Building and Maintaining a Native Fish Pond and Stream

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Author and daughter.

Captive breeding of native fish is a rewarding endeavor but carrying this out in glass aquariums can become quite a task that involves time, money, water treatment, and continuous maintenance. A larger self-sustaining environment can prove to be much more feasible and trouble free. This article documents the construction of an 8000-gallon back yard pond fed by a continuously flowing and well-oxygenated riffle stream. The total cost was less than $2000.00 plus a lot of hard work. I dug it with a shovel and wheelbarrow over the course of the summer in 2004 during my spare time.

Unlike the typical koi pond or ornamental water feature, a native fish habitat must have the following characteristics:

1. A balanced and self-sustaining ecosystem that includes water plants, micro-organisms and small invertebrates. With a large enough environment, introduced fish food is not required nor is it recommended. A healthy supply of aquatic plants will also curb the spread of algae.

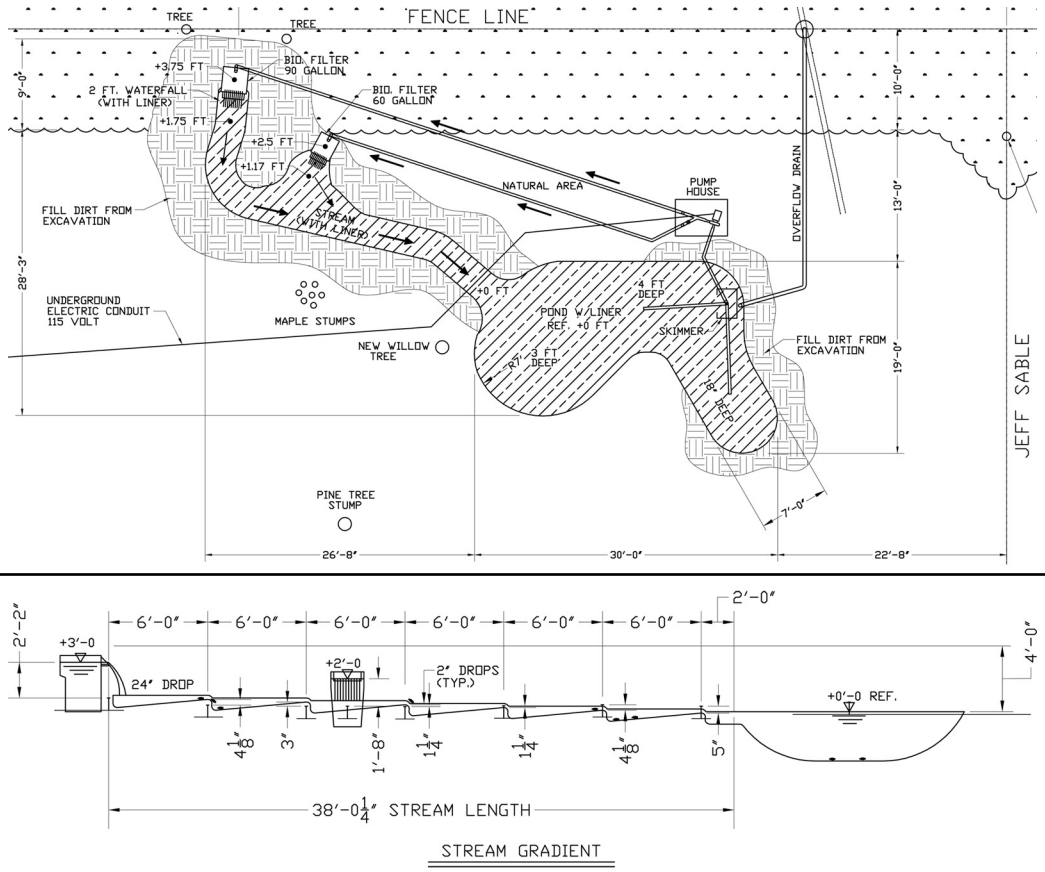
2. A variety of suitable spawning environment for targeted species. The stream will provide the spawning habitat for a lot of species and it must be fully navigable by your fish.

3. Constant movement and oxygenation of the water supply.

4. A sufficient filtration system.

5. Sufficient depth to avoid freezing solid to the bottom during winter months and provide a cooler water temperature zone during the summer.

6. Means of containing the water, whether natural or artificial.



STREAM GRADIENT

Initial Planning

The first consideration is determining the location and identifying the natural water table. A well-shaded location is best for a cooler average temperature; however some sunlight is needed to benefit the growth of plant life necessary to balance the ecosystem. I selected a partial-sun location adjacent to a wooded fence line at my property boundary. The natural water table must be identified by digging a few test holes. Be patient and observe the water table in the holes during both dry spells and wet periods. A rubber liner may be necessary to hold the pond water from infiltrating through the soil, and it will be mandatory for the feeder stream. My site required a rubber liner in both the pond reservoir and the feeder stream. A rubber liner also serves the purpose of isolating your habitat water from foreign contamination. The size of the reservoir and stream bed both need to be coordinated with an affordable size of rubber that can be procured. There is opportunity to be resourceful through connections with the right people so that you do not have to pay top dollar consumer prices for something that is basically a commercial roofing material. Some suggestions include local suppliers of rubber roofing, roofing contractors, rubber manufactures such as Firestone, as well as pond supply centers. Do your research ahead of time but be very careful not to get the standard roofing product that contains talc and chemical additives that can be toxic to fish. I secured a 35 feet x 50 feet piece of "fish grade" rubber for about $ 750.00, customer pick up. You will need enough surfaces of rubber to cover the flat area + (depth x 2) + nearly two feet around the perimeter. Single and double-sided tape strips with adhesive (and instructions) are available and can be used, although this is not recommended anywhere where you would have to drain the entire pond to repair a future leak. My only rubber splice joint is located at the very mouth of the stream where a repair would not be difficult. A drawing of the end design including the stream section is highly recommended. You will need to operate a continuous pump, so a protected electrical supply line will need to be incorporated into initial plans. A centrifugal pump will draw substantially less kilowatts of electricity to operate than a submersible pump, however most centrifugals require weather protection such as a pump house. Remember the well-known phrase "Call-Before-You-Dig!" Invisible stuff underground may include phone lines, utility cables, underground drainage tiles, and perhaps your leach field if you live in the country. I unintentionally severed my telephone line during the dig, but I switched to cable phone service rather than change my pond plans.

Time to Dig

After all the initial planning is done it's now time to dig. Use a rope or string to define the boundary of the pond reservoir and dig a full perimeter "moat" about six inches deep around the circumference. Use a garden hose to fill the moat with water to the desired finished water level. Place marking rods around the entire perimeter noting the exact location of where the final water surface will be. These marks will be used later as a surveying reference for the stream contour. The moat water level precisely represents the finished pond water level and you will determine during this process if your terrain slopes and needs a local correction. Also lay out and identify the course of the stream bed. The soil removed from the reservoir hole is most logically used to build up the stream bed to a higher elevation. Start digging the basin, using the perimeter

moat as the boundary. Depending on natural water table levels in your area, you might need to time the excavation to be done during the dry season. Never just pile up excavated dirt around the edge of the pond like many pond diggers traditionally do. That practice will cause erosion and mud wash to repeatedly enter your pond every time it rains. Your native fish habitat must be just as clear right after a torrential downpour as it is at any other time. Use the excavated dirt to mound up for the elevated stream bed then haul any excess soil off-site. Give the basin some character and variation. Make deep-cool channels, shallows, reefs, and side bays. A narrow perimeter shelf about 12-18 inches deep is good for a vegetative planting edge and is used by all aquatic life for multiple purposes just like in a natural environment. I dug my basin 4-feet-6-inches deep in the deepest channel.

Creating the riffle stream takes some careful attention. You want to create a gradient drop of about 12 inches/30 feet of stream run. Combined with a single 11,000-gallon per hour pump, this gradient resulted in a fairly strong flow comparable to what might be a small mountainous headwater stream. In order to permit fish to easily navigate the entire stream you must create a "fish ladder" using about two inches of surface water drop per step with the lowest step being the basin water level. Rent a small horizontal surveying transit for this work. Level the sight head and use the metering stick to reference the stream step water levels off the finished water level in the basin (as previously determined by the moat water level marking rods). Back dig "holding pools" behind some of the stream steps. The high points of the soil will essentially become the surface water levels of the finished stream steps. Deeper pools in the stream will become favorite fish hang-outs during summer months and pea gravel poured in these pools will be used as spawning beds. A shallow pool or no pool will result in a section of fast riffle current that can later be adjusted using rocks.

At the head of the stream will be your only waterfall. Excavate here for a large filtration barrel with a waterfall slot at the top. You can buy "filter falls" specifically designed for this from a pond supply store, but being on a tight budget, I make them out of 90-gallon plastic garbage totes. The "garbage-tote filter falls" have worked just fine for seven years now, trouble free. Seat the barrel such that the waterfall spout is approximately two feet above the head of the stream. This will provide a continuous supply of turbulent oxygenation needed for the stream water. I actually used two of them for "double action." Set the filter-fall barrels in place and fill around them with excavated soil. Finally, install a screened overflow drain line at the far end of the basin and pipe it to a drainage tile or other point somewhere below the water level.

Now carefully inspect the soil surface in the pond and stream. Remove all sharp rocks and stones that could puncture the rubber. Then lay down a full layer of soft padding (old carpets are good for this). The rubber liner is now placed into the reservoir basin and the stream. Push it all the way down before attempting to cut it. Wrinkles will occur that can be easily folded over. Run the stream rubber up the filtration barrel all the way to the falls slot. Cut the perimeter about 2 feet beyond the water boundary and shim it up a good 2 inches above all anticipated water surfaces. The biggest problem with elevated stream beds is water spillage over the edge of the rubber. A 100-foot roll of 4-foot corrugated plastic

Pond and stream

Pump house

drain tile works good for this as it can be half buried around water's edge with the rubber stretched over the top half, excess rubber being dug in behind. The plastic will not deteriorate and will remain as permanent edge reinforcement even if repeatedly stepped on. Around the basin it will also serve to prevent contamination from surface run-in during storms. I eventually decorated most of my perimeter with flat roadside slate rocks fitted over the rubber edge to look more natural and create some shaded edge hideouts for topminnows. You can allow some rainwater to collect or just start filling the basin with a water source, but don't seal in the edge rubber until the pond is full. Don't worry if ground water seepage begins to float the rubber off the bottom from underneath. The addition of water on top of the rubber will overcome the pressure of the ground water and in short time will push it back into the ground. Never use well water to fill the pond unless you have treated it for iron removal. Soluble iron in most straight well water will oxidize when it comes in contact with air resulting in red-orange precipitate that will render your new creation similar looking to a stream polluted with strip mine-acid.

Two types of underground lines need to be made; plumbing lines for the falls and an electrical line to operate the pump. I used 3-inch PVC plastic sewer line to feed the falls, burying it about two feet deep. I used 90-degree elbows to exit the soil vertically at the filter barrels and at the pump area. I cut a hole into the garbage tote lids and turned the water line into the top extending it downward to the bottom inside the barrels. A tee connection at the end of the line was used to divert the water flow in two directions through the filter medium. The beginning of the water lines is plumbed into the pump with a disconnect union. Be sure to do a very good job of cementing all connections together. This is a high-pressure line and underground leaks will be very hard to detect, let alone fix. For the electrical line, use underground electrical cable and be sure to run it through plastic conduit for protection against damage.

Pump and Filtration

The filter barrels are to be filled up with a filtration medium. There are many choices for this and numerous schools of thought. I am not a filtration expert, but I did purchase 3000 plastic shotgun shell wads from an ammunition supply center. I chose shotgun shell wads because they are very lightweight, easily cleanable and replaceable, and they contain many exposed surfaces on which beneficial purifying bacteria can harbor and grow. Even when tightly packed, they still contain a lot of open volume and do not impede water flow. I filled each tote with the plastic wads and placed a screen mesh with bricks on top to hold them down.

The centrifugal pump is a 1/4-hp Superfalls KJ11000LHC low-head model with leaf trap. It draws 3.6 amps and 415 watts. I purchased it from Koi Joy's Pond Shop in Kennewick Washington. It flows 11,000 GPH and is stationed inside a homemade pump house. I am very impressed with this pump; seven years now and it has never failed. Since I run two waterfalls, I split the water line shortly after the pump exit so one pump feeds both waterfalls. I currently have a ball valve in each feed line to adjust the flow dis-

Filter barrels

tribution as is sometimes necessary. I structured the set up so that I could easily convert to two such pumps (a dedicated pump to each waterfall). That would double the flow in the stream, eliminate the need for valve adjustments, and provide "flow insurance" in case one pump ever conks out. The intake uses a 3-inch line with a check valve surrounded by a 5-gallon bucket riddled with one-eighth inch diameter drilled holes. I located the intake approximately 15 inches below the water surface. The re-circulating water mixes with hot air as it oxygenates during the summer, so limiting that water to the top surface leaves the bottom water channel rather cool at the lower depths.

Lights - Camera - Action

Turning on the pump for the first time–this is a very exciting moment, almost like a Genesis experience. You suddenly get to watch your hard work burst into full action! Hopefully all will go as planned and you will be smiling.

Now don't go speeding off to your favorite collecting sites just quite yet–maybe next year. This is a long-term project and you need to first get the habitat well established. A suitable bottom with plants comes first. Pour the stream bed full of pea gravel and collect an assortment of rocks to create structure and riffles. The very bottom of the basin should be left as bare rubber so it can be periodically vacuumed. Otherwise detritus will collect followed by extensive plant growth that will choke out the entire reservoir. You can use cut landscaping stone underwater to fence off planted bottom area from clean bottom. Edges and other portions of the reservoir can be filled with sand for a planting medium. Potted plants can be used at first until enough detritus naturally accumulates to support natural plant growth–this doesn't take long. You can try native plants such as milfoils, hornworts, and water lilies collected from local watersheds, but be careful not to introduce problematic plants such as duckweed. It does not hurt to try just about everything you can find. In the long run the types of plants that are most adaptive to the habitat you created will be what you have. Inappropriate stuff will fail and die out. Once water plants become established, spike the ecosystem with a good injection of small copepods, like scuds or freshwater shrimp, that can rapidly multiply and become self-sustaining. This is part of your natural fish food source that needs to get established. A vast array of insect larvae will naturally happen. I avoided the introduction of crayfish for fear of what kind of impact their burrowing habits might have on the rubber membrane liner. During one plant collecting trip from a local swamp, I inadvertently introduced leeches, but I turned that into a family announcement that forever stopped the kids from using it as a swimming hole. Whether it's true or not, one notification about leeches and no kid will ever dare jump in.

Now you have established the essentials to start adding fish. My first introduction was about 12 juvenile Northern Starhead Topminnows (*Fundulus dispar*)[see page 14] courtesy of Jonah's Aquarium. With no competition, the topminnows were an instant success and propagated explosively. Subsequent introduction of other species brings competition. Certain species will eventually become dominant over others so planning the fish inhabit-

ants becomes important. This depends on your specific interests, but a logical assortment could be one species of topminnow, a few species of minnows and sunfish for mid-depth, with darters and madtoms ruling the bottom.

Care and Maintenance

Operating your native fish habitat is a very rewarding experience but there are some maintenance concerns that include the following:

1. Wintertime waterline freeze up.
2. Spring algae blooms.
3. Leaf litter cleanup in autumn.
4. Periodic bottom vacuuming.
5. Edge leaks.

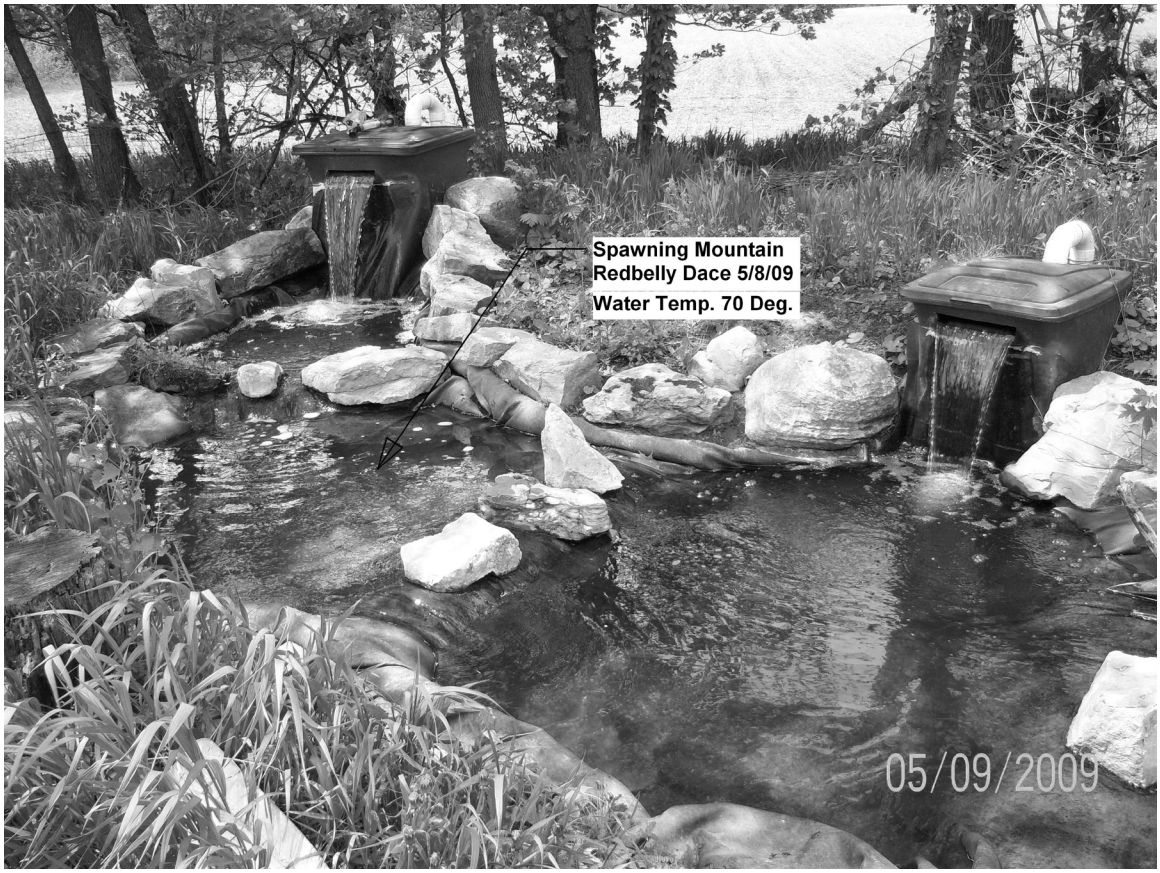
Running water does not freeze (unless it gets really cold). The stream system can run continuously for all but the very coldest months of the year. Continuing to run the pump after a thick ice cap has formed over the surface leads to a number of catastrophic events that you do not want to encounter. In central Ohio, I have learned the hard way to shut down about the first or second week of January and then fire things back up about the first of March. I installed clean-out fittings at the lowest point of the feed lines and I use a small auxiliary pump to evacuate most all the water from the lines and the filter barrels immediately after disconnecting the pump. At that point the fish are pretty dormant underneath the ice cap somewhere at the bottom of the main basin.

Spring algae blooms can be a problem before water plants emerge into full growth. Algae can be manually removed with a grass rake or effectively burned out with a powdered product called "Green Clean," but be sure to follow the instructions. Last year I applied it to the entire stream bed in April at about twice the recommended dosage. Despite the claims that it's not harmful to fish, it killed an otherwise very healthy pair of adult Redfin Darters (*Etheostoma whipplei*) that were almost ready to commence with spawning.

During autumn months it is necessary to remove fallen leaves. If left in, they accumulate on the bottom, generate tannic acid, and then turn to a thick black muck by next spring. Use a telescoping long pole pool net to remove as many fallen leaves as possible before winter.

Periodically vacuum a designated "clean bottom" area using a pool vacuum. You may want to snorkel in your pond to make observations without stirring up bottom muck. An auxiliary sand filter can also prove beneficial and adds another blast of current to the reservoir.

A sudden loss of water indicates an edge leak. This requires immediate attention. An edge leaks will cause your pond to become "pumped dry" in a matter of days. First place to look is the edge of the elevated stream bed. Usually leaks occur from the edge rubber sinking below the water level, but they also occur due to leaf litter clogs, algae clogs, or ice dams that raise portions of the



stream water above the initial design level. Edge leaks are very easy to correct, but it can be maddeningly difficult to pin point the root cause.

Finished Masterpiece

Conclusion

This is a very rewarding venture that for the most part is self-sustaining. Currently I have breeding populations of Northern Starhead Topminnows from Indiana, Mountain Redbelly Dace (*Chrosomus oreas*) from West Virginia, and Blackbanded Sunfish (*Enneacanthus chaetodon*) from South Carolina. I have recently introduced Fieryblack Shiners (*Cyprinella pyrrhomelas*) from North Carolina, Redfin Darters from Oklahoma, and Arrow Darters (*Etheostoma sagitta*) from Whitley County, Kentucky. To date there is a lot of frogs and newts, but no evidence of any unintended fish introductions like Bluegills (*Lepomis macrochirus*). In your spare time you end up landscaping it, planting the edges, and creating more habitats. It eventually attracts everything from thirsty stray dogs, nesting ducks, great blue herons, kingfishers, raccoons, snakes, turtles, and other things higher up the food chain that you sometimes have to chase off. Always full of surprises but all very cool!

Last Minute Update

Arrow Darters spawned over a clean bed of pea gravel in the stream bed on March 17, 2012. The water temperature at the time rose to 65° F.

Starhead Topminnow - Konrad Schmidt