Shad in the Classroom
Program Report
(2009–2025)

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Table of Contents

Executive Summary

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. 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 their environment while learning about the importance of American Shad restoration and water quality. Teachers report great enthusiasm for the program, both for themselves and their students.

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 2025 Shad season we received grant funding from APNEP, USFWS, and Triangle Fly Fishers.

The Shad in the Classroom Program has reached 378 classrooms from 2009 to 2025 (Appendix A, Table 8) and many thousands of students. Between 2013─2025, approximately 26,480 students were reached (prior to 2013, the numbers of students were not tracked). Twenty-three classes in 11 counties (Tier 1 – 2, Tier 2 – 3, Tier 3 – 6) participated in 2025 (Table 1). This year 2,162 students participated with 760 students being in Title 1 schools.

In the years from 2013–2025 (excluding 2020), each school received approximately 600-2,000 eggs from the NCWRC. Presently the Shad in the Classroom Program is only working with Neuse River American Shad and schools in this program are the only ones releasing American Shad in North Carolina, all of which are released in the Neuse River Basin.

Over the years, various state and federal agencies and NCSU have played significant roles in the implementation of the program, including:

- Abermarle-Pamlico National Estuary Partnership (APNEP)
- Dominion Power
- East Carolina University (ECU)
- National Fish and Wildlife Foundation
- North Carolina Chapter of the American Fisheries Society
- North Carolina State University (NCSU)
- North Carolina Wildlife Resources Commission (NCWRC)
- Triangle Fly Fishers
- United States Fish and Wildlife Service (USFWS)

ACKNOWLEDGEMENTS

We would like to acknowledge all 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 in 2025 are listed below.

Workshop Guest Speaker

Todd VanMiddlesworth todd.vanmiddlesworth@ncwildlife.org – (NCWRC, District Fisheries Biologist)

Additional Education

Fish Anatomy-Dissection Lecture
Andrew McMains mcmainsa20@students.ecu.edu – (ECU, Grad Student) – Lecturer
Cami Miller millerca23@students.ecu.edu – (ECU, Grad Student) - Lecturer
Chase Spicer spicerc21@students.ecu.edu – (ECU, Grad Student) – Lecturer
Erimi Kendrick emkendr3@ncsu.edu – (NCSU, Grad Student) – Lecturer
Jessica Miller millerje23@students.ecu.edu – (ECU, Grad Student) – Lecturer
Kendall Proctor knproct2@ncsu.edu – (NCSU, Grad Student) – Lecturer
Trent Ford trford2@ncsu.edu – (NCSU, Grad Student) – Lecturer
Danci Guiot danci.guiot@ncwildlife.gov – (NCWRC, District Fisheries Biologist)

Egg Delivery and Larvae Release Assistance

Beth Cranford beth.cranford@naturalsciences.org – (NCMNS, Coordinator, Elementary Education)
Christy Flint christy.flint@naturalsciences.org – (NCMNS, Director of Education)
David Cranford david.cranford@dncr.nc.gov – (NCDNCR, Assistant State Archaeologist)
Heather Jennings Heather.jennings@apnep.org – (APNEP, Program Manager)
Jimmy Johnson jimmy.johnson@ncdenr.gov – (APNEP, Coastal Habitats Coordinator, retired)

In addition, we are very appreciative of the fish donations for dissections from Dr. Jim Rice, Dr. Rich Noble, Dr. Phil Doerr, and fellow anglers, from NCWRC district biologists Seth Mycko and Danci Guiot, and from ECU graduate students, Chase Spicer and Andrew McMains. We greatly appreciate Todd VanMiddlesworth and Mason Collins for their collection of American Shad broodstock. American Shad embryos were generously provided by Jeff Evans and the staff at the Watha State Fish Hatchery. We also appreciate Trent Ford, Tyler Muller, and Tucker Gaddy, NCSU, and Chase Spicer and Andrew McMains, ECU for assisting with organizing students for the fish anatomy-dissection lessons. Additional thanks to Dr. Jim Rice for assisting with our Cashie River pre-trip and to him, Dr. Rich Noble, and Dr. Greg Cope for loaning fishing tackle.

Report cover photos: Top left – Lakewood Montessori MS students sorting embryos; Bottom left – view of Cashie River Treehouses at night; Bottom middle – Lakewood Montessori MS release at West Point Eno River; Right – First Flight MS students fish anatomy/dissection lesson.

Shad in the Classroom Program 2025 Report

This report summarizes the activities accomplished for the 2025 Shad in the Classroom Program. Twenty-three classes at 19 different schools (Table 1) were accepted into the 2025 program: 7 elementary, 11 middle, and 5 high school classes.

Photo 1. Seawell ES students releasing shad, Gold Park, Eno River

Table 1. 2025 Schools Accepted to the North Carolina Shad in the Classroom Program
(Title 1 indicated with an *)

School	County	Tier	Numbers of Classes
Abbotts Creek ES	Wake	3	1
Brinson Memorial ES	Craven*	2	1
Davis Drive MS	Wake	3	1
East Duplin HS	Duplin*	1	1
First Flight MS	Dare	2	2
Fuller GT/AIG Basics Magnet ES	Wake	3	1
Fuquay Varina MS	Wake	3	3
Glenwood ES	Orange	3	1
Lakewood ES	Durham*	3	1
Lakewood Montessori MS	Durham	3	2
Middlesex ES	Nash*	1	1
Moore Square Magnet MS	Wake	3	1
Oberlin Magnet MS	Wake	3	1

Table 1. 2024 Schools Accepted to the North Carolina Shad in the Classroom Program – cont'd
(Title 1 indicated with an *)

School	County	Tier	Numbers of Classes
Perquimans County HS	Perquimans*	2	1
Seawell ES	Orange	3	1
Sherwood Githens MS	Durham*	3	1
South Iredell HS	Iredell	3	1
West Johnston HS	Johnston	3	1
Woods Charter HS	Chatham	3	1
Total Number of Schools			**19**
Total Number of Classrooms			**23**

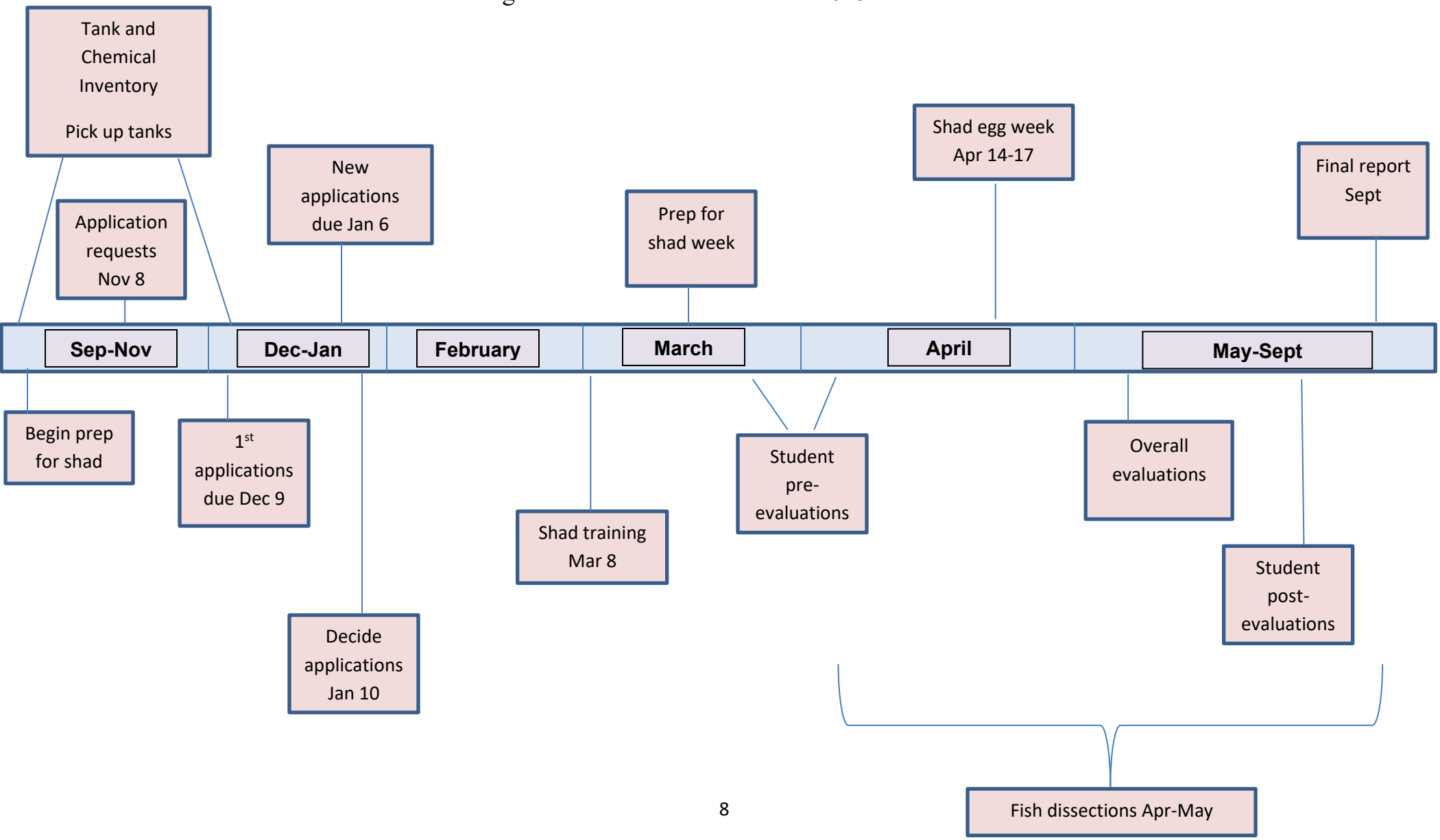
In July of 2022 we received a grant award from the USFWS for Project RESTORE (Rescuing Endangered Species through Outreach, Restoration, and Education) for $165,000 to be utilized up until 9/2027. Project RESTORE employs a multiple species approach focusing on endangered and imperiled species in North Carolina, including American shad, Venus flytrap, Carolina madtom, Neuse River waterdog, and the red wolf. For the 2025 Shad in the Classroom program, we received $20,000 in grant funding from APNEP. Triangle Fly Fishers also gifted us with $500 for the Shad in the Classroom Program. In addition, we leveraged over $26,633 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.

Current new tank construction of the red tub style tanks cost approximately $406 per tank system. The plexiglass tank systems cost approximately $605 per tank system. Other substantial expenses include tank refurbishment, chemical resupply, teacher training workshop, school field trips to release sites, travel for egg delivery, and part-time staff. Yearly program planning began with forming a timeline (Figure 1), reviewing applications, and conducting a tank and parts inventory. Due to Watha State Hatchery constraints, we were only able to offer one week of shad this year. Due to these constraints and lower shad embryo availability we had several of our returning teachers decide to take a "hiatus" year and we did not accept new applications. Returning

Photo 2. S. Iredell HS shad release, Gold Park, Eno River

teachers had the opportunity to attend a modified training session in person or by Zoom in early March. Teachers typically began preparing their classrooms for the arrival of the Shad eggs 2–4 weeks prior to receiving the eggs in April. NCWRC American Shad broodstock collection began the week of April 9th, and only one collection was necessary this year. Classes released the shad larvae on the Thursday or Friday of the week that they received them. Many of the classes took advantage of an in-person fish anatomy and dissection lecture by NCSU and ECU students and by the NCWRC staff.

Figure 1. Shad in the Classroom 2025 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. We did not construct new tank plexiglass tank systems this year due to program uncertainty. An updated inventory list is on file.

Teacher Training and Hatchery Visit

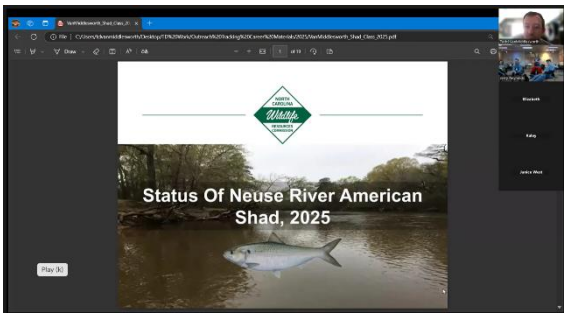


Photo 3. Teachers learning about the status of American Shad from T. D. VanMiddlesworth

A modified teacher training session was conducted in person and by zoom on March 8, 2025. Danielle Pender led the session and T.D. VanMiddlesworth joined in by Zoom to present information on the current status of American Shad. In addition to being provided information about American Shad life history, restoration, and management, teachers brushed up on their water quality testing skills and other activities for raising shad that they found necessary. For those teachers who were not able to attend on March 8th, they were given two additional opportunities to meet with Danielle by zoom to work on these skills. In addition to the training, teachers were given the opportunity to attend a visit to the Watha State Fish Hatchery on April 12th.

Photos 4-5. Teachers learning about American shad and other fish from Jeff Evans at the Watha State Fish Hatchery

Nine teachers attended the 2025 training in person or by zoom. Jeff Evans at Watha State Fish Hatchery led the tour for 3 attending teachers. All teachers were very engaged and enjoyed the tour.

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 considered school schedules. American Shad collection was successful the week of April 7th and we were able to deliver embryos for the week of April 14h. Many people assisted with the delivery of the eggs and with the release of the larval fish and are mentioned in the acknowledgments.

Photo 6. Jeff Evans and Landon Beaver packaging American Shad embryos for schools.

Photo 7. Brinson Memorial ES releasing shad, lower Neuse River

Since we were only able to accommodate one week for shad deliveries, all classes received their embryos on Monday April 14th. Unfortunately, this led to West Johnston HS not being able to participate as they could only do so they could receive the embryos on the scheduled "back-up" week. Most classes (19) released their fry on Thursday 4/17 as Friday 4/18 was a holiday. However, a few (4) released their fry on that Friday. (Table 2, Figure 2). Classes received approximately 575 viable eggs according to the hatchery; however, some classes reported receiving a different number (Table 3). Most classes had students at the release (426 students attending). A few classes that had failed tanks (0% survivability) did not attend a release. Of those that were able to attend a release, all teachers reported that it enhanced the learning experience for their students.

Photo 8. Glenwood ES release Gold Park, Eno R.

Photo 9. Lakewood Montessori MS release West Point Eno (invert sampling)

Table 2. Egg and Larval Release Timing and Release Site Information

Educator	School	Received Eggs	Released Eggs/Larva	Neuse River Release Site
Beth Selig	Fuquay-Varina MS	4/14/2025	4/17/2025	Smithfield Boat Ramp
Branson Phillips	Githens MS	4/14/2025	4/17/2025	West Point on the Eno
Corie Hlavaty	Lakewood Montessori MS	4/14/2025	4/17/2025	West Point on the Eno
Denise O'Gorman	Woods Charter	4/14/2025	4/17/2025	Confluence of the Eno
Douglas Poole	Perquimans County HS	4/14/2025	.	Lawson Cr. Park
Edward Tidd	Moore Square MS	4/14/2025	.	Raleigh Beach
Elizabeth Hartell	Middlesex ES	4/14/2025	4/17/2025	Smithfield Boat Ramp
Endiga Holdness	Fuquay Varina MS	4/14/2025	4/17/2025	Smithfield Boat Ramp
Fred Pfeiffer	Lakewood Montessori MS	4/14/2025	4/17/2025	West Point on the Eno
Gina Bobbitt	Southern Wake Academy	4/14/2025	.	Lassiter Mill
Ginny Jones/Christina Davidson	Seawell ES	4/14/2025	4/17/2025	Gold Park
Jackie Smith	East Duplin HS	4/14/2025	4/17/2025	Cliffs of the Neuse
Kaley Kiffner	First Flight MS	4/14/2025	4/18/2025	Glenburnie Park
Krista Brinchek	Abbotts creek ES	4/14/2025	4/18/2025	Falls Dam
Lee Deans	First Flight MS	4/14/2025	4/18/2025	Glenburnie Park
Lenae Scafidi	South Iredell HS	4/14/2025	4/17/2025	Gold Park
Matthew Lanner	Fuquay Varina MS	4/14/2025	4/17/2025	Smithfield Boat Ramp
Richard Kowaleski	Oberlin Magnet MS	4/14/2025	4/17/2025	Lassiter Mill

Table 2. Egg and Larval Release Timing and Release Site Information – Cont'd

Educator	School	Received Eggs	Released Eggs/Larva	Neuse River Release Site
Shannon Lee	Brinson Memorial ES	4/14/2025	4/17/2025	Behind school (319 Neuse Forrest Ave, Ampitheater)
Sheryl Kirkey-Dean	Glenwood ES	4/14/2025	4/17/2025	Gold Park
Sophie Hatcher Peters	Lakewood ES	4/14/2025	4/17/2025	Falls Dam
Wayne Shore	Fuller ES	4/14/2025	4/18/2025	Walnut Creek Wetland Center

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

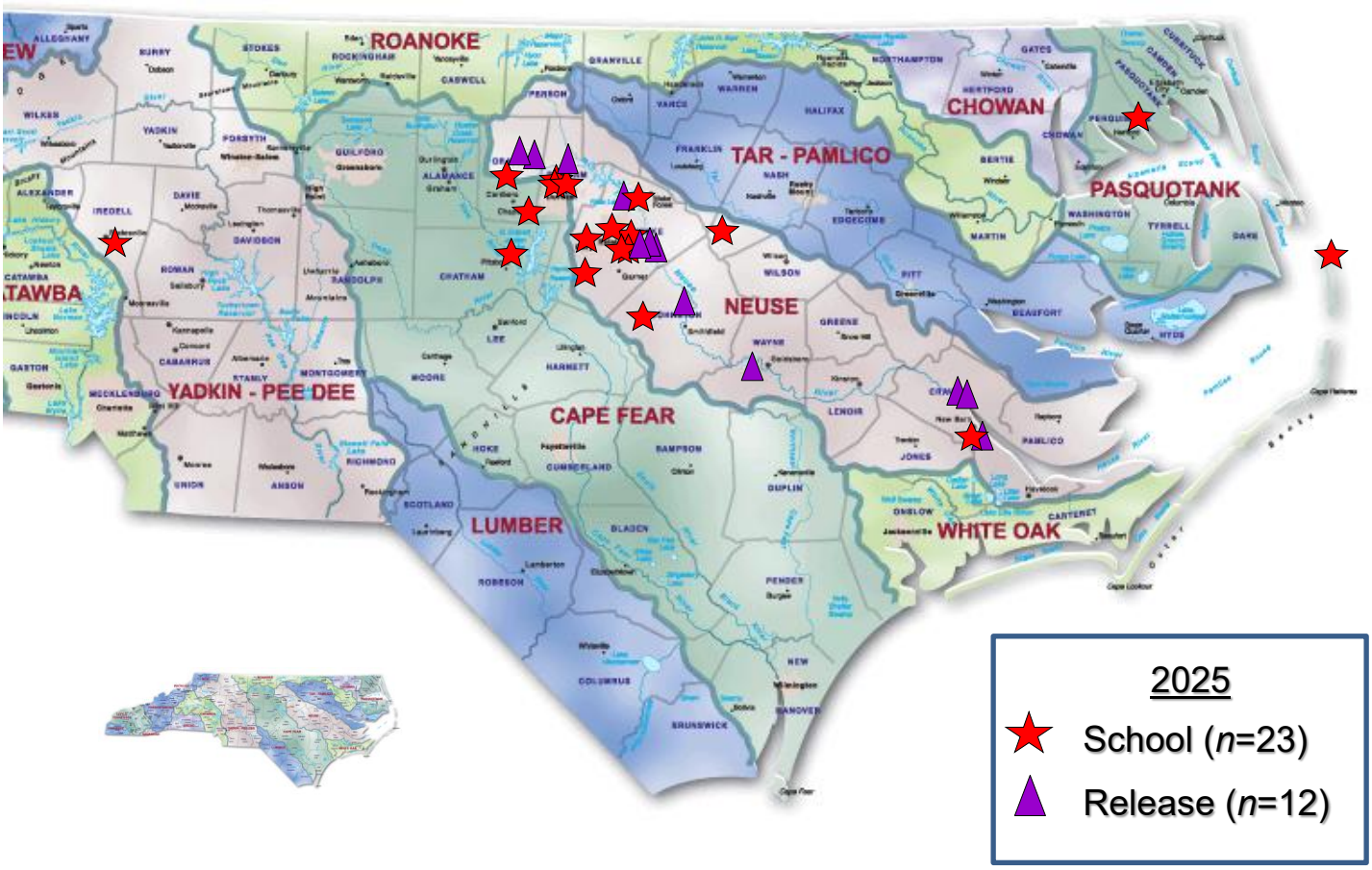


Photo 10. Seawell ES measuring tank water quality

Overall, the shad rearing and release was fairly successful for most schools, but with a few issues for some. Each class was to receive approximately 500 – 600 embryos; however, counts may differ as to what the school reported receiving. Some teachers reported only the viable eggs to start and others reported all that they received. This difference in reporting may affect the percent survivability reported. This year 22 classes received their embryos on, Monday, April 14th and one class had to opt out to receive the embryos as they could only participate on the back up week. Of those that turned in their water quality information (18), many reporting lower survivability also reported water quality issues. Three reported higher temperature ranges and ammonia issues, and one reported nitrate issues. Three reported fungus issues and three had issues with their pumps. Eight classes used river water rather than tap. It is possible that water quality issues contributed to lower survivability for some schools. However, reporting differences (those that counted all that they received, including unviable eggs, vs that started their count with only viable eggs received) may have affected the survivability percentages the most.

Overall, the percent survival ranged from a low of 0% to a high of 83% and averaged 27% (Table 3). Seventeen classes averaged ≤ 50%, 5 averaged >50%, and 1 averaged ≥75% survival to release. There were 5 classes that averaged 10% survivability or below. Average survivability was the lowest reported since 2019 at 27% for 2025; 2024 and 2021 (35%), 2022 (39%), 2022 (41%), and 2019 (53%). The percentage of classes that were in the ≥75% survival rate at (5%) was lowest as well; 2021 (11%), 2023 (24%), 2022 (28%), and 2019 (34%) (no shad were raised in 2020 due to Covid-19).

Table 3. Egg and Larval Survival and Release Numbers

Educator	School	No. Eggs Received	No. Eggs/Larva Survived to Release	Percent Survival (%)
Beth Selig	Fuquay-Varina MS	381	91	24
Branson Phillips	Githens MS	1200	200	17
Corie Hlavaty	Lakewood Montessori MS	1200	350	29
Denise O'Gorman	Woods Charter	250	180	72
Douglas Poole	Perquimans County HS	1000	0	0
Edward Tidd	Moore Square MS	400	0	0
Elizabeth Hartell	Middlesex ES	1200	200	17
Endiga Holdness	Fuquay Varina MS	369	218	59

Table 3. Egg and Larval Survival and Release Numbers – Cont'd

Educator	School	No. Eggs Received	No. Eggs/Larva Survived to Release	Percent Survival (%)
Fred Pfeiffer	Lakewood Montessori MS	600	350	58
Gina Bobbitt	Southern Wake Academy	225	0	0
Ginny Jones/Christina Davidson	Seawell ES	1000	200	20
Jackie Smith	East Duplin HS	500	180	36
Kaley Kiffner	First Flight MS	242	200	83
Krista Brinchek	Abbotts creek ES	680	200	29
Lee Deans	First Flight MS	1500	200	13
Lenae Scafidi	South Iredell HS	200	47	24
Matthew Lanner	Fuquay Varina MS	400	150	38
Richard Kowaleski	Oberlin Magnet MS	1200	200	17
Shannon Lee	Brinson Memorial ES	1500	1200	80
Sheryl Kirkey-Dean	Glenwood ES	1500	80	5
Sophie Hatcher Peters	Lakewood ES	350	200	57
Wayne Shore	Fuller ES	600	300	50
Average survival percent				**27**

"This is such an amazing citizen science and environmental education project. I love the ability for students to engage in experiential learning by watching the fish develop in real time. It is the most unique and most rewarding part of my year!!"

"It's just a great program with multiple curriculum entry points in a variety of disciplines. It also offers myriad leadership opportunities for young students and connects them rather profoundly to environmental and conservation education and practices."

Teachers reported that the students in the program were more engaged and had a stronger investment in the natural world. Many reported that the students have an increased interest in stewardship. The Shad Program increases students' interest and confidence in science. We have received great feedback on the program from the teachers throughout the 2025 program year.

Photo 11. Brinson Memorial ES releasing shad, lower Neuse River

Photo 12. Lakewood Montessori MS sorting embryos

Additional Student 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 4).

Gyotaku (fish printing)

All teachers who wish to receive a Gyotaku (fish printing kit) for their class can have one. The kit consists of 4 American Shad casts, supporting instructions, and prints of American Shad photos. Schools provide the paint and materials to print on (e.g., t-shirts, bags, posters). Seven classes reported doing this activity and that it enhanced learning.

Photo 13 Seawell ES Shad gyotaku printing

Photo 14. S. Iredell HS Shad gyotaku t-shirts

Fish Dissection

Photo 15. S. Iredell HS fish anatomy lesson

We coordinated with the NC State University (NCSU) Student Fisheries Subunit, the East Carolina University (ECU) Student Fisheries subunit, and the NC Wildlife Resources Commission (NCWRC) to conduct fish anatomy/morphology and dissection lessons. Eight students and educators from the above listed agencies and universities (individuals listed in acknowledgments) conducted these lessons. Because of these volunteers and the generosity of fish donations (136 fish from friends and NCWRC staff, 130 collected by ECU), we were able to facilitate the dissection lecture for 11 classrooms (897 students). All eleven teachers (Table 4) reported that these lectures enhanced learning.

> "This is so powerful for the students to be part of understanding how to study an organism for science not just about the process of how to skin it for food which many of my students are used to. It is an entirely new perspective that many of them would not otherwise experience.

Curriculum Activities and Videos

Photo 16. Example of the fish weir activity.

We continually add or update supplementary materials for the teachers to use to augment the learning process in the classroom and at the release. This year we created a Native American fish weir storyboard in conjunction with Dr. David Cranford, NC Division of Historical Resources. By navigation through the storyboard, students will learn about early anadromous fishing techniques used by Native Americans such as brush and rock weirs. (3 reported it enhanced the learning experience for their students). In addition, Dr. Cranford attended one of the shad releases and brought his fish weir model activity for the students to simulate making a v-shaped alignment of stones to capture "fish". All programs within the Project RESTORE umbrella have supplemental activities that are available to any/all teachers participating in any one or more of the species programs. (See Table 4 for the analysis of activities and videos)

Teachers continue to use the short videos we developed focusing on the diversity of North Carolina fish/aquatic biologists and accompanying questions in 2020 (6 teachers reported enhanced learning). These videos were created as an attempt to address the difference in learning revealed in the student surveys from 2016−2019 (and continued in 2021-2025) where students who self-identified as white showed greater increases in learning relative to students who self-identified as other races, particularly those that self-identified as Black or African American and Hispanic or Latino (see Student Analytics 2016−2019 – Appendix B). We hope that having the opportunity to hear from experts from diverse backgrounds will help students of color to picture themselves pursuing careers more readily in science and/or fisheries.

The genetic based exercise, “Who’s your Shaddy”, (developed in 2013 and updated in 2014) was also continued. Five teachers (1 high school, 2 middle schools, 1 elementary school) reported this exercise was “just right” as far as understandability and complexity for their students. The usefulness of this activity seems mostly related to the class vs the grade as 1 middle school reported it was “too complicated” and one elementary school reported it was “too easy” (the remaining schools just reported that they did not use the activity). Additional curriculum activities are available for the teachers to use including Food Web Activities (17 teachers reported this as useful), GIS Watershed Activity (5 reported as useful), How Old is your Shad (7 reported as useful), Shad Lifecycle Activity (20 reported as enhanced learning), Dichotomous Key Activity (10 reported as enhanced learning), Fintastic Sort (3 reported as enhanced learning), Shad Scents (6 reported as enhanced learning), and a pipette art activity (5 reported as enhanced learning). 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 4. Additional Education and Video Use Survey Results

Question	Response variable
Catch you later! – enhanced learning?	9% (2) greatly enhanced; 22% (5) enhanced; 70% (16) did not use
Dichotomous Key – enhance learning?	26% (4) greatly enhanced; 16% (6) enhanced; 57% (13) did not use
Fintastic Sort – enhance learning?	13% (3) enhanced; 87% (20) did not use
Fish Dissection – enhance learning?	39% (9) greatly enhanced; 4% (1) enhanced; 57% (13) did not attend
Fish Weir Story Board – enhance learning?	4% (1) greatly enhanced; 9% (2) enhanced; 87% (20) did not use
Food Web Activities – usefulness?	39% (9) very useful; 30% (7) useful; 4% (1) somewhat; 26% (6) did not use
Genetic Exercise – complexity or understanding?	17% (4) just right; 4% (1) too hard; 4% (1) too easy; 74% (17) did not use
GIS Watershed Activity – usefulness?	17% (4) very useful; 4% (1) useful; 3% (1) somewhat; 65% (20) did not use
Gyotaku – enhanced learning?	10% (3) greatly enhanced; 10% (3) enhanced; 78% (18) did not use
How Old is Your Shad? – usefulness?	30% (7) useful; 70% (16) did not use
Migration Madness – enhanced learning?	13% (3) greatly enhanced; 9% (2) somewhat; 78% (18) did not use
Shad Lifecycle Activity – enhance learning?	43% (10) greatly enhanced; 39% (9) enhanced; 4% (1) somewhat; 13% (3) did not use
Shad Pipette Art – enhance learning?	9% (2) greatly enhanced; 9% (2) enhanced; 4% (1) somewhat; 78% (18) did not use
Shad Scents – enhance learning?	9% (2) greatly enhanced; 13% (3) enhanced; 4% (1) somewhat; 74% (17) did not use
Wishes of Fishes Activity – usefulness?	13% (3) useful; 9% (2) somewhat useful; 78% (18) did not use
Video -Add the eggs – usefulness?	52% (12) very useful; 30% (7) useful; 17% (4) did not use
Video –Build the Tank – usefulness?	57% (13) very useful; 17% (4) useful; 26% (6) did not use

Table 4. Additional Education and Video Use Survey Results – Cont'd

Question	Response variable
Video – Fish Passage – usefulness?	48% (11) very useful; 26% (6) useful; 26% (6) did not use
Video – History – usefulness?	78% (18) very useful; 22% (5) useful
Video – It is Time usefulness?	39% (9) very useful; 13% (3) useful; 4% (1) somewhat; 43% (10) did not use
Video - Lifecycle – usefulness?	57% (13) very useful; 39% (9) useful; 4% (71) somewhat
Video – Overview – usefulness?	48% (11) very useful; 22% (5) useful; 4% (1) somewhat useful; 26% (6) did not use

Additional Teacher Education Programs

On April 4-6, we conducted a Swamp Treehouse Adventure Educator Trek, a two-night trip to the camping treehouses on the Cashie River in Windsor, NC. Ten educators participated in this workshop from multiple counties (2 tier 1, 1 tier 2, and 7 tier 3; 1 title 1). We paddled on the Cashie River each day of the workshop, exploring different aspects of the bottomland hardwood ecosystem. We conducted activities exploring tree species, lichens, and aquatic organisms. Educators participated in various hands-on activities, including nature journaling, that they could take back to their classrooms. Educators also were giving casting lessons and tried their hand at rod and reel fishing. The Roanoke/Cashie River Center generously provided canoes, paddles, and PFDs. We appreciate that the NCWRC provided an NC Inland Fishing License Exemption for participants. Participants were overwhelmingly satisfied with the experience and many felt that learning from a canoe was highly engaging.

Photo 17. Educators paddling on the Cashie River

Photo 18. Educators fishing on the Cashie River

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).

Student Analytics 2025

We continue our evaluation of the Shad in the Classroom Program's impact on student's understanding and learning with a questionnaire that uses multiple choice questions to determine a participant's knowledge of the American Shad. Demographic questions about age, gender, grade level, and whether the participant hunted or fished are included. Teachers who agreed to participate (15 in 2016, 18 in 2017, 16 in 2018, 18 in 2019, 14 in 2021, 25 in 2022, 18 in 2023, 20 in 2024, 12 in 2025) provided the pre- and post-tests to their students (n =505 for 2016, n =835 for 2017, n =591 for 2018, n =672 for 2019, n =393 for 2021, n = 711 for 2022, n = 643 for 2023, n = 651 for 2024, n = 357 for 2025). See Appendix B for a detailed explanation of the analysis for 2016–2019. For the year 2020, there were no data as most students were unable to participate in the program (one classroom from Exploris ES did a few shad activities). In addition, there were two "control" classrooms in 2017 and 2018, four control classrooms in 2019, two control classrooms in 2021, three control classrooms for 2022, and one control classroom for 2023 and 2024 that completed both the pre- and post-tests. The control classrooms were non-participating classrooms from the same schools that participate in the Shad in the Classroom program. We did not have a control classroom that completed both the pre and post survey for 2025.

All students in the program had a significantly positive increase in learning. However, like in other years, we saw unequal learning growth and final scores across races. Black/African American and Hispanic students showed significantly small percent increase in knowledge compared to their peers. Students that self-identified as Black or African American showed a significant difference in learning from White students (p =0.0067), other (p =.0455), "two or more" (p =.0159), and Asian (p =.0184), but there was no significant difference in learning between students Black or African American and Hispanic (Figure 3). This year we also saw a significant difference in learning among those identifying as Hispanic to White (p <.0001), Other (p =.0039),

"two or more" (p =.0004), and Asian (p =.0004). What this means is that although *all* students gained knowledge, students identifying as Black or African American and Hispanic race/ethnicities fell behind their peers. This year students that identified as Asian were extracted from the group identified as "other" due to a significant increase in students reporting that they identify as Asian. There was no significant difference in learning detected among students who identified as males, females, or other/preferred not to say (these were combined due to low numbers) (Figure 4). Two classes had students that participated in the previous year. Those students showed a starting level higher in knowledge than the new students and showed a smaller increase in learning as the new students [average increase for all students: repeat students (9%), new students (21%)].

Figure 3. ─ Change in student knowledge by race (2025)

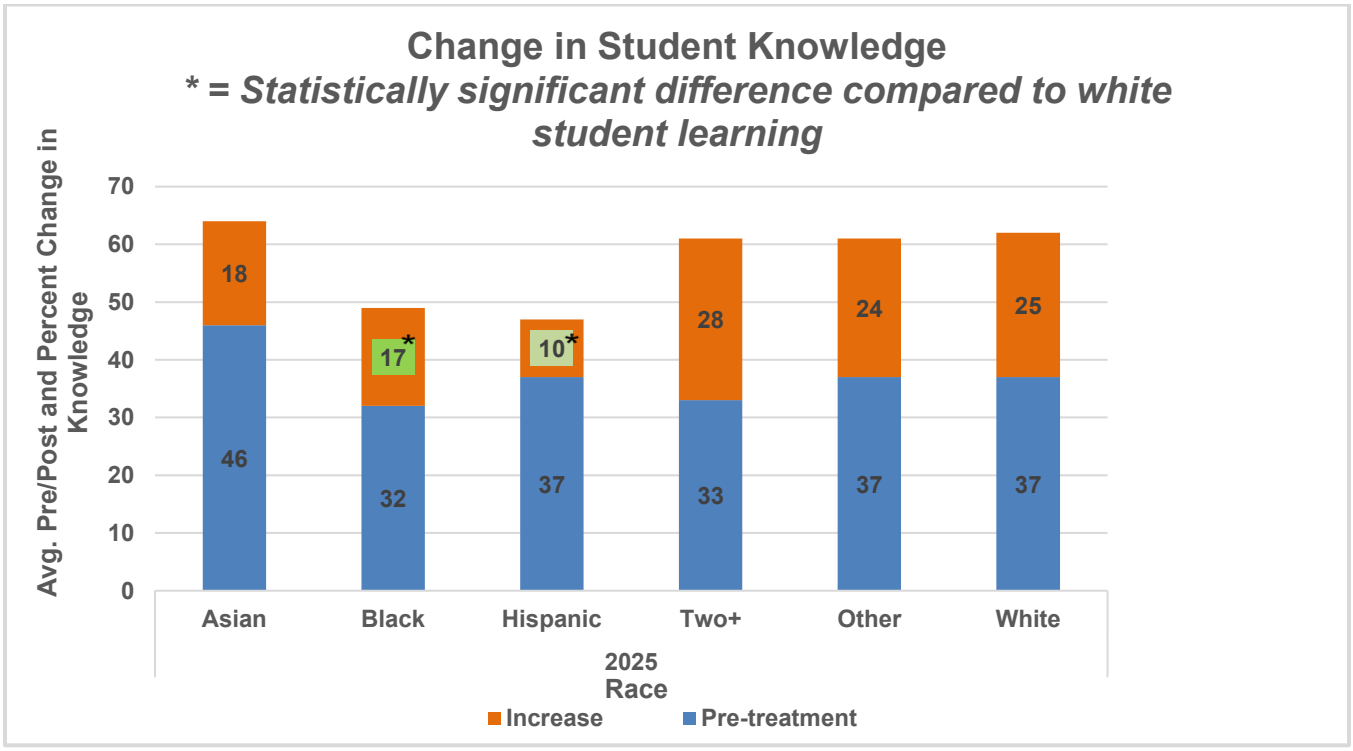
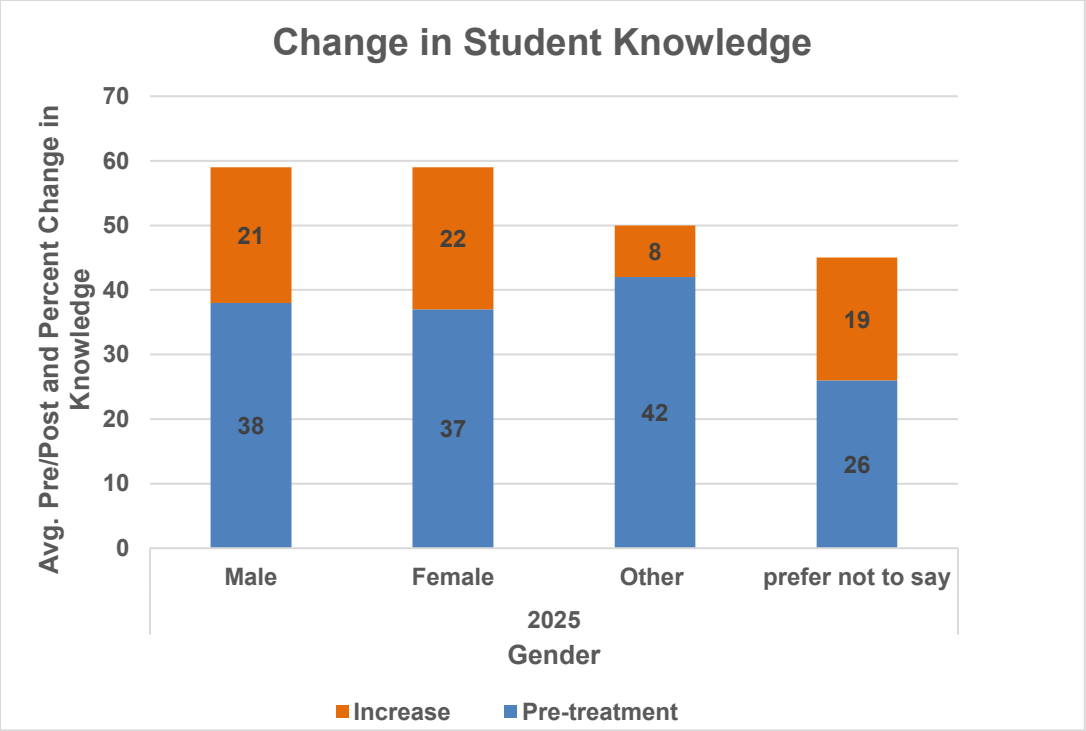


Figure 4. ─ Change in student knowledge by gender (2025 – note no significant difference)



The student surveys also contained questions to assess environmental attitudes and behaviors of the students. The analysis focused on the following 3 questions (one question was eliminated due to testing confusion):

1. **I talk to my family or friends outside of school about what I've learned about science**
2. **I feel I can do something to help my local watershed or river**
3. **I ask others about things I can do about environmental problems**

Table 7 shows pre- and post-program percentages for those that answered "Agree or Strongly Agree" for questions 1-2 or "sometimes, often, or always" for question 3. We looked at all students and groupings by general grade (Elementary Students ES, Middle School Students MS, and High School students HS), gender, and race. Attitude and behavior changes that reflect an increase of 10% or more from pre- to post-survey are marked with an asterisk in the table. We found no discernable pattern between pre- and post- responses with a few notable exceptions. Positive changes in attitude and behavior were found for most questions in all school levels. However, elementary students had higher pre- and post-values than the upper grades. For all other student-identifying factors, there was variation by race and gender as to whether there was any increase in attitude and behavior for each question.

Q: Have you seen any changes in the students who participated in this program?

"Student engagement, curiosity, and investment in the natural world skyrockets when they have living organisms to study firsthand. Students transform from observers to caretakers, meticulously monitoring water quality parameters to ensure the safety and comfort of the unfamiliar organisms that they watch change in their eggs every day. The more the developing embryo move the more fascinating they become. By the 3rd and 4th mornings, students run to the classroom to celebrate the success of the tiny, hatched fry and point out to their friends "the fish" they named as their own.

Table 5. 2025 Analysis of Student Attitude and Behavior (*= notable increase of more than 10%)

Category	Q.1 % Pre	Q.1 % Post	Q.2 % Pre	Q.2 % Post	Q.3 % Pre	Q.3 % Post
All	43	45	48	51	45	51
ES	63	63	79	79	56	65
MS	23	21	21	25	25	31
HS	39	43	46	47	43	45
Female	47	47	45	53	48	51
Male	38	38	53	47	41	51
Other/Prefer not to answer	38	**77***	46	54	46	46
Asian	68	59	64	70	55	**73***
Black	28	**47***	44	41	47	41
Hispanic	41	35	35	33	48	43
Other	29	38	43	**57***	43	43
Two	47	50	44	47	47	35
White	41	43	51	53	41	**53***

In summary, it is notable that all student groups in the program had a significantly positive increase in learning for all the years that these parameters have been evaluated (2016–2019, 2021–2025). However, students identified as Black or African American were found to fall behind their peers in learning in each year (reports 2016-2025). Other groups showing significantly lower learning levels for some comparisons were those self-identified as Hispanic or Latino (6 of the years) and those self-identified as "Other" (2 of the years). We plan to continue collecting student questionnaires and refine questions as necessary so that we can monitor student

learning and attitudes and behavior in all groups between the beginning and end of the Shad program. We will also continue to look for more ways to address any issues identified.

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, the Shad in the Classroom Program was featured through:

- NCDEQ Lunchtime Discovery Series – Earth Day Series April 2025.
- Presentation on Shad in the Classroom to Friends Board Meeting April 2025.
- The "We are the River Film" won the Gold Telly award in the nature category in 2018.
- The 2017 student analysis was published in Fisheries. Reaching Underserved Populations Through a Fisheries Education Program (Fisheries | Vol. 45 • No. 3 • March 2020).

An update on the Shad in the Classroom Program will be published in the North Carolina Chapter American Fisheries Society Fall Newsletter in 2025.

Future Planning

We will be transitioning to working with the anadromous Striped Bass for 2026. This shift in programming is primarily due to hatchery constraints with the American Shad. We will continue to transition tanks to the plexiglass styles as the teachers report that the new, clear tanks enhance students' experience since they can more readily see the tiny fry. 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, 74% of teachers reported that they were extremely satisfied and 17% reported they were very satisfied with the Shad in the Classroom experience [9% (2) teacher reported being moderately satisfied]. For both teachers with the lower satisfaction level, it seemed to stem from tank issues and embryo viability, as all other comments were positive. Most teachers and students provided positive feedback on all aspects of the program including the activities and the overall program. Twenty-two of the 23 teachers participating in the Shad in the Classroom Program in 2025 reported that they would like to continue with the program next year (one teacher is retiring). We have a number of teachers that were on hiatus for 2025 that may like to return for 2026. At present, we have eleven new teachers on the waiting list for the program in 2026. We

> "This program gives your students an authentic, firsthand experience in North Carolina stewardship in a way that no paper or virtual simulated lab ever could."
>
> "The students had so much fun witnessing the fry being born from the eggs. They got so excited. The release trip was very memorable for all of the students, it was so great seeing the kids connect with nature and just get excited about exploring all of the amazing wonders of our outdoor world.

received invaluable assistance from partners and volunteers helping with the deliveries of eggs and educational lectures. Working with this program is a positive experience for all involved.

Appendix A

Table 8. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2025)

Release Basin School	Nos. of Classes	Years
Cape Fear River Basin		
Harnett Central Middle School (NCWRC)	2	2009-2010
Lake Rim Elementary (NCWRC)	2	2009-2010
Overhills Elementary (NCWRC)	1	2010
Neuse River Basin		
Abbotts Creek Elementary School	8	2016-2025
Angier Elementary	2	2013-2014
Ballentine Elementary	4	2017-2021
Bertie Early College High School	3	2019-2021
Bertie High School	3	2022-2024
Brinson Memorial Elementary School	2	2024-2025
Brogden Middle School	6	2015-2019, 2023
Broughton High School	3	2014-2015
Bunn High School	6	2012-2015
Cedar Creek Middle School	1	2015
Centennial Campus Magnet Middle School	2	2009-2010
Central Park School for Children	12	2013-2023
Chaloner Middle School	5	2019, 2023-2024
Chatham Central High School	1	2012
Chestnut Grove Middle School	1	2012
Clarkton School of Discovery (CFRW)	1	2019
Clayton High School	3	2016-2018
Cleveland High School	3	2016-2018
Cook Literacy Model School	2	2017-2018

Table 8. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2025) continued

Release Basin School	**Nos. of Classes**	**Years**
Neuse River Basin		
Cumberland Polytechnic High School	1	2023
Daniels IBMYP Magnet MS/**Oberlin** MS	17	2010-2019, 2022-2025
Davis Drive MS	1	2025
Dillard Middle School	1	2017
Don D. Steed Elementary	1	2012
Durham Public Schools Hub Farm	1	2023
East Duplin High School	3	2023-2025
East Garner Middle School	4	2018-2021
East Wake Middle School	11	2010-2015, 2017
East Wake School of Integrated Technology	1	2014
E.B. Frink Middle School	1	2019
Emereau Bladen (CFRW)	1	2019
The Expedition School	8	2015-2019
Exploris Elementary School	10	2017-2023
Exploris Middle School	7	2010-2016
Falls Lake Academy	2	2023-2024
First Flight Middle School	9	2021-2025
Forest Pines Dr Elementary	1	2013
Fuller GT/AIG Basics Magnet Elementary School	2	2023-2024
Fuquay Varina Middle School	26	2014-2025
George Moses Middle School	3	2022-2024
Glenwood Elementary School	2	2024- 2025
Grady A. Brown Elementary	1	2018

Table 8. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2025) continued

Release Basin School	Nos. of Classes	Years
Neuse River Basin		
Hall Woodward Elementary	2	2012-2013
Horton Middle School	3	2017-2019
Knightdale Elementary School	1	2022
Lakewood Elementary School	2	2024-2025
Lakewood Montessori Middle School	17	2013-2017, 2022-2025
Lincoln Heights Elementary	2	2021-2022
Lead Mine Elementary	3	2009-2011
Lillington Shawtown Elementary	2	2011-2012
Longleaf School of the Arts	2	2019, 2023
Longview Middle School	1	2021
Margaret B. Pollard Middle School	1	2023
McLauchlin Elementary	1	2012
Middlesex Elementary School	1	2015
Midway Middle School	1	2012
Millbrook Environmental Connections Magnet Elementary	2	2018-2019
Mills Park Middle School	1	2017
Mineral Springs Middle School	1	2014
Moore Square Magnet Middle School	3	2023-2025
Moss Hill Elementary	3	2017-2019
North Duplin JR/SR High School	2	2015-2016
Northeast Academy for Aerospace & Advanced Technologies	2	2021

Table 8. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2025) Continued

Release Basin School	Nos. of Classes	Years
Neuse River Basin		
Perquimans County Middle School	1	2019
Perquimans County High School	6	2021-2025
Petree Elementary	1	2019
Pine Hollow Middle School	2	2018-2019
PreEminent Charter School	1	2022
Roanoke Rapids High School	1	2022
Rolesville Middle School	1	2017
Sandy Grove Middle School	2	2012-2013
Seawell Elementary School	4	2022-2025
Sherwood Githens Middle	6	2019, 2022, 2024-2025
Smithfield-Selma Senior High School	6	2018-2023
South Asheboro Middle School	1	2012
South Iredell High School	10	2013-2018, 2022-2025
South View High School	1	2012
Southern Vance High School	4	2012-2015
Southern Wake Academy	2	2024
Speas Elementary	1	2012
Tar Heel Middle School	1	2016
Terrell Lane Middle School	3	2021-2022,2023
The Oakwood School	1	2012
Tiller Elementary School (Carteret County Charter School)	8	2013-2019, 2023

Table 8. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2025) continued

Release Basin School	Nos. of Classes	Years
Neuse River Basin		
Upchurch Elementary	7	2012-2018
Uwharrie Charter Academy	1	2016
Wake Forest Middle School	2	2015-2016
Wake Young Men's Learning Academy	2	2023-2024
Wakefield Middle School	2	2022
Walkertown Middle School	1	2016
West Hoke Elementary	1	2012
West Johnston High School	3	2019, 2024-2025
W.G. Enloe High School	4	2017-2021
W.J. Gurganus Elementary School	1	2021
Woods Charter Middle School	8	2012-2017, 2019-2022
Woods Charter High School	3	2023-2025
Roanoke River Basin		
Bartlet Yancey High School	1	2010
Bertie Early College High School	4	2015-2018
Cedar Creek Middle School	1	2016
Chaloner Middle School	1	2018
Chestnut Grove Middle School	3	2010-2012
Don D. Steed Elementary	1	2011
Hall Woodward Elementary	1	2011
East Bladen High School (CFRW)	1	2018
Hawk Eye Elementary	1	2011

Table 8. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2025) continued

Release Basin School	Nos. of Classes	Years
Roanoke River Basin		
Hertford County High School	2	2014-2015
McLauchlin Elementary	1	2011
Pasquotank county High School	1	2018
Perquimans County Middle School	2	2017-2018
Red Oak Middle School	2	2013
Rockfish Hoke Elementary	1	2011
Sandy Grove Middle School	1	2011
Scurlock Elementary	1	2011
Southern Vance High School	4	2011-2012, 2017-2018
Speas Elementary	2	2010-2011
The Oakwood School	1	2011
Upchurch Elementary	1	2011
Vance Charter School	1	2016
West Hoke Elementary	1	2011
Windsor Elementary	1	2010
W.L. Manning Elementary School	2	2016-2017
Total Number of Schools	**138**	**2009-2025**
Total Number of Classrooms	**378**	**2009-2025**

Appendix B

Student Analytics 2016–2019

To better evaluate the Shad in the Classroom Program's impact on student's understanding and learning, we created a questionnaire that used multiple choice questions in order to determine a participant's knowledge of the American Shad. We also included demographic questions about age, gender, grade level, and whether the participant hunted or fished. Teachers who agreed to participate (15 in 2016, 18 in 2017, 16 in 2018, 18 in 2019, 14 in 2021) provided the pre- and post-tests to their students (n=505 for 2016, n=835 for 2017, n=591, n=672 for 2019). In addition, there were two "control" classrooms in 2017 and 2018 and four control classrooms in 2019 that completed both the pre- and post-tests. The control classrooms were non-participating classrooms from the same schools and grade level that participate in the Shad in the Classroom program.

We partnered with Dr. Nils Peterson, Dr. Kathryn Stevenson, and graduate students Kalysha Clark, Danielle Lawson, and Rachel Szczytko at the NCSU Human Dimensions of Conservation Biology Lab for the 2017 analysis. The results of the 2017 shad season's questionnaire analysis were published in Fisheries (Fisheries | Vol. 45 • No. 3 • March 2020). Analysis of the 2017 data showed that participation in the program created large improvements in American Shad knowledge between pre-and post-tests ($\bar{x}$=0.67, SD=1.22, $p < 0.001$). All students gained knowledge, but African American ($p<0.001$) and students identifying as "other" race/ethnicity ($p=0.003$) fell behind their peers. These results point to the need for improvement in reaching these race/ethnic groups. However, the human dimensions researchers concluded that increased exposure to nature, such as working with hands-on programs like Shad in the Classroom, may be the most consistent pathway to making students comfortable with learning in natural environments.

During the COVID-19 shutdown, we analyzed the larger pool of student knowledge data from 2016-2019 (student surveys began in 2016). In the survey, students self-selected race from the following options: Asian or Pacific Islander, Black or African American, Hispanic or Latino, Native American, White, two or more of the above, or other. Because in each of the years Asian or Pacific Islander and Native American were found to be a low percentage of the student population, these two groups were combined with the "other" category for analysis. Student knowledge data was analyzed by race and gender for pre- and post-knowledge and change in knowledge. Over the four years, we found similar results to those mentioned above for the 2017 analysis (Figure 5). All races and genders were found to have a significant positive increase in knowledge for all four years ($p<0.0001$). However, there were statistically significant differences in learning between some race groups, when compared to White students, in each of the four years.

For the 2016 year, students that self-identified as Black or African American showed a significant difference in learning from White students ($p=0.0188$), but there was no significant difference ($p>0.05$) in learning for Black or African American students compared to other race categories. For the 2017 year, those analysis were explained in detail above; in summary, all races were significantly different from White students but were not significantly different from each other. For the 2018 year, students that self-identified as Black or African American or Hispanic or Latino showed a significant difference in learning from White students ($p=0.0002$ and $p=0.0013$, respectively) and "other" ($p=0.0125$ and $p=0.0241$, respectively), but there was no significant difference in learning between each other or from "two or more". Finally, for the 2019-year students, it was found that students that self-identified as Black or African American or Hispanic or Latino showed a significant difference in learning from White students ($p<0.0001$ for both), "other" ($p=0.039$ and $p=0.0155$, respectively),

and “two or more” ($p<0.0001$ for both). There was no significant difference (no increase in knowledge) for the pre- and post-survey for control students for all years tested.

In summary, although all student groups in the program had a significantly positive increase in learning, students identified as Black or African American were found to have a significant difference in learning in every year and those self-identified as Hispanic or Latino had a significant difference in learning in three of the four years from their White peers. Also, for the 2019 year, we found a small significant difference in learning for gender ($p=0.04$), which was in the positive direction for females, and no significant difference for all other years ($p>0.05$) (Figure 6).

Figure 5. ─ Change in student knowledge by race (2016–2019)

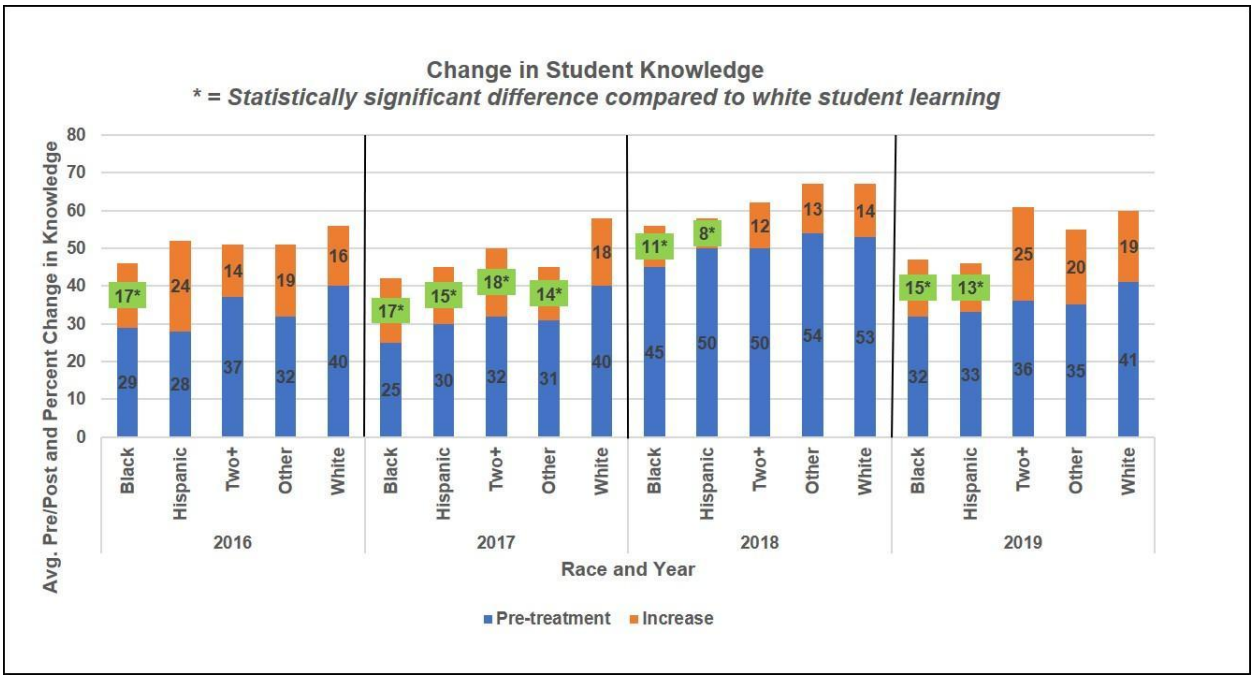
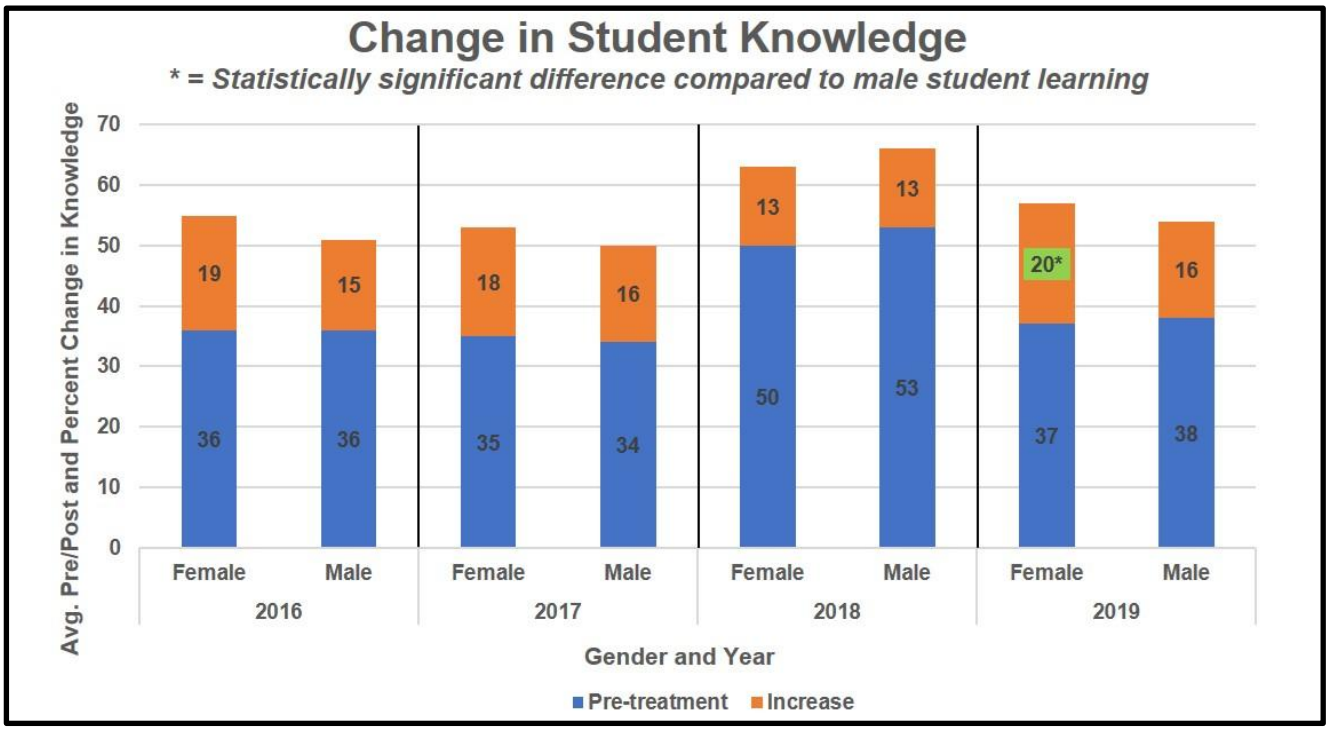


Figure 6. ─ Change in student knowledge by gender (2016–2019)



One way we are addressing the results of these student surveys is to create a series of video interviews of a diverse group of aquatic or fisheries biologists, as mentioned in the Curriculum Activities and Videos section. These videos will be made available to teachers and students. Our hope is that these videos will help students of color to more easily relate to scientists and begin to envision careers in the aquatic biology field. We continue to look for additional ways to engage these populations and increase their knowledge over the scope of the program.

The student surveys also contained questions to assess environmental attitudes and behaviors of the students. In our 2019 analysis we focused on the following 4 questions (this analysis was done only for 2019 as that is the year these particular questions were given):

1. **I talk to my family or friends outside of school about what I've learned about science**
2. **I feel I can do something to help my local watershed or river**
3. **I feel I can do something to help fish like the American Shad**
4. **I ask others about things I can do about environmental problems**

Table 8 shows pre- and post-program percentages for those that answered "Agree or Strongly Agree" for questions 1-3 or "sometimes, often, or always" for question 4. We looked at all students and groupings by general grade (Elementary Students ES, Middle School Students MS, and High School students HS), gender, and race. We found no discernable pattern between pre- and post- responses with a few notable exceptions, in which students had an increase of 10% or more from pre- to post-survey (marked with an asterisk in the table). Both elementary students and those who self-reported their race as "other" (other includes those that chose "other" and also includes Asian and Native American) showed an increase of more than 10% in their answers to Question 3, indicating a positive shift in attitude regarding American Shad restoration. Additionally, high

school students showed an 11% increase from pre- to post-survey in their responses to Question 4, indicating a positive change in behavior. Also notable was those students that self-reported as Black and "other" showed a positive increase in responses to all questions (though only at the 10% level for "other" in Question 3).

Table 9. 2019 Analysis of Student Attitude and Behavior (* = notable increase of more than 10%)

Category	Q.1 % Pre	Q.1 % Post	Q.2 % Pre	Q.2 % Post	Q.3 % Pre	Q.3 % Post	Q.4 % Pre	Q.4 % Post
All	44	43	54	55	61	61	49	53
ES	46	49	71	70	65	**77***	57	59
MS	45	42	50	51	59	57	47	41
HS	36	44	53	56	64	59	49	**60***
Female	49	46	60	64	64	66	55	59
Male	39	38	48	45	58	56	43	47
Black	36	43	48	53	57	58	35	43
Hispanic	47	39	57	55	63	57	52	52
Other	43	47	45	52	53	**70***	57	58
Two	45	43	51	48	56	55	48	51
White	46	43	57	57	64	62	52	56

Additional notable results were females answered 10% or more higher in positive answers (except question 1 post- at 8% higher) compared to males, and elementary students answered 10% or more higher in positive answers for pre- and post- question 2 and post- question 3 compared to middle school and high school. We plan to continue collecting student questionnaires and refine questions as necessary so that we can monitor student learning and attitudes and behavior in all groups between the beginning and end of the Shad program.

Shad in the Classroom Background (Updated 2020)

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, by 2014 there were 37 schools, and by 2020 they increased to 73 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, Pennsylvania, Virginia, and West Virginia, and the District of Columbia (Figure 7). The Connecticut River Museum was looking into starting a Shad in the Classroom Program in their state, but the program got suspended. Previously, a number of participating states were part of the Interstate Commission on the Potomac River Basin (ICPRB). However, as of 2020, Anacostia Watershed Society continues the work and includes schools in Maryland, DC, and Virginia. 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.

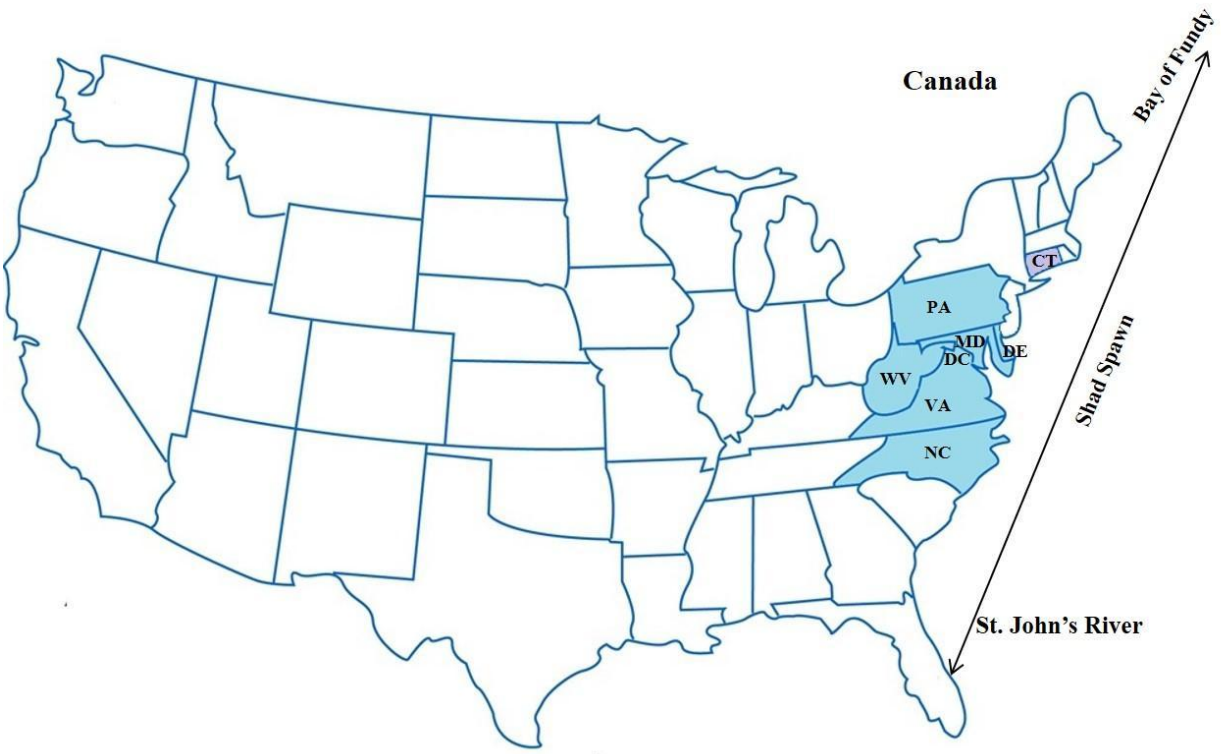


Figure 7. ─ Map of the states we found to participate in some version of a shad in the classroom program: Delaware, Maryland, North Carolina, Pennsylvania, Virginia, and West Virginia, and the District of Columbia (a program in Connecticut in proposed). Arrow depicts American Shad spawning distribution 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 in the 2015 and 2016 program years. Funding was provided through APNEP and the USFWS for the years 2017-2019 and 33 classrooms were reached for the 2017 year, 30 for the 2018 year, and 32 for the 2019 year. 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 – 2021) is included in Table 7. 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, and all shad used for the program in 2019 were spawned at the NCWRC Watha State Fish 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. Due to the results of multiple years of study, the NCWRC is presently (as of 2019) not stocking American Shad in NC waters, but are continuing to monitor the populations. American Shad are collected and brought to the Watha State Fish Hatchery solely for the Shad in the Classroom Program. Even though the NCWRC are not collecting broodstock, they continue to monitor the fishery as part of their restoration program. Having the schools be part of this restoration program is a valuable educational tool.