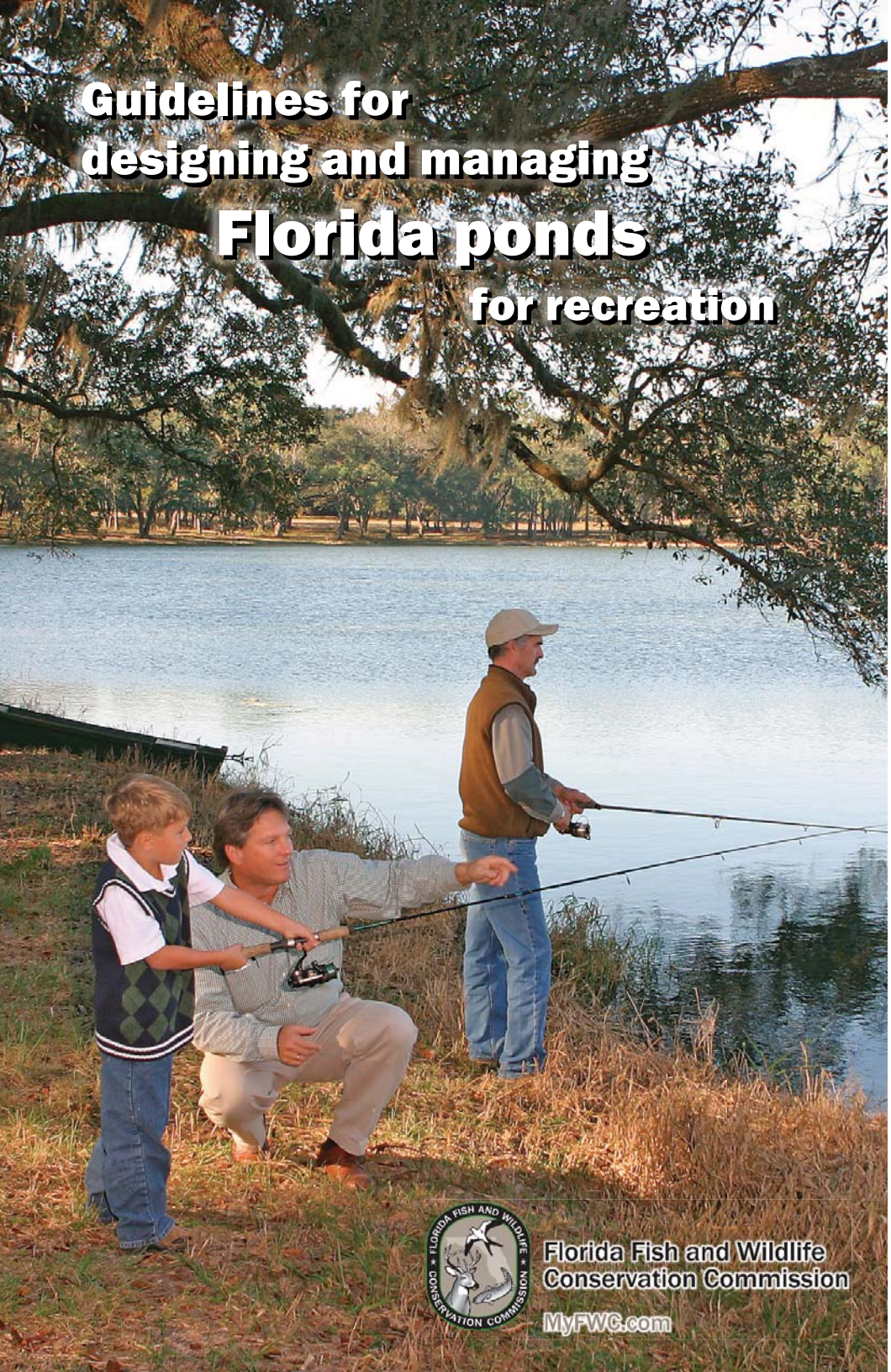
Guidelines for designing and managing Florida ponds for recreation



Florida Fish and Wildlife Conservation Commission

MyFWC.com

Introduction

Fishing is one of the most popular recreational activities in Florida. The state has many small natural and manmade ponds that, if managed properly, can provide excellent fishing, waterfowl hunting and bird watching. Largemouth bass, bream (bluegill and redear sunfish) and channel catfish are raised in Florida fish ponds. Ponds can be managed intensively for high fish production while attracting wading birds, waterfowl and other wildlife species. Often, ponds are constructed or managed for a variety of uses such as swimming, residential development, drainage, irrigation, livestock watering and mining. Some of these uses can be incompatible with fish and wildlife pond management. Identifying conflicting uses must be a primary concern when developing a fish and wildlife management program.

This booklet was prepared to help pond owners develop a sound program for managing a recreational waterbody including fishing, waterfowling and wildlife viewing. It covers such topics as water quality, vegetation and fish population management. A reference section is located on page 26 to provide additional sources of information on these subjects. Whether you are constructing a new pond or improving an existing one, if you need further assistance after reading this publication and referring to the **Florida Fish and Wildlife Conservation Commission** (**FWC**) Web site (**MyFWC.com**), feel free to consult a FWC fish or wildlife biologist (see page 29). The FWC has biologists at each of its five regional offices to provide technical assistance. If your goal is fish farming (aquaculture) and not recreational fishing, please contact the **Florida Department of Agriculture and Consumer Services** (**FDACS**) Division of Aquaculture (850) 488-5471 and seek the advice of an aquaculture biologist.

Ecology

It is necessary to have an understanding of basic aquatic ecology to manage a pond properly. **Ecology** is the study of relationships living things have to each other and their environment. These relationships frequently operate at a complex level, where a change in one factor can influence many different organisms and their habitats in a variety of ways.

Figure 1 shows a simplified food pyramid, which depicts the interdependence of various aquatic organisms. The bottom level represents various species of algae. Algae are microscopic plants that use nutrients in combination with sunlight to produce food—a process called photosynthesis. Some algae are eaten by small, free-floating animals called zooplankton, located at the second level of the food pyramid. Organisms in the top four levels generally consume other organisms in the levels shown immediately below them. A pond's ability to support a large number of organisms in the upper levels of the pyramid is dependent upon the strength of its food base as depicted by the lower levels. In ponds, humans, otters,

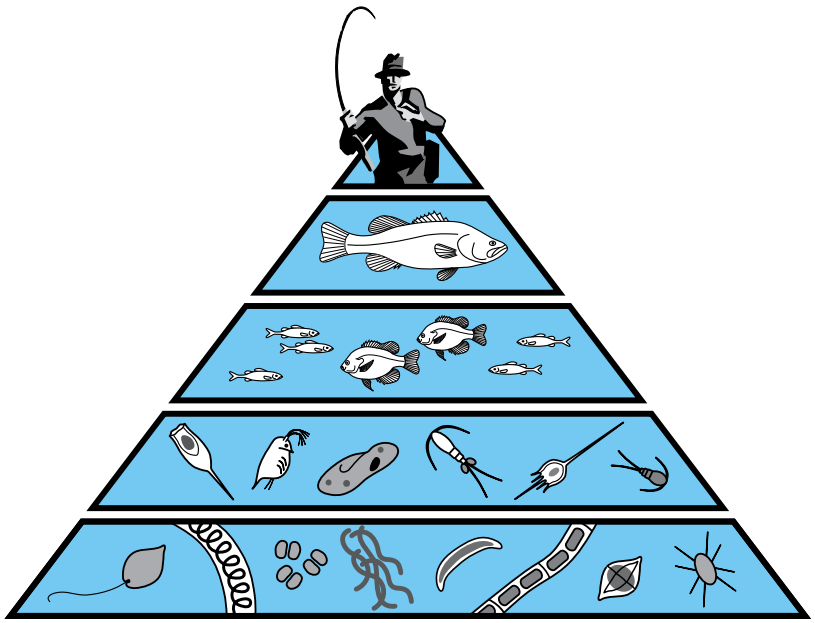


Figure 1. *Aquatic food pyramid is based on phytoplankton (microscopic plants) at the bottom, which serve as food for barely visible animals called zooplankton. In turn, small fish eat the zooplankton and themselves become prey for predators like bass and wading birds. The angler and hunter are at the top of this pyramid.*

alligators and some wading birds are the top predators. Largemouth bass are the top fish consumers (predators) that feed on insect-eating fishes such as bream, shiners and minnows. Some ponds may support gizzard and/or threadfin shad populations. Both feed on plankton, and are important prey for bass. The objective for most ponds is to establish a simple predator-prey relationship using largemouth bass, bluegill and redear sunfish. Wildlife will use the pond and shoreline for watering, feeding and hiding from predators.

Algal production is limited in waters by the availability of nutrients, mainly nitrogen and phosphorus. Ponds with low nutrient concentrations are described as infertile and produce limited quantities of aquatic life. These waters are usually extremely clear and support a low number of fish.

Moderate nutrient levels result in fertile waters that possess the potential for significantly greater fish production than infertile waters. Sport fish can be more numerous in fertile ponds due to the abundance of available food organisms. Fertile waters usually appear green as a result of high algal concentrations.

Excessive fertility disrupts the food chain by channeling too much energy into algal production. During daylight periods, algae cells produce oxygen required for respiration by fish. When sunlight is not present (night or overcast skies), oxygen production by algae is reduced. Dense algal blooms will deplete dissolved oxygen (**DO**) during periods of limited sunlight, and fish kills may result. Fish kills caused by low DO levels are most common during warmer months when algal concentrations are highest and extended periods of calm weather reduce exchange of atmospheric oxygen at the pond's surface. **Figure 2** shows a typical 24-hour DO cycle, and **Figure 3** shows when, during a 12-month period, fish kills are most prevalent.

Waterbodies can receive nutrients from many sources within a watershed. Many of these are the results of human activity (e.g. agricultural practices, lawn fertilizer and urban development), while others occur naturally (e.g. nutrient-rich soils, decaying vegetation). Therefore, some pond owners may have to eliminate or divert nutrient sources to prevent excessive fertility.

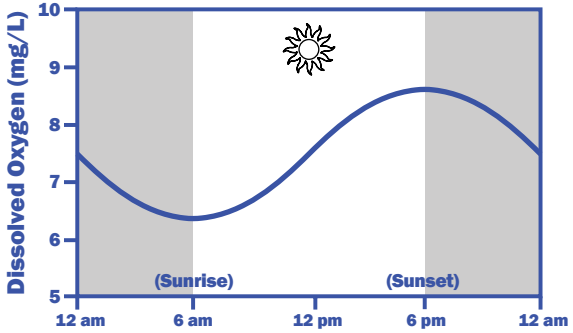


Figure 2. *Typical 24-hour dissolved oxygen (DO) cycle.*

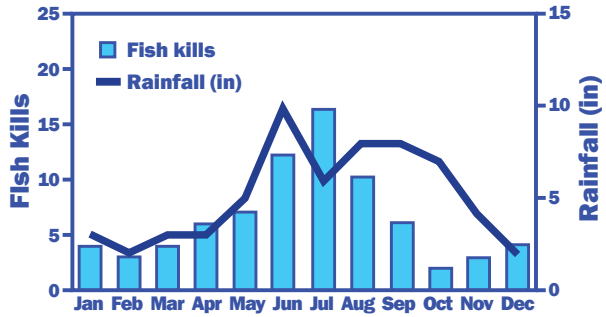


Figure 3. *Twelve month rainfall-versus-fish kill event graphs (based on South Florida Water Management District data).*

Stormwater retention ponds are mandatory in new residential and industrial developments in Florida. These areas are designed to collect street and yard drainage, often containing high concentrations of nutrients that would lead to excessive algal production if allowed to enter natural waters. Prospective homeowners should realize the water quality in many retention ponds is not conducive to sport fish production. Consequently, fish and wildlife management potential may be limited.

Pond design and construction

The first step in determining a design is to consider the purposes for which the pond will be used. A pond built for drainage or watering livestock is not necessarily the best design for a fish pond. If the pond serves more than a

single purpose, construction should reflect its primary purpose. Ponds used primarily for agricultural purposes such as water storage or watering animals should be designed to minimize adverse impacts that farming activities may have on water quality. Livestock access should be limited to a small area to reduce erosion and prevent high turbidity levels. Runoff from crop fields should be diverted with swales or berms to prevent excessive nutrient loading, siltation and contamination by pesticides.

Information on planning, design and construction of ponds is available from the United States Department of Agriculture. Contact your local **Natural Resource Conservation Service** (**NRCS**) agent and ask for Agriculture Handbook Number 590 titled **Ponds — Planning, Design, Construction** (see page 26).

Most ponds constructed in Florida consist of a hole excavated in fairly level ground and require minimal site maintenance. A second type is constructed where ground elevations vary significantly and requires an embankment to impound water. Safety concerns and maintenance requirements are described in Agriculture Handbook Number 590.

Your local NRCS agent can provide detailed pond construction information about site selection, soil permeability, whether a plastic liner is needed and locations for soil analysis. This information is essential in determining a pond's natural fertility, pH (acidity) and ability to retain water.

If possible, design your pond to allow near complete draining. The ability to dewater allows for fish population renovation, bottom improvement and vegetation management. Dewatering is accomplished easily in embankment ponds through a standpipe/spillway system, while a water pump can be used in excavated ponds. On the other hand, various pond liners and sealers are available to prevent the possible problem of pond seepage and unwanted water loss.

Ponds designed primarily for fishing should incorporate as much shoreline as possible (**Figure 4**). The amount of available shoreline can be increased by use of peninsulas and islands in construction. Such

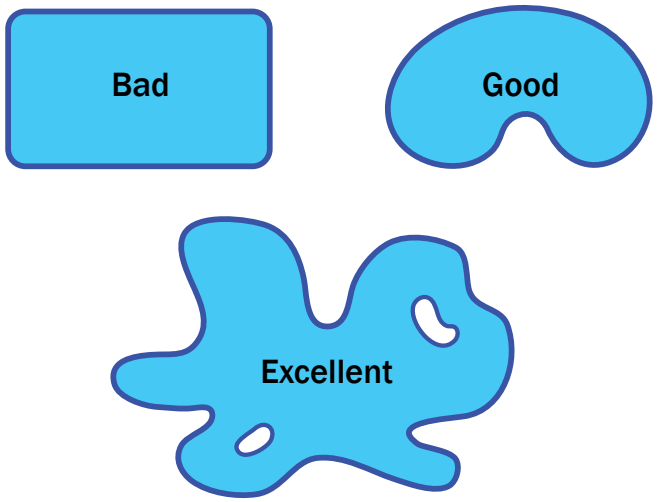


Figure 4. *Example of various pond configurations. The best pond shape has complex edges providing varied habitat for fish and wildlife.*

construction increases the "edge effect," which results in concentration of sportfish, improves fishing success and provides more shoreline habitat for wildlife.

Ponds should be constructed with mostly steep slopes (20- to 30-degree grade) to a depth of 8 to 15 feet. Steep shorelines will naturally limit the growth of aquatic plants. A narrow band of vegetation benefits the pond by providing fish and wildlife habitat and preventing shoreline erosion. However, excessive plant growth can cause problems. Sodding or stabilizing the land adjacent to the pond immediately after construction also will reduce erosion. Digging ponds deeper than 15 feet does not increase fish production, and deep ponds can develop serious water quality problems if thermal stratification occurs.

Figure 5 (next page) shows a cross-section of a well-designed fish pond. Notice the bottom contours are irregular, creating what fishermen call "structure." Fish tend to congregate in these areas, making it easier for anglers to locate them. You can create structure during pond construction by leaving elevated outcroppings or rock piles or by installing fish attractors made of tree limbs or other man-made fish attractors sold through aquatic management supply companies.

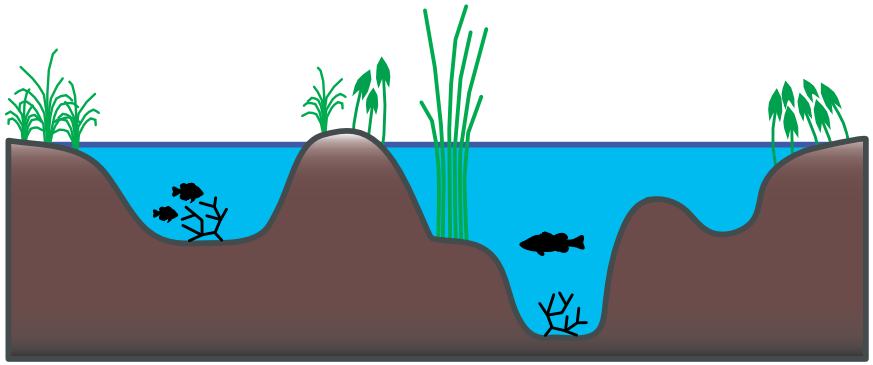


Figure 5. Recommended profile and design for man-made pond. Note the deep spots and extra structural features on the bottom.

Prior to starting construction, check with your county, **Florida Department of Environmental Protection** (**DEP**), **Water Management District** (**WMD**), and the **U.S. Army Corps of Engineers** (**USACE**) for any permit requirements.

Aquatic plant management

Aquatic plants growing in and around a pond provide many benefits. They help maintain good water quality by reducing erosion and absorbing nutrients. Plants provide cover for fish and a substrate for the colonization of minute organisms used by small fishes. Wildlife will use the shoreline vegetation for concealment and as areas to search for food.

Properly designed ponds with a narrow fringe of vegetation seldom develop problems. You can maintain access sites simply by removing excess vegetation by hand. Planting desirable species will allow you to maximize the biological, aesthetic and recreational potential of the pond. A mixture of **submerged** (below water), **emergent** (stems below and leaves above water) and **shoreline** (entire plant out of water, but can tolerate occasional flooding) species are recommended for "aquascaping." Desirable plants can be found in the FWC's **Invasive Plant Management Section** Circular #4 titled **Plants for Lakefront Revegetation** (see page 26). **Figure 6** provides some examples. When established, these plants may out-compete problem species such as cattails

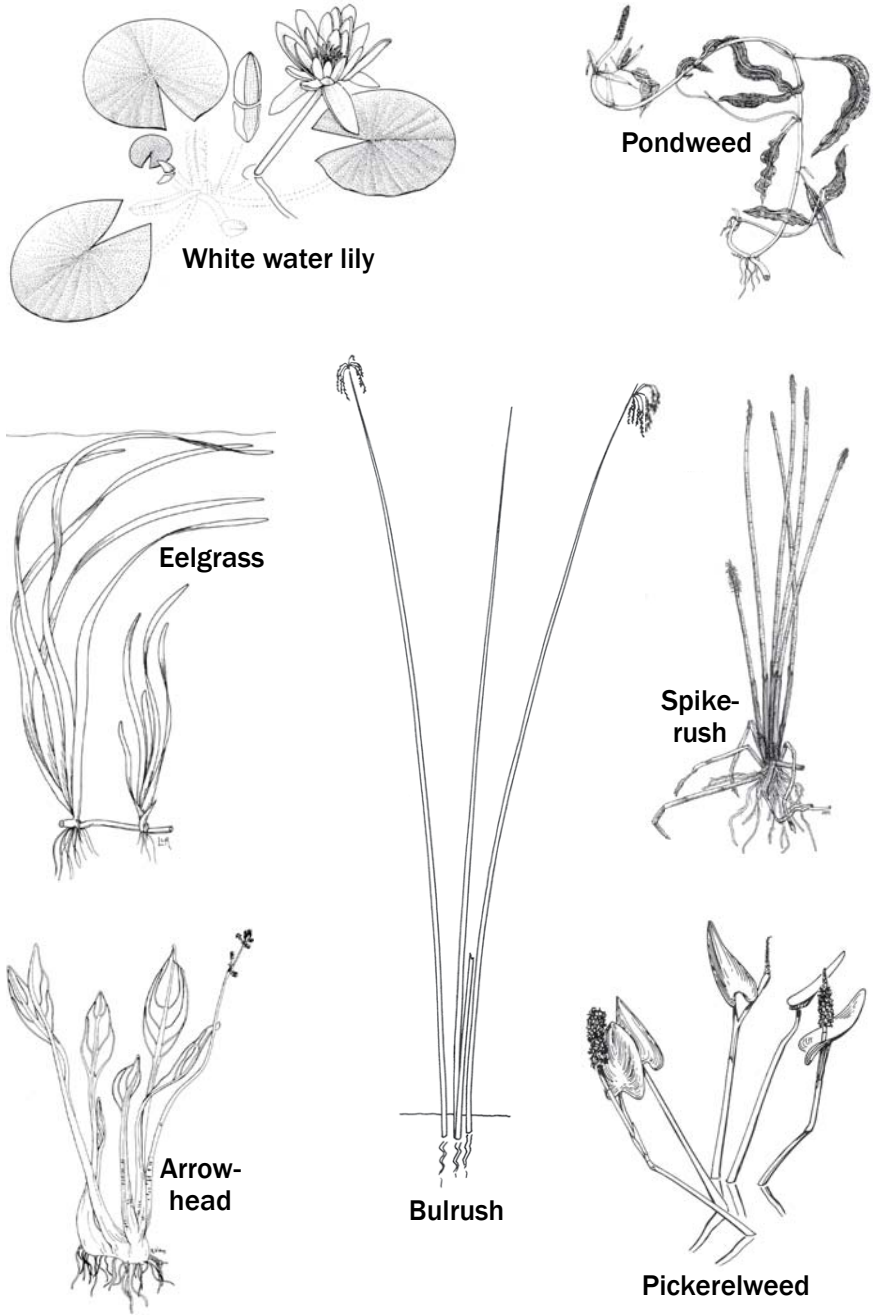


Figure 6. Desirable native plant species suitable for establishing a healthy pond. Aquatic plant line drawings are the copyright property of the University of Florida Center for Aquatic Plants (Gainesville). Used with permission.

and torpedo grass. The introduction of nonnative plants into ponds that are connected to natural waters is prohibited by law. FWC recommends that only plants native to Florida be planted in ponds. Planting around islands will provide excellent habitat for wildlife that will not interfere with bank angling. You may need to obtain a permit from the **Florida Department of Agriculture and Consumer Services** (**FDACS**, see page 26) prior to any plant collection or transplanting activities. FWC provides information pertaining to private companies who specialize in aquascaping and aquatic plant control. FWC's **Invasive Plant Management Section** also has a web site that will help you identify and manage various aquatic plant species (**MyFWC.com/WILDLIFEHABITATS/InvasivePlants_index.htm**).

Excessive gradual slopes, shallow ponds and the introduction of problematic nonnative plants such as hydrilla and water hyacinth can lead to overgrowth of vegetation. When plants become too abundant, recreational use is restricted and the ability of predators (bass) to feed on prey (bluegill) is reduced. Growth rates of both bass and bluegill will decrease, and fishing quality will decline. In some instances, excessive plant growth will deplete DO and may cause fish kills.

The Florida Cooperative Extension Service or any FWC regional office can assist you with aquatic plant identification and management advice.

The three methods for controlling nuisance plants are **mechanical** (removal by hand or machine), **biological** (triploid grass carp and hyacinth weevil) and **chemical** (herbicides).

Mechanical or hand removal is the safest method and is preferred over either chemical or biological control. Harvesting of the plant material removes unwanted nutrients from decomposing plants and eliminates muck buildup on the pond bottom. Before applying any herbicide or mechanical control, contact FWC to determine whether any permits or inspections are required.

When a biological agent can provide adequate vegetation control, it is usually recommended over the use of chemicals. Triploid grass carp can be an effective tool to control certain plant species. Since triploid grass carp are an exotic fish and importation of all such species is strictly regulated, you should refer to the FWC Web site, or contact the appropriate FWC regional office to obtain a permit application (see page 29). A biologist may inspect the pond, and if appropriate, will issue a permit to allow you to purchase a specified number of triploid grass carp. You may be required to install a fish barrier to prevent the carp from escaping to another water body. Only certified triploid grass carp are allowed for use since these fish are sterile.

The last method for vegetation control is herbicidal, and chemical control is frequently the least expensive or the most practical method. In extreme situations, a combination of chemical treatment followed by the stocking of grass carp to maintain control, is a viable solution.

Water quality

Maintaining good water quality is critical to pond management. Proper levels of pond productivity are required to sustain a fish population, which supports wildlife. Poor water quality is the most common cause for poor pond production.

- **Turbidity —** Turbid or muddy water should not be confused with stained or green colored water. Turbidity is caused by clay and silt particles held in suspension in the water column. Colored water that is clear, but resembles tea, is caused by tannins and lignins leached from certain upland soils. Ponds that are highly colored are capable of producing good fish populations. Green water is caused by suspended microscopic (phytoplankton) algae, and will be discussed in the "Managing Pond Fertility" section.

Muddy water can reduce sunlight penetration, which will disrupt biological production. Newly dug ponds will usually experience temporary turbidity; however, if the pond fails to clear within three or four months, take corrective measures. The most common source of turbidity is erosion from barren shorelines and upland areas. Sodding, seeding and aquascaping will reduce this source. Resuspension of clay and silt can result from high winds, livestock wading along the shoreline, and the burrowing actions of crayfish and certain fishes. Planting trees to buffer winds and fencing livestock to restricted areas of the pond are effective. If crayfish are the suspected cause, the establishment of largemouth

bass and bream will reduce crayfish populations.

If sources are controlled and the water remains turbid, it can be cleared by several methods. The easiest and safest method to reduce turbidity is to apply green hay to the pond's surface. Green hay attracts and neutralizes charged soil particles, causing them to settle on the pond's bottom. Apply four to six bales of hay per surface acre. Tear the hay apart and distribute it evenly across the pond. The decaying hay will also promote the growth of microscopic plants and animals that provide food for small fishes. Another way to reduce turbidity is to apply alum at a rate of 200 pounds per surface acre. Spread it as evenly as possible across the entire surface of the pond. Alum is usually available from farm supply dealers who sell fertilizer in bulk quantities.

■ **Controlling pH —** Ponds constructed on acidic soils can have low pH (highly acidic, **Figure 7**), which restricts the pond's biological productivity. Fish growth, reproduction and survival can be affected by pH. Ideal pH should range from 6.0 to 8.0. You can increase low pH by liming. A county agricultural extension agent can assist you in determining how much lime your pond requires. One ton of finely ground agricultural limestone will raise the pH of one surface-acre by one pH unit. Apply lime to the pond bottom (if dewatered), pond surface or along the shallow edges of the pond. Response time and frequency of treatments will depend on local soil conditions, pond flush rate and rainfall.

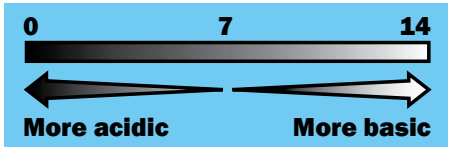


Figure 7. Understanding pH. The lower the number, the more acidic the pond water.

■ **Managing pond fertility —** You can manage your pond at different levels of fertility depending on your desires and objectives. Infertile ponds produce low fish crops; more fertile ponds produce higher yields. Artificial methods to increase production include fertilization and supplemental feeding. In many ponds, however, nutrient inputs are excessive and problems develop from over-enrichment.

One way to determine a pond's fertility is to measure water transparency during spring and summer. You can devise a simple tool to do the job. Cut a 2-inch square of white plastic from a bleach bottle and fasten it to the end of a wooden yardstick. Push this apparatus into the pond vertically until the white plastic cannot be seen. Note the depth at which the plastic first disappears.

If the plastic disappears between 16 and 36 inches, your pond has a desirable productivity level. Visibility greater than 36 inches indicates low production. In this situation, fertilization can increase fish production. By adding nutrients to the water, you will stimulate algal growth and strengthen the food chain. Fertilization is an expensive, time-consuming and complicated process. If done improperly, undesirable effects will result. You should fertilize only if your pond is infertile and you strongly desire maximum fish production. Overfertilization will cause fish kills; consult a FWC biologist before starting a fertilization program.

If visibility is less than 16 inches, it is important to distinguish whether turbidity or suspended microscopic algae is to blame. Healthy algae blooms give the water a green hue. If the pond is over-enriched, sources of nutrient inputs should be identified and eliminated. Ponds located near septic drain fields, fertilized lawns, cultivated crops and livestock are often overloaded with nutrients. Consider these factors before pond construction. Fencing the pond from livestock, discontinuing use of fertilizers within 20 feet of the pond, and constructing swales or berms adjacent to the pond edge will help reduce nutrient inputs. Do not allow lawn clippings, leaves or any other organic material to enter your pond. Leave an "unmanicured" buffer of desirable vegetation between lawns, agricultural fields, pastures, and the waterbody. This helps reduce nutrients and erosion. Retention ponds required for new developments are extremely vulnerable to poor water quality since, by design, they collect runoff from streets, parking lots and lawns. However, if homeowners adhere to the above suggestions, those too can provide a waterbody for recreation and aesthetic enjoyment.

■ **Fish kills, disease and parasites —** Most fish kills result from low DO conditions that overfertile ponds commonly experience. Algae and aquatic plants using oxygen in the absence of sunlight (nighttime or cloudy days), decaying vegetation or the input of runoff containing organic

matter can deplete oxygen levels. Ponds located near coastal areas may experience saltwater intrusion from surface or groundwater sources. Rapid changes in temperature, DO, salinity and pH can stress the fish population and cause a fish kill resulting from a secondary bacterial or viral infection. Disease outbreaks may also occur in crowded fish populations that compete for space, food or reproductive advantage. Spawning stress occurs because fish are expending a lot of energy, feeding less and are in close proximity to each other. The larger the waterbody, the less that can be done to stop a fish kill once it has begun. It is best to let the kill run its course.

The best way to prevent a fish kill is to maintain good water quality. If you begin an intensive supplemental feeding program, sudden stoppage may create food shortages and stress. If DO related fish kills occur on a regular basis, you may want to install an aeration system (**Figure 8**). Paddle wheels, bottom airstones, fountains and other devices that create bottom-to-top vertical mixing (destratification) of the water column while adding oxygen can help maintain adequate DO levels and reduce the chances of a fish kill. Consult a FWC biologist or aquaculture supply company representative before making a decision on aeration.

Parasitic animals can be found in most fish. They dwell in the gills, eyes, flesh, digestive tract, reproductive organs and skin. These organisms are a natural part of a fish's environment. Most parasites do not seriously affect fish mortality and rarely cause fish kills. Human consumption of fish containing parasites poses no health threat if the fish is properly cooked.

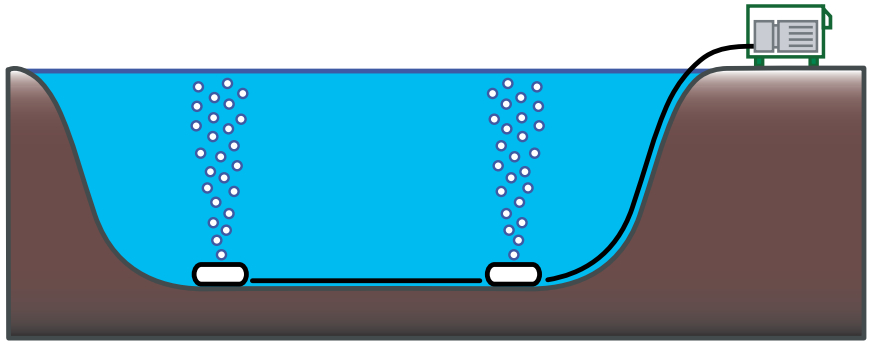


Figure 8. *An aeration system will improve water quality and help prevent low-oxygen-related fish kills. This system utilizes an air compressor and airstones.*

The input (from runoff or direct application) of toxic pesticides is another cause of fish kills. When chemically treating large areas of vegetation during warmer months, only treat one-third of the total area scheduled for treatment at a time, waiting three weeks between treatments. Exercise extreme caution when applying any chemicals near the pond.

Fish management

Once you have designed your pond and addressed water quality and aquatic plant management concerns, the next step is to determine fish management strategy. Evaluate your desired species (**Figure 9**), level of manage-

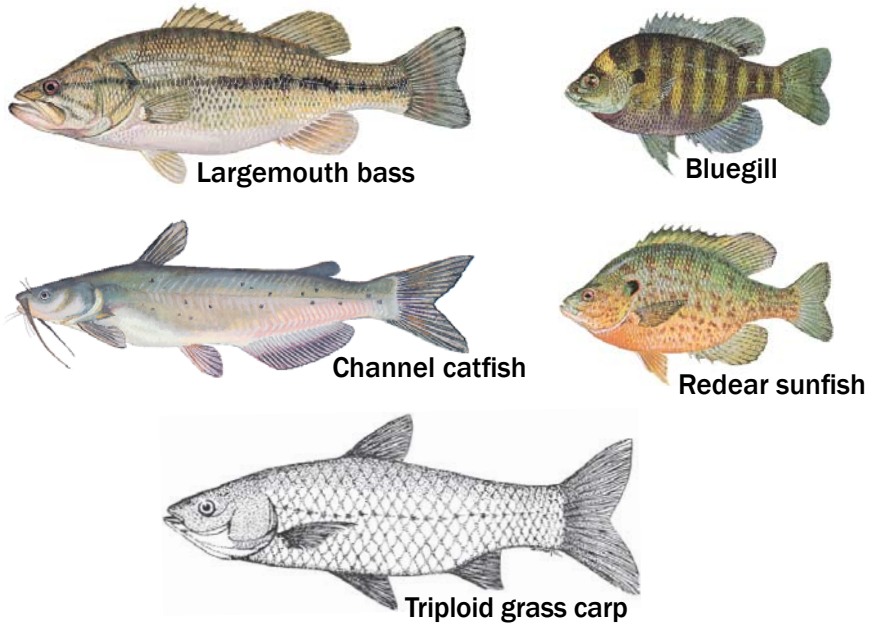


Figure 9. *These species are desirable for stocking ponds. Largemouth bass is the most popular of the game fishes, but requires large numbers of prey for good growth. The bluegill and redear sunfish provide food for the largemouth bass and are good panfish. The channel catfish is a popular food and sport fish and can be stocked alone or with other species. The triploid grass carp can be stocked (with permit) to help control problem aquatic vegetation. Illustrations by Duane Raver, Jr.; triploid grass carp by Ted Walke.*

ment intensity and realistic expectations. Then design and implement a sound fish management program. Seek several sources of advice before making any decisions on stocking. The FWC web site or the Regional Office can provide a list of fish suppliers in your area. (Note: state operated hatcheries do not stock privately owned waterbodies).

Establishing a fishery — There are three reasons to consider stocking: (1) the pond is new with no fish population; (2) undesirable species have invaded the pond; or (3) an established fish population has reached an unbalanced state where prey species (bream) have overpopulated and interfered with predator (bass) reproduction, or vice-versa.

An unbalanced population may be the result of fish kills, improper fish harvest, incorrect stocking ratios, poor water quality or a combination of these factors. Stocking fingerling game fish into an existing fish population is ineffective. Survival of fingerlings is low, and stocking them will not improve fishing success. Stocking large juveniles, or 1 year-old fish can be successful, provided there is adequate habitat to ensure survival. Renovation (killing out) and restocking is usually the most feasible method of correcting an unbalanced or undesirable fish population. Proper methods to kill out a pond are covered in the renovation section. Whether your pond is newly dug or renovated, stock fingerling fish soon, before a fish population becomes established inadvertently.

Ponds less than one surface acre in size generally will not provide a good largemouth bass/bream fishery for a substantial length of time. Channel catfish are recommended for stocking, since natural reproduction is limited in small ponds. This allows a pond owner to have a fishery he can maintain without fear of overpopulation or unbalance. If you want to begin fishing immediately, stock adult catfish. The disadvantage of stocking only channel catfish is that they require supplemental feeding to achieve good growth. Keep accurate harvest records so as the population becomes depleted, you can stock more fish. A catfish pond is very simple to manage and provides good fishing and an edible crop.

You can establish a largemouth bass/bream fishery in a new pond by stocking 250-500 bream fingerlings per acre in the fall, followed by 50-100 largemouth bass fingerlings per acre the next spring. Numbers stocked varies, depending on pond fertility. The bream stocking should consist of approximately 70 percent bluegill and 30 percent redear sunfish. This stocking schedule will allow bream to grow and reproduce. Some of their offspring are then eaten by developing bass. You can begin bass fishing 18 months after stocking largemouth bass fingerlings. Bluegill and redear sunfish harvest should begin eight months after stocking. Restocking is not usually required since bass and bream reproduce naturally. In some ponds that are infertile or acidic, bass fingerlings should be stocked again one year after the initial stocking. This is needed when bass grow slowly and fail to reproduce after their first year. If properly managed, a largemouth bass/bream fishery can sustain itself indefinitely.

You can stock catfish along with bass and bream. Stock fingerling catfish (100-500 per acre) with bass in the spring. Once bass have established and grown, it is necessary to stock larger (> 8 inches) catfish, since bass will consume catfish fingerlings. In fertile ponds that support threadfin shad, it may be desirable to stock hatchery-reared sunshine bass. These fish are a cross between striped bass and white bass. They will not reproduce, so you will need to restock them. Overstocking sunshine bass or introducing them into infertile waters will create competition with largemouth bass and should be avoided. If shad are stocked as prey, only use threadfin shad; their limited growth is best suited as a prey species for largemouth bass, sunshine bass, and black crappie, if present.

Fish species you should not stock are common carp, brown bullhead, black crappie (in most situations), Georgia Giants, Nile perch (tilapia), gizzard shad, or any non-native or aquarium species. It is unlawful to stock exotic species, or native species from hatcheries residing outside the state without FWC permission. While black crappie are a popular game

Figure 10. Bluegill sizes indicative of balanced (left with robust healthy shape) and unbalanced (right with skinny undernourished appearance) populations. Unbalanced populations occur when there are too many prey fish and not enough predators—the result is not enough food and space for the prey fish, so a stunted population occurs. Illustrations by or modified from Duane Raver, Jr.

fish in lakes, they have a tendency to overpopulate and cause unbalanced populations in smaller ponds.

■ **Fishery maintenance —** The main objective for managing a bass/bream fishery is to maintain a properly balanced population. If too many or too few bass are harvested (removed) from small ponds, the balance established with the initial stocking can become disturbed. Overharvest of bass and/or under harvest of bream are one cause of population imbalance, and results in poor fishing success.

Stunted bream are a good indication of imbalance. Stunted bream are usually between 3 and 5 inches in total length and have abnormally large eyes (**Figure 10**). Stunted bream will constitute a large percentage of a pond's total fish population, and few bream will be larger than 6 inches. Bream reproduce at high rates and stunting occurs when reproduction exceeds predation. A stunted bream population also adversely affects largemouth bass reproduction and results in poor fishing success.

A practice of restricting bass harvest coupled with high removal of bream will help prevent stunting. As a general rule, remove 10 pounds of bream for each pound of largemouth bass. Take care not to remove too many largemouth bass, particularly in ponds less than 5 acres.

If you notice many small bass two to three years after stocking, it may be necessary to harvest some bass that are less than 12 inches in length. An overcrowded population of small bass will exhibit slow growth, and you will catch very few quality-size individuals. While removing smaller bass, maintain a practice of catch-and-release for those greater than 14 inches.

Once a pond becomes unbalanced with too many bluegill, the addition of adult bass may help restore proper prey/predator ratios. This measure is practical only in small ponds where the owner can acquire enough adult bass. Bass should be at least 10-12 inches long and stocked at 10 to 15 per acre. Stocking fingerling bass does not work in this situation (see "Establishing a Fishery" section).

■ **Renovation —** If supplemental stocking of adult bass is not possible, the only way to restore the fishery is to chemically renovate the existing population and restock with fingerling fish. **Rotenone** is the fish toxicant labeled for aquatic use in Florida and kills by preventing fish from using oxygen present in the water. We recommend using 5 percent emulsified liquid rotenone for pond renovation, due to the difficulty of applying powdered rotenone properly. Drain the pond to the greatest extent possible prior to application to reduce the amount of chemical needed for renovation. Rotenone is available at major chemical and farm supply stores; however, rotenone is a restricted use pesticide and can only be purchased and applied by a certified applicator. For information about the use of rotenone contact the **Florida Department of Agriculture and Consumer Services** (**FDACS**) Pesticide Certification & Licensing Section (850) 488-3314 (**http://www.flaes.org/complimonitoring/pesticidecertification.html**).

Seek the advice of a FWC biologist when planning a pond renovation. Rotenone is not harmful to warm-blooded animals when applied properly and at recommended application rates. Water temperatures lower than 70º F reduce

rotenone's effectiveness and prolong its toxicity. The best time to renovate is late summer. Restocking fingerling bream should then occur in fall followed by bass during the spring.

Be certain all outflows from the pond remain closed for at least three weeks after rotenone application to prevent killing fish in areas outside of the pond. Uniform distribution of the fish toxicant is essential to obtain proper results. Collect and bury all dead fish. Do not stock fish for at least one month after rotenone application.

Another type of renovation may consist of draining, drying or scraping the lake bottom. All Florida lakes and/or ponds over time gradually fill in and develop muck deposits on the bottom that can affect water quality, spawning, and juvenile fish survival. The more frequently vegetation is chemically treated and the more silt that flows into the lake, the quicker the lake fills in.

■ **Feeding —** Fish-feeding stations are excellent for attracting bluegill and channel catfish to a location where they can be caught easily. Fish food can be used to supplement their natural diet, and if fish are fed at adequate levels, growth rates will increase significantly. Do not feed in ponds where grass carp have been stocked to control vegetation. Grass carp will stop eating vegetation and consume the fish food.

Commercially prepared fish food is available at most farm supply stores. Pellets are available in various sizes and in either a floating or sinking form. The advantage of using floating pellets, rather than sinking food, is that the pond manager can more accurately determine how much food the fish are eating. This prevents excessive feeding, which can lead to oxygen depletion in the pond. With floating food, it is easy to observe feeding fish, allowing you to determine sizes of bluegill to evaluate population balance. Disadvantage of floating pellets is that the food can drift into shallow water, making it difficult for fish to feed and more is consumed by birds. It is recommended to mix sinking and floating feed if observing fish at the surface is desired. Regardless of the type of fish food used, dispense only enough so that all is eaten within 15 minutes.

Dispense food at the same time and location every day to train fish. You can feed fish as often as you desire, but twice daily is usually enough for recreational fish ponds. Initially, dispense only 2 pounds per surface acre per day. If food is consumed rapidly, then gradually increase the amount dispensed, up to a maximum of 20 pounds per surface acre daily. Discontinue or switch to sinking and reduce feeding amount when water temperature is below 60° F because fish usually become less active.

Implement intensive feeding programs only when you desire maximum fish production (aquaculture or fee fishing). High fish density can increase the frequency of disease outbreaks, and sudden stoppage of feeding can stress the population. Dispensing too much feed can deplete dissolved oxygen levels, and aeration is often required to prevent fish kills.

Automatic feeders relieve the pond manager from the daily duty of feeding. **Figure 11** shows two types of automatic feeders you can use. The amount of feed, frequency of discharge and time of feeding are controllable. Prices for various models are from $200 to $800 depending on the capabilities of the unit.

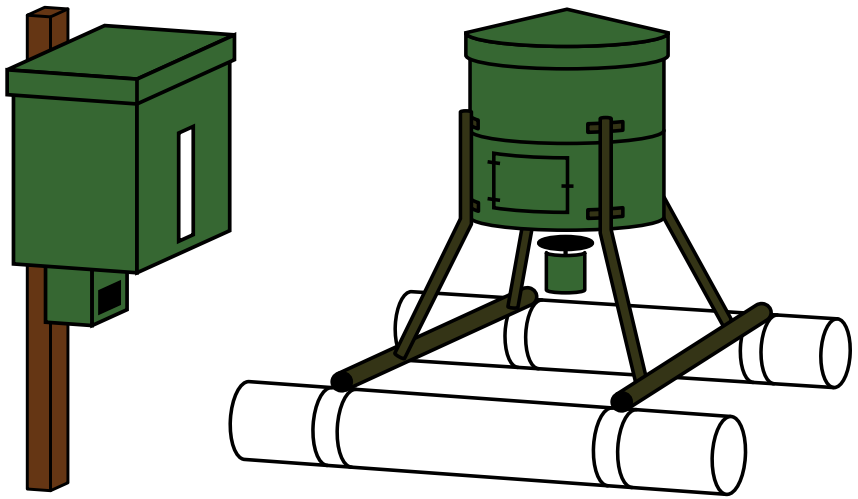


Figure 11. *Automatic fish feeders can improve fish growth rates and also congregate fish making it easier to catch them.*

Some pond owners suspend a bug-zapping light over their pond. At night, the light attracts and kills many flying insects. Bugs dropping on the water surface are eagerly consumed by bluegill and even small bass. It is best to suspend these off the end of a small pier or over a fish attractor, but somewhat away from where you may stand to fish.

■ **Fish Attractors —** Fish attractors will help concentrate fish where anglers can catch them easily (**Figure 12**). Fish are attracted to brush piles in search of food and protection from predators. Oak and citrus trees provide excellent attractor materials. Recycled Christmas trees, although popularly used, do not make good fish attractors; they do not last very long because the branches tend to be too small and the trunk is a softwood. Green trees with numerous small limbs are best and sink with a minimum weighting material. Rock piles, plastic pipe, concrete culverts and wood boxes also can provide shelter areas. If a sandy or gravel bottom is not present, areas 5' (W) X 20' (L) X 4" (D) of #57 lime rock create attractors and spawning areas for largemouth bass and bream. There are also many man-made attractors on the market which eliminates refurbishing natural materials. Placing brush in lakes owned by two or more parties may require a permit from DEP.

Wildlife management

The availability of water, food and cover will attract many types of wildlife to your pond. Many species add to the natural beauty and enjoyment of the pond while others may cause problems.

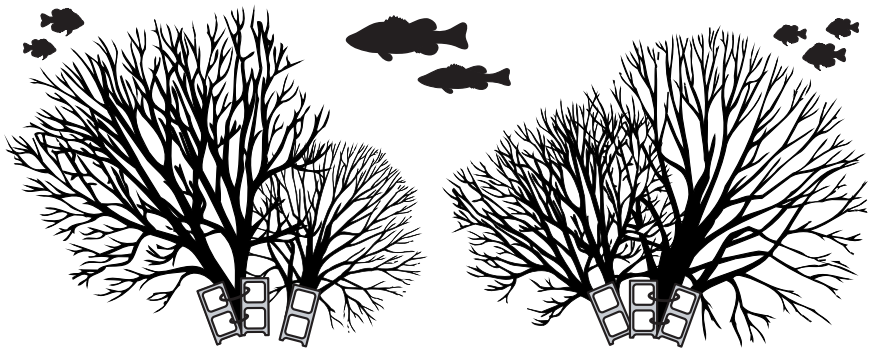
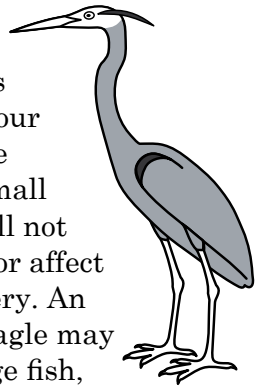


Figure 12. *Fish attractors, whether natural or man-made, provide cover that attracts and holds fish. Here, cinder blocks are used to anchor small trees on the bottom.*

Most birds are an aesthetic asset to ponds. Wading birds such as herons, egrets, ibis and even wood storks may visit your pond. These birds eat small fish, but will not have a major affect on the fishery. An osprey or eagle may catch a large fish, but their effects are insignificant. Cormorants and anhingas swim underwater in pursuit of small fish, and can reduce sportfish populations if too many are present.



Great blue heron

Most people are afraid of snakes, and the feeling is mutual. Pond owners should learn to identify venomous snakes. Non-venomous water snakes are much more common, and they feed on a variety of animals including frogs, tadpoles and small fish.

Frogs are very vocal at night when pond owners are trying to sleep. Frog density in the pond will be very low when bass are managed properly.

Many people incorrectly assume turtles are harmful to a fish population. The diet of most turtles consists primarily of vegetation and dead animals. A few species such as alligator snapping and softshell turtles do feed primarily upon fish, but their predation is not detrimental to the overall fish population. A limited number of turtles can be caught for food. Reference the **FWC Freshwater Fishing Regulations** booklet or contact a FWC office for information concerning the taking of turtles.

Alligators are migratory at times and will find your pond sooner or later. Their presence is of little concern unless they lose their fear of humans. Feeding alligators is dangerous and strictly prohibited by state and federal laws. They do not affect recreational fisheries. If you observe an alligator more than 4 feet long that displays bold or aggressive behavior, call the **FWC Alligator Hotline** 1-866-FWC-GATOR (392-4286) to request its removal.

Otters are cute and fun to observe, but unfortunately, they can harm the fish population of a small pond. Beaver and nutria can also damage a pond by destroy-

ing surrounding trees and vegetation stands. Details concerning otter, beaver and nutria removal are available in the **FWC Hunting Regulations** booklet, or from any FWC office.

One of the most important strategies to improve wildlife habitat around the pond is to establish a buffer of vegetation along the pond's shoreline. The vegetative buffer will improve sediment and nutrient retention, help stabilize the shoreline, and improve water quality. The vegetative buffer zone should include a variety of native plants such as grasses and herbaceous seed producing plants and woody stem plants such as trees and shrubs.

Grass and herbaceous plants such as wild millets, nut grasses, and numerous native "volunteer" plants provide nesting cover and shelter for a variety of wildlife. Many of these plants provide food resources such as seeds, berries, and other edible plant parts. They also serve to attract numerous insects, which are an important dietary component for birds, reptiles, amphibians, fish and a variety of mammals.

Woody stem plants, such as wax myrtles, salt bush, willows, and Florida maples also provide food resources, cover, nesting habitat, and perching sites for a variety of birds. Artificial nesting structures (nest boxes) can be attached to trees or placed on posts with predator guards near the pond to attract cavity-nesting birds such as wood ducks, purple martins and bluebirds. Guidelines for constructing various nest boxes are available from any FWC Regional office. Woody stem plants have the additional benefit of providing shade and serving as windbreaks and sight and sound barriers.

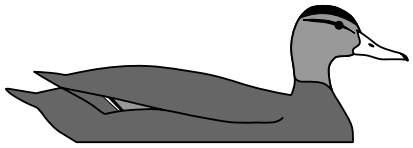
The location of plants can be as important as the species planted. For instance, trees or shrubs should never be planted on a dam or spillway as their roots can damage or weaken the structures and may attract burrowing animals. Also, consider planting trees far enough back from the water's edge such that they allow enough sun to reach grasses and other herbaceous plants and allow easy access for recreation. Areas planted in grasses and herbaceous cover should be protected from disturbance by livestock.

When flooding and drainage of a pond can be controlled, plant and animal communities can be enhanced by water level manipulation. For instance, implementing a slow, one- to two-foot drawdown over a period of four to six weeks in early spring will provide additional food resources for spring migrating waterfowl.

As water level recedes along the ponds edge, newly exposed mudflats can also attract a variety of spring migrating shorebirds and wading birds. Drawdowns will stimulate the growth of beneficial plants on the exposed mud flats, which can be slowly reflooded with the accumulation of water during the summer rainy season. When reflooded, these plants will provide food and cover for many fish, amphibians and wading birds. Drawdowns can be invaluable in facilitating pond revitalization, structure repairs, and/or redesign.

Other considerations to enhancing a pond's attractiveness to wildlife are to add large rocks and logs along the ponds edge and in shallow water. These will be used as cover and nesting sites by small animals and serve as basking sites for turtles. These areas are also good for fish habitat.

We recommend you discourage domestic ducks and geese from using your pond, because they are unnatural and compete with native wildlife. In fact, domestic mallards are causing major problems for Florida's native, wild mottled ducks. For more information, visit FWC's Waterfowl Web site (**MyFWC.com/duck/**) and click on the links "Florida's Waterfowl" and "Mallards in Florida."



Mottled duck

For the landowner, there are several cost-share incentive programs for improving wetlands and surrounding uplands for which your property may qualify. For additional information on these programs and other habitat improvements, contact your local FWC Private Lands Biologist or the nearest NRCS office for details.

Following these guidelines should help provide good fish and wildlife habitat in the form of food, water, and cover. This habitat will attract a variety of species to your pond and provide year-round viewing and recreational opportunities.

License requirements and fee fishing

License requirements (**MyFWC.com/License**), rules and regulations that pertain to all ponds are available at any Commission office. Some pond owners generate income by charging a fee for fishermen to fish in their pond. Short-term and long-term leases are common.

Sources of additional information

The following are topics in which the sources listed below should be contacted for:

A = Aquaculture
DC = Pond design and construction
F = Fish management
LI = Landowner incentives
P = Permits
V = Vegetation management
W = Wildlife management
WQ = Water quality

Water Management Districts:
P, WQ, V

- Northwest WMD
81 Water Management Drive
Havana, FL 32333-4712
(850) 539-5999
www.nwfwmd.state.fl.us/

- Suwannee River WMD
9225 County Road 49
Live Oak, FL 32060
(386) 362-1001
www.srwmd.state.fl.us/

- St. Johns River WMD
4049 Reid Street
Palatka, FL 32177
(386) 329-4500
http://sjr.state.fl.us/

- South Florida WMD
3301 Gun Club Road
West Palm Beach, FL 33406
(561) 686-8800
www.sfwmd.gov/

- Southwest Florida WMD
2379 Board Street
Brooksville, FL 34604
(352) 796-7211
www.swfwmd.state.fl.us/

Florida Department of Environmental Protection
P, V, WQ
3900 Commonwealth Blvd.
Tallahassee, FL 32399
(850) 245-2118
www.dep.state.fl.us/

Natural Resources Conservation Service
DC, LI
2614 NW 43rd Street
Gainesville, FL 32606
(352) 338-9541
www.fl.nrcs.usda.gov/

US Army Corps of Engineers
P
710 San Marco Blvd.
Jacksonville, FL 32207
(904) 232-2568
www.saj.usace.army.mil/

Florida Department of Forestry
LI, P, V, W
3125 Conner Blvd.
Tallahassee, FL 32399
(850) 488-6591
www.fl-dof.com/

Florida Department of Agricultural and Consumer Services
A
1203 Governors Square Blvd
Tallahassee, FL 32301
(850) 488-5471
www.floridaaquaculture.com/contact.htm

US Fish and Wildlife Service
F, LI, W
1875 Century Blvd
Suite 400
Atlanta, GA 30345
(404) 679-4000
www.fws.gov/southeast

Southern Regional Aquaculture Center
A, F, WQ, V
127 Experimental Station Rd.
Stineville, MS 38776
(662) 686-3285
www.msstate.edu/dept/srac

Florida Aquatic Plant Management Society
WQ, V
PO Box 560700
Orlando, FL 32856-1327
www.fapms.org/

University of Florida IFAS
A, F, V, W, WQ

- Fisheries and Aquatic Sciences
7922 NW 71st Street
Gainesville, FL 32653-3071
(352) 392-4817
www.fishweb.ifas.ufl.edu/
- Aquatic Plants: www.plants.ifas.ufl.edu/guide/
- Wildlife Ecology and Conservation
110 Newins-Ziegler Hall
Gainesville, FL 32611-0430
(352) 846-0643
www.wec.ufl.edu/extension/
- Plants for Wildlife: www.wec.ufl.edu/extension/fl_habitat_program.htm
- All UF Extension Publications: www.wec.ufl.edu/Extension/Extenspubs.htm

Aquaplant Pond Manager Diagnostics Tool
V
Texas A&M University
AgriLife Extension Service
312 Nagle Hall, TAMUS 2258
College Station, TX 77843-2258
(979) 845-7473
http://aquaplant.tamu.edu/index.htm

Lake Watch
F, V, WQ
Citizen Hotline 1-800-527-3928
lakewatch.ifas.ufl.edu/

Association of Florida Native Nurseries
V
http://www.afnn.org/

The Center for Wetlands
V, W, WQ
http://www.cfw.ufl.edu/

FWC Invasive Plant Management Section
V
MyFWC.com/WILDLIFEHABITATS/InvasivePlants_index.htm

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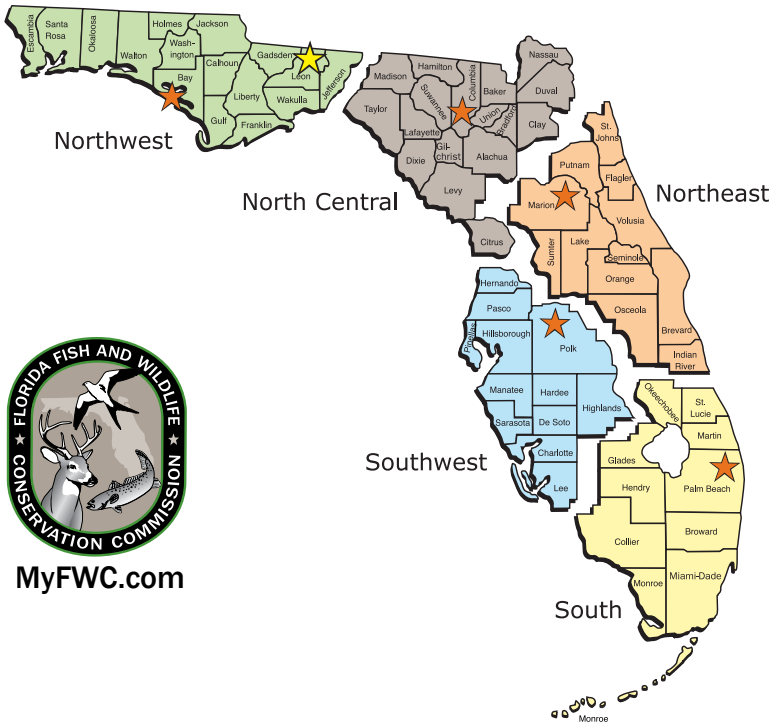
Florida Fish and Wildlife Conservation Commission
Headquarters and Regional Offices



MyFWC.com

Headquarters
620 South Meridian Street
Tallahassee, FL 32399-1600
(850) 488-4676
(800) 955-8771 TDD

Northwest Region
3911 Highway 2321
Panama City, FL 32409-1658
(850) 265-3676

North Central Region
3377 East U.S. Highway 90
Lake City, FL 32055-8795
(386) 758-0525

Northeast Region
1239 Southwest 10th Street
Ocala, FL 34471-0323
(352) 732-1225

Southwest Region
3900 Drane Field Road
Lakeland, FL 33811-1299
(863) 648-3200

South Region
8535 Northlake Blvd.
West Palm Beach, FL 33412-3303
(561) 625-5122

FWC Web Site — MyFWC.com
Fishing License Sales — 1-888-FISH FLORIDA (347-4356)
Wildlife Alert (to report fishing/boating violations) **—** 1-888-404-3922
Fish Kill Hotline — (800) 636-0511
Alligator Hotline — (866) FWC-GATOR (392-4286)

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MyFWC.com