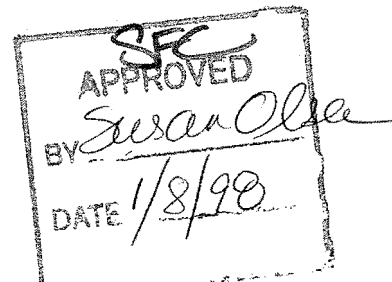


UNITED STATES
DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region
State, Federal & Constituent Programs Office



COMPLETION REPORT

Grantee: VIRGINIA DEPARTMENT OF GAME & INLAND FISHERIES

Project No: N/A

Grant No: NA56FU0483

Project Title: ANADROMOUS FISH RESTORATION

Period Covered: 08/01/95 - 09/30/97

Prepared by: J. Alan Weaver

Approved by: _____

Date: DECEMBER 19, 1997

Statutory Funding Authority: Anadromous Fish Conservation Act

(P.L. 89-304)

☒ Chesapeake Bay Studies

☐ Endangered Species Act

☐ Interjurisdictional Fisheries

Act (Title III of P.L. 99-659)

☐ Magnuson Act

☐ Oyster Disease Research

☐ Saltonstall-Kennedy

☐ Unallied Industry Projects

☐ Unallied Science Projects

Ref. No. NA56FU0483

**Final Report for the period August 1, 1995 to September 30, 1997
for the project:**

**Anadromous Fish Restoration -
State of Virginia**

Author:

L. Alan Weaver, Fish Passage Coordinator

Virginia Department of Game & Inland Fisheries
12108 Washington Highway
Ashland, Virginia 23005

December 18, 1997

Objectives

The main objectives of the study "Anadromous Fish Restoration" are to supplement existing state, federal, and local efforts to restore anadromous fish populations throughout Virginia. Direct components of this study are:

1. To provide funding for a Virginia Fish Passage Coordinator position to facilitate the projects under this grant agreement and other ongoing projects. An additional component is to provide funding for technician support.
2. To provide funding for Year 1 of a comprehensive impediment survey on the Rappahannock River and its tributaries (Job II). This grant was amended and extended to also provide funding for Year 2 of this four-year study.
3. To provide funding support for monitoring activities by the Virginia Department of Game & Inland Fisheries (VDGIF) for anadromous fishes within waters of the state (Job III).
4. To provide funding support for other related restorative activities by the VDGIF, such as trap and transport of river herring, and American shad brood collection, rearing, transport, and stocking throughout the state (Job I).

Grant Amendment

The original amount (\$95K) for this grant (#NA56FUO483) was increased by \$50K and the grant period was extended through September 30, 1997 to include Year 2 of the Rappahannock Impediment Survey (Job II). Obligated funds not used by another jurisdiction became available for use by Virginia on the Rappahannock project.

Job I: Anadromous Fish Restoration

Trap and Transport

In April 1996, the VDGIF and the U.S. Fish & Wildlife Service (USFWS) combined their efforts to trap and transport pre-spawn blueback herring in an effort to restore the migratory run of herring to areas of the James River that have not had spawning runs since the construction of dams in the Richmond area. This was the third consecutive year for this operation. Blueback herring were collected by electrofishing at the base of Walker's Dam on the Chickahominy River (a lower James tributary). The fish were then counted and placed into circular hauling tanks equipped with oxygen for aeration and a water recirculation system to provide directional flow for orientation. The VDGIF operated a 450 gallon tank and the USFWS operated a 900 gallon tank. Tank hauling density was approximately one fish per gallon and hauling mortality was less than 10% for all stocking locations. Most of the herring were transported to Columbia on the James which is approximately 45 river miles upstream of Boshier Dam. The other tributary sites are also above Boshier Dam except for Harrison Lake which is on Herring Creek (Table 1).

American Shad Restoration

American shad fry stocking was begun in Virginia in 1992 in a cooperative effort between the VDGIF and Virginia Commonwealth University (VCU). In 1992 and 1993 the fry were reared at the Pennsylvania Fish and Boat Commission's Van Dyke hatchery and then transported in oxygenated containers back to the James for stocking. In 1994, the VDGIF opened the King and Queen shad hatchery addition in Stevensville, Virginia. A harvest moratorium was placed on American shad in 1994 in Virginia for the Bay and its tributaries.

In April and May 1996, spawning American shad were collected on the Pamunkey River by Commercial Watermen funded by the Virginia Marine Resources Commission. VDGIF biologists and technicians extracted eggs, stripped males to fertilize the eggs in the field, and transported the eggs to either the King and Queen State Fish Hatchery or the Harrison Lake National Fish Hatchery. A total of 21.6 million fertilized eggs were produced. The fry were hatched in McDonald jars and reared in 200 gallon circular tanks. Shad fry were fed salmon starter and brine shrimp. Oxytetracycline treatments were applied to tag otoliths in order to identify stocked fish during out migration and return spawning runs to determine the contribution of the hatchery fish to the overall restoration effort.

At seven days old, American shad fry were stocked in the middle James above Boshier Dam to reintroduce the species to that river section in anticipation of fish passage at Boshier Dam and in the Pamunkey River to supplement natural recruitment. The circular tanks were loaded onto distribution trucks, hauled to the river, tempered, and the fry were quick released into the water. Using this procedure eliminated handling stress on the fry. The James River received 4.5 million fry from King and Queen and 1.3 million fry from Harrison Lake. The Pamunkey River received 2.0 million fry from King and Queen.

Complete details on American shad restoration can be found in the 1996 report titled "Virginia's American Shad Restoration Project" which is attached. This report covers all aspects of the project including stocking and hatchery product evaluation (juvenile monitoring).

Job II: Rappahannock Impediment Survey; Year 1 and Year 2

In September 1995, VCU was contracted by the VDGIF to conduct the first two years of this four year study. Dr. Stephen McIninch was hired by VCU as a Postdoctoral Research Associate to work with Dr. Greg Garman on this project. The two year progress report submitted by VCU is attached. The working title of the study is: "An Evaluation of Habitat Relationships and Barriers to Migration for Anadromous Fishes in the Rappahannock River Basin." Year 3 and Year 4 of this continuing study is funded by Grant #NA76FU0392 for the period August 1, 1997 to July 31, 1999. This study is intended to directly benefit the VDGIF in prioritizing anadromous fish restoration efforts in the Rappahannock River Basin.

Job III: Anadromous Fish Monitoring

In 1994 and 1995, the Fish Passage Coordinator monitored Virginia Bay tributaries on a limited basis due to limited field crew resources. In 1996, the Fish Passage Coordinator was able to expand the monitoring effort due to the addition of a field technician funded by this Bay Program grant. The purpose for this monitoring is to describe the temporal and spatial distribution of anadromous fishes (adults and juveniles) targeted for restoration through fish passage implementation and stocking efforts.

Spawning Run Monitoring

Documenting the migratory run at, and downstream of, impediments validates the need for fish passage and directly aids in setting fish passage priorities. Boat electrofishing was conducted at several locations using either a 16' Smith-Root boat with a 7500 watt generator or a 14' jon boat with a 3500 watt generator. Pulsed DC current was employed and output power was generally 2700 watts (5.0 A x 540V; 120hz). Species presence/absence was determined and relative abundance information (Catch Per Unit Effort, or CPUE, in fish/hr) was collected. Basic information such as sex, spawning condition, fork and total length, and in some cases, weight, was collected. Data were entered into a spreadsheet to be analyzed for site specific and regional trends. A summary of the CPUE results are presented in Table 2.

Highlights of the 1996 sampling effort include finding a considerable number of American shad at Ashland Mill Dam on the South Anna River and the continued occurrence of American shad at the base of Boshier Dam on the James River. Ashland Mill Dam is a future fish passage priority and a vertical slot fishway will be built at Boshier Dam (1998). As in 1995, we found one blueback herring at Boshier Dam in 1996. This occurred after Trap and Transport was initiated and the specimen may have "down run" after stocking. However, the fish was very "fresh" (i.e. scales not missing) and did not appear to be a fish that was netted several times during a translocation procedure. Therefore, it is equally likely that the herring did migrate up to Boshier Dam after passing through the breaches in downstream dams. Finding a much larger migrating herring population at Boshier Dam in the future will help to answer this question.

Juvenile Monitoring

Monitoring for juvenile alosids was conducted on the James River and the Pamunkey River at several locations. The James River was sampled for three main reasons; 1) American shad restoration and fish passage is of highest priority on the James River, 2) OTC marked American shad fry were stocked at Westview (VDGIF) and Wingina (USFWS) in spring 1996, and 3) pre-spawn river herring were stocked at Columbia on the James, Byrd Creek (tributary to James), and Big Licking Hole Creek (tributary to James) in 1996. The Pamunkey was sampled because OTC marked American shad fry were stocked at Rockahock which is the collection site for brood stock. Descriptions of the juvenile monitoring sites are provided in Table 3.

The first method employed in May and June of 1996 was an ichthyoplankton net (mesh size 560 microns; mouth opening 38 cm). The net was towed just below the surface approximately

50 feet behind a jon boat using a 15 hp motor. A flow meter was used to calculate the volume of water sampled. No alosa fry were collected in 1996 using this method. In the future, the net will be pushed in front of the boat in an attempt to increase sampling efficiency.

The remaining sampling was conducted from July through November 1996 and was done primarily at nighttime when the juvenile fish tend to rise to the surface and are thus more susceptible to collection by the sampling gear types that were used. The sampling gears used were a push net, an electrofishing boat, and a seine. The push net has 10 square foot mouth opening with a 3/16" mesh size that is pushed in front of a jon boat with a 25 horsepower motor run at full thrust. The USFWS provided the push net gear and boat. The VDGIF provided the outboard motor and worked cooperatively with the Service to conduct the push net portion of the juvenile surveys. Electrofishing was conducted with the VDGIF Smith-Root boat using pulsed DC current (5.0 A x 540 V = 2700 watts; 120 hz). Seining was done with a 100' x 4' Delta seine (1/4" mesh). The results of the push net survey are shown in Table 4 and the electrofishing results are presented in Table 5. Seining was conducted on only one date (August 27, 1996) at Westview and Maidens and no alosids were collected.

Juvenile alosids appeared to be utilizing the pool habitat behind Boshier Dam (Watkins) as a nursery ground prior to out migration to the tidal habitat downstream of the fall line. For this reason, the Watkins site was determined to be a pivotal sampling location. Also, because the herring juveniles are not chemically marked, collection of any herring above the dam would indicate successful spawning of transported adults. Figure 1 shows the 1996 American shad juvenile CPUE trend for both push net and electrofishing samples at Watkins. Push net sampling for American shad juveniles was terminated when the fish began to exceed 90 mm at which size the fish are able to start avoiding the net (Doug Dixon, VIMS - pers. comm.). When blueback herring juveniles were finally located by electrofishing (Table 4) they were still less than 90 mm. Push net sampling may still have been effective for bluebacks throughout September and October.

Hurricane Fran, which occurred just after Labor Day 1996, caused severe flooding of the James River. However, even after the flood, juvenile alosids were still found above the dam (Tables 4 and 5; Figure 1). As the water temperature dropped, the electrofishing CPUE for American shad juveniles also declined (Figure 1). November electrofishing did not result in the collection of any alosids upstream of Boshier Dam so efforts were ceased. More information is needed to better understand the mechanisms contributing to out migration of juvenile alosids in the James River above Boshier Dam.

Otoliths were extracted from a subsample of 50 (30%) juvenile American shad collected with the push net on July 1, 1996. All 50 fish displayed the oxytetracycline (OTC) mark that was administered at the King and Queen State Hatchery. Confirmation of fry surviving to the juvenile phase and the retention of the OTC marks are both major milestones for the American shad stocking program. When the fishway at Boshier Dam is complete (1998) and shad are naturally spawning above the dam, the OTC marking tool will be especially beneficial for distinguishing hatchery fish from wild fish. This information will contribute to analyzing the contribution of both fish passage and stocking efforts. (Complete hatchery product evaluation details are provided in the 1996 report "Virginia's American Shad Restoration Product" which is attached).

Finding even a few river herring juveniles above Boshier Dam was a major step for the Trap and Transport project. Some portion of the adult herring survived translocation and were able to spawn. The eggs survived and hatched, and the fry grew to the juvenile phase. There is no tool available to distinguish "wild" fish from "relocated" fish in areas where both may occur which presents a challenge for attempting to analyze the contribution of Trap and Transport to the herring run restoration effort. However, with virtually no run presently occurring at Boshier Dam, a future, recognizable run may be due in part to the Trap and Transport effort.

Other Fish Passage Coordination Efforts

During this grant period the Virginia Fish Passage Coordinator also continued to coordinate other, ongoing, projects funded by other sources (i.e. federal grants, state funds, local funds, private funds, etc.). The following is a brief update on additional Virginia projects that are not specific to this grant but are closely related to the work done under this grant.

Ashland Mill Dam, South Anna River, Hanover County:

This 13' dam blocks 9 miles of spawning habitat on the South Anna River up to the Ashland water supply dam (3') which blocks another 28 miles. Negotiations with the owner, Ashland Milling Company (Linwood Attkisson), have temporarily been terminated due to problems over personal financing of the project. The VDGIF offered federal grant money (#NA36FU0326) but could not guarantee that the owner would not be required to spend any personal funds or time on the fishway. The VDGIF plans to reopen negotiations with the owner in the future. However, Chesapeake Bay Program funds originally granted for the Ashland project were first extended and transferred to the Ruffins Pond Dam project and then again extended and transferred to the Boshier Dam fishway project. Further details on this project will be provided in the final report for Grant #NA36FU0326 which was extended until September 30, 1998.

Ruffins Pond Dam, Massaponax Creek, Spotsylvania County:

This 16' dam is owned by Tarmac, Inc. and a fishway is needed to reopen 8 miles of spawning habitat above the dam. This includes 3.5 miles on Massaponax Creek (including 122 acres of Ruffins Pond), and 4.5 miles on a permanent tributary of Massaponax Creek. The final design was completed by J.K. Timmons and Associates in December 1996 and was accepted by Tarmac, the USFWS and the VDGIF. Two construction bids were received in January 1997. Unfortunately, both bids were approximately \$275K over the available grant amount (\$208K for construction). Tarmac considered donating \$40K worth of materials but was not able to supply the remaining funds (about \$125K). This project was postponed indefinitely and the remaining grant funds were transferred to the Boshier Dam fishway project which was in need of additional funding. Details on this project will be provided in the final report for grant #NA36FU0326 which was extended until September 30, 1998.

Boshier Dam, James River, Henrico County: This 10' dam is the last blockage to migratory fishes on the James River in Richmond, and a vertical slot fishway will reopen 137.6

mainstem miles of anadromous fish spawning habitat up to Lynchburg. Approximately 200 miles of additional spawning habitat will also become accessible on major tributaries (e.g., 36.3 miles on the Rivanna River). The final design and construction bidding was completed in 1996 by J.K. Timmons and Associates. After receiving high bids (twice the original budget), additional funds had to be raised and construction was finally begun on a vertical slot fishway on June 23, 1996 by English Construction, Inc. and should be completed in time for the 1998 spawning run. Fund raising for this project was a multi-faceted, public-private venture spearheaded by the James River Association. The fishway will be operated and monitored by the VDGIF and the City of Richmond will maintain the structure (CSX Railroad is transferring ownership to the City of Richmond). Details on this project will be provided in the final reports for Grant #NA46FU0284 (design - ends December 31, 1997) and Grant #NA36FU0326 (portion of construction - ends September 30, 1998).

Harvell Dam, Appomattox River, City of Petersburg:

The owner, Joshua Greenwood, is constructing a Denil fishway for this 9' dam in accordance with FERC orders (license #8657). The fishway will have one entrance channel on the new hydro siphon unit side and one on the spillway side. The lower portions of the fishway and the sections that interface with the dam crest were made of concrete. The main baffle run sections are being fabricated out of steel and wooden baffles will be inserted.

The fishway is scheduled to be operational in time for the 1998 spawning run and will reopen 5.6 miles of spawning habitat up to the Abutment Dam (Battersea Dam is passable and is also a FERC project owned by Greenwood).

Abutment Dam, Appomattox River, City of Petersburg:

The Abutment Dam is an old Virginia Electric and Power Company facility that currently serves only as a water source for an historic canal. This dam is located 1.4 miles below Brasfield Dam (Lake Chesdin) and 5.1 miles upstream of Battersea Dam (Greenwood; FERC license). The Abutment Dam zigzags across the river and is connected to an island in the middle. An old, non-functional, pool and weir fishway exists near the north shore. A natural breach has formed near the old fishway, but the dam is too high for the breach to be passable. We are uncertain as to how the City of Petersburg plans to deal with the issue of fish passage at this dam. A Denil fishway will be completed at Harvell Dam (FERC) in time for the 1998 spawning run so migratory fishes will soon be reaching the Abutment Dam. The USFWS is preparing conceptual plans for a series of notches to pass fish over the Abutment Dam. No formal plans have yet been made.

Embrey Dam, Rappahannock River, Spotsylvania County:

This 22' dam on the Rappahannock River in Fredericksburg is the only mainstem migration impediment and is located about one mile upstream of the head of tide in the fall line. Passage here would reopen 70.6 miles of the mainstem and several miles on significant tributaries (e.g., 41.6 miles on the Rapidan River). In 1994 a sediment study done by the VDGIF and DEQ showed the sediments to be non-toxic. These results allowed for consideration of removing all or part of the dam. In 1996, the City of Fredericksburg and Spotsylvania County

made the decision to build a joint water plant at Mott's Run Reservoir which is on a tributary to the Rappahannock a few miles upstream of Embrey. This will make Embrey obsolete as a potable water supply by early 1999. In January 1997, the VDGIF was instructed by Virginia Senate Joint Resolution No. 296 to conduct a feasibility study on providing fish passage at Embrey Dam. J.K. Timmons & Associates was hired in June 1997 to complete this study which included a synthesis of all previous studies, development of technical and local decision matrices, recommendations, and cost estimates for various scenarios. GKY & Associates was sub-contracted by Timmons to evaluate the sediment load entrapped by the dam and to conduct a sediment fate and transport study (HEC-6 model). Throughout the study all interested parties and agencies were included in discussions and their comments were incorporated into the decision making process. The report, which was funded by the state, was submitted to the General Assembly in December 1997 for review in the 1998 session. After acceptance by the General Assembly, the study will be available for use in the decision making process.

Additional Fish Passage Program Efforts

The Fish Passage Coordinator is also involved in the ongoing process of pursuing additional fish passage projects as they are needed, and as they fit into the long range planning for restoration in Virginia. Public and professional meeting speaking engagements and written communication are also an integral part of the process of promoting and advancing the Fish Passage Program. Opportunities for anadromous fish restoration education are an additional, and very important, part of the overall program. The educational aspect of the program will be expanded in the future.

TABLE 1. Blueback herring stocked by site from April 22, 1996 to May 2, 1996 during the Trap and Transport Project (VDGIF and USFWS combined). The fish were collected at Walker's Dam on the Chickahominy River (lower, major tributary of the James).

Stream	Stocking Site	No. of Bluebacks Stocked	Percent Mortality
James River	Columbia	4,076	9.4
Big Lickinghole Creek	Rt. 6	360	7.7
Byrd Creek	Rt. 603	437	9.2
Herring Creek	Harrison Lake	1,271	5.9
	TOTAL	6,144	8.6

TABLE 2. Maximal CPUE (fish/hr) for alosid species collected during spring 1996 electrofishing sampling at several locations on Virginia Chesapeake Bay tributaries from March to June.

River	Site	Blueback herring (fish/hr)	American shad (fish/hr)	Hickory shad (fish/hr)	Alewife (fish/hr)
Appomattox	Harvell Dam (Denil construction)	2.6	0.0	100.0	13.2
James	14th Street (fall line)	41.3	0.0	1.8	0.0
James	Bosher Dam (vert. slot const.)	2.3	29.6	0.0	0.0
Chickahominy	Walkers Dam (existing Denil)	4095.5	0.0	11.6	3.9
S. Anna	Ashland Mill Dam (future Denil)	8.1	37.8	0.0	0.0
Rappahannock	Route 1 (fall line)	24.3	0.0	0.0	102.8
Rappahannock	Embrey Dam (future passage)	21.3	0.0	0.0	0.0
Pamunkey	301 Bridge	0.0	0.0	0.0	0.0

TABLE 3. - Description of James River and Pamunkey River sites sampled during the 1996 juvenile alosid monitoring effort.

Site	River	Time Sampled	Gear Used	Site Characteristics
Columbia	James	N	P	~ 45 miles above Boshers dam, site is about 1 mile long typified by a shallow pool between boat landing and upstream riffle, site contains Rivanna River confluence
Westview	James	D,E,N	E,P,H,I	~ 31.5 miles above Boshers Dam, site is about 2 miles long typified by shallow pool and run characteristics with two large islands between boat landing and downstream riffle
Maidens	James	E,N	E,H	~ 20.7 miles above Boshers Dam, site is about 2.5 miles long typified by pool and run characteristics with several islands and sand bars between boat landing and upstream riffle
Watkins	James	D,N,E	E,P,I	site begins at Boshers Dam and extends ~ 8.3 miles upstream to the boat landing site is a large pool with suburban and agricultural land use and includes Tuckahoe Creek confluence
Boshers	James	E,N	E,P,I	site begins immediately below Boshers Dam and extends ~ 1 mile downstream to riffle, typified by run/riffle characteristics with several islands, sand bars and with numerous large boulders
Mayos	James	E,N	E,P,I	~ 9 miles downstream of Boshers Dam, site is about 2.5 miles long extending between the riffle at 14th St. Bridge and below Richmond Waste Water Treatment outfall, typified by pool and run characteristics with islands, sandbars, industrial outfalls; located within City of Richmond limits just downstream of downtown
Osborne	James	E	E	~ 20 miles downstream of Boshers Dam, site has pool characteristics that extend about 1.5 miles between boat landing and 1/4 mile downstream of Virginia Power outfall
Interstate 295	James	N	P	~ 23 miles downstream of Boshers Dam, site has pool characteristics with several large tidal flats, site extends about 1 mile upstream and downstream of I295 Bridge
Hopewell	James	E,N	E,P	~ 31 miles downstream of Boshers Dam, site starts in the mouth of the Appomattox River and extends about 3 miles upstream to Turkey Island
Benjamin Harrison Br.	James	E,N	E,P	~ 33 miles downstream of Boshers Dam, site has large tidal river characteristics with many large tidal flats, site starts at City Point (mouth of Appomattox) and extends about 1.5 miles downstream of Benjamin Harrison Bridge near Buoy marker #89 on the James River
Lafferty's	Pamunkey		E	~ 34 miles above mouth (West Point), tidal, main channel
Rockahock	Pamunkey	N	E,P	~ 29 miles above mouth (West Point), tidal, main channel
Cumberland	Pamunkey	N	P	~ 22 miles above mouth (West Point), tidal, wash channel on outside bend of tidal flat and main channel (1 mile above and at Cumberland Landing)

Time of Day Sampled

D: daytime sampling

E: evening/dusk sampling

N: nighttime sampling

Gear Used

E: electrofishing

P: push-net

H: haul seine

I: ichthyoplankton net

TABLE 4. - Results of summer and fall 1996 push net surveys for alosid juveniles at several sites on Virginia Chesapeake Bay tributaries presented as CPUE (fish/hr).

Site	River	Date	Effort (hrs)	Blueback herring (fish/hr)	American shad (fish/hr)	Alewife (fish/hr)	Hickory shad (fish/hr)	Total <i>Alosa</i> (fish/hr)
Above Bosher Dam								
Columbia	James	24Jul96	0.40	0.00	0.00	0.00	0.00	0.00
Westview	James	10Jul96	0.54	0.00	0.00	0.00	0.00	0.00
Watkins	James	01Jul96	1.25	0.00	132.00	0.00	0.00	132.00
Watkins	James	17Jul96	0.33	0.00	24.24	0.00	0.00	24.24
Watkins	James	19Aug96	1.00	0.00	1.00	0.00	0.00	0.00
Below Bosher Dam								
Bosher Dam	James	23Jul96	0.43	0.00	0.00	0.00	0.00	0.00
Mayos	James	02Jul96	1.00	69.00	88.00	0.00	0.00	157.00
295	James	29Jul96	0.45	1522.22	2.22	0.00	0.00	1524.44
Hopewell	James	06Aug96	0.50	3544.00	0.00	0.00	0.00	3544.00
Shad Broodstock Area								
Cumberland	Pamunkey	25Jun96	0.58	0.00	72.41	0.00	0.00	72.41
Rockahock	Pamunkey	01Aug96	0.50	694.00	280.00	0.00	0.00	974.00

TABLE 5. - Results of summer and fall 1996 electrofishing surveys for juvenile alosids at several sites on Virginia Chesapeake Bay tributaries presented as CPUE (fish/hr).

Site	River	Date	Effort (hrs)	Blueback herring (fish/hr)	American shad (fish/hr)	Alewife (fish/hr)	Hickory shad (fish/hr)	Total <i>Alosa</i> (fish/hr)
Above Boshers Dam								
Westview	James	03Jun96	0.5	0.00	0.00	0.00	0.00	0.00
Westview	James	18Jun96	0.45	0.00	0.00	0.00	0.00	0.00
Westview	James	08Aug96	0.67	0.00	0.00	0.00	0.00	0.00
Maidens	James	01Aug96	1.25	0.00	2.40	0.00	0.00	2.40
Maidens	James	24Sep96	0.70	0.00	0.00	0.00	0.00	0.00
Maidens	James	01Oct96	0.98	0.00	0.00	0.00	0.00	0.00
Watkins	James	05Jun96	0.68	0.00	0.00	0.00	0.00	0.00
Watkins	James	16Jul96	1.53	0.00	3.27	0.00	0.00	3.27
Watkins	James	13Aug96	0.95	1.05	9.47	0.00	0.00	10.53
Watkins	James	04Sep96	0.58	0.00	41.38	0.00	0.00	41.38
Watkins	James	17Sep96	1.08	0.00	16.67	0.00	0.00	16.67
Watkins	James	07Oct96	0.95	0.00	1.05	3.15	0.00	4.20
Watkins	James	05Nov96	0.61	0.00	0.00	0.00	0.00	0.00
Watkins	James	19Nov96	1.33	0.00	0.00	0.00	0.00	0.00
Below Boshers Dam								
Boshers Dam	James	19Jun96	0.91	0.00	0.00	0.00	0.00	0.00
Mayos	James	21Aug96	0.58	8.62	6.90	0.00	0.00	15.52
Osborne	James	14Aug96	0.34	23.53	5.88	0.00	0.00	29.41
Osborne	James	21Aug96	0.46	80.43	10.87	0.00	0.00	91.30
Osborne	James	29Oct96	0.09	0.00	200.00	0.00	0.00	200.00
Hopewell	James	06Aug96	1.10	139.09	0.00	0.00	0.00	139.09
Benj. Harr.	James	28Aug96	0.85	21.28	0.00	0.00	0.00	21.28
Shad Broodstock Area								
Rockahock	Pamunkey	18Sep96	0.49	26.53	185.71	4.08	0.00	216.32
Lafferty's	Pamunkey	30Oct96	0.73	0.00	52.05	0.00	0.00	52.05

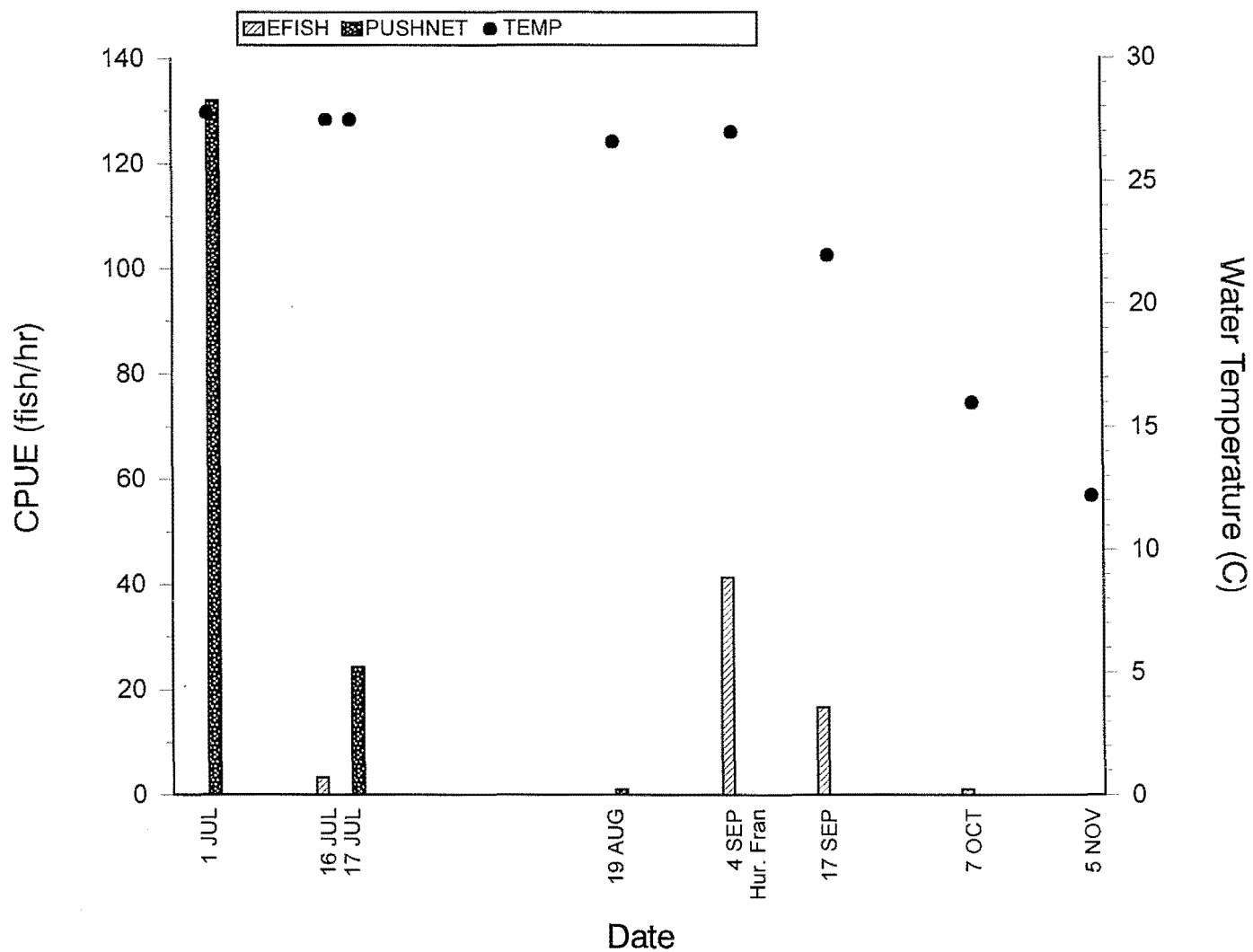


FIGURE 1. - CPUE (fish/hr) for American shad juveniles from 1996 electrofishing and pushnet samples in the pool above Bosher Dam (Watkins). Hurricane Fran hit the James River watershed on September 6, 1996.