

**Shad in the Classroom
Program Report
(2009-2015)**

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By
Danielle Pender
Shad in the Classroom Program Specialist

Melissa Dowland
Coordinator of Teacher Education

and

Megan Chesser
Curator of Teacher Education

North Carolina Museum of Natural Sciences



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Executive Summary

Many programs across the nation introduce fish and their associated habitats into the classroom to teach students about nature and the environment. These programs go by various names, including Trout in the Classroom, Salmon in the Classroom, and Shad in the Classroom. In North Carolina, Trout in the Classroom is led by the North Carolina Chapter of Trout Unlimited, and Shad in the Classroom is led by the North Carolina Museum of Natural Sciences (Museum). Similar to the Trout in the Classroom, which began in 2007 in North Carolina, the Shad in the Classroom program provides a hands-on, real-life science learning opportunity.

The American shad fishery was once one of the East Coast's most abundant and economically important. However, by the mid-1970s water pollution, over-harvesting and the blocking of spawning habitat by dams led to their decline. Today, American shad continue to have ecological, economic, and historical importance to North Carolina and much of the eastern seaboard of the U.S. Similar American shad programs have existed in the Potomac River basin since 1996, setting the groundwork for the Shad in the Classroom program in North Carolina. What began in 2009 as a pilot study in North Carolina involving four schools, the Shad in the Classroom program has grown to include 27 classrooms at 22 different schools in 2015. Students and teachers become involved in the program several weeks prior to receiving American shad eggs (fertilized embryos) spawned in North Carolina Wildlife Resource Commission (NCWRC) and United States Fish and Wildlife Service (USFWS) hatcheries.

The program timeline begins with the teacher workshop in February and concludes with the release of fry reared by students into native rivers in April to early May. Each February participating teachers attend an all-day workshop and learn how to construct their fish hatcheries, attend expert presentations, participate in hands-on activities, and receive curriculum materials to use in their classrooms. The timing for delivery of eggs to the classrooms is dependent on the natural spawning of the fish. Teachers typically begin setting up their tanks and teaching materials related to the program 2–4 weeks prior to receiving the eggs. Students learn how to set up the tank and pump system, monitor water quality, and tend their shad eggs in special rearing systems prior to the arrival of their eggs. For one week during the spawning period, each classroom receives, monitors, and cares for a batch of shad eggs as part of this hands-on approach to learning about water quality, fisheries science, ecology, and history. Fry hatch within 4–5 days and are then released by the students in their river basin of origin. Lessons and activities related to the American shad are prime examples of cross curricular connections, integrating history, social studies, ecology, and management. Some teachers elect to have students keep journals throughout the course of the program, further incorporating writing components and practice. Teachers in the program also participate in an overnight canoe trip along the Roanoke River in late April or early May to explore the river-swamp ecosystem and its resources and to gain valuable insight to take back to their classrooms.

In the wild, or after release for hatchery-reared fish, the fry move downstream, and come together in schools. They will eventually leave the river and move into the sounds and then to the ocean. They will remain in the ocean for 4–6 years and then return to spawn in their native river basin in the spring to complete the life cycle. The NCWRC sample the young shad (collecting genetic material) as they move

downstream and prior to moving into the sounds. They use this information to determine the proportion of shad that have been reared in the state and federal hatcheries (including the schools) compared to shad that were spawned directly in the river. These data help the NCWRC determine the management strategies for the American shad fishery. Having the schools be part of this restoration program is a valuable educational tool.

The Shad in the Classroom Program is the result of many dedicated partners. The program is managed by the Museum and it receives significant logistical and financial support from the Albemarle-Pamlico National Estuary Program (APNEP), the NCWRC, and the USFWS. Very important to the program are the many volunteers who generously give their time to enhance the program and the dedicated teachers.

The Shad in the Classroom Program has reached 126 classrooms from 2009 to 2015 and many thousands of students. Between 2013—2015, approximately 7,734 students were reached (prior to 2013, the numbers of students were not tracked). Through their observations and experiences, students learn concepts related to the American shad's survival, the species cultural and biological importance, its ecological connections to other species and habitats, and the significance of genetic integrity. Teachers also integrate various other disciplines into the program, such as math, social studies, technology, art, literacy, and writing. The program heightens knowledge and awareness in future generations of an important migratory fish, the American shad.

ACKNOWLEDGEMENTS

We would like to acknowledge all of the teachers and volunteers who help implement the Shad in the Classroom Program each year. The teachers and volunteers are dedicated to making the program a success and are invaluable. Specific individuals who assisted with various aspects of the program for 2015 are listed below.

Workshop Speakers

Ben Ricks ben.ricks@ncwildlife.org – (NCWRC District Biologist)

Dr. Jesse Fischer jessefischer@gmail.com – (NCSU Post-doc Researcher)

Dr. Wilson Laney wilson_laney@fws.gov – (USFWS Fishery Biologist and NCSU Adjunct Faculty)

Additional Education

Fish Anatomy-Dissection Lecture

Ani Popp apopp@ncsu.edu – (NCSU Grad Student)

Caitlin Bradley cebrad13@ncsu.edu – (NCSU Grad Student)

Casey Grieshaber cagriesh@ncsu.edu – (NCSU Grad Student and helped coordinate with the graduate students)

Dylan Owensby dpowensb@ncsu.edu – (NCSU Grad Student)

Gus Engman acengman@ncsu.edu – (NCSU Grad Student)

Hunter Wainwright hpwainwr@ncsu.edu – (NCSU Student)

James Wehbie jdwehbie@ncsu.edu (NCSU Research Assistant)

Jared Flowers hjflower@ncsu.edu – (NCSU Grad Student)

Jennifer Archambault jmarcham@ncsu.edu – (NCSU Research Associate)

Dr. Jesse Fischer jessefischer@gmail.com – (NCSU Post-doc Researcher)

Tiffany Penland tjpenlan@ncsu.edu – (NCSU Grad Student)

Tomas Ivasauskas tjivasau@ncsu.edu – (NCSU Grad Student)

Hatchery Tour

Sam Pollock sam_pollock@fws.gov – (USFWS, Edenton National Fish Hatchery Fish Biologist)

Wildlife Lecture

Bob Curry robert.curry@ncwildlife.org – (NCWRC – Chief, Inland Fisheries)

Egg Delivery and Larvae Release Assistance

Emily Jernigan emily_jernigan@fws.gov – (USFWS Biologist)

Jerry Reynolds jerry.reynolds@naturalsciences.org – (Museum Senior Manager of Outreach)

Jim Hawhee jim.hawhee@apnep.org – (APNEP Policy and Engagement Manager)

John Ellis john_ellis@fws.gov – (USFWS Biologist)

Katia Griffin-Jakymec katiagj@gmail.com – (APNEP Education and Outreach Assistant)

Linda Saah linda.saah@naturalsciences.org – (Museum Classroom Programs Specialist)

Lynn Cross lynn.cross@naturalsciences.org – (Museum Coordinator of Youth Programs)

Mike Dunn roadsendnaturalist@gmail.com – (Former Museum Educator)

Mike Wicker mike_wicker@fws.gov – (USFWS Biologist)

Miranda Dowdy miranda.dowdy@naturalsciences.org – (Museum Educational Events Specialist)

River Days – Geodome

Karen Polk – karen.polk@naturalsciences.org – (Museum River Days Specialist)

Marie English – marie.english@ncdenr.gov – (APNEP AmeriCorp Member)

Mickey Sorrell – mickey.sorrell@ncdenr.gov – (Museum River Days Contractor)

In addition, we are very appreciative of the fish donations for the 2015 dissection lectures from Rich Noble, Phil Doerr, Jim Rice and fellow anglers, Mary Henson (NCSU Grad Student), and the NCWRC's Armstrong Hatchery. Also, Mary Henson and Casey Grieshaber helped coordinate with the NCSU graduate students for the anatomy-dissection lectures. American shad eggs were generously provided by Jeff Evans and the staff at the Watha State Fish Hatchery and Stephen Jackson and the staff at the Edenton National Fish Hatchery.

Background and Partners

There are many programs throughout the U.S. that bring fish and their habitats into the classroom. In North Carolina, Trout in the Classroom began in 2007 and Shad in the Classroom began in 2009. Trout in the Classroom is administered by the North Carolina Trout Unlimited Chapters. The Chapter started with two schools and by 2014 there were 37 schools in North Carolina. Schools receive between 100 and 150 trout eggs (embryos) and they raise them about 7 months to the fingerling stage prior to release. The cost of the trout program is about \$900 per classroom (includes cost of cooling system).

In addition to North Carolina, several states participate in similar shad in the classroom programs: Delaware, Maryland, New Jersey, Pennsylvania, Virginia, and West Virginia, and the District of Columbia (Figure 1). A number of participating states are part of the Interstate Commission on the Potomac River Basin (ICPRB). The Delaware River Shad Fishermen's Association is another large organization that works with a shad in the classroom program. Some of the names used for these programs include Shad in the Classroom, Schools in Schools, and Shad in Schools. Some of the states also have a Trout in the Classroom program and some even have Perch or American eels in the Classroom Programs.



Figure 1. —Map of the states we found to participate in some version of a shad in the classroom program: Delaware, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, and West Virginia, and the District of Columbia. Arrow depicts American shad spawning distribution which ranges from the Bay of Fundy in Canada to the Saint John's River in Florida.

In North Carolina, the United States Fish and Wildlife Service (USFWS) started a pilot American shad program with four schools in 2009. Two of those school programs were administered by the North Carolina Wildlife Resources Commission (NCWRC), Education Section. The following year (2010) the USFWS partnered with the North Carolina Museum of Natural Sciences (Museum), and the program grew to 13 schools (USFWS funding), three of which were administered by the NCWRC, Education Section. Beginning in 2011, the Museum assumed control of the Shad in the Classroom program and worked with 19 classrooms [with funding provided by the Albemarle-Pamlico National Estuary Partnership (APNEP), Dominion Power, and National Fish and Wildlife Foundation], while the NCWRC, Education Section continued a separate program. Under the Museum’s guidance (and with funding provided solely through APNEP), the Shad in the Classroom program reached 20 classrooms each in 2012 and 2013, 23 classrooms in 2014, and 27 classrooms (9 new) in the 2015 program year. Note that these numbers reflect the number of tanks that are in a school; some schools had multiple classrooms sharing in the shad rearing or at least observing the program. A comprehensive list of the participating schools (2009 – 2015) is included in Table 1.

Table 1. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2015)

Release Basin/School	Number of Classrooms by year						
	2009	2010	2011	2012	2013	2014	2015
Cape Fear River Basin							
Harnett Central Middle School (NCWRC)	1	1					
Lake Rim Elementary (NCWRC)	1	1					
Overhills Elementary (NCWRC)		1					
Neuse River Basin							
Angier Elementary					1	1	
Brogden Middle School							1
Broughton High School						2	1
Bunn High School				1	2	2	1
Cedar Creek Middle School							1
Centennial Campus Magnet Middle School	1	1					
Central Park School for Children					1	1	1
Chatham Central High School						1	
Chestnut Grove Middle School				1			
Daniels IBMYP Magnet Middle School		1	1	1	1	2	3
Clayton High School							1
Don D. Steed Elementary				1			
The Expedition School							2
Exploris Middle School		1	1	1	1	1	1
East Wake Middle School		1	2	2	2	2	1
East Wake School of Integrated Technology						1	
Forest Pines Dr Elementary					1		
Fuquay Varina Middle School						1	2
Hall Woodward Elementary				1	1		
Lakewood Montessori Middle School					2	2	2

Table 1. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2015)
Continued

Release Basin/School	Number of Classrooms by year						
	2009	2010	2011	2012	2013	2014	2015
Neuse River Basin							
Lead Mine Elementary	1	1	1				
Lillington Shawtown Elementary			1	1			
McLauchlin Elementary				1			
Midway Middle School							1
Mineral Springs Middle School						1	
North Duplin JR/SR High School							1
Sandy Grove Middle School				1	1		
South Asheboro Middle School				1			
South Iredell High School					1	1	1
South View High School				1			
Southern Vance High School				1	1	1	1
Speas Elementary				1			
The Oakwood School				1			
Tiller School Elementary (Carteret County Charter School)					1	1	1
Upchurch Elementary				1	1	1	1
West Hoke Elementary				1			
Wake Forest Middle School							1
Woods Charter Middle School				1	1	1	1
Roanoke River Basin							
Bartlet Yancey High School		1					
Bertie Early College High School							1
Chestnut Grove Middle School		1	1	1			
Don D. Steed Elementary			1				
Hall Woodward Elementary			1				
Hawk Eye Elementary			1				
Hertford County High School						1	1
McLauchlin Elementary			1				
Red Oak Middle School					2		
Rockfish Hoke Elementary			1				
Sandy Grove Middle School			1				
Scurlock Elementary			1				
Southern Vance High School		1	1				
Speas Elementary		1	1				
The Oakwood School			1				
Upchurch Elementary			1				
West Hoke Elementary			1				
Windsor Elementary		1					
Total Number of Schools	4	13	18	19	16	17	22
Total Number of Classrooms	4	13	19	20	20	23	27

Current new tank construction costs approximately \$300 per tank system. Other substantial expenses include tank refurbishment, chemical resupply, teacher training workshop, teacher professional development trek, school field trips to release sites, travel for eggs and delivery, presentations and conferences, part-time staff, Geodome supplies and contractors, and museum overhead. Programs from other states have reported the costs for tank construction and running their program ranges from \$550 to \$2,000 per system (with some programs, some of those costs are due to a cooling system).

In 2013, 2014, and 2015 each school received about 1,000 eggs from the NCWRC. The Neuse River broodstock fish are brought to the Edenton National Fish Hatchery and the Roanoke River broodstock fish are brought to the Watha State Fish Hatchery. Originally, American shad fry were released in the river basin closest or most convenient to the school. However, this was not in-line with the NCWRC's American shad management goals of keeping shad in their specific watershed. Therefore, since 2011, fry are only released in the river basin of their parentage, and since 2013, Roanoke basin fish are specifically only released at the NCWRC boat ramp at Weldon on the Roanoke River.

In summary, the Shad in the Classroom program has been led and administered by the Museum since 2011. Over the years, state and federal agencies and NCSU have played significant roles in the implementation of the program, including:

- Abermarle-Pamlico National Estuary Partnership
- Dominion Power
- National Fish and Wildlife Foundation
- North Carolina State University
- North Carolina Wildlife Resources Commission
- United States Fish and Wildlife Service

American shad have ecological, economic, and historical importance to North Carolina and much of the eastern coast of the U.S. Through the Shad in the Classroom program, students get a hands-on and real-life connection with learning about their environment while addressing the importance of American shad restoration and water quality. Teachers report a great enthusiasm by themselves and their students for the program.

Shad in the Classroom Program 2015 Report

This report summarizes the activities that were accomplished for the 2015 Shad in the Classroom Program. Twenty-seven classes at 22 different schools participated in the program: 5 elementary, 15 middle, and 7 high school classes. We increased the program by three classes from 2013-2014 and by four classes from 2014-2015. We originally accepted 28 classrooms, but one determined that they were unable to commit to the program this year.

Yearly program planning began with forming a timeline, reviewing applications, and conducting a tank and parts inventory. All new teachers and several returning teachers attended an orientation and training session in February. Returning to their schools, they typically began preparing their classrooms for the arrival of the shad eggs 2–4 weeks prior to receiving the eggs in April. American shad broodstock were collected beginning the week of March 30. Most classes released the shad larvae on the Thursday or Friday of the week that they received them; however, for the second year one classroom retained half of their shad fry for an additional week, feeding them on brine shrimp that they raised in their classroom. Many of the teachers took advantage of either (or both) a fish dissection lecture that we coordinated with NCSU graduate students and post doctorates or a shad printing (Gyotaku) activity and supplies that we made available.

We continued the ‘River Days’ program to reach students and communities along the Roanoke River in 2015. We used the Museum’s inflatable immersion theater, the Geodome, to show a video production entitled ‘We are the River’ documenting the cultural and natural history, conservation, and connection of local communities to the Roanoke River. Contract staff and Americorps members presented supplemental activities to build on the video content.

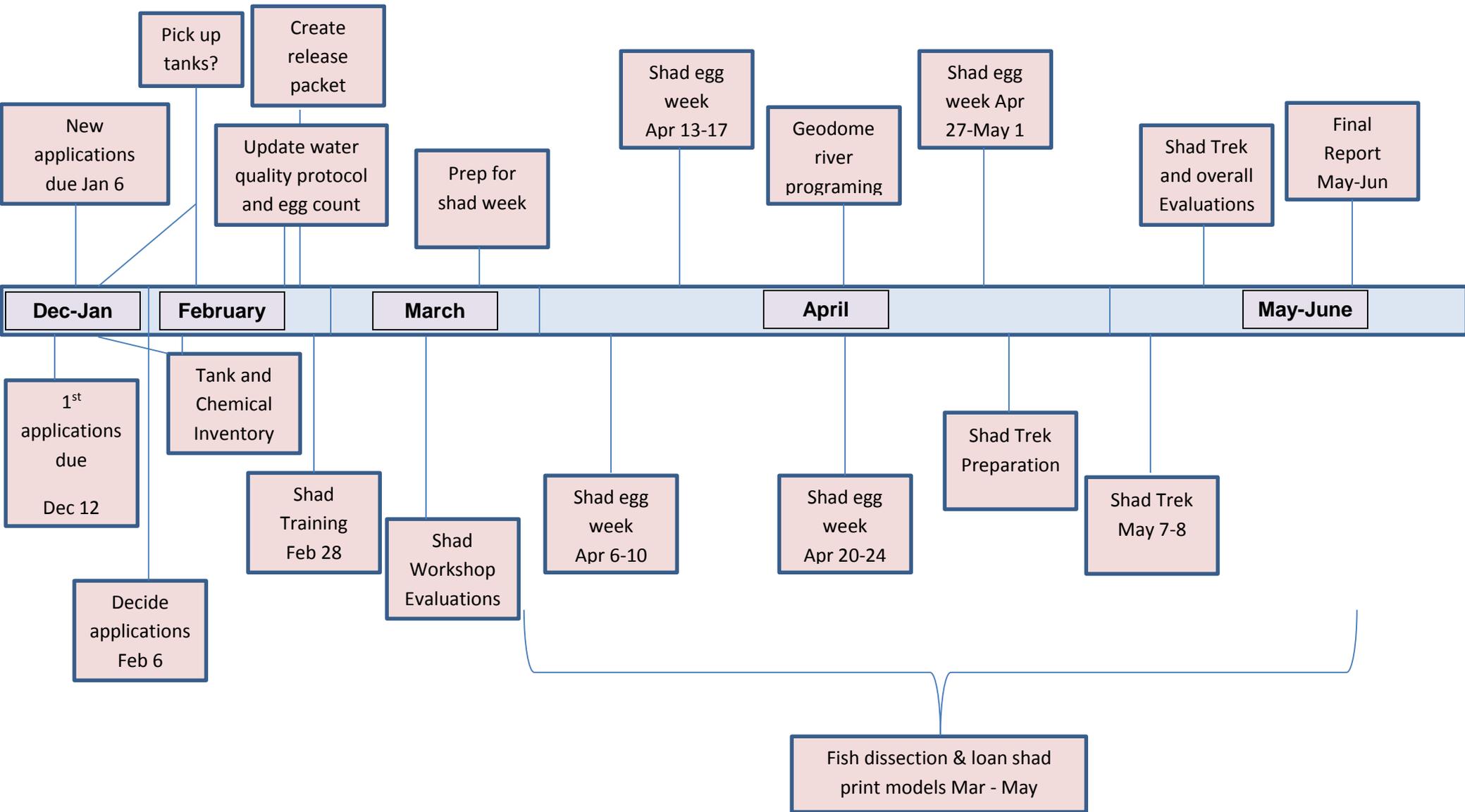


Photo 1. NCSU grad student, Casey Grieshaber dissection lecture, Brogden MS



Photo 2. Teachers shad printing

Shad in the Classroom 2015 Timeline



Tank Inventory

At the start of the program, tank parts and chemicals were inventoried and items purchased as needed. Tanks were retrieved from schools no longer participating in the program. New tanks were constructed and old tanks refurbished, as needed, with the assistance of Museum exhibits staff. An updated inventory list is on file.

Teacher Orientation and Training

A teacher orientation and training session was conducted on February 28, 2015. Danielle Pender, Melissa Dowland, and Megan Chesser co-lead the session. Ben Ricks (NCWRC), Jesse Fisher (NCSU), and Wilson Laney (USFWS) were guest lecturers. Teachers were provided information about American shad life history, restoration, and management. They received equipment and instructions for raising shad and learned ways to incorporate shad and aquatic ecology into their curriculum. Teachers were provided with hands-on fish anatomy, morphology, and dissection lessons and participated in shad printing (Gyotaku) and Shad Scent exercises. Meeting in a central location with researchers, collaborating partners, and museum program staff facilitated networking among all teachers and schools involved in the project. Twenty-one teachers attended the 2015 workshop. Of those, 19 responded to the 9 question survey regarding the workshop. Most teachers reported that they were very to extremely satisfied with the workshop and they learned the concepts very to extremely well (Table 2).



Photo 3. Jesse Fisher, Workshop Dissection Lecture



Photo 4. Teachers, Workshop Tank Construction

Table 2. Workshop Survey Results

Question	Response variable												
How well did the workshop explain the importance of the shad restoration and management program?	53% (10) extremely well; 42% (8) very well; 5% (1) moderately well												
How well did the workshop explain the life history of shad?	55% (10) extremely well; 39% (7) very well; 5% (1) moderately well												
How well did the workshop explain the proper components to raising shad eggs to the larval stage?	26% (5) extremely well; 58% (11) very well; 16% (3) moderately well												
How confident do you feel in building the shad tank system on your own?	58% (11) extremely confident; 32% (6) very confident; 10% moderately confident												
How resourceful was the leadership team in helping you with your questions about the program?	95% (18) extremely resourceful; 5% very resourceful (1)												
How comfortable do you feel in contacting the other teachers that you met at the workshop with questions?	37% (7) extremely comfortable; 42% (8) very comfortable; 16% (3) moderately comfortable; 5% (1) not comfortable												
How sufficient was the information you learned to incorporate shad into your curriculum?	32% (6) extremely sufficient; 53% (10) very sufficient; 10% (2) moderately sufficient; 5% (1) slightly sufficient												
What aspects of the workshop were useful? Please choose all that apply.	<table border="1"> <thead> <tr> <th>Life History</th> <th>Shad Restoration</th> <th>Dissection</th> <th>Tank Building</th> <th>Shad Scents</th> <th>Sharing Experience</th> </tr> </thead> <tbody> <tr> <td>95% (18)</td> <td>95% (18)</td> <td>79% (15)</td> <td>79% (15)</td> <td>74% (14)</td> <td>95% (18)</td> </tr> </tbody> </table>	Life History	Shad Restoration	Dissection	Tank Building	Shad Scents	Sharing Experience	95% (18)	95% (18)	79% (15)	79% (15)	74% (14)	95% (18)
Life History	Shad Restoration	Dissection	Tank Building	Shad Scents	Sharing Experience								
95% (18)	95% (18)	79% (15)	79% (15)	74% (14)	95% (18)								
Overall, how satisfied are you with the workshop?	84% (16) extremely satisfied; 11% (2) very satisfied; 5% (1) moderately satisfied												

Egg Delivery and Larval Fish Release

We coordinated the arrival of the eggs and the release of the larval fish with the schools, hatchery, drivers, and fisheries biologists. This involved foremost the timing of the spawning of the American shad, but also took into account school schedules. American shad broodstock were collected from the Roanoke the week of March 30 and from the Neuse the week of April 6. Many people assisted with the delivery of the eggs and with the release of the larval fish and are mentioned in the acknowledgments.

Classes were divided into three groups. Group 1 received their eggs Monday, April 13, Group 2 received them on Monday, April 20, and Group 3 received their eggs on Monday, April 27. In Group 1 there were 12 classes. Of those, 8 classes released larval fish on Thursday, April 16, 2015, 7 in the Neuse Basin and 1 in the Roanoke River Basin at Weldon and 4 released larval fish on Friday, April 17, 2015, 3 in the Neuse and 1 in the Roanoke River Basin at Weldon (Table 3, Figure 2). Nine classes (Group 2) received eggs on Monday, April 20, 2015. Of those, 4 classes released larval fish on Thursday, April 23, 2015, 4 released on Friday, April



Photo 5. The Expedition School Release at Gold Park on the Eno River



Photo 6. Bob Curry Wildlife Lecture demonstration for East Wake MS and Wake Forest MS at Milburnie Dam

24, 2015 in the Neuse River Basin, and one class lost all of their fish. The remaining six classes (Group 3) received their eggs on Monday, April 27, 2015. One of these classes released on Thursday, April 30, 2015 and the rest released larval fish on Friday, May 1, 2015 in the Neuse River Basin. One class raised a second tank of shad and fed them on brine shrimp. Those fry were released on Friday, May 8, 2015. Classes releasing in to the Neuse River Basin received approximately 26,000 eggs from the Edenton National Fish Hatchery (1,000 to each class, with the exception of one classroom which has two tanks and received 2,000 eggs). Two schools received eggs from Watha State Fish Hatchery (approximately 1,000 eggs each; 2,000 total).

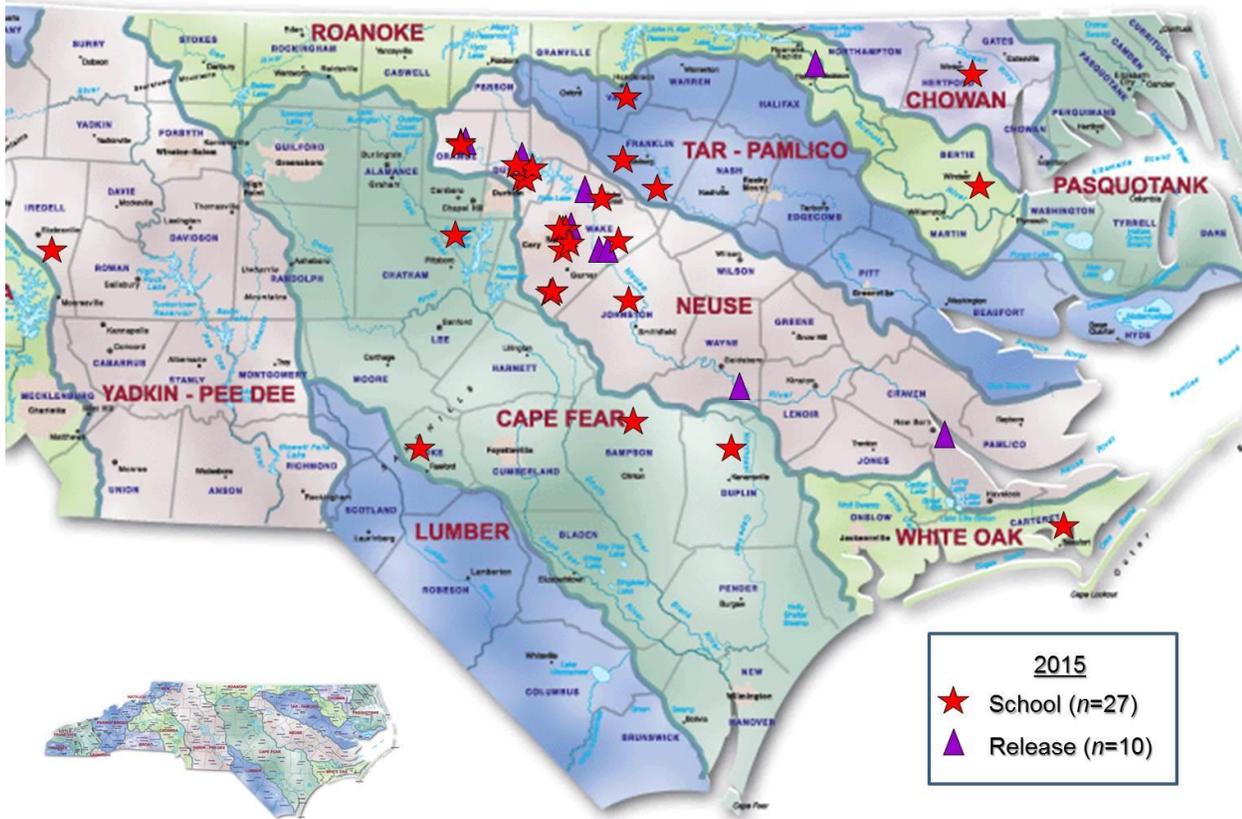
Table 3. Egg and Larval Release Timing and Release Site Information

Educator	School	Received Eggs	Released Eggs/Larva	Release Site
Anne Howell	Hertford County HS	4-13-2015	4-16-2015	Roanoke River at Weldon
Beth Selig	Fuquay Varina MS	4-13-2015	4-16-2015	Neuse River (Smithfield)
Brian Reynolds	Bertie Early College HS	4-13-2015	4-17-2015	Roanoke River at Weldon
Cheryl Henry	Cedar Creek MS	4-13-2015	4-17-2015	Neuse River, Falls Dam
Dorothy Holley	Clayton HS	4-13-2015	4-16-2015	Neuse River (Smithfield)
Jason Stehly	Midway MS	4-13-2015	4-16-2015	Neuse River (Cliffs of the Neuse State Park)
Kate Whittier	Daniels IBMYP Magnet MS	4-13-2015	4-16-2015	Neuse (Lassiter Mill Dam, Crabtree Creek)
Laine Staton	Lakewood Montessori MS	4-13-2015	4-17-2015	Neuse (West Point, Eno River)
Matthew Lanner	Fuquay Varina MS	4-13-2015	4-16-2015	Neuse River (Smithfield)
Richard Kowaleski	Daniels IBMYP Magnet MS	4-13-2015	4-16-2015	Neuse (Lassiter Mill Dam, Crabtree Creek)
Sarah Lancaster	Daniels IBMYP Magnet MS	4-13-2015	4-16-2015	Neuse (Lassiter Mill Dam, Crabtree Creek)
Sonja Younger	Woods Charter MS	4-13-2015	4-17-2015	Neuse (West Point, Eno River)
Angie Archbold	The Expedition School	4-20-2015	4-23-2015	Neuse (Gold Park, Eno River)
Christina Edmiston	Upchurch ES	4-20-2015	4-23-2015	Neuse (Anderson Point, Crabtree Creek)
Christina Livingstone	Brogden MS	4-20-2015	4-24-2015	Neuse (West Point, Eno River)
Daniel Cates	North Duplin JR/SR HS	4-20-2015	4-24-2015	Neuse River (Cliffs of the Neuse State Park)
Jane Forde	Broughton HS	4-20-2015	No survival	No survival
Jennifer Howard	Southern Vance HS	4-20-2015	4-23-2015	Neuse (Anderson Point, Crabtree Creek)

Table 3. Egg and Larval Release Timing and Release Site Information - Continued

Educator	School	Received Eggs	Released Eggs/Larva	Release Site
Judy Compton	Central Park School for Children	4-20-2015	4-23-2015	Neuse River (Cliffs of the Neuse State Park)
Meg Millard	The Expedition School	4-20-2015	4-23-2015	Neuse (Gold Park, Eno River)
Shannon Hardy	Exploris MS	4-20-2015	4-23-2015	Neuse River (Milburnie Dam)
Courtney Millis	Lakewood Montessori MS	4-27-2015	5-1-2015	Neuse River, Falls Dam
Karen Curry	East Wake MS	4-27-2015	5-1-2015, 5-8-2015	Neuse River (Milburnie Dam)
Kelly Riley	Tiller ES	4-27-2015	5-1-2015	Neuse River (Flanners Beach)
Sarah "Kristen" Bright	South Iredell HS	4-27-2015	5-1-2015	Neuse (West Point, Eno River)
Melissa Oakley	Bunn HS	4-27-2015	4-30-2015	Neuse (Anderson Point, Crabtree Creek)
Michelle Amato	Wake Forest MS	4-27-2015	5-1-2015	Neuse River (Milburnie Dam)

Figure 2. — School and release site locations (approximate)



Overall, the shad rearing and release was successful for most schools. Each class was to receive approximately 1,000 eggs; however, counts may differ as to what the school actually reported receiving. A number of schools reported receiving unfertilized eggs. A few of the schools had problems with some water quality issues, and one of those lost all of their larval fish and eggs. This year we added additional water quality measurements for alkalinity and hardness. Schools that had low alkalinity were instructed to add 1 teaspoon of baking soda per 10 gallons of water with water changes as necessary. This procedure appeared to help with the low pH fluctuations that some school experienced in previous years. Percent survival for each tank ranged from as low as 0% up to 95% and averaged 58% (Table 4). Twelve classes averaged $\leq 50\%$, 15 averaged $\geq 51\%$, and 9 averaged $\geq 75\%$ survival to release.

Table 4. Egg and Larval Survival and Release Numbers

Educator	School	No. Eggs Received	No. Eggs/Larva Survived to Release	Percent Survival (%)
Angie Archbold	The Expedition School	1000	500	50
Anne Howell	Hertford County HS	800	596	75
Beth Selig	Fuquay Varina MS	2000	1800	90
Brian Reynolds	Bertie Early College HS	1000	950	95
Cheryl Henry	Cedar Creek MS	1000	892	89
Christina Edmiston	Upchurch ES	1000	500	50
Christina Livingstone	Brogden Middle School	1000	528	53
Courtney Millis	Lakewood Montessori MS	1000	400	40
Daniel Cates	North Duplin JR/SR HS	1500	250	17
Dorothy Holley	Clayton HS	1000	900	90
Jane Forde	Broughton HS	1000	0	0
Jason Stehly	Midway MS	1000	300	30
Jennifer Howard	Southern Vance HS	1000	695	70
Judy Compton	Central Park School for Children	1500	100	7
Karen Curry	East Wake MS	2000	1650	83
Kate Whittier	Daniels IBMYP Magnet MS	1000	850	85
Kelly Riley	Tiller School	1000	62	6
Laine Staton	Lakewood Montessori MS	1000	700	70
Matthew Lanner	Fuquay Varina MS	2200	1503	68
Meg Millard	The Expedition School	1000	420	42
Melissa Oakley	Bunn HS	1900	1400	74
Michelle Amato	Wake Forest MS	1000	850	75
Richard Kowaleski	Daniels IBMYP Magnet MS	1300	550	42
Sarah “Kristen” Bright	South Iredell HS	3000	1000	33
Sarah Lancaster	Daniels IBMYP Magnet MS	1300	1144	88
Shannon Hardy	Exploris MS	1350	1095	81
Sonja Younger	Woods Charter MS	1000	500	50

The learning experience the students receive while rearing the shad is quote “priceless” as stated by many teachers. Students are fascinated that they are working with actual life and that what they are learning in school is actually applicable outside of school. We have received such great feedback on the program from the teachers throughout the 2015 program year.

“The chemical testing helped them understand words they had heard before but didn’t have any meaning behind.”

“The learning experience cannot be replaced by any simulation or video.”

“The students have been inspired by the classroom shad and seem to think more about how their actions impact the environment.”

Additional Education

In addition to learning concepts related to the shad survival, cultural and biological importance of the species, its ecological connections to community assemblages and habitat, and the significance of genetic integrity, we have made available additional educational activities to enhance the program. All teachers responded to the program evaluation survey (Table 5). This year Bob Curry (NCWRC, Chief Inland Fisheries) conducted a local wildlife lecture at one release (2 classrooms; East Wake Middle School and Wake Forest Middle School) and we assisted a number of schools with basic aquatic invertebrate sampling during their release. This year we continued with the shad mold loaning program and expanded the fish dissection program, which are described in more detail below.

American Shad Molds – Fish Printing

This year we continued to make available two travel kits (4 American shad molds each) of fish printing (Gyotaku) supplies for the teachers to borrow and use in their classrooms. Eight teachers took advantage of these available resources, and reported that the exercise enhanced the learning experience for their students.

Fish Dissection

We coordinated with the NC Chapter of the American Fisheries Society Student subunit (Chapter) at NCSU to conduct fish anatomy/morphology and dissection lessons. Twelve student, post-doc, and researchers from the Chapter volunteered (listed in acknowledgments) to conduct these lessons. Kevin Hining (NCWRC District Biologist) also volunteered to conduct one of the lessons; however, the teacher got sick and they were unable to reschedule. Because of these volunteers and the generosity of fish donations (over 250 fish), we were able to facilitate the dissection lecture for 18 classes (823 students). We were fortunate that all teachers that requested a dissection lecture at their school were able to be accommodated. We are very grateful to the Chapter and for the fish donations, which led to the great success of this activity. All teachers that were able to participate in this class reported that the activity enhanced the learning experience for their students.

The fish dissection is a highly appreciated component that we have added to the program. One of the high schools (South Iredell High School) started an Ichthyology club because of this program and the fish dissection.

“I have some kids who don’t like bugs and squishy things. They were skeptical about dissection. However, during the actual lesson, many biologists were born. Kids who didn’t want to do the dissection got fascinated by what they saw and found. They’ve referenced the experience many times in the weeks we’ve been working with shad and other fish.”

“It was the highlight of the student’s year.”

“The dissection was AWESOME! The kids loved it.”

“Some of the kids said it was the best day ever!!”

Curriculum Activities and Videos

This year we created a Shad Scent classroom exercise (developed from Sockeye Scents). Teachers participated in the exercise at the workshop. Two teachers reported that the exercise enhanced the learning experience for their students and a few more reported that they would have liked to do the exercise, but ran out of time this year. In addition, we put together supplementary materials for the teachers to use to augment the learning process in the classroom and at the release. These have all been uploaded to a shared dropbox site with the teachers. Materials include, but are not limited to, the Shad Scent exercise, a guide for stream sampling, the genetic exercise, and materials provided by the teachers.

The genetic based exercise, “Who’s your Shaddy”, (developed in 2013 and updated in 2014) was continued. Four teachers (3 high schools and 1 middle school) reported using this exercise. The 3 high schools reported that it was “just right” as far as understandability and complexity for their students, and the middle school reported that it was somewhat complicated. Two additional middle school teachers reported not using the genetic exercise due to its complexity. Additional on-line (Museum website) curriculum activities are available for the teachers to use including Food Web Activities (16 reported as useful), GIS Watershed Activity (7 reported as useful), Wishes of Fishes Activity (6 reported as useful), Non-Fiction Reading Activity (13 reported as useful), and Hands-on Activities for Students (18 reported as useful). Seven videos were created for the program previously and all teachers reported using at least some videos and many reported that they were very useful.

Table 5. Additional Education Survey Results

Question	Response variable
Fish Printing – enhance learning?	8% (2) greatly enhanced; 11 (3) enhanced; 11% (3) somewhat; 70% (19) did not use
Fish Dissection – enhance learning?	48% (13) greatly enhanced; 15% (4) enhanced; 30% (8) did not use; 7% (2) not yet happened at time of survey
Shad Scents – enhance learning?	4% (1) greatly enhanced; 4% (1) enhanced; 92% (25) did not use
Genetic Exercise – complexity or understanding?	11% (3) just right; 4% (1) somewhat complicated; 7% (2) too complicated; 78% (21) did not use
Food Web Activities – usefulness?	37% (10) very useful; 11% (3) useful; 11% (3) somewhat useful 41% (11) did not use
GIS Watershed Activity – usefulness?	15% (4) very useful; 4% (1) useful; 7% (2) somewhat useful 74% (20) did not use
Wishes of Fishes Activity – usefulness?	11% (3) very useful; 11% (3) useful; 78% (21) did not use
Non-Fiction Reading Activity – usefulness?	26% (7) very useful; 15% (4) useful; 2% (7) somewhat useful 52% (14) did not use
Hands-on Activities – usefulness?	44% (12) very useful; 19% (5) useful; 4% (1) somewhat useful 33% (9) did not use
Video -Add the eggs – usefulness?	52% (14) very useful; 30% (8) useful; 18% (5) did not use
Video –Build the Tank – usefulness?	37% (10) very useful; 7% (2) useful; 19% (5) somewhat useful; 37% (10) did not use
Video – Fish Passage – usefulness?	63% (17) very useful; 15% (4) useful; 22% (6) did not use
Video – History – usefulness?	85% (23) very useful; 4% (1) useful; 7% (2) somewhat useful; 4% (1) did not use
Video – It is Time usefulness?	52% (14) very useful; 30% (8) useful; 7% (2) somewhat useful 11% (3) did not use
Video - Lifecycle – usefulness?	85% (23) very useful; 8% (2) useful; 8% (2) not use
Video – Overview – usefulness?	63% (17) very useful; 19% (5) useful; 7% (2) somewhat useful; 11% (3) did not use

Shad Trek – Secrets of the Swamp

Nine teachers, two APNEP personnel (one an Americorp member), and 3 museum staff attended the shad trek in 2015. On Thursday, 7 May 2015, the group canoed approximately 3 and 3/4 miles on Gardner Creek and Upper Deadwater Creek, tributaries of the Roanoke River. Camping took place at Beaver Lodge and Beaver Tail platform campsites. On Friday, 8 May 2015 the group completed the approximately 2 and 1/2 mile downstream canoe trip to the Astoria Landing Access Area (NCWRC). The group then participated in a tour conducted at the USFWS Edenton National Fish Hatchery. During the two day trip, the group learned about local and Neotropical migrant birds, aquatic invertebrates, reptiles, amphibians, fish, and plants in the Roanoke River ecosystem. Teachers responded very positively to the Trek with 100% of teachers indicating that the workshop increased their knowledge of science, their understanding and appreciation of the natural environment, and their comfort in the natural world. They also stated that they would use the workshop in their teaching and would recommend the workshop to other educators.



Photo 7. Teachers observing aquatic fauna at platform

River Days – Geodome

The “River Days” component of the Shad in the Classroom program that began in 2014 continued this year, and was primarily based around the Museum’s travelling, inflatable immersion theater, the Geodome. Over the course of the “River Days” week, the Geodome visited 5 schools (all public, Title 1 schools). In addition, the Geodome was also attended by staff from Northeast Regional School of Biotechnology and Agriculture, a public charter school, Brad Davis, the Mayor of Jamesville, and a couple of other members of the community, including Carol Shields, Director of Roanoke River Partners. For the participating schools, 22.25 hours of programming (total) was provided, serving grades 5 through 9 (totaling 616 people). Each class (with the exception of the Weldon 8th graders) rotated through the following activities.



Photo 8. Students at geodome

1. ***We Are the River*** video in the Geodome with accompanying riverbank development activity
2. ***Hooks and Ladders***--fish migration enactment/game or ***The Incredible Journey*** – a water cycle activity (which of these two activities were used was weather dependent)

Program Outcomes

Student Impact

The Shad in the Classroom Program exposes students to important science and math concepts including those listed below.

1. History, cultural and biological importance, and life cycle of the American shad
2. The shad's ecological connections to other species
3. The significance of genetic integrity to population studies
4. Scientific procedures for measuring, testing, collecting, and organizing data
5. Mathematics to estimate, calculate, and predict results
6. Charts, maps, and graphs to aid in using information
7. Information exchange among other classes in the school and to parents and adults
8. The delicate balance of nature and work toward conserving or improving natural resources
9. American shad restoration in rivers
10. Reporting and presentation techniques, both oral and written

This program provides a valuable experiential learning opportunity for students in the classroom that houses the tank (direct involvement) and those indirectly involved (e.g. collecting and recording water quality during their science period). Some teachers reported that it created an “excitement in the whole school”. There were 1,992 students directly involved with the Shad in the Classroom Program this year and more that got to experience it indirectly.

Public Outreach

Information on the Shad in the Classroom Program is available on the Museum's website. The program also receives a lot of publicity by word-of-mouth from those who have participated in the program previously (including teachers, students, and volunteers). The River Days – Geodome component reached 616 people from April 13-17. This year information on the Shad in the Classroom Program was presented at the NC Chapter of the American Fisheries Society Student Subunit (NCSU) Meeting on January 13, 2015.

Information on the Shad in the Classroom Program will be published in the North Carolina Chapter American Fisheries Society Summer Newsletter in 2015. We will also be presenting information on the program at the Environmental Educators of North Carolina Annual Conference in September 2015.

Future Planning

On June 11, 2015 we had a meeting among partners. Representatives from the Museum, APNEP, the NCWRC, and the USFWS were present. Among items discussed were strengths of the program and visions for the future. All partners agreed that the program is highly valued by their agencies and by the public and that we should continue with the program for the foreseeable future.

The shad models for fish printing (Gyotaku) and the fish dissection lectures were very well received and we plan to continue them for next year. We will also continue to make additional curriculum activities available for in-classroom and at-release use. We are considering ways to allow more teachers to experience the hatchery tour as many listed it as a highlight.

Shad in the Classroom was very successful again this year. Teachers and students provided positive feedback on all aspects of the program including the workshop, Trek, River Days – Geodome, and the overall program. Most teachers participating in the Shad in the Classroom Program reported that they would like to continue with the program next year. Two classrooms will not be returning, and one of those is due to the teacher moving out of the country and the other is due to the teacher retiring. At present, we have 13 new teachers on the waiting list for the program in 2016. A few new activities were implemented this year, and others were improved, which added to the students' overall learning experiences. We received invaluable assistance from partners and volunteers helping with the deliveries of eggs, attendance at releases, and educational lectures. Working with this program is a positive experience for all involved.

USFWS – “It is important to engage kids as anglers of tomorrow ... this is one of the most effective ways I have seen”.

NCWRC – Program is highly valued ... “Even if they were no longer stocking shad they would still provide the broodstock for educational purposes”.

APNEP – “the Program provides a connection of the ocean to the sounds to the rivers to Raleigh to kids to parents to voters”.

“It is what science should be about—actually carrying out an experiment, collecting data, analyzing data, applying concepts you have learned to a real world issue.”