Demonstration project for tank spawning American shad at Hugh Moore Park – Easton, PA

Report for 2011 (year 1)

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Performed in partnership with the City of Easton, PA

Cooperators:
Delaware River Basin Fish and Wildlife Management Cooperative
National Canal Museum
Delaware River Shad Fisherman's Association

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Introduction

American shad restoration on the Lehigh and Schuylkill Rivers currently depends on egg collections by strip-spawning of ripe adult shad at Smithfield Beach on the main stem Delaware River and subsequent stocking of cultured larvae. Shad are collected at night when they are actively spawning by deploying anchored gill nets. The process of gill-netting and strip spawning results in mortality to all shad collected which averages about 755 fish per year. Egg viability resulting from the strip spawning technique varies from 0 to 70%. Egg viability is related to availability of spermiating males, the reproductive condition of the females, the presence of blood and feces in the eggs before fertilization, and environmental conditions.

Recent advances in tank spawning of American shad without the use of spawning hormones has been an efficient way of obtaining high percentages of viable eggs resulting in up to 3 times more fry per female than traditional strip spawning techniques. In addition, after spawning is completed a high percentage of the broodstock can be returned alive to the river and the fish can return to spawn again in subsequent years. With these benefits in mind, we embarked upon a demonstration project to determine the feasibility of tank spawning Delaware River American shad as a more efficient use of the resource in support of the PA Fish and Boat Commission's shad restoration efforts on the Lehigh and Schuylkill Rivers.

The intention for the first year (2011) of this project was to determine the feasibility and logistics of performing tank spawning of American shad captured in the Delaware River without administering spawning hormones to the fish and using only ambient temperature water from the Lehigh Canal. The second year (2012) will be used to refine the technique based upon findings from year one. Since this project represents a significant departure from the traditional strip spawning, we proceeded cautiously in a step-wise manner to (1) minimize errors which could result in unforeseen mortality, (2) test the potential for this tool to be used for future recovery efforts in the Lehigh and Schuylkill Rivers and, (3) determine specific infrastructure needs for successfully obtaining fertilized eggs using this technique. Strip spawning activities normally conducted by the PA Fish & Boat Commission were also performed concurrently with our study.

Methods

General project details.- The project was located in the Hugh Moore Park at Easton, PA (Figure 1) and was performed under a Memorandum of Agreement between the U.S. Fish & Wildlife Service and the City of Easton. The Agreement was dated the 13th of April, 2011 and is effective for performing two years of study, terminating after shad spawning season is over in 2012. In addition to the Agreement, a GP-3 permit was obtained from the PA Department of Environmental Protection for placement of the intake/outfall structure on the bank of the Lehigh Canal. A zoning permit for the project was obtained from the City of Easton as well as a building and an electrical permit. The project was unanimously approved by both the Zoning Hearing Board as well as the Easton Environmental Advisory Council. All equipment, labor, utilities, or other needs for the project were provided "in-kind" with neither party to the Agreement receiving any funding from the other. In addition, a volunteer labor force consisting

of individuals from the U.S. Fish & Wildlife Service, the National Canal Museum, and the Delaware River Shad Fisherman's Association was also mobilized to assist in construction and operation of the project.

Spawning tank equipment and setup.- A single 12-ft diameter circular tank with a volume of approximately 2500 gallons was assembled outside on a leveled bed of #2-B limestone gravel and used as the spawning tank. The tank was dark gray in color. Additional Equipment included (2) 1-Horspower, 220-Volt electric pumps; a pump control panel; an Ideal Horizons 4-bulb ultraviolet water disinfection unit (UV system); a 10 X 2-ft rectangular fiberglass egg collection trough; (2) 2-inch PVC plastic intake lines with foot valves at the Canal; a 4-inch PVC plastic drain line, and three clear acrylic plastic egg incubation jars. The pump control panel was outfitted with a pressure switch configured to activate a secondary or backup pump in the event of a pressure loss in the water supply line. All system equipment was positioned adjacent to a structure known as the Boat Store located about 40 feet away from Lehigh Canal (Figure 2). Public safety features incorporated into the system consisted of a 3-foot high plastic fence encircling the top of the spawning tank, a locked gate to prevent access to an observation platform adjacent to the tank, a locked door to prevent access to the fenced-in ultraviolet system, and a 3-foot high plastic fence surrounding the exposed plumbing (Figure 3). In addition, the intake and drain lines were buried in a trench to prevent obstruction to people and animals related to operation of a replica canal boat which is docked at the site. A waterproof, battery-powered, 12-Volt camera was suspended underwater from an overhead support located above the center of the spawning tank and was used to discreetly observe the shad via a black and white monitor on a daily basis. Time to assemble and test the tank system was approximately two weeks using three workers and represented approximately 300 man-hours. Skill sets required for system construction included basic plumbing, carpentry, and electrical wiring. In addition, previous experience in performing tank spawning along with knowledge of American shad biology was a necessary requirement for at least one individual involved with the project.

Shad transport system.- A 30-foot gooseneck trailer with a wooden plank bed was outfitted with (2) five-foot diameter, insulated circular tanks with hinged lids. Two gasoline-powered water pumps (Model WX-15, Honda, Inc.) were mounted to the trailer bed adjacent to each tank and plumbed to re-circulate water from their respective tank using 1.5-inch diameter flexible reinforced plastic tubing. The pump intake tubing was inserted into a side-mounted standpipe on each tank and water was re-circulated back into the tank via an angled fitting incorporated into the tank lid. This design provided a circular flow pattern in the tank, which is essential for survival of American shad during transport. Two bottles of compressed oxygen secured to the trailer headboard were used to supply each transport tank with oxygen. Each oxygen tank had its own regulator and an additional manually-regulated oxygen flow metering valve was attached to each of the transport tanks to provide greater control of the oxygen injection (Figure 4). The transport trailer was towed using a one-ton capacity dual-wheel pickup truck powered by a 454 cubic-inch gasoline engine.

Shad capture and transport.- On May 10, water was pumped from the Lehigh Canal into the transport tanks using the Honda pumps and treated with 12.5 mg/l of tricane methanesulfonate (MS-222) to lightly sedate the fish. Oxygen was added to the transport tanks at a rate of 1 liter per minute. The transport truck was then driven to the capture site on the mainstem Delaware River where daytime electrofishing was performed by the PA Fish and Boat Commission in the vicinity of Raubsville, PA. A total of 10 American shad were captured and placed into one of the transport tanks where they were transported back to Hugh Moore Park (approximately 30 minutes) and placed into the spawning tank.

On May 12, the transport truck was driven to the Easton boat launch near the confluence of the Lehigh and Delaware Rivers. Water was pumped from the boat launch area into the transport tanks and treated as described above. Volunteer anglers used hook and line to capture 18 shad at this location. The angled fish were brought to the transport truck via a shuttle boat and hand-transferred to the transport tanks using a 5-gallon bucket containing water. The transport time back to the tank spawn system at Hugh Moore Park was approximately 10 minutes.

On May 16, the transport truck was driven to the National Park Service access ramp at Smithfield Beach and filled with water from the mainstem Delaware using procedures described above. One additional shad was obtained for the project via electro-fishing by the PA Fish and Boat Commission just upstream from Smithfield Beach boat ramp.

On May 19, the transport truck was again driven to the Easton boat launch and filled with water as described above. Volunteer anglers used hook and line to provide five additional shad for the tank spawning project. All fish were transported to the Hugh Moore site as described previously. The total number of fish residing in the spawning tank at the beginning of the study was 33 (21 females and 12 males).

In all capture circumstances, males were identified by expression of a small amount of milt upon using the thumb and index finger to gently apply pressure to the uro-genital opening. Females were identified by the presence of bulging sides and a swollen uro-genital opening.

Spawning system operation.- Final setup concluded on May 10. Water for the system was pumped from the Lehigh canal into the spawning tank using one of the system pumps. Water flowed through the UV system to reduce the level of pathogens and parasites which may have naturally occurred in the Canal water. The flow rate from the pump and through the UV filter was approximately 50 gallons per minute with a total water exchange rate of about 1 hour. No oxygenation was provided to the system during the study. Water pressure in the system was maintained at 22 p.s.i. Flow entered the spawning tank through a 2” PVC pipe with a 90° elbow at the end to provide a circular flow for the shad. Water exited the tank via a bottom drain. The water level in the spawning tank was controlled by a four-inch diameter PVC external standpipe (Figure 3) which allowed water to drain into the egg collection trough. The down leg on the standpipe was outfitted a 45° PVC elbow and a fine mesh bag which trapped eggs and debris exiting the spawning tank. Water that exited the egg collection trough flowed back into

the Canal through a 4-inch PVC drain line. No hormones, chemicals, additives, or fish feed were added to the process water at any time during the project and water was at the ambient temperature of the Lehigh Canal.

Maintenance of the spawning tank system was minimal and consisted of clearing debris away from the intake lines in the canal, removing and emptying the contents of the mesh bag, occasionally running the backup pump, and skimming debris from the surface of the spawning tank. These procedures were performed once in the morning and once in the evening and generally took about an hour. After spawning occurred, eggs were sifted to remove debris and placed into McDonald-style egg jars. Egg sifting consisted of turning the mesh bag inside out and gently placing the eggs into three rectangular nested plastic totes with open mesh bottoms. The totes were suspended in the water of the egg collection trough to protect the eggs during sifting. The mesh size was sequentially smaller on each tote causing large debris to be retained in the top tote while eggs could float through and be trapped in the smaller meshed totes. Smaller debris was siphoned out of the eggs using a rubber bulb (turkey baster) and cleaned eggs were transferred into egg jars. Water flow in the egg jars was directed to the bottom of the jar through a center tube and exited the top of the jar through a fine mesh screen and a spout (Figure 5).

Water quality measurement.- A temperature logger (TidbiT model, Onset, Inc., Cape Cod, MA) was programmed to record temperature every 30 minutes over the course of the study and secured into the spawning tank via a tether. Dissolved oxygen was measured in the spawning tank, egg trough, and Lehigh Canal using a hand-held meter (model 55, YSI Inc., Yellow Springs, OH).

Results

Egg production.- Approximately 15 L of eggs were collected during the study. This represents 800,000 eggs, using 2010 records from the PA Fish & Boat Commission's Van Dyke Shad Hatchery where Delaware River eggs were enumerated at about 54,000 eggs per liter. Spawning first occurred during the night of May 19 which resulted in 700 ml of eggs collected the morning of May 20. Water temperature was 16 °C. In general, egg production increased with an increase in water temperature. Peak egg production occurred the night of May 26 when the average daily water temperature rose to 18.8°C and resulted in the collection of 3,300 ml of eggs. Egg production concluded on May 30 with the final egg collection of 1240 ml on the morning of May 31 (Figure 6). Even though the tank was operational for a 21-day period, all 15 L of eggs were obtained within an 11-day window. Debris falling from the trees surrounding the spawning tanks hindered the efficient collection of eggs beginning on May 22. Eggs were difficult to separate from the debris preventing a more accurate measurement of egg production.

Egg fertilization.- Fertilization rate was poor and estimated at less than 10%. This was possibly due to an inadequate number of males in the spawning tank. The preferred ratio of males : females in this type of tank spawning system is 3 : 2 (M. Stangl, Delaware Dept. of Natural Resources, personal communication). However, since the ratio in our spawning tank was

approximately 1 : 2 males to females, the amount of milt produced in relation to the number of females present and the volume of water in the tank was likely inadequate to obtain a higher fertilization rate. Since the majority of eggs produced were largely unfertilized and could not easily be separated from the fertilized ones, all eggs were either released into the Canal or into the Lehigh River downstream of the Easton Dam. The egg jar system proved to be unreliable at maintaining the flow setting necessary to gently keep the eggs in suspension. It is uncertain whether this was a result of poor quality flow valves or poor plumbing configuration in general.

Water quality.- Average daily water temperature ranged from 15.1 – 20.7° C from May 10 to May 31 (Figure 6). Measurements of dissolved oxygen levels on May 11, 13, and 18 revealed values greater than 9 mg/L in the system, more than adequate for adult shad survival. A measurement during the final day of the study, which was also the day of highest water temperature, showed dissolved oxygen to be 8.8 mg/L in the Canal and 7.4 mg/L in the egg trough at 8:30 AM.

Survival and condition of broodstock.- Survival of fish placed into the spawning tank over the course of study was 94% with a total of 2 mortalities. Fish were in the spawning tank a total of 21 days. On May 31, the shad were removed from the spawning tank, transported back to the Delaware River, and released from the Phillipsburg, NJ boat launch. One female died on May 27 from unknown causes during the active tank spawning period and one male died from injuries sustained during removal from the spawning tank and transport back to the river. Other fish were released unharmed and appeared to be in good physical condition. No fungus was observed on any fish upon release and there was no apparent scale loss over the course of the study. Our observations showed that many of the released females still had swollen abdomens, indicating that more eggs could have been collected had the tank remained operational for a longer period of time.

Conclusions and recommendations

The tank system was successful in providing conditions for the production and collection of American shad eggs with a minimum of labor. The poor fertilization rate observed this season would likely improve by establishing a higher ratio of males to females in the spawning tank (minimum of 3 : 2).

The spawning tank system was conducive to broodstock survival as evidenced by the 94% survival rate over the 3 weeks of operation. In addition, the underwater camera system was a valuable addition to the system since it was not possible to see the fish in the tank due to natural turbidity, light conditions, and the dark gray color of the tank interior.

The outdoor location of the spawning tank resulted in much tree detritus falling into the spawning tank and eventually becoming trapped in the mesh egg bag along with shad eggs, complicating egg retrieval. This could be easily remedied by fastening some type of weatherproof fabric cover on the overhead frame of the spawning tank.

Improvements could also be made in plumbing to the egg jars by installing higher quality flow valves and reworking the configuration to prevent air lock from occurring and interrupting water flow.

The egg sifting plastic totes were somewhat cumbersome and required 2 people to safely sort and transfer eggs into the egg jars. This could possibly be remedied by fabricating smaller containers out of 5-gallon buckets as opposed to the larger rectangular ones used in 2011.

Even though there were no pump failures or water supply interruptions during the 2011 study, a secondary screen system should be installed at the Canal intake lines. This would minimize the amount of debris on the foot valve screens, and would make it much easier to clean debris from the intake area on a daily basis. In addition to the automatic pump back-up system, a float switch should be incorporated into the spawning tank and interfaced with an automatic phone dialer to alert for loss of water level in the system.

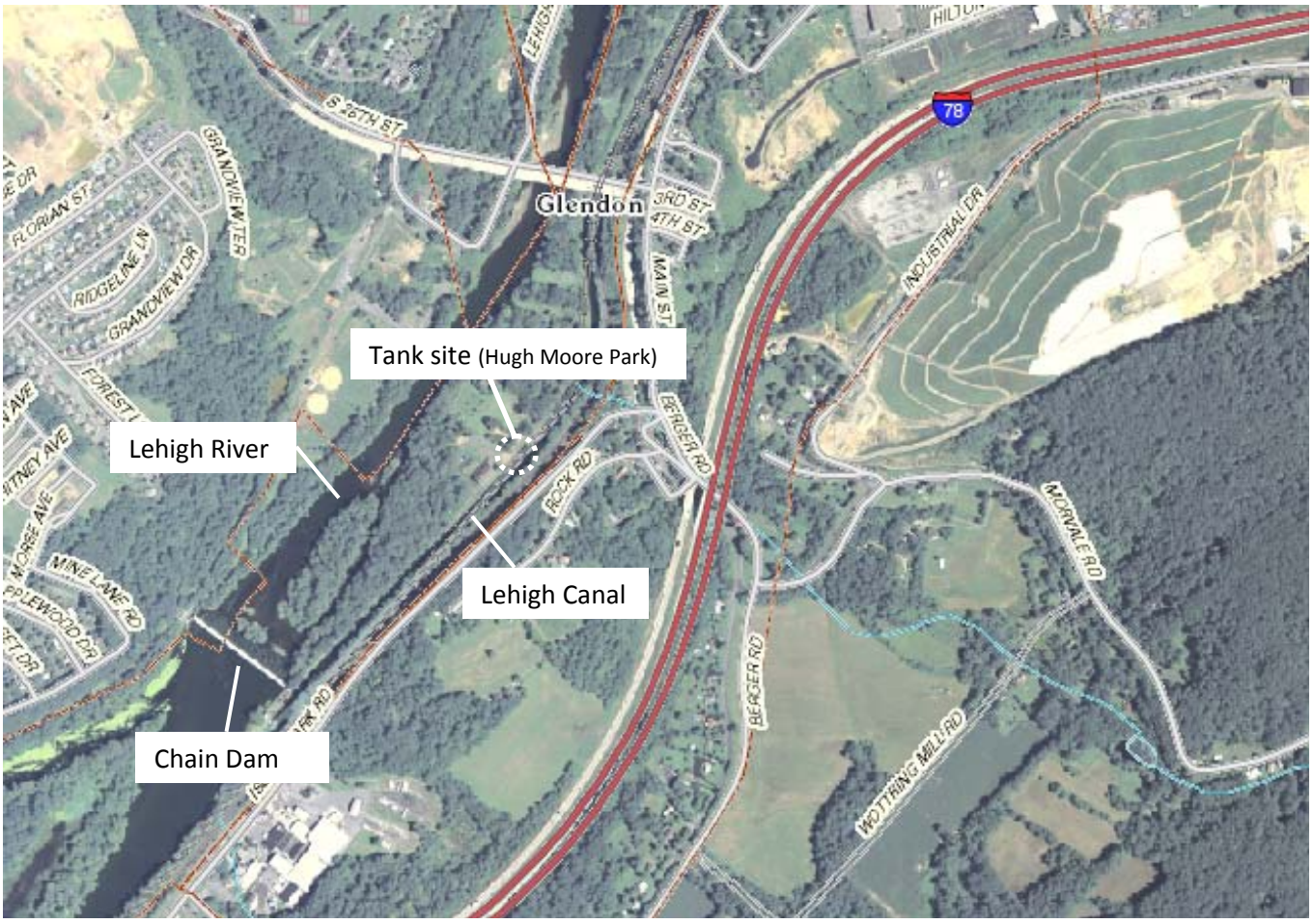

Figure 1 - Project location - Easton, PA

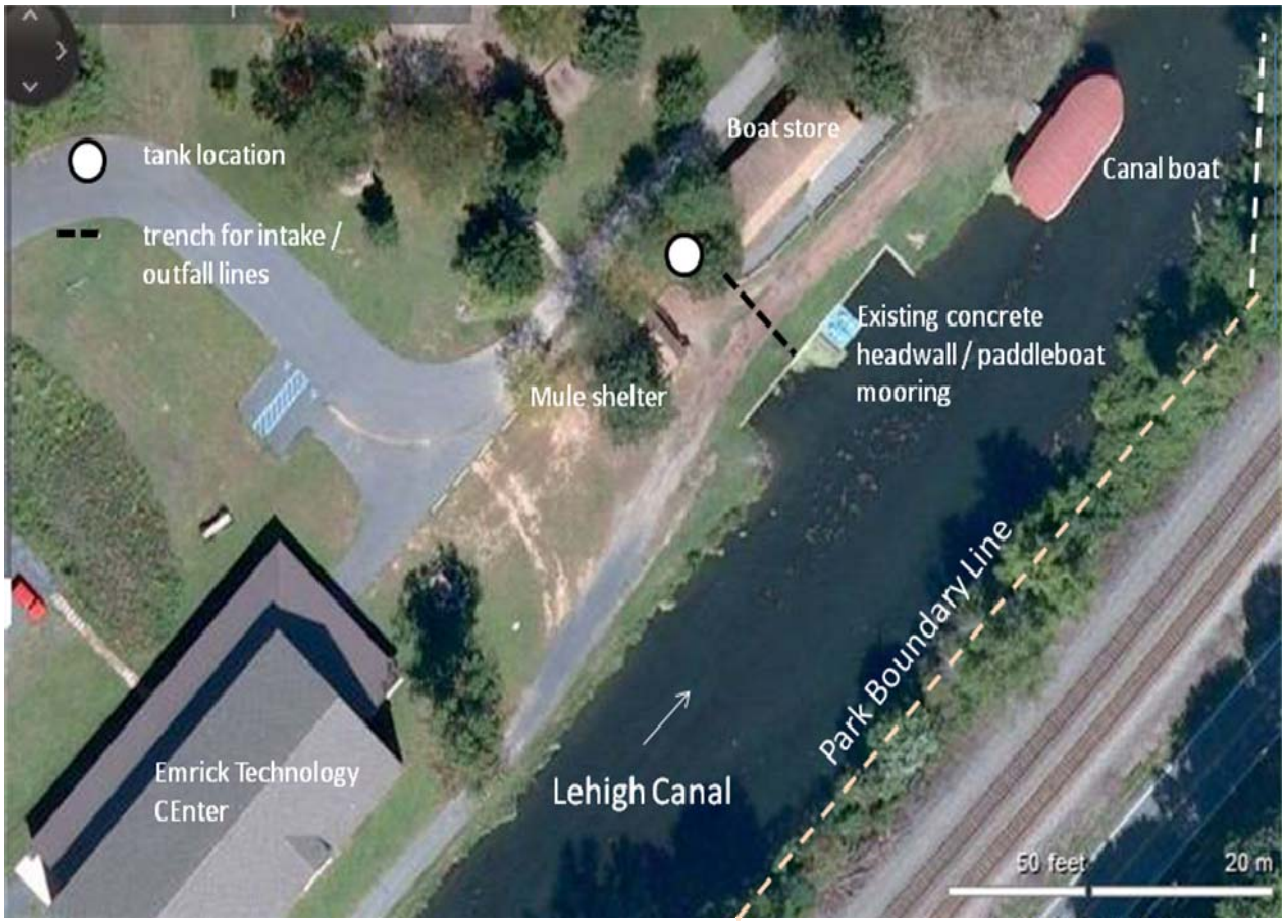

Figure 2 - System location in Hugh Moore Park

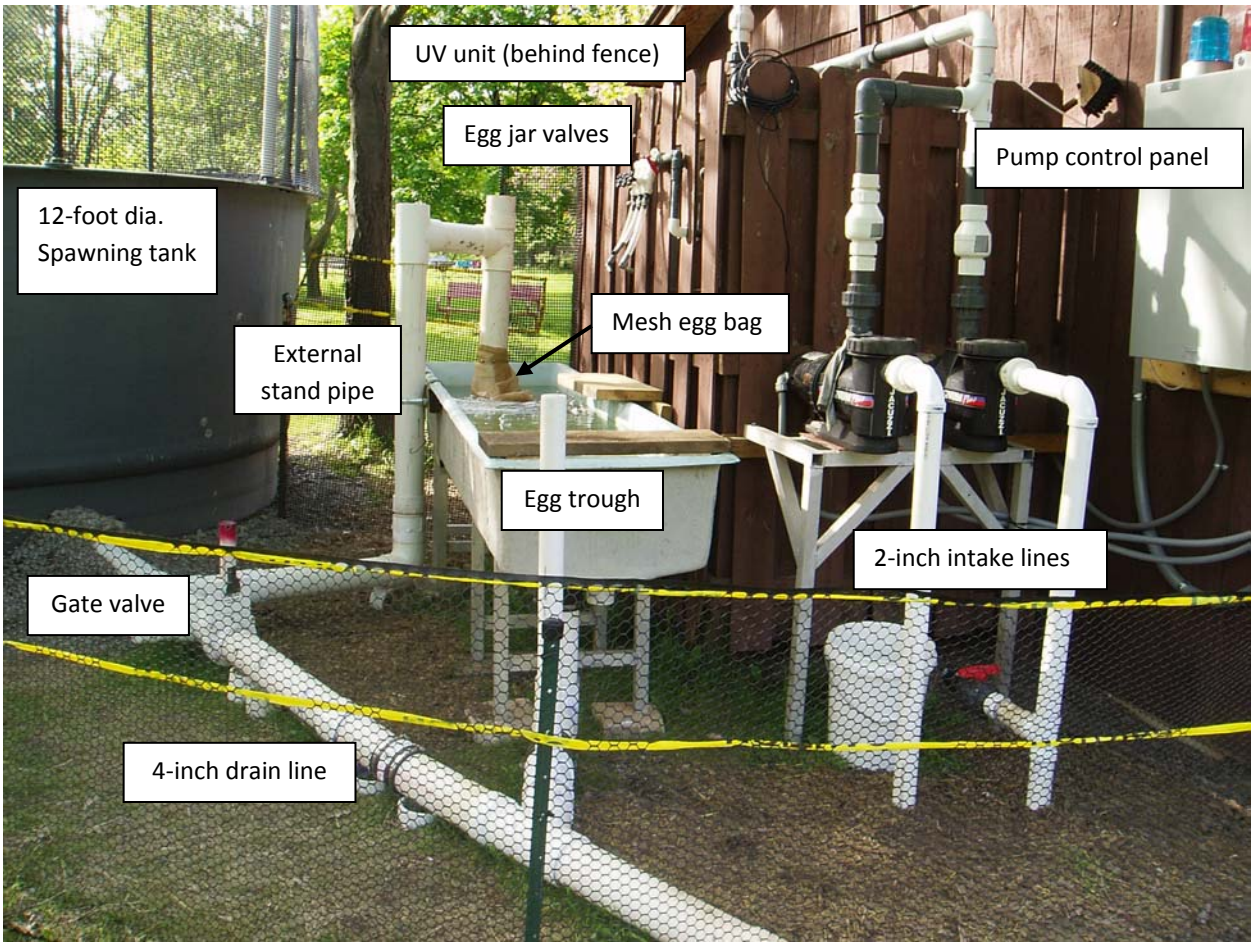

Figure 3 - Configuration of tank spawning components at Hugh Moore Park – Easton, PA

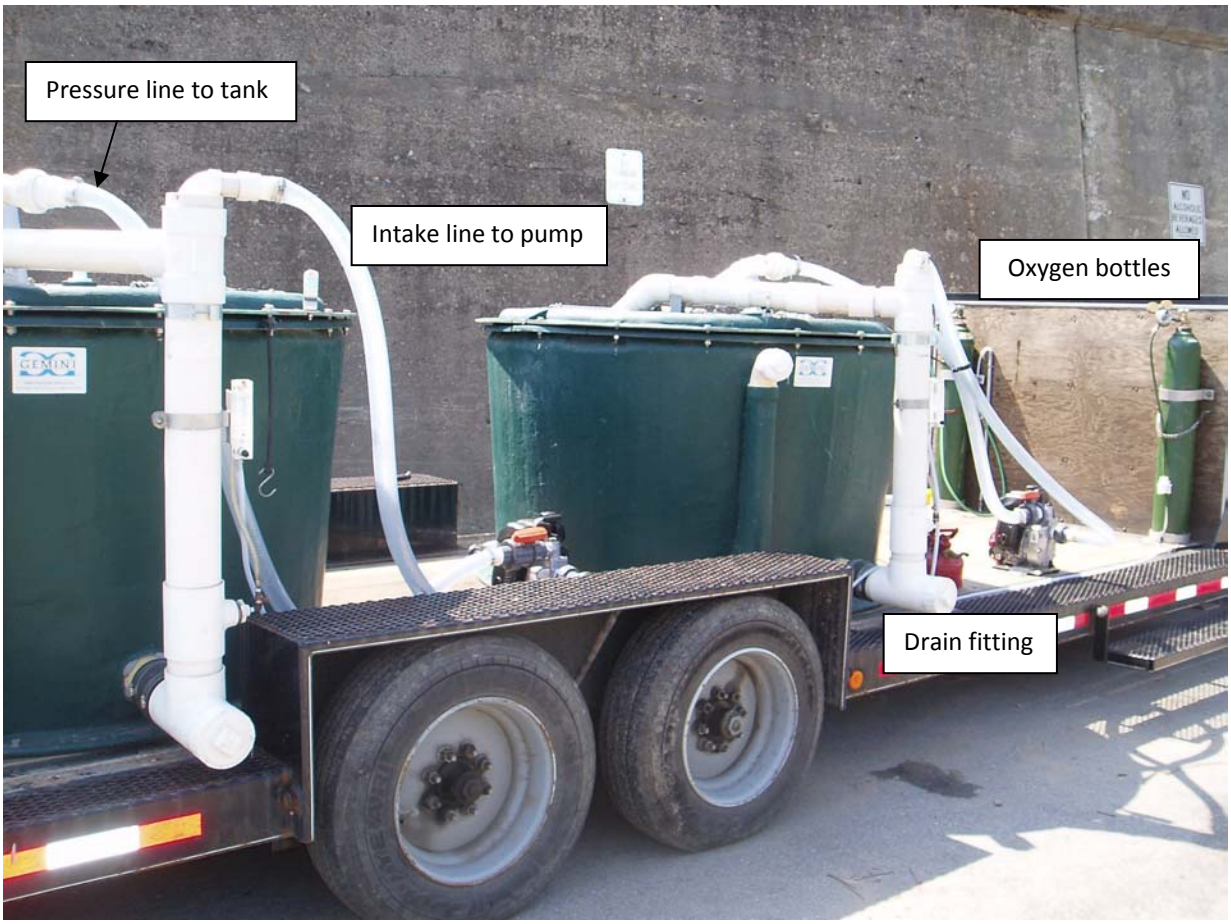

Figure 4 - American shad transport system

Figure 5 - McDonald style egg jars

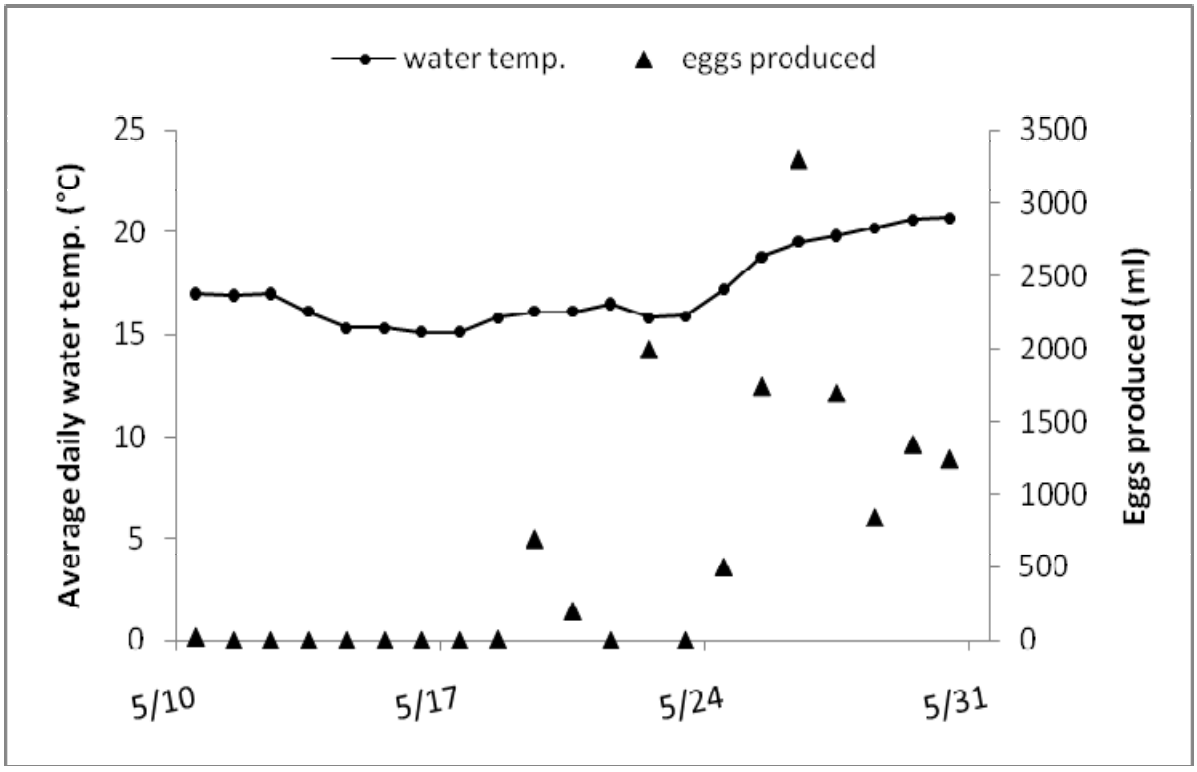

Figure 6 – American shad eggs produced by date and average daily water temperature

Table 1 - Expenditures for 2011

Item	**Cost**
transport trailer	on hand
spawning tank	on hand
egg trough	on hand
UV unit	on hand
spawning tank pumps	on hand
underwater camera system	borrowed
pump control panel repair	$1,779.00
electrical wiring	$898.52
Plumbing (combination of used and new)	$306.59
transport trailer pumps	$900.00
misc. plumbing and hardware	$375.00
travel trailer repair	$2,722.64
travel trailer lot rent	$1,700.00
travel costs / per diem (1 person)	$952.25
Fuel for travel and operation	$1,000.00
Total for 2011	**$10,634.00**