MP360

Farm Pond Management for Recreational Fishing

Cooperative Extension Program,
University of Arkansas at Pine Bluff,
U.S. Department of Agriculture,
and County Governments
in cooperation with the
Arkansas Game and Fish Commission

Farm Pond Management for Recreational Fishing

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The Pond Ecosystem

A sportfish lake or farm pond is a complex system, but there are so many similarities to gardening and agriculture that most pond owners are able to quickly understand the important principles.

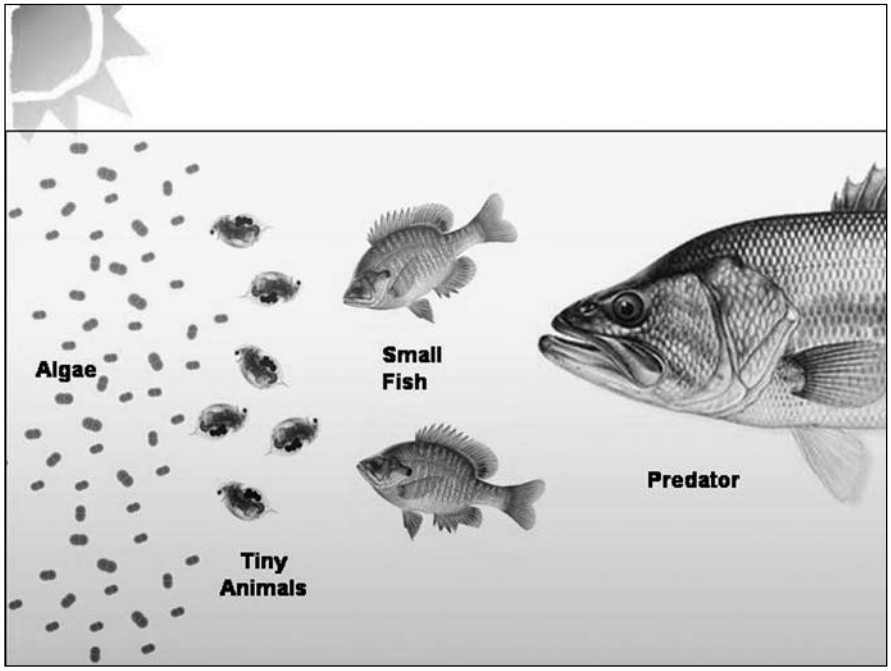
In a catfish pond, the sun provides energy to grow microscopic plants (plankton), tiny animals feed on the plankton, bigger animals feed on those animals and then the big fish eat them.

In a pasture, the sun shines on the plants, the plants convert the solar energy into food and the cattle eat the plants. The farmer manages soil chemistry and fertilizes to increase the growth of pasture plants so more cattle can be grown. In the same way, the production of fish is increased if water chemistry is adjusted and fertilizers added to increase growth of the tiny plants that are the first step in the food chain. The farmer can further increase production by using prepared cattle feeds to supplement the natural productivity of the pasture. Likewise, feeding commercial pelleted feeds can increase fish production. The main difference between raising cattle and raising fish is the water.

Producing a fish-eating predator like largemouth bass just adds another link to the food chain. The sun grows the microscopic plants, tiny animals eat those plants, those animals are eaten by small fish and those fish are eaten by the bass. Once again, the whole chain depends on plenty of sunshine and nutrients. The addition of the extra link in the chain means that more animals are involved and that the system is a bit more complicated so a bit more care is needed to make sure that the energy from the sun goes through channels that produce food for bass and not into pathways that might produce less desirable results like lots of snails or tiny bream. Insuring that the food gets to the bass is the result of stocking the right species, manipulating the pond environment and harvesting the right fish at the right time.

Returning to the parallels between agriculture and fish ponds, we see other similarities.

1. If the pasture is overgrown with noxious weeds, the cattle may starve even though the sun is shining and the pasture is well fertilized. Likewise, if the nutrients in a lake are taken up by large plants instead of by the microscopic plankton, then most of the food energy is diverted from the pathway that leads to desirable fish and into the production of big plants and undesirable plant eaters like snails.
2. On a farm with acidic soils, fertilizers are ineffective, plants won't grow and the cattle will starve. In a fish pond, soft acidic water also limits the growth of plankton and the fish don't get enough to eat.
3. If the farmer puts too many livestock in a pasture, even with sun and fertilizer, the cattle will run out of grass and starve. In a fish pond, if too many bass are stocked, the pond won't be able to provide enough food and the bass will starve.
4. If a farm is overrun with deer that graze in the pastures, the cattle will not get as much food and growth will suffer. In a fish pond, undesirable fish species like carp or green sunfish will compete with bass and catfish for food and the desirable fish will not grow as quickly as they should.
5. If the cattle ranch is also home to coyotes, they will eat all the calves and the cattle herd will shrink. If a fish pond has gar, they will eat the baby sportfish and fishing will be poor. *Fish ponds are just like other agriculture, just wetter.*



Designing and Building Your Pond

Most ponds can support useful populations of sportfish, but pond construction, fertilization and stocking plans will be different if the lake is intended to serve primarily for cattle watering or irrigation rather than fish production. The next section contains information on tailoring pond and watershed design and management for specific uses.

Pond Construction and Watershed Management

Ponds are built for a variety of reasons, but two basic rules remain the same. The pond must be sited on suitable soils and properly constructed to hold water, and there should be enough water available to fill the pond but not in great excess. Careful attention and expert advice on pond site selection and construction are essential. Once a pond is built, proper maintenance extends its useful life and beauty. In addition, most farm ponds depend on runoff from their watershed (land uphill from the pond) to fill and maintain the water level. Protecting the watershed ensures a quality supply of water to the pond.

Constructing New Ponds

Decide the primary use of a pond before construction so that the design can be adjusted to the proposed use. Ponds are most often used for livestock, recreation, landscaping, fish production, waterfowl and wildlife, irrigation, fire protection or for multiple purposes. Not all these uses are fully compatible, however. For example, a pond for commercial fish farming requires a regular shape and smooth bottom to facilitate harvest, while one built for wildlife may have standing timber, islands and shallow areas to promote the growth of aquatic plants.

The USDA Natural Resources Conservation Service (NRCS) provides assistance on pond site selection and construction under their small watershed program. The goal of the NRCS is "to prevent damages caused by erosion, floodwater and sediment and to further the conservation, development, utilization and disposal of water and the conservation and utilization of land." For the nearest office, check your phone book or contact the state NRCS office in Little Rock at (501) 301-3100. A list of offices within Arkansas is available at http://www.ar.nrcs.usda.gov/by_office.htm. NRCS Agriculture Handbook Number 590, *Ponds – Planning, Design, Construction* (see references), provides a detailed guide to building a pond. The USDA Consolidated Farm Services (which includes the former Agricultural Stabilization and Conservation Services) may provide partial funding for pond construction that meets local priority conservation criteria.

There are two basic types of ponds – watershed and levee. Ponds with one to three dams in a gently sloping location, where rainfall running off the land will fill the pond, are watershed ponds. Levee ponds are constructed in flat sites by cutting earth from the pond basin and using the soil to build up four surrounding levees. Levee ponds require water supplied by a well or pump. Groundwater is recommended if possible because surface water is a source of unwanted fish species and associated parasites. If surface water must be used, filter the water through a fine mesh screen. For either pond type, sites should have soils containing at least 20 percent clay. Proper pond construction is essential to avoid seepage problems. Make sure the pond dam is built over a core trench that was cut into the ground and then refilled with compacted layers of a good clayey material. A bulldozer alone will not provide adequate compaction for most soils, and a sheepsfoot roller or wheeled tractor and pan are required.

For ponds built for recreational fishing, there is no advantage in deep ponds (over 12 feet to 14 feet deep) or to a deep area within the pond. Deep ponds are not more productive and tend to have more oxygen problems. Ponds should not have extensive shallow areas (less than 3 feet deep) unless aquatic plants are desired. Constructing ponds to drop off rather quickly to a depth of at least 2 1/2 feet helps prevent aquatic weed growth.

In site selection for watershed ponds, matching the pond size to the area and characteristics of the watershed is critical. Too large a watershed results in excess water flow through the pond, removing fish and fertility and potentially damaging the dam. Too small a watershed results in too little water. Depending on the watershed vegetation and soils, somewhere between 5 acres and 30 acres of watershed are required for each acre of pond area. More water runs off of pasture than wooded land, for example, so that fewer acres are required. Be careful to avoid sites where the runoff water is muddy or contaminated. Watershed ponds should have an emergency spillway to handle heavy rains and a trickle tube for ordinary overflow. For recreational fishing ponds, a drainpipe is a good idea in case the pond needs to be renovated.

A drainpipe also allows ponds to be easily drawn down in late summer or early fall to improve the fishery (see section on drawdowns).

Spawning Areas and Fish Attractors

Another consideration in pond construction is that you can design the pond to make selected locations within your pond more attractive to fish. Many fish prefer to have a place to hide and will tend to congregate around tree roots and rocks. If you include some stumps, rock piles, concrete blocks or other relatively stable three-dimensional structures in your pond, the fish will tend to hang out nearby. This creates more stable habitat and predictable locations for your fish and makes it easier to find them when you go fishing. It is important to remember that any structures that you use must be safe for swimmers and boaters, and that they may snag your hooks and lures. It may improve your fishing success to add a couple of 5-foot diameter brush piles or your old Christmas tree to an established 1-acre pond. However, it is important not to leave too much brush in a newly constructed lake or add too much to an older lake. When the brush decomposes, it will use up too much oxygen and kill your fish.

Another way to improve conditions for fish is to provide them with some good spawning habitat. For the bream that supply your bass with food (see the Bass/Bream Stocking Option section), construct a flat area along the shore at a water depth of 3 feet to 5 feet and cover much of it with pea gravel. The bream will then use this place to build nests. For more information on spawning, see the descriptions of individual fish species later in this booklet.

Spillway Barriers

Some fish species are prone to escape ponds during periods of high flow when water flows over the emergency spillway. Grass carp in particular will leave ponds with flowing water. Usually, fencing emergency spillways is not recommended because wire mesh clogs with debris and leaves, blocking flow. Water may then rise and spill over the dam, leading to its failure. To reduce the clogging problem, a parallel-bar spillway barrier was developed by the Alabama Department of Conservation and Natural Resources (see references). The barrier is relatively self-cleaning but still should be cleaned and maintained, as woody debris and tall grass will still catch on the bars.

Maintaining Existing Ponds

Maintain a good grass cover on the pond dam(s) and emergency spillway. Do not let trees grow on pond levees. The roots will penetrate the dam, and when the trees die, the roots will decay and leave open channels. Trees can also be toppled by windstorms, leaving weakened areas or even holes in the levee where the roots were torn up. However, if you have existing trees taller than 15 feet to 20 feet on your pond levee, it is probably best to leave them alone.

Ponds for Watering Livestock

Where the primary use of a pond is for watering livestock, see Cooperative Extension Service Fact Sheet FSA3021, *Water for Beef Cattle*.

Stocking and Fishing Your Pond

Before a pond is stocked, deciding which species you would like to raise and which would do best in your pond is important. In this section, we introduce the common fish species and describe their biology. This publication focuses on fish species combinations that have proven to provide excellent fishing opportunities in farm ponds. Management practices to maintain good fishing in ponds with these species are fairly straightforward, simple and have been proven effective through years of research and experience. There are alternative management strategies for farm pond fisheries that rely on other species and more intensive management schemes. Some of these combinations are relatively untried or work well only under certain specific conditions. Farm pond owners should be aware that they might need to contract with a private farm pond consultant to properly implement and maintain such alternative fisheries. publication MP447, *Recreational Fishing in Small Impoundments: Alternative Management Options*, provides information on alternative species and their management in farm ponds.

Obtaining Fish for Pond Stocking

Fish fingerlings for stocking must be purchased from commercial fish farms. The farm will deliver large orders of fish to your pond by truck. For smaller orders, traveling to the fish farm or visiting a route truck when it comes to your area will prove less expensive. Most farms will pack your fish in plastic bags with water and oxygen so that they will do very well even if it takes several hours to get them to the pond. Larger fish, especially large catfish, are difficult to haul in bags, and you may want to transport them in a barrel of water or other container. If you choose this option, keep in mind that the fish will quickly run out of oxygen and may die in route. The number of fish that can be transported in this manner depends on the temperature, the water volume, the surface area of your container and the size of the fish. It is best to get advice from the farmer before choosing this option and to keep in mind the harm that will occur if the fish are without oxygen for any period. For smaller fish, insist on bags and pure oxygen.

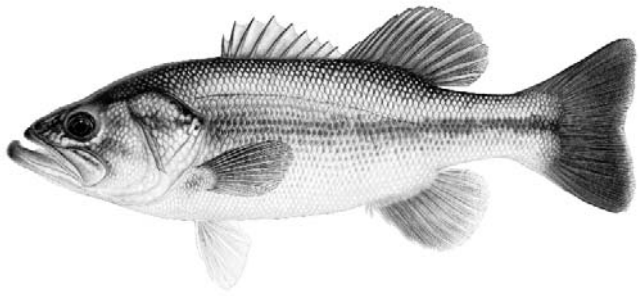
When stocking fish into a lake, slowly acclimating fish to the new water temperature is important. Rapid changes in temperature may cause the fish to die immediately or it may cause them to develop infections that may kill them up to a week later. If the fish farmer delivers the fish by truck, the farmer should make sure that the fish are acclimated to the new pond. If you pick up fish at the farm or a route truck, you will need to acclimate them yourself. The best method is to float the unopened bag in the pond for about 30 minutes. This allows a gradual change in the water temperature until the water inside the bag is the same as the water outside. Next, open the bag and release the fish into the pond. Transporting fish during the spring and fall when water temperatures are cool is easiest. If fish are to be moved during the summer months when the weather is warm, plan your stocking project so that the fish can be released into the pond early in the morning before the surface layer of water becomes too hot. If you transport fish by barrel or other container, use a bucket to add water from the pond to the barrel. This gradually changes the temperature and will provide new oxygen.

To find a suitable fish farm, ask for a copy of the Sportfish Supplier List produced annually by the UAPB Aquaculture/Fisheries Center and distributed through Extension offices and Arkansas Game and Fish. The list has all the contact, species availability, business hours and shipping information. Before visiting a farm, call ahead to check on prices and availability.

Fish Species to Consider

Largemouth Bass

The largemouth bass is a popular fish to catch in farm ponds. Its large mouth, long body and dark blotches along its side easily identify this species. Young bass feed on microscopic animals (zooplankton) and insects. Fish, crayfish, frogs and larger insects replace these food items as bass become larger. Growth rates are variable, but bass can reach a harvestable size, 12 inches or more, in 2 years when food is abundant. The primary food for bass in farm ponds is bream. They will not eat floating fish feed in

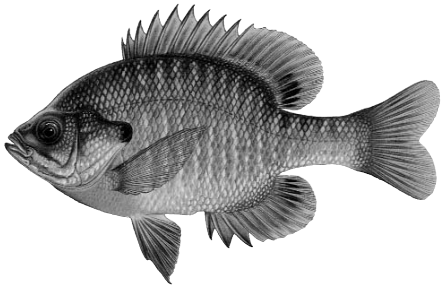


Largemouth Bass

backyard ponds. Bass spawn once each year between April and June when the water temperature reaches at least 65ºF.

Bluegill

Bluegill, also called bream, are compressed, deep-bodied sunfish with small mouths. Bluegill have a black spot located at the base of the soft dorsal fin and dark vertical bands on their sides. Their underside is yellow to reddish orange and their chin is often blue. Young bluegill feed on zooplankton. Adults feed primarily on insects, and they do well on floating fish feed. Bluegill will spawn multiple times throughout the spring and summer. They make an ideal food for bass because young bluegills are available through much of the year. Bluegills are also great food for humans. If bream are stocked in a pond, bass should be stocked as well to keep bream numbers under control. Otherwise, the pond will fill up with small bream.



Bluegill

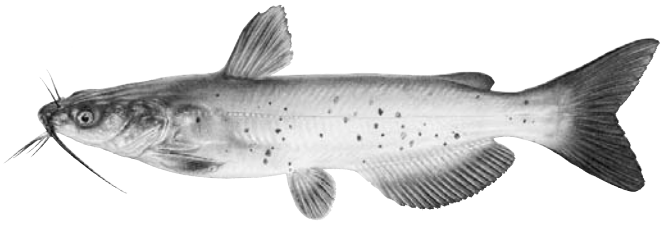
Redear Sunfish

Redear sunfish, also known as shell cracker, are another member of the bream family that can be stocked in combination with bluegill to provide additional bass forage and recreational fishing. This species can be identified apart from the bluegill by its red-orange marking on the earflap and lack of vertical bars along its side or black spot on its dorsal fin. Redear sunfish reach a larger size than bluegill, but they do not produce enough young to feed a hungry bass population. They feed primarily on zooplankton and bottom-dwelling insects and snails. They do not eat floating fish feed. Spawning occurs from April through August in Arkansas. Like the bluegill, redears are fun to catch and eat.

Redear Sunfish

Channel Catfish

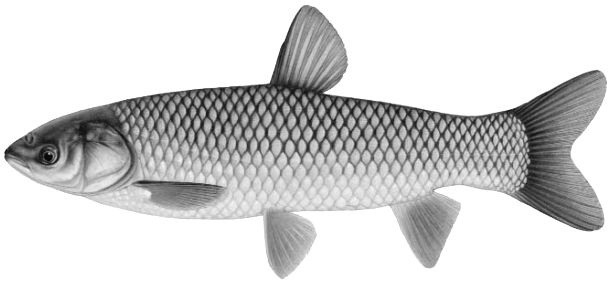
The channel catfish is silver with a dark back and variable numbers of black spots. The undesirable bullhead catfish species (“mud cats”) are similar in appearance, but the tail edge is straight or even rounded, not forked like the channel catfish. Channel catfish reach 1 to 2 pounds within two growing seasons and may reach sizes of more than 10 pounds in 5 to 10 years if food is abundant. Adult channel catfish eat a variety of natural foods, including insects, snails, crawfish, plant material and small fish, and they are easily raised in farm ponds using floating feeds. While they occasionally reproduce in ponds, other fish consume the vast majority of the catfish young. When schools of small catfish are seen in the spring, pond owners should be suspicious that these are actually bullheads, not channel catfish. Because channel catfish reproduction is rarely successful, you need to occasionally stock additional channel catfish to replace those caught and removed from the pond. When restocking catfish into ponds with an existing bass population, stock fingerlings at least 8 inches in length so that the bass do not eat them.



Channel Catfish

Grass Carp

Grass carp, also known as white amur, are elongate fish silvery-gray in color. They can be stocked in farm ponds to provide economical long-term protection from many aquatic weeds. Stock newly constructed ponds with 3 to 5 grass carp per



Grass Carp

acre. Ponds with moderate to heavy weed problems require 10 or more fish for adequate control. New ponds can be stocked with 2 inch to 6 inch fish while larger 9 inch to 12 inch fish are required in ponds that contain adult bass. As grass carp become large, they become less efficient at controlling weeds. They eat some fish feed but prefer to consume a diet primarily of plants. The fish should be replaced or supplemented every 5 to 7 years. Grass carp can be harvested by snagging, bow fishing, spearing or angling. Although somewhat bony, the grass carp is considered an excellent fish to eat.

Unwanted Fish Species in Farm Ponds

Species to avoid in farm ponds include white crappie, gizzard shad, green sunfish, common carp and bullhead. These fish either have a tendency to overpopulate or may interfere with the bass-bluegill predator:prey relationship. There is less enjoyment from ponds with unwanted fish, and management is difficult. The feeding habits of common carp and bullhead tend to muddy the water. Bullhead look similar to channel catfish but do not have a forked tail.

Black crappie, hybrid bream and hybrid striped bass may be successfully reared in ponds if managed correctly. For information on the pros and cons of stocking these species in farm ponds, see publication MP447. Ordinarily these species should be avoided in farm ponds unless intensive management schemes are adopted.

Strategies for Stocking New Ponds

Largemouth Bass/Bream/Channel Catfish Fishery

The most widely recommended combination for good fishing is largemouth bass, bream (either bluegill alone or bluegill and redear sunfish) and channel catfish. The bass consume enough small fish to control the bream population. If the proper number and sizes are present, this predator:prey relationship results in good numbers of nice sized bass and bream. Channel catfish provide additional fishing opportunities. In properly managed bass-bream ponds, both the bass and the bream reproduce each year, and good fishing can be sustained for year after year without stocking additional fish. However, if catfish are desired as well, replacement catfish fingerlings have to be added every couple of years.

In a new pond, stock bluegill and redear sunfish fingerlings in the fall. Stock the bass fingerlings in the following spring. This allows the bream to grow large enough to avoid predation and spawn late the next spring when the bass are stocked. The baby bream provide food for the newly stocked bass. Channel catfish fingerlings and grass carp can be stocked in the fall or the spring, but it is a good idea to get them into the pond before the bass get too large.

Pay close attention to the number of fish to put in the pond (See Table 1). A pond produces a limited amount of food for each fish species. More food is available to fish that are lower on the food chain. Thus, a pond can support more bream, which feed on insects, than largemouth bass, which primarily feed on other fish. Ponds that are managed with a proper fertilization program (see Liming and Fertilization) or are naturally productive will support larger fish populations than unfertilized ponds because of the increased availability of food.

In ponds greater than one acre in size, the bass/bream population can be maintained as a result of their predator:prey relationship. The bluegill feed on insects in the pond and reproduce in fairly large numbers, providing food for the bass. Ponds that are less than one acre in size are too small to support the predator:prey relationship of largemouth bass and bream. These ponds are best suited for channel catfish only (see Table 1).

A proper harvest strategy leads to years of good fishing. Don't remove any bass from the pond for at least 2 or 3 years after stocking. This allows the initial stocking of bass to grow, spawn and establish the population. Once harvest begins, remove 10 to 15 pounds of bass per acre each year of less than 13 inches in length. Return all bass between 13 inches and 16 inches long. Harvest bass greater than 16 inches, as desired. Bream can be harvested as desired. If you primarily are interested in harvesting large bream, modify your management strategy: after the initial 2 to 3 year period of bass catch and release, harvest all bass over 16 inches in length. High densities of 13 inch to 16 inch bass will eat a lot of the small bream, leaving the remaining ones to grow fast and large.

To reduce the amount of time before harvesting can take place, stock adult fish instead of fingerlings in a new or renovated pond. Stocking recommendations are different if you decide on this option (see Table 2). Very little research has been conducted on this option, but it does allow faster development of fish populations. Fewer fish are stocked because of their larger size. In this case, stock the bass and bream at the same time, in the spring. To provide a supplemental food source for the bass, stock also 2 to 3 pounds of fathead minnow per acre. Channel catfish may also be stocked with adult bass and bream but should be at least 6" to 8" in length to avoid being eaten by the bass (see Table 2).

Table 1. Species selection and stocking rates (fingerlings/acre) for largemouth bass and bream fisheries.

Pond Type	Largemouth Bass	Bluegill*	Redear Sunfish	Channel Catfish	Grass Carp
Unfertilized	50	400	100	100	5
Fertilized or Fed	100	800	200	200	5

* If you wish to stock only bluegill, increase the stocking rate to include the redear sunfish stocking rate.

Table 2. Adult stocking recommendations (fish/acre) for new or renovated ponds.

Species	Number Per Acre	Size (inches)
Largemouth Bass	20	8 to 14
Bluegill and Redear Sunfish	70 30	3 to 5 3 to 5
Channel Catfish	100 if unfertilized 200 if fertilized or fed	6 to 8

If you use the adult stocking option, don't fish in the pond until the summer one year after stocking. Follow harvest recommendations as outlined above (see page 7).

Channel Catfish Option

A popular option to consider is stocking channel catfish alone. This option works particularly well in small ponds (<1 acre) or in ponds that are muddy. Bass and bream are primarily sight feeders and muddy ponds make it difficult for them to see their prey. Stocking rates vary depending on whether or not you plan to feed your fish (see Feeding Programs) and the size of your pond. Stock between 100 and 200 channel catfish fingerlings per acre in ponds less than 1 acre (see Table 3). Stock larger ponds with 100 fingerlings per acre if you do not plan on feeding and up to 200 fingerlings per acre if you are going to feed. The more fish you stock, the more you have to feed. Before stocking, decide how much money and time you are willing to spend on feeding your fish. Fish should be of harvestable size (3/4 pound) within a year of stocking if you feed your fish. The frequency and number of fingerling channel catfish that you will have to restock will depend on how many fish you harvest.

Table 3. Stocking rates for ponds with channel catfish only.

Pond Type	Fingerlings Per Acre
Unfertilized	100
Fertilized	200

Dealing With Older Ponds and Existing Fish

Evaluating Fish Populations

Stocking a new pond is easy. Much more difficult is trying to figure out what to do with an older pond with an established fish population. A basic understanding of what is being caught can help keep track and identify problems with the fish population.

One method to evaluate the bass and bream population is to fish for both large and small bluegill and bass and keep track of what you are able to catch. Then, look at Table 4 (below) to see if your pond is in balance or if corrections need to be made. A better but more difficult technique is to capture some of the young fish using a 20 ft net ("seine"). The best time to do this is in mid-May to late June after the bass and bluegill have spawned. Using a 20-foot seine (4 to 5 feet deep with 3/8 inch mesh), make three to five semi-circular passes in shallow areas of the pond and record what you catch. Allow the seine to arch so that the fish cannot easily swim around it. The fish caught in the seine hauls provide information on the reproductive success of the fish in the pond and also help determine if there are unwanted species present. Look at the fish in the seine, and then look for the right description in Table 4 to find out what kind of fish population you have. A significant problem with seining is that many ponds are full of deep water, brush or other obstructions that make finding a suitable spot to seine difficult. Lightweight seines suitable for checking ponds cost only about $25.

If catfish are desired and are not being caught, stock more fish. In ponds with existing bass populations, make sure to stock catfish fingerlings at least 8 inches in length. Keeping records of the number of catfish stocked and caught help determine if and when additional stockings are needed. Catfish may spawn in farm ponds, but predators often eat resulting fry (small fish), so stocking is recommended.

Managing the Fish Population

When everything is in balance, the bluegill are providing all of the food that the bass need, and the bass are controlling the bluegill population. Ponds that are in balance have bluegill and bass present in all of the possible sizes from newly hatched to large adult. Seine hauls in a balanced pond should contain many recently hatched bluegill (less than 2 inches), some intermediate size bluegill (2" to 4") and some recently hatched largemouth bass (1" to 4"). These ponds provide great fishing. Monitor the fish in a balanced pond using a seine each summer to check for adequate reproduction and through angler catch information throughout the year. If the pond is in balance, then no corrective measures are needed; just follow the harvesting directions in the Bass/Bream Option section and if desired, fertilize or feed as described in the Fertilization and Feeding sections.

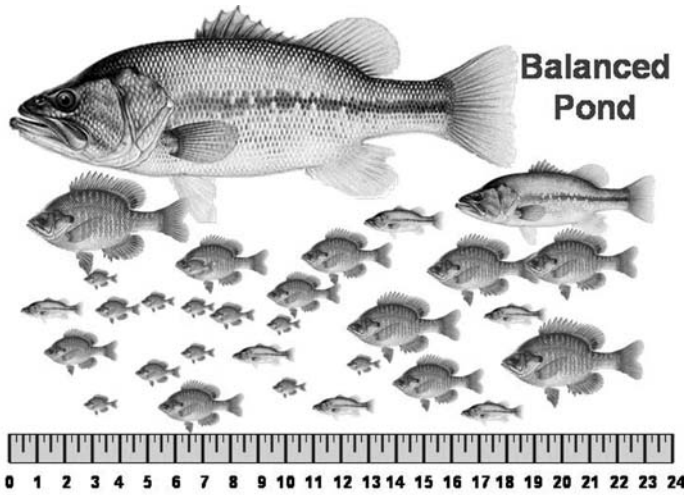
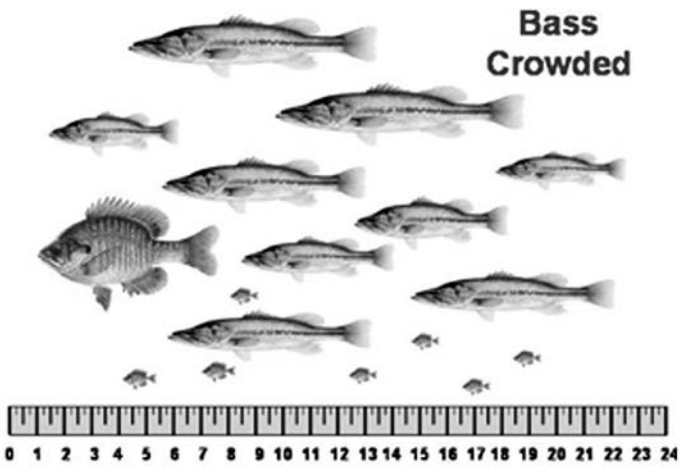


Table 4. Fish population status based on seine and angler catch data.

Population Status	Seine Data	Angler Catch Data
Balanced population	Many recently hatched bluegill less than 2"; some intermediate size (2"-4") bluegill; some recently hatched largemouth bass (1"-4")	Largemouth bass and bluegill of various sizes
Bluegill crowded	No or very few recently hatched bluegill; many intermediate size bluegill; no recently hatched largemouth bass	Largemouth bass catch low and only larger fish (15" and larger); few harvestable size bluegill (6" and larger)
Bass crowded	Many recently hatched bluegill; very few to no intermediate size bluegill; very few to no recently hatched largemouth bass	Largemouth bass numerous but small and often thin (12" or less); bluegill few but large and robust (8" and larger)

Bass Crowded

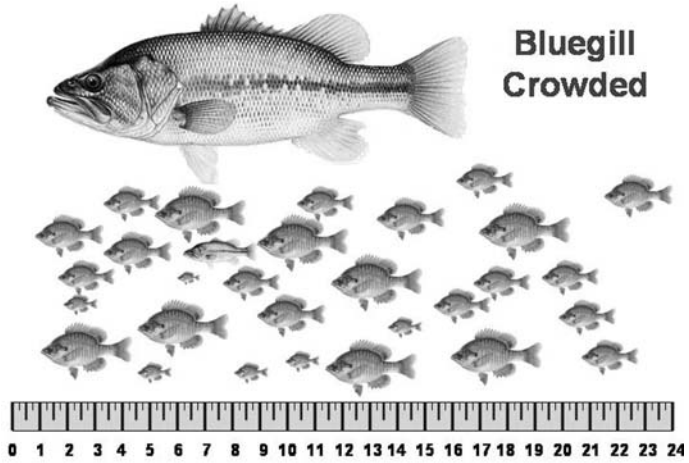
When there are too many bass in the pond, they eat most of the bream before the bream reach 2 inches to 4 inches in length. When this happens, there is not enough food for the medium-sized bass and they can't grow to larger sizes. The only bream present are the newly hatched fish that have not been eaten yet and rare large adults that have somehow escaped the bass and reached a size too large for the bass to eat. Ponds that are bass crowded have large numbers of small (12 inches or less) and thin bass and a small population of large bluegill. This is a desirable situation if you prefer to catch large bluegill. However, if bass are the desired species, then ponds in this condition would benefit from an increased annual harvest of bass. In a single year, remove approximately 35 pounds of bass (12 inches or less) per acre. This reduces the competition for food among the remaining bass resulting in increased growth in following years.



Bluegill Crowded

If you remove too many of the larger bass from a pond, too few predators will remain to control the bream population and they will overpopulate the pond. The overcrowded bream are unable to find enough food and they don't grow well. The small bass that are left in the pond are unable to compete with the bream for food so the bass are unable to grow to a size large enough to eat the bream that are present in such high numbers. Most of the baby bass are eaten when they are tiny so there are few small bass in the pond. Rarely, a bass manages to get large enough to eat the stunted bluegills. When that happens, the bass grows quickly. Bluegill crowded ponds are characterized by a large population of stunted bluegill (2" – 4") with very few of harvestable size. The bass population consists primarily of a very few large individuals. Successful bass and bluegill reproduction is greatly reduced. Summer seine hauls have very few, if any, newly hatched bass or bluegill. Ponds that are overcrowded with bluegill are more difficult to correct. However, there are four potential methods of correcting this situation.

1. Harvest as many bluegill of all sizes as possible. The number needed to reduce the effects of the overcrowded situation may not be possible through fishing alone. Most pond owners will not be able to catch and remove enough of the very small 2" to 4" bluegill.
2. Lower the water level in the pond to about one-half the original volume. This concentrates the bluegill so that the bass can more readily eat them. This is best done in late summer or early fall. Allow the pond to refill before the following spring.
3. Stock 20 to 30 adult (8" to 12") largemouth bass per acre. These adult fish will eat and help reduce the overcrowded bluegill population.
4. The methods described above are often successful in fixing an out-of-balance pond. However, they do require some work and dedication, and improvements may be slow to happen or may not happen at all. An alternative to the methods above is a complete renovation that includes draining and killing all of the fish in the pond. Once the pond has refilled, start over with stocking. This may be the best choice in cases where large numbers of unwanted species are in the pond or corrective measures do not improve the size structure of the population and return the pond to balance.



Drawdowns

One of the methods listed above to correct ponds overcrowded with bluegill is the drawdown, where the water level in the pond is lowered to about one-half the original volume in late summer or early fall. Other benefits to a drawdown should be considered as well. Drawing down the water allows shoreline vegetation to grow during the winter, which when

flooded in the spring provides shelter to newly hatched fish. Also, winter drawdowns help control certain aquatic weeds by exposing them to freezing conditions.

Starting Over

If you have read the fish population management section of this manual and determined that the best course of action is to start over, you need to select a method to remove the fish from your pond. One possibility is to drain, dry and refill. If this is not possible, the only alternative is rotenone, the only chemical approved to remove unwanted fish populations from lakes and ponds. Rotenone is a natural chemical from the root of the tropical derris plant. A synthetic version may also be purchased. Rotenone is distributed in the water as a powder or liquid. When fish are exposed to rotenone, their red blood cells lose the ability to deliver oxygen to the fish's tissues. The fish die because they are no longer able to make use of the oxygen in the water around them. Rotenone breaks down into nontoxic chemicals in a few days or weeks depending on the water temperature.

Rotenone is a restricted use pesticide and, while it is relatively safe, it does pose some risk to livestock drinking the pond water and to humans applying the chemical. Applicators of restricted use pesticides must have a special license to purchase and apply this class of chemicals. It is also important to remember that treated water escaping from the pond can have very detrimental effects on wild fish and other animals downstream. Pond or lake owners considering the use of rotenone should contact their state wildlife authority (in Arkansas: Arkansas Game and Fish Commission) before purchasing or applying rotenone. State wildlife specialists can help you to use the chemical legally, effectively and safely.

After rotenone treatment, make sure that the chemical is gone before adding new fish. One practical method is to place several small fish in a porous minnow bucket and leave them in the pond for a day or two. If the fish die, rotenone may still be present. [Note: if the fish survive, do not release them in your pond!].

A carefully applied rotenone dose will remove all or most fish from a pond. Consider that this is a pointless exercise if the situation is such that new undesirable fish will be able to quickly reinfest the pond. Before using rotenone, make sure that the wild fish will be unable to reinfest the pond. For example, if your pond is located immediately below another pond containing the undesirable fish species, it's likely that your pond will become contaminated again with the next big rain. If eliminating the source of these undesirable fish isn't possible, forget about the rotenone and concentrate on controlling undesirable species by maintaining a healthy population of predators like largemouth bass.

Managing the Pond Environment

Liming

Adding lime (finely crushed limestone) to a pond reduces acidity of bottom soils and makes nutrients more available, increasing production of the microscopic plants and animals that start the food chain that feeds your sport fish. Lime is not needed in all ponds and is recommended only if the carbonates and bicarbonates dissolved in water ("alkalinity") is below 20 PPM (parts per million). Adding lime also has the added benefit of increasing the hardness (calcium, magnesium) of the water as well. Ponds low in alkalinity usually have low hardness as well. Ponds in limestone areas (many ponds in northern Arkansas) generally have high alkalinity waters. However, if the soils on pastures or fields near your pond require lime, the pond would likely benefit from liming as well. Ponds in south Arkansas generally need lime.

There is another reason for liming low alkalinity ponds. Waters low in dissolved minerals (low alkalinity, low hardness) stress fish and they are more like to will get sick (see fish health section). Alkalinity is easily measured with relatively inexpensive test kits or water samples can be sent for testing through your local Cooperative Extension Service office.

The easiest way to lime a new pond is to test the soil, then add limestone before filling the pond with water. New ponds are best tested and lime applied, if needed, before they fill with water. Taking many small samples in an "S" pattern across the pond and combining them is best. Dry, crush and pour the mud into a soil sample box available from the county Cooperative Extension Service office. Typically, at least 1,000 lb/acre of lime is required. Lime will have to be added periodically, every four years or so, depending on the amount of flushing that occurs. If the pond is still dry, use spreader trucks to apply the material.

Only agricultural limestone should be used for existing ponds with fish populations. Hydrated and slaked lime are different chemical compounds that are very caustic and may kill your fish. Hydrated lime can be used in new ponds before stocking provided that you wait several weeks before stocking and have the pH of your water analyzed before putting fish in the pond.

For ponds that already have water, collect a water sample and have it tested to determine the alkalinity. If it is less than 20 ppm, liming would be beneficial. To determine the amount of lime required, obtain pond bottom soil samples by scooping up mud using a tin can attached to a long stick. Again, following an "S" pattern across your pond and mixing all the samples together is best. Dry, crush and send your sample for testing through your county Cooperative Extension Service office.

Alternatively, if lime is required, at least 1 ton/acre will be needed. It's also possible to add about 1 ton of crushed agricultural limestone per surface acre of pond and then recheck the alkalinity in 4 to 5 months. If it is not at least 20 ppm, then lime the pond again with another ton/acre the next fall. Liming is most effective when the lime is broadcast over the entire pond area by spreading bagged lime from a boat or by building a platform across two boats to carry the large amounts required. Alternatively, a spreader truck may be able to back up to the pond in a number of locations to cover as much of the pond as possible. The best time to lime is in late fall or winter. This gives time for the lime to react with the bottom mud and to counteract the acid soil before the next growing season. Lime should not be applied at the same time as fertilizer; the calcium in the lime reduces the effectiveness of the fertilizer by precipitating the phosphorus out of the water.

Where liming is not an option, raising catfish or hybrid bream (see publication MP447) with feed is an excellent choice. The feed substitutes for natural foods lacking in the pond. See the Feeding Your Fish section for advice on feeding.

Fertilization

Fertilization stimulates the growth of the microscopic plants that feed the fish and shade out undesirable weeds. The growth of these plants is called a "bloom." If the bloom is too thin, light can reach the pond bottom and cause the growth of rooted aquatic weeds and fish may go hungry. If the bloom is too thick and dense, it can cause low dissolved oxygen, especially on cloudy days. Using pelleted feeds for catfish and bream also increases bloom density through nutrients provided by fish wastes and excess feed.

Unfertile ponds typically support around 50 to 150 lb/acre of fish. Fertilization can increase fish production by three to four times, resulting in more and bigger fish (in properly managed ponds). For farm pond owners with unproductive ponds who desire better fishing, a fertilization or feeding program can improve fishing dramatically as fish grow in response to the increased food supply. However, if fishing is not the primary use of the pond, there is little reason to fertilize. Similarly, if fishing pressure

is light, the additional fish production may not be utilized. Note that fertilization changes the appearance of the pond. The added nutrients result in the water becoming green or brownish green. Do you want a green pond?

Ponds that already receive nutrients from the watershed (e.g., from cattle or from application of poultry litter) usually do not need additional nutrients. For example, applying chicken litter to a field at a typical rate of 2 tons/acre adds an average of 116 pounds of phosphorus/acre. Ponds require only 3 to 4 pounds/acre of phosphorus to develop a plankton bloom, so it's easy to see that if even a fraction of the phosphorus in the litter makes its way into the pond, there will be plenty available to fertilize the pond without adding any more.

Ponds that are muddy, weedy, with existing dense plankton blooms, where the fish population is out of balance, or ponds that have excessive water flow should not be fertilized until the problem is corrected. Fertilizing when nuisance weeds are already established is like throwing gasoline on a fire. See the sections on muddy ponds, weed control and fish population balance.

Before fertilizing a pond, test the alkalinity of the water to see if the pond would benefit from the addition of lime (see section on Liming). If fish in ponds will be fed (for example, a pond of catfish) there is usually no need to fertilize, as the uneaten feed and fish wastes will serve as fertilizer. It is also beneficial to test the hardness of the water. Hardness is a measure of the concentration of calcium and magnesium. Phosphorus is less soluble in water with a high hardness so fertilization rates must be adjusted accordingly (see Table 5)

Table 5. Suggested fertilizer rates (per application) for farm ponds. Use this as a starting point and modify for your pond conditions by adding more or less fertilizer per application. After the initial application, apply one-half of the recommended rate.

Fertilizer		Water Calcium Hardness*	
Type	Grade	Low Hardness	Moderate Hardness
Liquid	11-37-0 13-37-0 10-34-0	1/2 to 1 gallon/acre	1 to 2 gallons per acre
Powder	12-52-4 12-49-6 10-52-0	4 to 8 pounds/acre	8 to 16 pounds per acre
Granular	18-46-0 0-46-0	4 to 8 pounds/acre	8 to 16 pounds per acre

* Low hardness is defined as having a calcium hardness of less than 50 PPM. Most farm pond waters have low hardness.

Carefully considering whether or not your pond would benefit from a fertilizer program is important. Once a fertilization program is started, it should be continued each year because the total weight of fish in the pond will increase, and the fish will come to depend upon the additional food resulting from fertilization. If you decide to fertilize, follow recommended guidelines. Improper or excessive fertilizer applications can pollute natural waters, especially for ponds located on ecologically sensitive watersheds. In addition, while some increase in fertility may be beneficial, too many nutrients lead to dense algae blooms, oxygen depletions and even fish kills. Ponds can develop a thick scum of algae and become unsuitable for watering cattle.

Applying Fertilizer

If you decide to fertilize, begin applications in the spring when the water warms above 65ºF, usually early March. This timing promotes the growth of the algae bloom before rooted aquatic weeds can become established. Once a fertilization program is started, it should be maintained throughout the growing season. The total weight of fish in a pond will increase in response to the increased productivity, and fish will come to depend on this additional food. Fertilization is effective only during warmer temperatures and should be discontinued when water temperatures fall below 60ºF. The required number of applications during the growing season will vary from one to 10 or more, depending upon the response of the pond to fertilization.

Choose a fertilizer high in phosphorus, as it is the most important nutrient in ponds. Some nitrogen is beneficial as well, especially in newer ponds, while additional potassium is rarely if ever needed. The formulation or grade of a fertilizer is given by three numbers, for example, 12-52-4, which represent the percentage (by weight) of nitrogen (12), phosphorus (52) and potassium (4) in the fertilizer.

Fertilizer comes in three forms: liquid, powdered and granular. Powdered fertilizers are more expensive but the easiest to apply, as they can simply be broadcast over the pond surface. Liquid fertilizer is heavy and must be diluted with water (10 parts water to 1 part fertilizer) before being splashed or sprayed over the surface. Granular fertilizers are in the form of small pellets and are the easiest type to find in stores. However, granular fertilizers should NOT be thrown out into the water. Little of the fertilizer dissolves; most of it sinks to the bottom where the phosphorus is chemically bound by mud and lost. If granular fertilizers are used, they must be kept off the mud until the pellets dissolve. Granules can be placed on a wooden platform set at 4" to 12" below the water

surface, or the fertilizer bag can simply be slit open on top in an "X" and carefully sunk in shallow water.

Table 5 provides suggested fertilizer rates for ponds. Because each pond is unique, one set fertilizer rate does not work for all ponds. Ponds on fertile watersheds, for example, need less fertilizer than ponds located in areas with poor soils.

Monitoring the Bloom

After the initial fertilizer application, see how the pond responds to the added nutrients. The water should develop a greenish or green-brown color within a week or so. Algae blooms develop faster in warmer water. Allow at least one week, and preferably two, between applications in order to monitor the results of each addition. Periodically measure how dense the algae bloom is so that you can decide whether or not to fertilize the pond again. A good way to measure bloom density is to use a pie tin nailed to the bottom of a yardstick. Alternatively, a round piece of plastic or wood painted with alternating black and white colors can be used for better contrast. Scientists call these "Secchi disks" (pronounced like "secky"). Lower your pie tin or disk into the water until the disk just disappears from view, and record the depth at that point. Then raise the disk until the disk can just be seen again, and again record the depth. The average of these two depths is the Secchi disk depth. In farm ponds, a depth between 18 inches and 24 inches is ideal. If the bloom is thicker than this (Secchi reading less than 18"), don't fertilize. If it is greater than 24", apply fertilizer.

For additional information on pond fertilization, ask your county Cooperative Extension Service office for SRAC fact sheet # 471, *Fertilization of Fish Ponds*.

Feeding

The amount of fish that a pond can grow is dependent on the food available. In a natural lake, the sun shines on the pond, microscopic plants (plankton) use the sun, tiny animals eat the plants, bigger critters eat those animals, and fish eat those critters and each other. The amount of food available is limited by the amount of sunshine and the availability of nutrients. One way to increase fish production is to bypass this food chain and provide the fish with nutrients and energy in the form of commercial feeds.

Many species of fish will eat commercial feeds. The sportfish that profit most directly are catfish and bluegill. Predators like largemouth bass and crappie will not eat these feeds, but profit indirectly. Feed consumed by bluegills and minnows is turned into young fish that are food for predators. Thus, a feeding program increases the production of many kinds of fish allowing for higher stocking densities and faster growth. Feed is particularly beneficial in lakes and ponds where the production of natural food is limited by low nutrients or other water quality problems.

The choice of feeds is an important one. Foremost, selecting quality feed that is formulated specifically for fish is important. The least expensive and most appropriate feeds for most ponds are those labeled for catfish and that contain at least 28 percent protein. Higher protein levels are more expensive and unlikely to produce more fish. Do not use feeds designed for other animals. The nutrient requirements of dogs are different from those of fish, and improper feeds may make the fish sick.

The other important consideration is the feed form. Catfish feeds are available in both floating and sinking forms. Sinking feeds are less expensive and provide suitable nutrition, but with them there is no way to tell if the fish are really eating or if the feed is just sinking to the bottom wasting your money and polluting the water. The only way to know how much feed to use is to use floating feeds and watch the fish eat. Also, sinking feed pellets fall apart quickly once they are added to the water, while floating pellets remain intact for a much longer time.

During the summer when it is warm, most fish will eat 2 to 3 percent of their weight in feed every day; however, most pond owners do not have any accurate estimate of the pounds of fish in their ponds, and mathematical approaches to feeding are not feasible. With floating feeds, it is a simple matter of throwing feed into the pond, watching the fish eat, then stopping when the fish get full and feeding slows. Your goal is to feed them all that they want to consume in 5 or 10 minutes.

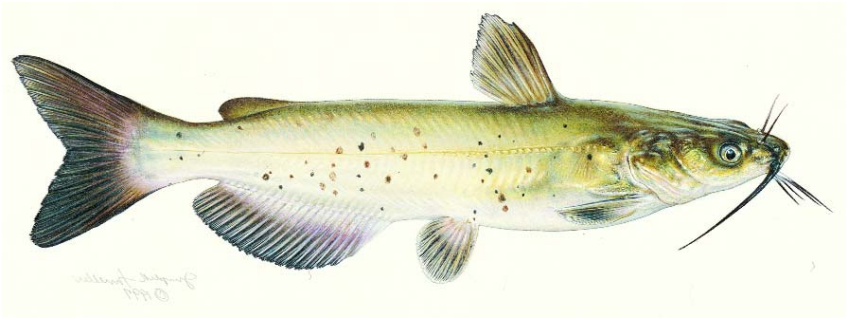
Throw the feed well out into the water, and try to feed in the same part of the pond at the same time of day. If possible, feed during the morning in the summer when temperatures are high and during the late afternoon during cooler periods in the spring and fall. As the water cools in the fall, the fish will gradually go off feed and remain off feed until temperatures warm in the spring. In the spring and fall, feed only on warm days. During the winter, the fish may be fed during unusually warm periods. When in doubt, throw out a couple of handfuls of feed and see what happens. If they eat it, give them some more.

One problem with floating feeds is that on windy days with slow feeding, the feed may blow up against

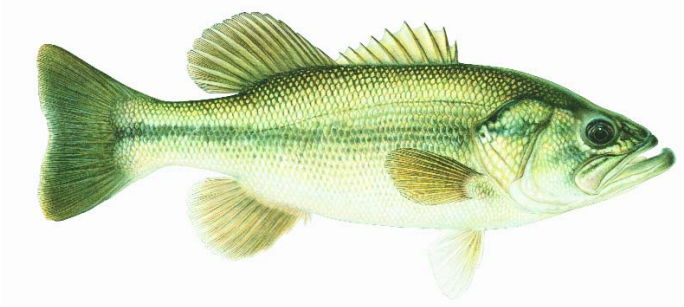
the bank before the fish have a chance to eat it. If this is a problem, move to the upwind side or make a floating feeding ring (a 3 foot or 4 foot square or ring of PVC pipe). Pick a feeding location with deep enough water that the fish are comfortable and that is free of large aquatic plants.

There are some important things to consider when embarking on a feeding program. If the pond has large populations of fish species that eat feed but do not contribute to sportfish production (for example the bullhead, or carp), then much of your expensive feed will go toward feeding fish that you don't want. In this case, it may be better not to feed. The best plan might be to clean out the pond and start over (see the pond renovation part of this book). With feeding, it is possible to grow far more fish in your pond, and fish should be harvested regularly. Otherwise, as the fish population grows and gets denser and feeding gets heavier, you will start to run into new problems like low oxygen or poor water quality. The stocking sections of this guide will help you not to overstock. Later sections will help you to prevent and deal with oxygen problems. In any case, if your fish are eating more that 20 pounds of feed per acre daily, you are headed for problems.

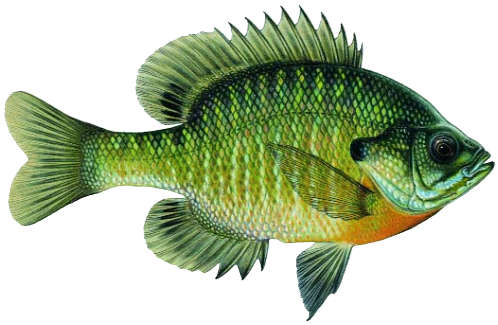
Desirable Fish Commonly Found in Arkansas Farm Ponds



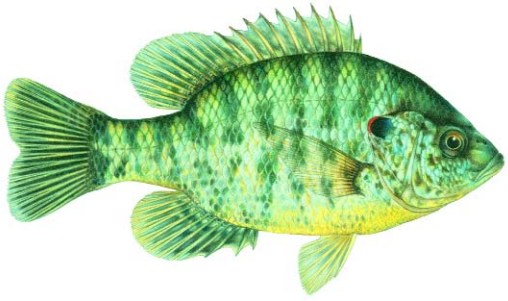
Channel Catfish



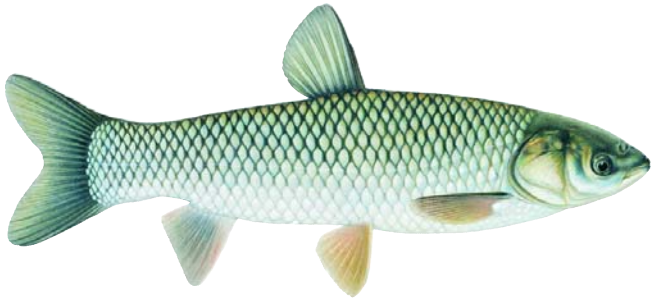
Largemouth Bass



Bluegill



Redear Sunfish

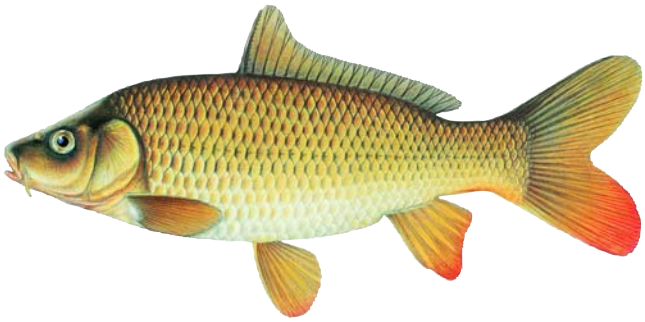


Grass Carp

Undesirable Fish Commonly Found in Arkansas Farm Ponds

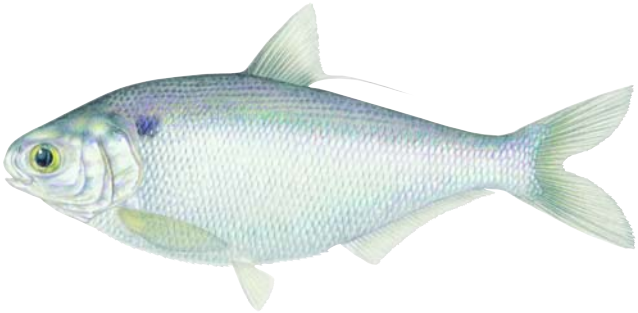
Green Sunfish

Yellow Bullhead



Common Carp

White Crappie



Gizzard Shad

Problems and Fish Kills

Fish killed in private sportfish ponds by infectious diseases or by pesticides and other accidental chemical contamination is extremely rare. Sudden fish die-offs are usually caused by oxygen problems. Die-offs of a few fish per day are usually due to other water quality problems

Oxygen Problems

Sudden mixing of a pond ("turnovers") is a common cause of low oxygen. Deep and sheltered ponds are particularly affected, although this happens in many different sizes and shapes of ponds. Hot, still days result in ponds developing temperature layers. The thin upper layer of water is hotter and contains the microscopic plants that produce oxygen. The hot water is lighter and floats on top of the cool deeper water that is not directly exposed to the sun. The cooler bottom water is cut off from the surface by the upper layer and, over time, becomes low in oxygen. Leaves and other organic matter in the pond bottom also decrease the supply of dissolved oxygen as they decompose. Strong winds or rain after a period of still weather can lead to a turnover, where the layers mix. The overall mixture can be very low in oxygen, especially in ponds that have a large percentage of deep water.

Another type of oxygen problem is referred to as an oxygen depletion. In ponds with a thick bloom, that is, with an overabundance of microscopic plants that give the water a rich green color, low oxygen problems can occur after several cloudy days. The plankton bloom produces a surplus of oxygen during the day but is also a major consumer of oxygen at night. Cloudy days reduce oxygen production and may result in low oxygen levels, especially during the early morning. Plankton blooms can also die suddenly resulting in oxygen problems. In cases where the dissolved oxygen is low but the fish are still alive, night will bring even lower oxygen levels as oxygen production by the microscopic plants shuts down with darkness.

The first sign of low oxygen that most farm pond owners see is fish at the pond surface, piping. Piping refers to fish with their mouths at the surface, where they suck at the surface water that has a higher oxygen content. Fish that startle and submerge on being approached can probably be saved if aeration is supplied soon enough. Fish that remain at the surface or lie listlessly in the shallows are close to death. While fish are normally able to seek out areas of higher oxygen, fish in this extreme state of stress are unable to move to aerators. Commercial fish farmers provide permanent aerators in ponds during summer months that fish quickly learn to locate and depend upon for their nightly oxygen. Note that sick fish also tend to congregate at the pond surface and edges. Certain diseases can affect the fishes' gills, causing low oxygen-like behavior in fish even in waters with sufficient oxygen.

Another sign of a potential problem is a sudden change in pond appearance. Turnovers and bloom die-offs can also create changes in the color of the pond water, turning a once green pond to a dirty brown or thin gray. In a few cases, turnovers result in the release of hydrogen sulfide gas from the pond bottom mud, which is very toxic to fish. Hydrogen sulfide can be detected by its strong "rotten egg" smell. Ponds recover from turnovers relatively quickly, usually within several days. Mixing brings up nutrients from the bottom, and ponds may develop new blooms rather quickly.

Early detection of oxygen problems is critical. Keep a close eye on a pond, especially in turnover weather conditions (a storm after hot, still weather). Most fish die within a few hours in water with less than 1 1/2 ppm of dissolved oxygen. The longer fish are exposed to low oxygen, the greater the chances of losses. Typically, big fish die before the smaller ones, and game species such as bass are quicker to die than bullheads or carp. A cold front with wind and rain may move through in the evening causing a turnover. By morning fish may be dead.

The effect of a turnover may be greater than just the dead fish you see. Fish that experience the stress of low oxygen are also more susceptible to diseases. Fish farmers know to look for disease problems within a week to 10 days after oxygen problems.

All of the following contribute to oxygen problems.

1. Dense plankton blooms or excessive plant growth
2. High temperatures that decrease oxygen solubility and increase oxygen use
3. Cloudy weather that reduces oxygen production by plants
4. Sudden die offs of plankton or plants (be especially careful about herbicides in warm weather! See the aquatic plants section).
5. Introduction of organic material like hay, straw, cottonseed meal, manure or sewage
6. Stormy weather that through wind or run-off may mix organic material from the pond bottom into the water
7. Excessive stocking and feeding rates (see feeding and stocking recommendations)

Oxygen problems are easy to recognize even without an oxygen test kit or meter. Signs of oxygen depletion include...

1. Fish gulping at the surface especially in the early morning
2. A sudden fish die-off during a time when conditions make low oxygen likely (see above)
3. The dead fish present are all large (big fish die first with oxygen problems)
4. More than one species is dead (usually a sign of oxygen or water quality problems)

The only reliable means to combat low oxygen is aeration. Despite claims, no chemical method that has been found to be satisfactory. Aeration can be accomplished by adding water that contains oxygen, by splashing pond water into the air so that oxygen enters the water or by adding air to the pond water (bubbles). For best results, use a large pump with a screened inlet to spray water back into the pond. Commercial fish farmers use large tractor-driven paddlewheel aerators. Small pumps can also be used to create a zone of higher oxygen. The water does not have to go more than 3 feet into the air, but it should be broken up by falling through screening or splashing onto a hard surface. Try to maximize the amount of "white-water" produced, which shows mixing of air and water. Wells can be used to add fresh water to a pond, but be aware that most well water contains no oxygen. Water must be sprayed out or splashed and aerated before entering the pond.

A number of small aerators are available commercially. These are typically 1/2 to 2 HP vertical pump units, usually consisting of a submersible motor with a propeller suspended from a float. Such aerators retail for $450 to $900 and should provide 5 to 7 years of service. Larger 1 to 3 HP paddlewheel or propeller-aspirator-pump type aerators retail for $1,000 to $1,500. Air blowers can be used to add oxygen to the water through airlines and diffusers. These systems are inexpensive but are best for deep ponds or for a series of small ponds. They are relatively inefficient in shallow water.

Other methods of aerating water that have been tried are the use of an outboard motor or a bushhog. Using an outboard in a fixed position is possible. Cranking up a bushhog unit in water is not recommended and is a good way to end up purchasing a new unit. If the fish in a pond are valuable enough to try to save, they are worth purchasing the proper aeration equipment.

How much aeration is needed? In an emergency, the more aeration that can be supplied, the better. For routine aeration, as a preventative measure or in ponds with rich blooms, smaller aerators provide a zone of higher oxygen. For ordinary use, aeration at a rate of 1/4 to 1/2 HP per acre should be sufficient. In commercial catfish farming, 1 to 2 HP/acre of pond is recommended.

There are several ways to reduce the chances of an oxygen problem. Do not build ponds with maximum depths in excess of 12 feet to 14 feet. Deep ponds are useful for storing water but do not produce more fish. Monitor pond fertility to avoid excessive blooms, and do not feed in excess of 30 lb/acre/day. Where the expense can be justified, place a small aerator on an all-weather timer, and run it nightly from mid-May through mid-September.

pH and Mineral Problems

After oxygen, the next most common cause of fish death in private ponds is poor water chemistry. In regions where soils tend to be acidic and limestone is commonly used on pastureland, water draining into ponds is acidic and very low in dissolved minerals. Under these conditions, most fish will survive (though grow slowly) but will die when stressed by other environmental conditions. The problem is most common in the winter months, especially following rainy periods. The usual result is a few dead fish every day. These fish will typically be of several species and sizes.

The best solution is to prevent this problem by having your water checked (contact your Extension agent) for pH, hardness (calcium and magnesium) and alkalinity. In ponds with low pH and minerals, the solution is to apply 1 to 2 tons of crushed limestone (ag-lime like they put on pastures, not hydrated, quick or slaked lime) per surface acre spreading it as widely as possible in the pond. This usually results in a quick end to fish losses. The treatment may last from one to several years depending on the water and rainfall. Once this problem is identified in a pond, an annual water check would be a good idea.

You are likely to have this problem if…

1. You are in a region with acidic soils (Contact your Extension agent for advice. Be suspicious if there are a lot of pine trees around.)
2. Your pond water is very clear or tea-colored (a possible sign of acidity)
3. Your pH is below 7 and your alkalinity and hardness are below 25 ppm
4. Fish die in cool weather following rain
5. The dead fish are several species and sizes

Chemicals

Accidental overspray is not likely to kill fish in private ponds. It is only possible if an applicator makes a grievous error like spraying the pond directly or applying chemicals to a field upwind of the pond on a windy day. Generally, while certain insecticides are quite toxic to fish, very few herbicides will kill fish even if the pond is directly sprayed. Small ponds in yards may be affected if there is an application of chemicals to the yard (for example, an insecticide for tick control) just before a heavy rain. If you suspect a chemical problem in your pond, call your Extension agent and describe what happened and what chemicals may be involved. Accidental application by overspray on adjacent cropland is the responsibility of the state pesticide regulatory authority (in Arkansas, the Arkansas Plant Board). In almost every case, the fish were killed by some other problem or the pesticide could not have killed fish at the rate applied. Pesticide kills can happen, but it is the least likely cause of fish death.

Parasites

One of the most troubling problems in a fish pond is parasites that disfigure the fish and make them unappetizing. These parasites are only harmful to fish if present in very high numbers. None of these parasites is a danger to humans (as long as the fish is cooked), but they are unappealing. Chemical disease treatments are not practical, effective or (for the most part) legal in private sportfish lakes or ponds.

Grubs

These are small white or yellow worms that insert themselves in the skin, muscle or internal organs of fish. Grubs are in round cysts and don't really look much like worms. Grubs have complex life cycles that involve fish, birds and snails.

The only way to deal with grubs is to break their life cycle. Limiting the access of birds to your pond is difficult, but there are ways to greatly reduce snail populations. One approach is to stock redear sunfish. Redears are also known as "shell crackers" because of their preference for snails as a food item. Snail populations can also be reduced if grass carp are stocked. The grass carp eat the weeds that the snails rely on for food. Once the snail's population is controlled, the numbers of grubs in fish will begin to decline. Grub problems are most common in clear, weedy ponds.

Nematodes

These are small round worms that may be from 1/4 inch to 1 inch long. They are commonly found coiled up around the fish's internal organs or in the liver. Some species inhabit skin or muscle. A bright red species is common in some fish.

Parasitic nematodes are difficult to control. They are much more common in wild fish than in farm-raised fish. If nematodes become a problem in your pond, a good idea is to take a close look at your water quality, fertilization and fish harvest programs to make sure that your fish are in good condition. As with grubs, nematodes are rarely seen in well-managed ponds.

Anchor Worms

These parasites are not really worms. They are crustacean relatives of crabs and shrimp. They look like short, stiff black or green/gray threads protruding from red spots on the fish's skin. While they look ugly on the fish, they are easily removed by skinning the fish.

There is no practical way to deal with anchor worm infestations. They are most common in ponds with high populations of highly susceptible species (like carp, minnows and green sunfish) but rarely a major problem on bass or catfish. These parasites have short simple life cycles and are likely to almost disappear within a few months of the onset of a severe infestation

Other Diseases to Think About

Fish are occasionally infested by other parasites, and bacterial and viral infections are very rare but possible. If your fish are sick or dying, get help by contacting your Extension agent or the UAPB Fish Disease Diagnostic Laboratories.

All lake owners should be aware of the risks posed by the introduction of fish from the wild. Wild fish carry many diseases and when you move a fish into your pond you may also introduce a disease. Particularly troubling is the Largemouth Bass Virus (LMBV). This virus is fairly common in wild fish and has caused many serious fish kills. In other states, a number of fish losses in private ponds appear to have been caused by the introduction of LMBV from wild fish.

Aquatic Plants and Weeds

Weeds are simply plants in the "wrong" place. Many types of aquatic plants are beneficial for wildlife, and plants form part of a healthy pond. Farm pond owners may consider leaving vegetation in and around ponds to provide cover and food for wildlife. However, excessive growth of plants can interfere with other uses of the pond, such as watering cattle, fishing and swimming, making the plants "weeds." Floating weeds, such as duckweed, can become so abundant that the pond surface becomes covered, cutting off light and oxygen to the fish below. On occasion, weeds can literally take over a pond and cause serious problems for the farm pond owner. The best way to avoid weed problems is prevention. With one exception, the six herbicides labeled for aquatic use are expensive (roughly $150 to $200/acre, with the smallest package available costing $180 to $310), and multiple treatments may be required. Unless the conditions that led to the growth of aquatic weeds change, they will return again and again. Given the high cost of most aquatic chemicals and the fact that there is not an effective herbicide for every problem weed, preventative measures are important.

Pond Depth

Shallow areas where light reaches the pond bottom are ideal for the growth of rooted aquatic weeds, and plants can be expected to grow in these areas. In most cases, measures to control weeds in such shallow water are futile. Deepening pond edges so that the water depth quickly reaches 2 1/2 to 3 feet helps reduce weeds. This may not be an appropriate option for ponds close to homes where the safety of children is a concern.

Nutrient Levels

Too many or not enough nutrients can lead to weed growth. Excess nutrients from livestock or other sources can run off into a pond and lead to weed problems, especially filamentous algae (commonly called "moss" or "pond scum"). Duckweed and watermeal, also thrive in nutrient-rich waters. This is especially evident in dry winters when ponds are not flushed out by rainwater. Ideally, ponds should be fenced to exclude cattle and livestock. Cattle and livestock can be watered from a stock tank below the pond.

In ponds without a bloom, sunlight can penetrate to the pond bottom and stimulate the growth of rooted plants. One way to prevent this problem is by fertilizing the water to stimulate the production of microscopic plants that shade the pond bottom. Not all ponds benefit from added fertilizer, and ponds on fertile watersheds will develop "blooms" without added nutrients. Fertilization also benefits the fish population in sportfish ponds by increasing the amount of foods available to fish (through the food chain). Fertilize the ponds in the late spring after water temperatures exceed 65ºF. Once a fertilization program is started, it should be continued throughout the summer months, as outlined in the section on Fertilization. Ponds with existing weed problems should not be fertilized, as this will only stimulate the growth of the weeds. Fertilization is not a good option for stock watering ponds. Dense algae blooms may develop during the summer months, making it look like blue-green paint has been poured on the surface, and although very rare, there have been reports of cattle lost to algal toxins.

Plant-eating Fish

Biological control is feasible for some types of aquatic weeds. Grass carp prefer tender, succulent vegetation submerged in the water but will not control tough, fibrous plants that grow up out of the water, such as alligatorweed and cattails. Other types of weeds may or may not be eaten by grass carp, depending on how hungry the fish become, so that results are not predictable. For more information on grass carp and the types of weeds they control, ask your county Extension Service office for SRAC Fact Sheet #3600, *Using Grass Carp in Aquaculture and Private Impoundments*.

Grass carp are readily available in Arkansas, and they provide cost-effective and long-term control. Either normal (diploid) or sterile (triploid) fish can be used in Arkansas, and no permit is required. New ponds can be stocked with 2" to 6" grass carp at 4 to 5 fish per acre. In ponds with existing bass populations, grass carp at least 8" to 10" long must be stocked to avoid having them eaten by the bass. If you have a problem with a weed that grass carp are known to consume, stocking rates of at least 15 to 30 fish/acre are required to provide control within a year or two.

Grass carp are capable of fast growth and can reach 20 to 25 pounds in weight. As these fish become older and mature, their rate of weed consumption declines, so restocking with additional fish after 4 to 5 years becomes necessary. Grass carp will also escape when heavy rains cause ponds to over-

flow. A parallel-bar spillway barrier can be built to reduce fish losses (see section on Enhancement Strategies). When more immediate results are required, applying a herbicide followed by stocking of grass carp (once the treated weeds have decomposed) may be the best option.

Mechanical Control

Physical control by cutting or pulling plants is possible for small ponds or isolated patches of weeds. Weeds that are cut often regrow and they have to be cut again. Floating weeds often are blown into a corner of the pond, where they can be scooped out with a fine mesh net.

Dealing With an Existing Weed Problem

If prevention methods fail, begin a a weed control program. The first step in weed control is to properly identify the problem weed(s). The most effective control measures vary with the kind of plant, so be sure to find out just which weed is causing problems. Your local Cooperative Extension Service office can help with weed identification. The Texas Agricultural Extension Service also has a web site with pictures to assist in aquatic weed identification and control (http://wildlife.tamu.edu/aquaplant/default.htm). Once the plants are identified, physical, biological, chemical or a combination of these control methods can be used.

Chemical control of aquatic weeds may be necessary as a last resort. Aquatic herbicides are typically expensive and sold in relatively large containers (e.g., 2.5 gallon). Cooperative Extension Service publication MP44 provides recommendations for selection and use of aquatic herbicides. When using chemicals, proper identification of the weed is important, as many herbicides are selective, that is, they only work on certain types of weeds. Be sure to follow label instructions, and note that the use of a chemical may restrict uses of the pond water for other purposes, such as irrigation or watering cattle.

Spot treatments of weedy areas usually can be accomplished without problems, but when whole pond treatments are required, actually measuring the pond area is important. To visually estimate the area of a pond is amazingly difficult, and even "experts" can be off by several-fold. Decomposition of weeds killed by herbicides removes oxygen from the water and can even result in a fish kill, especially in the summer months. When using a fast acting herbicide, treating only a section (up to a quarter of the pond area) at a time will reduce the chances of oxygen problems. Unless the herbicide is intended for whole pond application (i.e., fluridone), treating only a portion of the weeds at a time allows affected weeds to decompose before the next application. The heavier the growth of weeds, the smaller the area that should be treated in a single application. The best time to treat aquatic weeds is during the spring when the plants are growing rapidly and water temperatures are cooler (70ºF to 80ºF).

If you have fish in your pond and are thinking of using copper sulfate (sometimes called "bluestone") for algae control, be sure to have the alkalinity of your pond water tested. Copper sulfate is toxic to fish in low alkalinity waters (below 50 mg/L), and the correct dose is based upon the alkalinity.

In summary, when faced with a nuisance aquatic weed problem, look at the costs involved. In the long run deepening pond edges or adopting other prevention methods may be a viable option. If you have an existing weed problem and need immediate relief, identify the problem weed(s) and follow herbicide application(s) with biological and/or preventive measures to avoid a repeat of the problem.

Muddy Ponds

In ponds where fish are not fed, the whole food chain is dependent on energy from the sun. Microscopic plants use the sunshine and produce the energy that eventually goes to the desirable sportfish species. If the water is muddy, the sun cannot penetrate and fish production will be greatly reduced.

Two important factors contribute to the development of muddy ponds.

1. The rate at which clay and silt is stirred up from the pond bottom or comes into the pond with rainwater
2. The rate at which the clay and mud particles settle out of the water.

In some ponds clay and silt are constantly stirred up, but the pond stays clear because these particles quickly settle out and the water remains clear. Other ponds have very little disturbance or mixing, but the clay particles stay in suspension almost forever. Why the difference? Clay particles are small flakes with negative charges. They repel each other and alone are far too small to settle. In ponds with moderate water hardness, there are many positively charged calcium and magnesium molecules. These molecules cause the clay particles to stick together in larger clumps that settle quickly. Some other particles that help clay settle come from the decomposition of plant material.

The most common ways that clay and mud are mixed into the pond water are:

1. Livestock watering in the pond
2. Rain washing mud in from bare pond dams or plowed fields
3. Wind action producing waves that erode pond banks
4. Large populations of bottom feeding fish like bullheads or common carp

The water quality conditions that slow clay settling are:

1. Low hardness (low calcium and magnesium levels)
2. Low pH (acidic) water
3. New ponds with very little algae or organic material

The secret to clearing a muddy pond is to prevent as much clay mixing as possible and changing the water chemistry to speed the settling of clay particles. Limiting livestock access, planting grass, preventing erosion with plants or gravel and removing populations of bottom feeding fish reduce mixing. Ideally, a 100-foot-wide vegetated buffer strip to clean incoming runoff water should surround ponds. Excluding livestock from the pond is difficult, but if mud problems are severe, there are several possible approaches. Fence the pond completely. If it critical for watering animals, install a gravity-fed watering trough below the pond. Alternatively, fencing cattle out of the parts of the pond that are problematic may help, especially areas with earthen fill. In any case, eliminating the source of the mud before any treatment is applied to the pond is very helpful. Chemical methods to clear ponds will remove existing mud particles but do not have a residual effect and cannot prevent ponds from becoming muddy again.

At the same time you are dealing with clay mixing, contact your Extension agent and have your water tested for pH, hardness and alkalinity. If the pond has a pH below 8 and hardness below 50 ppm, add 1 to 2 tons of crushed agricultural limestone per surface acre of pond area. Spread the limestone out as widely as possible to speed it dissolving (in areas with acidic soils, it may be best to lime the pond bottom before filling). The limestone dissolves releasing calcium and magnesium ions that settle the clay within a few weeks. Once the pond is cleared and algae begin to grow, clay problems are unlikely to redevelop.

Sometimes muddy pond problems cannot be solved by reducing mixing and adding limestone. When this happens, consider the following…

1. The addition of plant material may speed the clearing process. Decaying organic matter creates weak acids that neutralize the charges on mud particles that keep them in suspension; however, organic matter also consumes oxygen during decomposition. Excessive amounts, especially during the summer months, can easily lead to oxygen depletion. In addition, adding organic matter doesn't always work. Treatments are normally confined to cooler times in the spring or fall. Older literature suggests adding 2 square bales of green hay per acre, broken apart and scattered over the surface, with 2 additional bales at 2-week intervals, not to exceed 10 bales/acre. Or cottonseed meal can be broadcast over the pond surface at a rate of 75 to 100 lb/acre. Again, use of organic matter can lead to oxygen depletion and a resultant fish kill.
2. Two other compounds are recommended for clearing muddy ponds, gypsum (calcium sulfate) and alum (aluminum sulfate). These chemicals are often used in water treatment facilities.

They work by coagulating mud particles and forming a floc, which settles out of the water. Ask your county Extension office for SRAC fact sheet # 460, *Control of Clay Turbidity in Ponds*, for complete information on these options. Alum is relatively inexpensive (around $0.18/lb) and effective at rates of 150 to 250 lb/acre, but it also destroys alkalinity, which could lead to a fish kill in waters with low alkalinity. To counteract this, apply hydrated lime at the same time at one-half of the alum rate. Hydrated lime by itself can cause fish kills, so caution is advised in using this method to clear ponds. Gypsum is safer to use in low alkalinity waters but a greater quantity is required, typically 1,000 to 2,000 lb/acre.

3. If the pond has a great deal of water flowing through it, limestone and particles from decaying plants are washed out so fast that they are unable to settle clay particles. Try to limit mixing and hope for the best. You may want to consider changing the pond design to increase surface area or decrease the size of the watershed. A diversion ditch can be used to direct excess runoff water away from the pond.

After a pond has been treated by one of the above methods and clears, and if the water is above 65ºF, fertilizer can be added (see section on fertilization) to create a plankton bloom in the water. The plankton aids in the removal of remaining mud particles. However, applying fertilizer to muddy ponds is pointless and older accounts suggesting the application of superphosphate are erroneous. Phosphorus in the fertilizer is adsorbed onto mud particles and becomes unavailable to the plankton, and the muddy water restricts the penetration of light necessary for plankton growth.

If efforts to clear the water are unsuccessful or too expensive, remember that there are ways to bypass the natural food chain. Stock species like catfish and hybrid sunfish (see publication MP447), then give them floating catfish feed. If feed is used, it is possible to produce lots of fish and have great fishing even in a muddy pond. Don't attempt pond clearing methods that involve very large doses of cottonseed meal or other organic material, and don't add large doses of phosphate or other fertilizers. These "cures" are likely to produce more problems than they solve.

Leaky Ponds

With the advent of summer, water levels begin to drop in many farm ponds. Pond owners who suspects that their pond is leaking excessively may want to measure the actual drop in water level. Submerge a plastic ruler tacked upright on a stake partway into the water. Record the initial level, and then measure the drop in water level over a 3 to 4 day period when there is no rain.

How much water loss is normal? The main sources of water loss are evaporation and seepage. Summertime evaporation lowers the water level in a pond about one-quarter of an inch per day (evaporation will range from one-eighth to one-half inch per day). Normal seepage rates vary with soil type. Heavy clay soils should have essentially no water loss to seepage, while ponds in sandier soils can lose up to one-quarter of an inch a day. Taken together, expect that a typical pond will lose one-half inch of water a day.

Typical causes of leaking ponds include:

1. Leaks through holes from muskrats, crawfish, tree roots or around overflow or drainpipes.
2. Thin layers of soil over fractured rock or solution cavities (especially NW Arkansas).
3. Permeable soils within ponds, or areas of sand or gravel.
4. Improper pond construction, such as failure to remove the organic layer, no core trench or poor soil compaction

If a pond leaks, inspect the dam for obvious sources of leaks, such as muskrat holes. Look for wet spots and holes. Ponds that were cut too deep during construction, outcroppings of crumbling or porous rock and soils with too little clay or poorly compacted soils are all potential causes of seepage problems.

Excessive water loss from a pond is a real concern because fixing the problem can be difficult and expensive. Simply reworking and compacting a pond may cost $300 to $1,000 per acre. Adding a minimal rate of bentonite clay will cost $3,500 to $4,000 per acre for the clay alone. Farm owners with pond seepage problems can obtain Fact Sheet SRAC #105, *Renovating Leaky Ponds*, through their county Cooperative Extension Service offices. The fact sheet provides additional information on the causes and potential treatments for leaky ponds. To seek help with a leaky pond, contact the Natural Resources Conservation Service, USDA or a private firm with the appropriate knowledge, equipment and references. There are a number of potential treatment options, but not all are equally effective or appropriate for a particular pond.

Mosquito Control

Mosquito larvae live in water so some pond owners worry that backyard ponds may increase mosquito numbers. Fortunately, mosquito larvae are a favorite food of many small fish species including bream. The mosquito fish (Gambusia) is famous for eating mosquitoes though it is perhaps no more effective in farm ponds than other fish species. Mosquito fish are extremely common in Arkansas and will generally stock themselves either through inflow or overflow from the pond, or mixed in with other fish that are stocked. Alternatively, fathead minnows also eat mosquito larvae and are available from commercial fish farms in Arkansas. Most mosquitoes are born in small temporary puddles that don't support fish.

Consumer Guidelines for Pond Management Consultants or Fish Suppliers

Guidelines assist pond owners in the selection of a private pond consultant or fish supplier. In order to make an informed decision, pond owners may wish to ask the following questions:

Questions for pond management consultants:

1. How many years of experience do you have in this business? (An established business may have more experience with unusual problems or needs).
2. Do you have a staff member with a fisheries management degree? (A manager with a fisheries degree would be better trained in scientific pond management)
3. How will you survey my pond, and will I receive a written report? (At a minimum, a qualified pond manager should check a pond firsthand and provide a written report on findings and recommendations to the pond owner).
4. Will you perform the needed management? (A good manager should be able to implement the recommendations, not simply stock fish as a cure-all for problems).
5. Can you provide me with a list of references? (An established, reputable manager should have plenty of satisfied customers).
6. How are your fees based? (Managers may charge by the job or by the hour. Get an estimate in writing, up front).

Questions for fish suppliers:

1. What is the warranty on your fish? (Some suppliers only guarantee live fish delivery, but the fish may die later from hauling stress or disease).
2. Do you raise the fish, or do you buy them from someone else? (It's important to know the source of the fish provided, should problems arise).
3. What species and sizes of fish do you supply? (Some suppliers only sell or raise certain species or sizes of fish that may not be right for your pond).

Acknowledgments

The authors recognize the contributions of the authors of previous Arkansas farm pond management guides:

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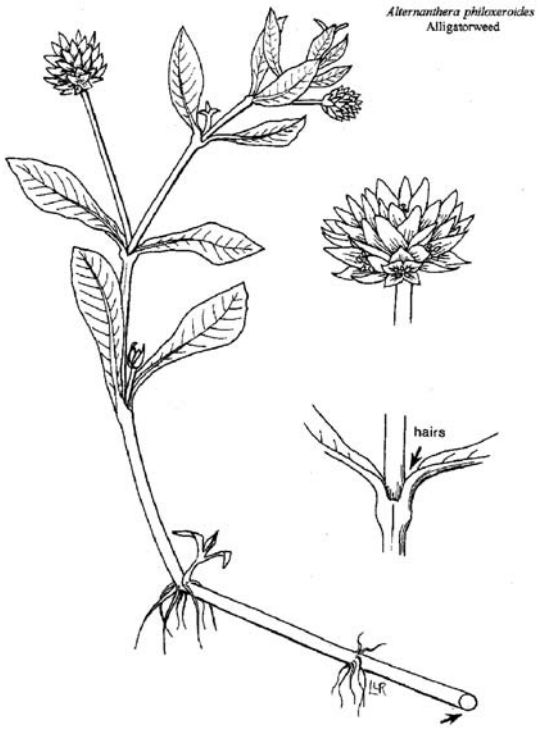
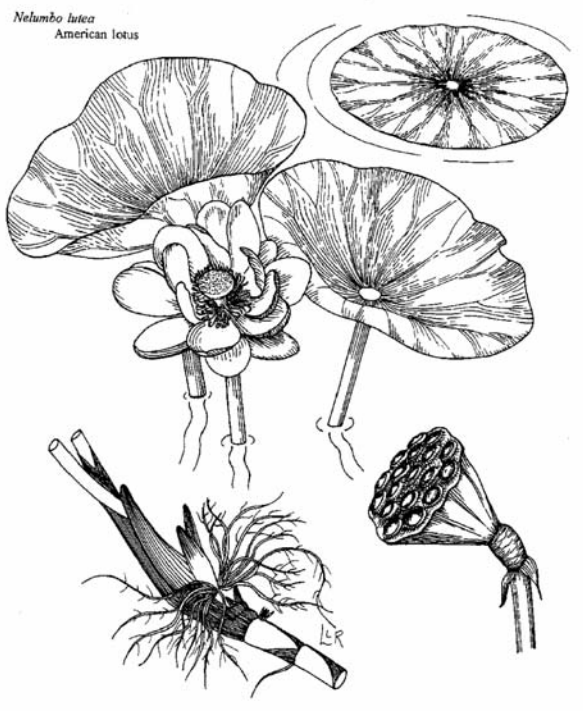
Appendix A: Common Aquatic Weeds

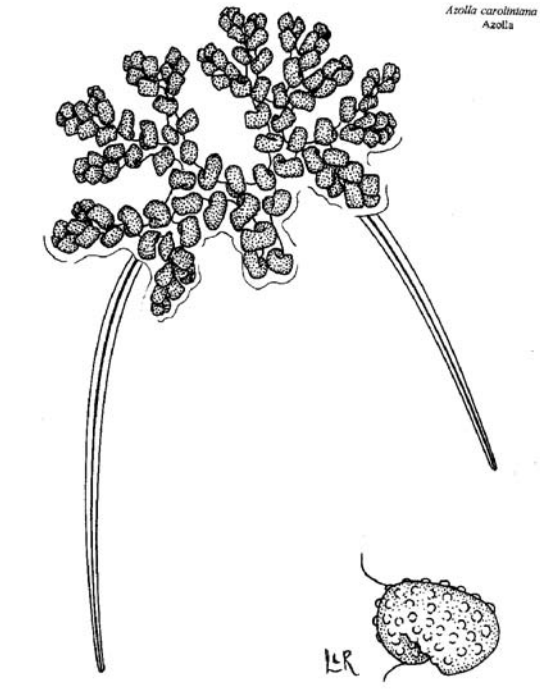
The University of Florida Center for Aquatic and Invasive Plants (http://aquat1.ifas.ufl.edu/welcome.html) provides a wealth of information on aquatic plants. These line drawings are the copyright property of the University of Florida Center for Aquatic and Invasive Plants (Gainesville). Used with permission.



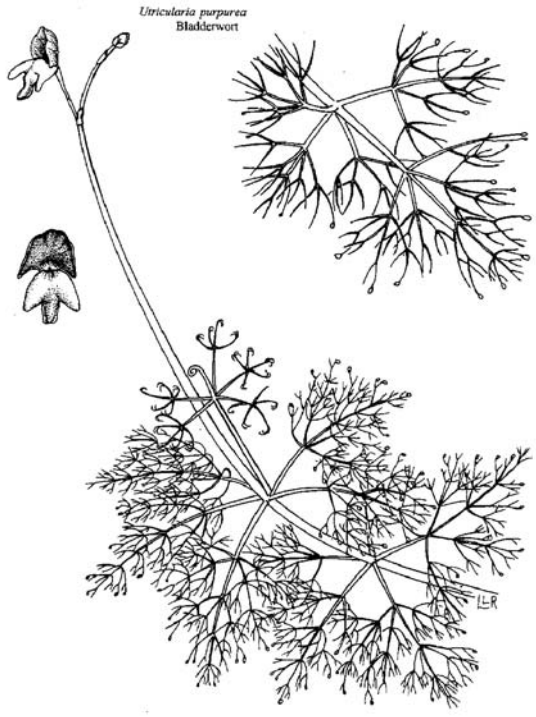
Alligatorweed



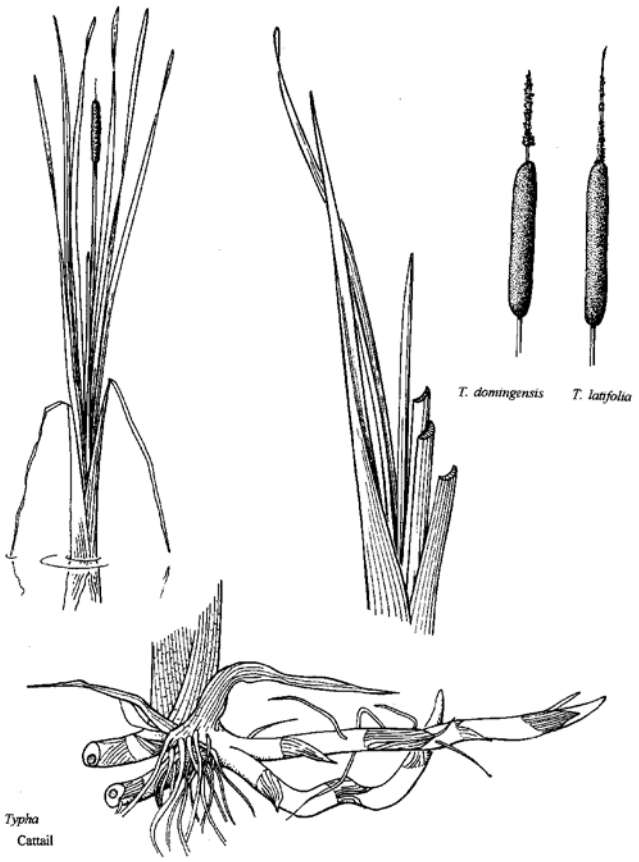
American Lotus



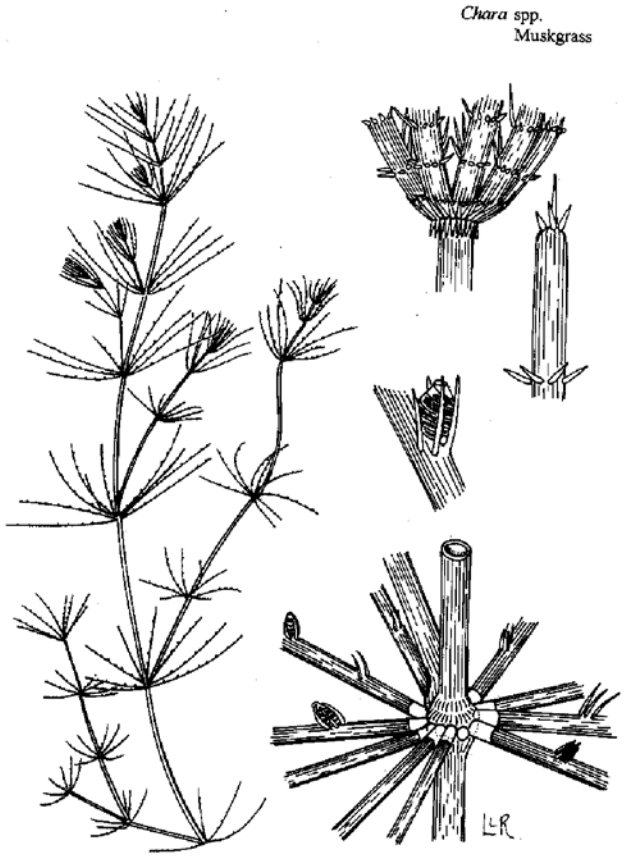
Azolla



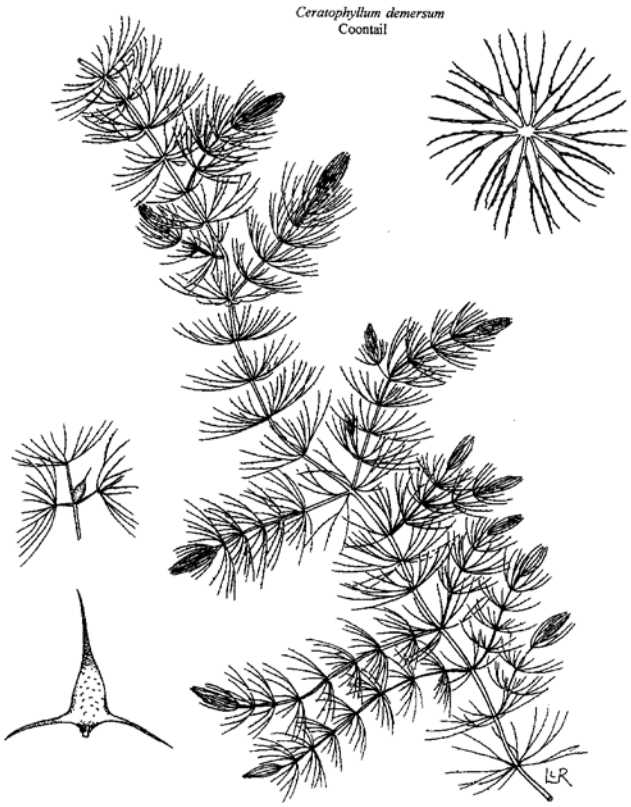
Bladderwort



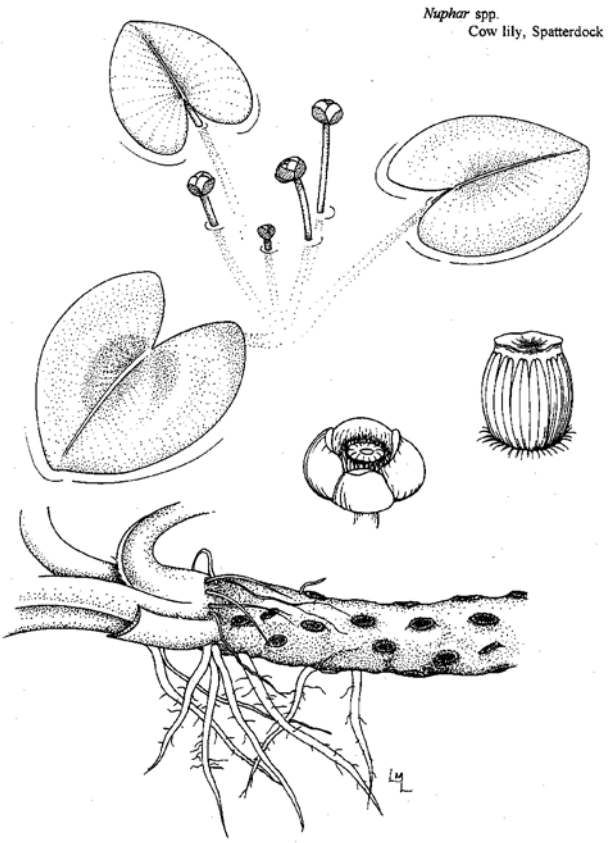
Cattail



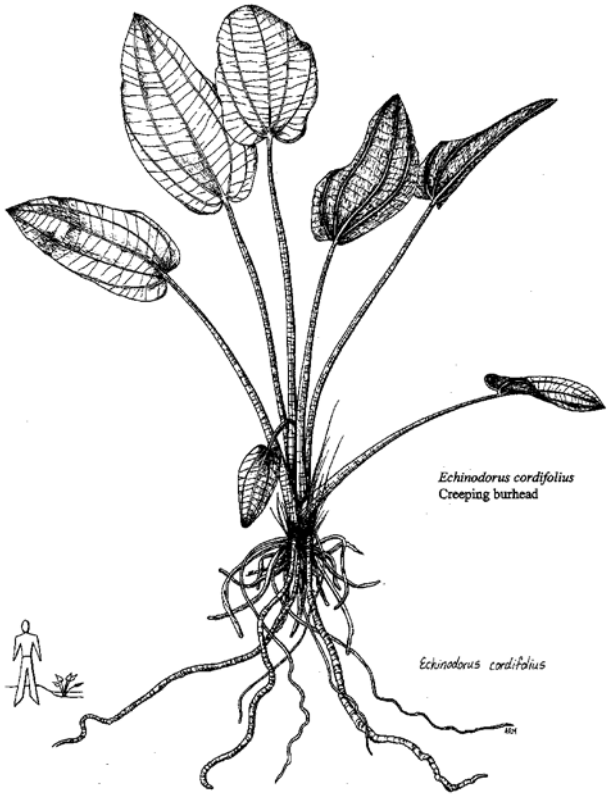
Chara



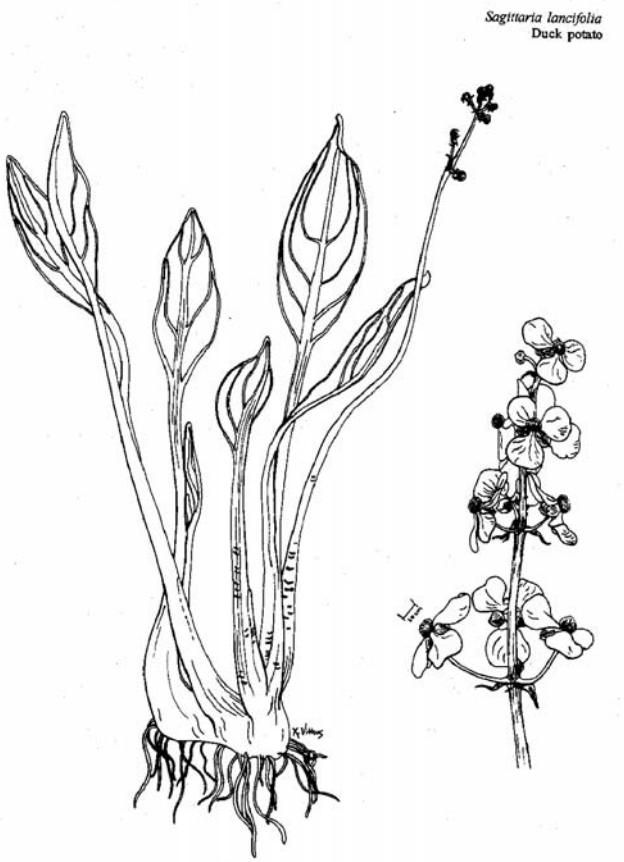
Coontail



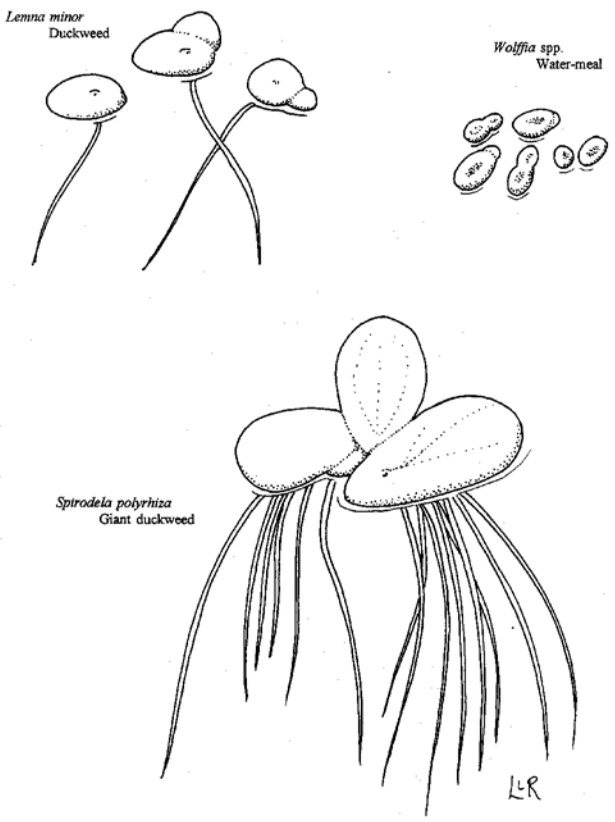
Cow Lily, Spatterdock



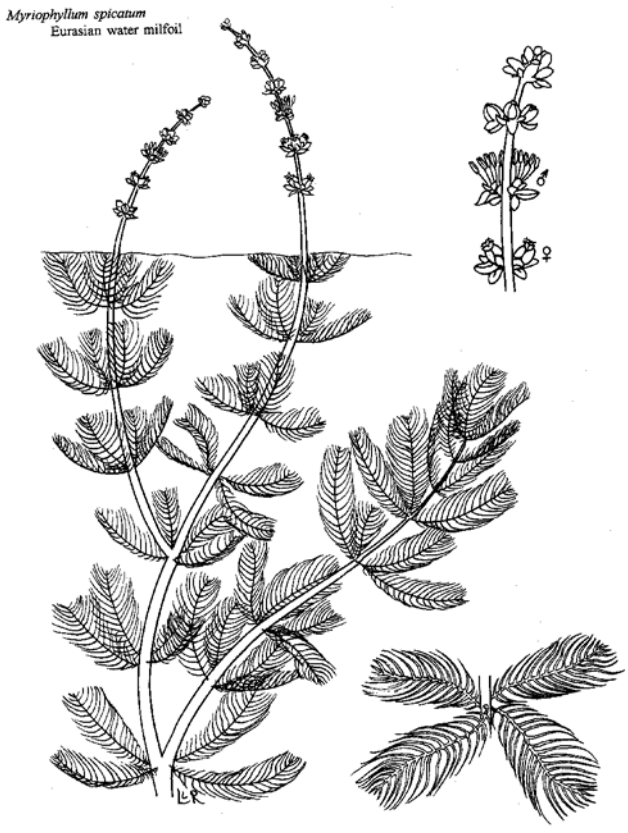
Creeping Burhead



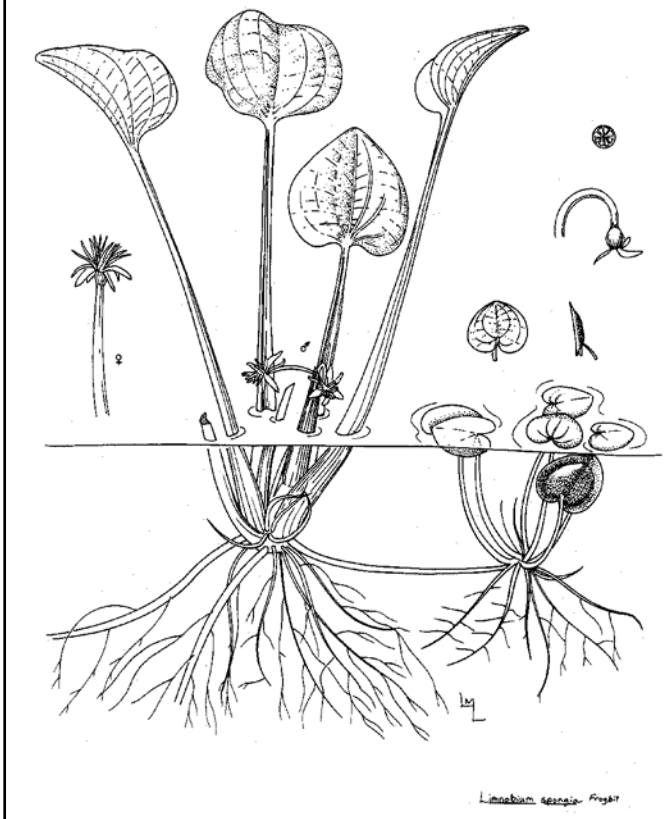
Duck Potato



Duckweed, Water-meal, Giant Duckweed



Eurasion Water Milfoil



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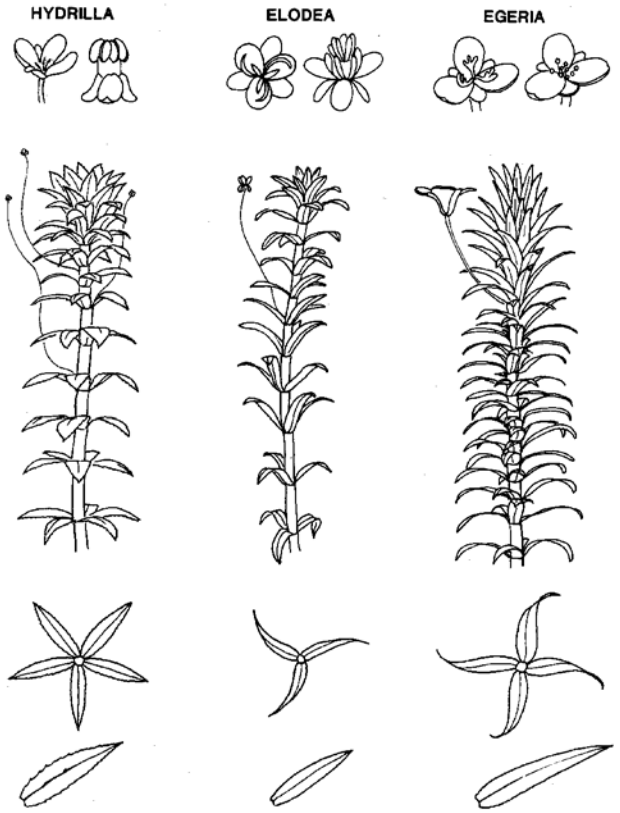
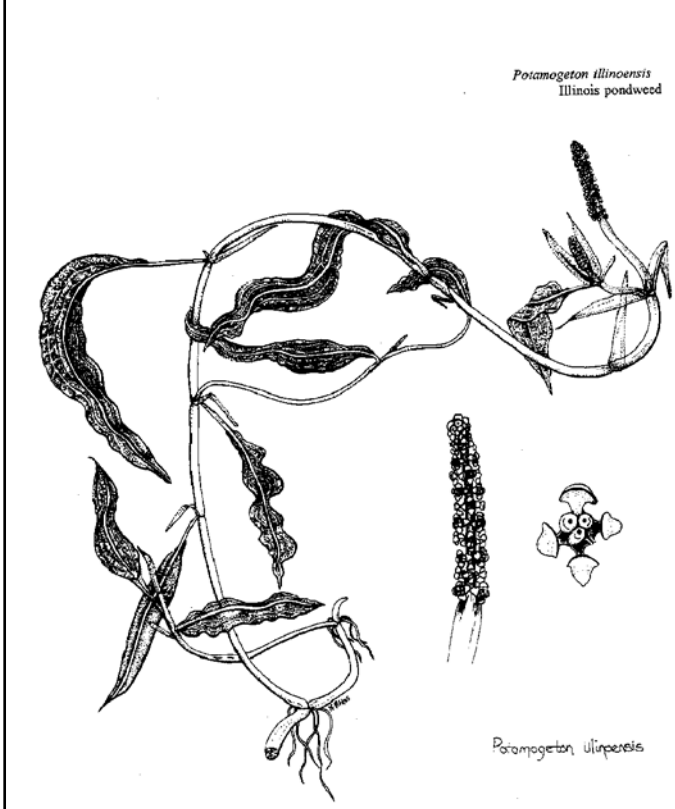
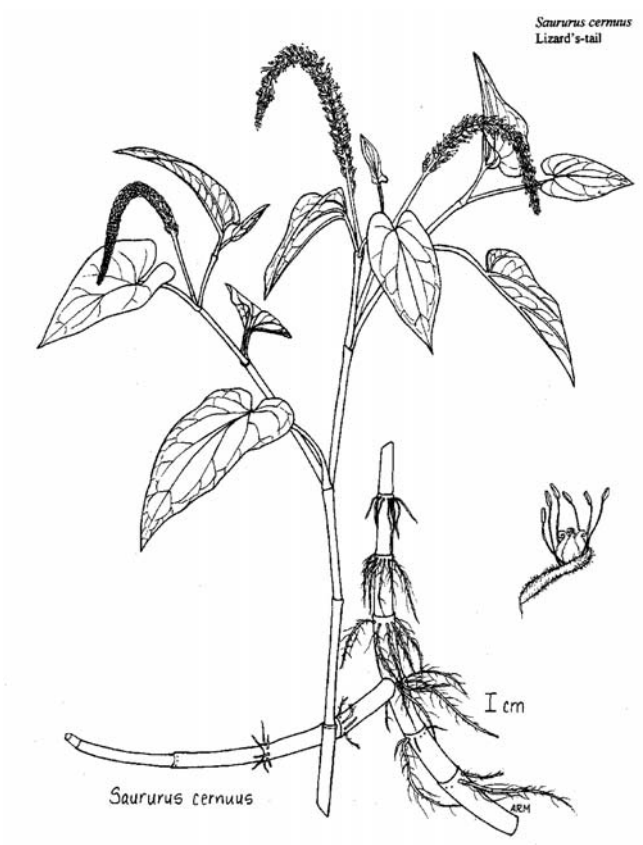


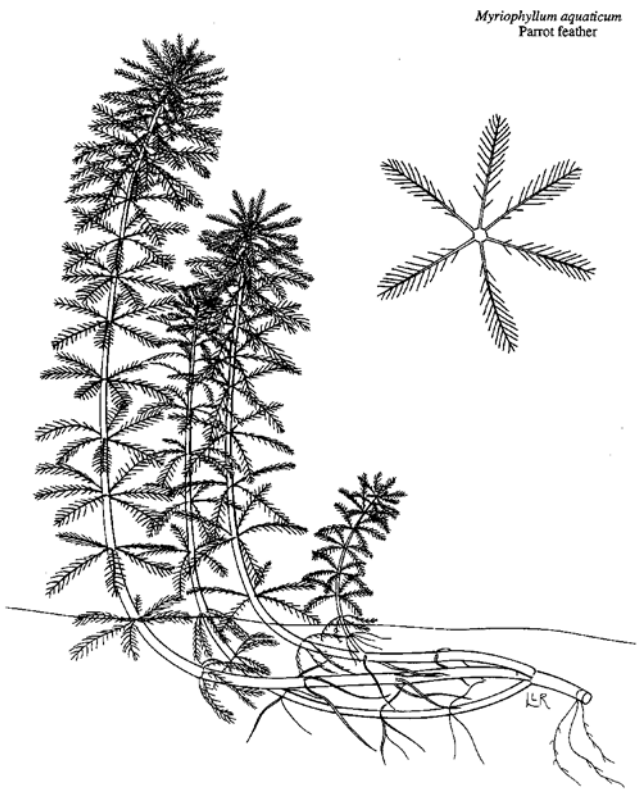
Hydrilla, Elodea, Egeria



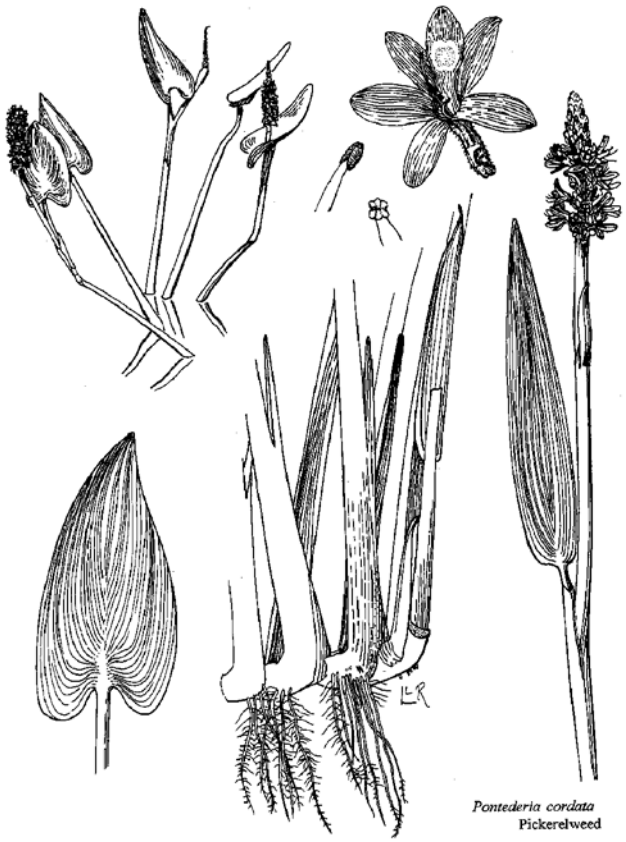
Illinois Pondweed



Lizard's-tail

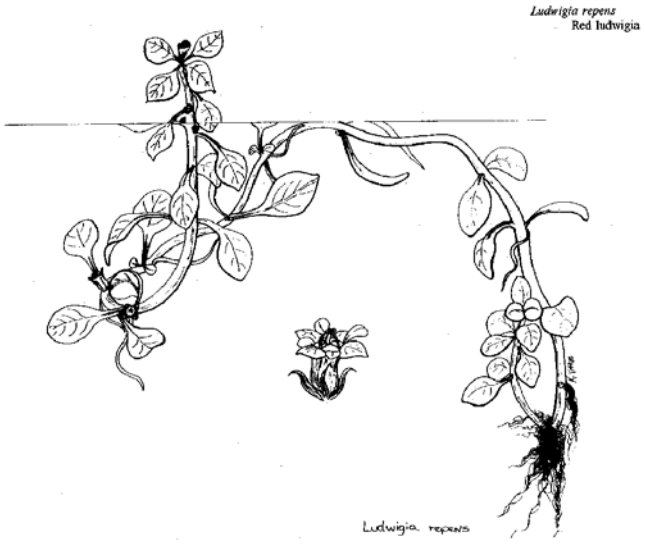


Parrot Feather

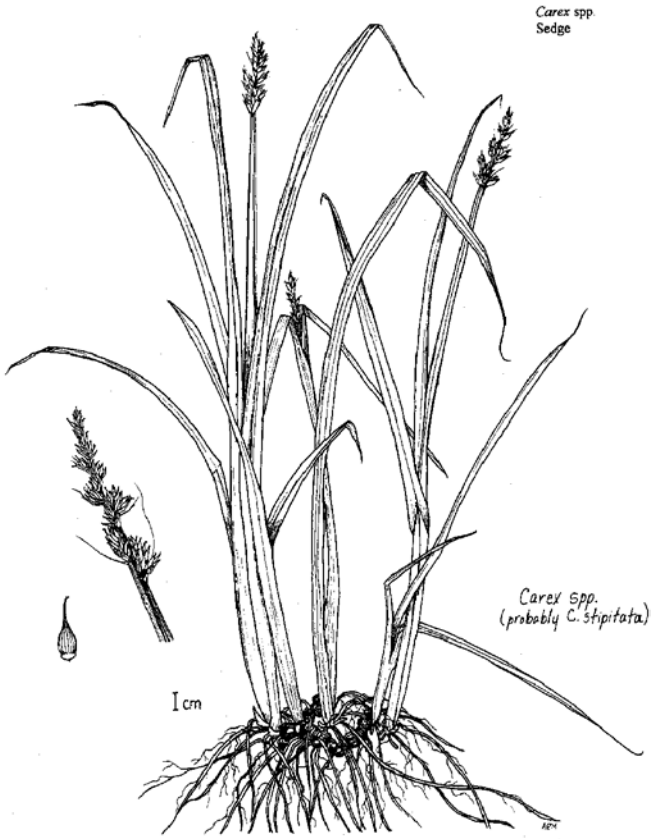


Pickerelweed

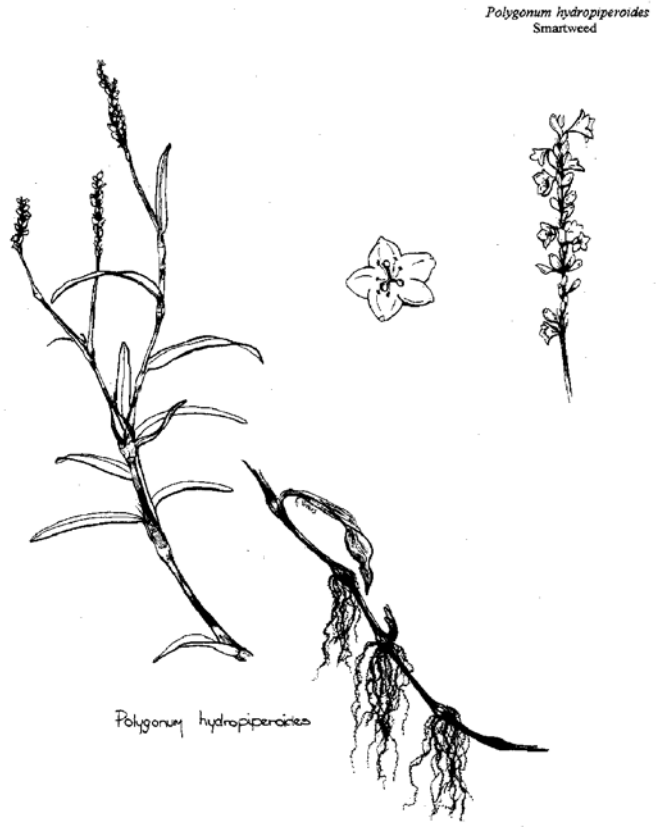
Pondweed



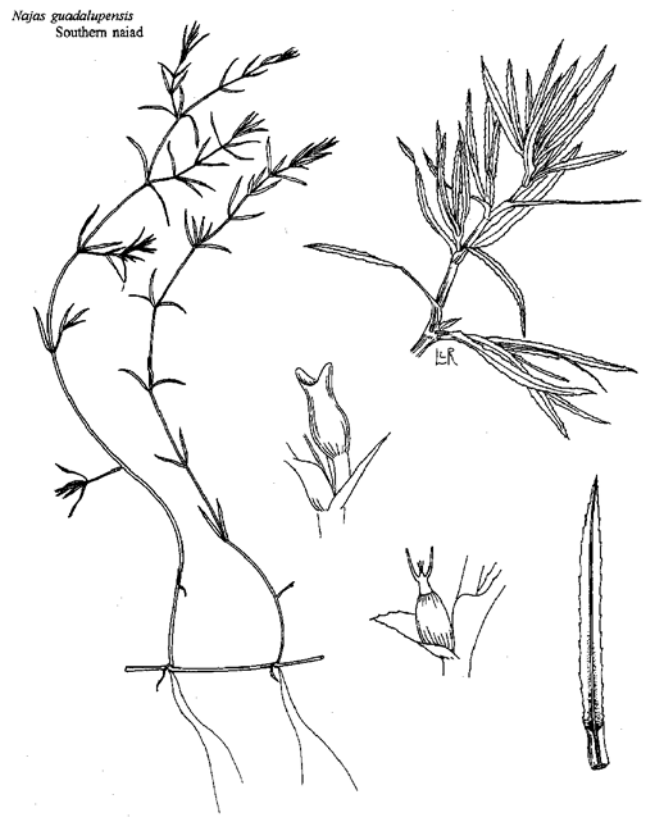
Primrose



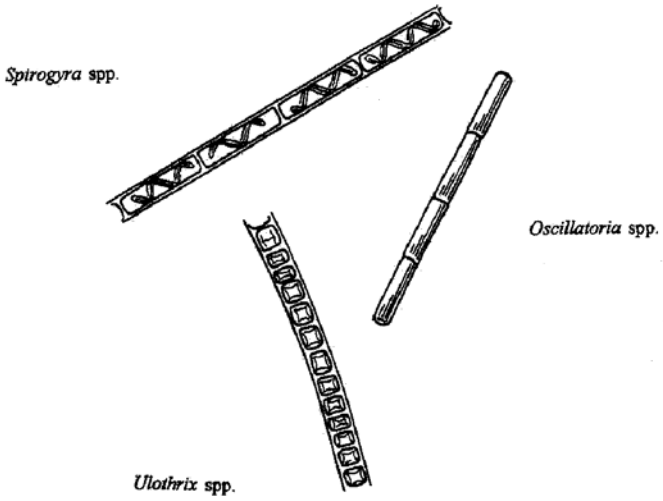
Sedge



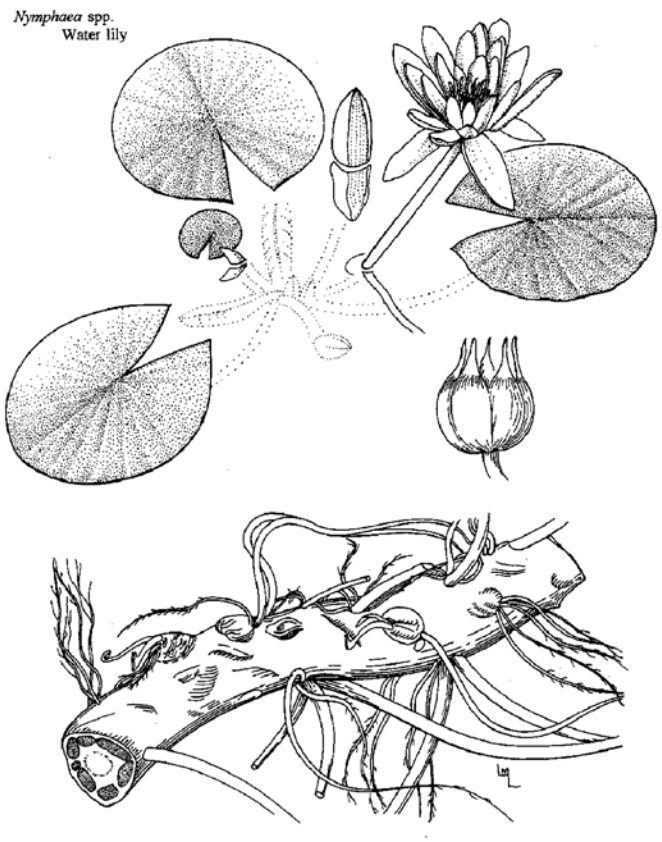
Smartweed



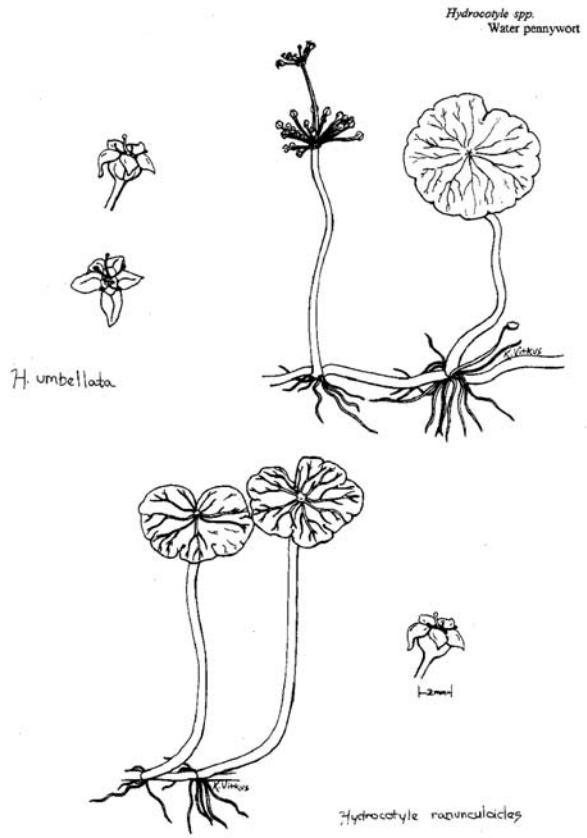
Southern Naiad



Spirogyra, Oscillatoria, Ulothrix

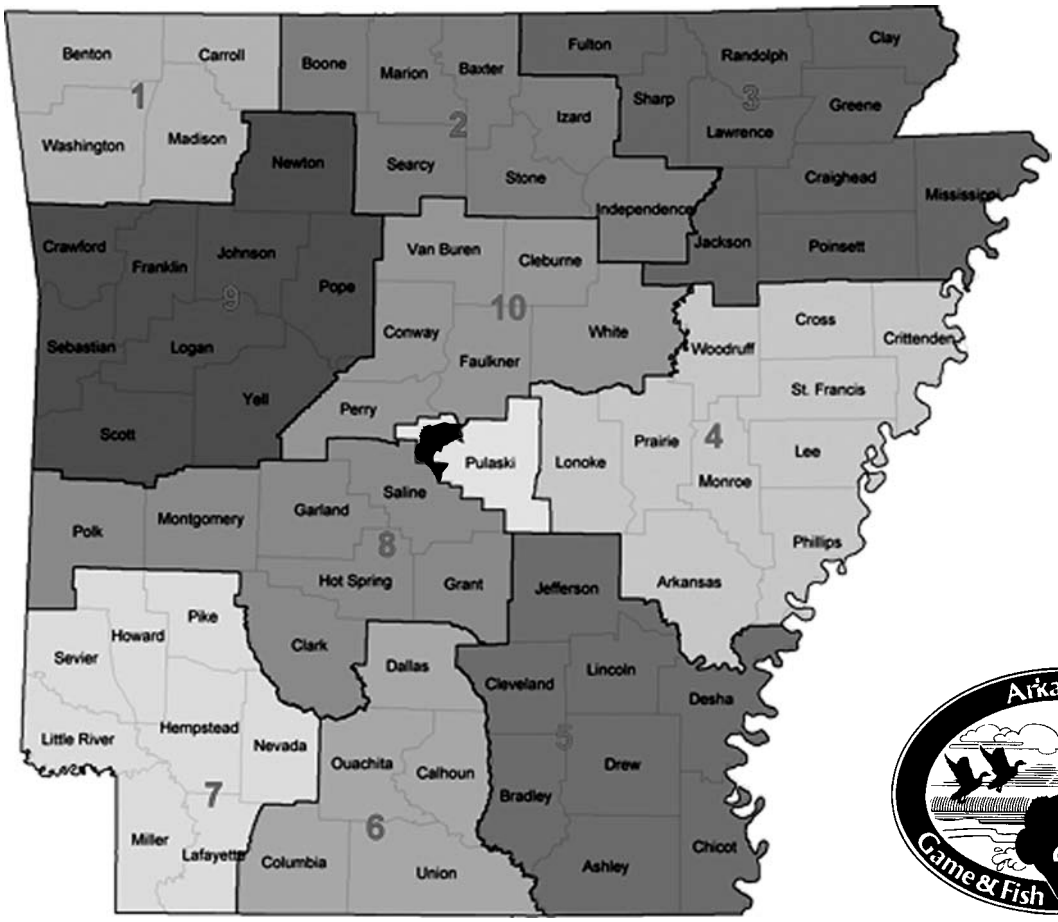


Water Lily



Water Pennywort

Appendix B: Fisheries Districts



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