

**SUMMARY OF OPERATIONS AT THE
SAFE HARBOR FISH PASSAGE FACILITY
SPRING 2012**

October 2012

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Prepared for

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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.

Objectives for 2012 operation were to (1) monitor passage of migratory and resident fishes through the fishway; and (2) assess fishway effectiveness.

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 over 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 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 regulating 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 (4,725 gal. capacity), 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 2012 season utilized a combination of entrances A, B, and C or A and C (Table 2).

2.2.2 Fishway Operation

Safe Harbor fishway operation commences soon after passage of approximately 500 American shad via the Holtwood fishway. In 2012, operations commenced on 12 April, six days after Holtwood passed 194 American shad into Lake Aldred.

The Safe Harbor fishway began operation on 12 April, with operations ending on 6 June. Lift operations ended due to the dwindling fish catch and rising water temperatures; indications that the migration run was ending.

Throughout the 2012 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, SHWPC performed maintenance activities that included periodic cleaning of the exit channel, daily inspections, cleaning of picket screens, and other routine maintenance activities. Mechanical and/or electrical problems were addressed as needed.

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 biologist and/or 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 reducing the channel width at the counting window from 36 in down to 18 in (and a range of intermediate widths) was adjusted as viewing conditions and fish passage dictated. For the entire 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 to a diskette 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 2012 by the Safe Harbor fishway is presented in Table 1. A total of 161,874 fish of 19 species and 1 hybrid passed upstream into Lake Clarke. Gizzard shad (136,369) was the dominant species passed and comprised 84% of the catch. Some 3,089 American shad were passed upstream through the fishway and comprised nearly 2% of the catch. Other predominant fishes passed included quillback (12,582), channel catfish (4,972), carp (1,475), shorthead redhorse (1,321) and walleye (1,296). Peak passage occurred on 5 May, when 9,495 fish, (78% gizzard shad), were passed.

3.2 American Shad Passage

The Safe Harbor fishway passed 3,089 American shad in 2012 during 56 days of operation (Table 1). This year's passage of American shad (3,089) is the fourth lowest in sixteen years of operation (Table 4). Safe Harbor managed to pass 72.9% of the American shad passed at Holtwood Dam and nearly 14% of the American shad passed by Conowingo Dam, (Table 4). Peak shad passage occurred on 5 May, when 288 American shad were captured and passed during 10 hours of operation.

American shad were passed at water temperatures of 54.9°F to 79.0°F and river flows of 13,700 to 107,300 cfs (Table 2 and Figures 1 and 2). Water temperature was relatively stable (remained below 70.0°) from April 12 to May 24. After May 24, the water temperature steadily climbed to the end of the season except for the last three days of operation.

The number of American shad observed passing through the trough by hour is shown in Table 3. With the season's shad catch broken down based on hours of observation, passage rates were consistent from 0900 hrs to 1659 hrs. Passage sharply declined after 1700 hrs. The peak passage hour for American shad during the entire season was observed between 1600 hrs to 1659 hrs, with a total of 369 American shad passed. The highest hourly passage (71) occurred between 1600 hrs and 1659 hrs on 5 May.

During the 2012 season, the Safe Harbor fishway passed no MD DNR tagged American shad that had been passed by downstream fish lift facilities.

Passage of other alosids, (alewife, blueback herring, and hickory shad), at the Safe Harbor fishway was not observed in 2012.

4.0 SUMMARY

The 2012 Safe Harbor fishway operating season was conducted with minimal disruptions to operations due to mechanical problems.

A total of 3,089 American shad were passed into Lake Clarke, or nearly 73% of the American shad that were passed into Lake Aldred by the Holtwood fishway (Table 4). More than 90% of the total American shad passed at Safe Harbor occurred prior to 22 May, shortly before Holtwood passed 90% of their American shad season total (23 May). Future operations of the fishway will build on the past sixteen 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

Table 1. Number and disposition of fish passed by the Safe Harbor fishway in 2012.

<i>Date:</i>	12-Apr	13-Apr	14-Apr	15-Apr	16-Apr	17-Apr	18-Apr	19-Apr	20-Apr	21-Apr	22-Apr
<i>Viewing Start Time:</i>	8:25	7:00	7:40	7:00	8:30	7:00	7:25	10:10	9:45	9:40	9:00
<i>Viewing End Time:</i>	16:50	16:40	16:50	16:40	17:20	17:40	17:50	18:00	17:30	18:07	17:30
<i>Hours of Operation:</i>	8.4	9.7	9.2	9.7	8.8	10.7	10.4	7.8	7.8	8.5	8.5
<i>Number of Lifts:</i>	9	5	10	8	8	12	14	11	10	11	9
<i>Water Temperature (°F):</i>	53.1	53.2	53.2	55.4	58	59.5	61	63	64.4	64.9	64.5
AMERICAN SHAD	41	2	36	21	3	142	181	211	241	158	70
GIZZARD SHAD	1187	113	236	29	60	521	873	4935	5187	3802	970
STRIPED BASS	0	0	0	0	0	0	0	0	0	0	0
SEA LAMPREY	0	0	0	0	0	0	0	0	0	1	0
BROWN TROUT	0	0	0	0	0	1	0	0	0	0	0
MUSKELLUNGE	0	0	0	0	0	0	0	0	0	0	1
CARP	0	10	43	12	29	140	351	270	45	42	37
QUILLBACK	43	3	18	36	129	1809	723	905	431	706	326
S. REDHORSE	2	1	0	0	1	42	18	5	20	19	15
BROWN BULLHEAD	0	0	0	0	0	0	0	0	0	0	0
CHANNEL CATFISH	1	1	0	2	12	14	104	62	32	35	105
HYBRID STRIPED BASS	0	0	0	0	0	0	0	0	0	0	0
ROCK BASS	0	0	0	0	0	0	0	0	3	1	0
BLUEGILL	0	0	0	0	0	0	0	0	0	2	0
SMALLMOUTH BASS	14	1	20	17	23	136	98	68	73	16	3
LARGEMOUTH BASS	0	0	0	0	0	1	1	0	0	0	0
WHITE CRAPPIE	0	0	0	0	0	0	0	1	0	0	0
BLACK CRAPPIE	0	0	0	0	0	0	1	0	0	0	0
WALLEYE	2	1	0	0	1	23	23	8	12	14	7
FLAT HEAD CATFISH	0	0	0	0	0	0	0	0	0	0	0
Daily Total	1,290	132	353	117	258	2,829	2,373	6,465	6,044	4,796	1,534

Table 1

Continued.

<i>Date:</i>	23-Apr	24-Apr	25-Apr	26-Apr	27-Apr	28-Apr	29-Apr	30-Apr	1-May	2-May	3-May
<i>Viewing Start Time:</i>	9:30	9:30	9:30	9:45	9:30	9:30	9:30	9:30	11:40	9:30	9:40
<i>Viewing End Time:</i>	18:00	17:45	17:55	17:35	16:30	17:30	17:30	17:30	17:45	17:30	17:45
<i>Hours of Operation:</i>	8.5	8.3	8.4	7.8	7.0	8.0	8.0	8.0	6.1	8.0	8.1
<i>Number of Lifts:</i>	11	11	11	11	8	8	8	6	7	10	11
<i>Water Temperature (°F):</i>	58.5	57	59.2	55.4	56.5	56.3	55.4	54.7	55.9	57.2	58.6
AMERICAN SHAD	215	102	119	58	5	26	0	0	14	29	43
GIZZARD SHAD	3849	4375	2174	290	427	419	23	69	1892	347	760
STRIPED BASS	0	0	0	0	0	0	0	0	0	0	0
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
MUSKELLUNGE	1	0	0	0	0	0	0	0	0	0	0
CARP	3	4	1	2	0	4	0	1	0	11	24
QUILLBACK	266	50	15	4	68	23	0	0	95	1155	565
S. REDHORSE	6	2	2	3	13	6	0	1	44	235	103
BROWN BULLHEAD	0	0	0	0	0	0	0	0	0	0	0
CHANNEL CATFISH	128	13	18	19	71	5	1	0	3	21	21
HYBRID STRIPED BASS	0	0	0	0	0	0	0	0	0	0	0
ROCK BASS	0	0	0	1	0	0	0	0	0	0	2
BLUEGILL	0	0	1	0	0	0	0	0	0	0	0
SMALLMOUTH BASS	4	5	2	2	4	3	0	0	5	6	23
LARGEMOUTH BASS	1	0	0	0	0	0	0	0	0	0	0
WHITE CRAPPIE	0	0	0	0	0	0	0	0	0	0	2
BLACK CRAPPIE	0	0	0	0	0	0	0	0	0	1	0
WALLEYE	19	4	10	20	1	3	1	2	9	43	52
FLAT HEAD CATFISH	0	0	0	0	0	0	0	0	0	0	0
Daily Total	4,492	4,555	2,342	399	589	489	25	73	2,062	1,848	1,595

Table 1

Continued.

<i>Date:</i>	4-May	5-May	6-May	7-May	8-May	9-May	10-May	11-May	12-May	13-May	14-May
<i>Viewing Start Time:</i>	11:20	8:20	9:00	9:30	9:30	9:00	9:30	9:25	9:30	9:00	9:00
<i>Viewing End Time:</i>	17:40	18:15	17:45	17:30	17:30	17:35	17:30	17:30	17:30	16:48	17:30
<i>Hours of Operation:</i>	6.3	9.9	8.8	8.0	8.0	8.6	8.0	8.1	8.0	7.8	8.5
<i>Number of Lifts:</i>	9	14	13	12	14	13	13	11	12	12	10
<i>Water Temperature (°F):</i>	61.5	64.5	68	67	64	63.3	63.3	63.5	62.5	63	65.7
AMERICAN SHAD	72	288	145	102	45	119	52	48	34	17	12
GIZZARD SHAD	1880	7418	2960	3518	7507	8066	8906	6871	6011	2703	1083
STRIPED BASS	0	0	0	0	0	0	0	0	0	0	0
SEA LAMPREY	1	0	0	0	0	0	0	0	0	0	0
BROWN TROUT	0	0	0	0	0	0	0	0	0	0	1
MUSKELLUNGE	0	0	1	0	0	0	0	0	1	0	0
CARP	24	136	55	15	10	3	0	0	0	3	2
QUILLBACK	834	1147	1045	580	41	14	11	6	3	4	68
S. REDHORSE	199	147	100	80	21	11	2	1	7	2	25
BROWN BULLHEAD	0	0	0	0	0	0	0	0	0	0	0
CHANNEL CATFISH	93	223	310	395	64	39	30	44	12	23	193
HYBRID STRIPED BASS	0	0	0	0	0	0	0	0	0	0	0
ROCK BASS	2	6	3	1	0	0	0	1	1	0	0
BLUEGILL	0	2	0	0	0	1	0	0	0	0	1
SMALLMOUTH BASS	30	23	35	21	3	2	2	6	2	1	2
LARGEMOUTH BASS	3	0	0	0	0	1	0	0	0	0	0
WHITE CRAPPIE	1	2	0	1	0	0	0	0	0	0	0
BLACK CRAPPIE	0	0	0	1	0	0	0	0	0	0	0
WALLEYE	81	103	55	138	17	13	16	7	15	11	45
FLAT HEAD CATFISH	0	0	0	0	0	0	1	0	0	0	0
Daily Total	3,220	9,495	4,709	4,852	7,708	8,269	9,020	6,984	6,086	2,764	1,432

Table 1

Continued.

<i>Date:</i>	15-May	16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May
<i>Viewing Start Time:</i>	9:00	8:30	8:30	10:00	8:48	8:30	8:45	9:00	8:45	9:00	8:30
<i>Viewing End Time:</i>	16:47	17:30	17:30	17:17	17:25	17:30	17:32	17:45	17:20	17:30	8:31
<i>Hours of Operation:</i>	7.8	9.0	9.0	7.3	8.6	9.0	8.8	8.8	8.6	8.5	0.0
<i>Number of Lifts:</i>	10	10	10	9	11	11	14	11	11	9	1
<i>Water Temperature (°F):</i>	65.5	65.5	64.9	64	66	68.2	70	69	70	71	71
AMERICAN SHAD	16	32	3	9	5	3	11	85	18	29	9
GIZZARD SHAD	761	8646	5771	1016	1002	1651	396	1430	1143	3125	19
STRIPED BASS	0	0	0	0	0	0	0	0	0	0	0
SEA LAMPREY	1	0	0	0	0	1	0	0	0	0	0
BROWN TROUT	0	1	0	0	0	0	0	0	0	0	0
MUSKELLUNGE	0	0	0	0	1	0	0	0	0	0	0
CARP	3	23	17	3	2	3	10	34	1	7	0
QUILLBACK	25	12	3	0	0	3	129	130	7	2	0
S. REDHORSE	2	9	5	1	0	2	8	26	16	7	0
BROWN BULLHEAD	0	0	0	0	0	0	0	0	0	0	0
CHANNEL CATFISH	104	190	117	24	91	167	325	300	61	90	0
HYBRID STRIPED BASS	0	0	0	0	0	0	0	0	0	0	0
ROCK BASS	0	0	0	0	0	1	0	0	1	1	0
BLUEGILL	1	0	0	0	0	0	0	1	0	2	0
SMALLMOUTH BASS	1	3	0	1	1	0	0	2	1	0	0
LARGEMOUTH BASS	0	0	0	0	1	0	0	2	0	1	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
WALLEYE	18	8	4	2	5	3	51	100	47	52	0
FLAT HEAD CATFISH	0	0	0	0	0	0	0	0	0	0	0
Daily Total	932	8,924	5,920	1,056	1,108	1,834	930	2,110	1,295	3,316	28

Table 1

Continued.

<i>Date:</i>	26-May	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	3-Jun	4-Jun	5-Jun
<i>Viewing Start Time:</i>	14:25	8:30	9:00	9:30	9:00	9:00	9:00	9:00	9:00	9:30	9:10
<i>Viewing End Time:</i>	18:35	17:30	17:05	17:30	17:50	17:30	17:30	16:10	16:12	16:10	16:15
<i>Hours of Operation:</i>	4.2	9.0	8.1	8.0	8.8	8.5	8.5	7.2	7.2	6.7	7.1
<i>Number of Lifts:</i>	7	10	10	9	9	9	9	6	8	8	7
<i>Water Temperature (°F):</i>	76	75.6	77	77	77	78	77.5	75	71.6	70.2	68.5
AMERICAN SHAD	45	51	35	39	19	9	9	1	3	2	1
GIZZARD SHAD	8497	4197	2740	1190	1461	715	488	1330	351	225	493
STRIPED BASS	0	0	0	0	0	0	0	0	0	0	0
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
MUSKELLUNGE	0	0	0	0	0	0	0	0	0	0	0
CARP	10	52	8	8	7	2	4	3	1	0	0
QUILLBACK	157	395	157	155	136	105	30	4	5	1	2
S. REDHORSE	20	51	18	18	3	1	1	0	0	0	0
BROWN BULLHEAD	0	0	0	0	0	0	0	1	0	0	0
CHANNEL CATFISH	80	138	167	200	311	80	233	50	67	24	36
HYBRID STRIPED BASS	0	0	0	0	0	0	0	0	0	1	1
ROCK BASS	1	1	0	0	0	0	0	0	0	0	0
BLUEGILL	3	2	5	6	3	0	0	0	0	0	1
SMALLMOUTH BASS	4	0	1	2	2	1	1	0	0	0	0
LARGEMOUTH BASS	0	0	0	0	0	0	0	0	0	0	1
WHITE CRAPPIE	0	0	1	0	0	0	0	0	0	0	0
BLACK CRAPPIE	0	0	0	0	0	0	0	0	0	0	0
WALLEYE	42	52	60	19	28	7	25	3	0	0	6
FLAT HEAD CATFISH	0	0	0	0	0	0	1	0	0	1	0
Daily Total	8,859	4,939	3,192	1,637	1,970	920	792	1,392	427	254	541

Table 1

Continued.

<i>Date:</i>	6-Jun	<i>Season Total</i>
<i>Viewing Start Time:</i>	9:00	21.4
<i>Viewing End Time:</i>	16:15	
<i>Hours of Operation:</i>	7.3	451.3
<i>Number of Lifts:</i>	8	549.0
<i>Water Temperature (°F):</i>	68	
AMERICAN SHAD	4	3,089
GIZZARD SHAD	261	136,369
STRIPED BASS	1	1
SEA LAMPREY	0	4
BROWN TROUT	0	3
MUSKELLUNGE	0	5
CARP	0	1,475
QUILLBACK	1	12,582
S. REDHORSE	0	1,321
BROWN BULLHEAD	0	1
CHANNEL CATFISH	23	4,972
HYBRID STRIPED BASS	0	2
ROCK BASS	0	26
BLUEGILL	0	31
SMALLMOUTH BASS	0	670
LARGEMOUTH BASS	0	12
WHITE CRAPPIE	1	9
BLACK CRAPPIE	0	3
WALLEYE	8	1,296
FLAT HEAD CATFISH	0	3
Daily Total	299	161,874

Table 2

Table 2. Summary of daily average river flow and water temperature as measured at Holtwood Dam, turbidity (secchi), unit operation, entrance gates utilized, attraction flow, and project water elevations during operation of the Safe Harbor fish passage facility in 2012.

Date	River Flow¹ (mcfs)	Water Temp (°F)	Secchi (in)	Maximum # of Units Operating	Entrance Gates Utilized	Attraction Flow (cfs)	Tailrace Elevation (ft)	Forebay Elevation (ft)
12-Apr	18,400	55.0	24	5	A/C	500	169.3	226.9
13-Apr	16,100	54.9	24	6	A/C	500	170.1	226.9
14-Apr	17,100	54.9	28	4	A/C	500	168.7	226.3
15-Apr	16,000	55.4	24	NA	A/C	500	168.2	226.5
16-Apr	16,100	56.5	24	3	A/B/C	500	169.5	226.4
17-Apr	15,500	59.2	24	1	A/B/C	500	167.2	226.1
18-Apr	14,900	60.1	22	2	A/C	500	167.5	226.1
19-Apr	14,300	62.3	24	4	A/C	500	169.1	225.8
20-Apr	16,900	63.1	22	1	A/C	500	168.3	226.2
21-Apr	13,700	64.5	20	4	A/C	500	168.5	226.8
22-Apr	14,800	64.4	18	3	A/C	500	168.6	227.0
23-Apr	18,500	62.5	18	5	A/C	500	170.0	226.2
24-Apr	18,000	61.6	16	6	A/C	500	170.4	226.2
25-Apr	23,400	61.2	16	6	A/C	500	170.5	226.2
26-Apr	35,200	59.0	16	9	A/C	500	172.2	266.3
27-Apr	43,500	56.1	16	10	A/C	500	173.3	226.3
28-Apr	41,200	55.9	18	10	A/C	500	172.4	226.8
29-Apr	39,200	55.8	18	8	A/C	500	171.9	227.2
30-Apr	37,300	55.6	18	8	A/C	500	172.9	226.5
1-May	33,600	55.5	24	7	A/C	500	172.3	226.9
2-May	31,400	56.5	24	7	A/C	500	172.5	226.3
3-May	30,700	58.0	30	7	A/C	500	170.5	227.3
4-May	29,400	60.9	30	9	A/C	500	171.9	225.9
5-May	41,300	63.3	30	5	A/C	500	171.6	226.8
6-May	46,400	65.8	32	7	A/C	500	172.5	226.9
7-May	50,200	67.6	30	9	A/C	500	173.6	226.5
8-May	46,300	65.4	30	7	A/C	500	173.2	226.5
9-May	45,600	64.3	20	8	A/C	500	173.5	226.6
10-May	56,700	64.3	18	10	A/C	500	174.7	226.3
11-May	65,200	63.6	16	11	A/C	500	175.3	225.8
12-May	64,500	62.9	20	9	A/C	500	174.8	226.9
13-May	56,800	63.5	24	8	A/C	500	173.8	227.0
14-May	49,100	64.8	30	9	A/C	500	173.7	226.6
15-May	51,500	65.4	24	8	A/C	500	173.4	226.7
16-May	89,000	65.7	24	11	A/C	500	176.4	225.2
17-May	107,300	66.1	12	12	A/C	500	176.5	225.5
18-May	90,200	65.5	12	11	A/C	500	176.2	226.8
19-May	70,800	66.0	16	8	A/C	500	174.4	226.1
20-May	57,100	67.0	16	9	A/C	500	173.7	226.9
21-May	47,500	68.4	18	11	A/C	500	174.1	226.2
22-May	41,700	69.1	24	7	A/C	500	171.5	227.1
23-May	39,800	69.2	24	8	A/C	500	173.3	226.1
24-May	40,400	69.9	24	7	A/C	500	173.5	226.1
25-May	39,100	71.4	24	8	A/C	500	173.4	226.3
26-May	34,800	72.7	24	5	A/C	500	172.4	226.5
27-May	31,800	74.4	24	7	A/C	500	172.4	226.9
28-May	39,400	76.4	24	6	A/C	500	171.5	227
29-May	46,900	78.2	24	7	A/C	500	174.1	226.1
30-May	44,300	79.0	20	8	A/C	500	173.3	226.3
31-May	46,900	78.3	18	8	A/C	500	173.1	226.3
1-Jun	46,500	77.0	18	9	A/C	500	173.1	226.6
2-Jun	53,600	74.4	10	9	A/C	500	174.1	226.9
3-Jun	64,400	71.4	10	9	A/C	500	173.8	226.5
4-Jun	56,300	69.8	6	8	A/C	500	173.8	226.1
5-Jun	50,700	68.4	10	8	A/C	500	173.5	227
6-Jun	45,300	67.9	16	7	A/C	500	172.8	226.8

¹ River flow and temperature measured at Holtwood Dam.

Table 3

Table 3. Hourly summary of American shad passage at the Safe Harbor fish passage facility in 2012.

<i>Date:</i>	12-Apr	13-Apr	14-Apr	15-Apr	16-Apr	17-Apr	18-Apr	19-Apr	20-Apr	21-Apr	22-Apr	23-Apr
Observation Time-Start:	8:25	7:00	7:40	7:00	8:30	7:00	7:25	10:10	9:45	9:40	9:00	9:30
Observation Time-End:	16:50	16:40	16:50	16:40	17:20	17:40	17:50	18:00	17:30	18:07	17:30	18:00
Military Time (hrs)												
0700 to 0759			0			3	7					
0800 to 0859			0	2	1	4	7					
0900 to 0959			2	1		0	14		11	0	3	11
1000 to 1059	5	1	5			2	30	28	16	12	7	26
1100 to 1159	8	1	0	5		12	29	37	40	21	7	22
1200 to 1259	3		2	4		17	18	26	31	22	8	36
1300 to 1359	6		7	1		12	20	22	34	14	9	25
1400 to 1459	1		6	1		12	16	35	33	16	4	31
1500 to 1559	9		5	5		27	11	24	34	20	9	42
1600 to 1659	9		9	2		37	9	25	27	18	15	17
1700 to 1759					2	16	20	14	15	32	8	5
1800 to 1859										3		
1900 to 1959												
Total	41	2	36	21	3	142	181	211	241	158	70	215
<i>Date:</i>	24-Apr	25-Apr	26-Apr	27-Apr	28-Apr	29-Apr	30-Apr	1-May	2-May	3-May	4-May	5-May
Observation Time-Start:	9:30	9:30	9:45	9:30	9:30	9:30	9:30	11:40	9:30	9:40	11:20	8:20
Observation Time-End:	17:45	17:55	17:35	16:30	17:30	17:30	17:30	17:45	17:30	17:45	17:40	18:15
Military Time (hrs)												
0700 to 0759											7	
0800 to 0859												12
0900 to 0959	8	9	2			0	0		0	6		35
1000 to 1059	9	22	17	1	3	0	0		2	5		31
1100 to 1159	7	14	9		5	0	0	1	2	1	4	11
1200 to 1259	9	12	5		2	0	0	2	8		6	34
1300 to 1359	11	21	10	1	2	0	0	1	5	6	6	28
1400 to 1459	15	10	3		6	0			3	4	12	12
1500 to 1559	15	7	6	1	2	0	0	1	2	7	6	24
1600 to 1659	15	9	5		3	0	0	6	6	8	11	71
1700 to 1759	13	15	1	2	3	0	0	3	1	6	20	14
1800 to 1859												16
1900 to 1959												
Total	102	119	58	5	26	0	0	14	29	43	72	288

Table 3

Continued.

<i>Date:</i>	6-May	7-May	8-May	9-May	10-May	11-May	12-May	13-May	14-May	15-May	16-May	17-May
<i>Observation Time-Start:</i>	9:00	9:30	9:30	9:00	9:30	9:25	9:30	9:00	9:00	9:00	8:30	8:30
<i>Observation Time-End:</i>	17:45	17:30	17:30	17:35	17:30	17:30	17:30	16:48	17:30	16:47	17:30	17:30
Military Time (hrs)												
0700 to 0759												
0800 to 0859											3	0
0900 to 0959	28	26	3	13	10	9	7	3	1	1	3	1
1000 to 1059	24	25	10	17	3	2		1	2	3	4	0
1100 to 1159	13	4	4	10	4	1	6	3	1	2	5	0
1200 to 1259	7	10	7	12	8	6	5	0	3	2	10	0
1300 to 1359	12	7	2	21	7	13	6	2	2	1	4	2
1400 to 1459	32	7		6	11	9	9	3	2	3	2	0
1500 to 1559	8	12	6	21	8	4	1	4	1	3	0	
1600 to 1659	6	6	8	15	1	4		1	0	1	0	0
1700 to 1759	15	5	5	4		0			0		1	0
1800 to 1859												
1900 to 1959												
Total	145	102	45	119	52	48	34	17	12	16	32	3

<i>Date:</i>	18-May	19-May	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May
<i>Observation Time-Start:</i>	10:00	8:48	8:30	8:45	9:00	8:45	9:00	8:30	14:25	8:30	9:00	9:30
<i>Observation Time-End:</i>	17:17	17:25	17:30	17:32	17:45	17:20	17:30	18:31	18:35	17:30	17:05	17:30
Military Time (hrs)												
0700 to 0759												
0800 to 0859	6	1	1	0		0		9		12		
0900 to 0959	0	1	0	1	4	0	5			13	4	12
1000 to 1059	0	0	0	5	6	0	4			9	2	7
1100 to 1159	0	1	0	1	2	6				3	9	4
1200 to 1259	1	0	0	0	19	2				4	3	4
1300 to 1359	0	1	1	1	13	2	8			0	7	7
1400 to 1459	1	0	0	2	21	2	9		2	6	0	1
1500 to 1559	1	1	0	0	14	0	2		1	1	9	2
1600 to 1659	0	0	1	0	2	4	1		11	1	1	2
1700 to 1759	0	0	0	1	4	2			26	2	0	
1800 to 1859									5			
1900 to 1959												
Total	9	5	3	11	85	18	29	9	45	51	35	39

Table 3

Continued.

<i>Date:</i>	<i>30-May</i>	<i>31-May</i>	<i>1-Jun</i>	<i>2-Jun</i>	<i>3-Jun</i>	<i>4-Jun</i>	<i>5-Jun</i>	<i>6-Jun</i>	<i>Season</i>
<i>Observation Time-Start:</i>	<i>9:00</i>	<i>9:00</i>	<i>9:00</i>	<i>9:00</i>	<i>9:00</i>	<i>9:30</i>	<i>9:10</i>	<i>9:00</i>	<i>Total</i>
<i>Observation Time-End:</i>	<i>17:50</i>	<i>17:30</i>	<i>17:30</i>	<i>16:10</i>	<i>16:12</i>	<i>16:10</i>	<i>16:15</i>	<i>16:15</i>	
Military Time (hrs)									
0700 to 0759									17
0800 to 0859									58
0900 to 0959	1	3	0		0	1	0		252
1000 to 1059	3	3	1	1	1		1	1	357
1100 to 1159	3	1	0		2		0		321
1200 to 1259	1		3		0		0		352
1300 to 1359	0		2		0	1	0	2	365
1400 to 1459	2	1	3		0		0	1	355
1500 to 1559	3	1	0		0		0		360
1600 to 1659	2		0		0		0		369
1700 to 1759	4		0						259
1800 to 1859									24
1900 to 1959									0
Total	19	9	9	1	3	2	1	4	3,089

Table 4**Table 4. Summary of American shad passage counts and percent passage values at Susquehanna River dams, 1997-2012.**

	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	43.63%	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%

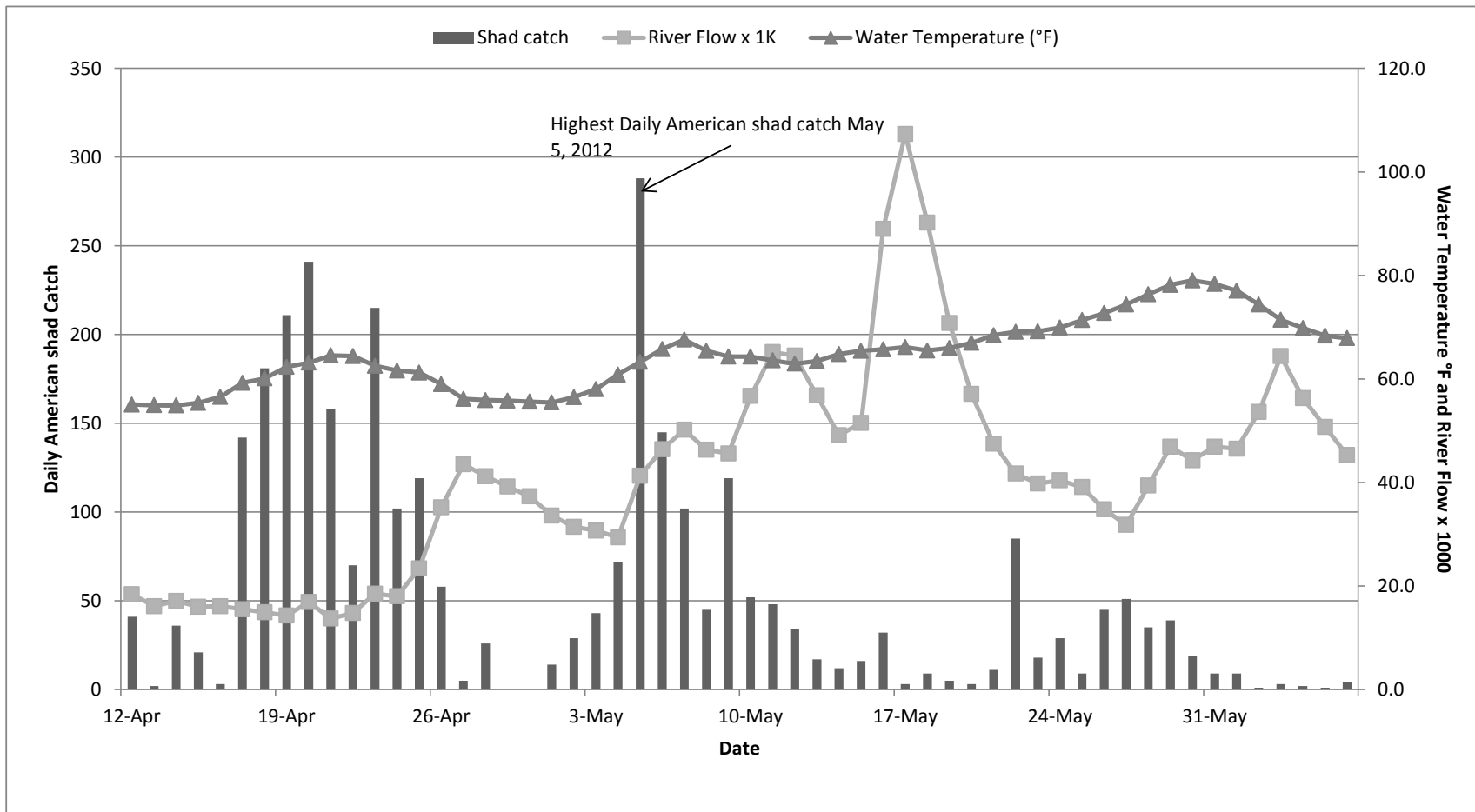


Figure 1

Figure 1. A plot of river flow (x 1000 cfs) and water temperature (°F) as measured at Holtwood Dam, in relationship to the daily American shad catch at the Safe Harbor Fish Passage Facility, spring 2012.

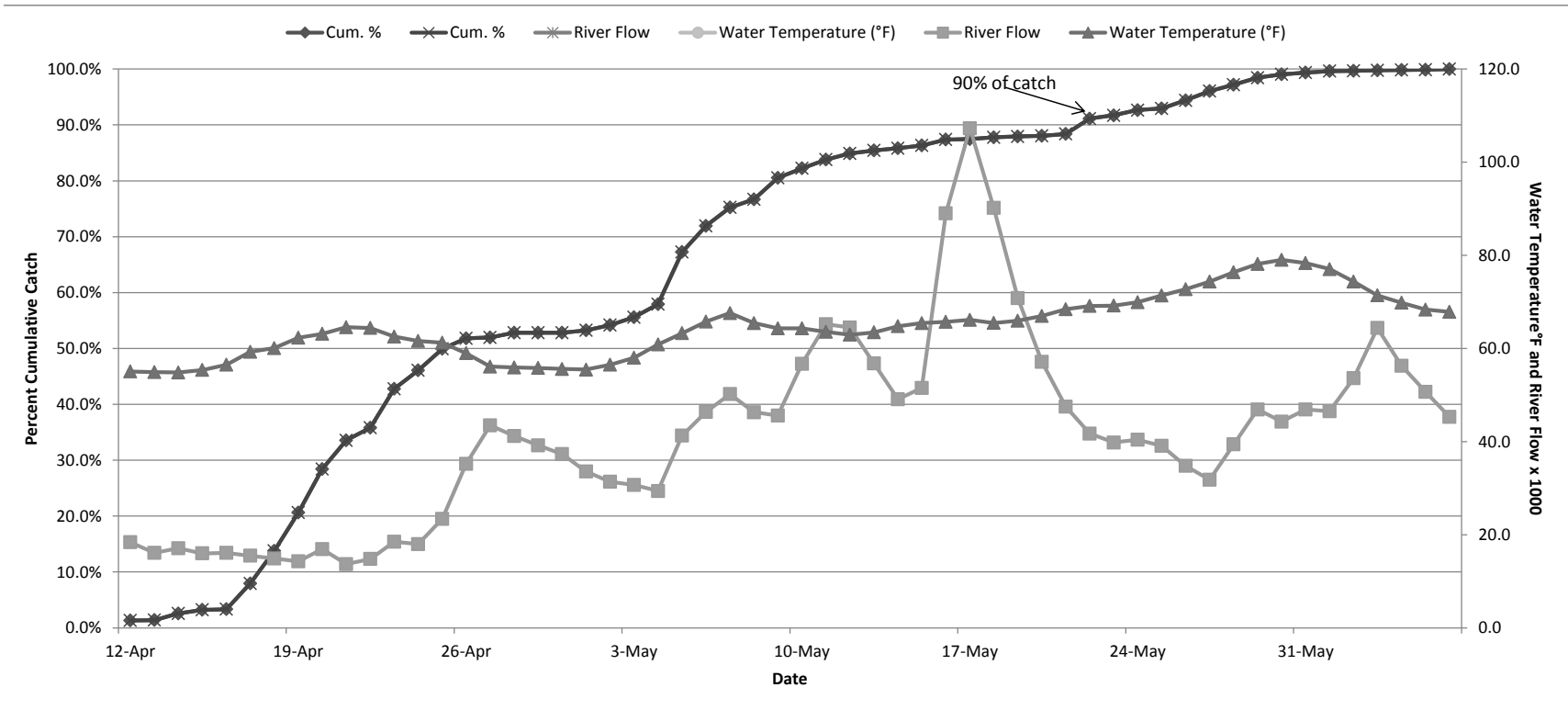


Figure 2

Figure 2. A plot of river flow (x 1000 cfs) and water temperature (°F) as measured at Holtwood Dam, in relationship to the percent cumulative American shad catch at the Safe Harbor Fish Passage Facility, spring 2012.