

Pools: Construction and Maintenance

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Photos by the author.

In our efforts to maintain fish in captivity, one eventually finds aquariums to be limited in their size and functionality in so far as simulating a natural environment is concerned. For me, a logical step up was to construct several outdoor pools to meet the needs of some of the fishes I keep. Using pools, I've successfully kept several species of pupfish (*Cyprinodon*), topminnows (*Fundulus*), and minnows. The first pool I constructed was for Armagosa pupfish (*Cyprinodon nevadensis*), which does very well outdoors.

Advantages of Pools Over Aquariums

There are several reasons why I like pools. The first two relate to size. The larger size of a pool compared to an aquarium means more water volume; the more water you have, the slower that toxins such as ammonia and nitrites build up. And with more water you can keep more species (or more of one species). This is especially important in a species maintenance program, since the more individuals you have the greater the genetic variability, which in turn helps reduce the chances of inbred deformities and conditions. If you wish to keep more than one species together, a pool better enables you to maintain a small habitat with fish that live together in nature.

Another reason why I like pools is that they offer a more natural habitat for your fish. Some species, such as pupfishes, benefit from full sunlight. A pool's greater surface-area-to-depth ratio allows for a better oxygen-to-carbon-dioxide exchange. In addition, pools (and their plants) attract insects, which benefit fish by providing a source of natural foods.

The larger size of a pool also allows for several habitats to be set up at once in the same pool. Areas with emergent plants can be set up at one end, while a deeper area with submerged plants can be set up at another. Different species

will seek out the areas most suited for them. For example, broadstripe topminnow (*Fundulus euryzonus*) go to a shadier area while Carbonera pupfish (*Cyprinodon fontinalis*) seek out and establish loose territories in sunny locations.

An extra benefit of a pool is that other wildlife is attracted to the water. Since setting up my pools, and the trees and plants associated with them, salamanders, toads, and many species of birds, including a kingfisher, have taken residence in my backyard. Fortunately, I was able to frighten the kingfisher away before it ate too many killies.

Before You Dig

Before you can begin constructing your pool, you need to figure out where you want to place it. There are several things to consider before you start to dig. The size, shape and depth of your pool depends on the location you select, the size of your liner, and how much soil you want to move.

In selecting a location, you need to consider the contours of your yard. Steep or shallow gradients can be incorporated into the shape, size and depth of your pool. If you have a steep gradient, several pools can be built and connected with raceways or small waterfalls. Use submersible pumps to circulate water from one pool to another.

Another consideration is whether the location receives sun or shade. If you live in a wooded area you have to contend with extra shade and fallen leaves. The area where I live is open grassland under full sun except for areas where I've added trees. The species of fish you keep is in some ways dictated by the location of your pool. Pupfishes, for example, require sunlight and do better in warmer water in an open area. *Notropis* and many other minnows are better suited to cooler waters in shady areas. Darters also do better in cool water.



Fig. 1.
The hole before laying
the liner in place.

If you live in a colder part of the continent, the location of your pool should be given careful consideration. Specifically, if you “enjoy” long and cold winters, you should consider a southern exposure when building your pool since a northern exposure can delay snowmelt and thawing in the spring. Extended snow cover can hinder photosynthesis and cause a depletion of oxygen.

Rocky areas can help or hinder your efforts at times. In some instances a rock face can serve as a backdrop. Washes and other areas that collect water can be used to some extent too. Displaced soil can be used as fill to step a series of pools.

Construction

Once you have selected the location of your pool, it's time to begin construction. Depending on the size of your pool, the only tools you need are a shovel, yard rake and broom. Materials consist of a pre-liner, liner, sand or similar material to cover the liner, and landscape materials of your choice. (I use lots of rocks and some wood.)

The liner I use is 8 mil PVC black plastic that you can purchase at most hardware stores and home centers. A 20' x 100' roll sells for around \$80 and is enough for four pools. Take care when laying this plastic. Remove or cover all sharp objects such as sticks and dried weed stems to prevent holes from being punched in the liner.

If you wish to keep a saltwater or brackish pool, you may want to invest in a heavy duty pool liner to avoid replacing salt water if it leaks. Salt can also accumulate in the soil around the pool. Gulf killifish (*Fundulus grandis*) and sheepshead topminnow (*Cyprinodon variegatus*) are two species that do well in salt or brackish pools.

Now it's time to move dirt. Since my yard has a slight downgrade to the northwest, I used displaced soil to terrace



Fig. 2.
Laying the liner.

my pools. Rocks and logs were positioned to hold the soil back. I constructed my pools with bowl-shaped bottoms. The extensive shallow areas around the pool edges allow for greater numbers of fry than would steep-sided pools. After digging the hole, I swept it smooth with a broom, and double checked for sharp objects (Fig. 1).

Next I applied a pre-liner consisting of newspapers. The function of a pre-liner is to help prevent punctures. If a puncture does occur, the paper will swell and help seal the leak. Used carpet can also work as a pre-liner.

Once the pre-liner is applied it's time to lay the liner (Fig. 2). I use rocks to hold the liner in place, then cover the liner with an inch or so of sand. This not only holds the liner down, but prevents it from being punctured by dog claws or when you have to step into the pool to perform maintenance. Sand also supports rockwork and plants.

Unless you're really industrious or your pool is small, it will probably take you several days from the time you start digging to when you fill the pool with water. Plan where hoses and power lines go (if you are using water pumps and lights) so they can be hidden from view. Also allow for a spillway or overflow vent. If you're constructing a series of pools, use small falls or pipes covered with mesh to prevent fish from moving from pool to pool (they will).

pH and Filtration

You will most likely use tap water to fill your pool. Most tap waters are fine for fish, although pH does change from region to region. The water I had in Indiana was fairly hard and alkaline. (Indiana bedrock is limestone and dolomite so the water has a high carbonate level.) The water here in the Rio Grande Valley is only slightly hard with a neutral pH. (Rock on my side of the mountains is mostly granite and



asphalt with some areas of limestone, sandstone and shales.)

Any rocks you add to your pool can change the pH. Limestone or dolomite rocks serve as buffers if hard-water species such as pupfishes are kept. Conversely, peat filters can be used to lower the pH if the pool is to be home to swamp species such as pygmy sunfishes (*Elassoma*) and dwarf sunfishes (*Enneacanthus*).

Organic matter that falls into a pool can dramatically alter the pH. To prevent leaves from entering the pool, choose the site and plants carefully. There is some cane growing near my pools and it's a nightmare in the fall. Remove debris as needed to prevent a pH crash and bacteria bloom.

In a pool with small native species filtration is more an option than a necessity. I've kept pupfish, topminnows, and other small natives in unfiltered pools without any problems. Small native species will not overwhelm a pool with waste as do goldfish and koi. Aquatic plants help to serve as a natural biological filtration system and take care of fish waste. Keep the pool well planted and the water should remain clear. If you want a filtration system, contact your local lawn and garden center for one that meets your needs. In addition to filtration, high-volume filters can be used to pump water from pool to pool, or to run small falls or runs. When installing submersible filters and pumps, be sure to use a ground fault interrupter to prevent electric shock (or worse).

Landscaping and Plants

Landscaping is next. After you trim excess liner and cover the edges with a layer of sand (Figs. 3 and 4), you can add rocks, plants and driftwood. This is my favorite part of pool construction. Decide where to place landscaping items on paper first. Just as in an aquarium, rocks and other objects should be rinsed off before they are placed in the pool. Rocks

Fig. 3.
Covering the liner
and adding stone.



Fig. 4.
Hiding the liner. should be chemically inert unless your goal is to keep hard- or brackish-water species.

Aquatic plants are a necessary element of any successful aquatic system. Plants are useful in several ways. They help filter the water by removing waste produced by fish and other pool inhabitants. They convert carbon dioxide into oxygen through photosynthesis. And they provide shelter and feeding places for both young and adults. For some species of fish plants also provide a spawning surface.

There are three types of aquatic plants: submerged, surface and emergent. Each has its own place in the ecosystem.

Submerged plants consist of various forms of algae, water mosses, naiads or water weeds, and pond weeds. Good submerged plants include crispy pondweed, southern naiads, bushy pondweeds, hornworts (Fig. 7), and milfoils. Use small, shallow trays to control their growth. Fountain moss requires cool, flowing water to be at their best. Some darter species (*Etheostoma*) spawn in fountain moss.

Surface plants provide cover, shade, and lots of areas for foods to grow. They either grow on the surface or have floating leaves. Surface plants include duckweeds, some pondweeds, and water lilies. Duckweeds do well in semi-shade and will cover the entire surface of a shaded pool unless they're controlled by netting off excess growth. They can provide cover for topminnow fry and small livebearers. Some pondweeds, such as floating brown leaf and variable pondweed, have both submerged and floating leaves. Water lilies have both floating and emergent leaves, providing shade with their large leaves and shelter with their stems. Many domesticated types of water lilies are available from commercial growers and suppliers.

Emergent plants grow above the water surface. They include cattails, some ferns, some milfoils, water plantains, pickerel weeds, flags, sedges, and rushes. Rootstocks can be completely submerged (as in cattails, Figs. 5 and 6), or grow above the surface along the shoreline.



Sedges and rushes are found at the water's edge, while water plantains, pickerel weeds and cattails grow in shallow water. The milfoil parrots feather (Fig. 8) has both small and submerged leaves and feather-like emergent leaves. It grows from the shoreline and provides surface cover with roots extending from its immersed stems. Flags and irises grow along the shoreline and into shallow water. They bloom in late spring. Cattails reproduce by both seeds and rootstocks. They may have to be thinned as they can grow fairly thick.

Problems with aquatic plants can include green water (algae bloom), overcrowding (cattails), and covering the surface (duckweed). To combat these problems filter green water, add more desirable plants, thin out overcrowded areas by removing excess rootstocks, or any combination thereof. Aquatic plants can also be potted to help control their growth.

Terrestrial plants help give a pool a more natural look. Plantings can revolve around a specific theme or habitat, such as a southwestern desert spring or a southeastern swamp. A more exotic theme can include garden plants, flower beds, various shrubs and ornamental plants, exotic grasses, or other cultivated types. It's up to you. Keep an eye out, though, for excess shade and falling debris and leaves.

Fig. 5.
Landscaping begins.
Plants are cattails.

I use both wild and store-bought plants. Since wild plants can harbor other organisms, take care to avoid unwanted animals such as hydras, dragonfly nymphs, and leeches.

Attracting Wildlife

An outdoor pool will become home to many kinds of animals other than fish. Some are beneficial, others harmful. Butterflies and other insects, amphibians, reptiles, hummingbirds and other small birds, and some mammals will be attracted to the water and the vegetation it contains.

Beneficial animals provide food for both fish fry and adults. Infusorians and small arthropods provide the foundation of the food web by nourishing newly hatched fry. Copepods, amphipods, and insect larvae and nymphs provide food for both young and adult fish. You can find copepods and amphipods on plants collected in the wild. Insects will populate pools on their own. Even here in the desert southwest dragonflies and other insects will find a pool miles from the nearest water.

Snails, worms and other small organisms can also be found on plants introduced into the pool. These creatures help break down organic matter.



Fig. 6.

Middle pool in author's garden.
15' x 15' x 3'. Age 6 years. Roses, cane,
cattails and water lilies are visible.

Animals that are pests either feed on fry and adults, eat eggs, or parasitize other pool inhabitants. Parasites include intestinal worms, some copepods, and several species of ciliates and dinoflagellates. Prevention is the best cure.

Predatory animals that feed on fish fry or adults include hydra species and various predatory insects such as dragonfly nymphs, backswimmers, giant water bugs, and predaceous diving beetles and their larvae. Remove them with a net. Backswimmers can have a painful bite so be careful.

In large numbers, frog and toad tadpoles can consume significant amounts of organic matter. Some fish eggs are sure to get eaten if tadpole numbers are left unchecked. Removing tadpoles is easier when they're still eggs. Should the eggs hatch, remove unwanted tadpoles with a net. Toad tadpoles congregate in groups, making removal a little easier.

Birds that eat fish can devastate a small pool. Shrikes and kingfishers also sometimes visit small pools. Usually human activity drives these birds away.

Snakes are sometimes attracted to the water. If you live near a stream or other permanent body of water, garter snakes and water snakes might set up residence in your pool. Water snakes are excellent fishers. They should be captured and released several miles away.

Turtles usually aren't a problem, although painted turtles might wander into the pool. Predatory turtles such as snappers and softshell turtles don't wander far from their homes. If one should set up residence in your pool, simply relocate it.

Other animals that might pay a visit to your pool include raccoons, skunks and opossums. Usually they will not cause problems or bother the fish.

Fig. 7.

Northern studfish (*Fundulus catenatus*) in author's pool.
Plant is hornwort.





A Few Thoughts on Fishes

The size and location of your pool, as well as the climate of your region, limit the types of fishes you can keep. The smaller the pool, the fewer the number of species and the smaller the size of the fish it can sustain. Location also limits the species you can keep. Pufffishes prefer a sunny location, while pygmy sunfishes prefer shade.

If you live in a cold area, you will have to bring warmwater species indoors for the winter. Flagfish (*Jordanella floridae*) die when the weather turns cold. I discovered by accident that Carbonera pupfish and broadstripe topminnow (*Fundulus euryzonus*) can survive with several inches of ice on the water here in New Mexico. As long as a pool doesn't freeze solid, most U.S. fishes can be kept outdoors year round. With a natural winter, many species will spawn in the spring. If winters are severe in your area, you may want to consider using a pool heater or bringing in cold-intolerant species. Be sure to have space prepared if over-wintering indoors is necessary.

A Rewarding Experience

A well-planned pool can be a thing of beauty and a

Fig. 8.
Parrot's feather in foreground. Cattails and water lilies in background.

rewarding experience. You'll feel a sense of accomplishment when you observe a third or fourth generation of fishes behaving naturally. I've found that the rewards of creating a microcosm in my backyard were well worth the effort I took to build it. Please enjoy a pool of your own. 🐟

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