

**SUMMARY OF OPERATIONS AT THE  
SAFE HARBOR FISH PASSAGE FACILITY  
SPRING 2017**

**November 2017**

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Prepared for

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## Executive Summary

Operation of the Safe Harbor Fish Lift began 20 April, 2017; soon after Holtwood passed 202 American shad into Lake Aldred. The average trough water temperature on 20 April was 61°F and the river flow was 40,500 cfs. A total of 145 American shad were passed on the initial day of operation. Operation at the Safe Harbor Fish Lift ended on June 9, 2017 due to the dwindling fish catch and warm water temperatures; indications that the migration run was ending. The 2017 fish passage season marks the twenty-first season of volitional fish passage at the Safe Harbor Fish Lift.

The Safe Harbor Fish Lift passed 107,834 fish of 19 species and 1 hybrid upstream into Lake Clarke. Gizzard shad (92,138), channel catfish (5,096), smallmouth bass (3,710), and American shad (2,007) dominated the catch, and comprised 95% of the total fish collected and passed. Gizzard shad was the dominant species passed and comprised 85% of the catch.

A total of 2,007 American shad was passed during the 2017 season at Safe Harbor during 46 days of operation. The highest daily passage of American shad occurred on 24 May, when 165 American shad were captured and passed upstream. The passage of American shad during the entire season was consistent between 0800 hours to 1559 hours, with the highest hour of passage occurring from 1000 hours to 1059 hours (240). The 7-hour period between 0800 and 1559 hours accounted for 86% of the total season passage.

Fishway operations were conducted at water temperatures ranging from 56.0°F to 71.8°F and river flows of 27,000 to 107,000 cfs. River flows were generally higher during the entire 2017 fish passage season, resulting in the suspension of fish passage operations from 7 to 11 May due to river flows exceeding 100,000 cfs. Water temperature surpassed 70° F on only 4 days of operation in 2017 and never exceeded 72.0° F.

On 32 of the 46 days of operation, water clarity was good (18-20 inches of visibility at the viewing window), allowing the viewing technicians to accurately identify American shad and other fish species. Although viewing conditions were good in 2017, no American Shad with Maryland DNR floy tags were observed at the Safe Harbor Fishway.

Prior to the start of Safe Harbor fish lift operations in 2016, federal and state resource agency personnel stated their concern regarding the station's use of an air bubbler system to keep the fish trough exit clear of debris during fish passage operation. The resource agencies requested that the station evaluate fish passage when the air bubbler system was in use to determine if the bubbler system impedes fish movement through the fish trough. Safe Harbor indicated to FERC and the resource agencies that fish lift personnel would document deviations in fish behavior/passage if and when the air bubbler system was utilized.

During the 2016 and 2017 fish passage seasons, daily observations of fish behavior/passage were made by the fish counting technicians. At no time during fish passage operations did the technicians observe fish "stacking up" at the trough exit area or large numbers of fish swimming downstream past the window after having passed the viewing window earlier in the day.

Future operations of the Safe Harbor Fish Lift will build on the past twenty-one years of experience.

**TABLE OF CONTENTS**

1.0 INTRODUCTION..... 1

2.0 SAFE HARBOR OPERATION ..... 1

    2.1 Project Operation..... 1

    2.2 Fishway Design and Operation ..... 1

        2.2.1 Fishway Design ..... 1

        2.2.2 Fishway Operation ..... 2

    2.3 Fish Counts..... 2

3.0 RESULTS..... 3

    3.1 Relative Abundance ..... 3

    3.2 American Shad Passage..... 3

    3.3 Other Alosids..... 3

    3.4 Evaluation of Air Bubbler System ..... 4

4.0 SUMMARY ..... 4

5.0 RECOMMENDATIONS ..... 4

6.0 LITERATURE CITED..... 4

TABLES AND FIGURES

**LIST OF TABLES AND FIGURES**

Table 1 Number and disposition of fish passed daily by the Safe Harbor fishway in 2017.

Table 2 Summary of daily average river flow as measured at USGS Gauge Marietta, water temperature, turbidity (secchi), unit operation, entrance gates utilized, attraction flow, and project water elevations during operation of the Safe Harbor fish passage facility in 2017.

Table 3 Summary of American shad passage counts and percent passage values at Susquehanna River dams, 1997-2017.

Table 4 Hourly summary of American shad passage at the Safe Harbor fish passage facility in 2017.

Figure 1 A plot of river flow as measured at USGS Gauge Marietta and water temperature in relation to the daily American shad catch at the Safe Harbor fish passage facility, spring 2017.

Figure 2 A plot of river flow as measured at USGS Gauge Marietta and water temperature in relation to the percent cumulative American shad catch at the Safe Harbor fish passage facility, spring 2017.

## **1.0 INTRODUCTION**

On June 1, 1993 representatives of Safe Harbor Water Power Corporation (SHWPC), two other upstream utilities, various state and federal resource agencies, and two sportsmen clubs signed the 1993 Susquehanna River Fish Passage Settlement Agreement. The agreement committed Safe Harbor, Holtwood, and York Haven Hydroelectric projects to provide migratory fish passage at the three locations by spring 2000. A major element of this agreement was for SHWPC, the operator of the Safe Harbor Hydroelectric Project (Safe Harbor), to construct and place in operation an upstream fishway by April 1, 1997. The fishway that provides fish access into Lake Clarke was placed into service in April of 1997. Brookfield Renewable is now the sole owner/operator of the Safe Harbor Hydroelectric Station.

Objectives for 2017 operation were to (1) monitor passage of migratory and resident fishes through the fishway; (2) assess fishway effectiveness; and (3) continue to assess any impacts of fish passage through the trough when the air bubbler system is in use during fish passage operations.

## **2.0 SAFE HARBOR OPERATION**

### **2.1 Project Operation**

Safe Harbor is situated on the Susquehanna River (river mile 31) in Lancaster and York counties, Pennsylvania. The project consists of a concrete gravity dam 4,869 ft long and 75 ft high, a powerhouse 1,011 ft long with 12 generating units with a combined generating capacity of 417.5 MW, and a reservoir of 7,360 surface acres. The net operating head is about 55 ft.

Safe Harbor is the third upstream dam on the Susquehanna River. The station was built in 1931 and originally consisted of seven generating units. Five units were added and operational in 1986, which increased the hydraulic capacity to 110,000 cfs. Each unit is capable of passing approximately 8,500 cfs. Natural river flows in excess of 110,000 cfs are spilled through three regulating and 28 crest gates. The five new mixed-flow turbines have seven fixed-runner blades, a diameter of 240 in, and runner speed of 76.6 rpm. The runner blades are somewhat spiraled and do not have bands at the top or bottom. Two of these new turbines are equipped with aeration systems that permit a unit to draw air into the unit (vented mode) or operate conventionally (unvented mode). The seven old units are five-blade Kaplan type turbines. These units have horizontal, adjustable, propeller-shaped blades.

### **2.2 Fishway Design and Operation**

#### **2.2.1 Fishway Design**

The fishway was sized to pass a design population of 2.5 million American shad and 5 million river herring. The design incorporated numerous criteria established by the USFWS and the resource agencies. Physical design parameters for the fishway are given in the 1997 summary report (Normandeau Associates, Inc. 1998).

The Safe Harbor fish lift has three entrances (gates A, B, and C). The lift has a fish handling system, which includes a mechanically operated crowder, picket screen, hopper, and hopper trough gate. Fishes captured in the lift are sluiced into the trough and pass into Lake Clarke. Attraction flow, in, through, and from the lift is supplied through a piping system controlled by motor operated valves, attraction water gates, attraction water pools, and two diffusers that are gravity fed from two intakes. Generally, water conveyance and attraction flow is controlled by regulating two motor operated valves and three attraction water gates, which control flow from and into the attraction water pools and the three entrance gates. Fish that enter the fishway entrances are attracted by water flow into the mechanically operated crowder chamber by regulating gate F. Once inside, fish are crowded over the hopper (capacity = 4,725 gallons), lifted, and sluiced into the trough. Fish swim upstream past a

counting facility, which includes a separate public viewing room and into the forebay approximately 150 ft upstream of the dam. The trough extends 40 ft into the forebay in order to sluice the fish past the skimmer wall.

Conceptual design guidelines for fishway operation included several entrance combinations. They are (1) entrance A, B, and C; (2) entrance B and C; (3) entrance A and C, and (4) entrance A, B, and C individually. Operation during the 2017 season utilized a combination of entrances A and C.

### **2.2.2 Fishway Operation**

Safe Harbor fishway operation commences soon after passage of approximately 500 American shad via the Holtwood fishway. In 2017, operations commenced on 20 April, after Holtwood passed 202 American shad into Lake Aldred.

The Safe Harbor fishway began operation on 20 April, with operations ending on 9 June. Lift operations ended due to the dwindling fish catch and rising water temperatures; indications that the adult American shad migration season was ending.

Throughout the 2017 season, operation of the Safe Harbor fishway was based on methods established during previous spring migration seasons. A detailed description of the fishway's major components and their operation is found in the 1997 and 1998 summary reports (Normandeau Associates, Inc. 1998, 1999).

Daily operation of the Safe Harbor fishway was dependent on the American shad catch and managed in a flexible fashion. To minimize interruptions to fishway operation, Safe Harbor performed maintenance activities that included periodic cleaning of the exit channel, daily inspections, cleaning of picket screens, and other routine maintenance activities. On 17 May, the counting room gate became disabled due to a tripped breaker, but the issue was quickly resolved and did not occur throughout the remainder of the season. Due to higher river flows this season which resulted in the accumulation of more natural debris inside the fish trough, it was necessary to drain and clean the trough on four days during the season (5, 19, 26 May, and 2 June). These cleaning activities were conducted in the morning prior to the start of fish lift operations to minimize any impacts to the fish lift operation. Aside from the issues stated previously, no other issues occurred during the fish passage season.

### **2.3 Fish Counts**

Fish lifted and sluiced into the trough were identified to species and enumerated as they passed the counting window by a biological technician. As fish swim upstream and approach the counting area they are directed by a series of fixed screens to swim up and through a 3 ft wide channel on the east side of the trough. The channel is adjacent to a 4 ft by 10 ft window located in the counting room where fish are enumerated prior to exiting the fishway. Fish passage was controlled by the biological technician, who opened/closed a gate located downstream of the viewing window from a controller mounted inside the counting room. Each night, after operations ended for the day, fish were denied passage from the fishway by closing the gate downstream of the window.

A 1,500 watt halogen lamp mounted above the viewing window and three adjustable 500 watt underwater lights (two at mid-depth on either side of the window and one on the bottom) gave the biologist and/or technician a degree of control over lighting conditions at the window. Overhead and underwater light intensity was adjusted daily, based on the constantly changing ambient light conditions. In addition, a screen capable of adjusting the channel width at the counting window from 18 in to 36 in (and a range of intermediate widths) was adjusted as viewing conditions and fish passage dictated. For the entire 2017 season, the adjustable screen was set at 18 in.

At the end of each hour, fish passage data were recorded on a worksheet and entered into a Microsoft Excel spreadsheet 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 e-mailed to plant personnel. Each day's data were backed up on electronic media and stored off site. Daily reports and weekly summaries of fish passage were electronically distributed to members of the SHFPTAC and other cooperators.

### **3.0 RESULTS**

#### **3.1 Relative Abundance**

The relative abundance of fishes collected and passed in 2017 by the Safe Harbor fishway is presented in Table 1. A total of 107,834 fish of 19 species and 1 hybrid passed upstream into Lake Clarke. Gizzard shad (92,138) was the dominant species passed and comprised 85.4% of the catch. Some 2,007 American shad were passed upstream through the fishway and comprised 1.8% of the catch. Other predominant fishes passed included channel catfish (5,096), smallmouth bass (3,710), shorthead redhorse (1,810), and quillback (1,783). The highest fish passage day occurred on 30 April, when 7,108 fish, (79% gizzard shad; 8.8% smallmouth bass), were passed.

#### **3.2 American Shad Passage**

The Safe Harbor fishway passed 2,007 American shad in 2017 during 46 days of operation (Tables 1 and 2). This year's passage of American shad (2,007) is the fifth lowest number of American shad passed since 1997 (Table 3). Safe Harbor managed to pass 63.3% of the American shad passed at Holtwood Dam and 12.3% of the American shad passed by Conowingo Dam, (Table 3). Peak shad passage occurred on 24 May, when 165 American shad were captured and passed during nearly 10.5 hours of operation. American shad passage from 20 through 25 May, (728), accounted for 36% of the total season's passage.

American shad were passed at water temperatures of 56.0°F to 71.0°F and river flows of 27,000 to 110,000 cfs (Table 2 and Figures 1 and 2). River flows were higher than observed in 2016, with two high flow events (river flow > 100,000 cfs) occurring between 23 April and 11 May resulting in spillage and/or suspension of fish passage operations. Water temperature did not spike drastically in 2017 compared to other recent years with temperatures  $\geq 70^\circ$  F recorded on only 4 days during the entire season.

The number of American shad observed passing through the trough by hour is shown in Table 4. With the season's shad catch broken down based on hours of observation, passage rates were generally consistent from 0800 hrs to 1559 hrs. The highest passage hours for American shad during the entire season were observed between 1000 hrs to 1059 hrs (240), 1500 hrs to 1559 hrs (234), and 1400 hrs to 1459 hrs (227). These three hourly periods accounted for nearly 35% of the total season passage. The highest number of American shad passed in one hour (38) occurred between 0800 hrs and 0859 hrs on 20 May.

During the 2017 season, the Safe Harbor fishway did not pass any American shad with MD DNR floy tags that had been passed by downstream fish lift facilities.

#### **3.3 Other Alosids**

Passage of other alosids, (alewife, blueback herring, and hickory shad), at the Safe Harbor fishway was not observed in 2017.

### **3.4 Evaluation of Air Bubbler System**

Prior to the start of Safe Harbor fish lift operations in 2016, federal and state resource agency personnel stated their concern regarding the station's use of an air bubbler system to keep the fish trough exit clear of debris during fish passage operation. The resource agencies requested that the station evaluate fish passage when the air bubbler system is in use to determine if the bubbler system impedes fish movement through the fish trough. Safe Harbor indicated to FERC and the resource agencies that fish lift personnel would document deviations in fish behavior/passage if and when the air bubbler system was utilized.

During the 2017 fish passage season, daily observations of fish behavior/passage were made by the fish counting technicians whether the air bubbler system was on or off. At no time during fish passage operations did the technicians observe fish "stacking up" at the trough exit area or large numbers of fish swimming downstream past the window after having passed the viewing window earlier in the day.

Since 1997 (initial year of operation at Safe Harbor), fish counting technicians have observed on a limited basis an initial unwillingness of fish to quickly swim past the viewing window. Upon inspection of the facility by station personnel, the cause has been a build-up of debris on the retractable screens at the viewing windows. Once the screens are cleaned of debris, fish passage returns to normal. It appears, based on these observations, that the air bubbler system located at the fish trough exit does prevent large amounts of debris from entering the fish trough when present at the trough exit, thus aiding in the maintenance of normal fish passage conditions for all fish species that enter and pass through the Safe Harbor fish lift.

### **4.0 SUMMARY**

Aside from the viewing room gate issue stated previously in Section 2.2.2, the 2017 Safe Harbor fishway operating season was conducted with minimal disruptions to operations due to mechanical problems.

A total of 2,007 American shad were passed into Lake Clarke, or 63.3% of the American shad that were passed into Lake Aldred by the Holtwood fishway (Table 3), similar to the passage percentage observed in 2016 (63.1%). Ninety percent of the total American shad passed at Safe Harbor occurred prior to 28 May (Figure 2), one day after Holtwood passed 90% of their American shad season total. Future operations of the fishway will build on the past twenty-one years of experience.

### **5.0 RECOMMENDATIONS**

- 1) Operate the fishway at Safe Harbor Dam per annual guideline developed and approved by the SHFPTAC. Fishway operation should adhere to the guideline; however, flexibility must remain with operating personnel to maximize fishway operation and performance.

### **6.0 LITERATURE CITED**

- Normandeau Associates, Inc. 1998. Summary of operation at the Safe Harbor Fish Passage Facility in 1997. Prepared for Safe Harbor Water Power Corporation, Conestoga, PA.
- Normandeau Associates, Inc. 1999. Summary of operation at the Safe Harbor Fish Passage Facility in 1998. Prepared for Safe Harbor Water Power Corporation, Conestoga, PA.



## **TABLES AND FIGURES**

**Table 1****Number and disposition of fish passed daily by the Safe Harbor fishway in 2017. No operation 5/7 - 5/11 due to high river flow.**

Date	4/20	4/21	4/22	4/23	4/24	4/25	4/26	4/27	4/28	4/29
Start Viewing Time	7:45	7:30	8:00	7:40	8:00	7:40	8:00	7:35	9:30	8:00
End Viewing Time	17:00	17:00	15:50	15:45	15:50	16:40	16:50	17:00	16:50	17:00
Elapsed Viewing Time	9.3	9.5	7.8	8.1	7.8	9.0	8.8	9.4	7.3	9.0
Lifts Per Day	12	11	11	11	10	10	10	11	9	11
Water Temperature (F)	61	62	62	61	59	58	57	57.3	61	64
AMERICAN SHAD	145	147	77	69	13	8	7	16	34	16
GIZZARD SHAD	4,050	1,379	951	1,520	585	125	1,194	2,414	2,163	3,445
SEA LAMPREY	0	0	0	1	0	0	0	0	0	0
BROWN TROUT	0	0	0	0	1	0	0	0	0	0
RAINBOW TROUT	0	0	0	0	0	0	0	0	0	0
MUSKELLUNGE	1	0	0	0	0	0	0	0	1	0
TIGER MUSKY	0	0	0	0	0	0	0	0	0	0
CARP	0	0	0	14	10	0	0	0	0	0
QUILLBACK	18	34	77	4	3	0	0	2	17	120
S. REDHORSE	48	72	173	10	6	3	12	27	201	323
CHANNEL CATFISH	9	4	2	46	131	29	8	15	8	11
FLATHEAD CATFISH	0	0	0	0	0	0	0	0	0	0
STRIPED BASS	0	0	0	0	0	1	0	0	0	0
ROCK BASS	2	3	0	0	0	0	0	0	0	1
BLUEGILL	0	0	2	0	1	0	0	0	0	1
SMALLMOUTH BASS	349	181	283	296	6	5	7	33	193	574
LARGEMOUTH BASS	0	0	0	0	0	0	0	0	0	0
WHITE CRAPPIE	0	0	0	0	0	0	0	0	0	0
YELLOW PERCH	0	0	0	0	0	0	0	0	0	0
WALLEYE	8	5	18	15	9	0	1	6	4	29
<b>TOTALS</b>	<b>4,630</b>	<b>1,825</b>	<b>1,583</b>	<b>1,975</b>	<b>765</b>	<b>171</b>	<b>1,229</b>	<b>2,513</b>	<b>2,621</b>	<b>4,520</b>

**Table 1 (continued)**

Date	4/30	5/1	5/2	5/3	5/4	5/5	5/6	5/7	5/8	5/9
Start Viewing Time	7:40	7:15	8:00	8:00	7:45	10:45	8:00			
End Viewing Time	17:20	17:20	16:40	15:40	16:25	16:40	11:40	Did	Did	Did
Elapsed Viewing Time	9.7	10.1	8.7	7.7	8.7	5.9	3.7	Not	Not	Not
Lifts Per Day	12	12	11	11	11	8	5	Operate	Operate	Operate
Water Temperature (F)	67	67	67	67	63.9	61	60.4			
AMERICAN SHAD	67	100	79	26	14	7	1			
GIZZARD SHAD	5,630	4,820	4,148	3,534	2,013	345	34			
SEA LAMPREY	0	1	0	0	0	0	0			
BROWN TROUT	1	0	0	0	0	0	0			
RAINBOW TROUT	0	0	0	0	0	0	0			
MUSKELLUNGE	0	0	0	0	0	0	0			
TIGER MUSKY	0	0	0	0	1	0	0			
CARP	4	1	0	1	8	0	0			
QUILLBACK	248	86	34	7	0	0	0			
S. REDHORSE	347	125	119	21	4	1	2			
CHANNEL CATFISH	89	60	26	4	62	39	11			
FLATHEAD CATFISH	0	0	0	0	0	0	0			
STRIPED BASS	0	0	0	0	0	0	0			
ROCK BASS	0	1	0	0	1	0	0			
BLUEGILL	0	0	1	0	1	1	0			
SMALLMOUTH BASS	629	154	105	27	3	0	0			
LARGEMOUTH BASS	3	2	0	0	0	0	0			
WHITE CRAPPIE	0	0	0	0	0	0	0			
YELLOW PERCH	0	0	0	0	0	0	0			
WALLEYE	90	41	32	1	7	0	4			
<b>TOTALS</b>	<b>7,108</b>	<b>5,391</b>	<b>4,544</b>	<b>3,621</b>	<b>2,114</b>	<b>393</b>	<b>52</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Table 1 (continued)**

Date	5/10	5/11	5/12	5/13	5/14	5/15	5/16	5/17	5/18	5/19
Start Viewing Time			8:25	8:00	7:50	7:45	7:30	10:20	7:45	9:00
End Viewing Time	Did	Did	15:20	14:30	15:45	16:45	16:10	17:15	17:15	17:30
Elapsed Viewing Time	Not	Not	6.9	6.5	7.9	9.0	8.7	6.9	9.5	8.5
Lifts Per Day	Operate	Operate	6	5	11	12	11	9	16	16
Water Temperature (F)			56	56	56	57	59	59	65.4	68.8
AMERICAN SHAD			0	0	2	0	11	8	11	27
GIZZARD SHAD			3	4	49	155	679	2,070	2,441	3,950
SEA LAMPREY			0	0	0	0	0	0	0	0
BROWN TROUT			0	0	0	0	0	0	0	0
RAINBOW TROUT			0	0	0	0	0	0	0	0
MUSKELLUNGE			0	0	0	0	0	0	0	0
TIGER MUSKY			0	0	0	0	0	0	0	0
CARP			0	0	0	0	3	22	29	24
QUILLBACK			0	0	0	0	6	157	330	218
S. REDHORSE			0	0	0	2	4	18	88	20
CHANNEL CATFISH			20	9	12	25	10	58	387	442
FLATHEAD CATFISH			0	0	0	0	0	0	0	0
STRIPED BASS			0	0	0	0	0	0	0	3
ROCK BASS			1	0	0	1	0	1	0	0
BLUEGILL			1	0	0	1	0	2	0	0
SMALLMOUTH BASS			0	0	1	15	37	192	107	100
LARGEMOUTH BASS			0	0	0	0	0	3	0	1
WHITE CRAPPIE			0	0	0	0	0	0	0	0
YELLOW PERCH			0	0	0	0	0	0	0	0
WALLEYE			1	3	5	5	8	32	64	22
<b>TOTALS</b>	<b>0</b>	<b>0</b>	<b>26</b>	<b>16</b>	<b>69</b>	<b>204</b>	<b>758</b>	<b>2,563</b>	<b>3,457</b>	<b>4,807</b>

**Table 1 (continued)**

Date	5/20	5/21	5/22	5/23	5/24	5/25	5/26	5/27	5/28	5/29	5/30
Start Viewing Time	8:00	7:10	8:00	7:30	7:20	7:30	8:45	8:00	7:35	7:45	7:30
End Viewing Time	16:50	17:40	16:30	17:25	17:45	17:42	16:15	16:15	16:10	16:15	17:20
Elapsed Viewing Time	8.8	10.5	8.5	9.9	10.4	10.2	7.5	8.3	8.6	8.5	9.8
Lifts Per Day	17	16	12	12	14	13	8	12	12	11	12
Water Temperature (F)	71.8	71.4	68	66	64	65	65	66	67	67	67.8
AMERICAN SHAD	121	129	70	114	165	129	43	85	73	68	34
GIZZARD SHAD	4,969	4,145	2,136	2,615	2,735	2,221	833	1,830	1,521	3,125	1,054
SEA LAMPREY	0	0	0	0	0	0	0	0	0	0	0
BROWN TROUT	0	0	0	0	0	0	0	0	0	0	0
RAINBOW TROUT	0	1	0	0	0	0	0	1	0	0	0
MUSKELLUNGE	0	1	1	1	0	0	0	0	0	0	0
TIGER MUSKY	0	0	0	0	0	0	0	0	0	0	0
CARP	132	46	4	5	2	1	0	0	16	5	7
QUILLBACK	202	62	5	1	2	4	2	11	30	14	26
S. REDHORSE	103	0	28	3	1	27	8	1	2	0	2
CHANNEL CATFISH	976	266	97	24	17	31	24	45	122	130	417
FLATHEAD CATFISH	0	0	0	0	0	0	0	0	0	0	0
STRIPED BASS	0	1	0	0	0	0	0	0	0	1	0
ROCK BASS	0	2	0	0	0	0	0	0	0	0	0
BLUEGILL	6	3	4	0	0	1	0	1	1	0	1
SMALLMOUTH BASS	189	65	18	8	5	8	9	24	17	11	14
LARGEMOUTH BASS	0	2	0	1	1	0	0	2	0	0	0
WHITE CRAPPIE	0	0	0	0	0	0	0	0	0	1	0
YELLOW PERCH	0	0	0	0	0	0	0	0	0	0	0
WALLEYE	105	51	10	17	24	35	2	36	12	11	24
<b>TOTALS</b>	<b>6,803</b>	<b>4,774</b>	<b>2,373</b>	<b>2,789</b>	<b>2,952</b>	<b>2,457</b>	<b>921</b>	<b>2,036</b>	<b>1,794</b>	<b>3,366</b>	<b>1,579</b>

**Table 1 (continued)**

Date	5/31	6/1	6/2	6/3	6/4	6/5	6/6	6/7	6/8	6/9	Season Total
Start Viewing Time	7:30	7:30	10:00	7:30	8:00	7:25	7:30	8:00	7:30	7:30	
End Viewing Time	17:15	16:10	16:15	17:15	17:15	16:20	15:45	16:10	16:45	15:45	
Elapsed Viewing Time	9.8	8.7	6.3	9.8	9.3	8.9	8.3	8.2	9.3	8.3	<b>392</b>
Lifts Per Day	12	11	9	12	12	11	10	11	10	10	<b>509</b>
Water Temperature (F)	67.7	69	71	69	69	70	68	68	67.8	67.7	
AMERICAN SHAD	56	16	11	2	0	3	1	1	1	0	<b>2,007</b>
GIZZARD SHAD	2,085	1,007	2,300	4,095	3,874	1,560	1,012	243	701	376	<b>92,138</b>
SEA LAMPREY	0	0	0	0	0	0	0	0	0	0	<b>2</b>
BROWN TROUT	0	0	0	0	0	0	0	0	0	0	<b>2</b>
RAINBOW TROUT	0	0	0	0	0	0	0	0	0	0	<b>2</b>
MUSKELLUNGE	0	0	0	0	0	1	0	0	0	0	<b>6</b>
TIGER MUSKY	0	0	0	0	0	0	0	0	0	0	<b>1</b>
CARP	7	30	10	5	0	2	2	0	0	0	<b>390</b>
QUILLBACK	12	12	17	2	3	14	0	2	0	1	<b>1,783</b>
S. REDHORSE	1	0	2	1	4	0	1	0	0	0	<b>1,810</b>
CHANNEL CATFISH	202	138	278	417	67	81	55	90	67	35	<b>5,096</b>
FLATHEAD CATFISH	0	0	1	0	0	0	0	0	0	0	<b>1</b>
STRIPED BASS	0	0	0	0	0	0	0	0	0	0	<b>6</b>
ROCK BASS	0	0	0	0	0	0	0	0	0	0	<b>13</b>
BLUEGILL	1	0	0	0	0	1	0	0	2	1	<b>33</b>
SMALLMOUTH BASS	6	8	6	2	7	3	2	1	9	1	<b>3,710</b>
LARGEMOUTH BASS	1	0	0	0	0	0	0	1	0	0	<b>17</b>
WHITE CRAPPIE	0	0	0	0	0	0	0	0	0	0	<b>1</b>
YELLOW PERCH	0	0	0	0	0	0	0	0	3	0	<b>3</b>
WALLEYE	7	5	3	14	7	13	1	19	2	5	<b>813</b>
<b>TOTALS</b>	<b>2,378</b>	<b>1,216</b>	<b>2,628</b>	<b>4,538</b>	<b>3,962</b>	<b>1,678</b>	<b>1,074</b>	<b>357</b>	<b>785</b>	<b>419</b>	<b>107,834</b>

Table 2

Summary of daily average river flow as measured at USGS Gauge Marietta, water temperature, turbidity (secchi), unit operation, entrance gates utilized, attraction flow, and project water elevations during operation of the Safe Harbor fish passage facility in 2017.

Date	River Flow <sup>1</sup> (mcfs)	Water Temp (°F)	Secchi (in)	Maximum # of Units Operating	Entrance Gates Utilized	Attraction Flow (cfs)	Tailrace Elevation (ft)	Forebay Elevation (ft)	Daily No. of Am. Shad Passed
20-Apr	40,500	61	18	7	A/C	500	170.5	226.6	145
21-Apr	38,700	62	18	NA	A/C	500	171.4	226.5	147
22-Apr	48,300	62	18	NA	A/C	500	170.6	226.7	77
23-Apr	105,000	61	18	11	A/C	500	175.7	226.3	69
24-Apr	110,000	59	10	NA	A/C	500	176.3	227.0	13
25-Apr	88,400	58	10	11	A/C	500	175.6	226.7	8
26-Apr	71,300	57	9	11	A/C	500	173.5	226.8	7
27-Apr	60,200	57.3	12	NA	A/C	500	173.5	226.6	16
28-Apr	51,800	61	18	NA	A/C	500	172.8	226.4	34
29-Apr	47,200	64	18	NA	A/C	500	171.7	226.7	16
30-Apr	46,000	67	20	NA	A/C	500	171.1	226.9	67
1-May	44,200	67	18	NA	A/C	500	171.6	226.5	100
2-May	40,900	67	12	6	A/C	500	171.1	226.0	79
3-May	66,800	67	12	NA	A/C	500	171.6	225.8	26
4-May	83,600	63.9	10	6	A/C	500	173.0	227.1	14
5-May	84,300	61	16	6	A/C	500	173.0	227.1	7
6-May	107,000	60.4	12	6	A/C	500	173.5	227.1	1
		No	Operation	Due to	River Flows	≥ 100,000	cfs from	7-11 May	
12-May	88,000	56	12	NA	A/C	500	173.2	227.1	0
13-May	76,200	56	8	NA	A/C	500	173.1	227.1	0
14-May	68,200	56	12	6	A/C	500	172.8	227.0	2
15-May	63,200	57	18	6	A/C	500	172.8	227.2	0
16-May	58,900	59	18	NA	A/C	500	172.8	226.5	11
17-May	54,400	59	18	NA	A/C	500	172.1	226.8	8
18-May	49,900	65.4	18	NA	A/C	500	172.6	226.3	11
19-May	44,500	68.8	18	NA	A/C	500	171.7	226.0	27
20-May	39,800	71.8	18	NA	A/C	500	171.2	226.6	121
21-May	35,800	71.4	18	NA	A/C	500	170.2	226.6	129
22-May	32,900	68	18	NA	A/C	500	169.8	226.5	70
23-May	30,600	66	18	NA	A/C	500	169.7	226.2	114
24-May	28,300	64	18	3	A/C	500	170.0	226.5	165
25-May	27,000	65	18	5	A/C	500	170.9	226.6	129
26-May	27,300	65	18	NA	A/C	500	170.2	226.3	43
27-May	29,100	66	18	NA	A/C	500	169.8	226.5	85
28-May	31,900	67	18	NA	A/C	500	171.6	226.7	73
29-May	32,400	67	18	NA	A/C	500	171.7	226.8	68
30-May	33,200	67.8	18	NA	A/C	500	170.6	226.6	34
31-May	40,200	67.7	20	NA	A/C	500	170.2	226.8	56
1-Jun	63,600	69	20	NA	A/C	500	173.6	226.6	16
2-Jun	71,600	71	20	NA	A/C	500	174.8	226.3	11
3-Jun	68,700	69	15	NA	A/C	500	173.8	226.6	2
4-Jun	59,900	69	15	NA	A/C	500	173.7	226.5	0
5-Jun	50,000	70	18	NA	A/C	500	172.7	226.3	3
6-Jun	42,700	68	18	NA	A/C	500	171.3	226.7	1
7-Jun	38,500	68	18	NA	A/C		171.0	226.6	1
8-Jun	41,300	67.8	18	NA	A/C	500	171.1	226.2	1
9-Jun	56,200	67.7	18	NA	A/C	500	172.8	226.7	0

<sup>1</sup> River flow measured at USGS Marietta Gauge.

NA: information not available

**Table 3**

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

	Conowingo East	Holtwood*		Safe Harbor		York Haven	
		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	77.14%	907	7.14%
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	63.4%	3,896	73.7%	43	1.1%
2016	14,276	6,718	47.1%	4,242	63.1%	178	4.2%
<b>2017</b>	<b>16,265</b>	<b>3,170</b>	<b>19.5%</b>	<b>2,007</b>	<b>63.3%</b>	<b>62</b>	<b>3.1%</b>

\*Am. Shad passed at Holtwood from April 17 to June 7.

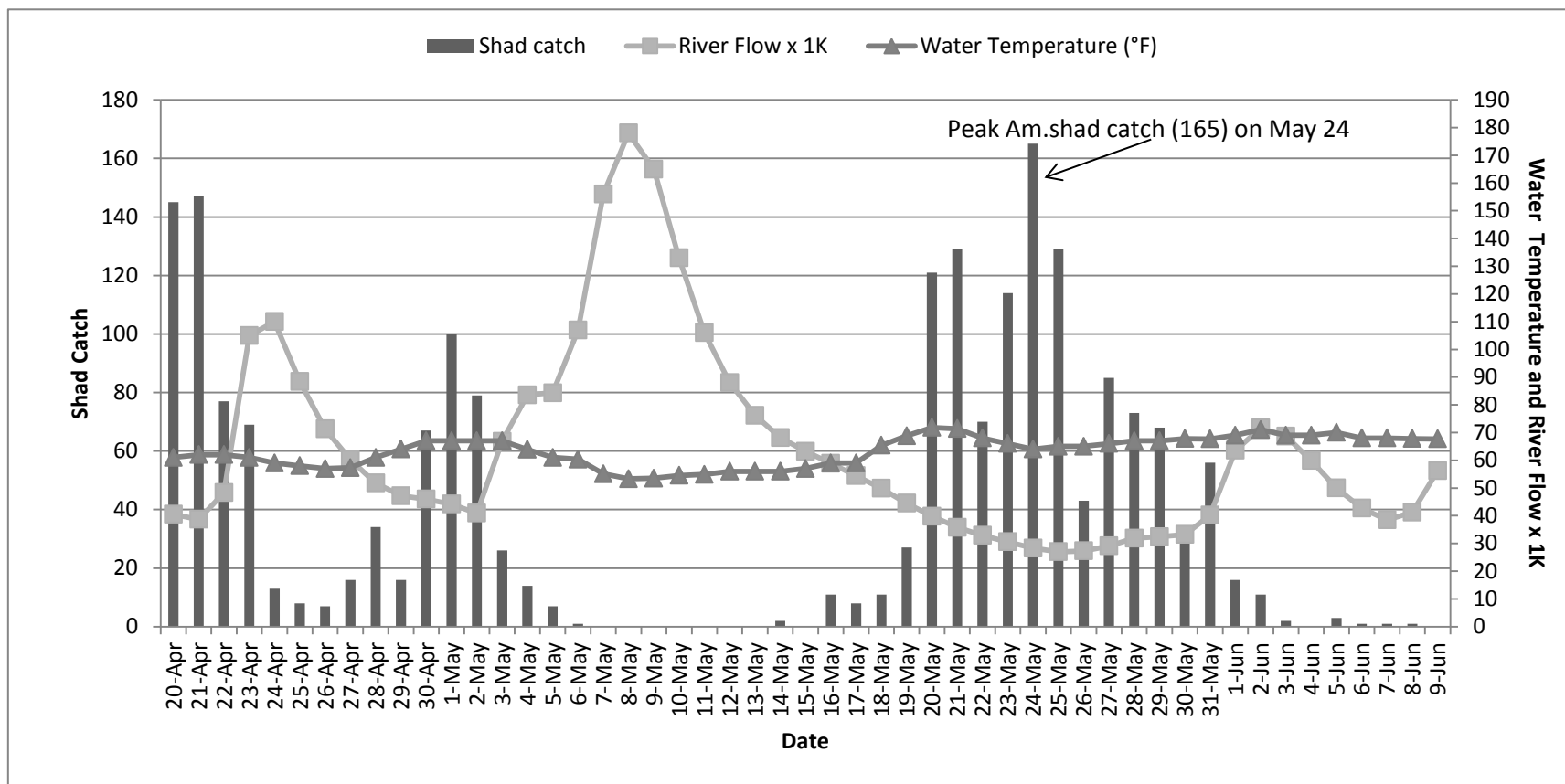




**Table 4**  
**Continued.**

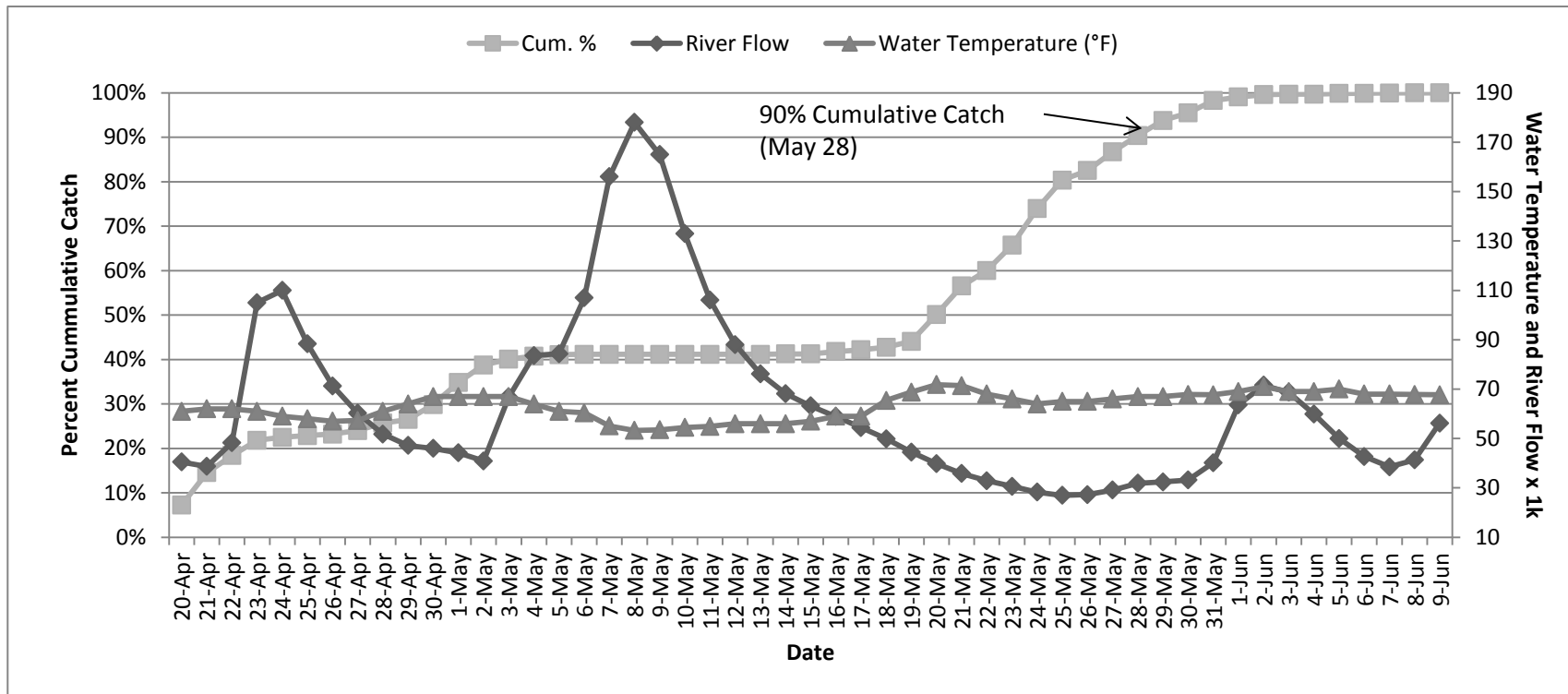
<i>Date:</i>	5/14	5/15	5/16	5/17	5/18	5/19	5/20	5/21	5/22	5/23	5/24	5/25	5/26
<i>Observation Time-Start:</i>	7:50	7:45	7:30	10:20	7:45	9:00	8:00	7:10	8:00	7:30	7:20	7:30	8:45
<i>Observation Time-End:</i>	15:45	16:45	16:10	17:15	17:15	17:30	16:50	17:40	16:30	17:25	17:45	17:42	16:15
<b>Military Time (hrs)</b>													
0600 to 0659													
0700 to 0759	0	0	0		4			3		5	23	3	
0800 to 0859	0	0	0		1		38	7	6	7	24	22	0
0900 to 0959	0	0	0		0	1	17	5	4	12	8	18	0
1000 to 1059	0	0	1	0	0	5	29	11	8	8	22	15	13
1100 to 1159	0	0	1	0	0	4	3	7	12	9	6	3	11
1200 to 1259	1	0	2	2	0	4	4	12	2	17	5	10	5
1300 to 1359	1	0	1	1	2	5	12	24	5	15	11	15	7
1400 to 1459	0	0	0	1	1	3	5	18	8	20	7	15	6
1500 to 1559	0	0	4	2	1	2	10	8	15	7	24	8	1
1600 to 1659		0	2	0	2	2	3	27	10	9	22	12	0
1700 to 1759				2	0	1		7		5	13	8	
1800 to 1859													
1900 to 1959													
<b>Total</b>	<b>2</b>	<b>0</b>	<b>11</b>	<b>8</b>	<b>11</b>	<b>27</b>	<b>121</b>	<b>129</b>	<b>70</b>	<b>114</b>	<b>165</b>	<b>129</b>	<b>43</b>

<i>Date:</i>	5/27	5/28	5/29	5/30	5/31	6/1	6/2	6/3	6/4	6/5	6/6	6/7	6/8	6/9	<i>Season Total</i>
<i>Observation Time-Start:</i>	8:00	7:35	7:45	7:30	7:30	7:30	10:00	7:30	8:00	7:25	7:30	8:00	7:30	7:30	
<i>Observation Time-End:</i>	16:15	16:10	16:15	17:20	17:15	16:10	16:15	17:15	17:15	16:20	15:45	16:10	16:45	15:45	
<b>Military Time (hrs)</b>															
0600 to 0659															<b>0</b>
0700 to 0759		0	1	0	3	0		0		0	0		0	0	<b>69</b>
0800 to 0859	10	6	3	2	7	0		0	0	0	0	0	0	0	<b>229</b>
0900 to 0959	8	11	5	4	5	0		0	0	0	1	0	0	0	<b>209</b>
1000 to 1059	12	12	14	6	6	2	3	0	0	0	0	0	0	0	<b>240</b>
1100 to 1159	12	19	5	3	11	2	0	0	0	0	0	1	1	0	<b>205</b>
1200 to 1259	8	6	7	5	5	2	2	0	0	1	0	0	0	0	<b>191</b>
1300 to 1359	5	5	6	3	6	5	3	1	0	0	0	0	0	0	<b>198</b>
1400 to 1459	15	7	12	4	5	2	2	0	0	0	0	0	0	0	<b>227</b>
1500 to 1559	8	6	11	4	5	2	0	1	0	1	0	0	0	0	<b>234</b>
1600 to 1659	7	1	4	3	3	1	1	0	0	1		0	0		<b>164</b>
1700 to 1759				0	0			0	0						<b>41</b>
1800 to 1859															<b>0</b>
1900 to 1959															<b>0</b>
<b>Total</b>	<b>85</b>	<b>73</b>	<b>68</b>	<b>34</b>	<b>56</b>	<b>16</b>	<b>11</b>	<b>2</b>	<b>0</b>	<b>3</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>2,007</b>



**Figure 1**

**A plot of river flow (USGS Marietta Gauge) and water temperature (°F), in relation to the daily American shad catch at the Safe Harbor Fish Passage Facility, Spring 2017.**



**Figure 2**

A plot of river flow (USGS Marietta Gauge) and water temperature (°F), in relation to the percent cumulative American shad catch at the Safe Harbor Fish Passage Facility, Spring 2017.