CORCORAN EDUCATION GRANT REPORT

EXPERIENTIAL EDUCATION AND NATIVE FISH

Kevin Brady, Ph.D.

Head of School,
Avon Grove Charter School, West Grove, PA
hos@agcharter.org

In 2012 Avon Grove Charter School (AGCS) was fortunate enough to receive a Corcoran Education Grant from NANFA. As a result, we were able to launch a project which would greatly improve our students' ability to study native fishes, stream ecology, and the surrounding watershed. Since our school's inception in 2002, AGCS students have conducted stream studies across the region, participated in riparian planting initiatives, managed tiny "trout hatcheries" in their classrooms (through the national "Trout in the Classroom" program), and raised American Shad (*Alosa sapidissima)* for reintroduction into local waterways. Projects involving freshwater ecosystems are a logical fit for our school for two important reasons:

1) We are located at the center of the White Clay Creek Watershed, which the federal government has designated a "National Wild and Scenic River System."

2) Our school's founding charter challenges us to provide experiential instruction for our students. This means that, whenever possible, we must endeavor to engage students through high-interest, hands-on, and project-based learning activities. Over the years, the streams that make up our watershed have been our school's "outdoor classroom."

ESTABLISHING A PLAN

Our school has been a member of NANFA for three years, and we have learned a great deal from reading the organization's publication, *American Currents*. Occasionally, we have come across articles which describe the care of native fish within large stock tanks. In some cases, these tanks were densely planted, and included both aquatic and terrestrial components. For a school like ours, the idea of an "indoor stream" was particularly appealing, and it was exciting to see that a number of NANFA articles offered some concrete suggestions for bringing highly naturalistic freshwater environments to life.

The NANFA website also includes a number of intriguing articles, such as Jeff Fullerton's "Striking Gold: The Eastern Starhead Topminnow, *Fundulus escambiae,*" which describes the author's experience with keeping fish in outdoor ponds and stock tanks, and Christopher Scharpf's online series of "Captive Care Notes" which meticulously describe larger-scale fish keeping/breeding practices and the importance of fast-flowing raceways for stream-dwelling fish.

The more we read, the more we wanted to find a way to apply some of these ideas to an educational setting.

The first stage of work on the Corcoran Aquatics Lab, with the tanks, plants, and aeration system in place and shelving, benches and workstations to follow.

For many years, our students have responded extremely well to stream studies, and building a functioning indoor stream could extend our students' exposure to freshwater fish species into the winter months, when local stream banks can be extremely treacherous.

We understood, on a very basic level, that regulating the movement of water might be complicated and did some additional reading in aquaculture journals on raceways (Heard and Martin, 1979), which are essentially channels of fast-moving water that enable fish accustomed to fast-moving stream environments to live in artificial conditions.

Our concepts seemed simple enough: we planned to begin with a 350-gallon Rubbermaid stock tank which would serve as the outer container for our indoor habitat. We would then use natural materials to channel the current created from a 750-gph recirculating pump to form a spiral-shaped channel or circular raceway. We hypothesized that this raceway, in addition to an elevated and heavily planted section of the tank, with a rocky substrate, would allow for natural filtration. When the Corcoran Grant Review team made the decision to fund our project, we were eager to set about building the system according to this plan.

THE BUILDING PROCESS

We started our project in the fall of 2012 by clearing a 20' x 20' space in our school's greenhouse and laying out our materials. Not surprisingly, we soon discovered that creating a simulated stream in a round stock tank was going to be somewhat more challenging than we had expected. The first problem we encountered related to natural materials. We initially had planned to avoid synthetic raw material in our system. However, we quickly learned that raceways and planting beds made from even the most carefully positioned stones were very difficult to keep in place and always prone to collapse.

We solved this initial problem by recycling dozens of plastic planting flats and large plastic pots. We also used large terracotta pots (turned upside down and sometimes stacked) to support our spiraling raceway channel. Later, the terra cotta pots would also prove ideal as hiding places for juvenile fishes. Our second challenge related to current. Based on what we had read, it seemed that a 750-gph pump would have sufficient power to push water through our spiraling raceway. This was definitely not the case. In reality, our pump was only able to produce enough of a current to move water half way around our spiral.

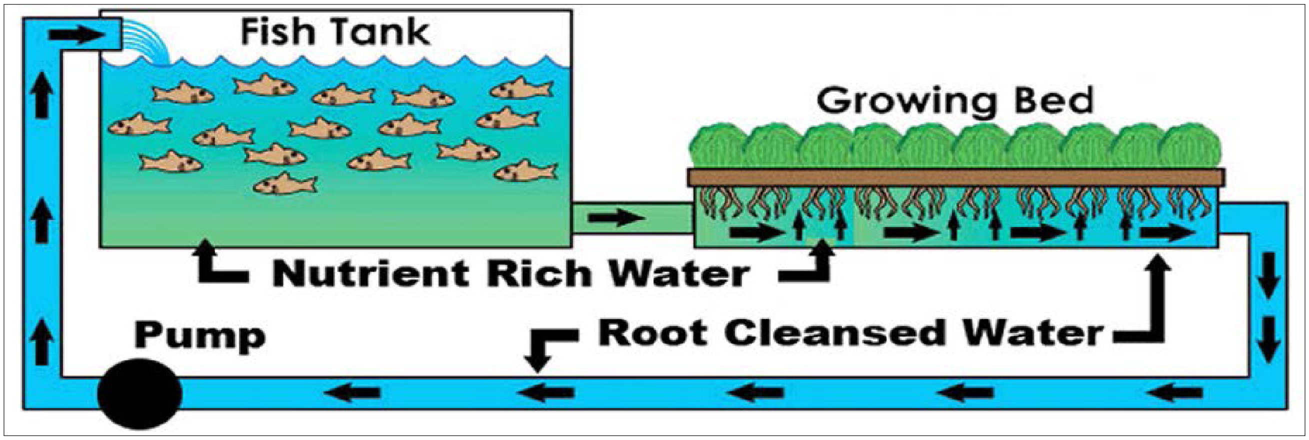
Students adjusting the wooden covering above one of the three pumps within the Freshwater Aquatic Lab.

We attempted to remedy this problem by creating deflectors to bounce moving water in a way that would extend our flow. Though this technique produced some very modest positive outcomes, it did not solve the problem.

After a great deal of experimentation and the addition of a few feet of PVC pipe, we managed to engineer a solution. We added another 750-gph pump precisely at the section of the raceway where our current went slack. The addition of the second pump immediately solved the problem, and within seconds, we had what we had hoped for: a swiftly-moving indoor stream!

We lined the raceway and the base of the tank with stones which were chemically neutral or which (like the limestone substrate of our watershed) mildly raised the pH of the system. Before placing these stones, we added a commercial substrate which would enable submerged plants to take root. For about two weeks, the pH of the tank fluctuated. At one point, our measurements were in the 6.5 range and a few days later, they spiked to 7.2. Our pH finally stabilized at 7.1, which is comparable to average readings in our local watershed (North, 2007).

We planted a variety of emergent plants along the perimeter of the tank including Pickerel Rush (*Pontederia cordata*) and Common Cattail (*Typha latifolia)*. Both of these species immediately began to thrive. A little later, we added a tiny sprig of Watercress (*Nasturtium officinale)* and some colorful garden-variety Nasturtiums *(Tropaeolum majus).* These two species would grow at an almost unreal rate, and throughout the coldest winter months, students would harvest massive bunches of Watercress and Nasturtium flowers



A traditional aquaponics system.

on a weekly basis. We eventually managed to sell Watercress to local restaurants which helped defray some of the costs associated with operating the aquatics lab.

We also added a number of oxygenating plants to the edges of the raceway and within the plunge pool at the center of the tank. We took a systematic approach to adding water to the system. We slowly filled the system with a mix of aged tap water and gleanings from an established outdoor pond on our property. As a result, we imported a number of micro- and macro-invertebrates, which provided a baseline food source for the fish we would eventually introduce.

When the pond was filled with water, the pumps were running properly, and our plants were in place, we turned our attention to regulating temperature. Luckily, our school had purchased a chiller for the previous classroom trout-hatchery project many years before, and it was still in excellent working order. This ¼-horsepower machine and an accompanying 400-gph pump kept our system at a fairly constant stream temperature between 55 and 63 degrees.

After about a week of tinkering, we allowed the tank to cycle for about 10 days, regularly checking ammonia, pH, and nitrate/nitrite levels.

NATIVE FISHES

One of our goals was to populate the Corcoran Freshwater Aquatics Lab with fish from our watershed. We managed to accomplish this goal with some help from the researchers at the Stroud Water Research Center. Our friends at Stroud provided some very healthy aquarium-raised fish, and we supplemented their contribution with fish from our outdoor pond and an online aquaculture supplier. By the spring of 2013, our collection included most of the fishes present in White Clay Creek, and a few species from the neighboring Delaware and Susquehanna watersheds. I have included our complete list of represented species (at right).

A UNIQUE TEACHING TOOL

Our students responded to the introduction of the Corcoran Freshwater Aquatics Lab with a tremendous amount of enthusiasm. During the course of the year, elementary, middle, and secondary students marveled at the sight of tiny fish leaping at the water's surface and colorful and determined darters working their way "upstream."

Although the tank contained a very healthy and self-sustaining culture of tiny insects and freshwater

Table. Species represented in the Corcoran Aquatics Lab

Species from White Clay watershed	
Common name	**Scientific name**
White Sucker	*Catostomus commersoni*
Rosyside Dace	*Clinostomus funduloides*
Tessellated Darter	*Etheostoma olmstedi*
Cutlips Minnow	*Exoglossum maxillingua*
Common Shiner	*Luxilus cornutus*
Spottail Shiner	*Notropis hudsonius*
Swallowtail Shiner	*Notropis procne*
Spotfin Shiner	*Cyprinella spiloptera*
Margined Madtom	*Noturus insignis*
Fathead Minnow	*Pimephales promelas*
Blacknose Dace	*Rhinichthys atratulus*
Longnose Dace	*Rhinichthys cataractae*
Creek Chub	*Semotilus atromaculatus*
Species from other regional watersheds	
Common name	**Scientific name**
Bluespotted Sunfish	*Enneacanthus gloriosus*
Chesapeake Logperch	*Percina bimaculata*
Green Darter	*Etheostoma blennioides*
Pirate Perch	*Aphredoderus sayanus*

plankton, the number of fish in the system made regular feeding necessary. Feeding time was particularly exciting for our students because many of the fish in the aquatics lab were captive-raised and fearless; they literally jumped for fish flakes and frozen bloodworms.

Our teachers immediately began finding ways to integrate the Corcoran Aquatics Lab into daily instruction. Bonnie Dickson, our school's middle school Environmental Science teacher, devised a number of activities that enabled students to identify native fish species on sight, and used our indoor stream to better illustrate the relationship between native fishes and other life forms within our watershed. Kathleen Logullo, our elementary-level Environmental Science Teacher, used the aquatics lab to engage the imaginations of our school's youngest students, who subsequently produced some truly stellar scientific and artistic work celebrating native fishes.

One of the most challenging and entertaining elements of the project was the introduction of a fish cam—essentially a 3 inch by ½ inch submersible video camera—which, through a small array of LED lights, enabled students to see what was happening underwater. Ms. Dickson and her students became very adept at using the camera to observe fish behavior. Although the quality of the short video clips captured by the students was never crystal clear, the fish cam was useful enough to get students up close and personal with their underwater subjects.

At Avon Grove Charter, we are lucky to have tremendously creative environmental educators like Ms. Dickson and Ms. Logullo, who see the unique potential of an instructional resource like the Corcoran Aquatics Lab and who, through experimentation and ingenuity, continually find new ways of integrating our indoor stream into their instruction.

As time passes, the Corcoran Aquatics Lab will continue to engage students, inspire teachers, and remind all of the members of our school community of the splendor and diversity of our native fish species.

Literature Cited

Fullerton, J. 1998. Striking Gold: The Eastern Starhead Topminnow, *Fundulus escambiae.* American Currents Volume 24 (Number 4): 13–14.

Heard, W. R. and R. M. Martin. 1979. Floating Horizontal and Vertical Raceways used in Freshwater and Estuarine Culture of Juvenile Salmon, *Oncorhynchus* spp. Marine Fisheries Review, March 1979: 18–23.

North, G. 2007. The White Clay Creek: State of the Watershed Report. Delaware Nature Society: 2–3.

WELCOME, NEW MEMBERS!

Jack Agliata, Davidson, NC
Lori Anton, Dixon, IL
Owain Berry, Saskatoon, SK
Tim Daniel, Columbus, OH
Erik Donofrio, Athens, GA
Jessica East, Lubbock, TX
Jack Fetters, Hamilton, OH
Pamela Hart, Auburn, AL
Brajaan Hayes, Richmond, KY
Kat Hentsch, Sumner, WA
Joseph Lachawiec, Waretown, NJ
Chris Lehenbauer, Worcester, NY
Otto Lorenz, Americus, GA
David MacNeill, Oswego, NY
Donald Mohney, North Kingsville, OH
Michael Moore, Blacksburg, VA
Heather Neptune, Derry, NH
Danielle Pitt, Moreno Valley, CA
Todd Radek, Spring Grove, IL
Roberta Reynolds, Abbeville, SC
Thomas Ruf, Amelia, OH
Paul Skvorc, Wasilla, AK
Ben Stenger, Hixson, TN
William Thorne, Richmond, VA
Thai Tran, Westminster, CA
Denis Vardaro, Staten Island, NY
Paul Westlund, Columbia Heights, MN