AMERICAN SHAD RESTORATION
POTOMAC RIVER,YEAR 2001
STOCKING EFFORT,
ASSISTANCE TO SCHOOLS-IN-SCHOOLS,
AND MONITORING

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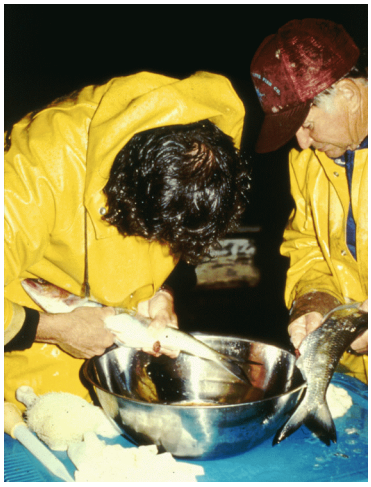

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Acknowledgments

Each year since this project started in 1995 it has been the fortunate recipient of a significant amount of volunteer help. The following individuals assisted the project in 2001, they worked into the late hours of night, in all kinds of weather, and deserve special praise. This list, arranged in order of appearance, also includes a few who were scheduled but missed due to weather and other cancellations:

1. Brood Stock Collections at Dogue Creek, Ft. Belvior: Drew Coslow, Kim Larsen, Larry Donahue, Matt Baldwin, Steve Minkinin, Sandy Burk, Pamela Rowe, Monica Noble, Joe Soell, Darin Crew, Steve Sarri, John Karwoski, Derek Orner, Doug and Melanie Fields and Judy, Emily, Sara, Dixie and Steve Kopecky, Chris Spaur, Caroline Cummins, Eric Hagen, Vince Colley, Joe Murray, Claire Buchanan, Sean Glomperons, Carlton and Grant Haywood, Matt Berres, Paul Gustafson, Sandi Geddes, Doug, Sara and John Gray, Wagner Wiegand, Joe and Jesse Smith, Tom and Clarke Gray, Jennifer Caddick, Karen Fligger, Lowell Curtis, Curtis Dalpra, Kristin Kresch, Mike Bailey, Phyllis and Sam Frucht, Andrew McDonald,

2. Collections at Fletcher's Boat House, D.C.: Dan Ward, Mike Bailey, Robert Smith, Mr. Draper, Dick Teehan, Dave Gwinn, Gordon Leisch, and Joe Fletcher.

Kevin Luebke and Steve Pugh of the U.S. Army Corps of Engineers, Baltimore District, deserve special recognition for the multiple times when they helped. Mike Hendricks of the Pennsylvania Fish and Boat Commission was again extremely valuable in the analysis of the American shad otoliths and scales. Similarly, recognition extends to staff at the National Park Service's George Washington Memorial Parkway, Great Falls Park and Chesapeake and Ohio National Historic Park for their assistance with various aspects of this project, including access and safety.

For the seventh year, much appreciation goes to the Chesapeake Bay Foundation, and in particular Jamie Baxter, for the Schools-in-Schools program conducted in conjunction with this project. Matt Berres and Sandy Burk of the Potomac Conservancy added much value this year through an expanded student program. The teachers, those going the real extra mile, were Dana Actress, Joyce Bailey, Mary Bailey, Ed Barger, Joe Beatty, Billie Bradshaw, Charley Constanzo, Jim Egenrieder, Jean Emery, Melanie Fields, Ed Fisher, Steven Fletcher, Sandra Geddes, Jennifer Gerlach, Jack Greene, Eileen Hart, Amy Kraut, Joanne Kress, Jackie Lee, Laura Martin, Martin McCarick, Mary Lou McCarmack, Frances Miceli, Karen Pape, Susanne Paper, Keri Putonen, Chris Rodger, and Linda Williams.

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REPORT ON THE POTOMAC RIVER
YEAR 2001 SHAD RESTORATION PROJECT

Interstate Commission on the Potomac River Basin (ICPRB)
January, 2001

Project Summary

This project is part of an effort by a coalition of federal, state, regional and local agencies and nonprofit groups, organized as a Task Force[1], to open historic spawning and nursery habitat for native and anadromous fishes in the Potomac River. An important milestone for this project was accomplished in January of 2000 with the completion of the fishway at the Little Falls (Brookmont) Dam by the US Army Corps of Engineers (USCOE). However, the fishway alone is not all that is required. Migratory fishes have been excluded from the ten mile area from Little Falls upstream to Great Falls for over fifty years and they need to be re-imprinted to that area to help them return and use it.

American shad stocks in particular had remained depressed in the Potomac River despite significant improvements in water quality made over the last several decades and a river harvest moratorium that has been in effect since 1982. The American shad stocking project[2] began in 1995 and is designed to imprint shad to the historic spawning and nursery waters and to help rebuild Potomac River shad stocks. One million stocked shad fry is the annual goal. **In 2001, a project record of approximately 3.3 million shad fry were stocked into the Potomac River, bringing the project total to over 14.1 million.** Fifty-eight volunteers helped during the Spring collections of adult shad. The Schools-in-Schools partnership with the Chesapeake Bay Foundation was again successful with 14 schools and hundreds of students participating. Through the student efforts an additional 15,000 fry were estimated to have been released.

The ICPRB also assists the U.S. Fish & Wildlife Service (USFWS) in monitoring the progress of the project. Springtime monitoring of the Little Falls fishway was performed by boat-electrofishing, gill and dipnets at Mather Gorge, an area approximately one mile downstream from Great Falls. Fifteen adult American shad were collected, four with the USFWS's hatchery marks (oxytetracycling HCL (OTC) in otolith) . No other migratory fishes were captured. Summer monitoring for young-of-the-year (YOY) American shad was also conducted in the tidal freshwater Potomac River. Night-time push net surveys were conducted at nine stations between Chain Bridge and Ft. Belvoir. **A project record four hundred and eighty-eight YOY American shad were collected, forty-four of these had OTC hatchery marks.**

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[1]Members of the Little Falls Fish Passage Task Force 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.

2The Fish and Wildlife Service's document entitled *A Strategic Plan for the Restoration of American Shad to the Potomac River Upstream of Little Falls Dam* (Odom, 1995), endorsed and adopted by the Little Falls Task Force, recommended that up to 8 years of a stocking effort for American shad will be necessary to sufficiently augment and imprint the Potomac River's stocks.

2001 Activities

A. Stocking Effort: The major activity conducted was the continuation of the Task Force's planned eight year American shad stocking program. Adult American shad were captured with the assistance of Virginia waterman Marvin Lewis Harley and fifty-one volunteers and school groups for the purpose of supplying fertilized shad eggs to the USFWS's Harrison Lake National Fish Hatchery. In total, 735 American shad were captured (See Table 1). These fish yielded over 6.6 million fertilized eggs. From these, approximately 3.3 million shad fry were stocked into the river in 2001. This is the largest number stocked since the program began and brings the seven year total for this project to over 14 million American shad fry being stocked into the Potomac River.

Table 1
Dates of Collections, Number of American Shad Captured and Eggs Produced in 2001

Date[1]	4/16	4/20	4/23	4/25	4/26	4/27	4/30	5/03	5/04	5/06	5/07	5/8	5/10	5/11	5/14	5/15	Total
Ripe Females	27	29	16	15	15	27	44	8	63	32	18	10		2	26	6	338
Green Females	20[2]	5	4	6	10	5	13	13	14	9	2	12	4	11	5	2	135
Spent Females			8	1						2	2	2	2	4	5	1	27
Males	33	29	32	6	13	21	14	4	21	9	4	5	3	7	23	11	235
Liters of Eggs[3]	5.5	16	8	10	10.5	16	22	3[4]	24[4]	4[5]	5	5	0	2[4]	14	4	149
Egg #s x 1000	170	659	331	534	430	708	1291	167	1221	570	242	241	0	87	665	190	6,565
Water Temp.	16	14	18	17	17	19	19	22	23	21	21	22	23	24	21	22	
Tidal Stage/Time	L10	H7	H9	L4.5	L5.5	L6	L9	H5	H6	H7.5	H8.5	H9.5	L5.5	L6	L8.5	L9.5	

3,336,000 fry were stocked in 2001 (= 54 % survival)

[1] Three collection events; 4/24, 4/26, and 5/9, were cancelled at the landing due to bad weather, equipment problems, etc.
[2] Eleven green females were used for USFWS fish health studies.
[3] Liter volumes are as measured in the field (eggs continue to enlarge after field packaging). The "Total" liter measurement is from Harrison Lake National Fish Hatchery records.
[4] Harrison Lake National Fish Hatchery reported that these batches as non-viable and were discarded.
[5] An additional four and one half liters went to the school hatchery program.

Five of these collections also included scheduled rendevous with the Chesapeake Bay Foundation's (CBF) research vessel, *Susquehanna,* as part of student involvement in the project and this assistance component is described in Section B of this report. An additional three collection events were cancelled at the launch site, Hallowing Point, Virginia, due to weather and/or river conditions. Details of the brood stock collection methodologies can be found in Appendix I.

The catch-per-unit-effort (CPUE) was calculated as 735 total fish/(16 collection events)(2 nets set) which equals 22.9 shad/net-set. The seven-year average CPUE is 18.4 shad/net-set, and 2001 had the second strongest CPUE of the program (Table 2, Page 3). From the 735 shad captured, 338 ripe females produced 6,565,000 eggs, which equals 19,420 eggs/ripe-female. The 735 shad captured produced 3,336,000 fry which equals approximately 4500 fry/shad-captured. If 1 in 337 (.26%) return[3], the 2001 stocking should yield an estimated 9,899 shad returning, or about 13.5 shad returning for each shad collected.

[3]Based on monitoring data from the Conowingo Dam fish lifts (Hendricks 2000) which found that it takes 373 hatchery fry stocked in the Susquehanna River to get one returning adult shad.

Table 2.
Summary of the Number of American Shad Captured, Eggs Collected, Fry Released, and Catch-Per-Unit-Effort (CPUE) for Project Period 1995-2001, Including Estimates of Shad Returns

Year	1995	1996	1997	1998	1999	2000	**2001**	Totals
# Ripe females	135	166	245	105	119	373	**338**	1481
# Green (unripe) Females	78	51	92	50	44	93	**135**	543
# Spent (post-spawn) Females	3	1	0	8	10	9	**27**	58
# Males	78	157	207	153	116	282	**235**	1228
# Total Shad	294	375	544	316	289	757	**735**	3310
# Eggs Collected x 1000	2,405	4,353	5,744	2,626	2,594	6,383	**6,565**	30670
# Collections/# nets set	11/22	11/22	12/24	14/28	15/30	11/22	**16/32**	90/180
CPUE (# Shad[4]/net-set)	**13.4**	**17.0**	**22.7**	**11.3**	**9.6**	**34.4**	**22.9**	**18.4**
# Eggs/Ripe-female	17,800	26,200	23,400	25,000	24,400	17,100	**19,400**	20,709
# Fry Stocked x 1000	**1,175**	**1,989**	**1,535**	**1,589**	**1,304**	**3,176**	**3,336**	**14,104**
# Fry Stocked / Each Shad Captured	4000	5300	2800	5000	4500	4200	**4500**	**4261**
Estimated # of Shad Returning[5]	3,487	5,902	4,555	4,715	3,869	9,424	**9,899**	**41,852**
Est. # Shad Returning / Each Shad Captured	11.9	15.7	8.4	14.9	13.4	12.4	**13.5**	**12.6[6]**

The CPUE, while good, was not as high as in 2000. 2001 was the driest Spring since the stocking program began and four out of the last five Springs have been below the long-term median (see Appendix II, Chart of Flows at Little Falls). Spring freshets, especially warm ones, tend to induce spawning activity as higher flows are better for negotiating obstacles and the murkier water helps conceal, especially the eggs and larvae, from predators and carries nutrients necessary for good plankton growth and food supply. Conversely, during dry Springs, shad and herring tend to "hold" their eggs without the cues that freshets bring. Therefore, during dry Springs, more "green" female shad are encountered. Green females are released alive whenever possible as part of the collection protocols. This negatively impacts, i.e., lowers, the CPUE, an action that is not readily reflected in the CPUE data. Other factors such as reduced movement and net avoidance due to the effects of clear water would also lower the CPUE.

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[4]CPUE is based upon numbers of shad actually kept for collection of eggs. It does not include green or spent females and surplus males which were released.

[5]Based on monitoring data from the Conowingo Dam fish lifts (Hendricks 2000) which found that it takes 337 hatchery fry stocked in the Susquehanna River to get one returning adult shad.

[6]Approximately 235 shad are needed to stock 1 million shad fry (with 2967 estimated to return).

B. Assistance to the Schools:

For the sixth year in a row the ICPRB worked with the Chesapeake Bay Foundation (CBF) "Schools-in-Schools" program and the USFWS Harrison Lake Fish Hatchery to incorporate schools in the raising of shad in the class room for release into the Potomac. The Potomac Conservancy also participated this year, helping to coordinate training and scheduling and responding to day-to-day concerns of the schools. Fifteen schools participated (See Appendix III for a listing of these schools). Student activities included field trips aboard the CBF research vessel, *Susquehanna,* on the Potomac to learn about the ecology of the river and to see the shad collections/egg stripping first hand. Each school subsequently tried to raise about 2000 shad fry in each of their classrooms for release in the Potomac River near Great Falls. The Virginia schools experienced water quality problems which remain a mystery but might be due to the switch from the use of chlorine to chloramine at the treatment plants. Still, an estimated 15,000 additional American shad fry were stocked into the Potomac River by the Schools-in-Schools project. Students take what they learn during the river trips and in their classrooms raising shad and use their experiences throughout the year, and longer. The project is seen as an excellent way to enhance their learning environment. For example, the students use math to calculate estimates of the number of eggs and fry in their tanks, they learn and apply water chemistry as necessary to keep the young shad alive, they write about the project and even construct web pages on the project. Almost all tell their fellow students what is going on, some make presentations to other classes.

C. Monitoring:

1. Young of the Year (YOY) American shad: The ICPRB also assists the US Fish and Wildlife Service in monitoring for YOY American shad in the Potomac River to help assess fish passage effectiveness and potential stock recovery. A 4' wide x 3' deep bow mounted pushnet (1/4" mesh) is used to sample nine stations in the tidal river between Chain Bridge and Fort Belvoir. Sampling is performed at night, from 9:30 p.m. to 1or 2:00 a.m. Collections in 2001 occurred over the course of five two-night monitoring events from July 25 to August 23. 2001 set a project record for YOY shad collected. Four hundred and eighty-six YOY shad were collected, compared to one hundred and eleven in 2000, twelve in 1999 (a severe drought year), and one hundred and forty eight in 1998. Forty-four (9.6%) of the YOY collected in 2001 had hatchery marks; 19 (43%) captured near Fletchers Boat House, 9 (20.4%) from near Three Sisters Island, 12 (27.3%) from near Roosevelt Island and 4 (9.1%) from near National Airport. No marked YOY shad were collected downstream from the Woodrow Wilson Bridge.

Since 1958, the Maryland Department of Natural Resources has conducted a bay-wide multi-species shore haulseine survey. In 2001 they collected 1626 YOY American shad, 1620 of them were from their sites in the Potomac River. This significantly surpassed the previous record established in 2000 (See Appendix IV, Maryland Haulseine Survey, Baywide YOY Shad Collected, 1958-2001) .

2. Adults: In 2001, Springtime monitoring of the Little Falls fishway was conducted primarily through dip-net and boat-electrofishing at Mather Gorge. Gill-netting was attempted but abandoned as not effective. Monitoring was conducted approximately twice weekly, weather and flow permitting, from April 10 to May 8. Electrofishing was scheduled to go into late May, but was discontinued after May 1 because the boat ramp at Mather Gorge became un-usable due to low flow conditions. Three American shad were collected by electrofishing, twelve were collected by Mike Odom of the USFWS using a long-handled dipnet.

C. Outreach: The Potomac Basin *Reporter* May-June 2001 newsletter included an article entitled "Project Continues to Add Shad in Potomac" (copy attached in Appendix V). Jim Cummins was interviewed by WAMU Radio (8/1). Presentations on the project were made to Virginia, Maryland and District of Columbia participating teachers (3/14, 3/15), American University, class on Conservation Politics, Prof. Harvey Lieber (4/4), training of DC anglers who collecting American shad heads, the Chesapeake Bay Foundation's summer course for Maryland teachers (7/12), and the Georgetown Kiwanis Club (8/8).

Discussion

Since this project started in 1995, the number of adult American shad collected during the Spring brood-stock collections has more than doubled and the number of fry stocked has tripled. Young-of-the-year shad have also become substantially more numerous, setting records in both Maryland and USFWS/ICPRB monitoring surveys. The Potomac River American shad population appears to be rebounding well. Is the stocking program the reason or is it something else?

The answer is there are many reasons. First, the Potomac is a remarkably productive river. Its record is ripe with accounts of the rivers remarkable capacity to produce huge quantities of fish. In 1886, Spencer F. Baird, in his report of the US Fish Commission stated: "No better illustration of the numbers in which anadromous fish enter the rivers can be given.... than a presentation of the case as it relates to the Potomac River in the short distance between its mouth and the Great Falls of the Potomac, only twelve miles above Washington. Although this stretch of water is even now very productive, many years will elapse, if ever, before it gets up to the measure of yield mentioned by (Joseph) Martin in his History of Virginia, a work published in 1835 (Martin, 1835). I give, however, the statement, allowing it to speak for itself:

> *'...of the Potomac, it may be well to mention that in the spring of the year quantities of shad and herrings are taken which may appear almost incredible. The number of shad frequently obtained at a haul is 4,000 and upwards, and of herrings from 100,000 to 300,000. In the spring of 1832 there were taken in one seine at one draught a few more than 950,000 accurately counted. The shad and herrings of the Potomac are transported by land to all parts of the county to which there is a convenient access from the river, and they are also shipped to various ports in the United States and West Indies.'"*

S.F. Baird continues: "Although the season lasted but about eight weeks, during this time (the 1830's) as many as 22,500,000 shad were taken and 750,000,000 herring. In curing the fish for later consumption, 995,000 barrels of salt were used. For the 750,000,000 actually captured we may suppose that this was not more than one-forth of the total number in the river during the season, which would give 3,000,000,000 for the Potomac River only. ....the fishery on the Potomac during the period referred to equaled the total yield of the Scottish salmon fisheries in 1873, prosecuted through-out the year, and employing 15,000 boats and 45,594 men, and equaled nearly twice the entire number of barrels of the sea herring put up in Canada in 1876."

Two other major factors contributing to recovery of the American shad are 1) the return of submerged aquatic grasses (SAVs), an important part of the shad's nursery habitat, in the tidal freshwater areas of the river and 2) the closures of the American shad fisheries in the Potomac and upper-Bay (MD). Both of these helped set the stage but there is no compelling evidence that they alone are the reason for the increase in shad numbers. SAVs have been doing well in the freshwater tidal Potomac since the mid-1980s, almost twenty years and more than a decade before the stocking effort started. The harvest moratorium was put into effect in 1982, thirteen years before stocking. By the mid 1990s, the shad population still remained very low, as reflected in the low numbers of young-of-the-year shad (see Appendix IV). Nothing apparent was happening in spite of the return of SAV or the harvest moratoriums. These were contributing reasons for initiating the American shad stocking program.

But the primary goal of the stocking program is to restore shad to the upper portions of the river, especially between Little Falls and Great Falls. It's secondary goal is to give a boost, a kick-start so to speak, to a shad population which was barely maintaining itself.

From the data collected so far the hatchery contribution to the upstream restoration is encouraging. All of the forty-four OTC marked YOY shad collected in 2001 were found in the upstream sections of the river with the largest amount (43%) captured near Fletchers Boat House. Perhaps the best measurement is how current conditions at Great Falls resemble those described for the same in an 1898 US Fish

Commission (Smith and Bean. 1898) report which stated that “striped bass, white perch and American shad ascended up to Great Falls, where shad "numbers are taken by means of long-handled dip-nets (Smith and Bean, 1898)." Mike Odom’s capture of eleven shad with a dip net is one of the best indicators that the goal is being approached, at least for American shad.

Conversely, there is no strong evidence that the hatchery program is contributing large percentages of fish to the general population of returning adults (0% (n=40) in 1999, 4% (n=137) in 2000 (USFWS,2000), data not yet available for 2001). But this is a small data set and the two years represented would lack coverage of year-classes that would have had OTC marked fish since most American shad return to spawn at five years old. Only four year old or younger OTC marked shad would have been returning to the Potomac in 1999. Also, there is uncertainty regarding what a "significant contribution" is, as even a small percentage could result in a threshold effect, like jump-starting a car battery that gets the car running. So the jury must remain out in this regard until the results of ensuing years accumulate, support for monitoring permitting.

Most striking though, is if the record-setting numbers of young shad are predictive of adult returns, which is likely, big changes are coming. The Potomac might be the template for opening other shad fisheries up and down the coast. If so, it should be a good one. But reopening the shad fishery, perhaps the ultimate test of recovery, will be a particularly daunting yet interesting task that needs to be worked on now.

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Appendix I
Description of the Techniques Employed to Capture Adult American Shad Brood Stock and the Process of Preparing Fertilized Eggs For Delivery to the U.S. Fish and Wildlife Service's Harrison Lake National Fish Hatchery
1995-2001

Acknowledgments

The fishing techniques herein described have been very successful for this project, providing an efficient, cost effective way of collecting the necessary brood stock. The drift net technique employed followed the traditional commercial fishing methods used in the Potomac River for many generations. While the basic steps described are fairly straight forward, fishing them is a skill and art that takes many years to master. A great deal of gratitude is deserved by Mr. Marvin "Lewis" Harley, the Virginia waterman assisting the project. His contributions have gone well beyond his contracted time and materials. His knowledge of the river and the methods used to capture fish have been invaluable. His skills, desire to help bring these fish back to recovery, and polite and gentlemanly demeanor have never failed to elicited admiration from myself, the volunteers, the students and teachers, and all involved in the project.

Methods

At mid-afternoon to early evening the crew, usually the author, Mr. Harley, and volunteers, would gather at Mr. Harley's home on Hallowing Point, Virginia. Nets and gear would be loaded on board his boat (a 21 foot Carolina skiff) at the Hallowing Point Estate's landing near his home and we would motor upstream, checking the condition of the tide by observing the effects of the current on the several navigational buoys we passed on the way. Collections were made along the Potomac River mainstem between Marshall Hall and Gunston Cove in the Ft. Belvoir area.

Two drifting gill nets, sequentially deployed, were fished together along the Virginia side of the channel. The nets were 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, with top line suspended below the surface approximately 1.5 meters (5 feet) from floating 16 centimeter (6 inch) diameter corks rigged about every 4.5 meters (15 feet). The bottom line was 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. The nets were fished at evening slack-water, at either the high or low tidal shift, for a duration of approximately two hours and continuously tended as described in the following paragraph. Fishing was performed roughly between 4:00 p.m. to midnight, depending on the tide, with the best "fishing tides" being near dusk and with a full moon. It is imperative that collections are made during slack tides because otherwise the currents in the Potomac River would be too strong for the nets to fish properly, they should hang loosely, and they would drift considerable distances (miles), subjecting them to snags, potential damage and loss.

The nets were tended, i.e., the nets were allowed to drift but when the bobbing of corks indicated that fish had become entangled in the net, that section of the net was lifted, fish were removed from the net, and the section of net was dropped and allowed to keep fishing. At the end of the drift, the net was taken up, starting at one end, and all fish were removed and the net put in a large bucket or tub. It was typical during most collections to have some by-catch, principally gizzard shad and channel and blue catfishes, but also longnose gar and rockfish. Care was taken to release by-catch alive. Captured shad were examined as brought on board for sex and maturity. Male or "buck shad" and females which appeared ripe, "roe shad," were kept alive on board the boat in a 100 gallon oval stock tank. The tank had a submerged bilge pump, modified with a large intake filter, that re-circulated and aerated the water while providing current which helped the shad orient correctly in the tank. Typically any female shad that did not have roe running from them, termed "green shad," were released back into the river. Some of the green shad that were kept were also the result of false positive decisions, i.e., they appeared as running

ripe females when captured and were therefore kept but at stripping they only produced a few eggs. Unfortunately, American shad do not handle well and all fish placed in the holding tank succumb to stress. Therefore, in some cases due to their condition, these green fish were also not released.

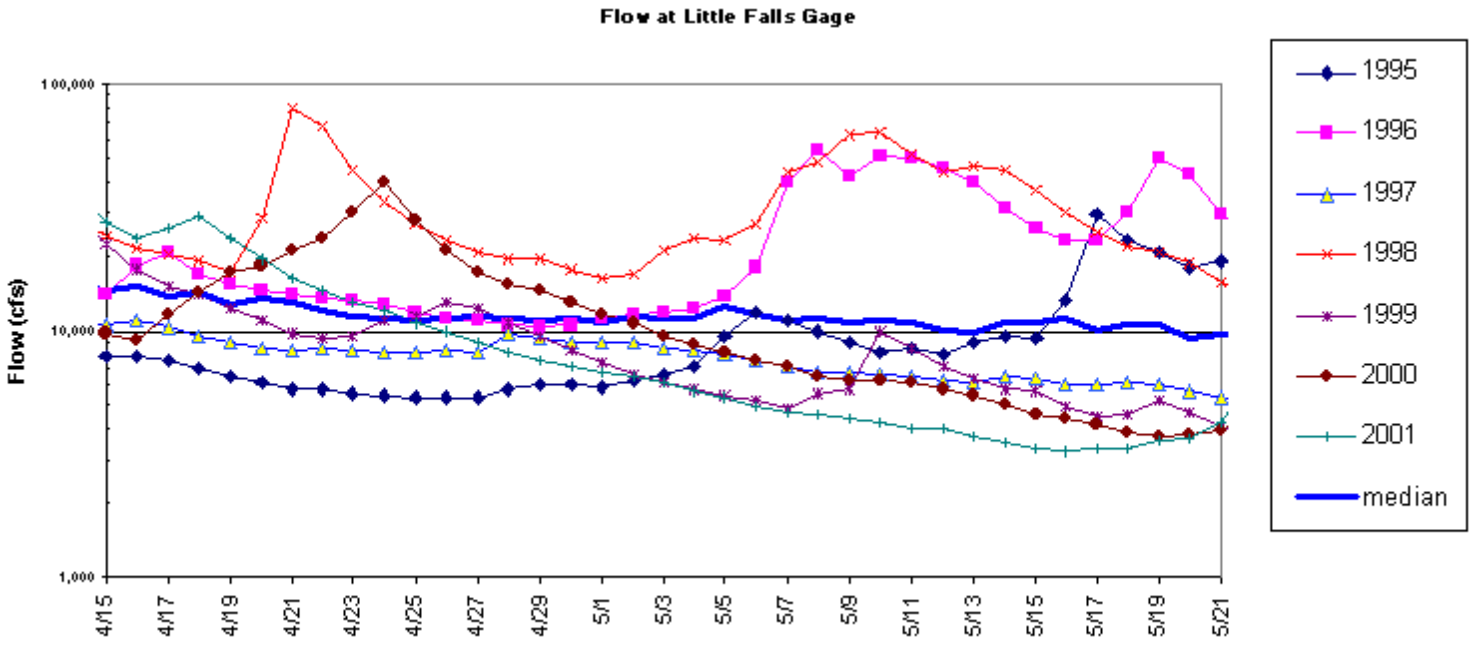
When enough shad were collected, at least 6 females and a similar number of males, the fish were quickly taken to the north (upstream) side of Ft. Belvoir and transferred to shore for stripping. Shad were transferred to 50 gallon containers of river water at the shoreline, bucks and roes going to separate containers to increase efficiency during stripping. This Fort Belvoir site is very handy because it is in close proximity to the channel edge where we drift the nets. Indeed, it is the closest that the main river channel comes to the Virginia shoreline downstream from Alexandria. Therefore it takes only a little time to transfer the fish, and personnel would remain behind to strip the eggs while the waterman and crew would return to finish fishing the drifting nets.

On the shore of Fort Belvoir, under the indirect light of a camp lantern, the eggs were stripped into a large stainless steel bowl. When the stripping of a batch of roe shad was complete, generally 4-6 fish, milt was stripped from a similar number of bucks onto the top of the eggs. Care must be taken to keep the eggs out of direct light during this entire process, as this has been found to cause egg mortality. Care also must be taken to minimize contamination from scales, blood and especially feces, the latter being removed when necessary from the eggs with turkey basters. Eggs and milt were then slightly mixed together with a quick but gently stirring by a wet hand and fingers. A large feather, often a turkey feather, has traditionally been used to stir the mixture. However, the wet hand and fingers method has not appeared to increase egg mortality and has worked well. River water was then slowly added to the bowl to activate the sperm. The bowl was then set aside, out of direct light, for approximately 5 minutes, during which fertilization was completed. During this time the eggs settle to the bottom of the bowl due to gravity. The mixture then undergoes a multiple and careful process of cleaning through which the top layer of water with its load of scales, mucous, clumps of unripe eggs, dead sperm cells, blood, etc., is decanted off, then new river water added, the eggs again allowed to settle, and then decanted. After 4-6 of these decanting/rinses, the fertilized eggs were transferred to a floating egg-box. During this transfer to the floating egg-box, another important egg-cleaning step is performed by pouring the eggs into a large kitchen colander held over the egg-box, through which the diameter of the colander's holes allow the eggs to pass but restrict remaining mucous, blood clots and fish scales from entering the floating egg box and contaminating the eggs. The eggs must then water-hardened for at least one hour, to allow the eggs to absorb water and harden the cell walls, before they are ready to move. Thus, after the final batch of eggs were stripped, fertilized and cleaned, an hour of time was still necessary for the eggs to harden. This time is not wasted and the fish that were used that evening were weighed and measured for fork and maximum total length and equipment brushed clean and loaded onto the boat. Additionally, over the course of the collecting period, subsets of ten to twenty of what eventually totaled one-hundred shad heads were also collected and prepared during this hour for later otolith aging and OTC tag research. At several occasions, fish tissue samples were also collected by the Fish and Wildlife Service as part of their standard procedures used to investigate wild fish health.

When all the fertilized eggs had sufficient time to harden and gear was assembled we returned to the landing at Hallowing Point. At this time the eggs were prepared for shipping to the USFWS hatchery. Eggs are poured from the egg-box into a two liter measuring cup then placed into plastic bags, four liters of eggs to the bag, adding an equal volume water. Air is forced out of the bag and then an equal volume of pure oxygen was added. Each bag was sealed, then double bagged and sealed with a label giving the date and river, boxed and then sealed with duct tape in Styrofoam boxes. They are thus sealed to be water, air and light-tight. The boxed eggs are then driven to Fredericksburg, Va where they are delivered to USFWS personnel for further transport to the hatchery. Typical transfer times where midnight to 3:00 a.m.. The next morning the equipment was cleaned, nets were straightened and re-packed by the waterman, and necessary repairs to either were made for the next collection. Weather permitting, the process began again that afternoon.

Appendix II:

Chart of Flows at Little Falls
March 15 to May 21, 1995 to 2001
Data from US Geologic Service



Graph prepared by Eric Hagen, Interstate Commission on the Potomac River Basin

Appendix III:

List of Schools-in-Schools Participants, 2001

Virginia Schools:	**City**
Walt Whitman Middle School	Alexandria
Hayfield Secondary School	Alexandria
Frost Middle School	Fairfax
Lake Braddock Secondary School	Burke
Langston Hughes Middle School	Reston
Lacey Instructional Center	Reston

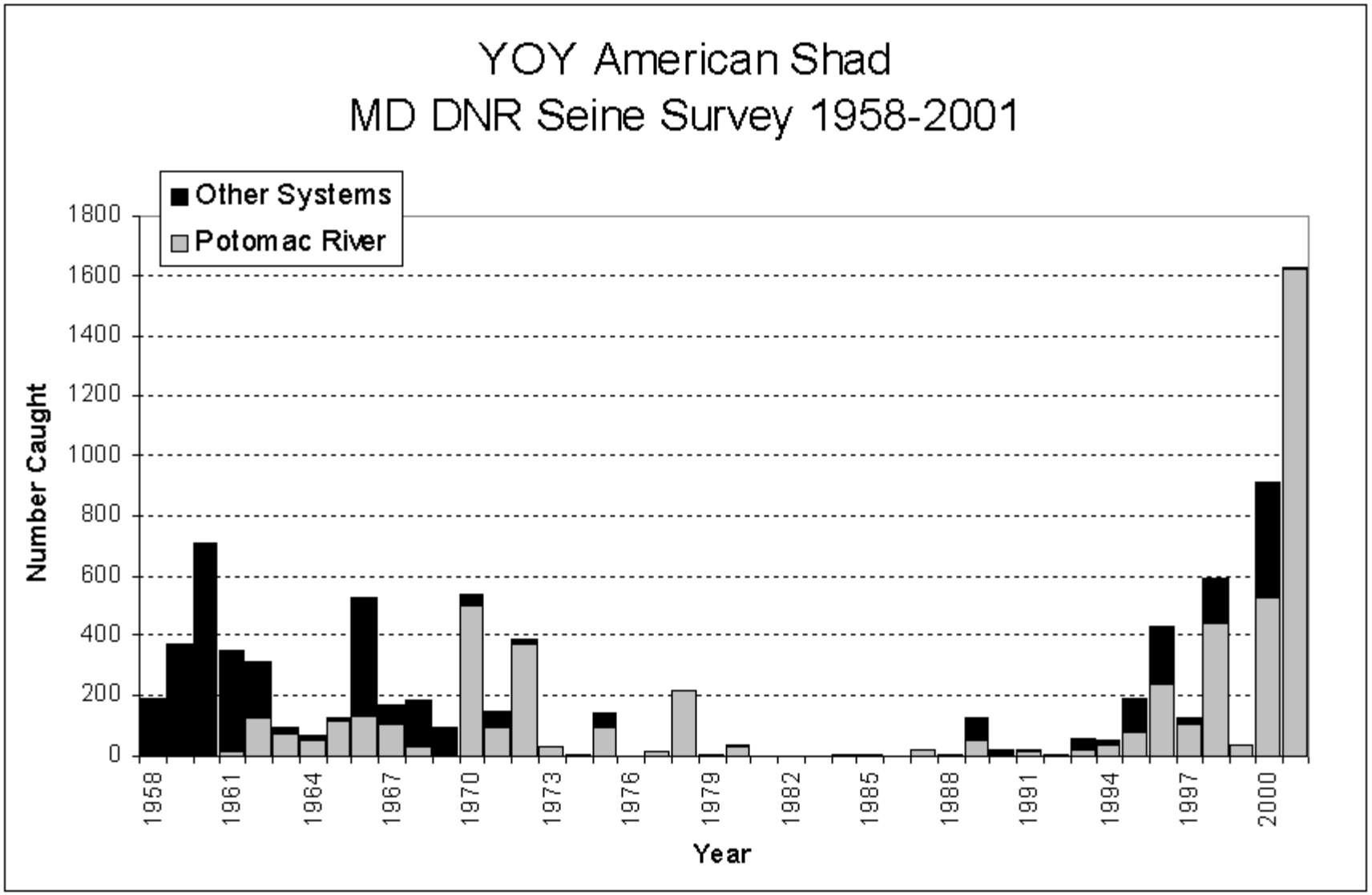
Maryland Schools:	**City**
Col. Brooke Lee Middle School	Silver Spring
Forest Oaks Middle School	Gaithersburg
Julius West Middle School	Rockville
Westbrook Elementary School	Bethesda
Hoover Middle School	Rockville
Jefferson School	Jefferson
Lake Seneca Elementary School	Germantown
Poolesville High School	Poolesville

District of Columbia School:

Sidwell Friends School

Appendix IV

Young-of-the-year (YOY) American Shad captured as part of MD Department of Natural Resources' Bay-wide Haul Seine Survey, 1958-2001.



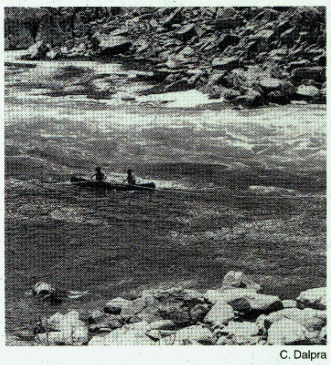
Appendix V.

MAY-JUNE 2001 ICPRB REPORTER article

Potomac Basin
REPORTER
Vol. 57, No. 3 Interstate Commission on the Potomac River Basin May/June 2001

C. Dalpra

Students participating in the Schools in Schools program release the shad fry they grew in the classroom into the river near Old Angler's Inn. The students also planted shad bushes at the site.



C. Dalpra

Stringing a net to capture shad just below Great Falls.

Shad Returning to Upper Potomac

For many people who meet him, especially on the river, ICPRB Associate Director for Living Resources Jim Cummins is a student of the American shad. Much of his time is spent thinking about the species and its history as one of the most important fish populations to have inhabited the Potomac River.

Collecting information on the history of the species, whose numbers are currently a shadow of the populations found even a half-century ago, is a pastime of Cummins. The restoration of the population to some semblance of its past health is a passion.

That passion was rewarded recently when, for the second year, shad were found upstream of the dam at Little Falls, which has long blocked the travel of the migratory fish. A fish passage structure was completed at the site in February 2000, reopening about 10 miles of prime spawning and nursery habitat between the dam and Great Falls. A cooperative restoration project led by ICPRB has placed shad fry in the upstream area each spring since 1995 in hopes that the adult fish would return there to spawn after returning from life in the ocean. Finding that fish are indeed returning is a triumph of years of cooperative effort with project partners including the U.S. Fish and Wildlife Service, The Virginia Chesapeake Bay Restoration Fund, the National Fish and Wildlife Foundation, and a cadre of volunteers, students, and nonprofit groups.

As in past years, Cummins, local waterman Lewis Harley, and volunteers spent spring evenings on the river at the change of tide, netting American shad to bolster the fish's presence on the Potomac. Into the night, they fished drift nets in the river near Fort Belvoir, Va., collecting female shad ripe with eggs. Eggs taken from females are mixed with sperm from male shad in a bowl of river water. After the eggs are fertilized, they change color and grow to several times their size in less than an hour. The shiny eggs are decanted and sent to a U.S. Fish and Wildlife Service hatchery in Virginia, where they are hatched, grown out for a few days, and marked with a harmless chemical tag for future identification. The fry are later released to the upstream Mather Gorge area, with the rest left up to nature.

Some of the eggs are given to a growing number of area schools, where students hatch and raise the shad for release at the same area. Raising fry and learning about the importance of the fish is a part of the students' science curriculum. This year, 15 schools participated in the "Schools in Schools" program, run by the Chesapeake Bay Foundation and the Potomac Conservancy. The ICPRB supports the program by providing the fertilized eggs.

With the help of 41 volunteers, approximately 3.3-million shad fry were stocked in the river, a new record for the program, which seeks to place at least one million during each of the project's six years. The high numbers of fry raised this year and last (about 3.2 million in 2000) reflect relatively strong spawning runs in the river during the last two years, according to Maryland Department of Natural Resources fishery surveys. The data suggest that these spawning runs were the best since the late 1970s.

Perhaps the best news for the project came in searching for shad in the previously blocked area of the river. Fifteen shad were captured near Great Falls, most with a dip net worked by Mike Odom of the U.S. Fish and Wildlife Service from the rocky outcrops that jut into the river. Low water in the river made boat access to the area with electro-shocking equipment difficult, and stringing a capture net in the eddies just below the falls was challenging. Cummins noted that catching those 15 fish is a strong indication

that many more made it over the dam at Little Falls. "Shad restoration work on rivers like the Susquehanna is easier to quantify," Cummins said. "They are counted as they are mechanically lifted over the dam."

While the news is exciting for fisheries managers and volunteers, the educational component of the project is just as important and exciting. Volunteers and students alike are impressed with the role the fish has played in the river's history and current status.

During the project, hundreds of students have learned that George Washington was a shad fisherman, using crews of workers to cast long nets across the Potomac from Mount Vernon, barreling thousands of shad each year. They learn about the steep decline of shad stocks in the 1950s due to fishing pressure, pollution, and loss of access to habitat, such as was caused by construction of the dam. (A fishway was constructed on the dam in the 1950s, but was not used by migrating fish.) Stocks fell to such low levels that Maryland banned the harvest of shad in 1980, the Potomac River Fisheries Commission halted harvests on the Potomac in 1982, and Virginia following in 1993. The students also learn that the problems are not only on the Potomac, but throughout the Chesapeake Bay and the Eastern Seaboard. They are taught that even with their hard work, and efforts throughout the bay watershed, that shad populations are currently only about 10 percent of their historical average.

A final treat for the school groups is a release party of sorts for the fry they have raised. As in past years, classes from the schools gathered at the river, acclimating their fry with river water before releasing them, and wishing them well on their journey through Mather Gorge, and down the river to the ocean, where they will grow for several years before swimming back upstream to complete the cycle. The event allowed the students to compare experiences with other schools, and to plant shad bushes, which flower about the time of the shad run, along the shore. Volunteers also are invited to a "shad planking" where split fish are roasted on boards next to an open fire, hosted by waterman Lewis Harley.

The fry-stocking part of the project is expected to end next season. Cummins is working to create a strong monitoring program to track the results of the project and changes to the shad population that result.

Cummins, who enjoys a good piece of shad smoked, fried, or planked looks forward to the day when he and other anglers can again enjoy eating the fish that is steeped in the Potomac's history. He may need to be patient, however.

Dale Weinrich, a natural resources biologist with Maryland's Department of Natural Resources, agreed that shad runs have improved in some parts of the Chesapeake Bay watershed during the last two years. He said the state was beginning an examination of data–especially from the upper bay, which is the largest data set–to reach a greater understanding of American shad stocks. He noted that there are many factors to consider when making determinations on the health of a fishery, and that ongoing assessment could take years. While heartened by recent developments, Weinrich noted that "Biologically, even a limited fishery is some distance off." He said that catch-and-release fishing for shad is occurring in the state now.

Cummins agrees that even a limited fishery is a couple of years away, but believes that planning for it should begin now to avoid having to quickly react to a recovery that "may surprise many people."