Seine Hauling for shad at Stoney Point, Mason Neck, Virginia circa 1890. Library of Congress.

The ICPRB 2013 American Shad Monitoring Survey
Task 5 Summary Report for the US Environmental Protection Agency
ICPRB Report # ICP13-11, Grant # I-98339411

Prepared by: Jim Cummins
The Interstate Commission on the Potomac River Basin

Introduction and Background

The Potomac River, once one of the most polluted rivers in the country, is now one of the nation's showcases for successful programs to restore water quality. A notable benefit of that recovery is the rebound of the Potomac's American shad population which was closed to fishing in 1982. In concert with the cleaner river, a multi-agency American shad recovery program coordinated by the Interstate Commission on the Potomac River Basin was initiated in 1995. That program proved very successful and in 2012 the Potomac River American shad population was again designated as a sustainable fishery by the Atlantic States Marine Fisheries Commission, the agency with regulatory oversight on migratory marine fishes. In order to help document the shad's rebound, evaluate its relationship to water quality improvements, and assess its status in the Chesapeake Bay as part of regional restoration efforts, the Interstate Commission on the Potomac River Basin conducts gill-net collections and maintains catch-per-unit-effort information. This is an annual report on the results of ICPRB's shad work funded by the US. EPA in 2013.

Gill Net Brood-Stock Collections and Monitoring Survey

American shad are collected in an ecologically and historically important section of their spawning habitat in the Potomac River during spawn runs, which in the section usually commences at the beginning of April and typically runs into mid-May. The project's research vessel is a 24' Carolina skiff captained by Virginia waterman Brad Harley. Two drifting gill nets, sequentially deployed, are fished along the river-right side of the main channel (the west or "Virginia side") at the mouth of Dogue Creek and along Fort Belvoir. The drift nets are rigged in the traditional manner for this section of the Potomac, i.e., a method used since the late 1880s. The nets are approximately 91 meters (300 feet) long, 7 meters (23 feet) deep, 14 centimeter (5 ½") stretch mesh, made of either #69 twine cotton or monofilament equivalent, with top line suspended below the surface

approximately 1.5 meters (5 feet) from floating 16 centimeter (6 inch) diameter corks rigged approximately every 4.5 meters (15 feet). The bottom line is very lightly weighted, rigged with 16 centimeter (6 inch) diameter 9 gauge galvanized metal rings set about 4.8 meters (16 feet) apart. A ring is rigged below each cork, the difference in spacing between the corks and rings is done because the bottom line is a little longer than the top line to help provide the necessary slack in the nets. A light, usually a glow-stick in a 2-liter soda bottle, is attached to the channel side of the net to help other boats see the nets at night and to aid in our own visual surveillance.

The nets are fished at evening slack-water, at either the high or low tidal shift, for a duration of approximately two hours. Continuously tended, fishing is performed roughly between 4:00 p.m. to midnight, depending on the tide, with the best fishing at slack-tides near dusk. It is imperative that collections are made during slack tides so that the nets will drift slowly, hang loosely and shad-fish properly. Otherwise the currents in the Potomac River will be so strong that the nets will go taught, catch few shad but many non-target fish species (by-catch), drift rapidly and considerable distances (miles), subjecting them to potential snags, damage and, worst of all, loss.

At the end of the drift the corks tend to close up and run together, the whole net was taken up, starting at one end, and all fish are removed, culling out the ripe female shad and attempting to keep roughly an equal number of males, during which the net is gathered up and placed into a large tub or bucket. Captured shad are examined when brought on board for sex and maturity. Care is taken to release non-ripe ("green") females, extra males ("bucks") shad, or any by-catch species. Females judged ripe ("roes") and kept bucks are placed in an oval-shaped 100 gallon stock tank, or equivalent, which is 2/3rds filled with river water. The tank has a submerged bilge pump, modified with a large intake filter, that re-circulates and aerates the water while providing a circular current which helps the shad orient correctly in the tank. Typically any green female shad which does not have eggs running fairly freely from her is released back into the river. However, some of the females are found to produce few eggs at egg-stripping. They are noted as "Green Females Kept" on our datasheet. All fish are measured for total length, which is recorded along with sex determination.

Results

American shad collected during the ICPRB 2013 spring gill-net collections are provided in Table 1 (page 3). The number of shad captured, fry stocked and comparisons with previous years of the project are in Appendix I due to landscape format. The 2013 shad spawning season started normally but then cool, dry and very windy weather persisted during the entire collection cycle. River temperatures remained relatively constant, 17º- 20º C (63º-68ºF), and never increased into the normal end-of-spawn temperatures (mid-20ºs C or 73º-79ºF). The strong winds which prevailed most of the season were the main reason we had to cancel five collections (on 4/22, 4/24, 5/6, 5/7, 5/8, 4/22), including two trips cancelled while on the river (4/22 and 5/6). The strong winds also made the collecting up of the nets and concurrent extracting of fish very difficult because of the way they push the boat away from the net, create chop which raises and lowers the boat and sometimes threatened to swamp it.

Shad did not start spawning in earnest until May, about 2 weeks behind the mid-April average and almost the opposite of 2012 when spawning started at the end of March. April weather remained cool and dry, so water temperatures were also cool and the river clear except on storm series which ran the first week of May. The Catch-Per-Unit-Effort (CPUE) in 2013 was 711shad captured in

36 net-sets, or 19.8 shad/net, which is a little below the long-term average of 21.4. We stocked 4.7 million shad fry, once again exceeding the annual stocking goal of 4 million.

Table 1: Dates of Collections, Number of American Shad Captured by ICPRB in 2013

Date	4/15	4/16	4/17	4/18	4/21	4/23	4/25	4/28[1]	4/29	4/30	5/1	5/2	5/5[1]	5/9	5/13	5/14	5/15	5/16	Totals
Shad Captured Nets Used	36/2	15/2	40/2	43/2	49/2	36/2	42/2	63/2	49/2	56/2	59/2	46/2	29/2	17/2	17/2	14/2	37/2	63/2	711/36
Total Females	4	14	24	12	31	26	36	43	19	25	45	45	23	16	14	12	35	48	472
Total Males	32	1	16	31	18	10	6	20	30	31	14	1	6	1	3	2	2	15	239
Ripe Females Used	4	5	19	10	8	15	22	24	9	12	28	4	4	11	4	7	26	27	239
Males Used	8	1	16	27	13	10	6	19	20	16	14	1	5	1	3	2	2	15	179
Green Released	0	4	2	0	2	5	5	0	4	6	9	20	11	2	4	0	0	0	74
Green Females Kept	0	5	2	2	21	6	7	19	5	7	7	18	8	2	5	3	5	16	138
Spent Females	0	0	1	0	0	0	2	0	1	0	1	3	0	1	1	2	4	5	21
Surface Temp.	18	19	20	20	18	17.5	18	18	18	18	18.5	19	18	20	17	17.5	18	19	
Tidal Stage Time	Low 18:30	Low 19:10	Low 19:50	Low 20:30	High 17:10	High 19:00	High 20:30	Low 20:00	Low 18:10	Low 19:00	Low 20:00	Low 20:50	High 17:30	High 20:36	Low 17:35	Low 18:10	Low 18:45	Low 19:20	

[1] April 28th and May 5th were collections for DC/MD/VA schools which hatch shad in their classrooms for release into the river.

Chesapeake Bay Indicator

The author of this report co-chairs the EPA Chesapeake Bay Program's American Shad Indicator Action Team. In 2013 this multi-agency team worked diligently and revised the Bay indicator, adding the Rappahannock and lower James Rivers as well as increasing the accuracy of Virginia's recovery targets. As of 2012, the last year of bay-wide available data, the Chesapeake Bay shad population was at 38% of the 100% recovery goal and continues to increase (Figure 1). The Potomac American shad population is a strong driver in this trend. The Atlantic States Marine Fisheries Commission's 2007 Shad Stock Assessment Report assigned a restoration target benchmark for the Potomac River: a running geometric mean (GM) of 31.1pounds/net-day.

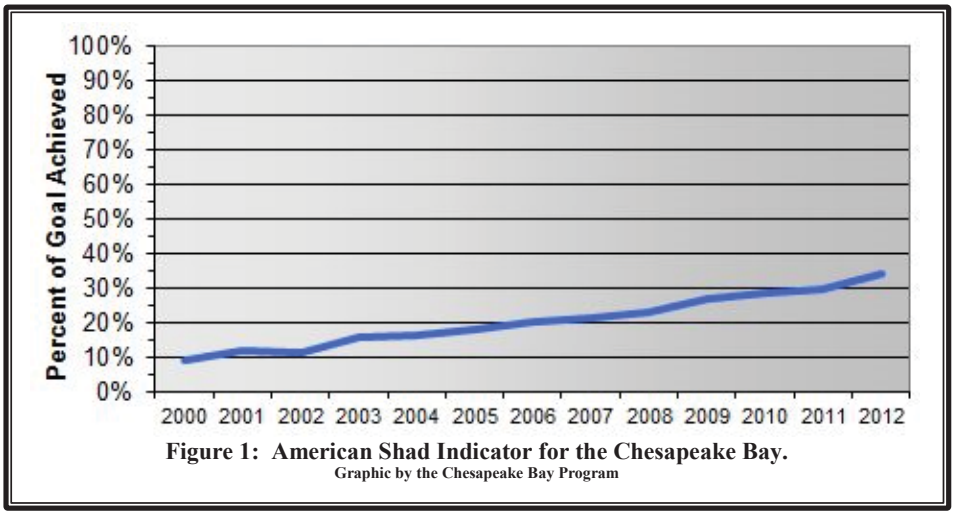

Figure 1: American Shad Indicator for the Chesapeake Bay.
Graphic by the Chesapeake Bay Program

The ASMFC's benchmark goal was exceeded in 2011 and continues to climb. The Potomac's shad population is now at nearly 120% of the goal. River specific components of the American shad indicator can be seen in Figure 2. Five rivers were used to calculate the American Shad Indicator for the Chesapeake Bay. Collectively they account for approximately 90% of the Chesapeake Bay's total shad populations. The Potomac River trend can be seen in the upper left. Individual river indices are proportionally weighted, based on watershed flow, and summed to calculate the indicator value for the Chesapeake Bay.

The team intends to add remaining river systems when their data becomes sufficiently robust. More information on the Chesapeake Bay's American shad Indicator can be found at chesapeakebay.net/indicators.

There are two additional indicators of the relative strength of American shad spawning runs and their reproductive success in the Potomac River which help document their recovery. The first is the Maryland Bay-Wide Shore Haul Seine Survey which incorporates an index for juvenile American Shad in the Potomac (Figure 3). This juvenile American shad index has increased substantially since restoration stocking was initiated and a fishway was installed in the dam at Little Falls and has remained fairly robust, with 11 out of the last 14 years exceeding the pre-closure peak which occurred in 1972.

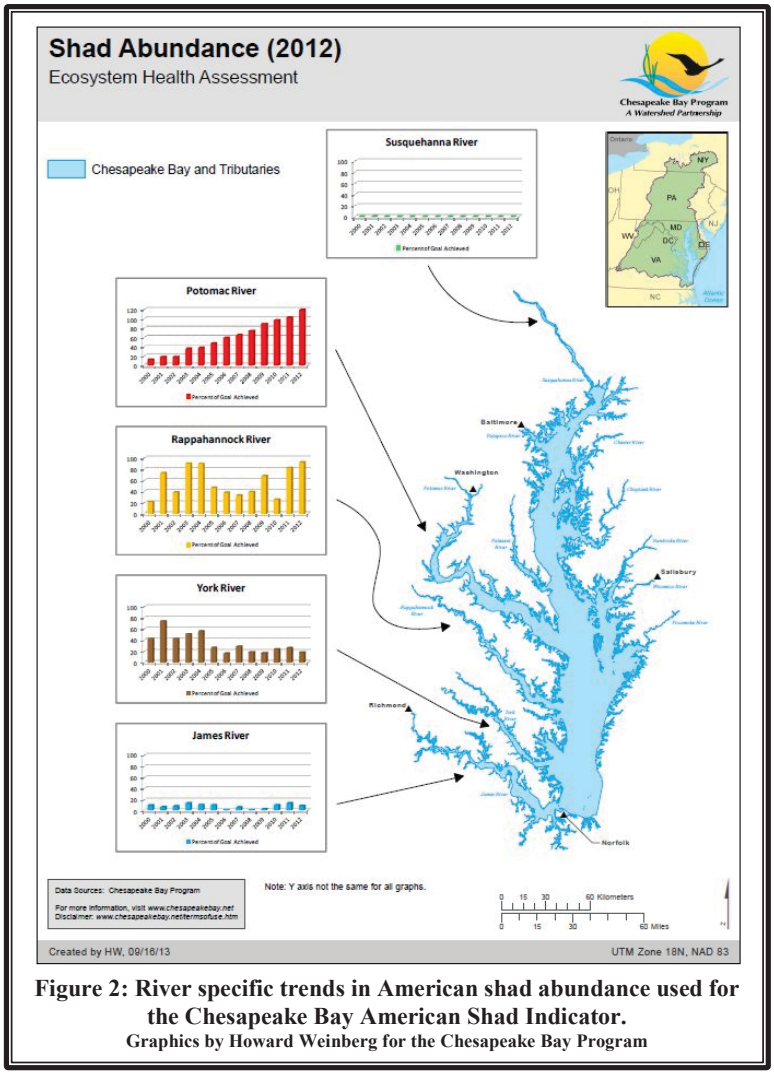

Figure 2: River specific trends in American shad abundance used for the Chesapeake Bay American Shad Indicator.
Graphics by Howard Weinberg for the Chesapeake Bay Program

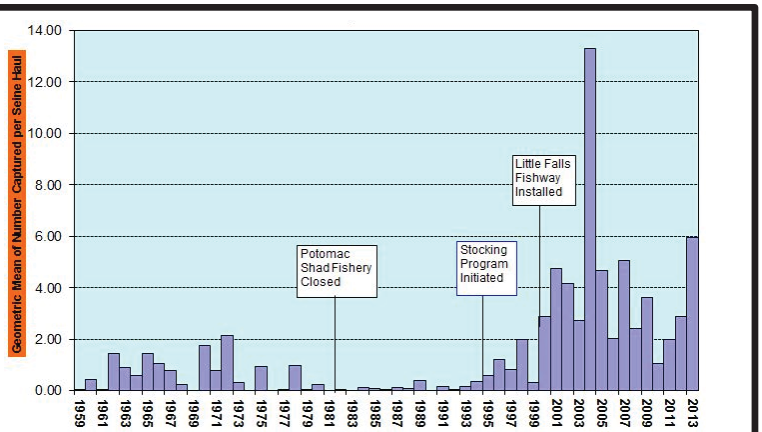

Figure 3: Juvenile American Shad Captured by the Maryland Shore Haul Seine Survey 1959-2013.
Data from MD DNR, Durell and Weedom, Chart by ICPRB

Similar increases in returning adult American shad has been documented by the Maryland Department of Natural Resources during their annual striped bass spawning stock surveys which have been conducted since 1996 (Figure 4). This survey uses random multiple-mesh size nets and likely produces a better representation of the full range of year classes in the population than shad brood stock collections which deploy 5"-5 ½" stretch mesh nets specifically to target mature female shad.

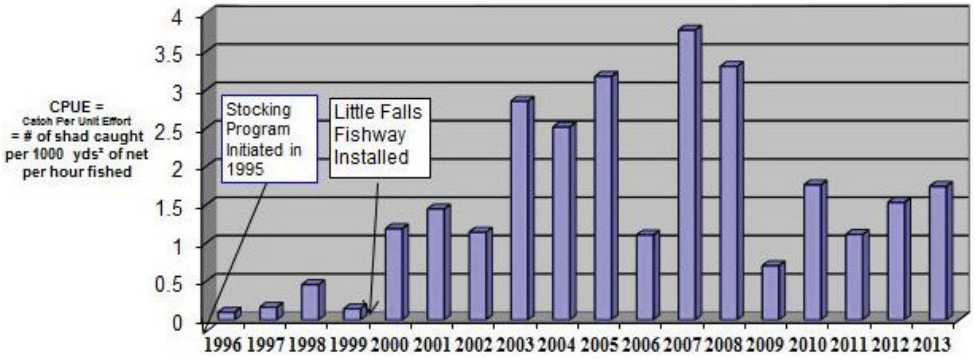

Figure 4: Adult American shad captured by the Maryland Gillnet Survey, 1996-2013
Data from Eric Durell, MD DNR. Chart by ICPRB.

Public Participation and Publicity

ICPRB incorporates a significant public involvement component into this project through the use of volunteers and schools. In 2013, 57 volunteers helped collect and approximately 2,500 students from 54 Washington metropolitan area schools hatched shad in their classrooms and stocked them into the Potomac and Anacostia rivers. The student component, which is partnered with Living Classrooms of the National Capitol Region and funded apart from this EPA grant, was featured in the July, 2013 issue (Volume 15, Number 4) of Impact, the newsletter of the Journal of the American Water Resources Association. This article can be found in Appendix II. Even though the student component is separately funded, it is enabled by the EPA's support of this project.

This report is available online, saved as file number ICP13-11_Cummins.pdf at www.PotomacRiver.org.

Disclaimer

The opinions expressed in this report are those of the author and should not be construed as representing the opinions or policies of the United States government or the signatories or Commissioners to the Interstate Commission on the Potomac River Basin.

Appendix I:

Summary of the Number of American Shad Captured, Eggs Collected, Fry Released, and Catch-Per-Unit-Effort (CPUE)

For the ICPRB/Harley boat during the Project Period 1995-2013, Including Estimates of Shad Returns[1]

Year	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003[2]**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	Totals
# Ripe females	135	166	245	105	119	373	338	245	240	387	246	316	441	349	183	379	244	418	239	5,168
# Green (unripe) Females	78	51	92	50	44	93	135	141	120	127	49	72	93	150	48	226	122	418	212	2,321
# Post-spawn (spent) Females	3	1	0	8	10	9	27	25	15	27	2	11	118	43	29	31	31	47	21	458
# Males	78	157	207	153	116	282	235	247	240	435	209	283	397	191	102	460	235	249	239	4,515
# Total Shad (Used)	**294**	**375**	**544**	**316**	**289**	**757**	**735**	**658**	**615**	**976**	**506**	**682**	**1049**	**733**	**333**	**890**	**409**	**858**	**556**	**11,575**
# Total Shad (Captured)								1801	1494	1852	1101	1010	1858	903	444	1096	789	1129	711	14,188
# Shad Released								1143	879	896	595	328	809	170	111	206	380	271	155	5,943
# Eggs Collected x 1000	2,405	4,353	5,744	2,626	2,594	6,383	6,565	5,943	5,327	5,773	8,129	NA[3]	NA	NA	NA	NA	NA	NA	NA	NA
# Collections/# nets set	11/27	11/22	12/24	14/28	15/30	11/22	16/32	18/36	10/16	14/25	13/25	16/32	17/34	16/31	16/32	16/32	17/35	19/38	18/36	280/557
Shad Used/net-set CPUE[4]	**10.9**	**17.0**	**22.7**	**11.3**	**9.6**	**34.4**	**22.9**	**18.3**	**35.9**	**39.0**	**20.2**	**21.3**	**30.9**	**23.6**	**10.4**	**27.8**	**11.7**	**22.6**	**15.4**	**μ=21.4**
Total shad/net-set CPUE								**50.0**	**93.4**	**74.1**	**44.0**	**31.6**	**54.6**	**29.1**	**13.9**	**34.3**	**22.5**	**29.7**	**19.8**	**μ=41.4**
# Eggs/Ripe-female	**17,800**	**26,200**	**23,400**	**25,000**	**24,400**	**17,100**	**19,400**	**24,260**	**22,195**	**14,917**	**24,783**	NA	NA	NA	NA	NA	NA	NA	NA	NA
# Fry Stocked Pot. R.	1,175	1,989	1,535	1,589	1,304	3,176	3,336	1,531	200	400	919	1,158	728	884	528	510	488	537	406	22,393
# Fry stocked Rapp. R. **(x 1000)**									1,200	3,100	3,400	6,265	4,453	4,832	2,718	3,943	4,116	5,995	4,265	40,026
Total # Fry Stocked (x 1000)	**1,175**	**1,989**	**1,535**	**1,589**	**1,304**	**3,176**	**3,336**	**1,531**	**1,400**	**3,500**	**4,319**	**7,423**	**5,181**	**5,716**	**3,246**	**4,453**	**4,604**	**6,532**	**4,671**	**66,680**
# Fry Stocked Each Shad Collected	4,000	5,300	2,800	5,000	4,500	4,200	4,500	2,326	2,435	3,586	5,690	NA	NA	NA	NA	NA	NA	NA	NA	NA
Est. # of Shad Returning[1]	**3,487**	**5,902**	**4,555**	**4,715**	**3,869**	**9,424**	**9,674**	**4,444**	**4,060**	**10,150**	**11,300**	**22,027**	**15,430**	**16,961**	**9,632**	**13,215**	**14,080**	**19,383**	**13,861**	**196,169**
Est. # Shad Returning Each Shad Collected	11.9	15.7	8.4	14.9	13.4	12.4	13.5	6	5.9	10.6	14.9	NA	NA	NA	NA	NA	NA	NA	NA	NA

[1] Monitoring at the Conowingo Dam fish lifts (Hendricks 2000) found, on average, that it takes 337 hatchery fry stocked in the Susquehanna River to get one returning adult shad. Subsequent results have modified that number slightly, but in order to have a consistent estimate the 1 shad returning per 337 stocked fry ratio has been used since 2001 as an assumed Potomac return rate.

[2] The Potomac Restoration Stocking Program for American Shad was conducted from 1995 until 2002, at which time recovery was considered sufficient for natural reproduction. In 2003, restoration stocking of the Rappahannock River began, using Potomac River origin shad eggs through a partnership between ICPRB, the Virginia Department of Game and Inland Fisheries, and the US Fish and Wildlife Service's Harrison Lake National Fish Hatchery. Stocking of the Potomac continues, but now as a "replacement stocking" to account for the Potomac shad sacrificed for another river systems. In 2013 we stocked approximately 4,671,000 shad fry of which 406,000 were stocked into the Potomac, or roughly 9% of our total shad fry stocked (10% replacement is the goal). Since 2003 we have used 7,051 shad. Replacement stocking totals 6,352,000 shad fry (2003-2012) for an average of approximately 635,000 stocked fry/yr. Based upon the Susquehanna return rate, as per footnote #1 above, we estimate an average of about 1884 shad returning/year. The 10 year total would be about 18,840 shad returning which would translate to about 2.7 shad returning for every shad used with replacement stocking.

[3] NA, for Not Applicable, is used after 2005 because these values could no longer be derived. Starting in 2006, we switched from using 1 boat to 2-3 boats for our collections (Watermen involved: Louis Harley (1995-2008), Mike Harley (starting in 2006), Brad Harley (starting in 2008), and Randy Kirby (2006-2007). Since 2005, shad from all boats are pooled together during the collection process, and it became too difficult to separate or accurately estimate egg or fry totals for each individual boat contribution.

[4] CPUE, or Catch-Per-Unit-Effort, is calculated by two methods in this project. The first CPUE (Shad used/ net-set) is based upon the number of shad used for egg collections and re-stocking of the Potomac and, starting in 2003, the Rappahannock Rivers. It does not include shad which were netted but released, i.e., the unripe or green females, spent females no longer spawning, or surplus males (we try to keep a 1/1 ratio of males to females). Starting in 2002, all shad netted were counted and a second CPUE (Total shad/net-set) has been calculated this time using all shad brought to the boat, even those released.

Appendix 2

WATER RESOURCES

IMPACT

July 2013 | Volume 15 | Number 4

YOUTH AND WATER RESOURCES

AWRA
Community, Conversation, Connections
American Water Resources Association

WATER RESOURCES
IMPACT

HOW STUDENTS FROM VIRGINIA, MARYLAND, AND DISTRICT OF COLUMBIA ARE HELPING TO RESTORE AMERICAN SHAD IN THE POTOMAC RIVER AND THE CHESAPEAKE BAY

Jim Cummins

BACKGROUND

The American shad was once one of the east coast's most abundant fish, tremendously important both ecologically and economically. Unfortunately, by the mid-1970s water pollution, overharvesting, and the blocking of spawning habitat by dams reduced their numbers to the point they practically disappeared (Figure 1). Despite significant improvements in water quality since the 1970s and a river harvest moratorium in effect since 1982, the American shad stocks had not recovered in the Potomac River by the mid-1990s. Almost no one under the age of 50 knew anything about them. They had become not only a lost fish, they were a forgotten fish. That has changed thanks to a partnership and the help of thousands of students.

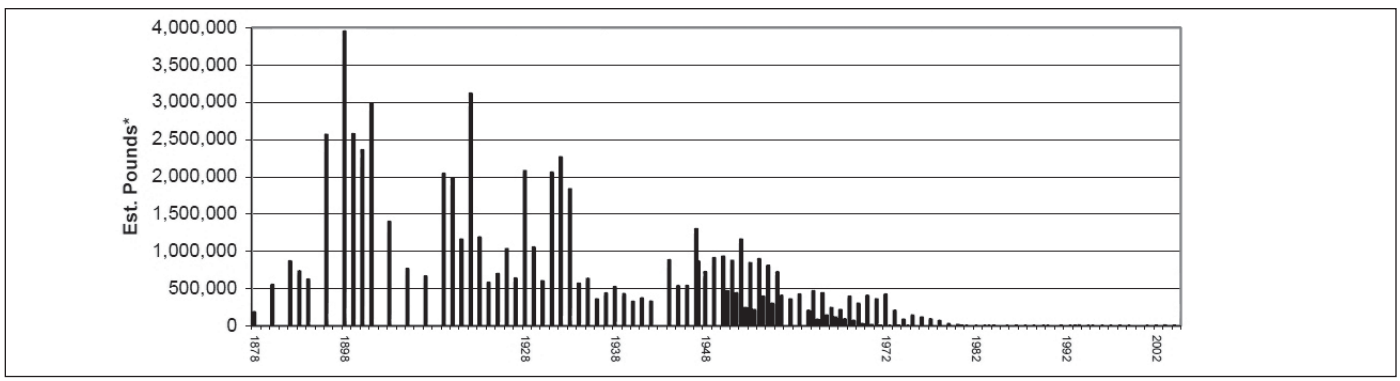

Figure 1. American Shad Landings in the Potomac River, 1878-2004
(graph by the Potomac River Fisheries Commission).

THE FISH

American shad are a type of herring; the world's largest growing up to 12 pounds and almost a yard long. They live as adults along the Atlantic coast from Florida to Canada. Each spring they return to their natal rivers, ascending hundreds of miles to freshwater spawning grounds. They have similar ecological functions as the Pacific salmon, bringing ocean derived energy and nutrients inland. Spawning adults are eaten by nesting Bald eagles and ospreys, their fry are eaten by minnows, and as they grow in the rivers and move out into the ocean they are prey for cod, striped bass, dolphins, and whales, just to name a few species that benefit from the American shad.

FISHTORY

Native Americans established towns where the shad concentrated to spawn. Colonists harvested them by the millions of pounds but not just because shad are delicious. Shad kept many from starving because their spring spawning runs occurred when winter food stores were running out. People would salt and barrel them for year-round use. Author John McPhee titled a book about them, "The Founding Fish," because they were so critical to the development of this nation. The shad's return each spring was a much anticipated event, heralded by newspaper headlines and restaurant marquees well into the mid-1900s. But, we were greedy and careless. We took too many fish. We dammed the rivers and cut off spawning waters. We let our rivers get so polluted that they caught fire, turned all kinds of colors, and became lethal to fish. The once great shad runs trickled away.

The 1972 Clean Water Act led to tremendous water quality improvements for our waterways. The Potomac River is one of the hallmarks of those efforts. Unfortunately, even with cleaner water and a 25-year harvest moratorium the American shad population continued to struggle because their numbers were so reduced.

An American shad stocking program for the Potomac River began in 1995 as part of an effort by a coalition of federal, state, regional, and local agencies, and nonprofit groups, organized as the Little Falls Fish Passage Task Force to modify a dam and open historic spawning and nursery habitats. (Members come from Virginia, Maryland, the District of Columbia, the Interstate Commission on the Potomac River Basin, the Potomac River Fisheries Commission, the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, the National Biological Survey, the U.S. Environmental Protection Agency, the National Park Service, the National Marine Fisheries Service, Montgomery County, Maryland, the Chesapeake Bay Foundation, and The Potomac Conservancy.) Led by the Interstate Commission on the Potomac River Basin (ICPRB), the restoration stocking was successfully concluded in 2002 when almost 16 million shad fry had been stocked and shad were reproducing well on their own. They recovered to such a degree that since 2003 the Potomac River is the egg source for many other American shad restoration programs including Virginia's Rappahannock River, Maryland's Choptank River, and the multistate Susquehanna River, the mother river of the Chesapeake Bay.

Arriving at that success came through an interesting and different path. It was more than just restoring the shad; it was also a matter of restoring interest in a mostly forgotten fish. It wasn't just the work of agencies either. A highlight of the effort is the significant community involvement of thousands of students and dozens of dedicated teachers. It grew because it was rooted as a partnership that combined biologists, environmental educators, watermen, and students, which is reuniting a community with an important part of its history and culture.

In 1995 the program had the very first stocking of shad fry into a section of the Potomac River blocked by a dam since the 1830s. At the invitation of the program's lead biologist, students from nearby Westbrook Elementary School, Montgomery County, Maryland, came out to witness the historic event. The excitement of those students was contagious. That winter an ICPRB biologist, U.S. Fish and Wildlife Service personnel from the Harrison Lake National Fish Hatchery, staff from the Chesapeake Bay Foundation, an exceptional teacher and an environmental educator formed a "Schools-in-Schools" partnership. We developed the idea of having the students hatch and raise American shad fry in their classrooms so that they could stock them into the Potomac River.

The idea worked, and the students loved it. What started with a few students has grown to involve over 50 schools and tens of thousands of students in the Washington metropolitan area. They are captivated by how rapidly shad eggs develop, going from a simple fertilized egg to a hatched free swimming fish in only 4-5 days. On the day the shad hatch, sometimes hundreds or thousands at a time right before their eyes, the students go wild! Teachers are thrilled by the cross-curricular nature of the project. Students gobble up the science but also are motivated to research and write about shad, from poems to historical stories. They perform math with a passion, estimating how many eggs and how many hatched. They create shad artworks. In several schools, students prepare electronic-format presentations which they give to younger grades. The students, fry raising fry, become teachers. Their teaching doesn't stop at the school doors. They teach their parents, they teach their siblings, they involve their neighbors, and they educate a community.

The demand for the program rose and within a few years a significant new partner came on board; Living Classrooms of the National Capitol Region, an environmental education organization. Living Classrooms brought in talent and person-power that allowed major expansions of participating schools, students, and resources. Agency biologists still provide the technical expertise and restoration leadership, but they are busy during the shad run and need to attend to shad brood stock collections and hatchery operations. Living Classrooms provide that crucial one-on-one contact with and support for the schools, especially during the school's first year or two in the program.

Participating schools range from K-12, with grades 4-6 the most common and probably the best fitting age group. But even high school seniors such as those at one of the most prestigious schools in the country, Sidwell Friends School that President Obama's daughters attend, find the program interesting by delving into greater details of developmental biology, ecology, and history. Westbrook Elementary and Sidwell Friends were pilot schools for the program and they continue to participate as the program now heads into its 17th year.

Each April and May selected students are able to join biologists and watermen on the Potomac River near Mount Vernon where they help net spawning shad to collect their eggs. Accompanied by their teachers and often their parents, the students participate in all aspects of the evening work (shad spawn at dusk into the night). They help load equipment, set nets, remove fish, strip shad eggs, collect data and clean up the boat and gear. They work and talk with the biologists and watermen. They looked up to one in particular; Louis Harley, a fifth generation Virginia waterman, who would teach them about the shad's importance to the culture, history, and ecological vibrancy of the Potomac River, the Chesapeake Bay and the entire east coast. His grand, fatherly demeanor always inspired admiration from thousands of students and their teachers, the scientists, the hundreds of volunteers, and all involved with the project. Louis Harley exemplified a waterman and made the trips a lasting memory. Not many people get to spend an evening out on the river working the nets with a waterman. Have you?

When the schools receive their shad eggs the students take over, monitoring water quality and tending to the eggs in miniature hatcheries designed by the U.S. Fish and Wildlife Service. They test for pH, nitrate, temperature, and chlorine, and in the process learn why the results are important to their classroom hatchery as well as to our rivers. Students use microscopes hooked up to computer screens to examine the eggs, watch as the developing embryos move inside the eggs and, in rapt attention, see the fry burst forth from their eggs and start swimming.

Figure 2. Students From Sligo Creek Elementary, Maryland, Check Their Shad Eggs (Photo: Teacher Charles Gale).

After the eggs hatch, the class gathers them into bags or buckets and makes a culminating field trip to the Potomac River. On the banks they test both the river water and the water holding their fry, slowly mixing each until the chemistry and temperatures match. Students then scoop up water and fry, line up along the riverbank, and gently release the fish into the river (Figures 2 and 3).

Figure 3. Students From Waples Hill Elementary VA, Get Ready to Release Their Shad Fry (photo by Jim Cummins).

While the largest share of restoration stocking has been through agency efforts, almost 30 million shad fry, the student's contribution of approximately 600,000 stocked fry for the Potomac is notable. Most importantly, the students generate great interest and publicity about the shad and their efforts through coverage by local newspapers, the *Washington Post*, National Public Radio, *Field and Stream* magazine, and various Washington metropolitan area television and radio stations.

The Potomac River's American shad population is recovering very well. In 2012 the Atlantic States Marine Fisheries Commission, which oversees the management of marine fish, officially declared the Potomac River American shad fishery a sustainable fishery. Bald eagles and ospreys are regularly observed capturing them, and minnows and bass dine and grow on the fry as they head to sea. A very modest harvest level was established and people in the region are once more finding Potomac River shad in their supermarkets.

Of course there are many dedicated teachers behind this story as well. They remark how well the program fits their curriculum.

- I LOVE ALL OF IT! It is great for the kids to see the eggs hatch, for them to learn about the value of the shad to the local ecosystem, the history of the shad, and to release them and see that in 3-5 years they come back!
- The students know they are actually helping to make a difference in the ecosystem. Also the students are really fascinated watching the development of new life.

- I have been doing it for 13 years and LOVE IT!
- The enthusiasm is contagious and spreads throughout our school.

RECOGNITION

One of the project's star environmental educators, Sandy Burk, wrote a book about the project, "Let the River Run Silver" that was named the Isaak Walton League's 2005 Conservation Book of the Year and received the Green Earth Book Award for 2006. The book is cited by the National Science Teachers Association as "one of the best available supplements for science teaching."

The National River Restoration Science Synthesis Project ranked our shad project as one of the nation's top 25 restoration projects for its wide range of groups involved and for the monitoring used to assess its progress. The lead biologist and author of this article was honored with the "Future of Fishing" award from the American Sportsfishing Association and was selected as one of Field and Stream Magazine's top six "Heroes of Conservation" projects in 2006.

SPAWN

Some students who participated early on in the program have since gone on to college and environmental careers, which they say were inspired by this project. A few of them have even returned to the river when we have the annual stocking event with the newer students. We stocked the shad fry so that they would return as adults. It is rewarding to see students return to the river with them.

More information about the project can be found at www.potomacriver.org, look under wildlife and habitat. The Living Classroom curriculum developed for the program can be found at http://shadproject.com/#/lesson-plans/4562274864.

AUTHOR LINK Jim Cummins
The Interstate Commission on the Potomac River Basin
51 Monroe Street, Suite PE-08
Rockville, MD 20850
(301) 274-8106/Fax: (301) 984.5841

E-MAIL jcummins@icprb.org

Jim Cummins has a Masters of Science (1985) in Biology from George Washington University. His major duties and responsibilities include interstate coordination, stimulation and implementation of projects relating to fisheries biology, natural resource development and management, aquatic ecology, and habitat restoration and enhancement. His projects include biological assessments of streams, environmental flow studies, and fish passage, especially in regard to the Little Falls Dam near Washington, D.C., and a linked American shad stocking program.

❖ ❖ ❖

HIGHLIGHTS OF JAWRA TECHNICAL PAPERS • JUNE 2013 • VOL. 49 • NO. 3

This issue includes two outstanding featured collections:

***Assessing Consumptive Water Use Via Satellite Data*, Steven W. Wolff and Bern S. Hinckley, Guest Associate Editors,** features the application of and new research on the use of remote sensed data, particularly from satellite-based systems, to assess evapotranspiration in managing water resources. The idea for this collection came from a special session convened at the AWRA 2011 Annual Conference. The eight papers represent two broad categories: application and research. Four papers present work where remotely sensed data were used to help assess real-life management needs related to consumptive water use. Another four papers are more research in nature, presenting specific topics on how to refine or advance the use of remotely sensed data in applied methods.

***Collaborative Modeling for Decision Support as a Tool to Implement IWRM*, Stacy M. Langsdale, Elizabeth C. Bourget, and Marjan van den Belt, Guest Associate Editors,** is based upon talks presented at the AWRA 2011 Summer Specialty Conference, plus additional invited papers. In addition to a transcript of the conference keynote address by Jerome Delli Priscoli, eight papers explore and critically discuss the appropriateness of Collaborative Modeling for Decision Support as a means of doing Integrated Water Resources Management (IWRM). The objective is to: (1) develop an understanding of how applications of the method vary in different contexts around the world and (2) identify commonalities that inform and build a set of common best practices.

This issue also includes book reviews!

A full Table of Contents may be viewed at http://www.blackwell-synergy.com/toc/jawr/49/3

JAWRA ~ Journal of the American Water Resources Association