Shad in the Classroom
Program Report
(2009–2021)

Date July 1, 2021

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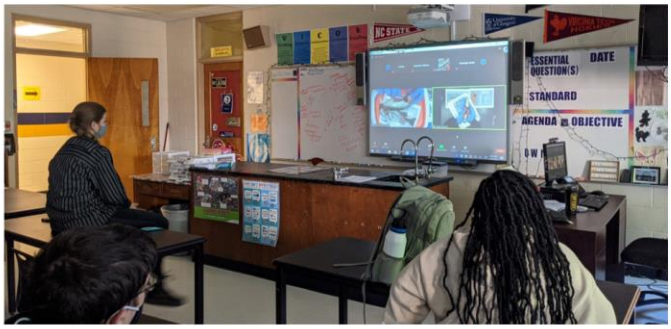

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Executive Summary

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 2021 program, we received $20,000 in grant funding from APNEP. We received $7,000 in grant funding from the USFWS. We also leveraged over $23,600 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 2021 Shad year operated a bit differently due to the COVID-19 pandemic. Some schools that had been part of the program in the past asked to have a "hiatus" year, and we did not accept any schools from which the teacher had not already had in-person training. The Shad in the Classroom Program reached 266 classrooms from 2009 to 2021 (Appendix A, Table 7) and many thousands of students. Between 2013─2021, approximately 17,774 students were reached (prior to 2013, the numbers of students were not tracked). Nineteen classrooms participated in 2021 (Table 1) with 6 of those being new to the program but were originally accepted in 2020 and attended the in-person training that season. Over 1,600 (1,629) students participated in the program this year and 52 participated in river releases.

Table 1. 2021 Schools Accepted to the North Carolina Shad in the Classroom Program

School	County	Numbers of Classes
Abbotts Creek ES	Wake	1
Ballentine ES	Wake	1
Bertie Early College HS	Bertie	1
Central Park School for Children ES	Durham	1
East Garner Magnet MS	Wake	1
Exploris ES	Wake	1
First Flight MS	Dare	1
Fuquay Varina MS	Wake	3
Lincoln Heights Environmental Connections Magnet ES	Wake	1
Longview MS	Wake	1
NE Academy for Aerospace & Advanced Technologies HS	Pasquotank	1
Perquimans County HS	Perquimans	1
Terrell Lane MS	Franklin	1
Smithfield-Selma Senior HS	Johnston	1
W.G. Enloe HS	Wake	1
W.J. Gurganus ES	Craven	1
Woods Charter MS	Chatham	1
Total Number of Schools		**17**
Total Number of Classrooms		**19**

Current new tank construction of the red tub style tanks cost approximately $385 per tank system. The plexiglass tank systems cost approximately $587 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, and part-time staff.

In the years from 2013–2021 (excluding 2020), each school received approximately 1,000 eggs from the NCWRC. Beginning in 2011, shad embryos were received from the Neuse River and the Roanoke River and were released in the river basin of their parentage. Starting with the 2019 season, stocking is not part of the NCWRC's American Shad Management Plan at this time. 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, which are all released in the Neuse River Basin.

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 (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)
- United States Fish and Wildlife Service (USFWS)

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 that could occur for 2021 are listed below.

Workshop Guest Speaker

Samantha Dowiarz dowiarzs19@students.ecu.edu – (ECU, Grad Student)

Additional Education

Career Paths: Interviews with North Carolina Aquatic Biologists -
(https://www.youtube.com/playlist?list=PLLJ57Fba87jQXFjo1sFCOeIgGw835si6f)
Ambar Torres Molinari atorre22@ncsu.edu – (NCSU, Grad Student)
Gabriela Hogue gabriela.hogue@naturalsciences.org – (Museum, Collections Manager, Ichthyology)
Dr. Gus Engman aengman@utk.edu – (University of Tennessee, Assistant Professor)
Dr. Harry Daniels harry_daniels@ncsu.edu – (NCSU, Senior Associate Dean for Administration)
Jessica Bauman Jessica_Baumann@ncsu.edu – (NCSU, Extension Associate, Lake Gaston)
Dr. Rebecca Asch aschr16@ecu.edu – (ECU, Assistant Professor of Fisheries Biology)
Dr. Stacy Nelson stacy_nelson@ncsu.edu - (NCSU, Professor and Interim Associate Dean for Diversity and Inclusion)

Live from the Field – Shad Exploration
Ben Ricks ben.ricks@ncwildlife.org – (NCWRC, District Fisheries Biologist)
Rachel Wilson rachel.wilson@naturalsciences.org – (Outdoor Curriculum Specialist, AmeriCorps Member)
Taylor Prichard taylor.prichard@naturalsciences.org – (Outdoor Curriculum Specialist, AmeriCorps Member & Teacher Education Specialist)
Todd VanMiddlesworth todd.vanmiddlesworth@ncwildlife.org – (NCWRC, District Assistant Fisheries Biologist)

Virtual Fish Anatomy-Dissection Lecture
Ambar Torres Molinari atorre22@ncsu.edu – (NCSU, Grad Student) – Lecturer
Annika Preheim aprehei@ncsu.edu – (NCSU, Undergrad Student) – Lecturer
Laura-Beth Speer laura.speer@naturalsciences.org – (Museum, Outreach Coordinator) – Moderator
Rachel Wilson rachel.wilson@naturalsciences.org – (Outdoor Curriculum Specialist, AmeriCorps Member) – Education Assistant
Samantha Frigero Samantha.Frigerio@naturalsciences.org – (Museum, Outreach Specialist) – Moderator
Taylor Prichard taylor.prichard@naturalsciences.org – (Outdoor Curriculum Specialist, AmeriCorps Member & Teacher Education Specialist) – Education Assistant

Egg Delivery

Heather Jennings Heather.B.Jennings@ncdenr.gov – (APNEP, Program Manager)
Taylor Prichard taylor.prichard@naturalsciences.org – (Outdoor Curriculum Specialist, AmeriCorps Member & Teacher Education Specialist) – Education Assistant
Dr. Tim Ellis tim.ellis@ncdenr.gov – (APNEP, Ecosystem Analyst)

In addition, we are very appreciative of the previous fish donations from 2020 that we were then able to use for 2021 from Dr. Rich Noble, Dr. Phil Doerr, Dr. Jim Rice, and fellow anglers and to Dr. Tom Kwak who provided additional Largemouth Bass for dissections. We greatly appreciate Ben Ricks and Todd VanMiddlesworth for coordinating shad weeks with us, and 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.

Report cover photos: Top left – Exploris ES release at Raleigh Beach; Top right – Ben Ricks and Todd VanMiddlesworth In the Field Program; Bottom left – Taylor Prichard and interactive zoom activity for students (art work created by Rachel Wilson); Bottom right – Smithfield-Selma Senior HS students attending virtual fish anatomy and dissection lesson.

Shad in the Classroom Program 2021 Report

This report summarizes the activities accomplished for the 2021 Shad in the Classroom Program. Nineteen classes at 17 different schools were accepted into the 2021 program: 6 elementary, 8 middle, and 5 high school classes. One teacher had two tanks – a traditional tank and a new clear plexiglass tank (Northeast Academy for Aerospace & Advanced Technologies). Thirteen classes (including Cape Fear River Watch) opted to have an off year due to Covid-19 complications and restrictions.

Photo 1. Teacher virtual training

Yearly program planning began with forming a timeline (Figure 1), reviewing applications, and conducting a tank and parts inventory. Several teachers attended a virtual orientation and training session in February by Zoom Conference.

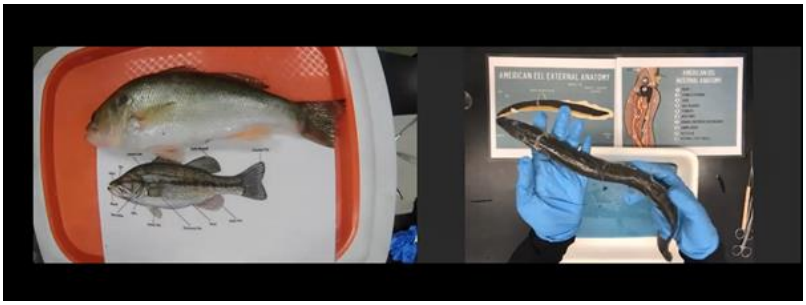
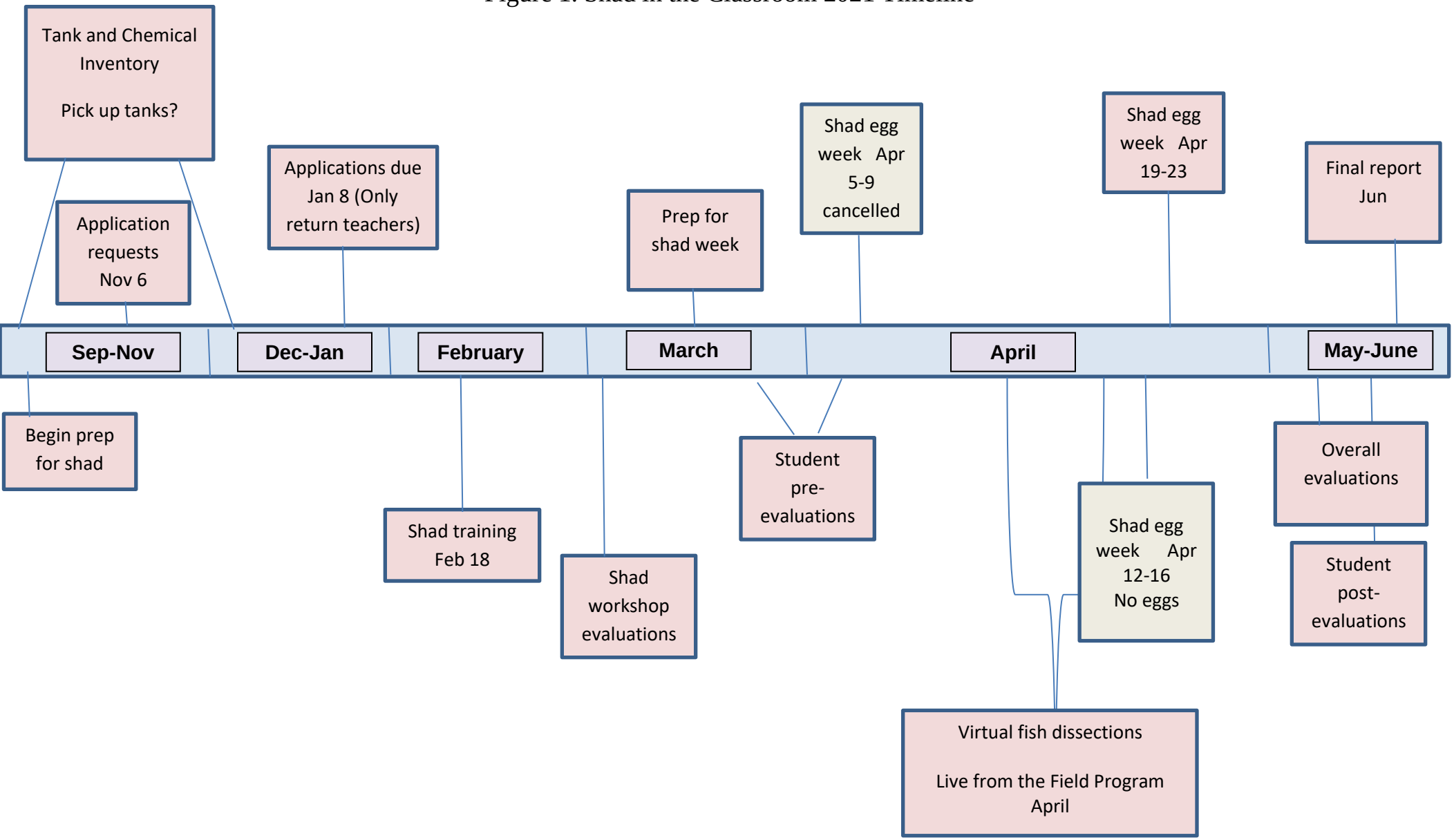


Photo 2. Comparing external anatomy of a Largemouth Bass and an American Eel.

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 5th. Teachers and some students released the shad larvae primarily on the Thursday or Friday of the week that they received them. Many of the teachers took advantage of either (or both) a virtual fish dissection lecture that we coordinated with NCSU graduate and undergraduate students and/or a virtual "Live from the Field" event that covered riparian and river ecology, what's in the river-who lives there?, fish diversity, and fisheries careers.

Photo 3. Rachel Wilson, Taylor Prichard, Ben Ricks, and Todd VanMiddlesworth - Live from the Field Program.

Figure 1. Shad in the Classroom 2021 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. Museum exhibits staff were able to construct five new tank plexiglass tank systems. An updated inventory list is on file.

Teacher Orientation and Training

Photo 4. Samantha Dowiarz Lecture.

A teacher orientation and training session was conducted on February 18, 2021. Danielle Pender and Melissa Dowland co-led the session. ECU graduate student, Samantha Dowiarz guest lectured on Hickory Shad Age and Spawning Structure. Teachers were provided information about American Shad life history, restoration, and management. They received instructions for raising shad and learned ways to incorporate shad and aquatic ecology into their curriculum virtually and in-person. Teachers participated in a shad egg and larval fish observation activity, Fintastic sort (sort fish by observation), and a dichotomous key activity (sort fish by using a key).

> "I really loved the jokes and how welcoming. I love the consistency of goal setting and checking on those goals. I liked the use of choice breakout rooms and the management of the chat!"

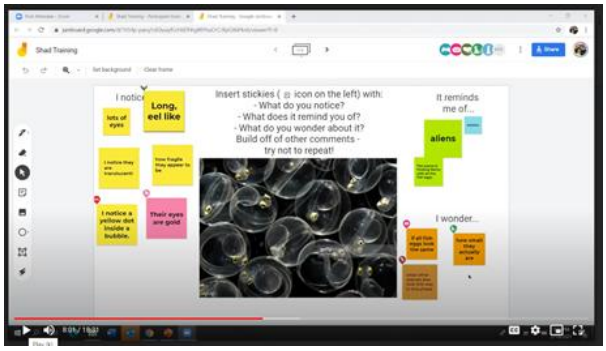


Photo 5. Fish observation activity.

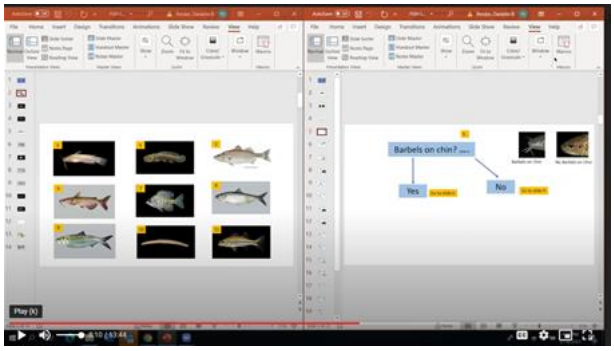


Photo 6. Fish dichotomous key activity.

Eleven teachers attended the 2021 workshop. Of those, 9 responded to the 8-question survey regarding the workshop. Of the 8 questions, 4 were quantitative and are included in Table 2. For the qualitative responses, many reported that they were appreciative of the digital resources, but some expressed the need for more practice on water quality testing and new tank construction. Overall, most teachers reported that they were very satisfied with the workshop (although they greatly prefer the in-person version) and that the concepts were explained very to extremely well. However, only 33% felt that the

virtual workshop refreshed their knowledge on the proper components to raising shad eggs to the larval stage (Table 2). We hope to be able to provide better support in the future as we return to in-person training.

Table 2. Virtual Workshop Survey Results

Question	Response variable
This workshop refreshed my knowledge of the importance of the shad restoration and management program.	22% (2) extremely well; 56% (5) very well; 22% (2) moderately well
This workshop refreshed my knowledge of the life history of shad.	33% (3) extremely well; 33% (3) very well; 33% (3) moderately well
This workshop refreshed my knowledge of the proper components to raising shad eggs to the larval stage.	33% (3) very well; 44% (4) moderately well; 11% (1) slightly well; 11% (1) not well
Overall, how satisfied are you with the workshop?	67% (6) very satisfied; 22% (2) moderately satisfied; 11% (1) slightly satisfied

Egg Delivery and Larval Fish Release

Photo 7. Exploris ES release Raleigh Beach.

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 broodstock were collected the week of April 5th and 12th. Many people assisted with the delivery of the eggs and with the release of the larval fish and are mentioned in the acknowledgments.

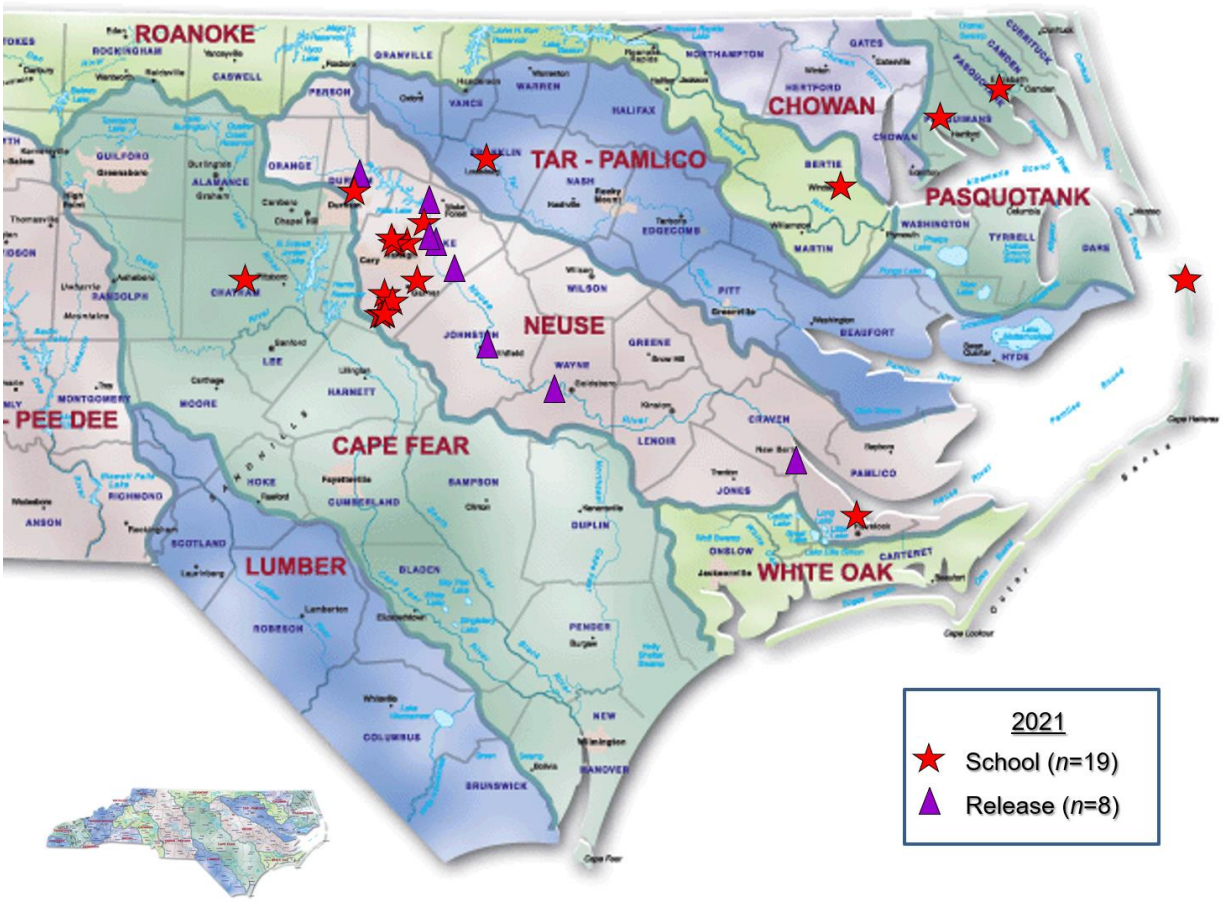
Classes were originally divided into two groups. However, the shad that were collected the week of April 5th did not spawn so there were no eggs for Monday 4/12. Therefore, all schools were then moved to the second group and received their eggs Monday, April 19. Two classes released on Wednesday 4/14. This "early" release was related to Covid schedule constraints. Nine classes released on Thursday 4/15 and 8 released on Friday 4/15 (Table 3, Figure 2). Classes received approximately 1,000 eggs from the Watha State Fish Hatchery. However, many of the teachers reported receiving many unfertilized eggs (Table 4). Due to Covid travel restraints, teachers were restricted on whether they could bring students to releases. Students that were able to attend releases generally arrived with a parent or other guardian, and 52 students were able to attend releases at the Neuse River.

Photo 8. Enloe HS release Raleigh Beach.

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

Educator	School	Received Eggs	Released Eggs/Larva	Neuse River Release Site
Annah Riedel/Maggie Gargan	Exploris ES	4-19-2021	4-21-2021	Raleigh Beach
Beth Selig	Fuquay Varina MS	4-19-2021	4-22-2021	Smithfield
Brian Reynolds	Bertie Early College HS	4-19-2021	4-21-2021	Falls Dam
Brian Wood	W.G. Enloe HS	4-19-2021	4-22-2021	Raleigh Beach
Caroline Smith	Fuquay Varina MS	4-19-2021	4-22-2021	Smithfield
Douglas Poole	Perquimans County HS	4-19-2021	4-23-2021	Cliffs of the Neuse State Park
Endiga Holdness	Fuquay Varina MS	4-19-2021	4-22-2021	Smithfield
J.D. “Tripp” Carter	Longview Gardens MS	4-19-2021	4-23-2021	Raleigh Beach
Judy Compton	Central Park School for Children ES	4-19-2021	4-22-2021	Cliffs of the Neuse State Park
Kaley Kiffner	Perquimans County MS	4-19-2021	4-23-2021	Falls Dam
Karel Klepacki	Smithfield-Selma Senior HS	4-19-2021	4-23-2021	Smithfield
Kathy Wall	Ballentine ES	4-19-2021	4-22-2021	Raleigh Beach
Krista Brinchek	Abbotts Creek ES	4-19-2021	4-23-2021	Falls Dam
Mark Miller	NE Academy for Aerospace & Advanced Technologies	4-19-2021	4-23-2021	Cliffs of the Neuse State Park
Matthew Lanner	East Garner MS	4-19-2021	4-22-2021	Neuse Trail Auburn Knightdale Rd.
Megan Jackson/Laura Wood	Lincoln Heights Environmental Connections Magnet ES	4-19-2021	4-23-2021	Lassiter Mill Dam
Sonja Younger	Woods Charter MS	4-19-2021	4-22-2021	West Point Eno
Susette McConnell	Terrell Lane M	4-19-2021	4-23-2021	Falls Dam
Virginia Jones	W.J. Gurganus ES	4-19-2021	4-22-2021	Cliffs of the Neuse State Park

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



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 1,000 embryos; however, counts may differ as to what the school actually reported receiving and many reported receiving unfertilized eggs. 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 all 19 classes received their embryos on the same date, Monday, April 19th. Several schools were scheduled to receive embryos the week prior; however, the shad broodstock did not spawn that week so all schools were moved to the 19th. Due to issues related to Covid, two of the schools released on Wednesday. Of those that turned in their water quality information (14), many that had lower survivability also reported water quality issues. Four reported higher temperature ranges, one reported low alkalinity, and one reported a spike in ammonia. One class reported having 0% survivability after a power outage to the tank overnight. It is possible that water quality issues

Photo 9. Ballentine ES measuring water quality.

contributed to lower than 50% survivability for some schools, however, for two of the schools that reported low survivability, there were no notable issues with the water quality parameters measured.

> "They have a greater appreciation of the river ecosystem and protecting the water quality."

Overall, the percent survival ranged from a low of 0% to a high of 95% and averaged 35% (Table 4). Seven classes averaged ≤ 50%, 12 averaged >50%, and 2 averaged ≥75% survival to release. There were 4 classes that averaged 10% survivability or below, and average survivability was reported at 35%, which was lower than 2019 (53%). The percent of classes that were in the ≥75% (11%) category was also lower than in 2019 (34%).

Table 4. Egg and Larval Survival and Release Numbers

Educator	School	No. Eggs Received	No. Eggs/Larva Survived to Release	Percent Survival (%)
Annah Riedel/Maggie Gargan	Exploris ES	1000	950	95
Beth Selig	Fuquay Varina MS	780	122	23
Brian Reynolds	Bertie Early College HS	809	700	70
Brian Wood	W.G. Enloe HS	1000	400	50
Caroline Smith	Fuquay Varina MS	3000	0	0
Douglas Poole	Perquimans County HS	850	110	24
Endiga Holdness	Fuquay Varina MS	700	750	75
J.D. "Tripp" Carter	Longview Gardens MS	1000	50	5
Judy Compton	Central Park School for Children ES	1000	340	45
Kaley Kiffner	Perquimans County MS	1000	0	0
Karel Klepacki	Smithfield-Selma Senior HS	1000	208	19
Kathy Wall	Ballentine ES	1100	300	30
Krista Brinchek	Abbotts Creek ES	741	500	50
Mark Miller	NE Academy for Aerospace & Advanced Technologies	2000	1000	50
Matthew Lanner	East Garner MS	700	570	39
Megan Jackson/Laura Wood	Lincoln Heights Environmental Connections Magnet ES	1000	150	15
Sonja Younger	Woods Charter MS	1000	169	51
Susette McConnell	Terrell Lane M	900	100	10
Virginia Jones	W.J. Gurganus ES	1000	60	20
		Average survival percent		**35**

Teachers reported appreciating the effort that the staff put into making the program work in this odd Covid-impacted year and all of the additional virtual learning opportunities that were created. Many reported that the students had increased engagement during their shad week. The Shad Program increases students' interest and confidence in science. We have received great feedback on the program from the teachers throughout the 2021 program year.

> "When we first got the eggs and had to sort them, my students were more focused than I have ever seen

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 5).

Fish Dissection

This year we did not send out the fish printing supplies due to Covid but did offer a modified fish dissection experience (Zoom conferencing). Danielle conducted two fish dissection and anatomy lessons from the NCMNS virtual studio and co-instructors Ambar Torres and Annika Preheim (both students at NCSU) joined from

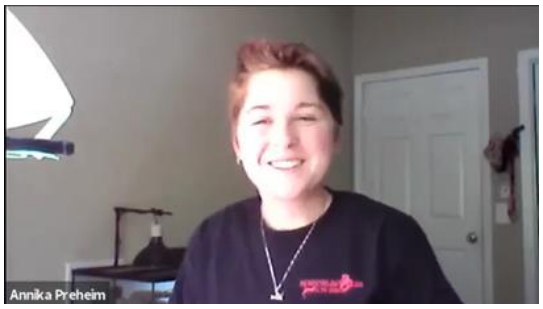


Photo 11 Annika Preheim (NCSU student) conducting a virtual fish anatomy lesson.

Photo 10. Fish dissection setup. NCMNS virtual lab.

Photo 12. Ambar Torres (NCSU grad student) and Danielle a conducting virtual fish anatomy lesson.

> "The side-by-side dissections were really interesting. Kids liked being able to see the different kinds of fish at the same time. Most of them also enjoyed all the body parts, etc. They learned a lot of anatomy vocabulary."

their remote locations (one on each of the two days) (all 6 classes reported the lesson enhanced learning). We were able to use Hickory Shad, blue gill sunfish, and crappie that were donated last year for the dissections, a few bass that were donated this year, and American Eels provided by Ambar.

Shad Exploration - Live from the Field

> "This was great. Kids were really interested in what the biologists had to say, and they liked being able to ask questions. Seeing all the different fish was cool."

Most of the classes were not able to attend the release of the shad fry; therefore, we created a virtual program (by Zoom conferencing) to share the "field" experience (all 5 classes reported that this activity enhanced learning). We focused on river and riparian ecology, animal fauna in the river, and an interview with NCWRC fish biologists, Ben Ricks and Todd VanMiddlesworth. Danielle, Ben, and Todd joined from Raleigh Beach and Americorps volunteers Rachel Wilson and Taylor Prichard joined from their remote locations. Ben and Todd provided multiple fish species that they caught by electrofishing to show to the students.

Photo 13. Ben Ricks and Todd VanMiddlesworth interview at Raleigh Beach.

Curriculum Activities and Videos

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 revamped the NCMNS website and all materials, activities, and exercises have all been uploaded and are shared with the teachers on a Google Drive site. This updated location and format will make it easier for the teachers and public to find materials on shad. Materials include, but are not limited to, a lifecycle activity, 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. Recent additions include a Fintastic Sort (6 reported enhanced learning) and Dichotomous Key activity (9 reported enhanced learning).

Photo 14. Biologists zoom interviews.

We also developed short videos focusing on the diversity of North Carolina fish/aquatic biologists and accompanying questions (5 reported enhanced learning). Five of the videos were conducted at the end of the Shad 2020 season and 2 additional interviews were conducted in the Fall of 2020. These videos were created as an attempt to address the difference in learning revealed in the student surveys from 2016−2019 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 continued. Four teachers (2 high schools, 1 middle school, and one elementary school) reported this exercise was "just right" as far as understandability and complexity for their students. Additional curriculum activities are available for the teachers to use including Food Web Activities (9 reported as useful), GIS Watershed Activity (3 reported as useful), Wishes of Fishes Activity (3 reported as useful), and a Non-Fiction Reading Activity (9 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
Biologist Interviews – enhance learning?	5% (1) greatly enhanced; 16% (3) enhanced; 5% (1) somewhat; 74% (14) did not use
Dichotomous Key – enhance learning?	16% (3) greatly enhanced; 21% (4) enhanced; 11% (2) somewhat; 53% (10) did not use
Fintastic Sort – enhance learning?	21% (4) greatly enhanced; 5% (1) enhanced; 5% (1) somewhat; 68% (13) did not use
Food Web Activities – usefulness?	26% (5) very useful; 11% (2) useful; 11% (2) somewhat; 53% (10) did not use
Fish Dissection – enhance learning?	21% (4) greatly enhanced; 5% (1) enhanced; 5% (1) somewhat; 68% (13) did not attend
Genetic Exercise – complexity or understanding?	21% (4) just right; 79% (15) did not use
GIS Watershed Activity – usefulness?	11% (2) very useful; 5% (1) useful; 84% (16) did not use
Live From The Field – enhance learning?	16% (3) greatly enhanced; 11% (2) enhanced; 74% (14) did not attend
Shad Lifecycle Activity – enhance learning?	37% (7) greatly enhanced; 26% (5) enhanced; 5% (1) somewhat; 32% (6) did not use
Shad Pipette Art – enhance learning?	5% (1) greatly enhanced; 5% (1) enhanced; 5% (1) somewhat; 84% (16) did not use
Shad Scents – enhance learning?	11% (2) greatly enhanced; 11% (2) enhanced; 79% (15) did not use
Wishes of Fishes Activity – usefulness?	5% (1) very useful; 11% (2) somewhat useful; 84% (16) did not use
Video -Add the eggs – usefulness?	58% (11) very useful; 11% (2) useful; 32% (6) did not use
Video –Build the Tank – usefulness?	42% (8) very useful; 16% (3) useful; 42% (8) did not use

Table 5. Additional Education and Video Use Survey Results Continued

Question	Response variable
Video – Fish Passage – usefulness?	47% (9) very useful; 5% (1) useful; 47% (9) did not use
Video – History – usefulness?	74% (14) very useful; 11% (2) useful; 16% (3) did not use
Video – It is Time usefulness?	42% (8) very useful; 11% (2) useful; 5% (1) somewhat; 42% (8) did not use
Video - Lifecycle – usefulness?	68% (13) very useful; 16% (3) useful; 16% (3) did not use
Video – Overview – usefulness?	47% (9) very useful; 16% (3) useful; 11% (2) somewhat useful; 26% (5) did not use

Additional Teacher Education Programs

On March 27-28, we conducted the Spring on the Millpond Educator Trek, an in-person canoe-camping trip to Merchants Millpond State Park in Gates County. The group included 10 educators, 4 Museum staff (including our two Americorps volunteers), and a representative from NC State Parks. The group had the opportunity to experience and learn about the bottomland hardwood ecosystem and its importance in eastern North Carolina.

On April 13, Rachel Wilson, one of our Americorps volunteers, conducted our first virtual Educator Trek, Watersheds 101. This workshop introduced 22 participating educators to a number of classroom-ready tools, including activities based on the NCDEQ River Basin GIS web application and using water quality monitoring test kits, which were provided free of charge to participating educators. All participants indicated that the workshop was "excellent" or "good" and agreed that the workshop helped them feel more comfortable teaching about watersheds. Follow-up resources provided to workshop participants included the "We are the River" video and supporting curriculum-correlated activities, which were developed with support from APNEP.

> "My mind is reeling with activities to do with my students. We have to start them early thinking about their environmental impact. I am proud of many decisions I have made in my personal life, but will continue to think of what I do to impact watersheds."

Additionally, we are in the final stages launching an asynchronous workshop in our Nature Neighborhood Online Workshop series on Watershed Stewardship that will incorporate activities that examine the habitats found in our streams and rivers, ask participants to collect and observe macroinvertebrates from a local waterway and calculate a biotic index, examine a case study about pollution in NC, and provide resources and ideas to help teachers get their students involved in watershed conservation. Once launched, this workshop will be available on an ongoing basis.

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 2021

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) provided the pre- and post-tests to their students (n=505 for 2016, n=835 for 2017, n=591, n=672 for 2019, n=393 for 2021). See Appendix A for a detailed explanation of the analysis for 2016–2019. For the year 2020, there was 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, and two control classrooms in 2021 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.

Similar to the other years' analysis, although all student groups in the program had a significantly positive increase in learning, students that self-identified as Black or African American and "Other"

showed a significant difference in learning from White students (p=0.0134 and p=0.0004, respectively), but there was no significant difference (p>0.05) in learning for Black or African American students compared to other race categories (Figure 3). There was also a slight significant difference in learning when comparing "Other" to Hispanic or Latino (p=0.0489). What this means is that although all students gained knowledge, Black or African American and students identifying as "Other" race/ethnicity fell behind their peers. There was no significant difference in learning detected between males and females (Figure 4). Also, there was no significant difference (no increase in knowledge) for the pre- and post-survey for control students for all but one question. More students in the control group picked the correct answer for what was not a life stage of a fish in the post-treatment (answer=polyp).

Figure 3. ─ Change in student knowledge by race (2021)

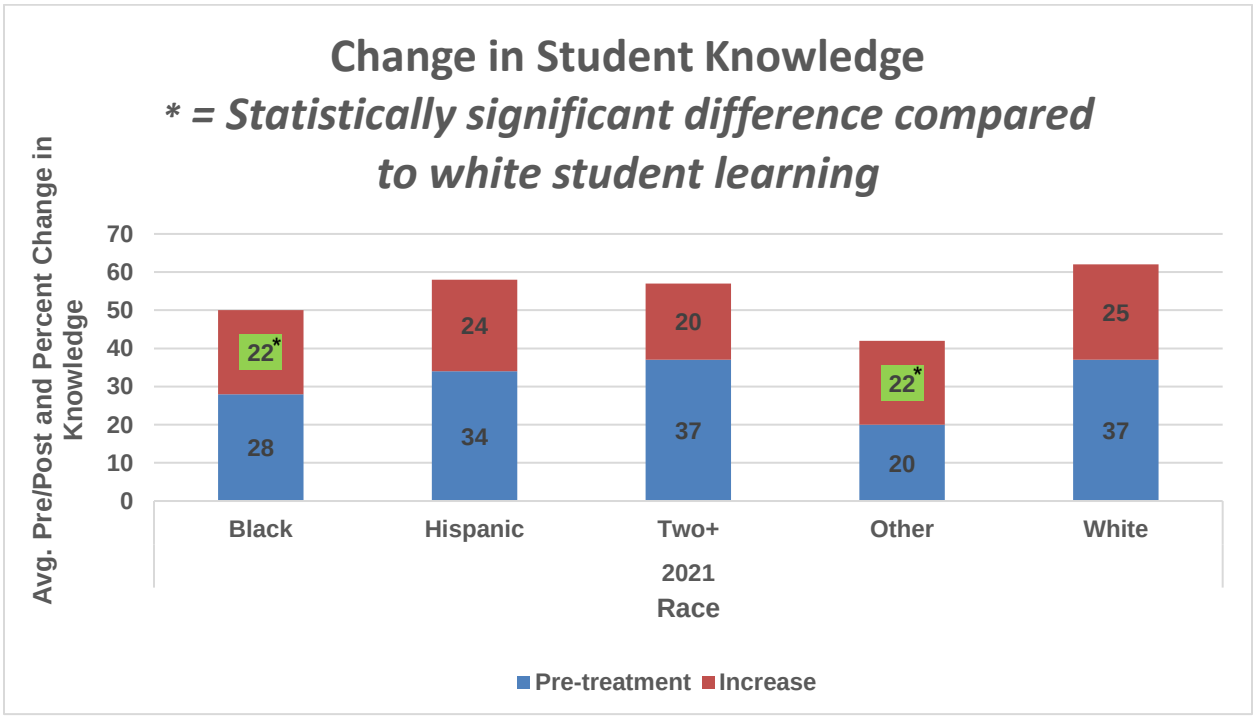
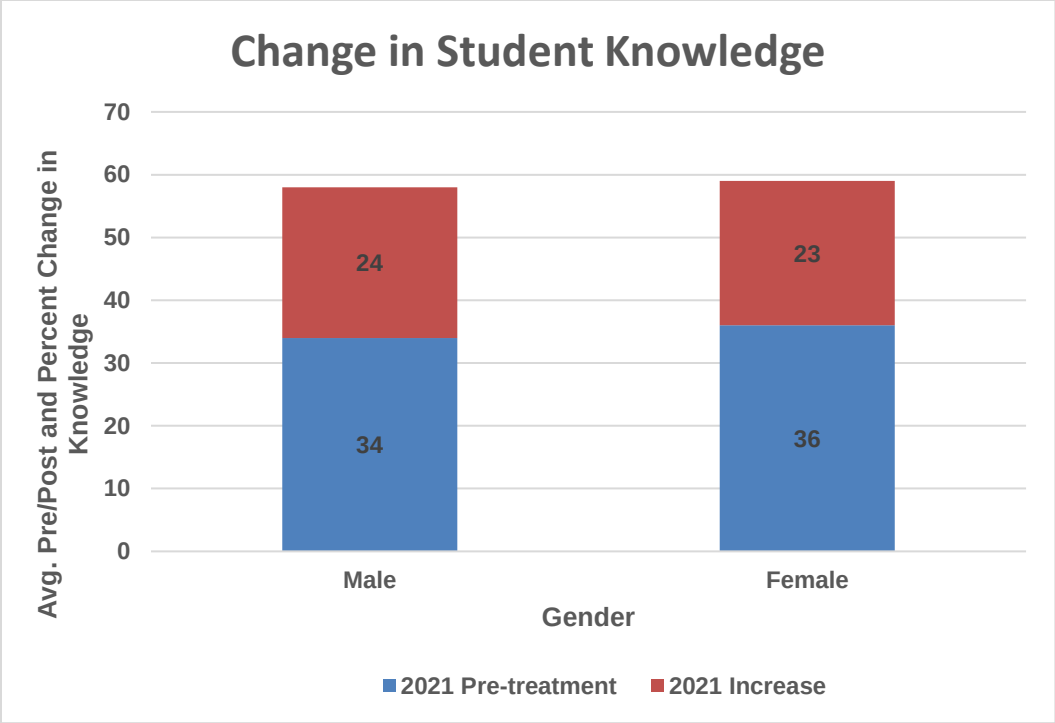


Figure 4. ─ Change in student knowledge by gender (2021 – note no significant difference)



The student surveys also contained questions to assess environmental attitudes and behaviors of the students. The analysis focused on the following 4 questions:

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 6 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 high school students and those who self-reported their race as "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 1, indicating a positive shift in attitude regarding talking to family or friends outside of school about science learning. Also, "Other" students showed a 17% increase from pre- to post-survey in their responses to Question 2, indicating a positive shift in attitude regarding helping their local watershed or river. Additionally, students self-identified as Hispanic or Latino, "Other", and two or more race identities showed a positive increase (≥10%) in attitude regarding American Shad Restoration. Also

notable was that high school students showed a positive increase in responses to all questions (though only at the ≥10% level for Question 1).

Table 6. 2021 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	46	44	47	52	45	53	43	48
ES	49	50	47	46	44	51	35	35
MS	45	41	48	55	46	55	46	54
HS	38	**50***	41	50	44	47	56	59
Female	51	49	52	56	50	56	48	54
Male	40	38	42	48	39	48	38	41
Black	43	48	50	55	48	48	39	43
Hispanic	30	33	35	43	28	**38***	33	33
Other	26	**46***	29	**46***	34	**49***	43	43
Two	59	53	47	56	50	**63***	47	50
White	49	44	51	53	48	56	49	52

An additional notable result was females answered ≥10% higher in positive answers (except question 2 and 3 post- at 8% higher) compared to males (this result was similar to what was found in the 2019 year).

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). However, students identified as Black or African American were found to fall behind their peers in learning in each year. Other groups showing significantly lower learning levels for some comparisons were those self-identified as Hispanic or Latino (3 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 with the Shad in the Classroom Program:

- 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 2021.

Future Planning

We hope to continue with "in-person" fish dissections next year as schools return to normal. We purchased additional shad models for the next shad season so that we can allow schools to keep the models while they are in the Shad Program (rather than mailing them around). We have purchased additional plexiglass tanks and plan to eventually phase out the older tanks 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, especially considering the difficulties with the pandemic. Fifty-eight percent of teachers reported that they were extremely satisfied and 42% reported they were very satisfied with the Shad in the Classroom experience. Teachers and students provided positive feedback on all aspects of the program including the workshop, activities, and the overall program. Seventeen of the 19 teachers participating in the Shad in the Classroom Program reported that they would like to continue with the program next year (2 are retiring). Thirteen of the teachers on "hiatus" for this year plan to return for 2022. At present, we have nine new teachers on the waiting list for the program in 2022. We 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.

"I think the program is fabulous. The materials were great. I was extremely satisfied with the opportunity especially considering my schedule this year with students due to covid."

"Even my most disengaged students came in everyday to check on our fish and look at the water quality data that we had posted on the board."

"Yes 300%. The students get involved with learning because it directly connects them to the natural world."

"My students enjoyed the whole process from the beginning to the end. I stressed the importance of being a citizen scientist and mathematician and what it looks like to apply this in real life. This is real life learning that the

Appendix A

Table 7. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2021)

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	5	2016-2021
Angier Elementary	2	2013-2014
Ballentine Elementary	4	2017-2021
Bertie Early College High School	2	2019-2021
Brogden Middle School	5	2015-2019
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	10	2013-2021
Chaloner Middle School	1	2019
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
Daniels IBMYP Magnet Middle School	14	2010-2019
Dillard Middle School	1	2017
Don D. Steed Elementary	1	2012
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	7	2017-2021
Exploris Middle School	7	2010-2016
First Flight Middle School	1	2021
Forest Pines Dr Elementary	1	2013
Fuquay Varina Middle School	14	2014-2021
Grady A. Brown Elementary	1	2018
Hall Woodward Elementary	2	2012-2013
Horton Middle School	3	2017-2019
Lakewood Montessori Middle School	10	2013-2017

Table 7. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2021) continued

Release Basin School	Nos. of Classes	Years
Neuse River Basin		
Lincoln Heights Elementary	1	2021
Lead Mine Elementary	3	2009-2011
Lillington Shawtown Elementary	2	2011-2012
Longleaf School of the Arts	1	2019
Longview Middle School	1	2021
McLauchlin Elementary	1	2012
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
Moss Hill Elementary	3	2017-2019
North Duplin JR/SR High School	2	2015-2016
Northeast Academy for Aerospace & Advanced Technologies	2	2021
Perquimans County Middle School	1	2019
Perquimans County High School	1	2021
Petree Elementary	1	2019
Pine Hollow Middle School	2	2018-2019
Rolesville Middle School	1	2017
Sandy Grove Middle School	2	2012-2013
Sherwood Githens Middle	2	2019
Smithfield-Selma Senior High School	3	2018-2021
South Asheboro Middle School	1	2012
South Iredell High School	6	2013-2018
South View High School	1	2012
Southern Vance High School	4	2012-2015
Speas Elementary	1	2012
Tar Heel Middle School	1	2016
Terrell Lane Middle School	1	2021
The Oakwood School	1	2012
Tiller Elementary School (Carteret County Charter School)	7	2013-2019
Upchurch Elementary	7	2012-2018
Uwharrie Charter Academy	1	2016
Wake Forest Middle School	2	2015-2016
Walkertown Middle School	1	2016
West Hoke Elementary	1	2012
West Johnston High School	1	2019
W.G. Enloe High School	4	2017-2021

Table 7. Schools Participating in the North Carolina Shad in the Classroom Program (2009–2021) Continued

Release Basin School	Nos. of Classes	Years
Neuse River Basin		
W.J. Gurganus Elementary School	1	2021
Woods Charter Middle School	7	2012-2017, 2019
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
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	**94**	**2009-2021**
Total Number of Classrooms	**266**	**2009-2021**

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) 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 ($\overline{x}$=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 students 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)

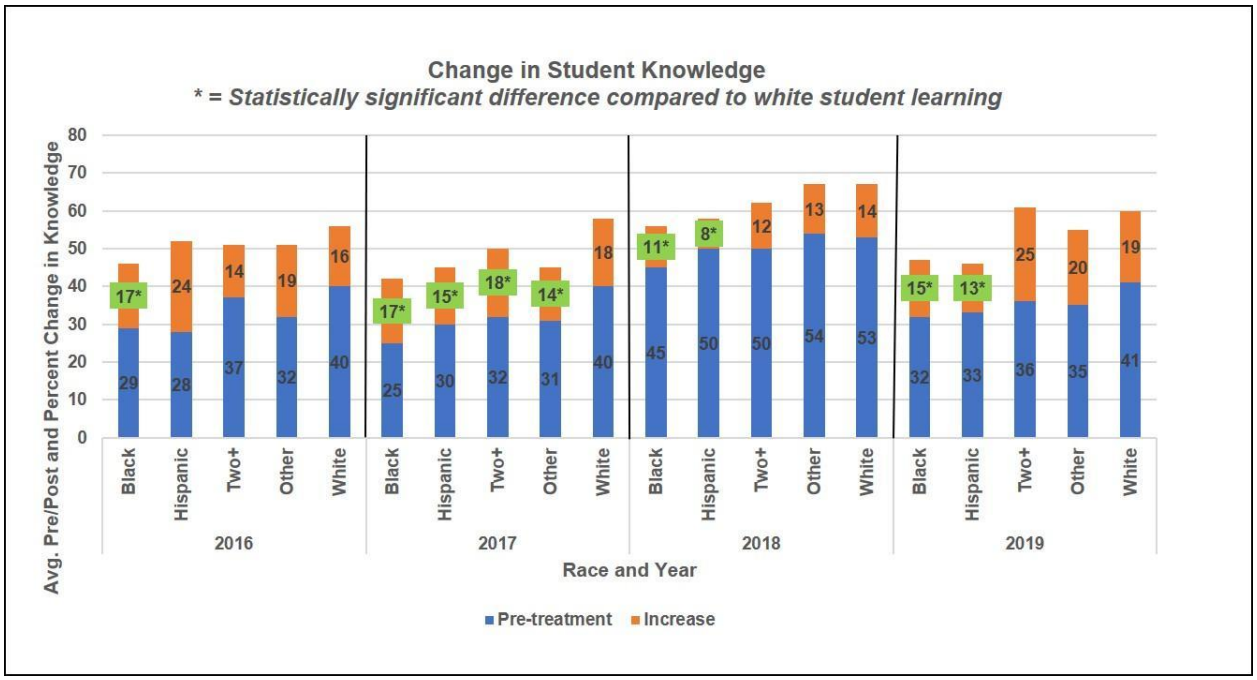
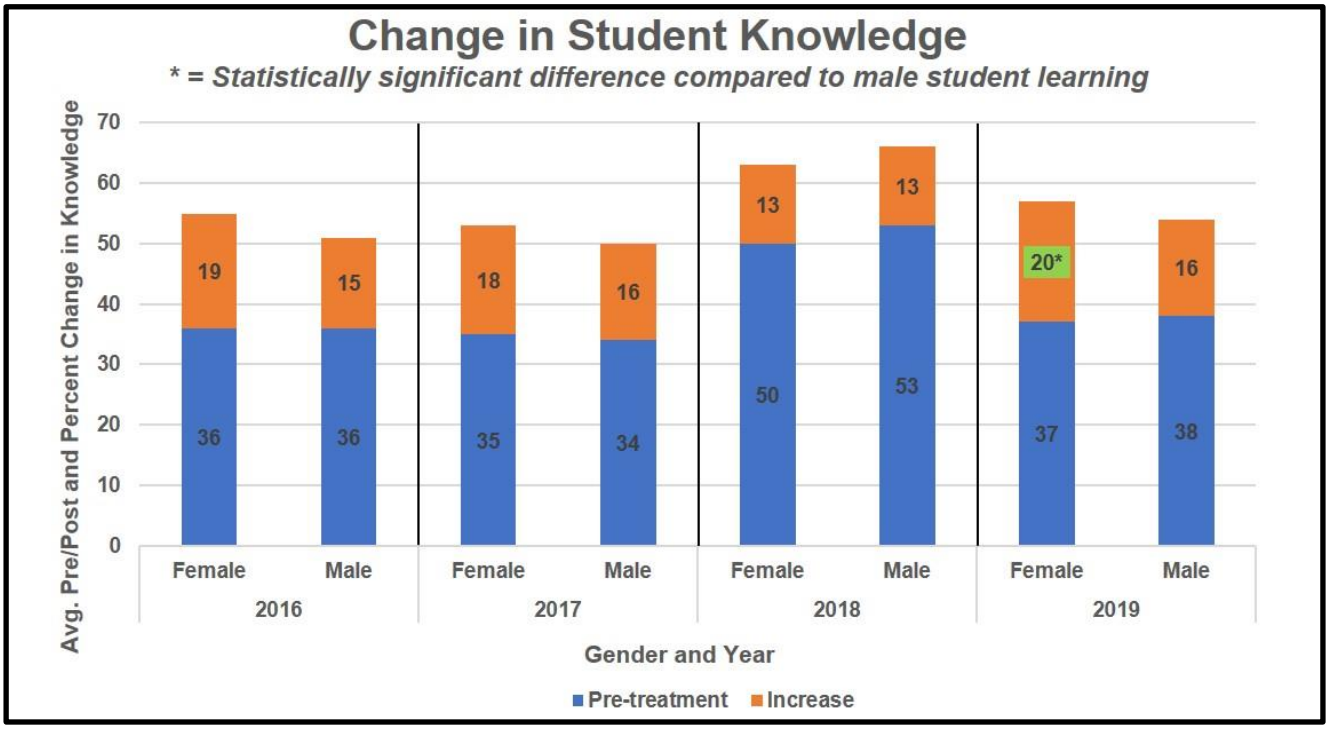


Figure 6. ─ Change in student knowledge by gender (2016–2019)



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 8. 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.

Appendix C

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.

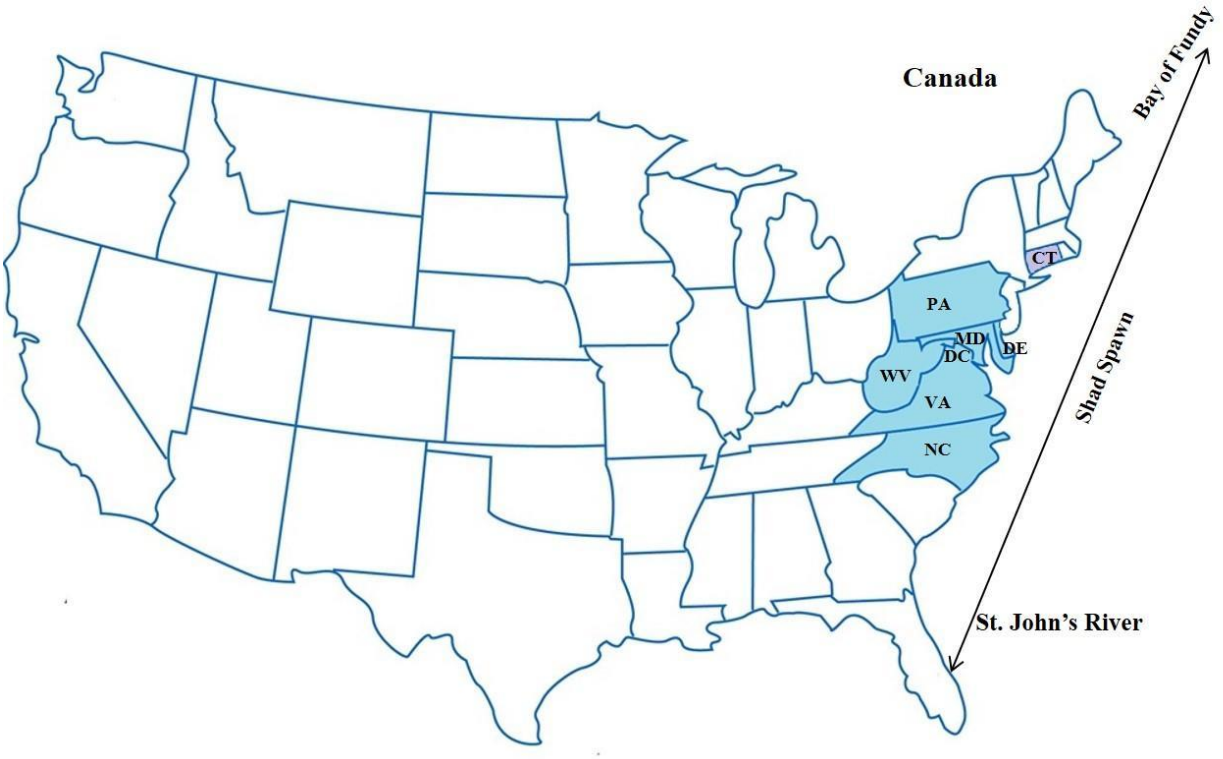


Figure 7. ─ Map of the states we found to participate in some version of a shad in the classroom program: Delaware, Maryland, North Carolina, Pennsylvania, Virginia, and West Virginia, and the District of Columbia (a program in Connecticut in proposed). Arrow depicts American Shad spawning distribution 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.