

**SUMMARY OF OPERATIONS AT THE
CONOWINGO DAM EAST FISH PASSAGE FACILITY
SPRING 2017**

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Prepared for

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December 2017

EXECUTIVE SUMMARY

Operation of the Conowingo East Fish Lift (EFL) began April 12, 2017 instead of April 1 due to high river flows during the first two weeks of the month. The water temperature was 53.6° F and river flow was 104,000 cfs during the first day of operation. The first American Shad was passed on April 16, the third day of operation. The EFL operated for 46 days in 2017; alternate day operation from April 12 through April 16, then everyday operation from April 17 through June 2 excepting May 7 - 10 due to river flows exceeding 133,000 cfs. EFL operation was terminated after facility shutdown on June 2 in concurrence with the Resource Agencies. The 2017 fish passage season experienced higher river flows on average than those observed in 2016 but managed to pass nearly 2,000 more American Shad. The 2017 fish passage season marks the twenty-seventh season of overall operation and the twenty-first year of volitional fish passage at the Conowingo EFL.

The EFL passed 844,917 fish of 33 species and two hybrids. Gizzard shad (813,687), American Shad (16,265), and channel catfish (9,972) dominated the catch, and comprised 99% of the total fish collected and passed. Gizzard shad alone accounted for 96% of the total fish collected and passed. We also documented the passage of a Northern snakehead into Conowingo Pond on May 20, 2017 between 1000 and 1059 hours. This fish is an invasive species and its spread in the Susquehanna River watershed is a concern among all Resource Agencies.

A total of 16,265 American Shad was passed. The highest daily passage of American Shad occurred on May 20 when 1,715 shad were passed upstream. On 4 of the 46 days of operation, American Shad passage exceeded 1,000 fish. On a daily basis, overall shad passage was steady throughout the day with the highest overall hour of shad passage (2,100) between 1100 and 1159 hours.

Fishway operations were conducted at water temperatures ranging from 53.6°F to 70.9°F and river flows between 27,000 and 110,000 cfs. High river flow events in 2017 interrupted operations from May 7 through 10.

Prior to the start of EFL operations in 2017, 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 a minimal loss of fishing time due to any mechanical failures throughout the entire fish passage season.

On 30 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 2017 was 26 yellow tags, all from this year's tagging efforts conducted in the Conowingo tailrace.

Future operations of the EFL will build on the past twenty-seven 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 2017 operation were: (1) monitor passage of migratory and resident fishes through the fishway; (2) assess fishway and trough effectiveness and make modifications as feasible and (3) assist the Holtwood hydro station with their Tier I study by providing American Shad from the EFL trough for PIT tagging efforts.

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 Mixed-Flow (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 current 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 2017 began on April 12, 2017, with the passage of the first American Shad on April 16 (Tables 1 and 2). The EFL operated for 46 days in 2017 with alternate day operation occurring from April 12 through April 16. Continuous operation of the EFL occurred

from April 17 through June 2 (excepting May 7 – 10 due to high river flows) when operations were terminated in concurrence with the Resource Agencies (Table 2).

Daily operation times were planned during optimal fish passage parameters. This year, operational methodologies were influenced by natural river flow, water temperature, station generation, 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 2017 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 throughout the 2017 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 (PC). 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 844,917 fish of 33 species and two hybrids passed upstream into Conowingo Pond. Gizzard shad (813,687), American Shad (16,265), and channel catfish (9,972) dominated the catch, and comprised 99% of the total fish collected and passed. Gizzard shad alone accounted for 96% of the total fish collected and passed. Peak passage occurred on April 29 when 42,143 fish, (98% gizzard shad; 1.5% American Shad), were passed. We also documented the passage of a Northern snakehead into Conowingo Pond on May 20, 2017 between 1000 and 1059 hours. This fish is an invasive species and its spread in the Susquehanna River watershed is a concern among all Resource Agencies.

3.2 American Shad Passage

The EFL collected and passed 16,265 American Shad (Table 1). The first American Shad passed on April 16 (third day of operation). Collection and passage of shad varied daily with 35.4% (5,750) of the shad passed from April 16 to April 30, 18.1% (2,957) passed from May 1 to May 15, and 46.5% (7,558) passed from May 16 to June 2, (Figures 1 and 2). On 4 of the 46 days of operation, American Shad passage exceeded 1,000 fish. The largest number of American Shad passed at the EFL in 2017 occurred on May 20 (1,715).

American Shad were collected and passed at water temperatures ranging from 56.3°F to 70.9°F and river flows between 27,000 and 110,000 cfs (Table 2, and Figure 1). The average daily river flow on the 4 days when American Shad passage exceeded 1,000 fish ranged between 32,900 cfs and 43,200 cfs. The average daily river flow during the operational season was 57,465 cfs.

The hourly passage of American Shad at the EFL is provided in Table 3. On a daily basis, overall shad passage was strongest through the fishway between 1100 and 1259 hours and 1600 to 1759 hours during which 44% of the total American Shad passage occurred. The highest hourly passage rate occurred from 1100 to 1159 hours. The highest number of American Shad passed in one hour (369) occurred from 1100 to 1159 hrs on May 20.

3.3 Gizzard Shad Passage

The EFL collected and passed 813,687 Gizzard shad in 2017 (Tables 1 and 4). Gizzard shad accounted for 96% of the total fish collected and passed. Gizzard shad passage exceeded 40,000 and 30,000 fish on 1 and 6 days, respectively. Table 4 provides the ratio of American Shad to Gizzard shad for the years of volitional passage (1997-2017). 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 Blueback herring, (59) and Alewife (6) were passed during the 2017 season (Table 5). No Hickory shad were passed in spring 2017.

3.5 Maryland tag-recapture

During the 2017 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 284 American Shad. The number of floy tags observed at the Conowingo EFL in 2017 was 26 yellow tags (9.1% of total tagged); all from this year's tagging efforts in the Conowingo tailrace.

4.0 SUMMARY

EFL operation was initiated on April 12 after river flow decreased to a level to allow safe operation of the facility. The first American Shad passed on the third day of operation (April 16). The EFL

passed 16,265 American Shad from April 16 through June 2. The total number of American Shad passed during the 2017 season was nearly 2,000 more shad than observed in 2016, although fish passage operations were suspended from May 7 through 10 and we operated 9 fewer days than in 2016. Water temperatures remained below 70.0° F until May 24 and may have provided a larger window of opportunity for the EFL to collect and pass more American Shad this season. This year marks the fifth consecutive year in which the EFL passed less than 20,000 American Shad (Table 6).

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 309 American Shad lift mortalities that did not contain PIT tags from the Holtwood fish passage efficiency study, (1.9% of the total shad passed), was observed in 2017, lower than the value observed in 2016 (2.0%), and less than values observed during the 1991 through 1996 trap and transport operations (1.5% to 10.5%).

Prior to the start of EFL operations in 2017, 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 a minimal amount of lost fishing time due to mechanical issues.

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 make “on the spot” decisions for maximizing 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 2017.

Date	4/12	4/13	4/14	4/15	4/16	4/17	4/18	4/19	4/20	4/21	4/22
Start Fishing Time	8:00		7:30		7:30	7:30	7:30	8:00	8:00	7:30	8:00
End Fishing Time	15:45		15:30		15:40	18:45	18:40	19:50	17:40	18:30	18:40
Elapsed Fishing Time	7.8		8.0		8.2	11.3	11.2	11.8	9.7	11.0	10.7
Viewing Hours	7.0		8.0		8.0	11.0	11.0	12.0	9.7	11.0	11
Lifts Per Day	10		10		13	23	20	24	19	18	22
Water Temperature (°F)	53.6	53.3	55.1	56.3	58.1	59.9	61	62.1	62.9	63.3	63.9
AMERICAN EEL	0		0		0	0	0	0	0	0	3
AMERICAN SHAD	0		0		1	423	737	1,151	155	485	462
HICKORY SHAD	0		0		0	0	0	0	0	0	0
BLUEBACK HERRING	0		0		0	1	0	0	0	0	0
ALEWIFE	0		0		0	0	4	0	0	0	0
GIZZARD SHAD	1,272		15,567		27,352	22,519	16,835	33,300	33,288	22,590	24,886
RAINBOW TROUT	0		0		0	0	0	0	0	0	0
BROWN TROUT	0		1		0	0	0	1	0	1	0
MUSKELLUNGE	0		0		0	1	0	0	0	0	1
TIGER MUSKY	0		0		0	0	2	0	0	0	0
CARP	0		0		0	0	0	0	0	0	0
LONGNOSE GAR	0		0		0	0	0	0	0	0	0
SPOTFIN SHINER	0		0		0	0	0	0	0	12	0
QUILLBACK	0		0		0	1	0	0	0	0	0
WHITE SUCKER	0		0		1	0	0	0	1	1	0
SHORTHEAD REDHORSE	0		2		0	12	1	2	3	0	0
YELLOW BULLHEAD	0		0		0	0	0	0	0	0	0
BROWN BULLHEAD	0		0		0	0	1	3	7	9	35
CHANNEL CATFISH	10		10		0	4	1	8	7	9	7
FLATHEAD CATFISH	0		0		0	0	0	0	0	0	0
WHITE PERCH	0		0		0	0	1	0	0	0	0
STRIPED BASS	0		1		0	4	0	0	3	0	2
STRIPED BASS HYBRID	0		0		0	0	0	0	0	0	0
ROCK BASS	0		0		0	0	0	0	0	0	0
REDBREAST SUNFISH	0		0		0	0	0	0	0	0	0
PUMPKINSEED	0		0		0	0	1	0	0	0	0
BLUEGILL	0		4		0	0	0	0	2	0	0
SMALLMOUTH BASS	0		1		27	60	34	18	7	33	20
LARGEMOUTH BASS	0		0		0	0	0	0	0	0	0
WHITE CRAPPIE	1		0		0	0	0	0	0	0	0
BLACK CRAPPIE	0	0	0	0	0	0	0	0	0	0	1
YELLOW PERCH	0		0		0	0	0	0	0	0	0
WALLEYE	1		5		1	4	3	5	2	1	2
ATLANTIC NEEDLEFISH	0		0		0	0	0	0	0	0	0
NORTHERN SNAKEHEAD	0		0		0	0	0	0	0	0	0
SEA LAMPREY	0		0		0	1	1	1	0	4	0
Total	1,284	0	15,591	0	27,382	23,030	17,621	34,489	33,475	23,145	25,419

Table 1 (continued)

Date	4/23	4/24	4/25	4/26	4/27	4/28	4/29	4/30	5/1	5/2	5/3
Start Fishing Time	8:00	8:00	7:30	7:30	7:30	7:45	7:30	8:00	8:00	7:50	7:45
End Fishing Time	17:40	17:40	17:45	17:40	17:40	19:35	18:10	19:00	18:10	17:40	17:45
Elapsed Fishing Time	9.7	9.7	10.3	10.2	10.2	11.8	10.7	11.0	10.2	9.8	10.0
Viewing Hours	10.0	10.0	10.0	10.0	10.0	12.0	10.7	11.3	10.5	10.0	10.0
Lifts Per Day	20	14	20	14	22	23	22	22	18	21	18
Water Temperature (°F)	61.8	61.3	58.8	58.3	58.5	60.5	62.4	64	66.6	68.1	68.1
AMERICAN EEL	0	0	0	1	0	0	1	0	0	0	0
AMERICAN SHAD	70	6	4	6	8	597	661	984	636	1,411	359
HICKORY SHAD	0	0	0	0	0	0	0	0	0	0	0
BLUEBACK HERRING	0	0	0	0	0	6	0	0	0	0	0
ALEWIFE	0	0	0	0	0	0	0	0	0	0	0
GIZZARD SHAD	30,620	8,142	14,529	18,129	32,970	35,305	41,433	29,504	20,124	31,709	20,355
RAINBOW TROUT	0	0	0	4	0	0	0	2	0	0	0
BROWN TROUT	0	1	0	0	1	0	1	2	0	0	0
MUSKELLUNGE	0	0	0	0	0	1	0	0	0	0	0
TIGER MUSKY	0	0	0	0	0	0	0	0	0	0	0
CARP	0	0	0	1	0	1	2	18	16	14	4
LONGNOSE GAR	0	0	0	0	0	0	0	0	0	0	0
SPOTFIN SHINER	0	0	0	0	0	0	0	0	0	0	0
QUILLBACK	0	0	0	0	0	0	3	1	0	2	6
WHITE SUCKER	0	0	0	0	0	1	0	0	0	0	0
SHORTHEAD REDHORSE	17	291	138	12	18	13	5	13	12	3	9
YELLOW BULLHEAD	0	0	0	0	0	0	0	0	0	0	0
BROWN BULLHEAD	71	22	5	0	0	19	1	7	28	7	25
CHANNEL CATFISH	165	339	1,224	155	95	11	0	4	12	31	79
FLATHEAD CATFISH	1	0	0	0	0	0	0	0	0	0	0
WHITE PERCH	14	2	1	1	0	29	0	0	0	1	0
STRIPED BASS	2	0	1	2	3	4	2	2	4	19	10
STRIPED BASS HYBRID	0	0	0	0	0	0	0	0	0	0	0
ROCK BASS	1	0	0	0	0	0	0	0	0	0	0
REDBREAST SUNFISH	0	0	0	0	0	0	0	0	0	0	0
PUMPKINSEED	0	0	0	0	0	0	0	0	0	0	0
BLUEGILL	0	1	1	0	0	0	1	0	4	0	1
SMALLMOUTH BASS	43	31	5	2	7	69	31	38	88	66	37
LARGEMOUTH BASS	0	0	0	0	0	0	0	0	0	0	0
WHITE CRAPPIE	0	0	0	0	0	0	0	0	0	0	0
BLACK CRAPPIE	0	0	0	0	0	0	0	0	0	0	0
YELLOW PERCH	0	0	0	0	0	0	0	0	0	0	0
WALLEYE	7	13	18	6	3	9	2	4	4	1	2
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	0	0	0	0	0
NORTHERN SNAKEHEAD	0	0	0	0	0	0	0	0	0	0	0
SEA LAMPREY	1	0	1	1	2	1	0	3	0	0	2
Total	31,012	8,848	15,927	18,320	33,107	36,066	42,143	30,582	20,928	33,264	20,889

Table 1 (continued)

Date	5/4	5/5	5/6	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14
Start Fishing Time	7:30	7:45	7:30					7:30	8:00	7:30	7:30
End Fishing Time	17:30	17:40	17:30					17:30	17:40	17:30	17:30
Elapsed Fishing Time	10.0	9.9	10.0					10.0	9.7	10.0	10.0
Viewing Hours	10.0	10.0	10.0					10.0	10.0	10.0	10.0
Lifts Per Day	21	20	19					14	14	16	19
Water Temperature (°F)	66.5	64.4	62.2	59.8	56.9	55.3	56	56.3	56.9	56.3	57
AMERICAN EEL	0	1	0					0	0	0	0
AMERICAN SHAD	132	157	111					0	6	4	54
HICKORY SHAD	0	0	0					0	0	0	0
BLUEBACK HERRING	0	0	0					0	0	0	0
ALEWIFE	2	0	0					0	0	0	0
GIZZARD SHAD	24,566	14,501	13,420					976	11,221	12,370	14,609
RAINBOW TROUT	0	0	0					0	0	0	0
BROWN TROUT	0	2	0					0	0	0	0
MUSKELLUNGE	0	0	0					0	0	0	0
TIGER MUSKY	0	0	0					0	0	0	0
CARP	0	2	3					1	1	0	0
LONGNOSE GAR	0	0	0					0	0	0	0
SPOTFIN SHINER	0	0	0					0	0	0	0
QUILLBACK	1	1	0					0	1	0	1
WHITE SUCKER	1	0	0					2	0	0	0
SHORTHEAD REDHORSE	48	236	226					6	15	3	2
YELLOW BULLHEAD	0	0	0					0	0	0	0
BROWN BULLHEAD	15	0	0					1	0	0	5
CHANNEL CATFISH	493	900	583					1,334	1,425	274	17
FLATHEAD CATFISH	0	0	0					0	0	0	0
WHITE PERCH	9	5	1					0	0	0	7
STRIPED BASS	16	21	15					5	2	5	7
STRIPED BASS HYBRID	0	0	0					0	0	1	0
ROCK BASS	0	0	0					0	0	0	0
REDBREAST SUNFISH	0	0	0					0	0	0	0
PUMPKINSEED	0	0	0					0	0	0	0
BLUEGILL	0	0	0					0	1	0	0
SMALLMOUTH BASS	21	30	9					11	46	14	39
LARGEMOUTH BASS	0	0	0					0	0	0	0
WHITE CRAPPIE	0	0	0					0	0	0	0
BLACK CRAPPIE	0	0	0					0	0	0	0
YELLOW PERCH	0	1	0					0	0	0	0
WALLEYE	15	26	4					16	4	4	1
ATLANTIC NEEDLEFISH	0	0	0					0	0	0	0
NORTHERN SNAKEHEAD	0	0	0					0	0	0	0
SEA LAMPREY	1	0	0					0	0	0	1
Total	25,320	15,883	14,372	0	0	0	0	2,352	12,722	12,675	14,743

Table 1 (continued)

Date	5/15	5/16	5/17	5/18	5/19	5/20	5/21	5/22	5/23	5/24	5/25
Start Fishing Time	7:30	7:30	8:00	7:30	7:30	7:30	8:00	7:30	8:00	7:30	7:45
End Fishing Time	18:00	17:30	17:30	18:00	17:30	18:00	17:30	17:30	17:45	17:45	17:30
Elapsed Fishing Time	10.5	10.0	9.5	10.5	10.0	10.5	9.5	10.0	9.8	10.5	9.8
Viewing Hours	10.0	10.0	10.0	10.0	10.0	10.3	10.0	10.0	10.0	10.0	10.0
Lifts Per Day	14	18	18	22	18	20	20	20	21	15	19
Water Temperature (°F)	57.7	60.2	61.5	65.7	68.3	68	68.8	69.1	69.9	70.3	69.2
AMERICAN EEL	0	0	0	3	0	1	0	0	0	0	0
AMERICAN SHAD	87	517	661	337	625	1,715	833	1,231	257	368	106
HICKORY SHAD	0	0	0	0	0	0	0	0	0	0	0
BLUEBACK HERRING	0	0	0	1	0	1	0	0	15	2	5
ALEWIFE	0	0	0	0	0	0	0	0	0	0	0
GIZZARD SHAD	12,722	14,152	17,110	25,790	19,339	20,710	8,853	16,530	13,946	7,550	8,956
RAINBOW TROUT	0	1	0	5	0	0	0	0	0	0	1
BROWN TROUT	0	0	0	0	1	0	1	0	0	0	0
MUSKELLUNGE	0	0	0	0	0	0	0	0	0	0	0
TIGER MUSKY	0	0	0	0	0	0	0	0	0	0	1
CARP	0	0	1	15	6	10	1	13	5	3	1
LONGNOSE GAR	0	0	0	0	0	0	0	0	0	0	1
SPOTFIN SHINER	0	0	0	0	0	0	0	0	0	0	0
QUILLBACK	0	0	3	24	4	6	14	1	1	5	9
WHITE SUCKER	0	0	0	0	0	0	0	0	0	0	0
SHORTHEAD REDHORSE	4	30	47	94	28	20	14	38	3	2	3
YELLOW BULLHEAD	1	0	0	0	0	0	0	0	0	0	0
BROWN BULLHEAD	0	1	2	9	1	0	35	12	12	7	8
CHANNEL CATFISH	92	28	24	53	52	66	41	84	71	27	236
FLATHEAD CATFISH	0	0	0	0	0	0	0	0	0	0	0
WHITE PERCH	0	0	1	0	1	4	5	5	0	1	1
STRIPED BASS	2	9	8	13	8	36	20	25	19	7	28
STRIPED BASS HYBRID	0	0	0	0	0	0	0	0	0	0	0
ROCK BASS	0	0	0	0	0	1	0	0	1	1	0
REDBREAST SUNFISH	0	0	0	0	0	1	0	0	0	0	0
PUMPKINSEED	0	0	0	0	0	0	0	0	0	0	0
BLUEGILL	1	0	0	0	0	0	2	10	0	0	0
SMALLMOUTH BASS	16	73	63	109	41	152	58	13	22	8	19
LARGEMOUTH BASS	0	1	0	0	0	0	0	0	0	0	0
WHITE CRAPPIE	0	0	0	0	0	0	1	0	0	0	0
BLACK CRAPPIE	0	0	0	0	0	0	1	0	0	0	0
YELLOW PERCH	0	0	0	0	1	0	1	0	0	0	0
WALLEYE	5	7	3	14	11	77	18	82	11	10	34
ATLANTIC NEEDLEFISH	0	0	0	0	0	0	0	0	0	0	0
NORTHERN SNAKEHEAD	0	0	0	0	0	1	0	0	0	0	0
SEA LAMPREY	2	1	0	0	1	1	1	2	0	0	0
Total	12,932	14,820	17,923	26,467	20,119	22,802	9,899	18,046	14,363	7,991	9,409

Table 1 (continued)

Date	5/26	5/27	5/28	5/29	5/30	5/31	6/1	6/2	Season
Start Fishing Time	8:00	7:30	7:45	7:30	7:45	7:30	7:45	7:45	Total
End Fishing Time	17:40	17:30	17:40	17:30	17:40	17:45	17:40	17:45	463
Elapsed Fishing Time	9.7	10.0	9.9	10.0	9.9	10.3	9.9	10.0	464
Viewing Hours	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	849
Lifts Per Day	18	19	20	20	16	17	19	19	
Water Temperature (°F)	69.5	68.2	69.1	69	68.4	69.8	70.9	70.2	
AMERICAN EEL	0	0	0	0	1	0	0	0	11
AMERICAN SHAD	297	369	38	89	39	16	48	12	16,265
HICKORY SHAD	0	0	0	0	0	0	0	0	0
BLUEBACK HERRING	0	0	2	0	0	0	25	1	59
ALEWIFE	0	0	0	0	0	0	0	0	6
GIZZARD SHAD	10,497	4,973	12,411	8,256	9,703	7,689	11,676	10,732	813,687
RAINBOW TROUT	0	2	2	0	0	2	0	0	19
BROWN TROUT	1	0	0	0	0	0	0	0	13
MUSKELLUNGE	0	0	1	0	0	0	0	0	4
TIGER MUSKY	0	0	0	0	0	0	0	0	3
CARP	9	3	17	0	4	7	7	11	176
LONGNOSE GAR	0	0	0	0	0	0	0	0	1
SPOTFIN SHINER	0	0	0	0	0	0	0	0	12
QUILLBACK	1	14	9	5	3	7	4	10	137
WHITE SUCKER	0	0	0	0	0	0	0	0	7
SHORTHEAD REDHORSE	3	3	0	1	0	1	5	3	1,386
YELLOW BULLHEAD	0	0	0	0	0	0	0	0	1
BROWN BULLHEAD	18	0	3	0	1	3	6	2	381
CHANNEL CATFISH	163	47	82	53	70	49	141	1,396	9,972
FLATHEAD CATFISH	0	0	0	0	0	0	0	0	1
WHITE PERCH	0	4	4	0	3	1	11	8	120
STRIPED BASS	12	26	32	21	22	25	33	38	514
STRIPED BASS HYBRID	0	0	0	0	0	0	0	0	1
ROCK BASS	0	0	1	0	0	0	0	0	5
REDBREAST SUNFISH	0	0	0	0	0	0	0	0	1
PUMPKINSEED	0	0	0	0	0	0	0	0	1
BLUEGILL	19	0	0	1	3	0	0	3	54
SMALLMOUTH BASS	9	7	4	8	10	15	13	11	1,438
LARGEMOUTH BASS	3	0	1	0	1	0	1	1	8
WHITE CRAPPIE	0	0	0	0	0	0	0	0	2
BLACK CRAPPIE	0	0	0	0	0	0	0	0	2
YELLOW PERCH	1	0	0	0	0	0	0	0	4
WALLEYE	19	7	17	13	20	7	15	60	593
ATLANTIC NEEDLEFISH	2	0	0	0	0	0	0	0	2
NORTHERN SNAKEHEAD	0	0	0	0	0	0	0	0	1
SEA LAMPREY	0	0	0	2	0	0	0	0	30
Total	11,054	5,455	12,624	8,449	9,880	7,822	11,985	12,288	844,917

*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 2017.

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
4/12	0		104,000	53.6	8	11	C	310	24.3	108.4	1
4/13	DNO		86,100	53.3							
4/14	0		73,800	55.1	9	10	C	310	23.8	107.0	0
4/15	DNO		64,400	56.3							
4/16	1		57,400	58.1	14	10	C	310	22.0	106.5	0
4/17	423		51,100	59.9	16	10	C	310	22.5	107.0	0
4/18	737		46,700	61	30	11	C/A	310	21.5	107.0	0
4/19	1,151		43,200	62.1	27	10	C	310	21.5	107.0	0
4/20	155		40,500	62.9	20	10	C	310	22.5	107.0	0
4/21	485		38,700	63.3	22	10	A/C	310	21.0	108.0	0
4/22	462		48,300	63.9	23	11	C	310	22.0	106.0	0
4/23	70		105,000	61.8	15	11	C	310	23.8	105.5	0
4/24	6		110,000	61.3	17	11	C	310	25.1	108.8	2
4/25	4		88,400	58.8	15	11	C	310	24.5	109	2
4/26	6		71,300	58.3	4	11	C	310	23.0	106.4	0
4/27	8		60,200	58.5	10	10	C	310	23.0	106	0
4/28	597	1 Yellow	51,800	60.5	20	10	C	310	23.0	107	0
4/29	661		47,200	62.4	20	9	A/C	310	22.0	107.5	0
4/30	984		46,000	64	26	9	A/C	310	22.0	107.4	0
5/1	636		44,200	66.6	28	9	C	310	23.0	108	0
5/2	1,411		40,900	68.1	28	9	C	310	23.0	107.4	0
5/3	359		66,800	68.1	28	11	C	310	23.0	107	0
5/4	132		83,600	66.5	12	11	C	310	23.0	105.5	0
5/5	157		84,300	64.4	7	11	C	310	23.5	105.5	0
5/6	111		107,000	62.2	8	11	C	310	23.4	107	0
5/7	DNO		156,000	59.8							

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)	Crest Gates Open
5/8	DNO		178,000	56.9							
5/9	DNO		165,000	55.3							
5/10	DNO		133,000	56							
5/11	0		106,000	56.3	4-6	11	C	310	25.0	109.0	2
5/12	6		88,000	56.9	14	11	C	310	23.8	108.0	2
5/13	4		76,200	56.3	8	11	C	310	23.5	105.5	0
5/14	54		68,200	57	24	11	C	310	23.5	107.0	0
5/15	87		63,200	57.7	18	10	C	310	23.4	107.0	0
5/16	517	2 Yellow	58,900	60.2	20	10	A/C	310	22.5	106.0	0
5/17	661	1 Yellow	54,400	61.5	24	10	C	310	23.0	106.3	0
5/18	337		49,900	65.7	25	10	C	310	23.5	106.5	0
5/19	625		44,500	68.3	25	10	A/C	310	23.0	107.0	0
5/20	1,715	10 Yellow	39,800	68	25	7	C	310	21.7	107.0	0
5/21	833	4 Yellow	35,800	68.8	26	6	C/A	310	21.4	106.6	0
5/22	1,231	2 Yellow	32,900	69.1	36	8	C	310	22.0	107.7	0
5/23	257	2 Yellow	30,600	69.9	30	8	C	310	21.0	106.8	0
5/24	368	2 Yellow	28,300	70.3	30	5	A/C	310	21.0	107.0	0
5/25	106		27,000	69.2	30	4	C	310	20.5	107.0	0
5/26	297	1 Yellow	27,300	69.5	30	7	A/C	310	21.0	108.5	0
5/27	369	1 Yellow	29,100	68.2	32	6	A/C	310	19.0	108.5	0
5/28	38		31,900	69.1	32	6	C	310	21.7	108.5	0
5/29	89		32,400	69	24	7	A/C	310	20.0	108.5	0
5/30	39		33,200	68.4	26	8	A/C	310	22.0	108.0	0
5/31	16		40,200	69.8	28	9	A/C	310	21.5	108.0	0
6/1	48		63,600	70.9	29	9	C	310	22.6	108.0	0
6/2	12		71,600	70.2	30	10	C	310	23.5	108.8	0

DNO = Did Not Operate

Yellow (26) = 2017 MDNR floy tags

Table 3

Hourly summary of American shad passage at the Conowingo Dam East Fish Passage Facility in 2017.

<i>Date:</i>	4/12	4/13	4/14	4/15	4/16	4/17	4/18	4/19	4/20	4/21	4/22	4/23
<i>Observation Time-Start:</i>	9:00		8:00		8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00
<i>Observation Time-End:</i>	16:00		16:00		16:00	19:00	19:00	20:00	18:00	19:00	19:00	18:00
Military Time (hrs)												
0600 to 0659												
0700 to 0759												
0800 to 0859			0		0	2	35	21	70	4	41	23
0900 to 0959	0		0		0	4	13	17	47	7	24	4
1000 to 1059	0		0		0	4	0	0	13	0	14	3
1100 to 1159	0		0		0	3	90	15	1	5	17	4
1200 to 1259	0		0		0	19	74	44	1	13	7	0
1300 to 1359	0		0		0	4	134	9	2	13	6	0
1400 to 1459	0		0		0	20	133	26	5	14	10	1
1500 to 1559	0		0		1	36	168	104	1	24	33	3
1600 to 1659						69	43	202	3	95	119	5
1700 to 1759						146	21	213	12	160	101	27
1800 to 1859						116	26	237		150	90	
1900 to 1959								263				
2000 to 2059												
Total	0	0	0	0	1	423	737	1,151	155	485	462	70

<i>Date:</i>	4/24	4/25	4/26	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5
<i>Observation Time-Start:</i>	8:00	8:00	8:00	8:00	8:00	7:50	8:00	8:00	7:50	7:45	7:30	7:45
<i>Observation Time-End:</i>	18:00	18:00	18:00	18:00	20:00	18:30	19:15	18:30	18:00	18:00	18:00	18:00
Military Time (hrs)												
0600 to 0659												
0700 to 0759						0			0	0	0	0
0800 to 0859						75	84	4	128	9	16	11
0900 to 0959	3	0	2	1	0	67	79	10	228	29	6	1
1000 to 1059	0	0	0	0	1	68	40	0	186	0	12	5
1100 to 1159	1	1	1	0	0	86	53	44	214	74	9	5
1200 to 1259	1	2	0	2	0	73	49	41	243	29	15	19
1300 to 1359	1	0	1	1	3	49	40	83	78	59	24	22
1400 to 1459	0	0	0	1	5	44	68	121	117	80	17	27
1500 to 1559	0	1	1	0	28	37	62	134	66	37	15	27
1600 to 1659	0	0	0	0	69	54	65	101	76	24	10	19
1700 to 1759	0	0	1	3	151	56	168	75	75	18	8	21
1800 to 1859					207	52	210	23				
1900 to 1959					133		66					
2000 to 2059												
Total	6	4	6	8	597	661	984	636	1,411	359	132	157

Table 3 (Continued).

<i>Date:</i>	5/6	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	5/16	5/17
<i>Observation Time-Start:</i>	7:30					8:00	8:00	8:00	8:00	8:00	8:00	8:00
<i>Observation Time-End:</i>	18:00					18:00	18:00	18:00	18:00	18:00	18:00	18:00
Military Time (hrs)												
0600 to 0659												
0700 to 0759	0											
0800 to 0859	2					0	0	0	2	2	16	9
0900 to 0959	0					0	0	0	0	3	4	18
1000 to 1059	2					0	0	0	0	4	12	0
1100 to 1159	1					0	0	0	0	5	26	124
1200 to 1259	6					0	0	1	1	3	29	105
1300 to 1359	10					0	2	0	3	7	132	93
1400 to 1459	8					0	1	1	3	5	63	70
1500 to 1559	6					0	1	0	7	4	54	57
1600 to 1659	31					0	0	1	15	21	141	71
1700 to 1759	45					0	2	1	23	33	40	114
1800 to 1859												
1900 to 1959												
2000 to 2059												
Total	111	0	0	0	0	0	6	4	54	87	517	661

<i>Date:</i>	5/18	5/19	5/20	5/21	5/22	5/23	5/24	5/25	5/26	5/27	5/28	5/29
<i>Observation Time-Start:</i>	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00	8:00
<i>Observation Time-End:</i>	18:00	18:00	18:15	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00	18:00
Military Time (hrs)												
0600 to 0659												
0700 to 0759												
0800 to 0859	84	104	43	66	20	7	20	33	5	12	10	3
0900 to 0959	45	41	150	159	74	35	15	33	3	14	18	15
1000 to 1059	23	0	284	192	0	11	0	11	6	116	4	17
1100 to 1159	29	190	369	76	351	29	106	6	55	93	0	5
1200 to 1259	33	131	170	58	181	59	77	4	57	28	1	4
1300 to 1359	14	72	111	52	168	4	51	3	99	25	0	6
1400 to 1459	29	39	149	77	168	7	25	3	8	41	1	20
1500 to 1559	19	14	172	29	155	38	19	4	29	25	0	6
1600 to 1659	30	18	107	68	83	31	17	3	22	8	1	12
1700 to 1759	31	16	93	56	31	36	38	6	13	7	3	1
1800 to 1859			67									
1900 to 1959												
2000 to 2059												
Total	337	625	1,715	833	1,231	257	368	106	297	369	38	89

Table 4
Summary Information for Conowingo EFL Volitional Passage, 1997 through 2017.

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
2016	55	536	860	865,179	14,276	833,681	34	1,006	1/58
2017	46	463	849	844,917	16,265	813,687	65	995	1/50

Table 5

Summary of selected operation and fish catch statistics at the Conowingo Dam East Fish Passage Facility, 1991 to 2017.

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
2016	55	860	536	27	14,276	34	0	0
2017	46	849	463	32	16,265	59	6	0

Table 6

Summary of American shad passage counts and percent passage values at Susquehanna River dams, 1997-2017.

	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%
2016	14,276	6,718	47.0%	4,242	63.1%	178	4.2%
2017	16,265	3,171	19.5%	2,007	63.3%	62	3.1%

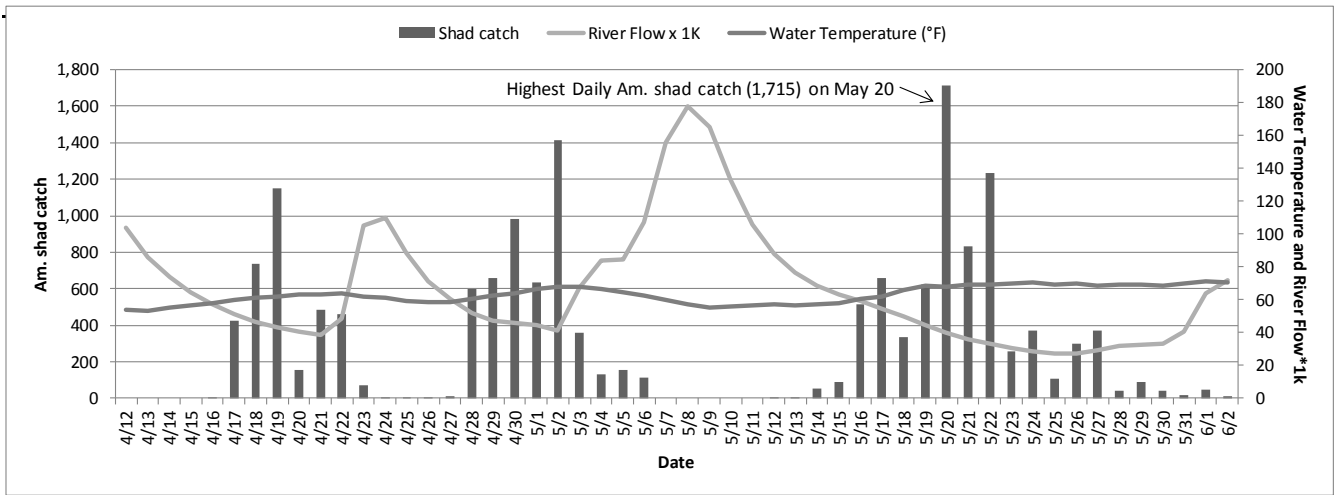


Figure 1

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 2017.

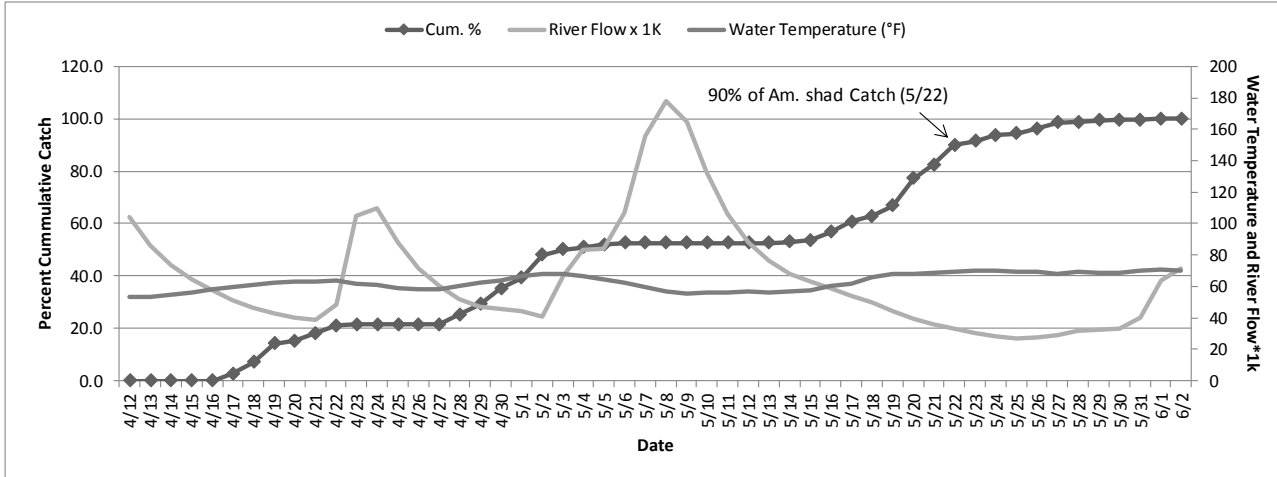


Figure 2

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, 2017.