

**Shad in the Classroom  
Program Report  
(2009-2018)**

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## Executive Summary

The Shad in the Classroom Program is the result of many dedicated partners. The program is managed by the NC Museum of Natural Sciences (Museum) and it receives significant logistical and financial support from the Albemarle-Pamlico National Estuary Partnership (APNEP), the North Carolina Wildlife Resources Commission (NCWRC), and the U.S. Fish and Wildlife Service (USFWS). For the 2018 program, we received \$9,420 in grant funding and also program specialist position funding from APNEP. We received \$7,000 in grant funding from the USFWS. And we received \$840 from the NC Chapter of the American Fisheries Society to purchase materials to construct higher quality tanks. We also leveraged over \$42,000 of in-kind support. 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 216 classrooms from 2009 to 2018 (Table 1) and many thousands of students. Between 2013–2018, approximately 13,764 students were reached (prior to 2013, the numbers of students were not tracked). Thirty classrooms participated in 2018 with 8 of those being new to the program this year. Five of the schools released larval fish and eggs in the Roanoke River basin and the other 25 schools released in the Neuse River basin. Over 2,000 students participated in the program this year and over 1,200 participated in river releases.

Table 1. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2018)

Release Basin/School	Number of Classrooms by year									
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
<b>Cape Fear River Basin</b>										
Harnett Central Middle School (NCWRC)	1	1								
Lake Rim Elementary (NCWRC)	1	1								
Overhills Elementary (NCWRC)		1								
<b>Neuse River Basin</b>										
Abbotts Creek Elementary School								1	1	1
Angier Elementary					1	1				
Ballentine Elementary									1	1
Bladen County (Cape Fear River Watch)										1
Brogden Middle School							1	1	1	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	2	2	1
Chatham Central High School						1				
Chestnut Grove Middle School				1						
Clayton High School								1	1	1
Cleveland High School								1	1	1
Cook Literacy Model School									1	1
Daniels IBMYP Magnet Middle School		1	1	1	1	2	3	1	2	1
Dillard Middle School									1	

Table 1. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2018)  
Continued

Release Basin/School	Number of Classrooms by year									
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
<b>Neuse River Basin</b>										
Don D. Steed Elementary				1						
East Garner Middle School										1
East Wake Middle School		1	2	2	2	2	1		1	
East Wake School of Integrated Technology						1				
The Expedition School							2	2	2	1
Exploris Elementary School									2	2
Exploris Middle School		1	1	1	1	1	1	1		
Forest Pines Dr Elementary					1					
Fuquay Varina Middle School						1	2	2	2	2
Grady A. Brown Elementary										1
Hall Woodward Elementary				1	1					
Horton Middle School									1	1
Lakewood Montessori Middle School					2	2	2	2	2	
Lead Mine Elementary	1	1	1							
Lillington Shawtown Elementary			1	1						
McLauchlin Elementary				1						
Midway Middle School							1			
Millbrook Environmental Connections										1
Magnet Elementary										
Mills Park Middle School									1	
Mineral Springs Middle School						1				
Moss Hill Elementary									1	1
North Duplin JR/SR High School							1	1		
Pine Hollow Middle School										1
Rolesville Middle School									1	
Sandy Grove Middle School				1	1					
Smithfield-Selma Senior High School										1
South Asheboro Middle School				1						
South Iredell High School					1	1	1	1	1	1
South View High School				1						
Southern Vance High School				1	1	1	1			
Speas Elementary				1						
Tar Heel Middle School								1		
The Oakwood School				1						
Tiller Elementary School (Carteret County Charter School)					1	1	1	1	1	1
Upchurch Elementary				1	1	1	1	1	1	1
Uwharrie Charter Academy								1		

Table 1. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2018)  
Continued

Release Basin/School	Number of Classrooms by year									
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
<b>Neuse River Basin</b>										
West Hoke Elementary				1						
Wake Forest Middle School							1	1		
Walkertown Middle School								1		
W.G. Enloe High School									1	1
Woods Charter Middle School				1	1	1	1	1	1	
<b>Roanoke River Basin</b>										
Bartlet Yancey High School		1								
Bertie Early College High School							1	1	1	1
Cedar Creek Middle School								1		
Chaloner Middle 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							
Pasquotank county High School										1
Perquimans County Middle School									1	1
Red Oak Middle School						2				
Rockfish Hoke Elementary			1							
Sandy Grove Middle School			1							
Scurlock Elementary			1							
Southern Vance High School		1	1						1	1
Speas Elementary		1	1							
The Oakwood School			1							
Upchurch Elementary			1							
Vance Charter School								1		
West Hoke Elementary			1							
Windsor Elementary		1								
W.L. Manning Elementary School								1	1	
<b>Total Number of Schools</b>	<b>4</b>	<b>13</b>	<b>18</b>	<b>19</b>	<b>16</b>	<b>17</b>	<b>22</b>	<b>23</b>	<b>27</b>	<b>28</b>
<b>Total Number of Classrooms</b>	<b>4</b>	<b>13</b>	<b>19</b>	<b>20</b>	<b>20</b>	<b>23</b>	<b>27</b>	<b>27</b>	<b>33</b>	<b>30</b>

Current new tank construction of the red tub style tanks cost approximately \$385 per tank system. The plexiglass tank systems cost approximately \$585 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 egg delivery, part-time staff, and River Days supplies and contractors.

In the years from 2013–2018, each school received approximately 1,000 eggs from the NCWRC. Both the Neuse River broodstock fish and the Roanoke River broodstock fish are brought to the Edenton National 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
- East Carolina University
- National Fish and Wildlife Foundation
- North Carolina Chapter of the American Fisheries Society
- 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 for themselves and their students through the program.

## 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 2018 are listed below.

### Additional Education

#### Fish Anatomy-Dissection Lecture

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In addition, we are very appreciative of the fish donations for the 2018 dissection lectures from Dr. Rich Noble, Dr. Phil Doerr, Dr. Jim Rice and fellow anglers, and the NCWRC's Armstrong Hatchery. Also, Stephen Parker and Riley Gallagher helped coordinate with the NCSU graduate students and also collected fish specimens and Jordan Smith helped coordinate with the ECU graduate students for the anatomy-dissection lectures. We greatly appreciate Ben Ricks and Katy Potoka for coordinating shad weeks with us, and for their, and additional NCWRC coastal regional staff and USFWS staff for the collection of American Shad broodstock. American Shad eggs were generously provided by Stephen Jackson, Sam Pollock, and the staff at the Edenton National Fish Hatchery.

Report cover photos: Top left – Tiller Elementary School students celebrating receiving their eggs; middle left - Cook Literacy Model School students release at West Point on the Eno; bottom left – Teachers participating in a tour of the Edenton National Fish Hatchery; right – East Bladen High School students release at Cliffs of the Neuse State Park.



# Shad in the Classroom Program 2018 Report

This report summarizes the activities accomplished for the 2018 Shad in the Classroom Program. Thirty classes at 28 different schools participated in the program: 12 elementary, 9 middle, and 9 high school classes.

Yearly program planning began with forming a timeline (Figure 1), 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, teachers 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 by NCWRC beginning the week of April 2nd. Classes released the Shad larvae on the Thursday or Friday of the week that they received them. Many of the teachers took advantage of either (or both) a fish dissection lecture that we coordinated with NCSU and ECU graduate students and NCSU post doctorates and NCWRC education staff or a Shad printing (Gyotaku) activity and supplies that we made available. Three teachers were also able to take advantage of an invertebrate lecture.



**Photo 1. Brogden MS building their tank.**



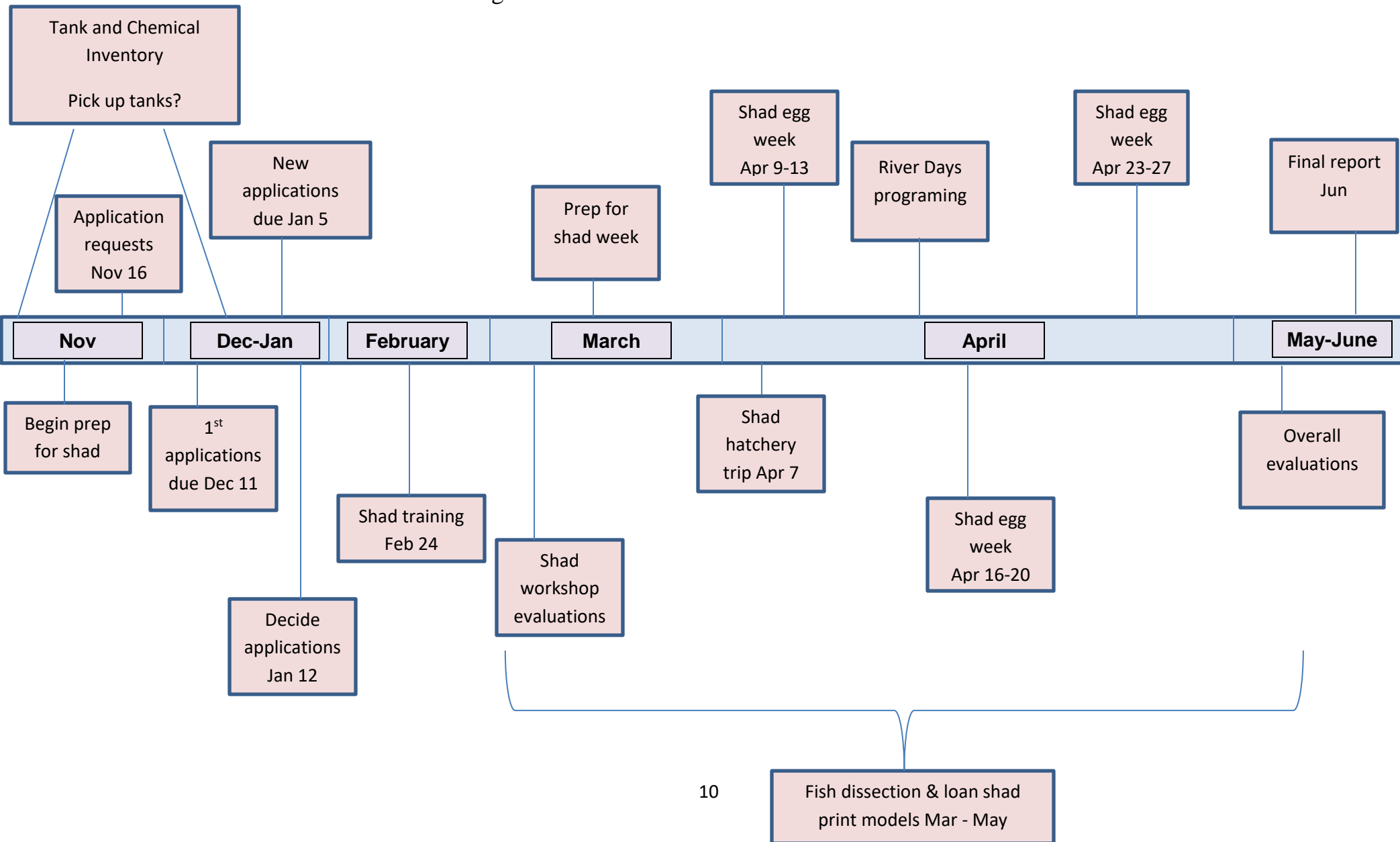
**Photo 2. Grady A. Brown ES, Releasing shad Gold Park Eno River**



**Photo 3. Sam Pollock conducting Edenton National Fish Hatchery Tour**

Five teachers and Katy Potoka, NCWRC District Biologist, attended a tour at the Edenton National Fish Hatchery. A two-day Roanoke River Trek was provided for local teachers. We continued the ‘River Days’ program to reach students and communities along the Roanoke River in 2018. We used a newly revised linear version of the *We Are the River* film documenting the cultural and natural history, conservation, and connection of local communities to the Roanoke River. Contract staff presented supplemental activities to build on the video content.

Figure 1. Shad in the Classroom 2018 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. Existing tanks were refurbished, as needed, with the assistance of Museum exhibits staff. The NC Chapter of the American Fisheries Society awarded us \$840 to purchase materials to construct two higher quality tanks, which will be constructed for the 2019 Shad year. An updated inventory list is on file.

## Teacher Orientation and Training

A teacher orientation and training session was conducted on February 24, 2018. Danielle Pender and Melissa Dowland co-led the session. Cicero Stutts, museum staff, and Kelsey Ellis, APNEP staff, assisted with the workshop. 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 participated in shad life cycle activity, water quality testing, egg sorting, “fry” removal, and building tanks.

This year we also took teachers to the Neuse River (former site of Milburnie Dam) to practice the release, to sample for aquatic macroinvertebrates, and to watch a back-pack electrofishing demonstration. 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-six teachers attended the 2018 workshop. Of those, 17 responded to the 10-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 4. Practicing water quality testing at teacher orientation**



**Photo 5. Neuse River site visit at teacher orientation**

Table 2. Workshop Survey Results

Question	Response variable			
How well did the workshop explain the importance of the shad restoration and management program?	65% (11) extremely well; 35% (6) very well			
How well did the workshop explain the life history of shad?	70% (12) extremely well; 24% (4) very well; 6% (1) moderately			
How well did the workshop explain the proper components to raising shad eggs to the larval stage?	76% (13) extremely well; 24% (4) very well			
How confident do you feel in building the shad tank system on your own?	65% (11) extremely confident; 23% (4) very confident; 12% (2) moderately confident			
How resourceful was the leadership team in helping you with your questions about the program?	71% (12) extremely resourceful; 29% (5) very resourceful			
How comfortable do you feel in contacting the other teachers that you met at the workshop with questions?	41% (7) extremely comfortable; 41% (7) very comfortable; 18% moderately comfortable			
How sufficient was the information you learned to incorporate shad into your curriculum?	35% (6) extremely sufficient; 59% (10) very sufficient; 6% (1) moderately sufficient			
What aspects of the workshop were useful? Please choose all that apply.	Lifecycle 88% (15)	Water testing 82% (14)	Egg chamber 65% (11)	Egg sort 71% (12)
What aspects of the workshop were useful? Please choose all that apply.	Fry removal 59%(10)	Tank building 76%(13)	Sharing experience 100%(17)	Site visit 95%(16)
Overall, how satisfied are you with the workshop?	65% (11) extremely satisfied; 35% (6) very 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 the week of April 2<sup>nd</sup>. 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 9, Group 2 received them on Monday, April 16, and Group 3 received their eggs on Monday, April 23. In Group 1 there were 7 Neuse River classes. Of those, 4 classes released larval fish on Thursday, April 12 and 3 released on Friday, April 13 (Table 3, Figure 2). Group 2 consisted of 14 classes. Twelve of the classes received Neuse eggs and 6 of those released on Thursday, April 19 and 6 released on Friday, April 20<sup>th</sup>. Two of the Group 2 classes received Roanoke fish and one released



Photo 6. East Bladen HS sorting shad eggs.



Photo 7. Exploris ES release at the Neuse River (former Milburnie Dam).

Thursday, April 19 and one released on Friday, April 20<sup>th</sup>. The remaining teachers, 9 classes, were all in Group 3. Five of the Neuse classes released on Thursday, April 26 and one released larval fish on Friday, April 27. Three teachers released larval fish in the Roanoke River Basin on Friday, April 27. Classes releasing in the Neuse River Basin received approximately 24,000 eggs (~1,000 to each class) and classes releasing into the Roanoke River Basin received approximately 5,000 eggs (1,000 to each class) from the Edenton National Fish Hatchery. However, many of the teachers reported receiving more or less eggs (Table 4). Teachers brought 1,201 students to the Neuse and Roanoke Rivers for release. For many of these students this is rare, or even a first-time opportunity to visit a river.

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

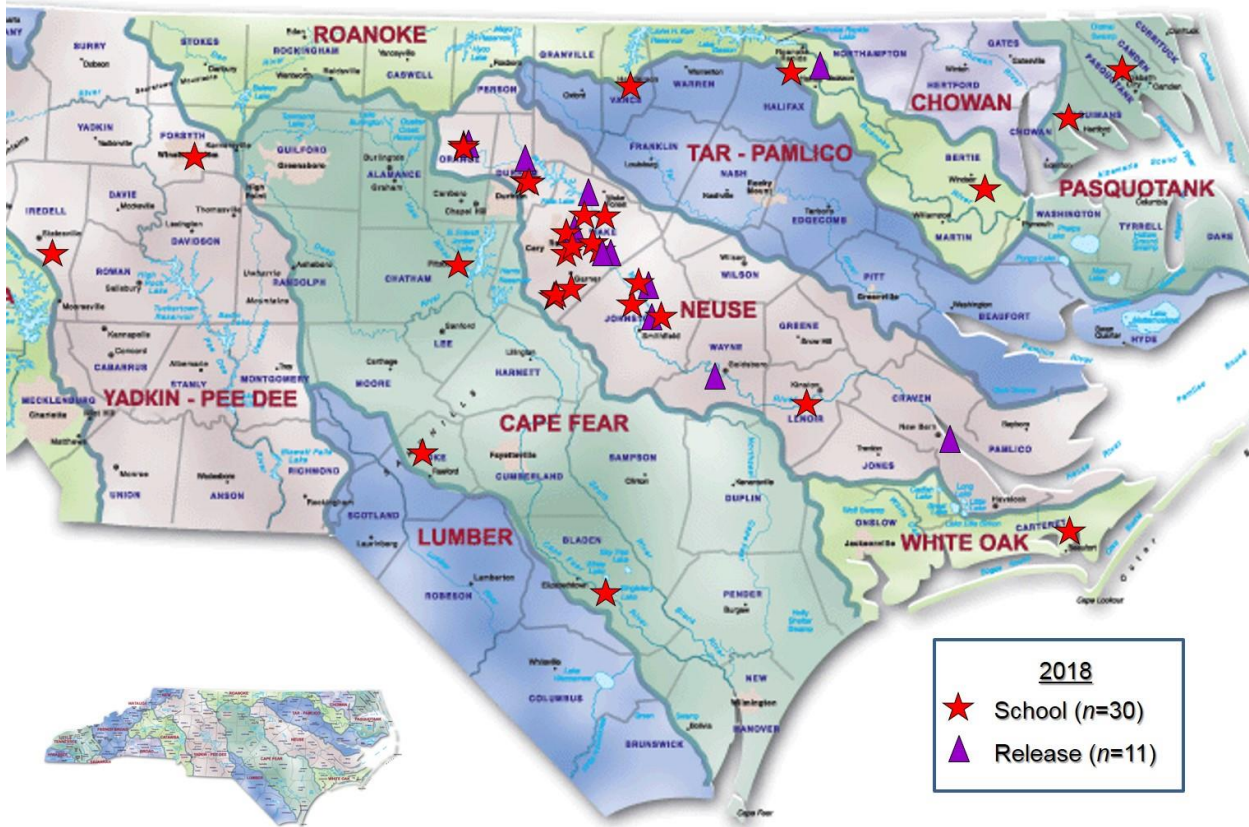
<b>Educator</b>	<b>School</b>	<b>Received Eggs</b>	<b>Released Eggs/Larva</b>	<b>Release Site</b>
<b>Group 1</b>				
Beth Selig	Fuquay Varina MS	4-9-2018	4-12-2017	Neuse River, Smithfield
Judy Compton	Central Park School for Children	4-9-2018	4-13-2018	Neuse River, Cliffs of the Neuse State Park
Kathy Wall	Ballentine Elementary	4-9-2018	4-13-2018	Neuse River, Former Milburnie Dam
Kristen Bright	South Iredell HS	4-9-2018	4-13-2018	Neuse, West Point, Eno River
Logan Behlke	Fuquay Varina MS	4-9-2018	4-12-2017	Neuse River, Smithfield
Matthew Lanner	East Garner MS	4-9-2018	4-12-2017	Neuse River, Smithfield
Sean Russell	Millbrook Magnet ES	4-9-2018	4-12-2017	Neuse River, Falls Dam
<b>Group 2</b>				
Brad Rhew	Cook Literacy Model School	4-16-2018	4-19-2018	Neuse, West Point, Eno River
Brian Reynolds	Bertie Early College HS	4-16-2018	4-19-2018	Roanoke River at Weldon
Brian Wood	W.G. Enloe HS	4-16-2018	4-20-2018	Neuse River, Former Milburnie Dam
Christina Edmiston	Upchurch ES	4-16-2018	4-20-2018	Neuse River, Anderson Point
Christina Livingstone	Brogden MS	4-16-2018	4-20-2018	Neuse, West Point, Eno River
Gail Clougherty	Cleveland HS	4-16-2018	4-19-2018	Neuse River, Smithfield
Janice West	Clayton HS	4-16-2018	4-19-2018	Neuse River bridge on 42
Jodie Berger	Grady A. Brown ES	4-16-2018	4-20-2018	Neuse, Gold Park, Eno River
Karel Klepacki	Smithfield-Selma Senior HS	4-16-2018	4-19-2018	Neuse River, Smithfield
Katina Hantz	Chaloner MS	4-16-2018	4-20-2018	Roanoke River at Weldon

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

<b>Educator</b>	<b>School</b>	<b>Received Eggs</b>	<b>Released Eggs/Larva</b>	<b>Release Site</b>
<b>Group 2 - continued</b>				
Krista Brinchek	Abbotts Creek ES	4-16-2018	4-20-2018	Neuse River, Falls Dam
Madison Polera	CFRW (East Bladen Hs)	4-16-2018	4-19-2018	Neuse River, Cliffs of the Neuse State Park
Richard Kowaleski	Daniels IBMYP Magnet MS	4-16-2018	4-19-2018	Neuse, Lassiter Mill Dam, Crabtree Creek
Sue Willis	The Expedition School	4-16-2018	4-20-2018	Neuse, Gold Park, Eno River
<b>Group 3</b>				
Allison Ketcham	Tiller ES	4-23-2018	4-27-2018	Neuse River, Flanners Beach
Chaundrea M. Mason	Southern Vance HS	4-23-2018	4-27-2018	Roanoke River at Weldon
Courtney Sykes	East Wake MS	4-23-2018	4-27-2018	Neuse River, Falls Dam
Kaley Kiffner	Perquimans County MS	4-23-2018	4-27-2018	Roanoke River at Weldon
Kristina Jones	Moss Hill Elementary	4-23-2018	4-26-2018	Neuse River, Cliffs of the Neuse State Park
Leah Ruto/Koren Morgan/Rachel Hearn	Exploris Elementary	4-23-2018	4-26-2018	Neuse River, Former Milburnie Dam
Mark Miller	Pasquotank County HS	4-23-2018	4-27-2018	Roanoke River at Weldon
Sonja McKay/Annah Riedel/Rachel Hearn	Exploris Elementary	4-23-2018	4-26-2018	Neuse River, Former Milburnie Dam
Rose Syroid	Horton MS	4-23-2018	4-26-2018	Neuse, West Point, Eno River



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



Overall, the shad rearing and release was successful for most schools, but with a number of issues for some. Each class was to receive approximately 1,000 – 2,000 eggs; however, counts may differ as to what the school actually reported receiving. Colder temperatures that occurred during Shad week affected the numbers of eggs produced in the hatchery and the fertilization rate, particularly in the first two weeks of the program. This year quite a few schools reported unfertilized eggs and slow development. Due to slower development, some schools were releasing embryos rather than fry, but also a number got to witness the fry emerge at their release. The lower fertilization led to reports of lower numbers of fry (or embryos) released. Those with the lowest survivability also reported water quality issues. One reported a pH spike and another reported low alkalinity, which may have led to an undetected pH spike. Another school reported a power outage, which led to the fry or eggs being sucked back into the pump. There was also an ammonia spike reported by a school that had low survivability.

Percent survival ranged from a low of 1% to a high of 86% and averaged 41% overall (Table 4). Nineteen classes averaged  $\leq 50\%$ , 10 averaged  $> 50\%$ , and 7 averaged  $\geq 75\%$  survival to release. There were 6 classes that averaged 10% survivability or below, and average survivability was reported at 41%, which was lower than 2017 (53%) and slightly lower than 2016 (42%). The classes that were in the  $\geq 75\%$  (24%) category fell between the 2017 (31%) and 2016 (15%) shad seasons.

Table 4. Egg and Larval Survival and Release Numbers

<b>Educator</b>	<b>School</b>	<b>No. Eggs Received</b>	<b>No. Eggs/Larva Survived to Release</b>	<b>Percent Survival (%)</b>
<b>Group 1</b>				
Beth Selig	Fuquay Varina MS	1179	313	27
Judy Compton	Central Park School for Children	1300	52	4
Kathy Wall	Ballentine Elementary	2000	1700	85
Kristen Bright	South Iredell HS	1000	250	25
Logan Behlke	Fuquay Varina MS	845	260	31
Matthew Lanner	East Garner MS	1100	400	36
Sean Russell	Millbrook Magnet ES	2000	400	20
Average survival percent				<b>33</b>
<b>Group 2</b>				
Brad Rhew	Cook Literacy Model School	1000	278	28
Brian Reynolds	Bertie Early College HS	2000	1206	60
Brian Wood	W.G. Enloe HS	800	600	75
Christina Edmiston	Upchurch ES	1000	800	80
Christina Livingstone	Brogden MS	1000	50	5
Gail Clougherty	Cleveland HS	1400	1100	79
Janice West	Clayton HS	1000	300	30
Jodie Berger	Grady A. Brown ES	1000	100	10
Karel Klepacki	Smithfield-Selma Senior HS	883	551	62
Katina Hantz	Chaloner MS	2000	1500	75
Krista Brinchek	Abbotts Creek ES	1000	300	30
Madison Polera	CFRW (East Bladen HS)	1000	500	50
Richard Kowaleski	Daniels IBMYP Magnet MS	700	350	50
Sue Willis	The Expedition School	400	60	15
Average survival percent				<b>46</b>
<b>Group 3</b>				
Allison Ketcham	Tiller ES	2000	351	18
Chaundrea M. Mason	Southern Vance HS	1200	6	1
Courtney Sykes	East Wake MS	2000	100	5
Kaley Kiffner	Perquimans County MS	1660	824	50
Kristina Jones	Moss Hill Elementary	1000	800	80



Table 4. Egg and Larval Survival and Release Numbers - Continued

Educator	School	No. Eggs Received	No. Eggs/Larva Survived to Release	Percent Survival (%)
<b>Group 3</b>				
Mark Miller	Pasquotank County HS	2000	200	10
McKay, Ruto, Morgan, Reidel, Hearn	Exploris Elementary	2200	1900	86
Rose Syroid	Horton MS	700	500	71
Average survival percent				<b>40</b>
<b>Total Average survival percent</b>				<b>41</b>

Teachers reported that the program motivates their students to work harder and participate more in the classroom. Many commented that the program provides valuable experience and opportunities for the students and the teachers. The Shad Program increases the students interest in science. We have received great feedback on the program from the teachers throughout the 2018 program year.

**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).

“**T**he Shad in the Classroom program gave my students a chance to see how they can directly impact a species and an ecosystem. They experienced a world of nature that they wouldn’t have experienced without this program.”

“**B**eing able to participate in the Shad in the Classroom program allowed the students and me to explore our natural environment outside of the classroom. Prior to this program, I would not have been prone to implement a plethora of outdoor activities throughout the semester.”



**Photo 8. Jennifer Archambault lecture at Cook Literacy Model School**

This year Jennifer Archambault, NCSU graduate student, conducted an aquatic macro-invertebrate lesson for Horton Middle School and Cook Literacy Model School, and Rebekah Ewing, NCSU graduate student, conducted an aquatic macro-invertebrate lesson for Ballentine Elementary School. We also worked with the schools at the releases sampling and identifying macro-invertebrates when possible. All teachers reported that the macro-invertebrate lectured enhanced the learning experience for their students.



**Photo 9. Student examining aquatic macroinvertebrates at Horton Middle School**

### American Shad Molds – Fish Printing

This year we made available three travel kits (4 American Shad molds each) of fish printing (Gyotaku) supplies for the teachers to borrow and use in their classrooms. Nine teachers took advantage of these available resources, and all but one reported that the exercise enhanced the learning experience for their students.

“We don't have art class at Moss Hill. Having this type of activity was really one of the highlights for the kids.”

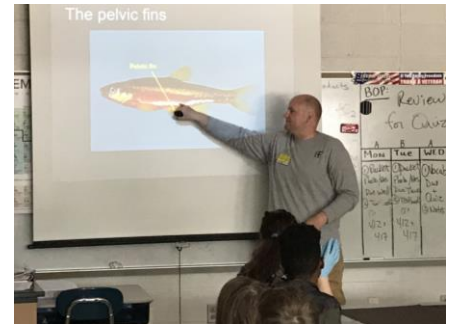
### Fish Dissection

We coordinated with the NC State University (NCSU) Student Fisheries Subunit, the East Carolina University (ECU) Student Fisheries subunit, and the NCWRC Education Section to conduct fish anatomy/morphology and dissection lessons. Sixteen student, post-doc, researchers, and educators from NCSU, ECU, and the NCWRC volunteered (listed in acknowledgments) to conduct these lessons. Because of these volunteers and the generosity of fish donations (>300 fish), we were able to facilitate the dissection lecture for 13 classrooms (1015 students).

“Loved it!!!! I had other staff, students (not mine) come in and see what it was all about. I included some special education students that would never get this type of opportunity in HS and beyond. They had a blast and did a great job.”

“The students absolutely loved it, for many it was their first chance to ever experience something like that.”

This year we were able to accommodate 13 of the 15 teachers that requested a dissection lecture at their school. We are very grateful to



**Photo 10. Bobby Cope fish dissection and anatomy lesson at East Garner Middle School.**

NCSU, ECU, and the NCWRC educators 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 continues to be a highly appreciated component that we have added to the program.

### Curriculum Activities and Videos

We continually add and update supplementary materials for the teachers to use to augment the learning process in the classroom and at the release. This year we added an American Shad Lifecycle Activity. In this activity, students match American Shad lifecycle images with written descriptions and then align themselves in the correct chronological order. Following this “sorting” phase, the students follow the life of a shad from a newly spawned egg to a post-spawning adult. This activity will assist students in understanding the lifecycle of American Shad in a visual and physical manner (25 teachers reported that the activity enhanced the program). This activity and other exercises have all been uploaded to a shared dropbox site with the teachers. Besides the lifecycle activity, materials include, but are not limited to, a Shad Scent exercise, Shad pipette art, a guide for stream sampling, a watershed GIS exercise, a genetic exercise, and materials provided by the teachers. In addition, this year we supplied all teachers with aquatic macro-invertebrate sampling gear to be used at their releases.



**Photo 11. Teachers experiencing the lifecycle activity during the workshop**

The genetic based exercise, “Who’s your Shaddy”, (developed in 2013 and updated in 2014) was continued. Seven teachers (5 high schools and 2 middle schools) reported this exercise was “just right” as far as understandability and complexity for their students. Additional on-line (Museum website) curriculum activities are available for the teachers to use including Food Web Activities (22 reported as useful), GIS Watershed Activity (8 reported as useful), Wishes of Fishes Activity (9 reported as useful), and a Non-Fiction Reading Activity (14 reported as useful). Seven videos were created for the program previously, most teachers reported using at least some videos, and many reported that they were very useful.

Table 5. Additional Education and Video Use Survey Results

Question	Response variable
Fish Printing – enhance learning?	10% (3) greatly enhanced; 14% (4) enhanced; 7% (2) somewhat; 69% (20) did not use
Shad Pipette Art?	7% (2) greatly enhanced; 7% (2) enhanced; 86% (25) did not use
Shad Lifecycle Activity?	55% (16) greatly enhanced; 31% (9) enhanced; 14% (4) did not use
Shad Scents – enhance learning?	14% (4) greatly enhanced; 31% (9) enhanced; 57% (17) did not use
Fish Dissection – enhance learning?	44% (14) greatly enhanced; 6% (2) enhanced; 50% (16) did not use
Genetic Exercise – complexity or understanding?	28% (7) just right; 72% (18) did not use
Food Web Activities – usefulness?	55% (16) very useful; 21% (6) useful; 24% (7) did not use
GIS Watershed Activity – usefulness?	14% (4) very useful; 7% (2) useful; 7% (2) somewhat; 72% (21) did not use
Wishes of Fishes Activity – usefulness?	10% (3) very useful; 14% (4) useful; 7% (2) somewhat; 69% (20) did not use
Non-Fiction Reading Activity – usefulness?	31% (9) very useful; 17% (5) useful; 52% (15) did not use
Video -Add the eggs – usefulness?	66% (19) very useful; 21% (6) useful; 3% (1) somewhat; 11% (3) did not use
Video –Build the Tank – usefulness?	45% (13) very useful; 14% (4) useful; 7% (2) somewhat; 34% (10) did not use
Video – Fish Passage – usefulness?	66% (19) very useful; 14% (4) useful; 7% (2) somewhat; 14% (4) did not use
Video – History – usefulness?	79% (23) very useful; 18% (5) useful; 3% (1) did not use
Video – It is Time usefulness?	66% (19) very useful; 14% (4) useful; 7% (2) somewhat; 14% (4) did not use
Video - Lifecycle – usefulness?	83% (24) very useful; 10% (3) useful; 7% (2) not use
Video – Overview – usefulness?	66% (19) very useful; 14% (4) useful; 20% (6) did not use

### Roanoke River Trek

This year, the Museum provided a 2-day 1-night canoe-camping experience on the Roanoke River for teachers. This trip helped forge a connection for those teachers with the Roanoke River basin through an immersive, impactful experience that highlighted the ecological importance of the bottomland hardwood forest.

## River Days

“This went along with the ecosystem that we’re studying... The kids really enjoyed the card game, but they learned so much from the video of the importance of the river... My students thoroughly enjoyed and understood the impact of the Survivor! activity.”

The “River Days” component of the Shad in the Classroom program that began in 2014 continued this year, but was modified, with a newly revised linear version of the *We Are the River* film. Therefore, it was no longer necessary to take the Geodome Theater along to each school. Due to a smaller staff team, we shortened each session to 90 minutes, allowing time to show the film, have a brief discussion of the film’s themes, and play the Survivor! game, which takes almost a full hour. Over the course of the “River Days” week, the



Photo 12. W.L. Ballentine  
Elementary School – River Days

educator team visited 6 schools. The program served grades 4 and 5 (totaling 333 people). As in years past, the teacher evaluations were uniformly positive.

## 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 2,051 students directly involved with the Shad in the Classroom Program this year and more that experienced it indirectly.

## Student Analytics 2016-2017

To better evaluate the Shad in the Classroom Program's impact on student's understanding, we partnered with Dr. Nils Peterson, Dr. Kathryn Stevenson, and graduate student Kalysha Clark at the NCSU Human Dimensions of Conservation Biology Lab. We created a questionnaire that used multiple choice questions in order to determine shad knowledge of participants. We also included demographic questions about age, gender, grade level, and whether the participant hunted or fished. Those who agreed to participate (15 teachers in 2016 and 18 teachers in 2017) provided the pre- and post-tests to their students (n=505 for 2016, n=835 for 2017). In addition, there were two "control" classrooms that completed both the pre- and post-tests in 2017. Preliminary 2016-2017 data analysis shows that the Shad in the Classroom Program improves shad knowledge. A 2018 questionnaire was also conducted, and those data will be analyzed at a later date.

## 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). In addition to the students and teachers reached with the Shad in the Classroom Program:

- The River Days component reached 333 people.
- The "We are the River Film" won the Gold Telly award in the nature category.
- This year information on the Shad in the Classroom Program was presented at the Albemarle-Pamlico Ecosystem Symposium on November 1, 2017, at the NC Chapter of the American Fisheries Society Student Subunit (NCSU) Meeting on February 6, 2018, and at the East Carolina University (ECU) Student Fisheries subunit on February 28, 2018.
- Two local news sites wrote articles on the program in 2018, [Coastal Review Online](#) and [Roanoke Rapids Daily Herald](#).

An update on the Shad in the Classroom Program will be published in the North Carolina Chapter American Fisheries Society Summer or Fall Newsletter in 2018. Also, a paper on the student analytics is proposed to be submitted to the journal Fisheries once the analysis is completed.

## Future Planning

The shad models for fish printing (Gyotaku) and the fish dissection lectures are greatly valued 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.

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, activities, the River Days, and the overall program. Twenty-eight of the 30 teachers participating in the Shad in the Classroom Program reported that they would like to continue with the program next year. Two of the teachers are leaving the area. At present, we have nine new teachers on the waiting list for the program in 2019. A new activity was created this year, 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.

“Participating in the Shad in the Classroom program has helped me become a better teacher and has helped making learning and exploring nature fun for all students!”

“The students are always amazed to watch the eggs change each day. Even students that are not usually motivated were engaged in the classroom during Shad Week.”

## Appendix 1

### **Shad in the Classroom Background**

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.

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 began in 2007 and Shad in the Classroom began in 2009. Trout in the Classroom is administered by the North Carolina Trout Unlimited Chapter. 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; 2015 costs). Shad 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).

Shad in the Classroom is led by the North Carolina Museum of Natural Sciences (Museum). Comparable to the Trout in the Classroom, the Shad in the Classroom program provides a hands-on, real-life science learning opportunity. 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. 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 3). 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.



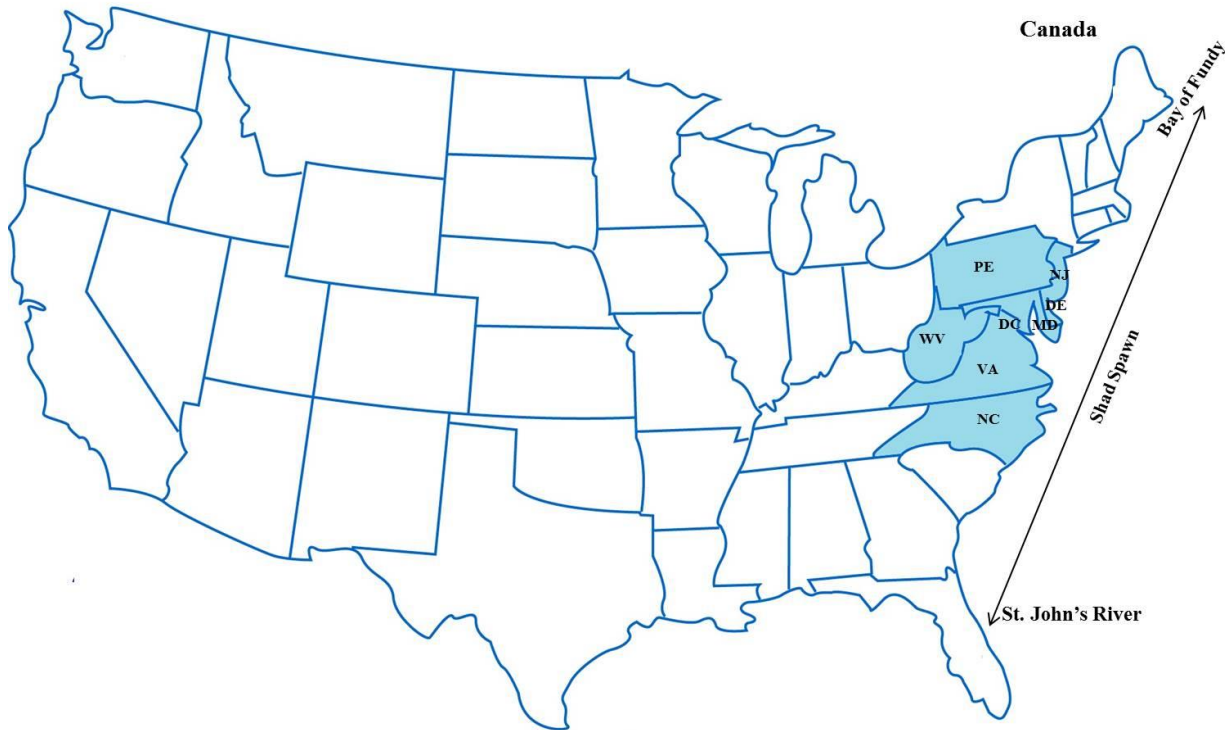


Figure 5. — Map of the states we found to participate in some version of a shad in the classroom program: Delaware, Maryland, New Jersey, North Carolina, Pennsylvania, Virginia, and West Virginia, and the District of Columbia. Arrow depicts American Shad spawning distribution which ranges from the Bay 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, 27 classrooms in the 2015 and 2016 program years, and 33 for the 2017 year. For the 2018 year, 30 classrooms (8 new) were accepted with funding provided through APNEP and the USFWS. Note that these numbers generally 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 – 2018) is included in Table 1. Students and teachers become involved in the program several weeks prior to receiving American Shad eggs (fertilized embryos) spawned in NCWRC and USFWS hatcheries. For 2018, all shad used for the program were spawned in the USFWS hatchery.

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 have also participated 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.