

Ornamental Ponds & Water Gardens in Texas

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Have you ever considered installing an ornamental pond or water garden? Perhaps you enjoy the aesthetic beauty of water features, the bubbling sound of a waterfall in the evening, you have a green thumb for plants and the garden alone will not suffice, would like to attract wildlife to your yard, are a fisherman who does not get to spend enough time on the water and enjoys watching fish, or maybe you simply want to add value and beauty to your home. What exactly is an ornamental pond or water garden? They can be very simple and small to extremely complex and large, and about any combination in between, but for the most part they are a landscaping feature that incorporates water, aquatic plants and in some cases ornamental or native fish. These features are not bird baths or water-peeing cherub statues, but instead contain some type of living ecosystem within the water feature itself. What is the difference between an ornamental pond and a water garden? You may call them an ornamental pond, water

garden, ornamental water garden, fish garden, or any of other various terms, but in general they are just different names for the same thing and may be used interchangeably. However, some purists state the difference between an ornamental pond and a water garden is an ornamental pond contains ornamental fish, while water gardens contain only plants - hence the name 'garden'. Both types of features include aquatic plants. In this publication, we often use these terms interchangeably, but have limited the use of the term water garden in the fish sections.



Location and Planning

Selecting a good location for the water garden is very important because they are generally long-term fixtures and should be expected to have at least a 10 year lifespan. Location is critical in maximizing personal enjoyment of the feature, providing easy maintenance, and supporting the biological performance and ecology of the pond. A water garden built in close view of the house allows for enjoyment, supervision of children and pets, observation in case of predators, and reduced expenses for pipes, electrical equipment, and pumping. An ornamental pond should never be built above gas, water, sewer, or electrical lines. Check the location of wires and piping with utility companies for the location *before* you start planning and construction.



Ensure to check the location of wires and pipes with utility companies your pond location *before* you start planning and construction. Remember to call 811 for utility locations prior to digging or laying the foundation.

The water garden should be situated so that it receives a minimum of 5 to 6 hours of sunlight per day, because sunlight is needed for photosynthesis as well as growth of periphyton—a green to reddish-brown film of algae and bacteria that grows on stable surfaces. Photosynthesis introduces

oxygen into the ecosystem for fish, while periphyton promotes water clarity by removing excess nutrients and providing food for aquatic insect larvae and subsequently food for fish. The ornamental pond or water garden should also be situated to avoid direct sunlight at midday, as full midday sun can create excessively high water temperatures in shallow waters that can be detrimental to fish and plants. High water temperatures can cause stress in fish and weaken their immune system, so using external fixtures, decorations, or floatable plants to add shaded areas can help reduce adverse effects of too much sunlight.

A water garden’s location should not interfere with surface water drainage from storm runoff or pond maintenance. The water garden location or structures should not lead to impounding of storm runoff around buildings and be situated so that overflow from storm runoff does not flood structures. Water from draining or filling during maintenance should not flow toward structural foundations of building, driveways, swimming pools or other landscaping; the wastewater may be collected to use for tree and garden irrigation. A water garden should not be placed directly underneath trees because roots can lead to problems during excavation and have a tendency to grow back and damage the pond in the future. Fallen tree leaves can foul the water, potentially exude toxic substances into the pond, and clog filters.

Desired depth of ornamental ponds depends on local climate, over-wintering management strategies, and design of the

main pool. Most ornamental ponds are 18-24 inches deep, but should have a 3-5 foot deep section to resist winter freezes and create a cool retreat for fish during hot weather.

Many different materials may be used to build the ornamental pond. An earthen or 'mud' pond in native soil is a simple hole dug in the ground. Earthen ponds are inexpensive and usually allow for the development of healthier fish and plants as well as a more stable water quality ecosystem. However, the water is seldom clear and may be more susceptible to algal blooms, seepage, and nuisance species or predators. Earthen ponds should be built in high clay content soil and contain a drain or standpipe in case of flooding events. Rigid and flexible liners are widely available and are favored for maintaining water clarity and reducing water loss from seepage. Pre-formed rigid polyethylene plastic liners may be placed in the excavated soil and backfilled around them, or they may be placed above ground with surrounding stone or masonry work to conceal the outside. Flexible liners, such as sheets of polyvinyl chloride (PVC), polyethylene, or EPDM (Ethylene Propylene Diene Monomer) rubber, are used to line the excavated hole.

Concrete and fiberglass liners are durable and long-lasting and are advantageous because penetrations for drains and fill lines can be molded into the liner during construction. However, rigid liners are usually more complicated to construct, may require heavy equipment, and are more expensive than flexible liner materials such as PVC, polyethylene, or EPDM rubber. Flexible liners range in

durability and lifespan, may be ultra-violet (UV) resistant, and are usually less expensive than rigid liners. EPDM sheeting is the most common lining in ornamental ponds because of its flexibility, ability to conform to irregular surfaces, chemical inertness, and resistance to puncturing and UV light.

When planning a water garden, make a to-scale model or precision drawing of the yard or location in order to find the best possible pool shapes and sizes to fit the available space. Be sure to plan access from all sides of the pond for maintenance and walkways, as well as pond and yard equipment or fixtures. Allow 1-3 feet on each side for liner burial and landscaping.



Small yards can easily be overtaken by poor planning and ornamental ponds that are too large. A to-scale drawing of the yard and planned pond help to ensure the size of the pond fits the yard.

Construction

Before beginning any construction project, submit plans to local governmental departments, zoning boards, or homeowner associations for review, as permits may be required. Be sure that plans comply with building codes such as water, drainage, and electrical requirements. Insurance companies may consider pools deeper than 18 inches an

attractive nuisance. As with any large projects, it might be helpful to contact a professional pool builder or plumbing contractor to assist in planning.

Always start an ornamental pond or water garden project small because it is an expensive endeavor, ranging from hundreds to thousands of dollars depending on the size, depth, materials, and labor of the project. However, most owners regret not building their ornamental pond larger because it may be hard to reconstruct or add on to later. Equipment and materials that may be used during construction and/or maintenance may include (but are not limited to):

- spare tanks for acclimating and isolating fish
- chemicals, brushes, and test kits to measure water quality
- biological or mechanical filters, and filter media such as zeolite or charcoal
- electrical hookups, lights, and pumps
- pipes, drain structures, nets, buckets
- sand or stone overlays or borders
- fountains, waterfalls, and aerators
- plants and plant enclosures

Design and construction of the main pool can be simple or complex, and can range from formal geometric shapes to more irregularly, natural-looking. Regardless of design, it is essential to **plan** well. Plan how pipes, filters, fountains, lights, and heaters will be concealed. Plan where electrical and water lines will be placed for lighting, pumps, and waterfalls. Plan the location of and space needed for any additional structures and their foundations. Plan how

the pool will be drained. Ornamental ponds may be drained via pump or siphon but an optional drain allows for easier management when cleaning and removing fish. It is useful to make sure the bottom slope is at least 1 percent to help drain and to construct a catch basin that is 6-12 inches deeper than the bottom to concentrate fish and debris. Cover the draining mechanism with mesh or a plastic drain cover so that fish cannot escape during draining.

Ornamental ponds that are constructed 2/3 below ground are kept warm during cold weather and cool during hot weather, but such excavated pools may have problems with run-off. Run-off water may have contaminants and cause muddiness and oxygen problems in your ornamental pond. Additionally, rainwater saturation of the soil underneath the pool can float the ornamental pond structure, so it is important to use under-pool drainage or a water-pressure relief system and to know the soil type present in your area. Consult with the United States Department of Agriculture Natural Resource Conservation Service for more information on the soil types located on your property. To avoid run-off contamination, water gardens should be sited at a slightly higher elevation and where the water table does not meet the depth of the main pool. If the surrounding land is higher than the water garden, consider using a “berm” to control run-off by deflecting surface around the water garden.



A pond properly constructed with tiered sides and ledges for plants. Fill the pond gradually, as above, to equalize the pressure between the liner and the ground. The above ground berm prevents contamination from runoff.

Vertical sides erode rapidly and allow the build-up of detritus on the bottom so be sure to use tiered or sloping sides to encourage movement of detritus toward the deepest part of the pool; 2-3 tiers, 12 inches wide each are effective for this purpose and provide ledges for aquatic plants and decorations. It is critical that the shoreline of the pool is level or else one side will be exposed on one end, with the other end about to overflow. Prior to liner installation, the sides of the excavated area should be covered and packed with sand to protect against puncture by roots or rocks. It may be more aesthetically appealing to allow the borders of the pond to overhang the water by 1-2 inches to conceal the liner and hide openings to equipment. Fill the ornamental pond with water gradually as you proceed during construction to equalize the pressure between the liner and the ground. This helps to prevent the form or liner from being displaced upward by earth, sand, concrete, stone, or other construction materials while the construction is in progress.

Ornamental ponds and water gardens are meant to be personal and the possibilities are virtually limitless, so have fun when designing the look and design. Try using rocks with various colors and shapes, fountains, waterfalls, windmills, underwater lighting, islands, bridges, aquatic plants, or surrounding flower gardens. Save money on electricity and the complication of adding electrical wires by using solar powered lights around the water garden for night lighting. Beware of copper fixtures that may leach into the ornamental pond, leaving an aqua-blue cast to the water or potentially creating toxic effects for your fish.



A waterfall and fountain fixture was added to this pond. Water gardens are meant to be personal and the style possibilities are virtually limitless.

Water

Be sure that you have access to an adequate amount of water to fill the water garden. Common sources are city water or well water, but occasionally rainwater collection is also used. Do not use surface water from a creek or an existing pond because this water may have contaminants, diseases, or wild fish or plants that could harm the water garden's ecosystem. City water should be dechlorinated prior to use to remove

hypochlorites. It is important to contact your water treatment facility to determine if the chlorine source is gas or liquid chlorine, or if it is chloramine. If the chlorine source is liquid or gaseous, dechlorination can be achieved by allowing water to sit in sunlight for one week. This degassing period can be dramatically shortened to as little as 24 hours if the water is well aerated by an air diffuser. If the chlorine source is chloramine, then it must be removed by chemical dechlorination using commercial dechlorinators containing either sodium thiosulfate or monosodium hydroxyl methane sulfonate, which are available in liquid, powdered, or pelleted form from most aquarium and pool suppliers. When building free-standing or above ground pools, remember that water is very heavy (about 8.3 lbs/gallon) so be sure to check for structural support. Also, it is important to know the dimensions of the ornamental pond: surface area, depth, and volume for a number of applications like dechlorination, nutrient application, fertilization, feeding, aeration, liming, etc. Refer to SRAC Publication No. 103 “Calculating Area and Volume of Ponds and Tanks” by M. P. Masser and J.W. Jenson at <https://srac.tamu.edu/>.

Water Quality

Good water quality is essential or the ornamental pond will decline in beauty as fish and plants become stressed and susceptible to diseases. Some common factors concerning water quality include dissolved oxygen, nutrients, algae, ammonia, nitrite, pH, alkalinity, hardness,

and contaminants or pollutants, such as pesticides. Water quality tests for dissolved oxygen, ammonia, pH, alkalinity, and chlorine can be purchased at most water garden or aquarium suppliers.

Dissolved oxygen (D.O.) is the measurement of the amount of oxygen in the ornamental pond. Dissolved oxygen is found in very small amounts in water, and therefore it is measured in parts per million (ppm) and typically ranges from 0 to 20 ppm, although 4 to 7 ppm is more common. Oxygen from the air becomes dissolved in the water by agitation, or as byproducts of photosynthesis from algae and underwater vascular plants. Dissolved oxygen varies throughout time depending on agitation, number of fish and plants, time of the day or year, and the temperature.

Agitation breaks the surface tension, allowing more water mixing and decreased surface tension, which lets more oxygen to diffuse into the water. There is more oxygen input into the water from photosynthesis during the day than at night, when plants actually consume oxygen for respiration. The total oxygen carrying capacity is higher and oxygen dissolves more readily into cooler water than in warmer water. Fish may become severely stressed at D.O. levels lower than 3 ppm and will begin to die at 2 ppm. Mechanical aeration, such as that from diffusers, fountains, and waterfalls, can help maintain minimum D.O. concentrations and remove excess carbon dioxide through degassing.

Nutrients enter the water garden from run-off (if improperly constructed), fish feed,

wastes, decomposing leaves and organic material, and fertilizers. Vascular plants remove these nutrients rapidly from the water, which should help suppress algal growth, but excessive nutrient input may stimulate algal growth and should be controlled. Algal blooms may either be free-floating (planktonic) or clingy (filamentous) algae; the former usually becomes a worse problem in ornamental fish ponds and such blooms turn the water cloudy green, restricting view, and sometimes causing localized oxygen depletions known as hypoxic zones. Algal blooms can be controlled by avoiding over-stocking and over-feeding fish or over-fertilizing plants. You can increase the number of plants or use bio-filters to remove the excess nutrients, or you might replace or flush water through the water garden to dilute nutrients and disperse the algae. Periodic algal blooms are part of a natural cycle and are still expected to occur, particularly from fall to early spring.



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Ammonia and nitrite are also common causes of problems in ornamental ponds. Ammonia is the major nitrogen waste excreted by fish, and certain types of bacteria

decompose or nitrify ammonia into nitrite. Both ammonia and nitrite are toxic to fish, but are usually removed by plants and used as nutrients for growth before they become problems in ornamental pools. They can both become hazardous if fish are over-fed, if plants are over-fertilized, or because of rapid decomposition of organic matter. Like other nutrients, these should be removed by adding plants, using bio-filtration, flushing, or adding bacterial water conditioners to speed the nitrification process.

The pH of the water garden should also be considered and is measured on a scale from 0-14. pH 7 is neutral, less than 7 is acidic, and greater than 7 is basic. The pH fluctuates daily due to the activities of photosynthesis and respiration and should normally cycle from 6.5 to 9 without harming the fish; if the pH is outside of this range, buffers should be added to increase the alkalinity.



Simple water test kits may be purchased to determine the pH, alkalinity, hardness and ammonia concentration of your pond.

water and so is related to the pH; it can range

from 0 ppm to more than 500 ppm in Texas. An alkalinity of 20 ppm or greater is considered adequate for ornamental ponds and water gardens, but should be 40 ppm or greater to maintain fish health and reproduction in ornamental fish ponds. The alkalinity can be increased by adding carbonates, such as agricultural limestone, oyster shell, or sodium bicarbonate (baking soda). Hardness is generally a measure of the calcium and magnesium concentrations in water, however, ferrous iron may contribute significantly to groundwater hardness levels. Hardness can range from 0 to more than 300 ppm in Texas. The acceptable range for hardness in ornamental ponds and water gardens is greater than 5 ppm, but should be 20 ppm or greater to maintain fish health and reproduction in ornamental ponds.

Pollutants may also harm the ornamental ponds health. A simple bioassay can be performed to test for the presence of such contaminants by placing a few baitfish, such as fathead minnows purchased from your local bait shop, in a minnow bucket and floating it in the pool for 24 hours in an area that gets some circulation but no direct sunlight. If no deaths occur, the water is probably not contaminated.

Filtration

Ornamental ponds and water gardens need water circulation to avoid stagnation, to remove solid materials, and to biologically degrade and detoxify dissolved materials. However, not all water gardens need filtration. Ornamental ponds and water gardens with large quantities of plants and a modest number of fish should not require

filtration because ornamental plants are active biological filters. A pond ecosystem needs to be correctly balanced between the number of plants, number of fish, and amount of nutrients to be healthy. If the use of additional filtration is needed or desired, there are a number of different types of systems, most of which can be accommodated in areas of 6 to 50 square feet. Filtration systems should be placed as close to the water garden as feasible to avoid loss of water velocity from friction or the accumulation of materials within the piping.



This mechanical filter collects leaves and larger debris in the reservoir while the fiber and foam filters help trap particles of dirt and organic matter.

Mechanical filters, such as leaf skimmers, foam filters, and settling basins, help to remove or trap particles of dirt and organic matter. They also protect the pump that cycles the water through the filter from clogging. Swimming pool or hot tub filters like sand filters and cartridge filters, should not be used in an ornamental fish pond or water garden because they clog or channel quickly and require large volumes of water for back-washing or frequent cartridge

changes. Remember that the demand on the filter arises from the amount of feed placed into the ornamental pond, not the volume of the pond.

Biological filters help to remove excess nitrogen that is produced from fish wastes and the decomposition of organic matter in the ornamental pond. Natural filtration, using plants, is most often achieved by using submerged aquatic plants. Building a plant basin equal to 10 percent of the ornamental pond's surface area through which the pond water is circulated every 2-4 hours can also be used as a means of natural filtration, and acts as a settling chamber for solid wastes after plants have removed excess nutrients. Nutrients can also be removed by algae and bacteria. Bacteria bio-filtration, which is common in pools where fish are the main attraction, can only occur if the bacteria are provided with the proper substrate and environment. This filtration process using nitrifying bacteria mimics the natural process, hastening it by seeding the bio-filter with a prepared commercial mix and layers of gravel or sand on which the bacteria may grow. These types of systems operate best at a pH of 7 to 8 and an alkalinity greater than or equal to 50 ppm, but they consume alkalinity due to acidification over time.

Some examples of common filtration systems include (but are not limited to) under-gravel filters, in-pond filters, and up-flow bio-filters. The under-gravel filter is fairly simple and uses gravel as a mechanical filter that is colonized by bacteria; they are built in the pool bottom or a nearby streambed, but are clogged with solids

regularly and require laborious cleaning. The in-pond filter uses plastic media and foam surrounding or connected to a submersible pump for mechanical and biological filtration. Sediment should not be allowed to build up at the bottom of an in-pond filter. An up-flow bio-filter allows water to enter through the bottom and exit through the top and contains a sediment basin to collect debris while a coarse media is colonized by bacteria. This type of filter is usually self-contained and kept separate from the pond.

Fish Stocking

The most common mistake that many ornamental pond owners make is stocking too many fish. At the time of stocking, little consideration is given to the fact that fish grow rapidly and each individual needs a lot of room. The ornamental pond's ecosystem should supply adequate oxygen and be able to decompose the wastes of each individual. In fact, the ornamental pond's carrying capacity varies depending on the size of the pond, the temperature, the amount of sunlight (which directly affects D.O. concentration), whether aeration is provided, and how effectively the filtration system removes wastes. The initial stocking rate should never exceed the estimated carrying capacity—that could lead to heavy algal blooms, diseases, and oxygen depletions in the pond. Generalizations are difficult given all the variables that contribute to a water garden's carrying capacity, but a very basic generalization is to stock no more than 1 pound of fish (final weight of adult fish) per 100 gallons of water.

Example 1. You have an ornamental pond that contains 400 gallons of water, no filtration, and moderate aeration from a small fountain and a few submersed plants. The maximum *ADULT* fish weight this pond is likely to support is 4 pounds of fish total. The weight of an average comet goldfish in the pet store is typically 0.4 to 1.1 ounces. You decide to stock two dozen goldfish in your pond, but that does not look like very many fish in 400 gallons of water because they are small. However, the adult weight of most comet goldfish in ornamental ponds ranges from 7 to 14 ounces. Fish losses do happen in ornamental ponds, so let us assume only 19 of the fish make it to their adult weight and their adult weight is the minimum 7 ounces. That is 133 ounces, or 8.3 pounds of fish, more than double your pond's carrying capacity!

Example 2. We will use the same 400 gallon ornamental pond from example 1. This time you choose to stock koi instead of comet goldfish. The weight of an average koi in the pet store is typically 1.1 to 2.1 ounces, but knowing koi obtain larger sizes than goldfish, you only stock 12 fish and 8 of them survive to adulthood. The average weight of an adult koi can be 25 pounds or more, but 4 to 5 pounds are more common in small ornamental ponds. That means your pond will contain at least 32 pounds of fish, 8 times the amount of fish your ornamental pond can handle.

Example 3. This time we use an ornamental pond that contains 400 gallons of water, a small pond bio-filtration system, and high

aeration from a waterfall, air diffuser, and a few submersed plants. This pushes the maximum *ADULT* fish weight this pond is likely to support to 2 pounds of fish per 100 gallons, or 8 pounds total. These additional features allow us to stock more fish in the same volume of water, so we can support 18 adult comet goldfish, or 2 adult koi, or 1 adult koi and 9 adult comet goldfish. This increase can be obtained with a few improvements to raise the carrying capacity.

Types of Fish

The most common types of fish used in ornamental fish ponds, goldfish and koi, belong to the carp family. Koi have been selectively bred for centuries from the common carp, *Cyprinus carpio*, to obtain their unique color, scale, and fin characteristics. Few people realize they are the same species as the common carp, just as a thoroughbred is the same species as a wild mustang. Development of the goldfish was accomplished by a millennium of selective breeding of the Prussian carp, *Carassius gibelio* or *Carassius auratus gibelio*. The coloration of the goldfish was obtained by breeding Prussian carp that had a recessive genetic mutation yielding a yellowish-orange coloration rather than the normal olive-grey appearance. After a millenium of breeding, the goldfish is now considered by many as a unique species, *Carassius auratus*, with unique scale counts and body morphology. However, it is not uncommon for feral goldfish to revert back to the olive-grey coloration after several generations of breeding in the wild.

Goldfish and koi host numerous forms or varieties that usually differ in coloration, fin shape, or eye or body conformation. However, normal body structure characteristics, such as those found in the comet goldfish or common koi, typically survive and thrive better in water gardens than some of their oddly-shaped or oddly-finned counterparts. Koi require a lot more room and dietary attention than goldfish, and can grow quite large sometimes living between 60 and 70 years, although 20 years or less is more common in ornamental ponds.

It can be advantageous to stock a few topminnows from the genus *Gambusia*, also known as mosquito fish, to help control nuisance insect larvae from developing in the pond. In some cases small members of the genus *Lepomis*, members of the sunfish family, may be stocked but their population must be managed as they overpopulate quickly. Some ornamental ponds and living streams are stocked with a variety of native minnows and shiners. They often do not fare well in small water bodies with limited water exchange and larval insects for food, but with care and special detail to model your water garden as close as possible to their native environment, some species can thrive. Whatever types of fish are used in the ornamental pond, it is important to know the environmental requirements of each species and to understand which fish will do well in your climate.



The most common types of fish used in ornamental fish ponds are koi (above) and goldfish. Koi and goldfish are often selected due to their various colors and body forms, but they are also tolerant of a wide range of water quality.

Acclimating the Fish at Stocking

The acts of harvesting, transporting, and holding fish at pet stores or hobby centers can be quite stressful on the fish and expose them to various infectious diseases. It is important to make sure fish appear healthy and active before purchase. New fish should be kept separate from the ornamental pond containing existing fish, in a quarantined area or tank with its own water and equipment, for a few days prior to their introduction to your pond and other fish. This quarantine period helps to ensure a disease free and healthy environment for all of your fish. When placing fish into the ornamental pond, it is important to acclimate them to the temperature and pH by floating a large plastic transport bag filled 1/3 to 1/2 full of water in the pond for 10-15 minutes. Be sure to keep the bag out of direct sunlight because it can act like a magnifying glass and heat the contents within it. After the temperatures have equalized, slowly splash water from the pond into the bag until the water volume within the bag has doubled its

original volume. Before releasing the fish, net it with a pre-wetted net or a wet hand, do not pour the transport water from another system into the water garden to limit the transport of disease or parasites. The fish should be able to swim away and behave normally without assistance. The quarantine procedure is not needed for the initial fish stocking into a new ornamental pond. Instead, jump directly to the bag floating stage and proceed as listed above.



Allow fish to acclimate to the water temperature by floating the bag they came in in your pond for 10-15 minutes. Then acclimate the fish to the water pH by slowly splashing water from the pond into the bag until the water volume within the bag has doubled its original volume.

Feeding Fish

Over-feeding fish is a common problem in the management of water gardens. It is important to estimate the proper feeding rate by weighing a sample of fish or to approximate it based on their length. Fish are fed for either growth or maintenance; being fed about 3% of their body weight per day promotes rapid growth, whereas 1% of the body weight is enough to sustain the fish and keep them healthy. Remember, these fish are in an outdoor environment and you

are providing only supplemental feeds. They also obtain food from the algae, zooplankton, insect larvae, and in some case plants contained within the ornamental pond. Maintenance feeding at 1% a day or 1.5% every other day is typically sufficient to maintain a healthy fish population. Additionally, fish are cold blooded, so they do not have to be fed each day and feeding must be reduced or even ceased during cooler winter months when their metabolism is not active. Fish should also be fed sparingly in temperatures above 85F. Warmer temperatures and high feeding rates can lead to oxygen depletions. In hot summer months, it is best to feed in the early to mid-morning before water temperatures become excessive. Fish should be fed a diet rich in protein and fat and most feeds contain more than 28% protein. It is important to choose a diet with a similar make-up to the natural food item consumed by the species and be aware that different species may require different feeds.

Fish should consume the feed quickly, usually within 5 minutes of being fed. Floating feeds typically ease the feeding process because you can see the fish feeding and make sure you are not feeding in excess. If feed remains within 10 to 15 minutes from the time food is offered, you are over feeding them and this can have dire consequences for your water garden's ecosystem such as algal blooms or oxygen depletions. Reduce the amount of food offered at the next feeding accordingly. Net out or physically remove any uneaten feed after 15 minutes. If the fish do not feed readily or vigorously, they might be stressed, diseased, or the water

temperature may be incompatible with the need for food.

Aquatic Plants

As previously mentioned, aquatic plants are important to the ecosystem of the water garden because they produce oxygen, filter the water by removing and recycling nutrients, and provide shade and hiding places for fish. Many water garden owners enjoy the beauty of aquatic species such as lilies, lotus, reeds, and other exotics; be sure to understand the climates in your area and the environmental and maintenance requirements for the plant species you plan to keep in the water garden. If they do not agree with your local climate, the plants will be unhealthy and require more maintenance. Also be aware that it is illegal to possess certain nonindigenous plants in some states because of the threat they pose to the natural environment; for example, hydrilla or giant salvinia are considered invasive species because of their capacity to quickly spread. In Texas, it is illegal to possess, transport, or introduce water hyacinths, giant or dotted duckweed, any giant or common salvinia, water lettuce, hydrilla, lagarosiphon, Eurasian watermilfoil, alligatorweed, paperbark, torpedograss, water spinach, and ambulia. For more information about invasive, prohibited species in Texas, contact the Texas Parks and Wildlife Department or visit http://www.tpwd.state.tx.us/huntwild/wild/species/exotic/prohibited_aquatic.phtml. For information about native or approved ornamental aquatic plant species contact an ornamental plant dealer or local

nursery for help. Another good resource for identification and management of aquatic plant species is Texas A&M's Aquaplant website, <http://aquaplant.tamu.edu>.



Selection of aquatic plant species should be carefully considered. Be aware that it is illegal to possess certain nonindigenous plants in some states because of the threat they pose to the natural environment.

It is important to choose plants that do not drop debris into the water garden because organic matter can clog filters and deplete oxygen as it decays, making it less available for fish and other organisms. Ideally, plants that float or closely shade the water should cover about 50-75% of the water garden's surface to suppress algal growth and provide shade to fish. Aquatic plants are best potted in heavy clay soil (free of organic matter, fertilizers, or pesticides) in plastic buckets, pans, or baskets that effectively hold soil around the roots so that plants may absorb nutrients. Any fertilizers that are added should be in a slow-release pellet formula placed deep in the root-ball to prevent leaching. However, little fertilization is needed for submerged plants. For the health of both the plants and the water

garden, plants should be periodically pruned, divided, repotted, and fertilized because plants can overpopulate quickly.

Enclosures may be used to protect the plants from being eaten by plant-eating fish like koi. A simple cage-like structure constructed with PVC coated wire, plastic mesh, or net can be constructed for submerged and emergent plants. Use PVC with plastic mesh to float a cage around the plant for floating plants. Using browse resistant plants such as reeds and lilies, or feeding fish small amounts several times throughout the day can also help reduce destruction of plants. The enclosures also serve as sanctuaries for smaller fish and protection for spawned eggs.



This lily has been planted in a pot to prevent unwanted expansion and protected with a wire mesh as seen below to protect it from grazing by fish.

Potential Problems

Water Quality

Some of the most common problems associated with water gardens and ornamental ponds are oxygen depletions and build-up of toxic nitrogenous wastes. Oxygen problems may occur because the number of fish has exceeded the pond's

carrying capacity or due to the excessive rate of decomposition of organic matter. Fish gulping at the surface of the pond is a sign of oxygen depletion, for which increasing aeration is the best management strategy. The accumulation of toxic wastes like ammonia and nitrites occur because of over-feeding, rapid decomposition of organic matter, or bio-filtration failure. To correct these problems, reduce or stop feeding, flush the pond with good quality water, or check and perform maintenance on the mechanical or biological filters. If you plan to be away for a few days or more, try to arrange to have a “pond babysitter” regularly check on the ornamental pond for problems and feed fish and plants.

Algae Control

Heavy algal blooms are a sign that an ornamental pond contains too many nutrients from fish wastes, uneaten food, or over-fertilization. Herbicides should not be used to treat algae problems because it can potentially kill fish and other decorative aquatic plants; instead, flush with fresh water, reduce feeding/fertilization, reduce the number of fish, or add more plants and/or nitrifying bacteria to treat algae problems. Some people add non-iodized salt to kill spring algae blooms because a small level acts as a tonic to fish without harming them and kills most parasites. Salts must be flushed out of the system after using this method because excess sodium can be harmful to the fish and plants.

Controlling Fish Reproduction

Overpopulation in the ornamental pond will limit fish growth, reduce water quality, and jeopardize the overall health of the fish and other inhabitants of the pond. Although eggs and fry are usually eaten by fish or aquatic insects, it may be a good idea to stock only one bluegill, a type of native sunfish, because they are very voracious and highly aggressive, usually eating all the eggs and fry. Their small mouth size limits their ability to eat older or newly stocked fish greater than 2 ounces, so your established fish will remain safe. Bluegill reproduce quickly and can spawn as many as eight times a year in some environments, so it is important to stock only one so no reproduction will occur.

Fish Diseases

Most diseases of fish are preceded by stress. Common signs of poor health or disease include reduced feeding, piping or sucking air at the surface of the pond, flashing by turning sideways and rubbing on objects, whirling, visible sores and discolorations of the fish, or appearing to swim weakly. There are more than 100 known diseases and parasites that may infect fish and they usually occur with seasonal changes in water temperature. It is essential to understand the life cycle of the parasite or disease-causing agent before an effective treatment can begin. If assistance is needed, take the fish to the nearest fish disease lab or veterinarian with knowledge of fish diseases; be warned that most fish are sacrificed in the diagnostic process, but it will provide a diagnosis to save your other fish. A quarantine area

should be set up for disease screening prior to introduction of new fish, for treating sick fish, and for temporary holding.

Stress, the precursor of many fish illnesses, is usually a reaction to unusual conditions. These conditions may include extreme temperature, rapid temperature or pH changes, high ammonia or nitrite concentration, low oxygen concentration, high carbon dioxide concentrations, crowding, handling, excessive particulate suspension, or poor nutrition. Stress is prevented through proper water garden construction and maintenance, good management, proper stocking and feeding, careful handling, and maintaining good water quality.

Predators and Other Nuisances

It is important to remember that water gardens attract wildlife and may invite predation or inhabitation by birds, cats, raccoons, snakes, turtles, frogs, or insects (and their larvae). Fences and netting can discourage animal nuisances but may detract from the beauty of the pool. Some ornamental pond owners may use scarecrows or plastic floating alligator heads to deter nuisance animals. Making the ornamental pond at least 3 feet deep provides a safe retreat for fish to help avoid predation from birds and land predators such as raccoons.

Turtles can become a problem because they eat a lot of vegetation and can foul the water by stirring up debris. Frogs lay large quantities of eggs and the resulting tadpoles deplete oxygen concentrations in ornamental ponds. Snails harbor parasites and reproduce

rapidly leading to their spread to other areas of the yard and home outside of the water garden. Mosquitos may become a problem in water gardens without fish or those choked with aquatic plants. To control mosquitos, consider adding mosquitofish or bacteria *Bacillus thuringiensis* (*B.t.*) to control larvae, and remove excess plants and detritus from the pool.



Gambusia, also known as mosquitofish, is a genus of small topminnows, shown here in the palm of a hand. These small fish are often stocked in ornamental ponds to help control noxious insect larvae.

Release of Plants and Fish

Non-native or exotic species should never be flushed or released to the wild or allowed to spread beyond the pond. Such invasive species can have long-lasting and far-reaching effects on native populations and ecosystems which may not be able to exhibit control over non-native species or diseases they may carry. Unwanted fish should be euthanized by being frozen in a bag of water and then properly disposed. Plants should be allowed to desiccate (dry out) in a safe place before being disposed of in a sanitary landfill. It is better to stock native plants and fish prevent introduction of exotic species.

Summary

As you can see, there are many factors involved in building and maintaining an ornamental water garden. The most important step is being thorough when creating a plan for your water garden. Before you begin, be sure you understand the different components involved in managing your water garden, such as water quality, filtration, and stocking fish. With proper care, an ornamental pond can be a valuable resource and increase the beauty and serenity of your home.

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