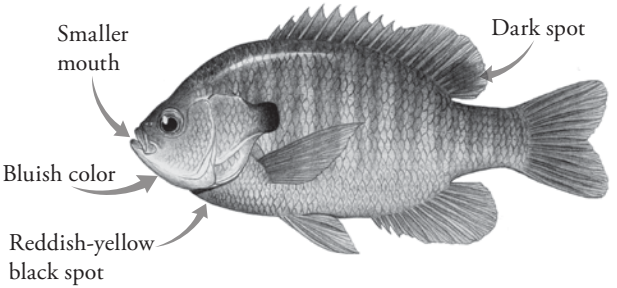
***Figure 2.*** *Desirable fish species in a Kentucky farm pond or lake. A. Bluegill; B. Largemouth bass; C. Channel catfish; D. Redear sunfish, or "shellcracker". Current or previous state record size fish for these species have been caught from ponds or small lakes.*

**A**




Bluegill up to11 inches can be seen in ponds. body color may be dark blue to silver blue with darker bands on body.

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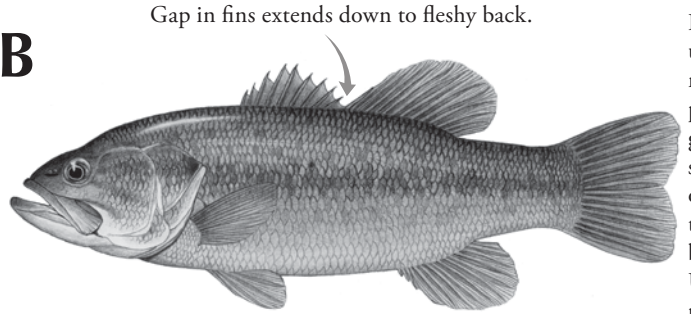
**B**




Largemouth bass up to 12 pounds or more may be seen in ponds. Body usually green to greenish silver; dark band on side from head to tail. Eyes may be brown or reddish. Usually no tooth patch on tongue.

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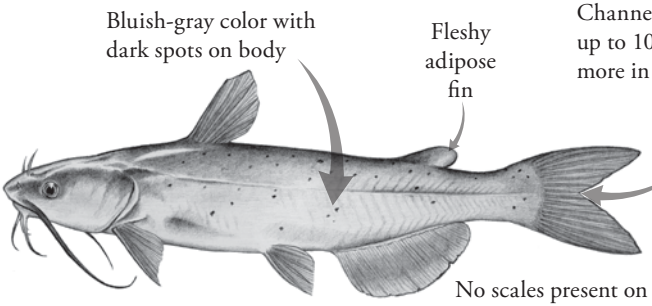
**C**




Channel catfish may get up to 10-20 pounds or more in ponds.

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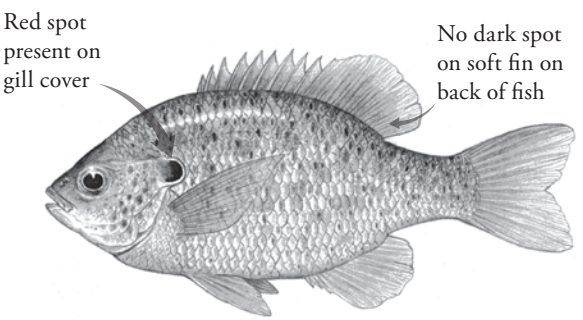
**D**




Redear sunfish may achieve lengths of up to 10 to 12 inches or more in ponds. Similar to bluegill except body is more spotted with yellow, brown, blue, or silver.

# CATCHING AND HARVESTING FISH FROM YOUR POND

There are a few important rules-of-thumb pertaining to the harvest of fish that will help keep your pond in balance (the desirable ratio of predators - largemouth bass, and prey - bluegill) for a longer period of time.

No fishing should take place the first year the pond is stocked. Several years after stocking, the pond will reach its carrying capacity (total pounds of fish it can support). In fertile ponds, largemouth bass generally will reach 12 inches 1 to 2 years following stocking. These bass usually spawn their second year. After the pond reaches carrying capacity, the largemouth bass will typically reach 12 inches in their third or fourth year. Bluegill may be harvested during the second summer after stocking if they have spawned successfully.

Fishing success is often good for the first few years after stocking. It is very important not to over-fish the bass during this time. Most people like to fish for bass, but confining the harvest to one fish species can harm the overall fish population in a pond. Harvesting only bass usually results in an over-population of bluegill. This is the single most common farm pond problem encountered by the Fisheries Division. It is best not to over-harvest or under-harvest either largemouth bass or bluegill. It is recommended that the pond owner impose a larger minimum harvest size for bass, perhaps 15 inches long or longer. This should allow a greater period of time for the bass to feed on bluegill and make more adult bass available to spawn in the pond. The catch-and-release of bass, and not harvest (removal), should be an important aspect of the pond fishing experience. On the other hand, a pond where no fish are allowed to be kept can become out of balance as well.

The number of fish that can safely be removed from a pond depends upon the ponds fertility and size. A pond found in a forested watershed is not going to be as fertile as a pond located in fertile farmlands. If the land surrounding the pond is fertile, then the pond will also be productive. The pounds of fish a one acre pond can support may range from 50 pounds in an infertile pond to as much as 400 or more pounds per acre in a fertile pond. Fertility is also related to how fast the fish will grow in your pond. One way a pond owner can determine the fertility of the pond is by chemical testing for alkalinity. Important elements related to production increase with increased alkalinity. Usually a pond can be considered very fertile if the alkalinity is 100 parts per million (ppm) or more; average if it is 50-100 ppm; and fair if the alkalinity is less than 50 ppm. See the fertilization and liming section of this booklet to find out how you can make your pond more productive.

Forty to fifty percent of the pond's annual production can be harvested each year. This means pounds of fish, not numbers. For instance, a fertile one-acre farm pond will generally support about 100 pounds of largemouth bass. Only 25 to 35 pounds of bass should be harvested per acre every year from this pond. Largemouth bass between 12 to 13 inches long, from a fertile

pond, should weigh one pound. This same fertile one-acre pond will support 200-300 pounds of bluegill, allowing for a harvest of approximately 100-150 pounds of bluegill annually or approximately 300 bluegill if they weigh one-third of a pound each (7 to 8 inches long). The above rates are suggested for a fertile one-acre pond. Many ponds in Kentucky are less than ½ acre in size. In an infertile ¼ acre pond, probably no more than 4 or 5 pounds of bass should be harvested annually. It is easy to see that with very little effort too many bass can be removed from a pond. In most instances, it is very difficult to manage a pond less than ½ acre in size for long term fishing. If possible, the pond owner should know what fish are in the pond, their relative abundance, and what fish are being removed. This is a difficult task if the pond is located in an area where access cannot be controlled. In summary, a good rule of thumb is for every one pound of bass taken out of the pond, remove 4 to 5 pounds of bluegill. Emphasis should be placed on harvesting bluegill.

If catfish have been stocked into the pond, they can be harvested anytime they are determined to be of edible size. Be aware that catfish will probably have to be restocked to replace those that are removed. See the section on catfish for further details.

If your stocked pond is 3 or 4 years old or older, there are several signs to look for in order to know whether or not you are experiencing problems with the fish population. Once largemouth bass become adults, they usually reproduce each spring. Largemouth bass in fertile ponds usually spawn for the first time when they are 2 years old or 10 to 12 inches long. Bluegill will reproduce after their first year. Bluegill begin spawning in May and may nest two or more times. If you do not see bass fry or bluegill fry sometime during the summer (after the pond has been stocked for at least 3 years), it should be a warning sign. The best way to know what is going on in your pond is to fish it yourself. Below is an example of what you should look for in your rod-and-reel catch to determine the status of the fish population in your pond.

**Balanced Fish Population**

Bluegill - 6 inches long and longer
Bass - all sizes up to 1-2 pounds (12-15 inches long) and perhaps larger.
No action needed.

**Unbalanced, Bluegill Overcrowded**

Bluegill - many 3-5 inches long
Bass - few caught but larger in size (2 pounds or larger)
Solution - remove excess 3-5 inch long bluegill (rod-and-reel, seine, trap), protect all bass (catch and release). Try stocking 50 bass (3 in-5 in) per acre for 1 to 2 years.

**Unbalanced, Bass Overcrowded**

Bluegill - average ⅓ pound (9 inches or more) or more in weight, less abundant

Bass - less than 1 pound (12 inches long or less), poor condition, very numerous

Solution - remove some bass, keep all sizes if you desire more quality bass; do not remove bluegill; if you want quality bluegill, maintain this population.

If conditions indicate that the bass size limit needs to be changed to better manage the fishery within the pond, contact your local Wildlife & Boating officer or your district fishery biologist to check the status of the fish population within the pond. The biologist can then authorize the appropriate size limit or removal of the size limit within the pond until the problem is resolved.

**Unbalanced**

Small crappie, sunfish, bullheads, carp or other undesirable fish present. Usually in a stunted population of crappie or sunfish, the fish are small, all about the same size, and may have bulging or very large eyes. Bass and catfish generally have large heads and thin bodies when they are over populated.

Solution - eradicate fish population (renovate) and restock.

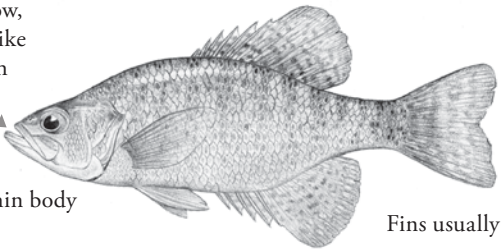
In summary, remember:

- maintain fertility
- keep aquatic vegetation under control
- place fishing efforts on bluegill
- fish on a regular basis
- return smaller bass (control bass harvest)
- know what kinds and sizes of fish are being removed from the pond
- do not allow fish from streams, unknown sources, or bait buckets to be stocked

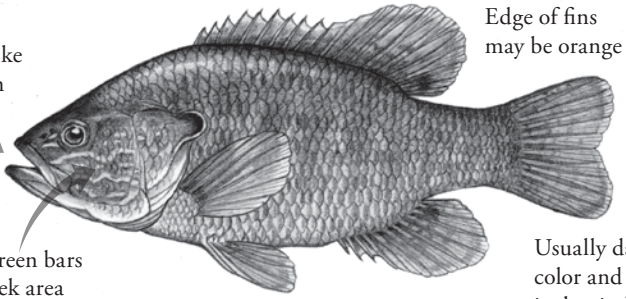
Follow these rules and with careful management you will have a pond to fish and enjoy for years to come.

***Figure 3.*** *Some undesirable fish species in a Kentucky farm pond or lake. A. White crappie; B. Green sunfish; C. Bullhead catfish; D. Common carp*

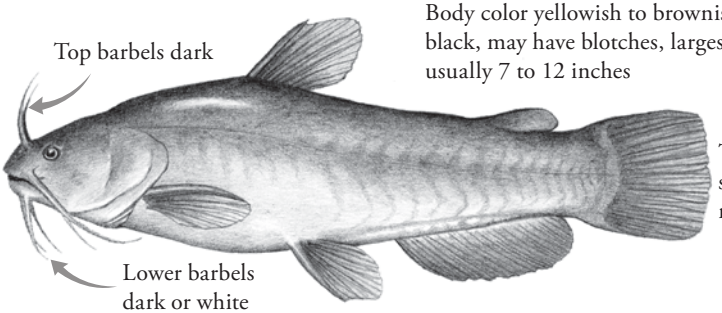
**A**


Narrow, bass-like mouth
White body color, vertical bars on body
Thin body
Fins usually spotted

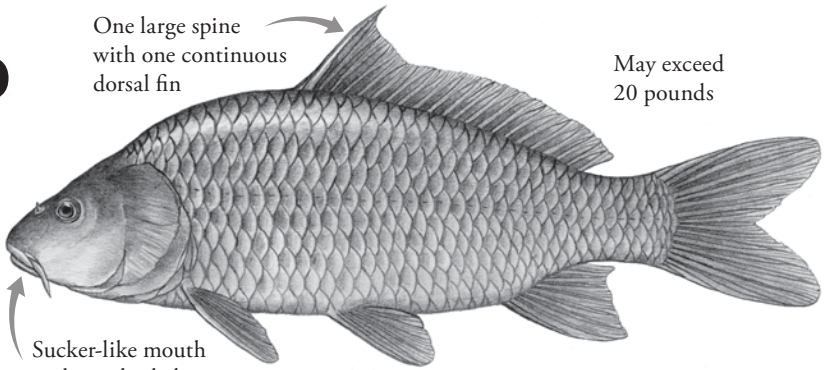
**B**


Large, bass-like mouth
Edge of fins may be orange
Blue-green bars on cheek area
Usually dark in color and 6 or 7 inches in length

**C**


Top barbels dark
Body color yellowish to brownish-black, may have blotches, largest size usually 7 to 12 inches
Tail fin squared, not forked
Lower barbels dark or white

**D**


One large spine with one continuous dorsal fin
May exceed 20 pounds
Sucker-like mouth with one barbel in each corner
Solid gold-brown body color

# UNDESIRABLE SPECIES

Almost any fish, even those normally considered sportfish, can be considered an undesirable fish in farm ponds. Most fish other than largemouth bass, bluegill, redear sunfish, channel catfish, and triploid grass carp are not recommended in a farm pond. Great care should be taken to prevent the accidental or deliberate stocking of undesirable fishes. Bait fishes as well as larger species can be introduced from sources such as discarded minnows or from well-meaning friends and neighbors. Ponds located close to streams may receive undesirable fish species during times of flooding. Species which should be controlled and are considered undesirable in a farm pond are:

## Common Carp

The common carp is sometimes stocked because pond owners believe that they will control aquatic vegetation or stop pond leaks. Carp will keep a pond muddy when numerous, but they will not keep the pond free from all aquatic vegetation. This muddy condition will also inhibit bass growth and reproduction. The quality of your pond for use as a fishing pond, livestock water source, or domestic water source will be affected by the action of the common carp.

## Crappie

Do not stock crappie in a pond or lake of less than 100 acres. These fish, although considered a sport fish, do not do well in small lakes or farm ponds. Largemouth bass and/or channel catfish must be large and numerous to keep their numbers under control.

## Green Sunfish and other Sunfishes

Green sunfish, hybrid sunfish, warmouth, longear sunfish, pumpkinseed, rockbass, etc., should not be stocked in farm ponds where balanced bass and bluegill fishing is desired. They all affect the bluegill and redear sunfish population by competing with them for food, space and nesting areas. Most of these fishes remain too small for harvest and tend to hybridize with the bluegill. Maintaining a hybrid sunfish fishery requires special care and harvest regulations. Hybrid sunfish tend to produce inferior offspring of the parent species. Large numbers of bass and catfish must be maintained to keep the young sunfish under control.

## Bullhead, Flathead Catfish, and other Catfish

Although bullhead catfish are excellent food fish they tend to overpopulate and stunt in farm ponds when bass are not present in enough numbers to keep them under control. Like the carp, they tend to muddy the pond with their bottom feeding habits. You should only stock channel catfish. Channel catfish have a forked tail and silvery sides with numerous black spots in the young fish. Bullheads have a square tail with rounded edges and dark olive sides. Flathead

catfish, as well as the white catfish are not recommended in a farm pond. Flathead catfish feed mainly on fish and may have a place in the management of small lakes that have an overpopulation of bluegill. Research continues on the use of this fish as a management tool.

### Miscellaneous Fishes

Pond owners are, at times, tempted to stock fish from local streams, other farm ponds, or lakes. Fish found in these sources include fishes that will not do well or will compete with desirable fishes. Minnows, shiners, and other fish provide food for bass, but bass should be feeding on bluegill. Other fish that may be introduced that are not considered desirable include gars, white bass, buffalos, walleye, sauger, suckers, madtoms, chubs, darters and carpsuckers. Each of these fishes may affect the balance of the pond and provide you with less harvestable fish. You also risk introduction of disease and parasites.

# FISH DISEASES

Generally, fish diseases are difficult to diagnose and few people are trained to do this in the state. Treatment is often costly and difficult. Fish mortality related to bacteria, protozoans, or other parasites is usually more prevalent in ponds during the spring and summer months. It is normal for a few fish to occasionally die, but outbreaks of certain disease-causing organisms often kill large numbers of fish. There are no practical methods for controlling these organisms when outbreaks occur in larger bodies of water; therefore, a portion of the fish population will die before the disease runs its course. Outbreaks in smaller lakes and ponds can often be controlled by the use of certain chemicals or feed additives. Since treatments for the various diseases are generally only partly successful, the best control for any disease is prevention. Several good, preventative measures for pond owners include purchasing disease- free fingerlings, utilizing a clean water source, excluding wild or exotic fish from a pond or lake, and aeration.

Whenever an unusual number of stressed or dying fish are discovered by a pond owner the district fishery biologist may be contacted. He may be able to identify the disease and suggest methods to correct the situation. Collect dying (moribund) fish rather than fish that are already dead if they are to be examined by a fish disease expert. It is recommended that the fish disease specialist at Kentucky State University - Aquaculture Section in Frankfort be contacted at 502-597-6581.

Some of the common disease-causing organisms found in Kentucky are described in the following paragraphs. The chemicals used for disease control in ponds are also mentioned, but it is wise to always have the fish disease specialist compute the correct application rates. Chemical overdose can kill fish, while an underdose may not eliminate the organism causing the damage. Be sure to purchase chemicals that readily dissolve in water and to closely follow any label warnings or directions. Certain chemicals can only be purchased by individuals

who have completed the Pesticide Certification Training Course offered through the county extension agent. Unfortunately, by the time diagnosis is made and chemicals are located, the disease usually has run its course. Fish with heavy fungal and bacterial infections will usually die anyway.

## Bacteria

Bacterial diseases may be external or internal and are often associated with some type of stress. Infected fish may appear listless, lose their appetite, or swim erratically. Aeromonas and Pseudomonas are two of the most frequently encountered bacteria. Often these organisms may cause red streaks at the base of the fins and on the underside of the fish or reddish circular ulcers on the sides of the body. In severe cases, the stomach area is swollen and the scales may protrude.

Flexibacter is another common bacteria. Infected fish may have light bands

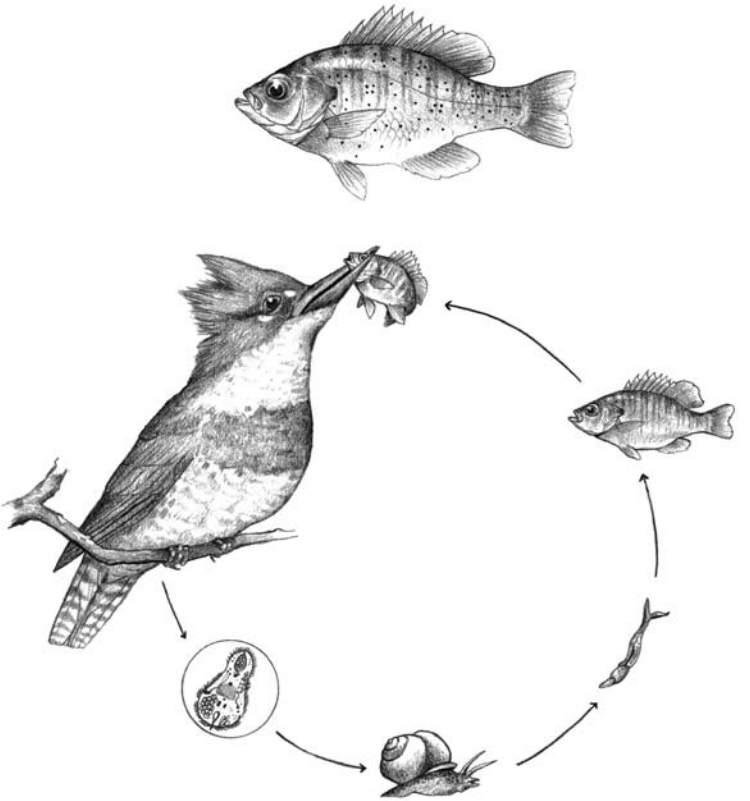


***Figure 4.*** *The life cycle of the digenetic trematode involves fish, fish-eating birds and snails. Black grub or "black-spot disease" in fish gives them a peppered appearance. Yellow or white grubs are found in the meat and/or organs of the fish and resembles grains of sand.*

across the back (saddleback), eroded areas on the mouth and/or fins, dead areas on the gills, and a dirty-yellow material around the mouth. Superficially, a Flexibacter infection may often resemble a fungal infection.

## Protozoans

Protozoans usually do not cause many problems in naturally occurring populations. They may cause losses in ponds where fish are cultured in high-density situations, such as in channel catfish culture. Fish infected with large numbers of protozoans may exhibit erratic swimming movements, abnormal coloration, loss of appetite, excess mucous production, hemorrhaging, swollen body, or distended eyes. Often the damage to the epithelium (skin) by protozoans may provide sites for secondary infections.

Ichthyophthirius often causes serious problems and is difficult to control because of a complex life cycle. The classic characteristic of an "Ich" infection is the presence of small white pustules (pimplelike bodies) on the skin and fins. Other common protozoans include blue slime disease (Trichodina, Costia), and red sore disease (Epistylis).

Chemical control of protozoan outbreaks in ponds may be achieved with one or two applications of potassium permanganate at 2 mg/1 or formalin at 15 to 25 mg/1 (4.5 to 7.5 gallons per acre foot). Potassium permanganate is usually the chemical of choice and should be used in warm weather. Formalin is approved for food fish use, but may caused dissolved oxygen depletions when the water temperature is around 80°F.

Control of "Ich" outbreaks varies somewhat from the general chemical treatments for protozoans. Copper sulfate applied at 0.5 mg/1 (1.3 pounds per acre-foot), each week or formalin at 20 mg/1 (6 gallons per acre-foot) every third day may help bring the outbreak under control. The treatments should run through the duration of the life cycle which takes five weeks to complete at 50°F, up to two weeks at 60°F, and three to four days at 70 to 75°F. As mentioned previously, use caution in applying copper sulfate to soft water and formalin during warm weather.

## Trematodes (Black, Yellow, or White Grub)

Monogenetic trematodes complete their life cycle on fish without involving other animal hosts. Large numbers may occur on the fish externally, usually on the gills, and may cause anemia, secondary infections, and irritation which may be exhibited by rubbing or flashing swimming movements. Common types of monogenetic trematodes include Gyrodactylus, Dactylogyrus, and Cleidodiscus. Outbreaks on fish in ponds may be controlled with formalin at 25 mg/1.

Digenetic trematodes (Figure 5) require one or more hosts (usually snails and fish-eating birds), other than fish, to complete their life cycle. The larval stages, commonly known as black, yellow, or white grubs, of certain digenetic flukes may encyst under the skin and over the entire body of the fish. Severely infected fish may be covered with black or yellow spots. These parasites normally do not kill fish, but may reduce the growth rate if heavily infested. Proper

cleaning and cooking will render the parasite harmless to man. Other digenetic trematodes may be found internally. Usually internally infected fish exhibit no external symptoms, but they may lose weight or appear listless. There is no known control of digenetic trematodes in ponds, other than the possible elimination of the snails and the bird roosts or perches over the pond. Snails can be killed by broadcasting 3lbs. of copper sulfate per surface acre around shoreline areas less than two feet deep; also redear sunfish will actively feed on snails. Great blue herons are probably the most common bird host. Herons may be discouraged with the use of heron decoys, noise-makers, or increased human or guard-dog presence.

## Nematodes

This is a form of worm (Philometra) that is most often found in bluegill but also occurs in largemouth bass. Infection with these worms is also known as "popeye disease" as the worm is located behind the eye causing it to bulge. It gives the area around the eye a reddish appearance and usually results in the loss of the eye. During infection, the eye can be removed and the long, red worm easily seen and removed.

## Cestodes (Tapeworms)

Tapeworms may be found in the intestine, stomach, or body cavity of fish. Heavy infestations of mature tapeworms (Corallobothrium), or "catfish tapeworm" in the intestine of catfish may retard growth. The larval form of (Proteocephalus), "bass tapeworm", may migrate through the body cavity and internal organs causing adhesions which may inhibit spawning capabilities of bass. If severe infestations occur in most of the fish, the best corrective measure is to renovate the pond and stock parasite-free fish.

## Fungus

Fungal infections are characterized by a cottony growth on the skin of the fish and are thought to always occur secondarily to an injury or invading organism. The most common fungus affecting both fish and eggs is Saprolengnia. Once a fungal infection starts, it can spread and result in death of the fish. Unfortunately, there are presently no fungicides which are feasible for pond use and have EPA or FDA approval.

## Copepods

Parasitic copepods, such as Lernaea (anchor worm) and Argulus (fish lice), often penetrate the skin of fish and feed on blood. The infected sites may appear as small lesions, but could become ulcerated and provide access for secondary infection by fungus or bacteria. Presently, there are no chemicals approved which may adequately control severe copepod infections in ponds.

# FISH KILLS

The term "fish kill" is used by biologists to describe a sudden die-off of a large number of fish. Fish kills can result from a variety of circumstances, but certain preventative steps can be taken to reduce the chances of a fish kill occurring in private ponds and lakes.

## Toxic Run-off

The use of agricultural pesticides or herbicides on the pond watershed (land area that drains into pond), can result in a fish kill as rain water carries the chemicals into the pond. Care should be taken not to apply pesticides to the pond watershed when rain is probable. Use only those herbicides on aquatic vegetation which have been recommended for that purpose.

## Oxygen Depletion

Most oxygen present in pond water is produced by tiny plants called "phytoplankton" or microscopic algae. The oxygen is produced through a process called photosynthesis which occurs only during daylight hours. Daily photosynthesis is necessary for the survival of this algae and the animal life in the pond. Although algae and other aquatic animals (fish, aquatic insects, etc.), are continuously using oxygen through the respiration process, enough oxygen is produced through photosynthesis to support life. Because oxygen is produced only during daylight hours, oxygen levels drop overnight and are lowest just prior to sunrise. Oxygen depletions usually occur during the night with dead fish appearing by morning. During the morning hours live fish may be seen gulping for oxygen at the pond surface.

## Summer Fish Kills

As summer progresses algal populations multiply rapidly. If excess nutrients are available (run-off from manure covered fields, fertilization, etc.), the algae can become so dense that adequate sunlight cannot penetrate beyond the first few feet of water. The algae (and therefore oxygen) become restricted to this upper, narrow layer of water. The demand for oxygen during night time respiration will often exceed that found in this narrow, upper layer of water and dissolved oxygen levels will decline. Depending on the magnitude of the oxygen decline, a fish kill may occur.

A fish kill can occur following several days of cloudy weather during the summer or early fall. The reduced sunlight during cloud cover restricts sunlight penetration to the upper layer of water. Those algae in the deeper water that are no longer receiving adequate sunlight will die-off quickly. As bacteria break down the algae, oxygen is used up and fish become stressed or die. Ponds that experience an algal die-off may appear brown in color.

Pond owners can reduce the chance of algal die-off by controlling the

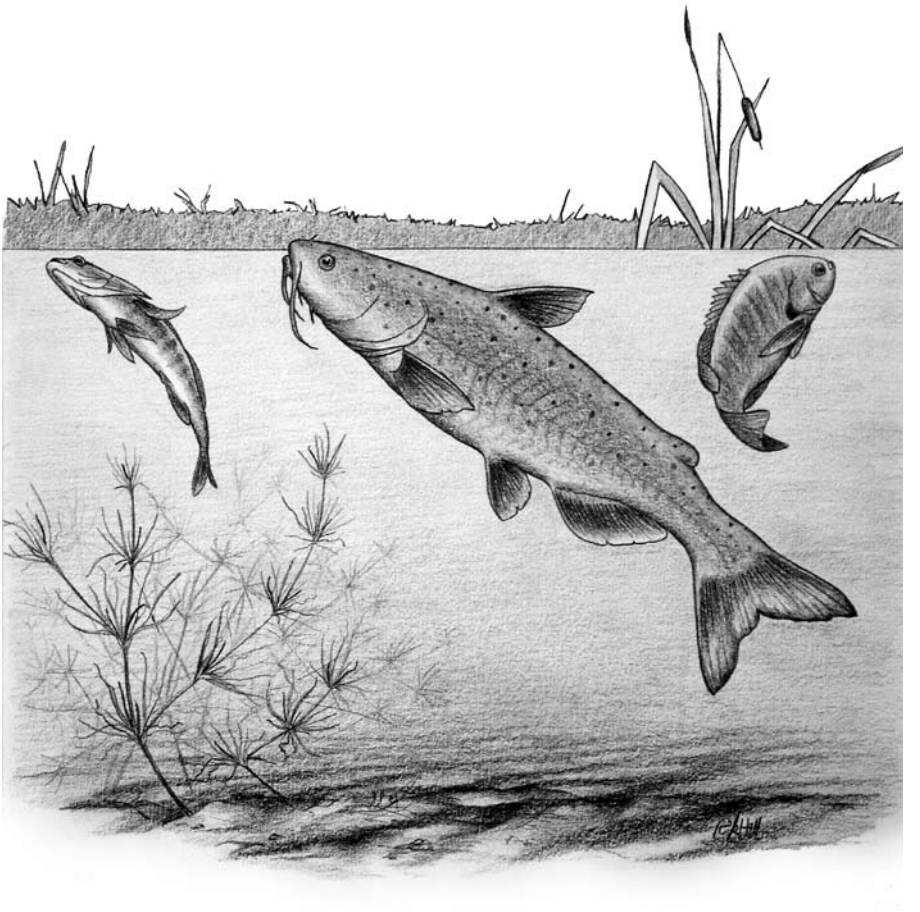


***Figure 5.*** *Fish kills due to oxygen depletion are characterized by fish gulping at the surface of the pond for oxygen. Larger fish will die first because of their greater oxygen demand. These fish kills usually do not kill all the fish in a pond.*

amount of nutrients that enter the pond. Care should be taken not to over fertilize the pond during the summer. Organic fertilizer (hay, tree tops, manure, etc.), should not be used; inorganic fertilizer is recommended (see section on pond fertilization). If ponds are sprayed with aquatic herbicides, care should be taken not to kill too much of the weed at one time as the dead plant material will also deplete oxygen levels in the water.

Ponds that have recurring oxygen problems may require an aeration system that will increase oxygen levels during critical periods. Aeration systems are available that agitate the pond surface or bubble air from the pond bottom. In an emergency, you can use a water pump and hose to create a fountain effect which will add more oxygen to the water to reduce fish loss. See figure 14 for illustrations of some aerators.

## Turnover

During the summer most ponds have adequate oxygen levels in only the upper 6 to 10 feet of water. The colder, deeper water is essentially void of oxygen. The upper, warmer layer of water remains separated from the colder water because of a difference in density between the two. Cold water is heavier than warm water and, therefore, remains associated to the bottom. The thin layer where these two areas meet is called the thermocline.

As fall approaches, the upper water layer cools down and the density difference between the two layers is reduced. A cold rain or strong wind can result in a sudden mixing (turnover), of the two water layers. If the deeper layer is relatively large as compared to the upper layer, then it is possible that a fish kill could result. This problem can be avoided by not building the pond too deep (see section on pond construction), or by installing an aeration system. Even with precautions, most ponds will eventually experience some type of fish kill or turnover.

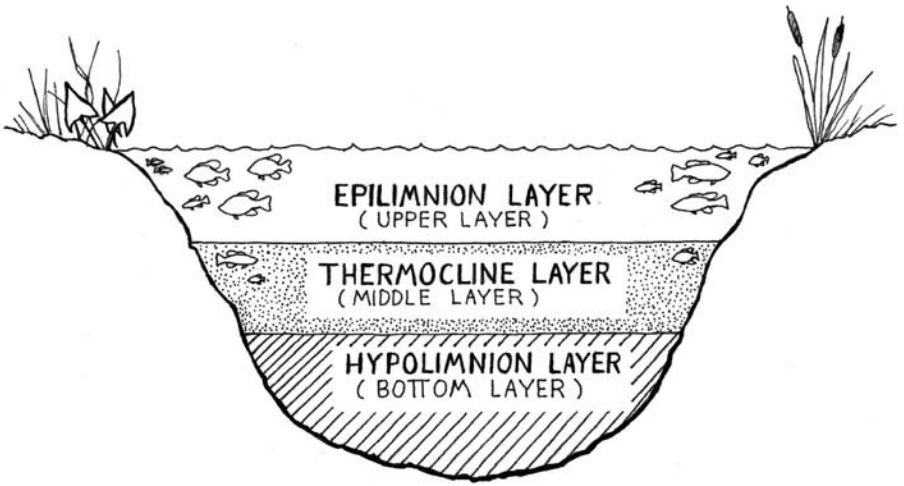



***Figure 6.*** *During the summer, your pond or lake will stratify into three layers: the upper layer is warmer and contains adequate oxygen; the bottom layer is colder and has very little oxygen; and the middle layer is the transition zone between the upper and bottom layers.*

## Winter Kill

If the pond surface freezes and is covered with snow for a long period of time, sunlight cannot reach the algae. This lack of sunlight can cause an algal die-off and subsequent fish kill. Pond owners whose pond frequently "winter kills" may consider installation of an aeration system. The mixing action of the aerator not only puts oxygen in the water but also prevents ice cover in the vicinity of the aerator.

## Fish Diseases

An extensive disease outbreak could lead to a fish kill. This often occurs in pay lakes where diseased or injured fish are delivered from some outside source, or in lakes and ponds with dense fish populations. See the section on fish diseases.

## Spring Die-off

Some fish, especially when over-abundant, will experience die-offs in the spring. This is a result of heavy competition for food during the previous year causing poor body condition and reduced resistance to bacterial and fungal infections. It is most obvious when the water temperature is between 60 and 70 degrees Fahrenheit. These die-offs are common and are usually somewhat beneficial to the overall fish population. Though some are more severe than others, it is nature's way of thinning an overcrowded situation. Most commonly affected are bluegill, though occasionally redear sunfish and a few small largemouth bass are also seen. Only the fish that were in poor condition, due to their inability to compete for food, will die. The stronger fish that competed well and maintained their good body condition will survive. Spring spawning behavior may also lead to poor body condition and bacterial infections. This is particularly common in bluegill (usually males) during the May spawning period.

***Figure 7.*** *If your pond or lake problems require an inspection and evaluation by your district fishery biologist, he (or she) will meet with you on site and make recommendations.*

# FOOD FROM FARM PONDS

All fish in a pond are a potential source of food. However, the majority of our farm ponds and small private lakes are not managed for maximum fish production and yield. A pond can be one of the most productive plots of real estate on a farm if managed for intensive production of fish. A good feed-out program for catfish can enhance recreational benefits, provide additional food for the table, or become a source of income.

For more information about fish culture call or write: Aquaculture Specialist, Aquaculture Research Center, Kentucky State University, Box 196, Frankfort, Kentucky 40601 (*www.ksuaquaculture.org*).

Successful catfish rearing requires constructing facilities, stocking and feeding fish, controlling water quality, harvesting, and utilizing or marketing the fish crop.

A number of questions need to be asked before stocking a pond.
1) Is the pond large enough for multi-species management?
2) Is recreation the primary purpose for the pond?
3) Are the fish to be fed?
4) Is total production of fish for food most important?

Before stocking ponds designated for food fish production only, remove existing fish populations. This is not a problem in new ponds; however, in older ponds there may be fish populations present that are not desirable.

In ponds less than one acre, it is hard to maintain a balanced fish population of bass and bluegill. The pond may be stocked solely with channel catfish if raising fish for food is most important. They will provide the best sport fishing as well as food for the table in these small ponds.

Catfish stocking rates vary from one operation to another depending on the desired use of fish, available resources, and the owner commitment to a specific level of management.

## Feeding

The feeding program is important and should be carried out properly. Catfish begin actively feeding in the spring when the water temperature warms to 65° F; they consume food at the highest rate when the water temperature is between 80° and 85° F. A good commercial catfish food which contains at least 32 percent crude protein should be used. These feeds are available at most feed stores in floating or sinking pellets. Floating pellets generally cost more but are more stable than sinking pellets. They also enable you to determine whether the fish are feeding. In general, the fish should be fed an equivalent of 3 percent of body weight per day during the height of the growing season. A good rule is to feed them all they will eat in about 10 to 15 minutes. For best results, feed every day at the same time, when oxygen concentrations in the water are highest. This is usually late-afternoon. To reduce the risk of low oxygen, never feed more than

35 pounds per acre per day unless water is flowing through the pond or aeration equipment is available.

Catfish growth and condition should be periodically checked. This can be accomplished by catching a few of them and observing their general condition. If the catfish are "skinny", this could be an indication of overcrowding and/or an inadequate food supply. This can be corrected by harvesting some of the fish or by increasing the feeding frequency. If daily visits to the pond are not practical, the use of an automatic feeder may be desirable.

Begin catfish harvest when the fish reach an edible size. In catch-out ponds, catch records are important in determining when supplemental stocking of catfish is needed. Catfish should be restocked in catch-out ponds after one-half of the original stocking have been harvested.

In ponds that can be drained, catfish can be totally harvested by draining the water and seining the fish from shallow water or the catch basin. Partial harvesting from ponds which cannot be drained can offer the advantage of distributing risk over a longer period, keeping ponds at higher stocking densities over longer periods, and maintaining an almost continuous harvest of fresh-caught fish for food or market. Partially harvesting ponds is accomplished by using a selective mesh seine large enough to grade larger fish for harvest. The harvested fish are replaced with fingerlings, thereby maintaining a continuous supply of various size fish.

Aquaculture specialist through Kentucky State University should be contacted for more information on this and any special permits involved.

# FERTILIZATION

Why do some ponds always seem to produce good fishing while other ponds (maybe yours), never produce the number of sizes of fish that you expect? There are a number of factors involved, many of which are discussed in other sections of this booklet, but one of the most important is the basic productivity of your pond. Ponds vary in fertility and fish production capacity much as farm fields vary in their ability to produce crops. Each pond's natural fertility is a result of its soil composition plus the amount and kind of nutrients added to the pond by runoff.

Many ponds in Kentucky are far below their fish producing capacity due to low fertility. Low fertility ponds are generally characterized by clear water and often have undesirable amounts of aquatic vegetation. Ponds located in wooded areas are often infertile due to little organic enrichment from watershed runoff. Infertile ponds are also characterized by poor fish production, including poor growth of individual fish and low numbers and pounds of fish per acre.

Fertilizing your pond may be the single most important thing you can do to increase fish production. Fish production, measured in pounds per acre, is often dramatically increased (two to four times in some instances) by the addition of inorganic fertilizers (Hall, 1962; Rouse, 1975; Dobbins and Boyd, 1976; Lichtkoppler and Boyd, 1977). However, to be effective, a fertilization program

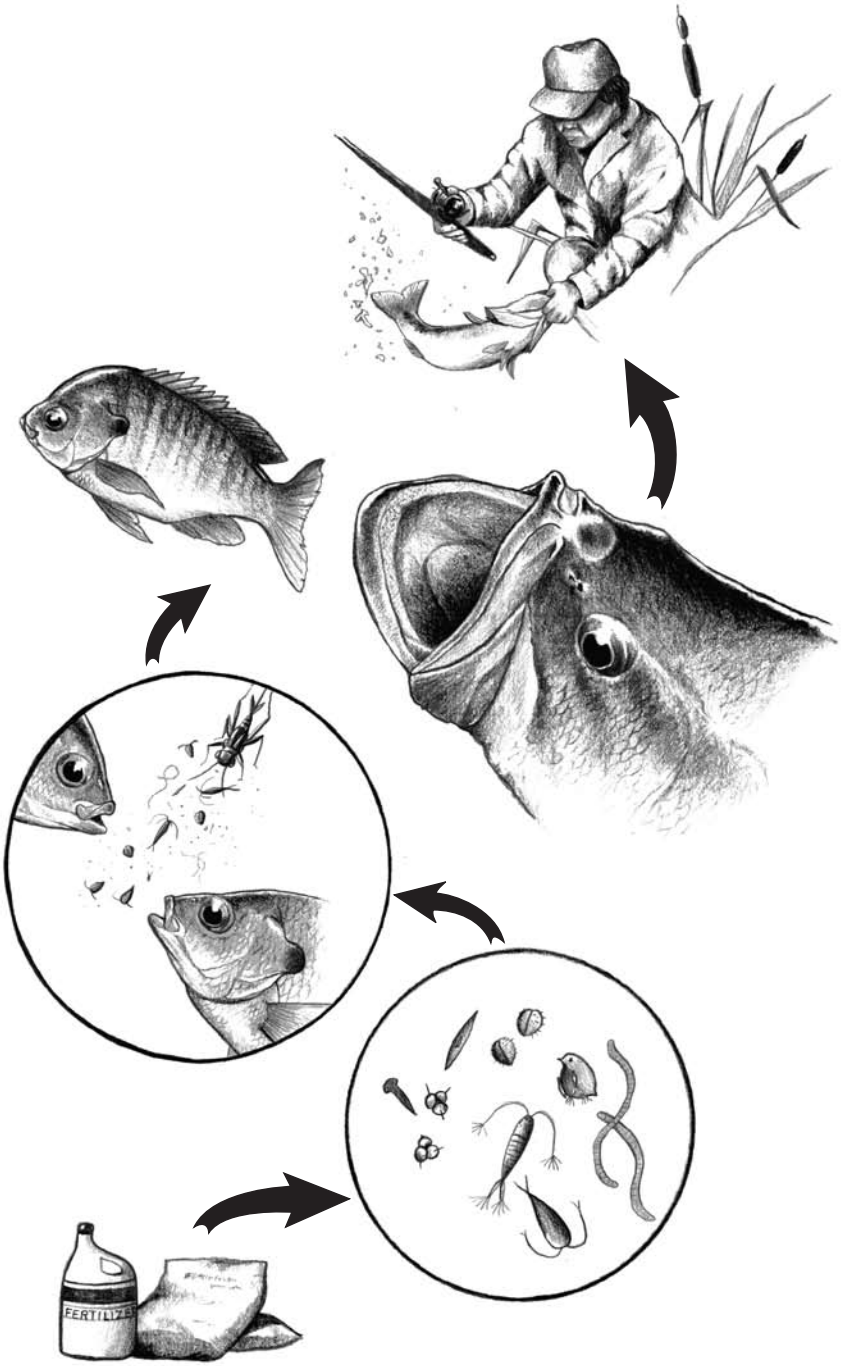



***Figure 8.*** *The farm pond food chain. Fertilizers may be added if nutrients in the watershed of the pond or lake are not adequate.*

must be properly conducted on an annual basis.

Not all ponds will benefit from fertilization. Do not fertilize if: 1. the pond has adequate natural fertility; 2. if the transparency of the pond's water is less than 18 inches deep during the summer; or 3. if there is excessive outflow over the pond's spillway. Fertilizer will also have little effect in correcting an imbalanced fish population. In some areas poor fertility may be caused by low alkalinity levels. This situation is easily detectable by a simple water quality test conducted by your district fishery biologist or other water quality specialist. Your district fishery biologist can also recommend proper liming techniques to correct this situation. Your pond should have a total alkalinity level of at least 20 mg / per liter for fertilization to be effective. (See "Application of Lime" in the following pages.)

## How does fertilizer help my pond grow fish?

Fertilizer adds nutrients to the pond, setting off a chain reaction that increases the ability of your pond to grow more fish as well as bigger fish. This process results because nutrients (fertilizer), added to the water create a rapid growth of microscopic plants (phytoplankton), and animals (zooplankton), that provide food for insects and small fishes. These insects and small fish are in turn eaten by larger fish with the end result being faster growth and more fish in your pond. The illustration of a food chain in Figure 9 simplifies these processes and shows how fertilizer can increase your pond's fish production.

## What type of fertilizer should you use?

Liquid fertilizers are preferred since they readily disperse in water thus requiring less time to establish a "bloom" (rapid growth of microscopic plants and animals). The Kentucky Department of Fish and Wildlife Resources has obtained excellent results using liquid 9-18-9 (nitrogen - phosphorus - potash), fertilizer. Fertilizer rates are 1 pound of nitrogen, 2 pounds of phosphorus, and 1 pound of potash per surface acre per treatment. Liquid 9-18-9 supplies approximately these amounts when applied at 1 gallon per acre.

Other liquid fertilizers may be used; however, make sure the formulation is water soluble. A common liquid fertilizer in Kentucky, 6-18-6 or 7-14-7 (liquid tobacco starter), may be used at the same rate as liquid 9-18-9. If you cannot obtain liquid 9-18-9 or 6-18-6 fertilizer in your area, consult your local fertilizer supplier to obtain desired amounts per acre of phosphorus.

## How do you apply the fertilizer?

Liquid fertilizer should be diluted with water (half and half), and applied across the pond's surface. On larger ponds and lakes a boat may be necessary to distribute the fertilizer. Granular fertilizers which are water soluble can be added directly to the pond. Some pond owners place open bags of fertilizer on floating platforms and allow wind and rain to do the work.

Your fertilization program should begin by mid-April when the water temperature reaches 60-65° F. On most ponds, applications should be made

every two weeks beginning May 1 and ending by June 15. At this time, applications should be regulated by the transparency of the water, i.e., by the amount of "bloom" or green color which has developed. Once a "bloom" is obtained, only enough fertilizer is added to maintain the "bloom". An excellent way to monitor the "bloom" is to measure the water transparency with a simple homemade measuring device. A black and white disc (a painted coffee can lid or pie pan works fine), is attached flat to the end of a yardstick or pole that is calibrated in inches. The disc is submerged vertically into the water, and you read from the yardstick the depth at which you can no longer distinguish black from white on the painted disc. If this depth is greater than 24 inches, then fertilizer should be added. If the depth is less than 24 inches, wait a week and measure again. Try to keep the water transparency between 18 and 24 inches. Fertilizer application should cease by July 1. After this time the water will become warm, non-beneficial algae may grow and oxygen levels in the pond will be lower.

Remember, no fertilization at all is preferable to a haphazard approach. Proper fertilization produces a "bloom" which shades out nuisance weeds and benefits fish growth. However, if applied at the wrong time the added nutrients may only result in increased weed or filamentous algae production. Proper fertilization increases the number and weight of fish. Over-fertilization can result in decreased oxygen and other water quality problems and may even result in fish kills. If you see that your pond responds quickly to fertilization, cut back on fertilizer rates and frequency to guard against over fertilizing and monitor for desired clarity.

# APPLICATION OF LIME

The following are excerpts from "Liming Fish Ponds" by Claude E. Boyd, Journal of Soil and Water Conservation, March-April 1981, Volume 37, Number 2:

Problems with acid-base relationships in fish ponds can often be solved by liming, which is not a form of fertilization but a remedial procedure to improve conditions for fish production.

Fish will not survive in ponds with water having a pH below 4. Where pH is between 4 and 5.5, fish will survive, but they will not grow and reproduce at normal rates. In many ponds with slightly acidic water (pH 5.5-7) and acidic muds (pH 4-5.5), fish will grow and reproduce, but attempts to increase fish production by inorganic fertilization are seldom very effective.

Common liming materials include agricultural limestone, calcium hydroxide, calcium oxide, basic slag, and liquid lime.

Liquid lime, an aqueous suspension of finely pulverized agricultural limestone, reacts quickly with acidity. Because liquid lime is about 50 percent water, application rates are usually twice those of ordinary agricultural limestone.

Total alkalinity of pond waters increases after liming because of greater concentrations of bicarbonate, carbonate, and hydroxide. When liming materials are properly applied, the increase in total alkalinity is caused almost exclusively

by bicarbonate. Because it enhances bicarbonate alkalinity, liming increases the amount of carbon available to plants.

Greater concentrations of calcium and magnesium after liming often flocculate colloidal particles in water. Thus, liming can reduce turbidity and increase the depth to which there is adequate sunlight for photosynthesis.

Liming of extremely acidic waters, such as abandoned surface coal pits, will raise the pH enough so that fish can survive and grow. Liming may also produce remarkable results in moderately acidic waters.

Liming is usually not necessary in ponds with total alkalinities above 20 milligrams per liter, but the need for lime becomes more critical as total alkalinity drops below this level.

Liming rates are often high (1,000-10,000 pounds per acre). Agricultural limestone or basic slag are the only materials safe to apply in such large quantities to ponds with fish. Small applications (not over 250-300 pounds/acre) of hydrated lime or calcium oxide can be applied to ponds with fish. One small application will often maintain adequate total alkalinity for several months, but frequent retreatment is necessary until the mud's lime requirement is satisfied.

New ponds are best limed before they are filled with water. The liming material can be spread over the pond bottom with a conventional spreader. Incorporation of the lime into the soil with a disc harrow will hasten the reaction of the liming materials, but this is not mandatory. When older ponds are drained for fish harvest or renovation, their bottoms can be allowed to dry and limed in this same manner.

Liming full ponds is more difficult because the liming material should be spread evenly over the pond bottom. For small ponds, a relatively small amount of lime is needed, and bagged liming materials can be spread from a boat as it moves over the pond surface.

Bulk liming materials are less expensive than bagged materials and should be used when large amounts are necessary.

The simplest technique for spreading bulk agricultural limestone is to have the delivery truck dump or spread the lime close to the pond shore. Limestone can then be spread with a shovel from a boat or allow rain to wash the lime into the pond. Applications to existing ponds is best done during the winter or early spring.

Treatment of ponds in Georgia with 2,000 pounds per acre of agricultural limestone or an equivalent amount of hydrated lime benefited productivity for 2 to 4 years.

In another experiment conducted in ponds with different hydrological features, the residual effect of liming depended upon the water exchange rate.

To determine how much lime to apply to your pond see your local farm supply store or county extension office for a soil test.

# POND LEAKAGE

Persistent leakage of a farm pond probably indicates that it was built in an area containing shale bedrock or other rock formations. If possible, drain the pond and apply a 12 to 15 inch layer of clay soil. During compaction, the pond bottom should be worked well with a sheepsfoot roller. The clay should be compacted to a thickness of no less than 8 to 10 inches. Prior to this application, all tree stumps or similar structures should be removed and cavities completed filled. Investigations should be made to locate any cracks or crevices in the pond bottom. Again, compaction is important in producing a good seal. The deeper the pond, the thicker the seal should be. In the deeper area of the pond, where the depth exceeds 10 feet, the clay layer should be doubled.

The most popular method of sealing leaks in a pond involves the use of bentonite. This is a type of clay material that can be applied in the water above the area of the leak. Bentonite will expand when in contact with water, thereby helping to impede flow through the sediment. According to sources, the most effective method is by applying it to the dry pond bottom followed by discing and compacting. Sources for bentonite can be located by contacting farm supply stores, construction companies, or well drillers. Application rates range from 1 to 2 pounds per square foot of pond bottom.

Another method would be to line the pond with a type of man-made sheeting. Liners are available from commercial dealers and are quite effective if installed correctly. If a liner is used, livestock should not be allowed access to the pond as the liner may be punctured.

Grouting the pond may be the only solution to a persistent leak. Contact your district fishery biologist or NRCS office for more information.

The best remedy for a leaky pond is thorough planning and preparation of the future pond site. Remember to avoid rocky or sandy areas when locating a pond site, compact the pond bottom well with soil and clay, and remove all tree stumps and logs from the fill material from the dam. Minor leaks after the pond is first impounded are not unusual and should soon cease. If the leak is persistent, contact your local NRCS office for information on your soil type, or possible leak location and recommended solutions.

# MUDDY WATER CONDITIONS

The appearance of muddy water in farm ponds may be the result of physical, environmental, or biological factors. Any one or all of these causes may be disturbing the pond sediments to the point where they are continually suspended. The smaller the clay particles, the longer they remain suspended in the water column. Continual muddiness may affect the fish population by reducing the ability of largemouth bass (sight feeder) to locate and feed on prey (bluegill). This may lead to smaller, overpopulated bluegill. Growth and condition of largemouth bass will also be reduced. Muddiness, or turbidity, will also reduce

oxygen production by plankton, as well as lower plankton numbers (needed in the food chain) by reducing light penetration.

The most serious problems are due to the size of clay particle itself. If the clay particles are very small and are of the type that do not adhere to each other, then treatments by various methods may be tried. These treatments include applications of the following:

50 pounds per surface acre of agricultural lime;
20 pounds per acre-foot of hydrated lime;
525 pounds per acre-foot of agricultural grade gypsum (hydrated calcium sulfate)
50 pounds per acre-foot of aluminum sulfate (filter alum)

Hay treatment: break open and scatter two square bales per acre in the pond every 14 days. Make no more than 4 or 5 applications per year. An alternative is to place a solid bale every 40 feet in the water along the shoreline.

Environmental factors include wind action and influx of silt due to inflowing water. These are usually temporary and will not produce long term problems. If wind action is chronic, however, planting of tree wind-breaks or placement of other structures may be considered. Newly - built ponds may remain muddy during the first year.

Biological factors appear to be the most common causes of pond turbidity in Kentucky. Most often it is caused by large numbers of catfish or the common carp that keep soil particles suspended. High numbers of crayfish or clam shrimp may also cause muddiness. Chemical eradication of the fish population, or complete draining and refilling the pond would be necessary to return water clarity. Another biological factor is livestock which have access to the pond and keep sediments suspended by wading activity.

# FISH ATTRACTORS

Attractors provide cover for small fishes thereby attracting larger fishes looking for a meal. Larger fish also like to seek cover in these structures. The primary purpose of fish attractors is to concentrate fish for the angler. Attractors may be made out of materials such as fallen trees, brushpiles anchored by concrete blocks, stake beds, rockpiles, or other such structures. Development of shallow islands, which then becomes covered with vegetation, will also act as fish attractors.Placement of materials as attractors should not be done in deep water due to lack of oxygen in these areas during the summer. Usually, structures can be placed from the shoreline out to about 6 feet. In larger lakes, attractors may be placed in water up to 15 feet depending on the location of the low oxygen levels.

# POND NUISANCES

## Muskrats

Muskrats primarily feed on cattail, bullrush, smartweed, water lily, sedges, young willows, and other plants. Muskrats become a nuisance when they begin burrowing into the banks or the dam of farm ponds. They dig these burrows below the surface of the water and extend them on an upward slant until a den chamber is hollowed out above the water line. A rise in the pond water level will force muskrats to dig further and higher into the banks or the dam. Burrows along the pond bank can lead to problems with bank sloughing. The greatest damage, however, is created when muskrats tunnel into the pond dam. This weakens narrow or poorly constructed dams which can result in a lowering, or complete loss, of the water level.

There are a number of methods which can be used to prevent muskrat damage to ponds while they are under construction. Damage to the dam can be reduced or eliminated if it is built to the following specifications: the inner face of the dam should have a 3 to 1 slope, with the outer face built at a 2 to 1 slope. The top of the dam should be between 10 to 12 feet wide. The dam should be built high enough so that the top is at least 3 feet above the water level.

Barriers to prevent burrowing can also be incorporated into the construction of new ponds. The placement of stone rip-rap along the inner face of the dam and along the banks will help exclude muskrats. Sections of chain link fences can also be used in place or in conjunction with rip-rap.

There are also ways to reduce damage caused by muskrats that already inhabit ponds. Burrows found when the water level is either naturally or intentionally lowered can be plugged with stone rip-rap or other fill material. Removing growths of cattail, willow, or other food sources may force muskrats to vacate the pond. Muskrats can also be hunted or trapped. The most effective times to hunt are either late in the evening or during the early morning. The two most commonly used traps are the Conibear 110 and the number 1-½ leghold. Traps should be placed at the entrance of burrows or in the trails or "runs" along the pond bottom or in the vegetation. Live traps are also available and when used, should be well camouflaged and baited with an attractive bait such as apples. Animals can then be relocated to a distant site.

Prior to trapping or hunting muskrats, pond owners must contact their local Wildlife & Boating officer for permission and proper disposition of the carcass. The officer should also be contacted if this activity is done at a time other than the legal hunting or trapping season.

## Turtles

Turtles commonly migrate from pond to pond in the spring and summer months on cool damp nights. In Kentucky ponds, turtles may occasionally become a nuisance to the fisherman by stealing bait and stealing fish from a stringer. Turtles usually do not harm healthy fish in a pond although they do

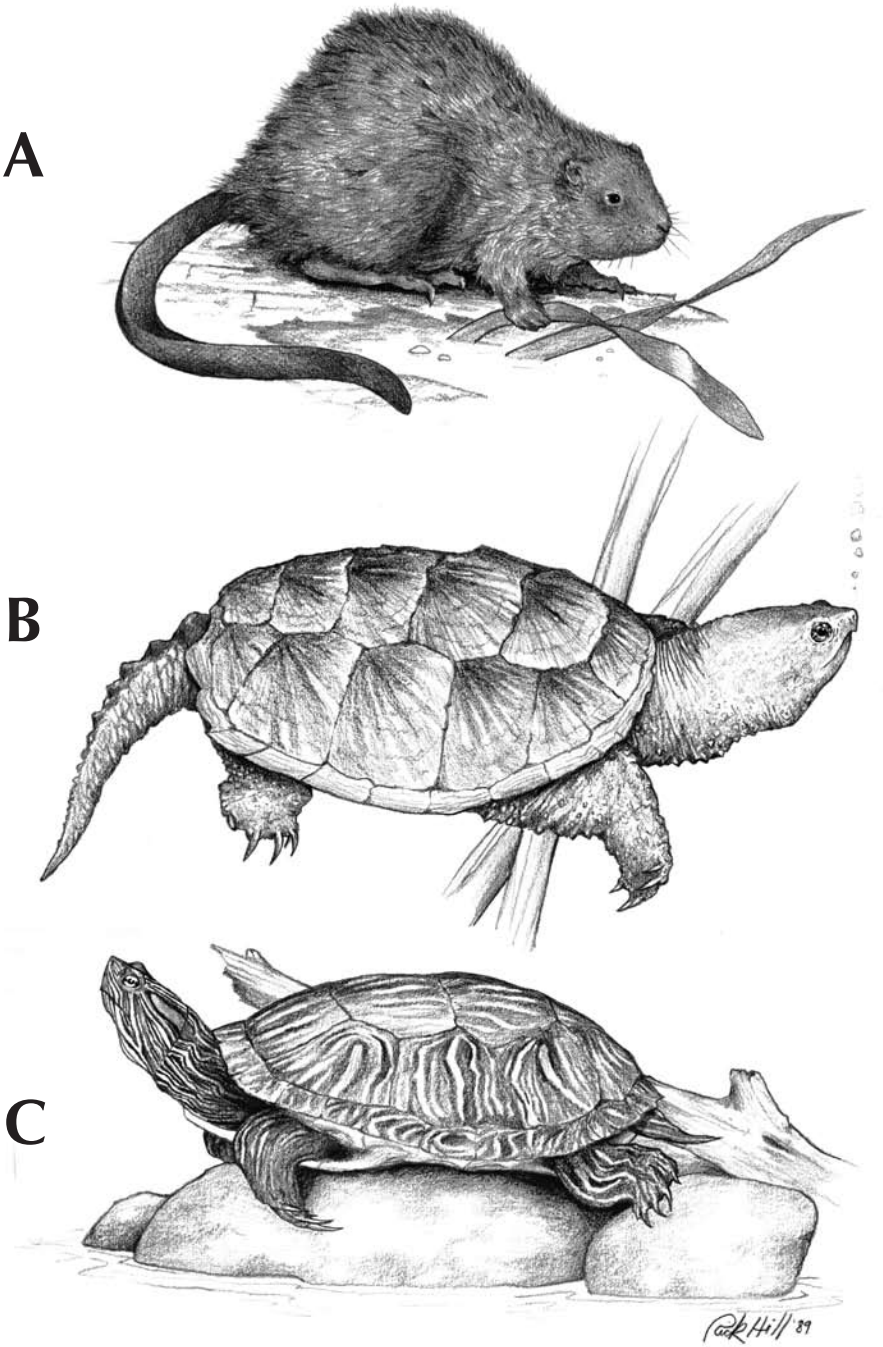



***Figure 9****. Some common animals that may cause problems for pond owners A. muskrat, B. snapping turtle, C. slider turtle.*

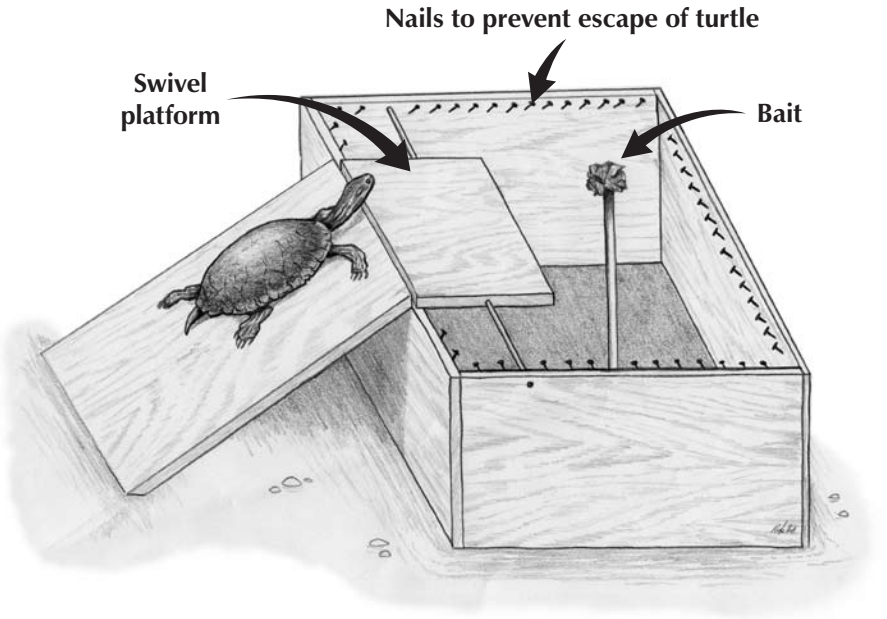



***Figure 10.*** *Turtle trap-pitfall*

feed on sick or diseased fish. Snapping turtles are known to feed on small ducks or other small animals.

The normal diet of most turtles found in Kentucky farm ponds is about 75 percent vegetable matter, 20 percent animal matter, and about 5 percent fish. If the pond owner wants to reduce or eliminate the turtle population in his pond, there are several ways to trap turtles with relatively little effort. Devices that are commonly used are baited bank lines or trot lines, and baited or unbaited pitfall and wire traps. An old method that may be tried is the placement of a double-spring steel trap on a board which is floated trap-side down. The trap or bank lines should be baited with chicken liver or gizzard. Use heavy twine to secure the board to the pond bank.

## Crayfish

Crayfish occasionally become a nuisance in ponds by building burrows and causing leaks. They can be controlled by introducing channel catfish into the bass-bluegill combination.

Crayfish that build burrows above the water line can be eliminated by applying a little rotenone or copper sulfate into the burrow and sealing it. Not all crayfish are harmful in Kentucky ponds. Many species of crayfish are an important food supply and are utilized by largemouth bass.

## Birds

Birds such as cormorants, diving ducks, gulls, ospreys, kingfishers, and herons commonly feed on fish. In the average farm pond, these birds will not upset the pond balance or cause major problems.

With the exception of the European starling and house sparrow, all birds are protected by federal law making it illegal to kill or capture them. There are, however, nonlethal methods to exclude birds from the farm pond. Some include noise-making devices, total or partial exclusion barriers, heron decoys, and increased human or canine presence.

Landowners having problems with birds should contact their local wildlife & boating officer. Additional information on ways to reduce damage caused by birds is available from the Animal Damage Control Unit of the U.S. Department of Agriculture. For information concerning assistance, contact:

U.S. Department of Agriculture/Animal
Damage Control
Reynolds Buildings, Room 140
2520 South Third Street
Louisville, Kentucky 40208

# AQUATIC VEGETATION

Common aquatic plants that are found in Kentucky lakes and ponds can be divided into two groups: non-vascular and vascular. This simply means whether or not they contain tissue which transports nutrients and gives support to the plant. Examples of non-vascular plants: microscopic phytoplankton (which gives water a green appearance), and filamentous algae which most often clumps together to form large floating or submerged cottony mats. Vascular plants usually have leaves, stems, roots and possibly flowers. Submerged (entirely underwater) or emergent (growing from pond bottom to above the water surface) vascular plants may grow directly from the pond/lake bottom or bank; however, some may float unattached on the surface of the water.

Aquatic plants benefit fish populations by supplying oxygen, providing cover, harboring food organisms, or by being a direct source of food for fish. When not over-abundant, they benefit fish populations. Up to one quarter of the pond should be vegetated. Aquatic plants, as well as plants found along the shoreline, may supply food and cover for waterfowl, mammals and many non-game species. The Kentucky Department of Fish and Wildlife Resources encourages the pond owner to leave as much vegetation as possible around the perimeter of the pond bank and control only that aquatic vegetation which may lead to imbalance of fish populations and inhibit angler access. Fish populations can become imbalanced when too much aquatic vegetation protects too many bluegill from largemouth bass. This can lead to large numbers of small bluegill, resulting in bass of poor quality. Large amounts of aquatic vegetation in a pond

***Figure 11.*** *Identification of troublesome plants in ponds and lakes is just a part of the fisheries management activities of district biologists and fishery technicians in Kentucky.*

may tie up available nutrients, thereby promoting clear water conditions. This will impede good fish growth and may lead to fish imbalance. With clear water conditions, submerged aquatic plants may eventually saturate the pond and actually displace fish or lead to periodic fish kills. Kills, or die-offs, occur when vegetation dies and decays, causing oxygen depletion. Continued vegetation growth and decay will speed the rate of the natural filling-in process of a pond.

# AQUATIC PLANT CONTROL

## Preventative Measures

The most basic step to good vegetation control in a pond is adequate depth along the shoreline and upper end. Depth along the shoreline should be 2 to 3 feet in order to retard plant growth. Plants can be expected to grow in shallow areas where sunlight penetrates directly to the bottom. This should be consid-

ered during pond construction or renovation. If the shoreline area has adequate depth, measures should be taken to maintain the depth and prevent pond bank destruction and the shallowing effect. Probably the most destructive process is open access to the pond by livestock. Livestock trample the bank when watering and may cause bank sloughing. This, combined with livestock wastes, causes shallowing, muddiness, promotes algae and other plant growth, increases water temperature and organic content, loss of fish habitat and nest, and increases the possibility of fish kills. Another preventative step is having an adequate plankton bloom, which can reduce vascular plants by shading. This can be accomplished through a fertilization program (see Fertilization Section). Too many nutrients can occur when livestock or other organic wastes are allowed to drain directly into the pond. Nutrients are necessary in a pond, but should not be allowed to overcome it.

## Mechanical (Manual) Control

Probably the least expensive (and most energy consuming) method of aquatic vegetation control is by pulling, raking, cutting, digging, shading, or mowing. This job is made easier, however, if it is done in the spring while plants are small or in low densities. If plants are continually cut back, their density is not only reduced, but production of food or reproductive parts by the plant is also reduced. Methods of this type of control include using a garden rake, dragging a cable or chain, pulling by hand, or mowing with a scythe or weed cutter. (It also should be mentioned that aquatic vegetation is a good source of phosphorous and nitrogen, so any plants removed can be tilled into your garden or compost pile.) If the plants to be removed are the type that are submerged and happen to be in a large quantity, it may help to do it after a windy day as vegetation may be wind-rowed or concentrated on one shore area. If the plants to be removed are of the type that grow out of the water, such as cattails, cutting should be done in the spring and summer, prior to seed spike formation. This basic rule would apply to most other plants as well. When removing plants by hand or with tools, care should be taken to remove as many of the plant fragments as possible, as many of them reproduce in this manner. Shading of submerged plants can be accomplished by placing large panels of black plastic in the pond. Panels can be floated or anchored to the bottom to facilitate shading. If anchored to the bottom, holes should be punched through the plastic so that gas bubbles do not build up and float it to the surface. When using this method only a section of the pond should be covered at any one time. Vegetation should be killed by this method in 2 to 4 weeks.

## Drawdown

Another means of aquatic vegetation control in ponds or lakes is water level fluctuation. This method is feasible only if the pond or lake has a control valve whereby about 5 to 10 feet of shore can be exposed over the winter months. During this time, exposed vegetation can be frozen and killed. After refilling the body of water in the spring, the vegetation will have to start again from seeds

or spores. If this method is used, you may want to consider sowing the exposed mud flats with a winter cover crop in the fall. This will provide food for wildlife during the winter, cover for fish after re-impoundment, and reduce erosion of exposed shorelines.

## Chemical Control

Chemical methods of aquatic vegetation control are the quickest and probably the most widely used method, and the most expensive. Often times chemicals are effective only during the warm months. Most importantly, the applicator must take precautions handling the chemical, and must consider its effects if the water treated is used for human or animal drinking, irrigation, swimming, or even fishing and fish consumption. Some chemical manufacturers require that the user be a certified chemical applicator. Only those chemicals designed for specific plants should be used - read the entire label carefully and follow all directions for use. Know the type of plants you are trying to eradicate. In most cases, only a portion of the pond vegetation should be killed at any one time. Oxygen depletion will occur as the plants rot - too many dead plants may cause fish kills.

Pictures of the more common aquatic plants in Kentucky are shown on the following pages. If your problem aquatic plant is not shown, then consult your district fishery biologist. Another important step is knowing the volume or size of the pond area to be treated. Formulae to help determine pond size and volume are located in the back of this booklet.

Another chemical means of controlling aquatic vegetation is by shading or coloring the water with a dye. This method is best suited for ponds with little outflow. Dyes are designed to defract light and to give the water a deep blue color. They can be used throughout the year.

# BIOLOGICAL CONTROL

## Fertilization

Fertilizing a pond to maintain a plankton bloom is the simplest means of biological control of aquatic plants. This procedure is most effective when the pond has adequate depth and the problem vegetation is some form of submerged vascular plant. During this procedure, the suspended plankton actually shades and kills the rooted vegetation. This can be an effective means of vegetation control if applied properly and should be used if possible. (See the “Fertilization” section for more details.)

## Triploid Grass Carp

Grass carp, which feed on aquatic vegetation, were legalized in the sterile (triploid) form in Kentucky in 1986. They are native to Asia, and were introduced into the United States in the late 1960’s. Research was conducted on

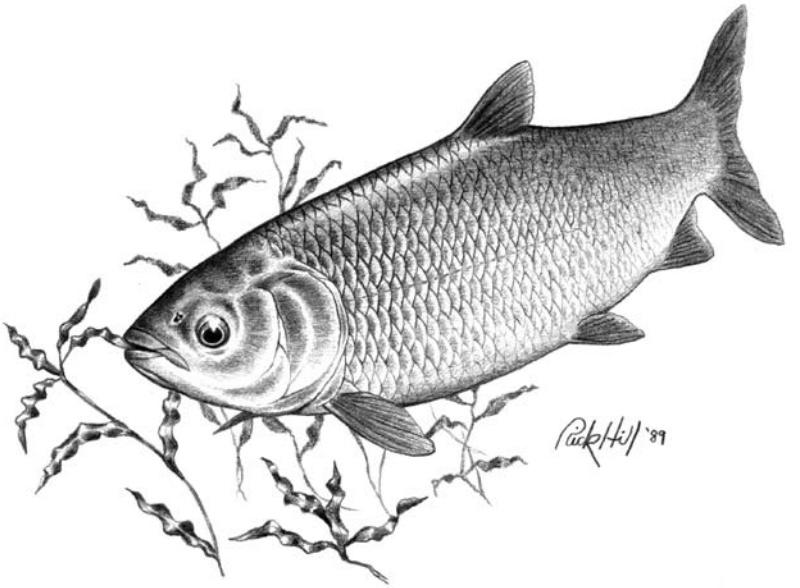


***Figure 12.*** *Triploid grass carp*

these fish in the southern U.S. in order to produce an effective, non-reproducing grass carp. This eventually resulted in the sterile triploid form. Those concerned with Kentucky's fish population do not want these fish established in public waters, KDFWR encourages the use of spillway barriers to prohibit their escape. Precautions are necessary because fertile grass carp may cause problems for wildlife that depend on aquatic vegetation in "the wild" (larger streams). Also, the KDFWR does not want to encourage the establishment of another exotic (not native to U.S.) animal species such as the common carp, house sparrow or European starling.

Triploid grass carp can be effective in controlling aquatic vegetation. Biologists recommend stocking a 10 to 12 inch (or larger) fish in order to reduce predation by largemouth bass. Numbers recommended range from 4 to 12 fish per acre, depending on the size of the pond and the type and amount of vegetation. Triploid grass carp will feed on almost all types of vegetation found in Kentucky waters. They prefer to eat those plants which are less fibrous first, and will later eat the more fibrous ones. Watermeal (Wolffia sp.) is one plant which they have difficulty eating due to the very small, granular size of the plant. Triploid grass carp are most effective for vegetation control for the first 5 to 7 years. After this period their effectiveness is diminished though they may live for 15 years or more. A supplemental stocking of grass carp may be needed in order to maintain control of vegetation after 5 or 7 years. Care should be taken when deciding if a pond spillway barrier is needed to prevent loss of these fish. Triploid grass carp will try to move downstream with flow if possible. All over-flow

structures such as pipes or spillways should be fenced with welded wire, chain-link, re-bar, or other long-lasting, rust-resistant material. Care should be taken to keep these screens free of debris. If you have a large dam, lake, and water flow-through rate, a barrier may not be practical as high water may damage your dam if the barrier is clogged. Grass carp stocking in these situations should be minimal and other methods used.

Triploid grass carp seem to be susceptible to low dissolved oxygen levels in ponds and may die during these conditions. These conditions may develop if the pond is receiving organic material from septic pipes or wastes from livestock areas.

Predators which may feed on newly-stocked or small grass carp are large-mouth bass, large catfish, herons, and possibly large turtles.

As with other fish, triploid grass carp are more active in warmer water temperatures. Control of vegetation by these fish may not be seen until the water temperature is at least 60 degrees Fahrenheit. Depending upon the amount and type of vegetation, it may take a year or more before the grass carp attain a size at which they are capable of controlling the vegetation.

Triploid grass carp, when not stocked at excessive rates, have not been found to interfere with panfish or game fish populations in ponds. As these fish will consume vegetation, which is cover for other species of fish, the pond owner may want to place brush piles, rock piles, or trees in the pond.

Triploid grass carp can be caught by hook and line fishing, especially when fishing with worms or other invertebrates. Care should be taken to release these fish as soon as possible with a minimal amount of handling. When removing grass carp, hook-and-line and possibly bow-fishing are best, as these fish avoid seines and electrofishing gear. Toxic food pellets are commercially available for grass carp removal.

For the latest information on the current triploid grass carp program, contact your county Wildlife & Boating officer, district fishery biologist, or the Fisheries Division of the Kentucky Department of Fish and Wildlife Resources in Frankfort (800-858-1549)(*www.fw.ky.gov*).

## Barley Straw

Placement of bales or packets of barley straw may be done to inhibit growth of filamentous algae. Control may take 30 days or longer and barley straw may need to be replaced after deterioration. See pages 42 and 43.

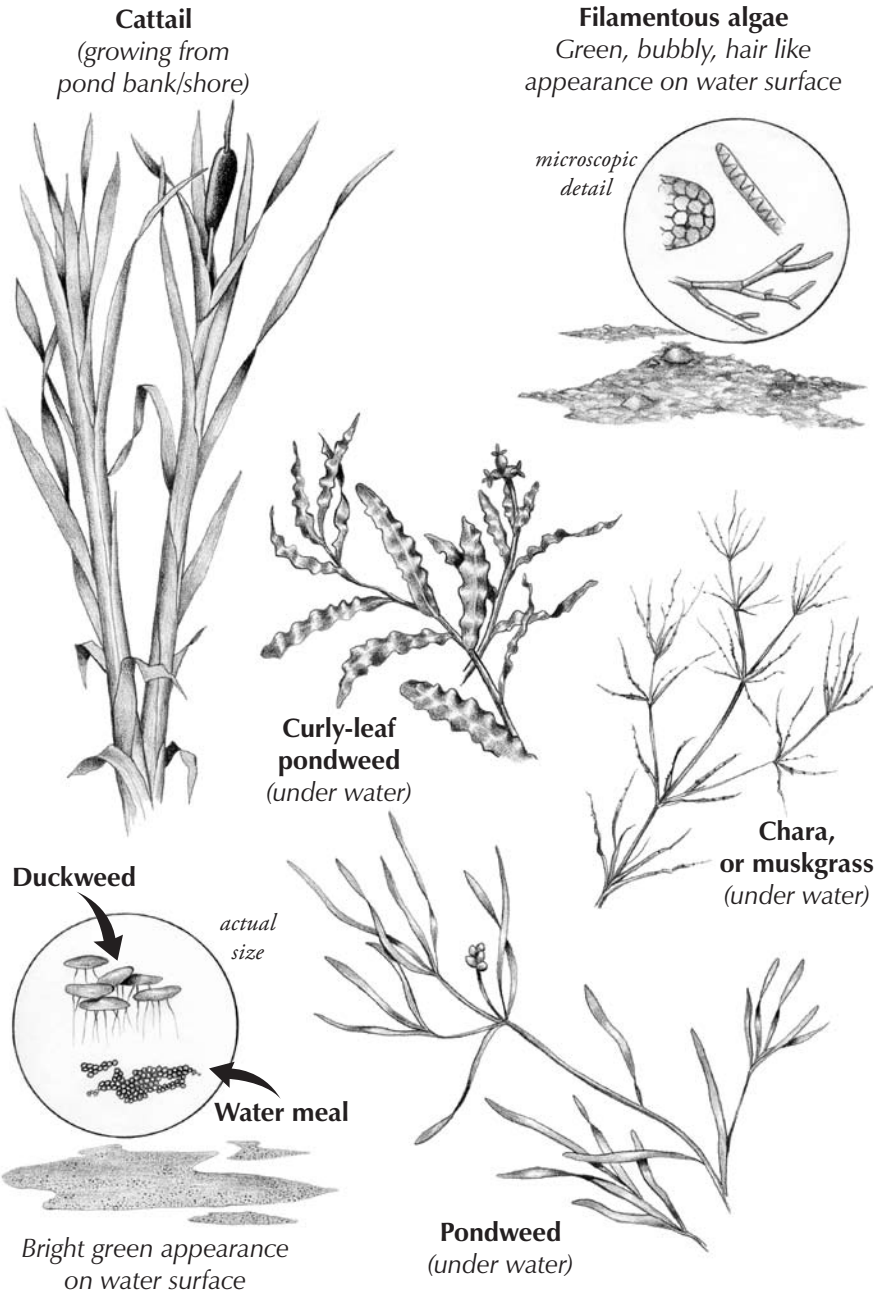



***Figure 13.*** *Some common aquatic plants found in Kentucky farm ponds and lakes.*

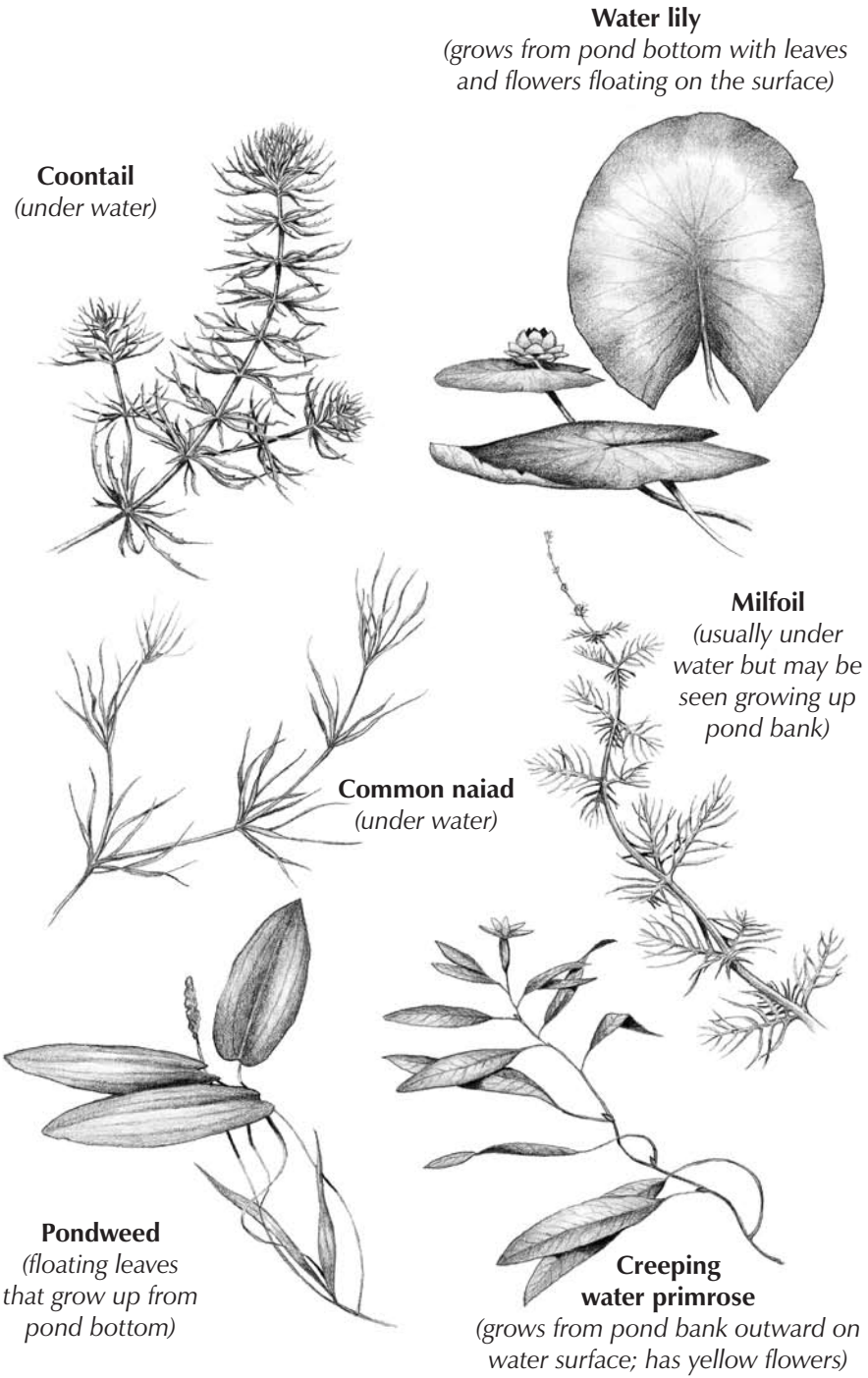



***Figure 13.*** *(continued)*

## Aquatic plants and recommended aquatic herbicides

| AQUATIC PLANT GROUP | Copper compounds | Diquat | Chelated Copper | Fluridone | 2, 4-D | Dipotassium Salt of Endothall |
|---|---|---|---|---|---|---|
| | Cutrine Plus liquid (9%) granular (3.7%) | Reward (37.3%), Weedtrine D (8.53%), | Komeen (8%); | Sonar (liquid, 41.7%) | Aquacide (pellet, 17.5%) | Aquathol K (liquid, 40.3%) |
| | Copper Sulfate: granuler (75-99%) | Weedtrol (4.35%), Diquat | Nautique (9%) | Sonar SRP (granular, 5%) | AquaKleen (granular, 27.6%) | Aquathol Super K (granular, 63%) |
| | K-Tea (8%); Captain (9%) | | | Avast! (liquid, 41.7%) | Navigate (granular, 27.6%) | |
| | Earthtec liquid copper sulfate; | | | Avast! SRP (granular, 5%) | DMA 4 IVM (liquid, 46.8%) | |
| | Clearigate (3.825%) | | | | Weedar 64 (liquid, 46.3%) | |
| **ALGAE** | | | | | | |
| Planktonic algae | X | | | | | |
| Filamentous algae | X | X | | | | |
| *Chara*/"muskgrass" (vine-like) | X | | | | | |
| **SUBMERGED VASCULARS (LEAVES, STEMS, ROOTS, SOME WITH FLOWERS)** | | | | | | |
| American elodea | | X | X | X | | |
| Naiads (leaves opposite) | | X | X | X | | X |
| Pondweeds (leaves alternate) | | X | X | X | | X |
| Coontail | | X | X | X | X* | X |
| Eel grass | | | | | | |
| Water milfoil | | X | X | X | X* | X |

| | | | | | | |
|---|---|---|---|---|---|---|
| **FREE FLOATING** | | | | | | |
| Common duckweed | | X | | X | X | |
| Watermeal | | | | X | | |
| **ROOTED FLOATING** | | | | | | |
| American lotus | | | | X* | X | |
| Floating leaf pondweeds | | X | | | | X |
| Water lily | | | | X* | X | |
| Watershield | | | | X* | X | |
| Spatterdock (*Nuphar*) | | | | X | X | |
| **EMERGENT** | | | | | | |
| Arrowhead | | | | | X* | |
| Rush | | | | | X* | |
| Cattail | | X | | | X* | |
| Creeping water primrose | | | | | X* | |
| Purple loosestrife | | | | | | |
| Water smartweed | | | | | X* | |
| Willow | | | | | X* | |

* Check label for control of this plant--products may vary.

** Surfactant additive may be needed--products may vary.

*** **NOT FOR USE IN WATER SUPPLY FOR HUMAN CONSUMPTION; DO NOT APPLY TO STREAMS OR OTHER NATURAL BODIES OF WATER.**

**** Application Rate: 1 ounce/3 sq. ft to 3.5 oz./3 sq ft, 6-8 weeks to work in water temps < 50 and 1-2 weeks > 70 degrees.

**This list is not intended for product endorsement and is for informational purposes only. More products with similar or same ingredients by different manufacturers may be available. Always consult the product label for complete information on plants controlled and precautions**

| AQUATIC PLANT GROUP | Monopotassium Salt of Endothall | Glyphosate** | Triclopyr | Aquatic dye/ shadow*** | BIOLOGICAL CONTROL METHODS | |
|---|---|---|---|---|---|---|
| | Hydrothall 191 (liquid, 53%) | Rodeo (53.8%) | Renovate 3 (44.4%) | Aquashade, Aquasadow | | |
| | Hydrothall 191 (granular 11.2%) | AquaNeat (53.8%) | | Aquatic Blue Lake & Pond Dye, | Barley straw**** | Triploid Grass Carp |
| | | AquaStar (53.8%) | | Cygnet Select, Blue Lagoon, Lochness SS, | | |
| | | Eagre (53.8%) | | Premium Pond Dye, Ocean Blue | | |
| | | Glyphosate 41 (41%) | | | | |
| **ALGAE** | | | | | | |
| Planktonic algae | | | | | | |
| Filamentous algae | X | | | X | X | X |
| *Chara*/"muskgrass" (vine-like) | X | | | X | | X |
| **SUBMERGED VASCULARS (LEAVES, STEMS, ROOTS, SOME WITH FLOWERS)** | | | | | | |
| American elodea | X | | | X | | X |
| Naiads (leaves opposite) | X | | | X | | X |
| Pondweeds (leaves alternate) | X | | | X | | X |
| Coontail | X | | | X | | X |
| Eel grass | X | | | X | | X |
| Water milfoil | X | | X | X | | X |

| | | | | | | |
|---|---|---|---|---|---|---|
| **FREE FLOATING** | | | | | | |
| Common duckweed | | | | | | X |
| Watermeal | | | | | | |
| **ROOTED FLOATING** | | | | | | |
| American lotus | | X* | X | | | |
| Floating leaf pondweeds | X | | | | | |
| Water lily | | X | X | | | |
| Watershield | | | | | | |
| Spatterdock (*Nuphar*) | | X | X | | | |
| **EMERGENT** | | | | | | |
| Arrowhead | | | | | | |
| Rush | | X | | | | |
| Cattail | | X | | | | |
| Creeping water primrose | | X | X | | | |
| Purple loosestrife | | X | X | | | |
| Water smartweed | | X | | | | |
| Willow | | X | X | | | |

* Check label for control of this plant--products may vary.

** Surfactant additive may be needed--products may vary.

*** **NOT FOR USE IN WATER SUPPLY FOR HUMAN CONSUMPTION; DO NOT APPLY TO STREAMS OR OTHER NATURAL BODIES OF WATER.**

**** Application Rate: 1 ounce/3 sq. ft to 3.5 oz./3 sq ft, 6-8 weeks to work in water temps < 50 and 1-2 weeks > 70 degrees.

**This list is not intended for product endorsement and is for informational purposes only. More products with similar or same ingredients by different manufacturers may be available. Always consult the product label for complete information on plants controlled and precautions**

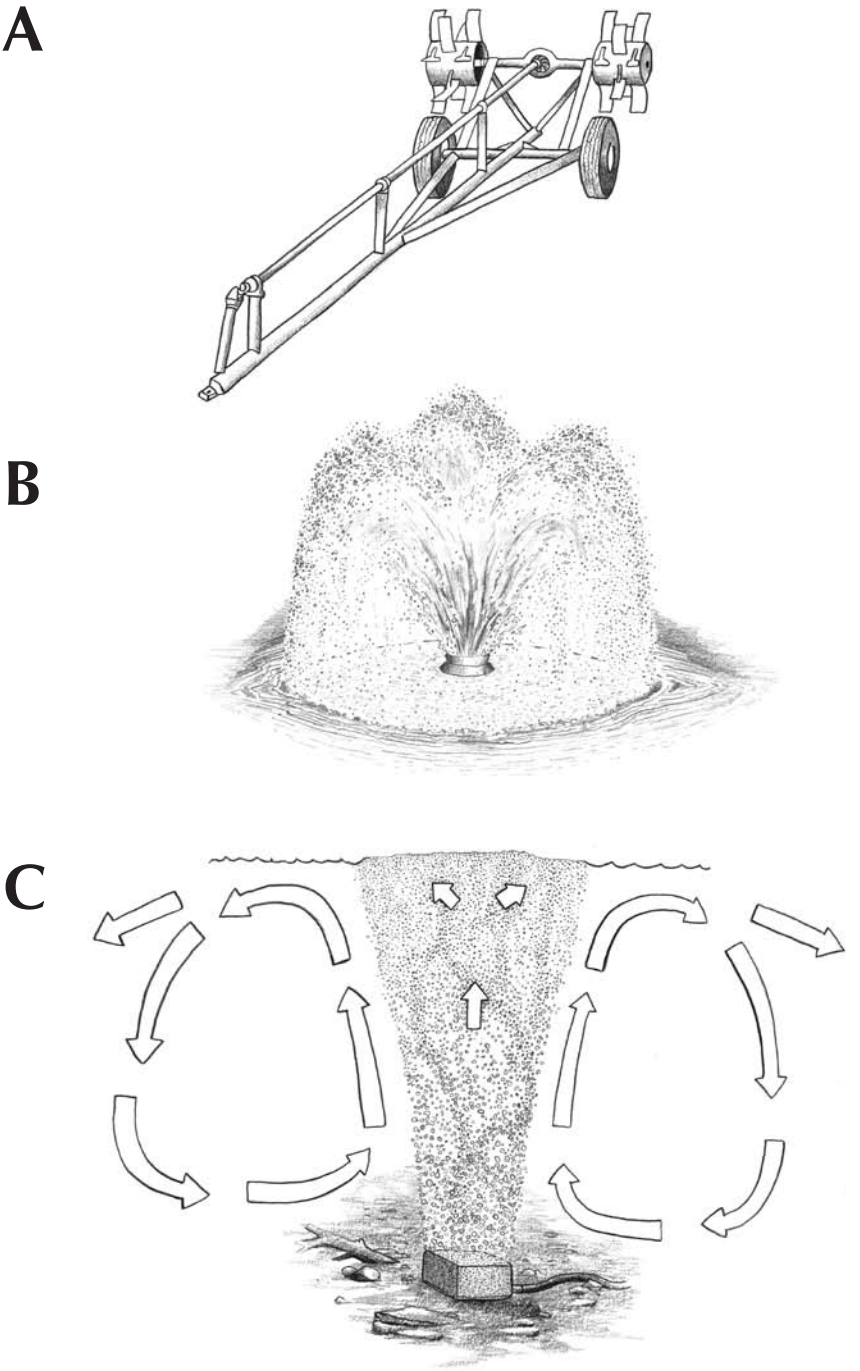



***Figure 14.*** *Common ways to aerate ponds or lakes: A. portable paddle-wheel powered by tractor power take-off; B. floating aerator or agitator; C. pump on bank, diffuser on pond bottom. For more information and possible sources for aeration systems, check the internet for pond aerators and sales.*

# FARM PONDS FOR PROFIT

There are several ways to make money from farm ponds if the ponds are constructed properly and are located in a suitable area. The raising of bait minnows for profit has become increasingly popular because of the ever-increasing fishing pressure on our many large reservoirs and lakes in the state. A ¼ acre pond will produce minnows as well as a larger pond but only in smaller numbers. However, three or four small ¼ acre ponds would be better for raising minnows than a one acre pond. Another factor that favors minnow production in a ¼ acre pond is the fact that a pond this small will not normally support an annual sport fish harvest. So if you have one or several small farm ponds and have had trouble managing them for a sport fishery, stock minnows if you have a local market for them.

For, probably the most popular kinds of minnows to raise would be fathead minnows or golden shiners.

## Fathead Minnow

**Habitat:** Small ponds and lakes.

**Breeding habits:** The spawning season extends in some localities from May until late August. A water temperature of about 64˚F is necessary before spawning begins. Females reach maturity at the end of their first year. The eggs are deposited on the underside of objects in the pond. A single female is capable of producing 4,144 offspring and spawning 12 times in one year. The eggs hatch in 4½ to 6 days. Some adults die shortly after the spawning season.

**Food:** The fathead minnow feeds mainly on zooplankton and insects.

**Stocking rate:** 500 to 600 (1 pound) adult fish per surface acre.

**Production:** More than 200,000 minnows (328 pounds) have been raised in one acre of water.

**Spawning requirements:** Spawning boards attached to a wire across a section of the pond or stuck in the bank just below water surface. When spawning, the fish will attach their eggs to the underside of these boards or other objects.

**Bait use:** Crappie, white bass, largemouth bass.

## Golden Shiner

The golden shiner is a very popular bait minnow in the western region of Kentucky.

**Habitat:** Lakes and streams.

**Breeding habits:** The golden shiner has a long spawning season, extending from the time the water reaches 68˚F through the rest of the summer. The female reaches maturity in one year and may live four years and reach 12 inches in length. The eggs are adhesive and stick to plants and are commonly scattered over filamentous algae. The eggs hatch in about four to five days.

**Food:** Filamentous algae and zooplankton.

**Stocking rate:** 4,000 adults per acre with periodic fry removal; 500 adults

per acre in natural ponds without fry removal.

**Production**: More than 60,000 saleable shiners can be raised per acre if the fry are left with the adults; 75,000 to 150,000 can be produced if the fry are removed to a new pond.

**Spawning requirements:** Masses of filamentous algae for spawning.

**Bait use:** Crappie, bass.

To make a profit with bait minnows in small farm ponds, it is very important to establish a market for selling the minnows before the original outlay of money is made to build ponds and purchase the minnows for stocking. A fertilization program for producing the large quantity of zooplankton for raising minnows may be necessary.

## Producing Fish for a Profit (Pay Lake)

A pay lake is an operation where the lake owner provides the fish and fishing privileges and the angler pays for the privilege of catching the fish.

To do this, the lake owner may purchase a license from the Department of Fish and Wildlife Resources and in addition, promise to purchase one thousand pounds of fish per acre for the lake each year to insure catchable-size fish. The Department gives to the lake owner a supply of pay lake permits that he issues to the fishermen for them to fish without a state fishing license. Without a pay lake license, a state fishing license is required of all fishermen using that pay lake.

Ideally, the pond should be located near a populated area to insure good usage. Facilities providing the fisherman with a place to buy beverages, tackle, and bait add to his profit. Fishing piers and platforms are also helpful in a pay lake.

The lake should be three acres or more in size to be profitable. A well or other water source with good oxygenated water is a definite asset to this kind of business.

A pay lake does not need to be fertilized because the fish will not be in the lake long enough to grow to any extent. Some supplemental feeding may be carried out in the off-fishing months to keep the fish in good condition.

More information on pay lakes can be obtained from the Aquaculture Specialist, Cooperative Extension Program, U.S. Department of Agriculture, Kentucky State University, Frankfort, KY, 40601 (*www.ksuaquaculture.org*).

# CONVERSION TABLE FOR DETERMINING ACREAGE OF PONDS

Length of pond in feet

| Width of pond in feet | 40′ | 50′ | 60′ | 70′ | 80′ | 90′ | 100′ | 120′ | 140′ | 160′ | 180′ | 200′ | 240′ | 280′ | 300′ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **40′** | .04 | .05 | .06 | .06 | .07 | .08 | .09 | .11 | .13 | .15 | .17 | .18 | .22 | .26 | .28 |
| **50′** | .05 | .06 | .07 | .08 | .09 | .10 | .11 | .14 | .16 | .18 | .21 | .23 | .27 | .32 | .34 |
| **60′** | .06 | .07 | .08 | .10 | .11 | .12 | .14 | .17 | .19 | .22 | .25 | .28 | .33 | .38 | .41 |
| **70′** | .06 | .08 | .10 | .11 | .12 | .14 | .17 | .19 | .22 | .26 | .29 | .32 | .39 | .45 | .48 |
| **80′** | .07 | .09 | .11 | .13 | .15 | .17 | .19 | .22 | .26 | .29 | .33 | .37 | .44 | .51 | .55 |
| **90′** | .08 | .10 | .12 | .15 | .17 | .19 | .21 | .25 | .29 | .33 | .37 | .41 | .50 | .58 | .62 |
| **100′** | .09 | .11 | .14 | .17 | .18 | .21 | .23 | .28 | .32 | .37 | .41 | .45 | .55 | .64 | .68 |
| **120′** | .11 | .14 | .17 | .19 | .22 | .25 | .28 | .33 | .39 | .44 | .50 | .55 | .66 | .77 | .82 |
| **140′** | .13 | .16 | .19 | .22 | .26 | .29 | .32 | .39 | .45 | .51 | .58 | .64 | .77 | .90 | .96 |
| **160′** | .15 | .18 | .20 | .26 | .29 | .33 | .37 | .44 | .51 | .59 | .66 | .73 | .88 | 1.03 | 1.10 |
| **180′** | .17 | .21 | .25 | .29 | .33 | .37 | .41 | .50 | .58 | .66 | .74 | .83 | .92 | 1.16 | 1.20 |
| **200′** | .18 | .23 | .28 | .32 | .37 | .41 | .45 | .55 | .64 | .73 | .83 | .92 | 1.10 | 1.30 | 1.40 |
| **240′** | .22 | .27 | .33 | .39 | .44 | .50 | .55 | .66 | .77 | .88 | .99 | 1.10 | 1.32 | 1.54 | 1.70 |
| **280′** | .26 | .32 | .38 | .45 | .51 | .58 | .64 | .77 | .90 | 1.03 | 1.16 | 1.30 | 1.54 | 1.80 | 1.90 |
| **300′** | .28 | .34 | .41 | .48 | .55 | .62 | .68 | .82 | .96 | 1.10 | 1.20 | 1.40 | 1.70 | 1.90 | 2.10 |

# HANDY CONVERSIONS AND FORMULAS

1 acre = 43,560 square feet

$$\text{Acre feet} = \frac{\text{length x average width x average depth}}{43{,}560}$$

**The Formulae for Determining Surface Acreage of Various Shaped Ponds**

$$\text{Square or rectangular} = \frac{\text{length x width}}{43{,}560}$$

$$\text{Round} = \frac{\text{radius}^2 \text{ x } 3.14}{43{,}560}$$

radius - is the distance from the shore to the center of a round pond;

radius$^2$ - is the value of the radius multiplied times itself.

$$\text{Triangular} = \frac{\text{length of dam x total length of pond}}{\frac{2}{43{,}560}}$$

Average depth is determined by making seven transects per two acres of water, recording depths at three-foot intervals along each transect, and averaging these figures.

**Liquid**

1 gallon = 4 quarts = 8 pints
1 pint = 16 ounces
1 cup = 8 ounces
1 tablespoon = 1/2 ounce

**Area**

1 acre = a square with 209 feet per side.

1 acre = a circle with a diameter of 235 feet.
1 hectare = 2.471 acres = 107.640 sq ft = 10,000 sq. meters.

1 pound = 16 oz. = 454 grams

1 ounce = 28.35 grams

1 kilogram = 2.2 pounds

1 cubic foot = 62.4 pounds = 7.5 gallons of water = 0.03 cubic meter

1 acre foot of water = 2,718,000 lb. = 326,000 gal. = 43,560 cu. ft.

1 gallon of water = 8.34 pounds = 3,800 cubic centimeters = 3,800 grams = 3.785 liters

1 liter of water = 0.264 gallons

1 part per million (ppm) requires:

2.7 pounds per acre-foot
0.0038 grams per gallon
0.0283 grams per cubic foot

0.6 mile = 1 kilometer

1 inch = 25 millimeters = 2.54 centimeters

To figure formulation for treating ponds with herbicides:

1% solution = 1.34 oz/gal
= 38 g/gal
= 10 g/liter

Degrees Centigrade = (degrees Fahrenheit - 32) x 5/9

Degrees Fahrenheit = 9/5 x degrees Centigrade + 32

# THE WILDLIFE AND BOATING OFFICER IS THERE TO HELP YOU

Wildlife and Boating officers of the KDFWR Law Enforcement Division, are your first line of assistance in counties throughout Kentucky. They are ready to assist you with information, applications and forms. They can also put you in touch with your district fishery biologist or wildlife biologist for detailed programs and information. Officers have the right to enter upon private property in the performance of their duties, and upon request will assist you with enforcement of fishing regulations.

## PLAY IT SAFE!

Always be aware of any dangers while fishing or working in the area of your pond.

- Life-saving equipment (poles, life-vest, throw-ring, etc.) should be present.
- Be aware of electrical wires nearby (power lines for aerators, lights, etc.).
- Proper use and disposal of chemicals (herbicides, pesticides, water quality treatments).
- Boating and outboard motor safety.
- Be aware of any weak points in structures (docks, piers, etc.)
- Be sure of safe ice thickness if winter ice fishing.
- Be aware of the possibility of lightning if a storm approaches.
- Cast safely when fishing to prevent hook embedment in other anglers.
- Alcohol, drugs, and water-related recreation don't mix.
- At least one person in the group should be a good swimmer; someone should know CPR or artificial respiration techniques.
- Never leave small children unattended around a pond or lake.
- Though snapping turtles are no danger to humans while swimming, they have a very quick and dangerous bite when cornered or handled on land.

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# NOTES

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*Take the time - keep the tradition*

# GO FISHING!