SUMMARY OF OPERATIONS AT THE CONOWINGO DAM EAST FISH PASSAGE FACILITY SPRING 2015

December 2015

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EXECUTIVE SUMMARY

Operation of the Conowingo East Fish Lift (EFL) began April 3, 2015 as the water temperature was near the season start trigger value of 50°F (49.2°F actual average EFL trough water temperature on April 3) and river flow was 44,600 cfs. The first two American shad were passed on April 21 at a water temperature of 58.8°F. The EFL operated for 46 days in 2015 of which only 15 days occurred in April due to low water temperatures (45.4°F to 48.8°F), and or high river flows above 100,000 cfs (107,000 cfs to 177,000 cfs). It should be noted that the EFL was operated on 5 days in April with river flows ranging from 100,000 cfs to 123,000 cfs resulting in the passage of only one American shad. Based on information gained in 2015 and in previous years, the standard operating procedure when spill conditions are in effect should be to cease operations when river flow is ≥ 100,000 cfs as very few American shad are attracted and passed during these severe conditions.

Continuous operation of the EFL occurred from April 20 through May 31(when operations were terminated in concurrence with the resource agencies). The 2015 fish passage season marks the twenty-fifth season of overall operation and the nineteenth year of volitional fish passage at the Conowingo EFL.

The EFL passed 754,057 fish of 29 species and one hybrid. Gizzard shad (742,661), American shad (8,341), and channel catfish (1,118) dominated the catch, and comprised nearly 100% of the total fish collected and passed. Gizzard shad alone accounted for 98% of the total fish collected and passed.

A total of 8,341 American shad was passed. The highest daily passage of American shad occurred on May 13 when 1,154 shad were passed upstream. On only 3 of the 46 days of operation, American shad passage exceeded 1,000 fish. On a daily basis, overall shad passage was strongest through the fishway between 0900-0959 hours and again between1700-1859 hours during which nearly 40% of all shad passage occurred.

Fishway operations were conducted at water temperatures ranging from 45.4°F to 78.5°F and river flows between 13,200 and 123,000 cfs. River flows of 100,000 cfs or higher (flow range: 100,000 to 177,000 cfs) occurred on 13 days between April 6 and April 24.

Prior to the start of EFL operations in 2015, routine pre-season maintenance activities were conducted and included testing of the fish collection equipment (crowder, crowder screen hoist, hopper hoist motor, and hopper door along with inspection of associated air hoses, pneumatic cylinders, etc.). These pre-season maintenance activities along with routine maintenance performed during the season resulted in no loss of fishing time due to any mechanical failures during the entire fish passage season.

On 34 of the 46 days of operation, water clarity was excellent (20 -36 inches of visibility at viewing window), allowing the viewing technicians to identify American shad with attached Maryland DNR floy tags. The number of floy tags observed at the Conowingo EFL in 2015 was 9, (2 yellow = 2014 effort; 7 blue = 2015 effort).

Future operations of the EFL will build on the past twenty-five years of operation experience.

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1.0 INTRODUCTION

Exelon Generation Company, LLC, formerly the Susquehanna Electric Company (SECO), has operated a fish passage facility (West lift) at its Conowingo Hydroelectric Station since 1972. Lift operations are part of a cooperative private, state, and federal effort to restore American shad (*Alosa sapidissima*) and other migratory fishes to the Susquehanna River. In accordance with the restoration plan, the operational goal had been to monitor fish populations below Conowingo Dam and transport pre-spawned migratory fishes upriver.

In 1988, the former PECO Energy Company negotiated an agreement with state and federal resource agencies and private organizations to enhance restoration of American shad and other anadromous species to the Susquehanna River. A major element of this agreement was for PECO Energy Company to construct an East Fish Lift Passage Facility (EFL) at Conowingo Dam. Construction of the EFL commenced in April 1990 and it was operational by spring 1991.

With the completion of fishways at Holtwood, Safe Harbor, and York Haven dams, the EFL has been operated to pass fish directly into Conowingo Pond since spring 1997.

Objectives of 2015 operation were: (1) monitor passage of migratory and resident fishes through the fishway; and (2) assess fishway and trough effectiveness and make modifications as feasible.

2.0 CONOWINGO OPERATION

2.1 Project Operation

The Conowingo Hydroelectric Station, built in 1928, is located at river mile 10 on the Susquehanna River (RMC 1992). The powerhouse has a peaking generating capacity of 549.5 MW and a hydraulic capacity of approximately 85,000 cfs. Flows in excess of station draft are spilled through two regulating and 50 crest gates. The powerhouse contains seven vertical Francis (numbered 1 through 7) and four Kaplan (numbered 8 through 11) turbines. The seven Francis units have been equipped with aeration systems that permit a unit to draw air into the unit (vented mode) or operate conventionally (unvented mode). The four original Kaplan turbines installed in 1964 were replaced over a period of four years (1992 to 1996), with more efficient mixed-flow Kaplan type turbines.

Minimum flow releases from the station during the spring spawning and fishway operating season follow the schedule outlined in the settlement agreement. Minimum flows of 10,000 cubic feet per second (cfs) or natural river flow, whichever is less, as measured at the United States Geological Survey (USGS) gauge at Marietta, PA were maintained for the period 1 to 30 April. A minimum flow of 7,500 cfs or natural river flow (as previously noted) was maintained for the period 1 to 31 May. A minimum flow of 5,000 cfs or natural river flow (as previously noted) is maintained when fish lift operations occur in June.

2.2 Fishway Operation

The start of operation for the EFL in 2015 began on April 3, 2015. The first American shad (2) were passed on April 21 (Table 1). The EFL operated for 46 days in 2015 despite dealing with river flows in excess of 100,000 cfs on 13 days in April. Continuous operation of the EFL occurred from April 20 through May 31when operations were terminated in concurrence with the Resource Agencies.

Daily operation times were planned during optimal fish passage parameters. This year, operational methodologies were influenced by natural river flow, water temperature, generation and spill conditions, and daily/hourly fish passage numbers. EFL operation was conducted by a staff of three personnel: a lift operator, a supervising biologist, and a biological technician.

The mechanical aspects of EFL operation in 2015 were similar to those described in RMC (1992) and Normandeau Associates, Inc. (1999). Fishing time and/or lift frequency was determined by fish abundance, but the hopper was generally cycled twice per hour throughout the day. The method of lift operation was also influenced by fish abundance. When a large number of fish were in the fishing channel, the crowder was not operated; instead the crowder screen was raised and then lowered, trapping fish over the hopper. This mode of operation, called "fast fish", involved leaving the crowder in the normal fishing position and raising the hopper frequently to remove fish that accumulated in the holding channel.

The specific entrance(s) used to attract fishes was dictated by the station discharge and which turbine units were operating. For example, when Kaplan turbine units 8, 9, 10, and 11 or any combination of Kaplan turbines were operating, entrance C was the primary entrance used to attract fishes. Under these conditions the attraction flow through the other entrances is negated or disrupted. Depending on river flow and/or generation, either entrance A or C was utilized most often throughout the 2015 season to attract fishes.

2.3 Fish Counts

Fish that were lifted and sluiced into the trough were guided by a series of fixed screens. The fixed screens directed the fish to swim up and through a 3 ft wide channel and past a 4 ft by 10 ft counting window located on the west wall of the trough. Fish passing the counting window were identified to species and enumerated by a biologist and/or technician. Passage of fish by the window and out of the trough system was controlled by a set of gates located downstream of the counting window. During periods of peak passage, two people were used to identify and count fish.

At the end of each hour, fish passage data were recorded on data sheets and entered into a Microsoft Excel worksheet on a Personal Computer. Data processing and reporting were PC based and accomplished by program scripts, or macros, created within Microsoft Excel software. After the technician verified the correctness of the raw data, a daily summary of fish passage was produced and distributed electronically to plant personnel. Each day's data were backed up and stored off site. Daily reports and weekly summaries of fish passage were electronically distributed to plant personnel and other cooperators.

3.0 RESULTS

3.1 Relative Abundance

The number of fishes collected and passed by the Conowingo Dam EFL is presented in Table 1. A total of 754,057 fish of 29 species and one hybrid passed upstream into Conowingo Pond. Gizzard shad (742,661), American shad (8,341), and channel catfish (1,118) dominated the catch, and comprised nearly 100% of the total fish collected and passed. Gizzard shad alone accounted for 98% of the total fish collected and passed. Peak passage occurred on May 11 when 43,333 fish, (nearly 99% gizzard shad), were passed.

3.2 American Shad Passage

The EFL collected and passed 8,341 American shad (Table 1). The first 2 American shad passed on April 21. Collection and passage of shad varied daily with 1% (72) of the shad passed from April 3 to April 30, 85% (7,127) passed from May 1 to May 15, and 14% (1,142) passed from May 16 to

May 31, (Figures 1 and 2). On 3 of the 46 days of operation, American shad passage exceeded 1,000 fish. The largest number of American shad passed at the EFL in 2015 occurred on May 13 (1,154).

American shad were collected and passed at water temperatures ranging from 58.8°F to 78.5°F and river flows between 13,200 and 113,000 cfs (Table 2, and Figure 1). The average daily river flow on the 3 days when American shad passage exceeded 1,000 fish ranged between 19,500 cfs and 33,700 cfs. The average daily river flow during the operational season was 57,953 cfs.

The hourly passage of American shad at the EFL is given in Table 3. On a daily basis, overall shad passage was strongest through the fishway between 0900 hours and 0959 hours and again from 1700 hrs through 1859 hrs during which nearly 40% of the total American shad passage occurred. The highest hourly passage rate occurred from 0900 to 0959 hours.

3.3 Gizzard Shad Passage

The EFL collected and passed 742,661 Gizzard shad in 2015 (Tables 1 and 4). Gizzard shad accounted for 98% of the total fish collected and passed. On 2 of 46 days of operation, Gizzard shad passage exceeded 40,000 fish. Gizzard shad passage exceeded 30,000 and 20,000 fish on 6 and 10 days, respectively. Table 4 provides the ratio of American shad to Gizzard shad for the years of volitional passage (1997-2015). In years when American shad passage exceeds 50,000 fish, the ratio ranges from 1:2 – 1:14 (Am. shad/gizzard shad). For those years when American shad passage is less than 50,000 fish, the ratio ranges from 1:16 – 1:112. The year 2011 is an exception to this because of the agency requested shutdown on May 19, 2011 which ended EFL operations earlier than previous years.

3.4 Alosids

A small number of river herring, (10 alewife and 3 blueback herring) were passed during the 2015 season. Eight hickory shad were also passed in spring 2015.

3.5 Maryland tag-recapture

During the 2015 season, the EFL passed American shad that were captured, floy-tagged and released downstream of Conowingo dam by the Maryland DNR. This year, the Maryland DNR tagged a total of 298 American shad. The number of floy tags observed at the Conowingo EFL in 2015 was 9; 2 yellow tags (2014 effort) and 7 blue tags (2015 effort).

4.0 SUMMARY

EFL operation was initiated on April 3 as river water temperature was nearly 50°F (49.2°F) and river flow was 44,600 cfs. The first 2 American shad passed on April 21 at a water temperature of 58.8°F. The EFL passed 8,341 American shad from April 21 through May 31. The total number of American shad passed during the 2015 season was the lowest passage value recorded since 1993 (8,203 American shad) when the EFL was operated for trap and transport purposes (Tables 4, 5, and 6). It is also the third consecutive year in which the EFL passed less than 13,000 American shad.

Modifications made to the fish trough, particularly the valve grating and hopper trough chute since 1999 have diminished the potential for the valve grating to clog with various types of debris and have decreased the number of American shad lift mortalities observed throughout the last several fish

passage seasons. Since the valve grating was modified prior to the start of the 2000 season, loss of water flow in the trough has not occurred, particularly during high river flow periods when large amounts of debris may enter the trough through the fish exit area. An aeration system was also installed prior to the 2000 passage season to diminish low dissolved oxygen levels when the American shad population is heavy in the trough. Prior to fishway operations in 2002, a 30 inch diameter fiberglass elbow was attached to the hopper extension chute, which had been installed in 2001. The modification allows fish to enter the trough center stream, instead of being directed toward the east trough wall. A decrease in lift mortalities has also been observed since the fiberglass elbow was installed. A total of 243 American shad lift mortalities that did not contain PIT tags from the Holtwood fish passage efficiency study, (2.9% of the total shad passed), was observed in 2015, slightly higher than the range observed in recent years (0.2% to 1.0%) but less than values observed during trap and transport operations (1.5% to 10.5%). A sharp increase in river water temperature observed from May 2 to May 9 (58.4°F to 70.6°F) and then sustained water temperatures above 71°F for the remainder of the season may have attributed to the higher number of lift mortalities in 2015.

Prior to the start of EFL operations in 2015, routine preseason maintenance activities were conducted, and included testing of the fish collection equipment (crowder, crowder screen hoist, hopper hoist motor, and hopper door along with inspection of associated air hoses, pneumatic cylinders, etc.). These maintenance activities, along with routine maintenance activities performed in season resulted in no loss of fishing time due to mechanical failures during the entire fish passage season.

5.0 RECOMMENDATIONS

1) Continue to operate the EFL at Conowingo Dam per annual guidelines developed and approved by the Susquehanna River Technical Committee. Lift operation should adhere to the guidelines; however, flexibility must remain with operating personnel to maximize fishway performance and fish passage.

2) Continue the use of two fish counters during periods of increased fish passage to accurately reflect the number of fish that pass through the EFL.

3) Continue to inspect cables, limit switches, and lift components to enhance season operability, and continue to evaluate effectiveness of fish trough and hopper door modifications.

6.0 LITERATURE CITED

RMC. 1992. Summary of the operations of the Conowingo Dam fish passage facilities in spring 1991. Prepared for Susquehanna Electric Company, Darlington, MD.

Normandeau Associates, Inc. 1999. Summary of the operations at the Conowingo Dam East fish passage facility in spring, 1998. Prepared for Susquehanna Electric Company, Darlington, MD.

TABLES AND FIGURES

Table 1

Summary of the daily number of fish passed by the Conowingo Dam East Fish Passage Facility in 2015.

Date	4/3	4/4	4/5	4/6	4/7	4/8	4/9	4/10	4/11	4/12
Start Fishing Time	9:00						8:30			
End Fishing Time	17:00						16:30			
Elapsed Fishing Time	8.0						8.0			
Lifts Per Day	15						8			
Water Temperature (°F)*	49.2	47.4	47.6	48.8	48.8	46.9	45.4	44.7	44.6	45.3
AMERICAN SHAD	0						0			
BLUEBACK HERRING	0						0			
ALEWIFE	0						0			
GIZZARD SHAD	0						0			
HICKORY SHAD	0						0			
STRIPED BASS	0						0			
SEA LAMPREY	0						0			
RAINBOW TROUT	0						0			
BROWN TROUT	0						0			
MUSKELLUNGE	0						0			
CARP	0						0			
QUILLBACK	0						0			
WHITE SUCKER	0						0			
SHORTHEAD REDHORSE	0						0			
BROWN BULLHEAD	0						0			
CHANNEL CATFISH	0						0			
WHITE PERCH	0						0			
HYBRID STRIPED BASS	0						0			
ROCK BASS	0						0			
PUMPKINSEED	0						0			
BLUEGILL	0						1			
SMALLMOUTH BASS	0						0			
LARGEMOUTH BASS	0						0			
YELLOW PERCH	0						0			
WALLEYE	0						0			
AMERICAN EEL	0						0			
GOLDEN SHINER	0						0			
SPOTTAIL SHINER	0						0			
SPOTFIN SHINER	0						0			
ATLANTIC NEEDLEFISH	0						0			
Total	**0**						**1**			

Table 1 (continued)

Date	4/13	4/14	4/15	4/16	4/17	4/18	4/19	4/20	4/21	4/22
Start Fishing Time			8:30		8:30			8:00	8:00	8:00
End Fishing Time			16:30		16:30			16:00	16:00	16:00
Elapsed Fishing Time			8.0		8.0			8.0	8.0	8.0
Lifts Per Day			8		8			12	10	13
Water Temperature (°F)	46.7	48.5	49.4	50.7	51.8	54.1	56.1	57.7	58.8	58.4
AMERICAN SHAD			0		0			0	2	1
BLUEBACK HERRING			0		0			0	0	0
ALEWIFE			0		0			0	3	0
GIZZARD SHAD			8		1,880			15,600	13,605	29,300
HICKORY SHAD			0		0			8	0	0
STRIPED BASS			0		0			0	0	0
SEA LAMPREY			0		0			1	1	1
RAINBOW TROUT			0		0			0	0	0
BROWN TROUT			0		0			0	0	1
MUSKELLUNGE			0		1			0	0	0
CARP			0		0			1	0	0
QUILLBACK			0		0			0	2	0
WHITE SUCKER			0		0			0	0	1
SHORTHEAD REDHORSE			1		15			0	4	5
BROWN BULLHEAD			0		0			0	0	0
CHANNEL CATFISH			1		0			4	2	18
WHITE PERCH			0		0			0	0	0
HYBRID STRIPED BASS			0		1			0	0	0
ROCK BASS			0		0			0	0	0
PUMPKINSEED			0		0			0	0	0
BLUEGILL			0		0			0	0	0
SMALLMOUTH BASS			0		0			0	2	3
LARGEMOUTH BASS			0		0			0	0	1
YELLOW PERCH			0		0			0	0	0
WALLEYE			0		0			4	0	0
AMERICAN EEL			0		0			1	0	0
GOLDEN SHINER			0		0			0	0	0
SPOTTAIL SHINER			0		0			0	0	0
SPOTFIN SHINER			0		0			0	0	0
ATLANTIC NEEDLEFISH			0		0			0	0	0
Total			**10**		**1,897**			**15,619**	**13,621**	**29,331**

Table 1 (continued)

Date	4/23	4/24	4/25	4/26	4/27	4/28	4/29	4/30	5/1	5/2
Start Fishing Time	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00	7:30
End Fishing Time	14:00	14:00	16:00	16:00	16:00	16:00	16:00	18:00	18:00	18:00
Elapsed Fishing Time	6.0	6.0	8.0	8.0	8.0	8.0	8.0	10.0	10.0	10.5
Lifts Per Day	9	8	8	8	9	10	11	17	18	23
Water Temperature (°F)	57	53.7	51.6	51.2	52.5	53.1	54.9	56	56.9	58.4
AMERICAN SHAD	0	0	0	0	0	0	0	69	333	702
BLUEBACK HERRING	0	0	0	0	0	0	0	0	0	0
ALEWIFE	0	0	0	0	0	1	1	0	3	0
GIZZARD SHAD	12,610	8,886	957	3,146	4,910	7,369	11,140	21,395	25,663	35,116
HICKORY SHAD	0	0	0	0	0	0	0	0	0	0
STRIPED BASS	0	0	0	0	0	0	0	0	1	0
SEA LAMPREY	0	0	0	0	0	0	0	1	1	4
RAINBOW TROUT	1	0	0	0	0	0	0	0	0	0
BROWN TROUT	0	0	0	0	0	0	0	0	0	0
MUSKELLUNGE	0	0	0	0	0	0	0	0	0	0
CARP	0	0	0	0	0	0	1	2	0	0
QUILLBACK	0	0	0	0	0	0	0	0	0	0
WHITE SUCKER	0	0	0	0	0	0	0	0	0	0
SHORTHEAD REDHORSE	11	5	0	0	0	0	2	7	25	5
BROWN BULLHEAD	0	0	0	0	0	0	0	0	0	0
CHANNEL CATFISH	35	20	4	6	0	1	1	2	4	0
WHITE PERCH	0	0	0	0	0	0	0	0	0	0
HYBRID STRIPED BASS	1	0	0	0	0	0	0	0	2	0
ROCK BASS	0	0	0	0	0	0	0	0	0	0
PUMPKINSEED	0	0	0	0	0	0	0	0	0	0
BLUEGILL	0	0	0	0	0	0	0	0	1	0
SMALLMOUTH BASS	1	0	1	0	0	0	0	1	4	2
LARGEMOUTH BASS	2	0	0	0	0	0	0	0	0	0
YELLOW PERCH	0	0	0	0	0	0	0	0	0	0
WALLEYE	1	1	0	1	0	0	0	2	3	0
AMERICAN EEL	0	0	0	0	0	0	0	0	0	0
GOLDEN SHINER	0	0	0	0	0	0	0	0	0	0
SPOTTAIL SHINER	0	0	0	0	0	0	0	0	0	0
SPOTFIN SHINER	0	0	0	0	0	0	0	0	0	0
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	0	0	0	0
Total	**12,662**	**8,912**	**962**	**3,153**	**4,910**	**7,371**	**11,145**	**21,479**	**26,040**	**35,829**

Table 1 (continued)

Date	5/3	5/4	5/5	5/6	5/7	5/8	5/9	5/10	5/11	5/12
Start Fishing Time	8:00	8:45	8:00	8:00	8:00	8:00	7:45	7:45	8:00	8:00
End Fishing Time	18:00	18:30	18:00	19:00	18:05	18:00	18:00	18:00	18:00	19:00
Elapsed Fishing Time	10.0	9.8	10.0	11.0	10.1	10.0	10.3	10.3	10.0	11.0
Lifts Per Day	20	19	21	25	25	21	19	19	21	22
Water Temperature (°F)	61.6	63.1	64.5	66.4	67.2	69.4	70.6	71.5	74.1	75.4
AMERICAN SHAD	385	1,083	755	1,135	465	313	126	106	31	265
BLUEBACK HERRING	0	0	0	0	0	0	0	0	0	0
ALEWIFE	0	0	0	2	0	0	0	0	0	0
GIZZARD SHAD	37,310	31,967	25,906	41,608	38,696	38,839	25,319	21,940	42,870	36,090
HICKORY SHAD	0	0	0	0	0	0	0	0	0	0
STRIPED BASS	0	0	1	0	0	0	4	0	2	1
SEA LAMPREY	0	1	0	2	1	4	4	3	1	2
RAINBOW TROUT	0	1	0	0	0	0	0	0	0	1
BROWN TROUT	0	0	1	0	0	0	0	1	0	0
MUSKELLUNGE	0	0	0	0	1	0	0	0	0	0
CARP	0	3	8	6	7	4	0	2	313	0
QUILLBACK	0	0	0	0	0	15	46	19	0	19
WHITE SUCKER	1	0	0	0	0	0	0	0	0	0
SHORTHEAD REDHORSE	1	2	0	1	3	16	20	18	31	16
BROWN BULLHEAD	0	0	0	0	0	8	1	0	31	21
CHANNEL CATFISH	0	11	3	7	1	4	3	0	26	9
WHITE PERCH	0	0	0	12	3	0	0	0	4	1
HYBRID STRIPED BASS	0	0	0	0	0	0	0	0	0	0
ROCK BASS	0	0	0	0	0	0	0	0	0	1
PUMPKINSEED	0	0	0	0	0	0	0	0	0	0
BLUEGILL	0	0	0	0	0	0	0	0	0	0
SMALLMOUTH BASS	3	2	1	5	6	2	5	17	12	2
LARGEMOUTH BASS	0	0	0	1	0	0	0	0	0	0
YELLOW PERCH	0	0	0	0	0	0	0	0	2	2
WALLEYE	0	2	0	9	3	1	0	0	6	0
AMERICAN EEL	0	0	0	1	0	0	0	0	2	1
GOLDEN SHINER	0	0	1	0	0	0	0	0	0	0
SPOTTAIL SHINER	0	0	0	68	1	0	0	0	2	0
SPOTFIN SHINER	0	0	0	0	0	0	0	0	0	0
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	0	0	0	0
Total	**37,700**	**33,072**	**26,676**	**42,857**	**39,187**	**39,206**	**25,528**	**22,106**	**43,333**	**36,431**

Table 1 (continued)

Date	5/13	5/14	5/15	5/16	5/17	5/18	5/19	5/20	5/21	5/22
Start Fishing Time	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00
End Fishing Time	19:00	18:30	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00
Elapsed Fishing Time	11.0	10.5	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Lifts Per Day	23	19	19	20	19	19	18	18	13	13
Water Temperature (°F)	74.3	73	73.7	73.6	75.4	77.9	76.8	76.2	73.5	72.5
AMERICAN SHAD	1,154	131	143	432	71	23	41	104	15	86
BLUEBACK HERRING	0	2	1	0	0	0	0	0	0	0
ALEWIFE	0	0	0	0	0	0	0	0	0	0
GIZZARD SHAD	16,790	27,562	23,500	20,803	19,880	29,273	14,682	8,125	8,571	6,599
HICKORY SHAD	0	0	0	0	0	0	0	0	0	0
STRIPED BASS	2	0	0	0	3	0	1	16	15	6
SEA LAMPREY	3	1	0	1	1	0	1	1	0	1
RAINBOW TROUT	1	0	0	0	0	0	0	0	0	0
BROWN TROUT	1	0	0	1	0	0	0	0	0	0
MUSKELLUNGE	0	0	0	0	0	0	0	0	0	0
CARP	3	0	1	2	57	33	2	1	3	1
QUILLBACK	3	1	0	0	31	0	10	0	0	1
WHITE SUCKER	0	0	0	0	0	0	0	0	0	0
SHORTHEAD REDHORSE	12	2	2	5	0	0	0	0	0	0
BROWN BULLHEAD	0	4	21	0	18	3	12	14	0	1
CHANNEL CATFISH	11	7	10	7	23	59	65	137	113	74
WHITE PERCH	0	0	0	0	0	0	0	0	0	0
HYBRID STRIPED BASS	0	0	0	0	0	0	0	0	0	0
ROCK BASS	0	0	0	0	0	0	0	0	0	0
PUMPKINSEED	0	0	0	0	0	0	0	0	0	0
BLUEGILL	3	2	0	1	0	4	0	1	0	3
SMALLMOUTH BASS	1	2	5	2	2	5	1	1	1	1
LARGEMOUTH BASS	1	0	0	1	0	0	1	1	1	0
YELLOW PERCH	2	0	0	0	0	0	0	0	0	0
WALLEYE	0	0	1	0	2	7	4	3	14	2
AMERICAN EEL	0	0	0	7	16	0	2	2	1	3
GOLDEN SHINER	0	0	0	0	0	0	0	0	0	0
SPOTTAIL SHINER	0	0	0	0	0	0	0	0	0	0
SPOTFIN SHINER	0	0	0	0	0	0	0	0	0	0
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	1	0	0	0
Total	**17,987**	**27,714**	**23,684**	**21,262**	**20,104**	**29,407**	**14,823**	**8,406**	**8,734**	**6,778**

Table 1 (continued)

Date	5/23	5/24	5/25	5/26	5/27	5/28	5/29	5/30	5/31	
Start Fishing Time	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00	**Season**
End Fishing Time	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	**Total**
Elapsed Fishing Time	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	433
Lifts Per Day	10	10	10	10	8	10	10	10	8	674
Water Temperature (°F)	72.1	73.4	73.9	75.8	74.8	76	77.7	77.2	78.5	
AMERICAN SHAD	58	64	69	15	32	46	11	56	19	8,341
BLUEBACK HERRING	0	0	0	0	0	0	0	0	0	3
ALEWIFE	0	0	0	0	0	0	0	0	0	10
GIZZARD SHAD	3,640	2,217	8,205	3,155	2,298	5,290	3,184	5,100	1,657	742,661
HICKORY SHAD	0	0	0	0	0	0	0	0	0	8
STRIPED BASS	6	13	19	73	43	34	40	25	102	407
SEA LAMPREY	0	1	2	0	1	1	1	2	2	46
RAINBOW TROUT	0	0	0	0	0	0	0	0	0	4
BROWN TROUT	0	0	0	0	0	1	0	0	0	6
MUSKELLUNGE	0	0	0	0	0	0	0	0	0	2
CARP	1	0	1	2	1	0	2	0	0	457
QUILLBACK	0	1	1	1	1	1	9	1	0	162
WHITE SUCKER	0	0	0	0	0	0	0	0	0	2
SHORTHEAD REDHORSE	0	0	0	0	0	0	1	0	0	210
BROWN BULLHEAD	0	2	0	4	0	0	0	0	0	140
CHANNEL CATFISH	28	82	48	44	141	34	25	18	30	1,118
WHITE PERCH	0	0	0	0	0	0	0	0	0	20
HYBRID STRIPED BASS	3	0	1	0	1	0	0	1	1	11
ROCK BASS	0	0	0	0	0	0	0	0	0	1
PUMPKINSEED	0	1	0	0	0	0	0	0	0	1
BLUEGILL	3	5	0	0	0	3	2	2	0	31
SMALLMOUTH BASS	0	3	0	2	0	2	0	0	0	97
LARGEMOUTH BASS	1	0	0	1	0	0	0	0	0	11
YELLOW PERCH	0	0	0	0	0	0	0	0	0	6
WALLEYE	3	1	6	6	9	3	5	9	3	111
AMERICAN EEL	0	5	3	0	1	0	1	0	2	48
GOLDEN SHINER	0	0	0	0	0	0	0	0	0	1
SPOTTAIL SHINER	0	0	0	0	0	0	0	0	0	71
SPOTFIN SHINER	0	0	0	0	0	0	0	0	70	70
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	0	0	0	1
Total	**3,743**	**2,395**	**8,355**	**3,303**	**2,528**	**5,415**	**3,281**	**5,214**	**1,886**	**754,057**

*Hobo water temperature data logger placed in EFL trough.

Table 2

Summary of American shad catch, Maryland DNR recaptures, daily average river flow, water temperature, turbidity (secchi), unit operation, entrance gates utilized, attraction flow, and average project water elevations during operation of the Conowingo Dam EFL in 2015.

Date	American Shad Catch	MD DNR Recaptures	Marietta River Flow (cfs)	Water Temp. (°F)	Secchi (in)	Maximum Units in Operation	Entrance Gates Utilized	Attraction Flow (cfs)	Tailrace Elevation (ft)	Forebay Elevation (ft)	Crest Gates Open
4/3	0		44,600	49.2	36	10	C/A	310	21.5	107.0	0
4/4	DNO		46,600	47.4				310			
4/5	DNO		82,500	47.6				310			
4/6	DNO		140,000	48.8				310			
4/7	DNO		130,000	48.8							
4/8	DNO		107,000	46.9							
4/9	0		100,000	45.4	10		C	310	24.4	108.5	2
4/10	DNO		123,000	44.7							
4/11	DNO		144,000	44.6							
4/12	DNO		177,000	45.3							
4/13	DNO		160,000	46.7							
4/14	DNO		126,000	48.5							
4/15	0		103,000	49.4	10	11	C	310	24.5	108.5	1
4/16	DNO		92,500	50.7							
4/17	0		84,100	51.8	13	11	C	310	24.1	108.2	0
4/18	DNO		73,200	54.1							
4/19	DNO		63,900	56.1							
4/20	0		59,800	57.7	13	11	C	310	24.0	107.0	0
4/21	2		75,100	58.8	20	11	C	310	24.0	107.8	0
4/22	1		113,000	58.4	20	11	C	310	24.6	108.5	2-3
4/23	0		123,000	57	15	11	C	310	25.5	108.5	2-3
4/24	0		109,000	53.7	8	11	C	310	25.5	108.8	2-3
4/25	0		93,500	51.6	6-8	11	C	310	23.8	108.0	0
4/26	0		79,300	51.2	12-15	11	C	310	23.2	107	0
4/27	0		68,100	52.5	15	11	C	310	23.4	107	0
4/28	0		60,000	53.1	15-18	11	C	310	22.6	107.3	0
4/29	0		53,200	54.9	18	11	C	310	20.6	107	0
4/30	69		47,900	56	20	11	C	310	21.3	106.7	0
5/1	333		43,900	56.9	20	11	C	310	20.6	106.9	0
5/2	702		40,200	58.4	22	8	A/C	310	21.0	106.7	0
5/3	385		36,800	61.6	25	9	C	310	20.6	106.2	0
5/4	1,083	*1 yellow*	33,700	63.1	25	8	C	310	20.6	107.8	0
5/5	755		30,900	64.5	17	10	A/C	310	20.3	107.6	0
5/6	1,135		28,700	66.4	22	8	C	310	21.1	107.2	0
5/7	465		27,400	67.2	25	8	A/C	310	21.0	107.1	0
5/8	313		26,000	69.4	27	6	A/C	310	20.0	107.4	0
5/9	126	*1 yellow/1blue*	25,100	70.6	36	4	A	310	18.1	106.5	0

Table 2
Continued.

Date	American Shad Catch	MD DNR Recaptures*	Marietta River Flow (cfs)	Water Temp. (°F)	Secchi (in)	Maximum Units in Operation	Entrance Gates Utilized	Attraction Flow (cfs)	Tailrace Elevation (ft)	Forebay Elevation (ft)	
5/10	106		24,300	71.5	36	4	A	310	19.0	106.6	0
5/11	31		22,800	74.1	36	7	C	310	22.2	106.8	0
5/12	265		21,000	75.4	36	5	A/C	310	20.0	106.8	0
5/13	1,154	*4 blue*	19,500	74.3	36	4	A	310	19.4	106.1	0
5/14	131		18,500	73	30	5	A/C	310	19.0	106.6	0
5/15	143		17,900	73.7	36	5	A/C	310	19.5	106.8	0
5/16	432	*2 blue*	18,800	73.6	36	2	A	310	17.9	106.9	0
5/17	71		19,600	75.4	36	6	A/C	310	19.8	107.4	0
5/18	23		19,500	77.9	36	9	A/C	310	23.0	107.5	0
5/19	41		23,300	76.8	36	7	A/C	310	20.1	107.1	0
5/20	104		25,700	76.2	36	8	A/C	310	20.3	108.0	0
5/21	15		23,400	73.5	36-18	8	A/C	310	20.9	107.7	0
5/22	86		25,100	72.5	30	6	A/C	310	19.4	107.3	0
5/23	58		27,000	72.1	36	5	A/C	310	18.8	107.8	0
5/24	64		24,200	73.4	36	5	A/C	310	18.2	108.1	0
5/25	69		21,100	73.9	36	5	A/C	310	19.1	108.0	0
5/26	15		19,000	75.8	30	10	A/C	310	23.0	108.1	0
5/27	32		17,100	74.8	30	6	A/C	310	19.2	106.7	0
5/28	46		16,700	76	32	6	A/C	310	18.7	107.1	0
5/29	11		15,200	77.7	32	5	A/C	310	19.0	107.1	0
5/30	56		14,300	77.2	32	4	A	310	18.0	107.9	0
5/31	19		13,200	78.5	26	5	A/C	310	18.6	107.8	0

DNO = Did Not Operate Yellow = 2014 MDNR floy tags Blue = 2015 MDNR floy tags

Table 3

Hourly summary of American shad passage at the Conowingo Dam East Fish Passage Facility in 2015.

Date:	4/3	4/9	4/15	4/17	4/20	4/21	4/22	4/23	4/24	4/25	4/26	4/27
Observation Time-Start:	9:00	9:00	9:00	9:00	8:30	8:00	8:15	8:15	8:30	8:00	8:00	8:15
Observation Time-End:	17:10	16:40	16:40	16:50	16:15	16:15	16:15	14:15	14:20	16:30	16:15	16:20
Military Time (hrs)												
0600 to 0659												
0700 to 0759												
0800 to 0859					0	0	1	0	0	0	0	0
0900 to 0959	0	0	0	0	0	0	0	0	0	0	0	0
1000 to 1059	0	0	0	0	0	0	0	0	0	0	0	0
1100 to 1159	0	0	0	0	0	0	0	0	0	0	0	0
1200 to 1259	0	0	0	0	0	0	0	0	0	0	0	0
1300 to 1359	0	0	0	0	0	0	0	0	0	0	0	0
1400 to 1459	0	0	0	0	0	0	0	0	0	0	0	0
1500 to 1559	0	0	0	0	0	1	0			0	0	0
1600 to 1659	0	0	0	0	0	1	0			0	0	0
1700 to 1759	0											
1800 to 1859	0											
1900 to 1959												
2000 to 2059												
Total	0	0	0	0	0	2	1	0	0	0	0	0

Date:	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6	5/7	5/8	5/9
Observation Time-Start:	8:10	8:10	8:15	8:10	7:45	8:15	9:00	8:00	8:15	8:15	8:00	7:45
Observation Time-End:	16:15	16:20	18:15	18:20	18:15	18:15	19:00	18:10	19:20	18:20	18:00	18:10
Military Time (hrs)												
0600 to 0659												
0700 to 0759					3							5
0800 to 0859	0	0	0	16	30	61		31	8	115	17	11
0900 to 0959	0	0	0	10	2	5	68	203	17	71	16	14
1000 to 1059	0	0	0	13	2	1	57	189	14	39	33	40
1100 to 1159	0	0	1	15	1	1	30	66	26	68	176	10
1200 to 1259	0	0	7	4	0	2	15	53	15	51	31	10
1300 to 1359	0	0	7	4	15	16	15	34	21	17	12	4
1400 to 1459	0	0	13	9	109	41	64	20	20	43	9	4
1500 to 1559	0	0	22	63	187	55	155	44	89	16	5	7
1600 to 1659	0	0	9	84	151	71	278	34	134	11	4	5
1700 to 1759			7	78	176	95	226	43	248	25	4	13
1800 to 1859			3	37	26	37	175	38	404	9	6	3
1900 to 1959									139			
2000 to 2059												
Total	0	0	69	333	702	385	1,083	755	1,135	465	313	126

Table 3 (Continued).

Date:	5/10	5/11	5/12	5/13	5/14	5/15	5/16	5/17	5/18	5/19	5/20	5/21
Observation Time-Start:	8:00	8:10	8:00	8:00	8:10	8:05	8:00	8:15	8:15	8:30	8:10	8:15
Observation Time-End:	18:10	18:20	19:15	19:20	18:50	18:20	18:10	18:15	18:25	18:15	18:15	18:20
Military Time (hrs)												
0600 to 0659												
0700 to 0759												
0800 to 0859	6	10	1	15	23	9	62	19	6	0	0	0
0900 to 0959	47	1	1	346	36	14	133	22	6	2	42	2
1000 to 1059	27	0	1	249	7	11	119	16	1	1	12	4
1100 to 1159	5	2	1	90	16	7	32	2	6	13	4	3
1200 to 1259	5	4	0	30	8	7	25	2	0	11	4	1
1300 to 1359	4	1	4	44	10	10	10	2	0	6	15	0
1400 to 1459	7	2	2	45	2	14	0	3	2	5	10	0
1500 to 1559	2	0	5	46	17	12	9	1	0	1	7	1
1600 to 1659	1	7	5	32	9	8	18	0	1	0	8	1
1700 to 1759	0	3	24	95	3	35	14	1	1	1	2	1
1800 to 1859	2	1	198	82	0	16	10	3	0	1	0	2
1900 to 1959			23	80								
2000 to 2059												
Total	106	31	265	1,154	131	143	432	71	23	41	104	15

Date:	5/22	5/23	5/24	5/25	5/26	5/27	5/28	5/29	5/30	5/31	***Season Total***
Observation Time-Start:	8:15	8:00	8:15	8:15	8:00	8:20	8:00	8:30	8:10	8:20	
Observation Time-End:	18:12	18:17	18:15	18:20	18:10	18:10	18:30	18:10	18:10	18:10	
Military Time (hrs)											
0600 to 0659											**0**
0700 to 0759											**8**
0800 to 0859	0	0	1	5	1	2	2	0	0	0	**452**
0900 to 0959	17	2	20	7	5	8	0	0	28	5	**1,150**
1000 to 1059	17	2	2	11	4	2	7	2	17	6	**906**
1100 to 1159	6	2	3	13	1	12	7	1	4	1	**625**
1200 to 1259	7	13	2	4	0	1	8	3	4	1	**328**
1300 to 1359	34	33	13	5	2	3	11	1	0	4	**357**
1400 to 1459	0	5	9	10	0	0	5	2	1	0	**456**
1500 to 1559	0	1	5	5	0	0	6	2	1	1	**766**
1600 to 1659	1	0	3	2	0	3	0	0	0	1	**882**
1700 to 1759	3	0	3	3	2	0	0	0	1	0	**1,107**
1800 to 1859	1	0	3	4	0	1	0	0	0	0	**1,062**
1900 to 1959											**242**
2000 to 2059											**0**
Total	86	58	64	69	15	32	46	11	56	19	**8,341**

Table 4
Summary Information for Conowingo EFL Volitional Passage, 1997 through 2015.

Year	#Days of Ops	#Hrs of Ops	Total # of Lifts	# Fish passed	# Am. shad	# Gizzard shad	# Herring	Avg.#fish/lift	Ratio A.S./Gizz
1997	64	640	652	719,297	90,971	344,332	242,815	1,103	1/4
1998	50	433	460	712,993	39,904	654,575	706	1,550	1/16
1999	52	467	610	1,184,101	69,712	950,500	130,639	1,941	1/14
2000	45	368	570	493,955	153,546	317,753	14,965	866	1/2
2001	43	360	559	921,916	193,574	429,461	292,379	1,649	1/2
2002	49	440	560	656,894	108,001	513,794	2,111	1,173	1/5
2003	44	416	645	589,177	125,135	459,634	551	913	1/4
2004	44	390	590	715,664	109,360	602,677	190	1,212	1/6
2005	52	434	541	377,762	68,926	305,378	4	698	1/4
2006	61	430	619	714,918	56,899	655,990	0	1,154	1/12
2007	39	335	479	539,203	25,464	508,627	889	1,125	1/20
2008	51	409	483	943,838	19,914	919,975	5	1,954	1/46
2009	57	495	618	915,417	29,272	876,412	231	1,481	1/30
2010	59	526	685	857,263	37,757	813,429	5	1,251	1/22
2011	15	142	259	289,453	20,571	257,522	19	1,117	1/13
2012	62	633	1,230	1,109,911	22,143	1,070,672	52	902	1/48
2013	60	575.6	925	1,094,526	12,733	1,076,048	7	1,183	1/85
2014	54	509	988	1,192,750	10,425	1,170,200	136	1,207	1/112
2015	**46**	**433**	**674**	**754,057**	**8,341**	**742,661**	**13**	**1,119**	**1/89**

Table 5

Summary of selected operation and fish catch statistics at the Conowingo Dam East Fish Passage Facility, 1991 to 2015.

Year	Number of Days Operated	Number of Lifts	Operating Time (hrs)	Number of Species	American shad	Blueback herring	Alewife	Hickory shad
1991	60	1168	647.2	42	13,897	13,149	323	0
1992	49	599	454.1	35	26,040	261	3	0
1993	42	848	463.5	29	8,203	4,574	0	0
1994	55	955	574.8	36	26,715	248	5	1
1995	68	986	706.2	36	46,062	4,004	170	1
1996	49	599	454.1	35	26,040	261	3	0
1997	64	652	640.0	36	90,971	242,815	63	0
1998	50	652	640.0	33	39,904	700	6	0
1999	52	610	467.0	31	69,712	130,625	14	0
2000	45	570	367.8	30	153,546	14,963	2	0
2001	43	559	359.8	30	193,574	284,921	7,458	0
2002	49	560	440.7	31	108,001	2,037	74	6
2003	44	645	416.6	25	125,135	530	21	0
2004	44	590	390.3	30	109,360	101	89	0
2005	52	541	434.3	30	68,926	4	0	0
2006	61	619	429.8	32	56,899	0	0	4
2007	39	479	335.3	31	25,464	460	429	0
2008	51	483	407.0	29	19,914	1	4	0
2009	57	618	495.6	30	29,272	71	160	0
2010	59	685	526.2	38	37,757	4	1	0
2011	15	259	142.4	24	20,571	17	2	20
2012	62	1230	633.7	35	22,143	25	27	0
2013	60	925	575.6	27	12,733	7	0	1
2014	54	988	509	34	10,425	25	111	2
2015	**46**	**674**	**433**	**28**	**8,341**	**3**	**10**	**8**

Table 6

Summary of American shad passage counts and percent passage values at Susquehanna River dams, 1997-2015.

	Conowingo	Holtwood		Safe Harbor		York Haven	
	East	Number	% of C.E.L.	Number	% of Holt.	Number	% of S.H.
1997	90,971	28,063	30.8%	20,828	74.2%	-	-
1998	39,904	8,235	20.6%	6,054	73.5%	-	-
1999	69,712	34,702	49.8%	34,150	98.4%	-	-
2000	153,546	29,421	19.2%	21,079	71.6%	4,687	22.2%
2001	193,574	109,976	56.8%	89,816	81.7%	16,200	18.0%
2002	108,001	17,522	16.2%	11,705	66.8%	1,555	13.3%
2003	125,135	25,254	20.2%	16,646	65.9%	2,536	15.2%
2004	109,360	3,428	3.1%	2,109	61.5%	219	10.4%
2005	68,926	34,189	49.6%	25,425	74.4%	1,772	7.0%
2006	56,899	35,968	63.2%	24,929	69.3%	1,913	7.7%
2007	25,464	10,338	40.6%	7,215	69.8%	192	2.7%
2008	19,914	2,795	14.0%	1,252	44.8%	21	1.7%
2009	29,272	10,896	37.2%	7,994	73.4%	402	5.0%
2010	37,757	16,472	43.6%	12,706	77.1%	907	7.1%
2011	20,571	21	0.1%	8	38.1%	0	0.0%
2012	22,143	4,238	19.1%	3,089	72.9%	224	7.3%
2013	12,733	2,503	19.7%	1,927	77.0%	202	10.5%
2014	10,425	2,589	24.8%	1,336	51.6%	8	0.6%
2015	**8,341**	**5,286**	**63.3%**	**3,896**	**73.7%**	**43**	**1.1%**

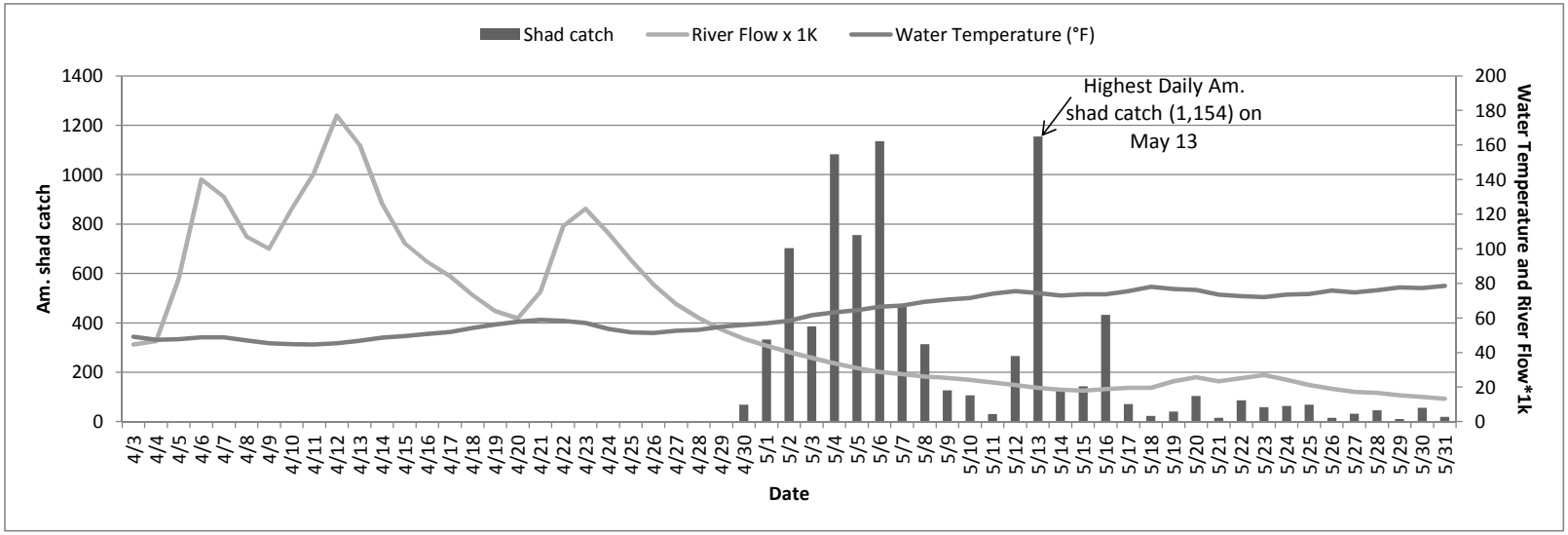

Figure 1

A plot of river flow (x 1000 cfs) (USGS Marietta Gauge) and water temperature (°F) in relation to daily American shad passage at the Conowingo EFL, spring 2015.

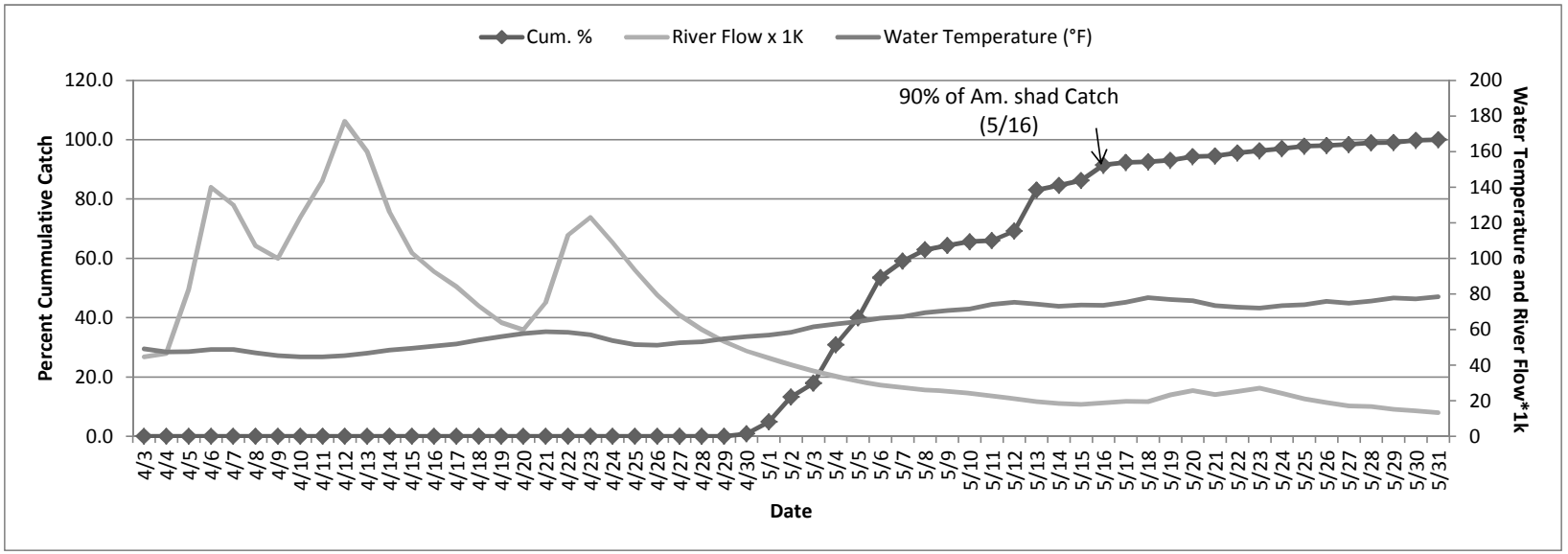

Figure 2

A plot of river flow (x 1000 cfs) (USGS Marietta Gauge) and water temperature (°F) in relation to the percent cumulative American shad passage at the Conowingo EFL, spring, 2015.