ORNAMENTAL GARDEN POOLS

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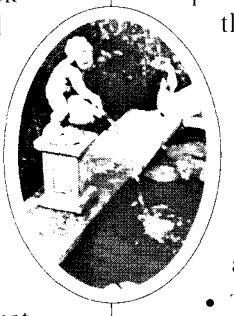
Ornamental pools, long common in the Orient, are becoming very popular in the United States. The soothing, visual beauty of pools is enhanced by aquatic plants, the ever-changing view of fish swimming among these plants, and the play of light and shadows reflected in the water. Pools can be found in private backyards, public parks, hotel lobbies, mall courtyards, restaurants, apartment balconies, and even basements in colder climates. In Japan, where ornamental pools have been popular for centuries, pool and garden designs are highly artistic. Some Japanese extend the pool into their living rooms where fish watching becomes a restful evening activity.



Little replicated research has been conducted on ornamental pools, therefore most of the information discussed herein is from related research areas and practical observation. This publication is intended to assist in understanding the requirements of fish within these miniature aquatic environments and in evaluating options in pool design.

POOL LOCATION, SIZE, AND TYPE

Location of the pool can be critical, not only to its owner's enjoyment but to the maintenance and biological performance of the pool. Site your ornamental pool to receive a minimum of 6 hours of sunlight each day. Sunlight is needed for photosynthesis by pool plants including algae, which provide oxygen to the pool. Abundant oxygen means a healthy environment for fish and other organisms in the pool. Locate your pool to avoid direct sunlight at mid-day during the warmest months. Fish can become stressed by high temperatures unless shade is provided by aquatic plants. For indoor pools, lights are available that simulate natural daylight.

Several advantages to locating the pool within view of the house are:

- To enhance human enjoyment.
- To more easily supervise children playing around the pool. **But, be sure to take precautions, such as controlling access, to ensure the safety of children.**
- To help you spot and ward-off predators, such as birds, raccoons, snakes, or that rare human thief.
- To reduce expense of pipes, electrical hookups, and pumping, which are usually lower for pools built close to the house.

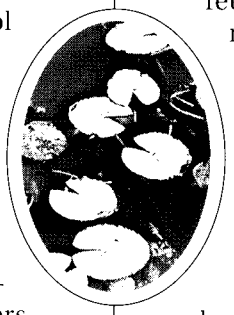
If you plan to excavate rather than build an aboveground pool, check with utility companies on the location of underground gas, water, sewer, and electrical lines. **Do not locate a pool above utility services.** Pools should not be located directly under trees, as their roots hamper excavation and may eventually cause structural damage to the pool. Also, leaves can foul the water and over-hanging branches may exude toxic substances into the pool.

Pool depths may vary depending on local climate and over-wintering management. Many pools are only 18 to 24 inches deep. Most of these shallow pools will require heaters in winter or the plants and fish will need to be moved indoors. Most permanent outdoor pools should have a

Table 1. Typical Construction Materials For Ornamental Pools.

Pool Type	Advantanges	Disadvantages	Special Considerations
Earthen	Inexpensive, especially for larger pools.	Seepage; wild plants may establish.	Soil must be high clay.
Flexible liners	Ease of construction.	Possible punctures; must be pumped or siphoned to drain.	Type of liner will determine lifetime, usually 10 to 20 years.
Fiberglass or plastic	Durable—long life; good for plant-only pools.	Shallow, not year-round habitat for fish. Can crack if water freezes.	Very small pools; could be moved inside during the winter.
Concrete	Very long life; can add decorative tiles.	Expensive; must be cured.	May need coating with Epoxy or pool paint to stop leaching of minerals.

portion at least 3 or 4 feet deep. This allows the fish an area deep enough to resist most winter freezes and a cool retreat during hot weather. Koi carp, in particular, tend to lose color and become stressed if they do not have a cool place to retreat to during hot weather. However, a depth of 18 inches is sufficient in the deep South, as long as only a few fish are stocked and plenty of floating aquatic plants are provided for shade.



Ponds are built out of several types of materials. Some of the more common construction materials are earth, plastic liners, fiberglass, and concrete (Table 1).

Many commercial firms selling pool equipment offer consulting services on design, construction, and maintenance. Use available expertise and your own creativity to design a pool that reflects your own imagination and taste.

EQUIPMENT AND COSTS

Pools can be relatively expensive to build and maintain, although many beginners start with little expense by using an old wash tub or a child's wading pool. Construction costs for most pools can range from several hundred to several thousand dollars depending on size, depth, materials used, and labor. Labor costs can be reduced by doing the work yourself or acting as back-up labor for the professionals you hire.

List Of Possible Pool Equipment And Materials

- Pipes, drain structures, nets, buckets.
- Spare tanks for acclimating and isolating fish, feed, chemicals, brushes, and test kits to measure oxygen, pH, etc.
- Electrical hookups, lights, pumps.
- Filters: biological or mechanical, filter media such as zeolite or charcoal.
- Sand or stone overlays or borders.
- Fountain, waterfall, aerator.
- Plants, plant enclosures.

Consult ornamental fish specialists or dealers of ornamental pool materials for assistance. Draw up a detailed plan so that a specialist can suggest specific improvements or spot potential pitfalls. A word of advice: Most pool owners regret not building their pools larger.

PERMITS

Constructions plans should be reviewed by local governmental departments (for example, Building and Zoning) to ensure that the proposed system complies with all building codes: water, drainage, and electrical requirements. Permits may be required.

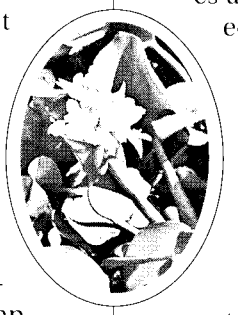
POOL CONSTRUCTION

Construction of a backyard pool can be simple or complex. Pools built on site of fiberglass or concrete take considerable construction skills. Earthen and plastic-lined pools require less construction skill or experience.

Pools may be irregular or geometric in shape. Irregularly shaped pools have a natural look, while the geometric shapes appear more formal. Try designing different pool shapes by using a garden hose or rope to outline the pool edges prior to excavation.

Before you start to dig, plan how pipes, filters, fountains, or water heaters will be concealed. Decide where electrical and water lines should be placed for night lighting, pumps, fountains, or waterfalls. This is also the time to set foundations for such structures as stepping stones, a walking bridge, or the base of a fountain.

Pools without drains are common, particularly those with liners, but a drain allows for easier management. Draining facilitates cleaning and fish removal in cases of maintenance or disease problems. Of course, pools can be drained by pumping or, in some cases, siphoning. Before building the pool, plan how the pool will be drained. Draining into city sewer lines or a storm drain is probably legal, but draining onto a neighbor's property is not. When in doubt consult local government agencies.



An important consideration when constructing a pool is to make sure the bottom slopes at least 1 percent (1 foot decline per 100-foot distance) so the water will drain. A catch basin, usually 6 to 12 inches deep, in the deepest part of the pool will help concentrate the fish during draw-down. Remember, the drain, pump, or siphon intake should be covered with mesh so no fish will escape during draw-down.

Pools that are at least two-thirds below ground level retain heat in cold weather and keep the pool cooler in hot weather. Pools that are built totally aboveground may have to be drained during the winter, requiring that fish and plants be moved indoors.

Excavated pools can have problems from water run-off. First, care should be taken during construction so that run-off water does not flow into the pool. If the surrounding terrain is higher than the pool, a berm may be required to control run-off. Run-off water can introduce chemical contaminants or cause muddiness or oxygen problems. Secondly, rain water saturation of the soil under the pool may cause the pool to overflow or float out of the ground. To prevent this problem, you will need a special under-pool drainage or water-pressure relief system. Consult the USDA Soil Conservation Service on soil characteristics in your area.

Liners are very popular because of their versatility. Liners allow for relatively quick and less expensive construction and allow future changes in size or shape of the pool.

Vertical pool sides can erode rapidly and let detritus (dirt, leaves, etc.) build up along the edge of the pool bottom. Tiered or sloping sides encourage movement of detritus toward the deepest part of the pool where the material can be drained or siphoned out. The pool sides should be cut in two or three tiers, each about 12 inches wide. Tiers help to hold liners in place as well as to provide ledges for plants and other decorative items. To protect a liner from puncture by roots and rocks, the dirt along the pool sides and bottom should be covered with sand prior to installing the liner. Firmly pack the pool sides and bottom, especially if liners are used. Smooth the pool corners so they will not become detritus traps.

Borders that overhang the water by 1 to 2 inches are visually pleasing and help conceal liner edges and hide openings to equipment. The pool's exterior borders may be decorated with washed sand or rocks. Aquatic plants such as lilies, lotus, hyacinths, reeds, and submerged plants add to the aesthetic beauty of the pool and function as biological filters and shade for fish in the pool.

In building the pool, remember that water will be level but your construction may not be. Unless leveling is accurate during construction, you may end up with an exposed area at one end of the pool and water about to overflow the other end. **Make sure the shoreline of your pool is level!**

For advice on construction, consult a professional pool builder or plumbing contractor. For advice on filters, consult an ornamental fish dealer, pool builder, or Extension fisheries specialist.

POOL DECORATIONS

Part of the fun of owning an ornamental pool is designing the overall look of the pool and its surroundings. The materials used can be as varied as your imagination. Consider rocks of varying colors and shapes, railroad ties, fountains, waterfalls, windmills, underwater lighting, islands, bridges, aquatic plants, and surrounding flower gardens. Some garden designers create spaces using arches, gates, fences, and even gazebos. One type of

traditional Japanese garden is made by raking sand of various shades of one color into a variety of designs.

Statuary fountains are common in formal pool designs.

WATER

WATER SOURCE

Whether your ornamental pool is a plastic tub or a backyard wonder with waterfalls and hidden lights, good water quality must be maintained. If not, the pool declines in beauty and the fish become stressed and susceptible to diseases. Once the basics of water quality are understood and practiced, maintenance will become second nature and require only a few hours per week.

The first consideration is the availability of a good quality water supply adequate to fill the pool. The most common sources are city water and well water. Surface water from a creek or pond is not recommended as it may contain contaminants, diseases, or wild fish, any of which may harm the pool's ecosystem. If city water is used, it must be dechlorinated. One week of sunlight (or less, if continuously aerated) will dechlorinate city water if the chlorine source is liquid or gaseous chlorine. If the chlorine source is chloramine, it is best removed by chemical dechlorination. Commercial dechlorinators made from sodium thiosulfate are available in liquid or pelleted forms from most aquarium and pool suppliers.

WATER VOLUME AND WEIGHT

Water volume of the pool must be determined before selecting a filter or pump or performing a chemical treatment. Knowing the pool's water weight is very important before placing a free-standing pool on a patio, roof, or on the living room floor. Be careful, check your structural support, because water is very heavy. For information on calculating area and volume request Southern Regional Aquaculture Center (SRAC) Publication No. 103, "Calculating Area and Volume of Ponds and Tanks," by M. P. Masser and J. W. Jensen, from your county Extension agent.

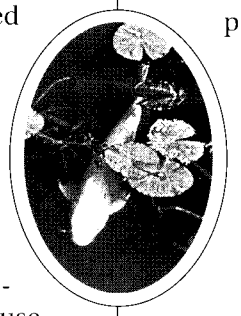
WATER QUALITY

Water quality is always a concern in any type of aquatic management. Water quality factors of common concern are dissolved oxygen, ammonia, nitrite, pH, alkalinity, hardness, carbon dioxide, and contaminants or pollutants (like pesticides). Not all of these factors deserve equal consideration. The following is a brief discussion of their importance as applied to ornamental pools.

The amount of oxygen that will dissolve in water (D.O.) is very small and is measured in parts per million (ppm). The amount of oxygen in a pool can range from 0 ppm to more than 20 ppm. Oxygen dissolves directly into the pool from the air if the water is agitated (by wind, waterfalls, etc.) or from underwater plants, which excrete oxygen as a byproduct of photosynthesis. Decorative underwater plants produce oxygen. The amount of oxygen in the pool will vary, depending on the amount of agitation, numbers

of fish and plants, time of day, and water temperature. More oxygen can dissolve in cool water than in warm. As temperature increases in the summer, fish increase their metabolism and less oxygen will be dissolved in the pool, particularly at night when underwater plants are also using oxygen in respiration. Fish will become severely stressed at less than 3 ppm D.O. and will die if oxygen concentrations fall near 1 ppm.

Pool nutrients come from fish feed, wastes, decomposing leaves (etc.), and from fertilizers applied to pool plants. In a well-balanced pool, ornamental plants will remove nutrients rapidly and suppress algal growth. Excessive nutrients stimulate rapid algal growth or blooms. The clinging, filamentous kind of algae are not the problem that the free-floating blooms are. Algal blooms quickly become a nuisance, causing the water to become a cloudy green and restricting the view of fish. Dense algal blooms may cause oxygen depletions at night or during extended cloudy weather. Mechanical aeration, such as water falls or fountains, can maintain minimum dissolved oxygen concentrations and remove excess carbon dioxide. Still, excessive algal blooms should be controlled.



- The best method to control algal blooms is to avoid over-stocking and over-feeding of fish or over-fertilizing pool plants.
- Another common management strategy is to either increase decorative plants or use bio-filters to remove excess nutrients on which algae flourish.
- A third method is to replace or flush water through the pool to dilute nutrients and disperse algae.

Ammonia is the major nitrogen waste excreted by fish. Certain types of bacteria decompose or nitrify ammonia to nitrite. Ammonia and nitrite are both toxic to fish but are seldom problems in ornamental pools. These compounds are normally removed from the water by pool plants and used as nutrients for growth. Ammonia and nitrite can become problems if the pool is overfed, over-fertilized, or from rapid decomposition of organic matter (leaves, dead plants, fish, etc.). Remove excess ammonia and nitrite by biofiltration (see Filtration section), by flushing, or by additions of bacterial water conditioners.

The pH is measured on a scale from 0 to 14 with 7 being neutral (less than 7 acidic, more than 7 basic). Pool pH cycles daily because of photosynthesis and respiration of plants and other organisms. Under normal conditions, pool pH can fluctuate from 6.5 to 9 without harming fish. A pH much above or below this range will stress or even kill fish. If the pH is fluctuating above or below 6.5 to 9, the pool needs buffers added to increase the alkalinity.

Alkalinity is a measure of bases in water and is therefore related to pH. Alkalinity is measured in ppm (or mg/l) and can range from 0 to more than 300 ppm. Sufficient alkalinity buffers or resists pH changes. Alkalinity can be increased in the pool by adding carbonates (agricultural limestone, oyster shell, or bicarbonate of soda). In general, an alkalinity of greater than 20 ppm is considered adequate, but 50 ppm or greater is better.

If you suspect any chemical contamination of the water, you can perform a simple bioassay using a few fish. Place three or four small fish in a minnow bucket and float 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. Use fish that look healthy to minimize the risk of introducing diseases into the pool. Do not set these fish free into the pool unless they are specific individuals you want stocked into the pool. Once you release fish into the pool it will be very difficult to remove them without draining the pool.

FILTRATION

Not all pools need filtration. Pools with abundant plants and a modest number of fish should not need filtration. The key is to maintain water quality and relatively clear water so your fish can be seen and enjoyed. Again, ornamental plants are active biological filters, and, if a balance is maintained between the number of plants, the number of fish, and the amount of nutrients the pool receives, no other filtration may be necessary. Keeping the proper balance is as much an art as a science. For this reason, many pool owners become frustrated with trying to maintain balance and opt for additional filtration.

The two basic types of filters are **mechanical** and **biological.**

- **Mechanical filters** remove or trap particles of dirt and organic matter. Typical mechanical filters include leaf skimmers, sand beds, foam or cartridge filters, and settling basins. Leaf skimmers, foam filters, or some type of settling basin are the most commonly used mechanical filters.

Bacteria on substrate of biological filters remove nutrients and improve water quality.

Sand filters and cartridge filters, like those used in swimming pools or hot tubs, are not generally used in ornamental pools because they clog or channel quickly and require fairly large volumes of water for back-washing.

- **Biological filtration** removes excess nitrogen produced from fish wastes and decomposition of organic matter. Natural biological filtration comes from nutrient removal by plants, algae, and bacteria. Decorative plants remove nutrients and slow water currents that cause suspended particles to fall out of the water column.

Bacteria also remove nutrients, but only if provided with the proper substrate and environment. Bacterial bio-filters are becoming common in ornamental pools, particularly those in which fish are the major attraction. Bio-filters require little maintenance if properly designed and installed.

Bacterial bio-filters rely on bacterial growth to clean the water of wastes. Bio-filters contain layers of gravel or coarse sand, corrugated plastic sheets, plastic rings, mesh, or foam, or some other material as a substrate or media on which bacteria grow. Like plants, the bacteria remove wastes as nutrients for growth. Bio-filters operate best at a pH of 7 to 7.5 and an alkalinity of around 50 ppm. Adjustments in pH and alkalinity can be done using agricultural limestone, oyster shell, and bicarbonate of soda.

Under-gravel filters, common in aquariums, are one of the simplest types of bio-filters. In these filters, the gravel acts as a mechanical filter and is colonized by bacteria. Large gravel filters can be built into the pool bottom or into the bed of a stream or brook that flows into the pool. The problem with gravel filters is that they become clogged with solids and require laborious cleaning.

A common type of in-pond filter uses plastic media and foam surrounding or connected to a submersible pump to accomplish both mechanical and biological filtration (Figure 1). The pump draws water through the filter media, trapping sediment and providing an area for bacteria to grow. This type of filter requires that you remove sediment periodically and clean the foam every 1 or 2 days. **Sediment should not be allowed to build up in the bottom of the filter.**

An up-flow bio-filter is another popular design (Figure 2). As the name indicates, water enters the filter from the bottom and exits through the top. Stainless steel or plastic mesh is used to hold the

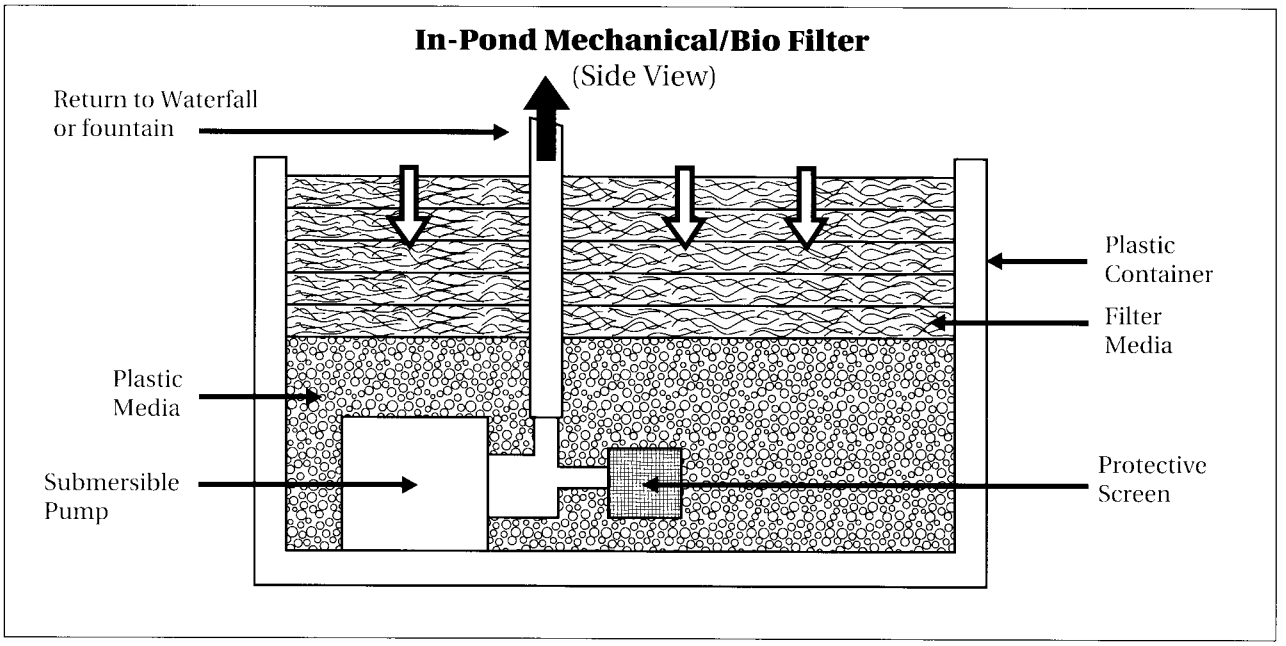


Figure 1. In-pond filter with submersible pump.

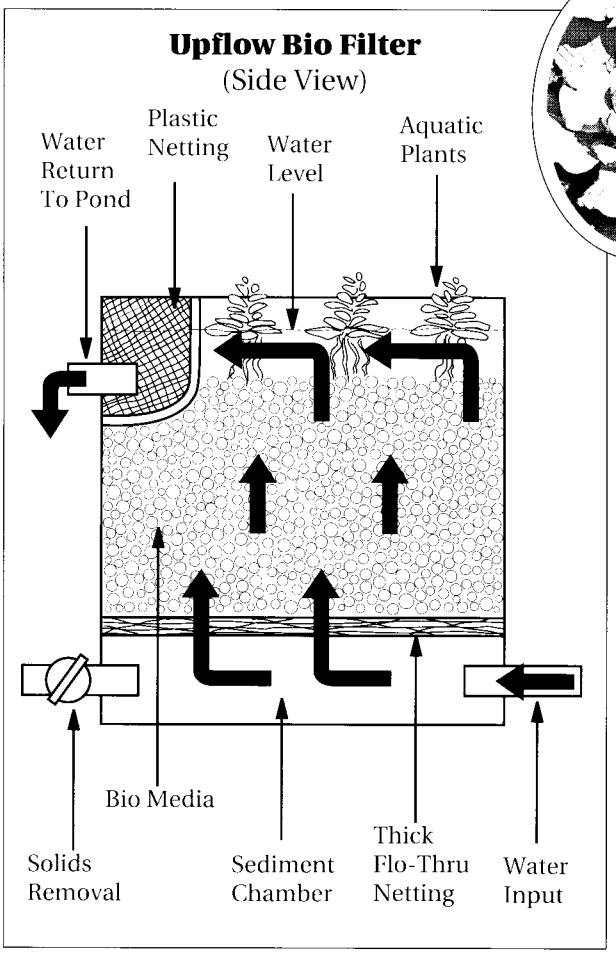
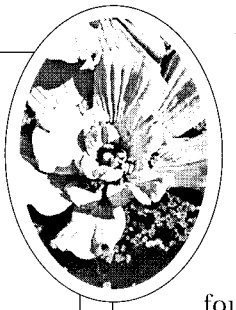


Figure 2. Up-flow biofilter.



bio-filter media off the bottom and it thus creates a sediment basin. Plastic beads and other coarse media are colonized by bacteria. Plants can be added to the surface of the filter for added nutrient removal. Up-flow filters are usually self-contained and separate from the pool.

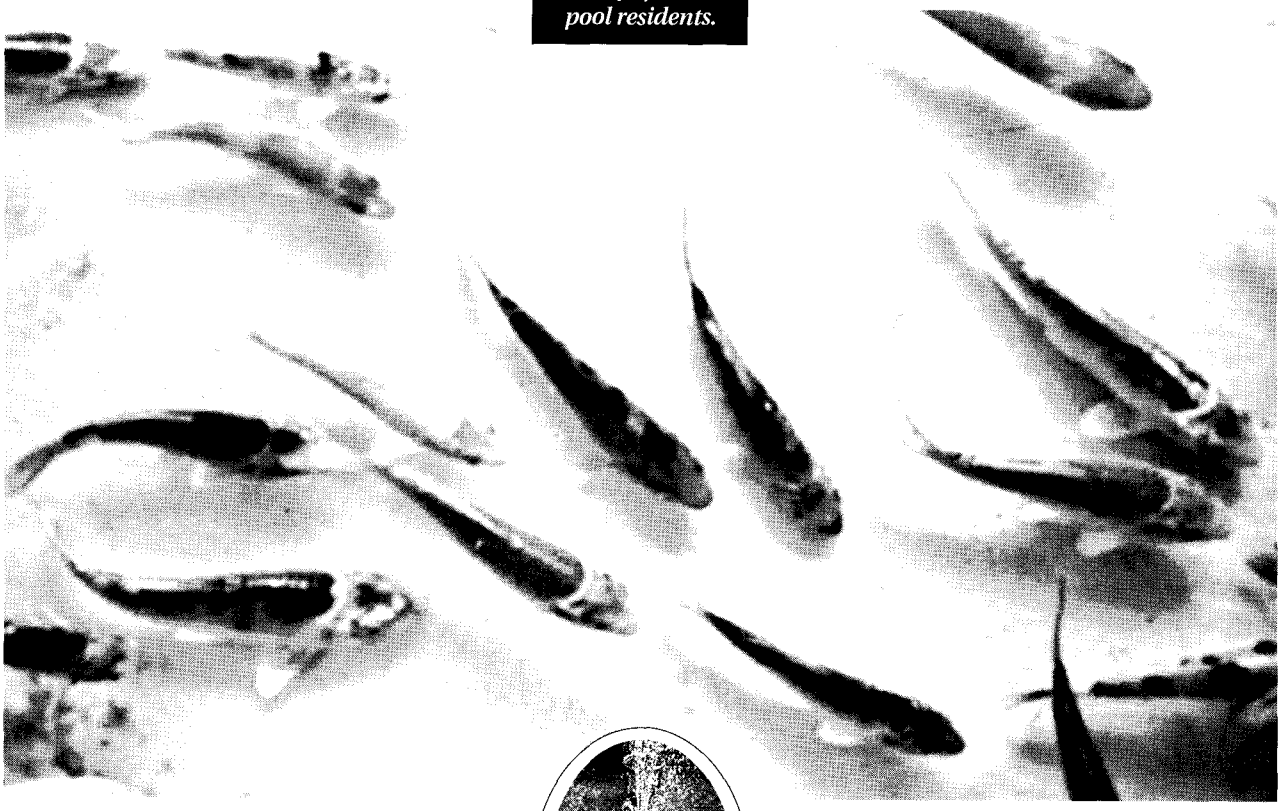
Other designs for bio-filters can be found in aquaculture and ornamental pool publications but are beyond the scope of this publication.

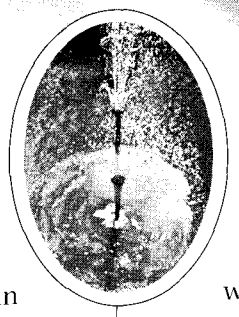
FISH

One common mistake made by novice ornamental pool owners is to stock too many fish. Many people do not consider the number of fish the pool can safely support and that fish grow. A pool is suitable for fish as long as it can supply adequate oxygen and decompose the wastes. Most of the fish commonly placed in ornamental pools grow rapidly and may keep on growing unless they are kept on a limited diet.

Pool carrying capacity, or number of fish the pool can support, varies, depending on a variety of factors. These factors include size of pool, temperature, amount of sunlight the pool receives (which influences oxygen levels), whether aeration is provided, and how well the filtration system removes wastes. The stocking rate, or num-

Colorful koi are popular pool residents.





ber of fish to put in the pool, should not exceed the pool's estimated carrying capacity. The following examples give stocking rates recommended by fish hobbyist magazines.

First, determine the pool's surface area in square feet. Stock an **unaerated pool** with one 12-inch fish (not including the tail) per 4.5 square feet of surface area. Stock an **aerated pool** with one fish per 2 to 3 square feet. Conservative hobbyists suggest stocking only 1 to 6 inches of fish per 5 square feet of surface or 8 to 12 inches of fish per 16.5 square feet of surface area.

For example, if a pool measures 9 × 15 feet, the surface area is 135 square feet. Dividing 135 square feet by 4.5 square feet = 30, the units of 12-inch fish bodies per unit, or 360 inches total. The average adult koi carp is 18 inches, so this 9- × 15-foot pool can support 20 adult koi carp. Top exhibitors in Japan stock only 10 to 15 koi even in large pools, while the majority of koi owners tend to slightly over stock.

KINDS OF FISH

Fish commonly stocked into ornamental pools belong to either the goldfish or the koi family. There are numerous varieties of these fish.

Early references to the common goldfish are found in Chinese poetry as early as 1,000 A.D. The Chinese and Japanese nobility led the way in developing many of the varieties we see today, most of which had been developed by the sixteenth century.

Common and fancy goldfish are the same species *(Carassius auratus)*. The common goldfish, shubunkin (or calico), comet, and fantail goldfish have body structures similar to the wild form. What makes these varieties distinct are differences in coloration or fin shape. Members of the goldfish family, which vary from the wild form in both body structures and fin shape, include the nymph, fringetail, and veiltail goldfish. Additionally, there are strange varieties that have markedly altered bodies bordering on the grotesque, such as the eggfish, tiger-head, lion-head, circled gill, and bubble-eyed goldfish.

Koi carp are descendants of the European common carp *(Cyprinus carpio)*. Koi is a Japanese word meaning "love," and koi-giving in Japan approximates the meaning of flower giving in the West. Koi have been bred in Japan since at least 300 A.D. They are a very popular ornamental fish because of their wide variety of colors and color patterns. Each color and pattern combination on

the koi is given a distinctive Japanese name. The most prized koi have the brightest, most intense colors, the sharpest color definitions, and the most distinctive placement of markings. Koi with exceptional coloration and patterning can be valued at thousands of dollars per fish.

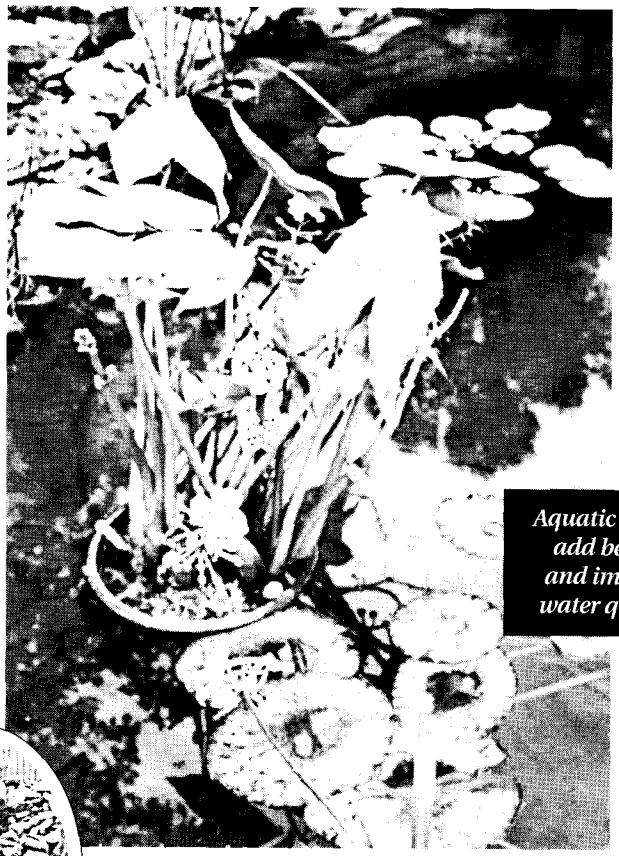
Pool owners should be aware that koi can grow quite large and sometimes live for 60 or 70 years. These fish can truly be lifelong pets and then be passed on as family heirlooms.

ACCLIMATING THE FISH AT STOCKING

First, inspect the fish carefully before purchase to be sure that they appear healthy (see disease and stress sections). Fish must be stocked correctly if they are to remain healthy. When stocking, it is necessary to acclimate the fish to the temperature and pH of the pool water. To do this, float the transport bag containing fish in the pool for 10 to 15 minutes. **Keep the bag out of direct sunlight,** because a plastic bag acts like a magnifying glass and will rapidly heat the water inside. Next, open the bag and slowly splash water from the pool into the bag. Check the water temperature in the bag and pool with a thermometer or your fingers. Once the water temperatures are the same or within 2 or 3 degrees, release the fish into the pool. It is best to dip the fish out of the bag to eliminate adding the transport water to the pool. The fish should swim away and behave normally.

AQUATIC PLANTS

Aquatic plants not only add beauty to an ornamental pool but are also effective filters and nutrient absorbers. Plants, like *sagittaria* or *anacharas* (elodea), come in a bunch and are submerged into the pool in areas with water movement. These multiply quickly, filtering and oxygenating the water. Plants such as water lilies, reeds, lotus, and primrose remain potted and are submerged in the pool to the proper depth. Plants like hyacinths float with roots free to absorb nutrients. Water hyacinths are efficient filters if they are floated in 6 to 8 inches of water with water flowing through their root mass.



Aquatic plants add beauty and improve water quality.

Decorative plants, just like other garden plants, will need periodic pruning, dividing, repotting, and fertilizing. Caution: Some plants overpopulate quickly and are best grown in containers.

Plants may need to be protected from the fish by surrounding them with wire or plastic mesh (see Enclosures: Use and Design). Choose plants that will not drop debris into the pool, since organic matter can clog filters and deplete oxygen as it decays. Many aquatic plants of tropical origin, like hyacinths, won't survive winter freezes and must be brought indoors. Hardy aquatic plants such as water lilies and water iris are winterized by cutting off the growth and placing the pots in the pool below the freeze line. **Check with the ornamental plant dealer as to the best care practices for the plants.**

ENCLOSURES: USE AND DESIGN

Many people construct ornamental pools for the beauty and variety of aquatic plants that can be grown and do not stock fish at all. If you desire both, aquatic plants will need to be protected when combined with plant-eating fish like koi

carp. Wire or plastic net enclosures work well. These enclosures may also serve as sanctuaries for smaller fish and to protect any eggs spawned. Enclosures also can be used to manage fish. Multiple feedings (three or four per day) of koi will reduce their destruction of plants.

Enclosures for potted plants are often constructed from stiff plastic mesh attached to the plant container and extended to the water's surface. It is important to extend the mesh to the surface or fish may invade the enclosure. The plastic mesh diameter should be a ½-inch or smaller.

A simple enclosure for floating plants can be built from PVC or polypropylene (poly) pipe and plastic mesh. The PVC or poly pipe is made into a float by cutting it to the desired dimensions and shape using 90-degree or 45-degree PVC pipe elbows and tubing connectors for poly pipe. A bag made of the plastic mesh is then glued onto the PVC frame. Use hot glue for gluing the plastic mesh to the PVC.

FEEDING FISH

As mentioned before, over-feeding is one of the most common problems in ornamental pools. Fish can be fed for either growth or maintenance. If you want the fish to grow rapidly you may have to either stock fewer fish or increase the pool's filtering capacity. Once the fish have reached the desired size, reduce feeding to a maintenance diet. Estimate proper feeding rate either by weighing a sample of fish periodically to find an average weight per fish (this can be very stressful to the fish) or by approximating their weight based on their length (Table 2). One word of caution: fish should consume feed quickly (within 5 minutes); in warm weather, never feed more than the fish will eat within 15 minutes. If the fish do not consume all the food within 15 minutes, you are probably over-feeding or the fish are under stress or have a disease. **Note, feeding activity may decline rapidly when temperatures drop quickly.**

Table 2. Approximate Length To Weight Relationships For Carp And Goldfish.

Total length (inches)	Carp weight per 10 fish (pounds)	Carp individual weight (ounces/grams)	Goldfish weight per 10 fish (pounds)	Goldfish individual weight (ounces/grams)
2	0.08	0.13/3.6	0.05	0.08/2.3
2.5	0.14	0.22/6.4	0.09	0.14/4.1
3	0.22	0.35/10	0.17	0.27/7.7
3.5	0.33	0.53/15	0.25	0.40/11.3
4	0.47	0.75/21.3	0.40	0.64/18.1
4.5	0.65	1.04/29.5		
5	0.85	1.36/38.6		
5.5	1.09	1.74/49.4		
6	1.37	2.19/62.1		
6.5	1.67	2.69/75.8		
7	2.06	3.29/93.4		
7.5	2.47	3.95/112.4		
8	2.93	4.69/132.9		
8.5	3.44	5.50/156.0		
9	3.99	6.38/181.0		
9.5	4.60	7.36/208.7		
10	5.27	8.43/239.1		
11	6.77	10.83/307.1		
12	8.51	13.62/386.0		
13	10.50	16.80/476.2		
14	12.76	20.42/578.8		
15	15.74	25.18/714.0		
16	19.03	30.45/863.2		
17	22.96	36.7/1042.5		
18	27.47	44.0/1246.0		
19	32.33	51.7/1466.5		
20	37.76	60.4/1712.8		

Table 3. Feeding Rates Based On Water Temperature For Growth Versus Maintenance Rations.

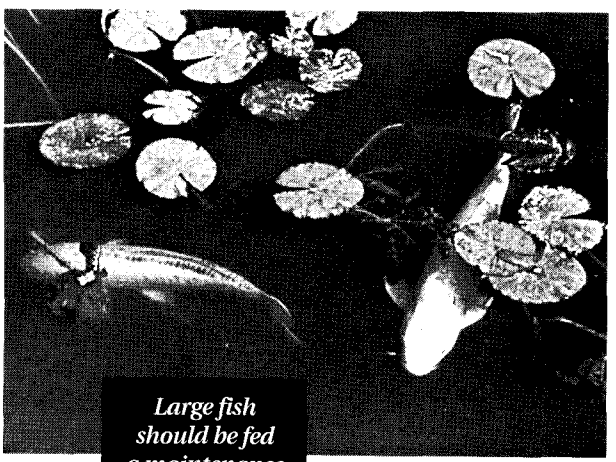
Water Temperature (°F)	Growth Ration (% body wt/day)	Maintenance Ration (% body wt/day[a])
Fish less than ½ lb.		
> 90	1.0	0
70 - 90	3.0	1.0
60 - 69	2.0	0.5
50 - 59	1.0	0.2
45 - 49	0.5	0
< 45	0	0
Fish greater than ½ lb.		
> 90	1.5	0
70 - 90	3.0	1.0
60 - 69	2.5	0.7
50 - 59	1.0	0.5
45 - 49	0.5	0.2
< 45	0	0

[a]Feed only 5 days per week.

A feeding rate of approximately 3 percent of body weight per day during warm weather (water temperatures above 70°F) will promote rapid fish growth (see Table 3). You may not want rapid fish growth.

Maintenance feeding is calculated as 1 percent of the average fish body weight multiplied by the number of fish, but feed only 5 days per week. Remember, on a maintenance diet the idea is not to promote growth but to sustain the fish and keep them healthy. Usually some growth will occur on a maintenance diet.

If the fish grow too large and surpass the carrying capacity, remove some of them. Pools pushed beyond the carrying capacity will eventually have problems, such as heavy algal blooms, diseases, or oxygen depletions.



Large fish should be fed a maintenance ration.

Feeding should be reduced at water temperatures above 90°F. At high temperatures fish do not feed well and are easily stressed by poor water quality. Also, do not feed fish at water temperatures below 45°F. Fish do not feed at lower temperatures because their metabolism decreases. Uneaten feed can create water quality problems. **It is a good practice to remove uneaten feed.**

PROBLEMS IN POOLS

WATER QUALITY PROBLEMS

The two most common water quality problems are oxygen depletions and the build-up of toxic nitrogenous wastes.

Oxygen depletions occur because the total amount of plant and animal life has exceeded the carrying capacity of the pool or because of an excessive rate of decomposition. Fish gasping at the surface is almost a sure sign of an oxygen depletion. Aeration, the best management for oxygen depletions, should begin immediately; then the cause of the depletion should be determined.

The other common water quality problem is the accumulation of toxic wastes such as ammonia and nitrites. This problem occurs because of over-feeding, rapid decomposition, or biofiltration failure. When high ammonia or nitrite concentrations are discovered, reduce or stop feeding, flush with good quality water, and check the mechanical or biological filters.

ALGAE CONTROL

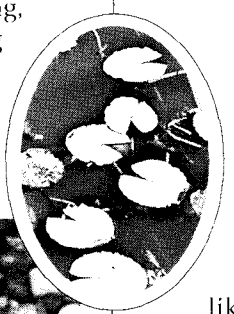
If the algal bloom starts to cut down on visibility, the natural tendency is to treat with herbicides. This is not recommended as it can easily kill fish if the herbicide is not applied properly, or if the decaying algae depletes oxygen. Herbicides may also kill the decorative aquatic plants in the pool. A heavy algal bloom is usually a sign that the pool contains too many nutrients derived from fish wastes, uneaten feed, or over-fertilization. To treat the problem, you may want to flush the pool with fresh water, reduce feeding or fertilization, add additional aquatic plants or nitrifying bacteria, or reduce the number of fish in the pool.

CONTROLLING FISH REPRODUCTION

Another common problem in ornamental pools is controlling fish reproduction. Over-populating the pool with fish will generally limit fish growth, reduce water quality, and jeopardize the overall health of all the fish. Usually the eggs or fry will be eaten by fish or aquatic insects. But, even if only a few survive, the pool will slowly become over-populated. One biological control method is to stock one sunfish (bluegill). Sunfish are voracious and aggressive enough to eat all eggs and fry in most pools.

FISH DISEASES

Disease strikes most pools at some time and is almost always preceded by stress on the fish. Stress has a wide variety of causes. Some signs of stress, disease, or parasites are easy to spot and watching for them should become a part of your pool maintenance routine. The most common signs are a reduction or cessation of feeding, piping (sucking air at the surface), flashing (quickly turning sideways and rubbing on objects), whirling, or visible sores and discolorations. There are more than 100 known diseases and parasites that can infect fish. To have a diseased fish diagnosed, you may send a live, diseased specimen to the nearest fish disease lab or contact a veterinarian who has training in fish diseases. Circular ANR-562, "Guidelines for Collecting and Shipping Diseased Fish," by M. P. Masser and Y. J. Brady, is available through your county Extension office. Pool owners should be warned that most fish are sacrificed in the diagnostic procedure.



Pools add natural beauty to our environment.

STRESS ON FISH

Stress is a reaction to unusual conditions. This includes extreme high or low temperatures, rapid temperature or pH changes, high ammonia or nitrite concentrations, low oxygen, high carbon dioxide, crowding, handling, excessive particulates, and poor nutrition. Stress can be reduced through good management, including proper stocking and feeding, careful handling, and maintaining good water quality.

PREDATORS AND OTHER COMMON NUISANCES

Predation by people, birds, raccoons, snakes, and other animals is a problem that cannot be eliminated entirely, but there are some precautions that should be practiced. Fences around the pool may reduce some predation by animals like raccoons and otters. Netting over the pool will discourage birds but will detract from the pool's beauty.

Turtles eat water lilies and other vegetation and should be removed from the pool. Also be aware that a few toads can lay lots of eggs and the resulting tadpoles can deplete oxygen from the pool. **Watch the pool and discourage animal nuisances.**

Mosquitoes can be a problem in pools without fish or in pools choked with aquatic plants. If you have a mosquito problem, add fish, remove excess plants and detritus, or add *Bacillus thuringiensis (B.t.)* to control mosquito larvae.

In conclusion, an ornamental pool provides a wonderful opportunity to enjoy the natural beauty of plants and fish and gain a better understanding of the complexities and interactions of aquatic communities. It also provides an outlet for creative expression in the design of the pool and its surroundings and enables urban dwellers to add a serene, natural environment to their yards.

The Alabama Cooperative Extension Service

Auburn University

CIRCULAR ANR-789

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For more information, contact your county Extension office. Look in your telephone directory under your county's name to find the number.