SUMMARY OF OPERATIONS AT THE SAFE HARBOR FISH PASSAGE FACILITY SPRING 2010

October 2010

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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 2010 operation were to (1) monitor passage of migratory and resident fishes through the fishway; (2) assess fishway effectiveness; and (3) provide American shad for the York Haven radio-telemetry study.

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 2010 season utilized a combination of entrances 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 2010, operations commenced on 23 April, one day after Holtwood passed 1,570 American shad into Lake Aldred.

The Safe Harbor fishway began operation on 23 April, with operations ending on 11 June. Lift operations ended due to the dwindling fish catch and rising water temperatures; indications that the migration run was ending.

Throughout the 2010 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 2010 by the Safe Harbor fishway is presented in Table 1. A total of 158,888 fish of 17 species and 1 hybrid passed upstream into Lake Clarke. Gizzard shad (130,482) was the dominant species passed and comprised 82% of the catch. Some 12,706 American shad were passed upstream through the fishway and comprised nearly 8% of the catch. Other predominant fishes passed included quillback (5,586), channel catfish (4,130), walleye (2,355), and shorthead redhorse (1,952). Peak passage occurred on 5 May, when 16,219 fish, (97% gizzard shad), were passed.

3.2 American Shad Passage

The Safe Harbor fishway passed 12,706 American shad in 2010 during 50 days of operation (Table 1). This year's operating season was two weeks longer than the 2009 season, with operations passing the highest number of American shad since 2006, (Table 4). Safe Harbor managed to pass 77% of the American shad passed at Holtwood Dam and 33% of the American shad passed by Conowingo Dam, (Table 4). Peak shad passage occurred on 24 April, (second day of operation), when 1,390 American shad were captured and passed during 10 hours of operation.

American shad were passed at water temperatures of 56.8°F to 80.9°F and river flows of 15,100 to 47,600 cfs (Table 2 and Figures 1and 2). Water temperature was relatively stable (remained below 70.0°) from April 23 to May 24. After May 24, the water temperatures steadily climbed to the end of the season.

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 0800 hrs to 1659 hrs. Passage sharply declined after 1700 hrs. The peak passage hour for American shad during the entire season was observed between 1500 hrs to 1559 hrs, with a total of 1,618 American shad passed. The highest hourly passage (188) occurred between 1000 hrs and 1059 hrs on 25 April.

During the 2010 season, the Safe Harbor fishway passed five MD DNR tagged American shad, (2010 pink floy tag), 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 2010.

4.0 SUMMARY

The 2010 Safe Harbor fishway operating season was conducted with minimal disruptions to operations due to mechanical problems and the collection and tagging of American shad for the York Haven radio-telemetry study.

A total of 12,706 American shad were passed into Lake Clarke, or 77% 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 30 May, shortly after Holtwood passed 90% of their American shad season total. Future operations of the fishway will build on the past fourteen 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 by the Safe Harbor fishway in 2010.

Date:	*23-Apr*	*24-Apr*	*25-Apr*	*26-Apr*	*27-Apr*	*28-Apr*	*29-Apr*	*30-Apr*	*1-May*	*2-May*	*3-May*
Hours of Operation:	*9.6*	*10.0*	*10.8*	*10.5*	*10.0*	*10.0*	*7.3*	*8.5*	*9.3*	*10.1*	*10.4*
Viewing Start Time:	*9:05*	*8:30*	*8:00*	*8:00*	*8:00*	*8:00*	*9:00*	*8:00*	*8:00*	*7:40*	*7:30*
Viewing End Time:	*18:40*	*18:30*	*18:50*	*18:30*	*18:00*	*17:59*	*16:15*	*16:30*	*17:15*	*17:45*	*17:55*
Number of Lifts:	*8*	*11*	*21*	*20*	*9*	*13*	*6*	*8*	*9*	*10*	*9*
Water Temperature (°F):	*59*	*60.5*	*61*	*60.8*	*59*	*57.4*	*55.4*	*56*	*59.2*	*62.5*	*65.5*
American Shad	634	1,390	1,171	758	293	173	12	170	815	478	320
Gizzard shad	2,620	4,011	2,608	2,659	3,370	1,497	545	1,033	2,974	3,014	5,116
Striped Bass	0	0	0	0	0	0	0	0	0	0	1
Hybrid 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	0	38	77	11	2	4	10	6	37	31	20
Quillback	95	235	311	32	3	1	1	14	584	766	566
Shorthead redhorse	70	302	140	38	18	16	1	55	386	254	138
Channel catfish	16	32	25	13	1	4	6	2	11	31	297
Flathead catfish	0	0	0	0	0	0	0	0	0	0	0
Rock bass	2	0	0	2	0	0	2	1	0	2	4
Bluegill	0	0	2	0	0	0	0	0	0	1	3
Smallmouth bass	59	187	141	23	2	3	1	2	56	44	46
Largemouth bass	2	2	1	1	0	0	1	1	0	2	0
White Crappie	0	0	0	0	0	0	0	0	0	0	0
Walleye	8	61	35	13	1	3	2	0	10	50	56
Daily Total	**3,506**	**6,258**	**4,511**	**3,550**	**3,690**	**1,701**	**581**	**1,284**	**4,873**	**4,673**	**6,567**

Table 1

Continued.

Date:	*4-May*	*5-May*	*6-May*	*7-May*	*8-May*	*9-May*	*10-May*	*11-May*	*12-May*	*13-May*	*14-May*
Hours of Operation:	*10.3*	*8.8*	*9.3*	*9.5*	*9.7*	*10.3*	*9.7*	*7.4*	*8.2*	*9.3*	*9.3*
Viewing Start Time:	*7:25*	*8:00*	*7:30*	*8:00*	*7:40*	*7:30*	*7:40*	*7:40*	*8:05*	*7:40*	*8:00*
Viewing End Time:	*17:45*	*16:45*	*16:50*	*17:30*	*17:20*	*17:45*	*17:20*	*15:05*	*16:15*	*17:00*	*17:20*
Number of Lifts:	*12*	*12*	*11*	*13*	*10*	*10*	*10*	*6*	*8*	*9*	*9*
Water Temperature (°F):	*67*	*68*	*68.2*	*68.5*	*68.5*	*66.3*	*64.5*	*62*	*58*	*57*	*57.2*
American Shad	312	283	265	96	142	189	125	197	60	67	112
Gizzard shad	8,027	15,775	5,711	3,410	2,444	6,408	5,695	1,926	173	765	238
Striped Bass	0	0	0	0	0	0	0	0	0	0	0
Hybrid 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	17	15	46	18	17	3	3	2	2	1	4
Quillback	159	35	379	3	1	2	0	0	0	0	0
Shorthead redhorse	95	28	36	0	0	1	0	0	0	0	2
Channel catfish	91	31	48	35	9	9	3	7	3	0	5
Flathead catfish	0	0	0	0	0	0	0	0	0	0	0
Rock bass	6	7	1	2	3	0	0	1	0	0	0
Bluegill	1	12	0	1	1	0	1	0	0	0	0
Smallmouth bass	56	17	20	8	4	4	2	1	0	0	0
Largemouth bass	1	0	0	1	0	0	0	0	0	0	0
White Crappie	0	0	0	0	0	0	0	0	0	0	0
Walleye	56	16	24	14	31	16	5	2	7	4	6
Daily Total	**8,821**	**16,219**	**6,530**	**3,588**	**2,652**	**6,632**	**5,834**	**2,136**	**245**	**837**	**367**

Table 1

Continued.

Date:	*15-May*	*16-May*	*17-May*	*18-May*	*19-May*	*20-May*	*21-May*	*22-May*	*23-May*	*24-May*	*25-May*
Hours of Operation:	*10.8*	*11.1*	*8.0*	*9.1*	*9.0*	*8.5*	*9.3*	*8.8*	*10.3*	*9.6*	*9.3*
Viewing Start Time:	*8:00*	*7:40*	*8:00*	*8:10*	*8:00*	*8:30*	*7:40*	*8:00*	*7:30*	*8:00*	*7:45*
Viewing End Time:	*18:45*	*18:45*	*16:00*	*17:15*	*17:00*	*17:00*	*17:00*	*16:45*	*17:50*	*17:35*	*17:00*
Number of Lifts:	*13*	*13*	*11*	*7*	*9*	*8*	*9*	*9*	*10*	*12*	*10*
Water Temperature (°F):	*60.6*	*63.3*	*64.6*	*63.5*	*62.6*	*61.7*	*62.6*	*62.6*	*68*	*69*	*69*
American Shad	442	234	33	37	60	85	84	54	127	377	506
Gizzard shad	8,671	3,537	622	875	341	2,186	691	184	964	6,200	1,841
Striped Bass	1	0	0	1	0	0	0	0	0	0	0
Hybrid 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	1
Brown trout	1	0	0	0	0	0	0	0	0	0	0
Muskellunge	0	0	0	0	0	0	0	0	0	0	0
Carp	5	23	50	81	0	2	3	12	8	3	5
Quillback	24	168	220	302	13	7	86	255	342	48	315
Shorthead redhorse	12	10	0	22	2	0	6	56	67	28	6
Channel catfish	35	21	51	51	17	7	13	35	370	102	57
Flathead catfish	0	0	0	0	0	0	0	0	0	0	0
Rock bass	4	1	2	0	4	5	1	1	4	3	2
Bluegill	0	1	1	3	2	4	1	4	15	4	2
Smallmouth bass	13	2	3	0	2	2	2	3	8	3	3
Largemouth bass	0	0	1	2	1	1	0	0	2	2	1
White Crappie	0	0	0	0	0	0	1	0	1	0	0
Walleye	33	71	32	91	27	14	51	213	298	86	119
Daily Total	**9,241**	**4,068**	**1,015**	**1,465**	**469**	**2,313**	**939**	**817**	**2,206**	**6,856**	**2,858**

Table 1

Continued.

Date:	*26-May*	*27-May*	*28-May*	*29-May*	*30-May*	*31-May*	*1-Jun*	*2-Jun*	*3-Jun*	*4-Jun*	*5-Jun*
Hours of Operation:	*9.4*	*9.6*	*9.8*	*9.1*	*9.0*	*8.8*	*8.8*	*8.2*	*8.6*	*8.2*	*8.9*
Viewing Start Time:	*8:00*	*8:10*	*7:40*	*7:45*	*7:30*	*7:45*	*7:40*	*8:20*	*8:00*	*8:20*	*7:45*
Viewing End Time:	*17:23*	*17:45*	*17:30*	*16:50*	*16:30*	*16:30*	*16:30*	*16:30*	*16:35*	*16:30*	*16:40*
Number of Lifts:	*13*	*8*	*10*	*9*	*9*	*9*	*9*	*9*	*9*	*9*	*9*
Water Temperature (°F):	*70.5*	*73.4*	*73.5*	*73.8*	*75*	*76.5*	*77.5*	*77.7*	*79.5*	*80*	*80*
American Shad	532	105	137	177	403	205	188	122	223	138	96
Gizzard shad	4,652	3,155	2,967	1,806	2,120	1,639	2,032	600	1,715	1,197	447
Striped Bass	0	0	0	0	0	0	0	0	0	0	2
Hybrid 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	1	0	0	0	0	0	0	0
Carp	11	15	10	8	3	2	8	2	27	5	4
Quillback	191	170	160	42	25	1	0	2	6	4	6
Shorthead redhorse	55	45	26	6	17	2	6	0	1	0	1
Channel catfish	115	148	293	59	103	114	401	80	294	410	121
Flathead catfish	0	0	0	0	0	2	0	0	0	0	0
Rock bass	1	3	2	0	0	1	0	3	0	2	0
Bluegill	5	9	10	12	1	5	7	1	2	4	4
Smallmouth bass	4	0	2	6	2	1	1	4	2	4	1
Largemouth bass	1	2	1	0	0	1	0	2	1	0	0
White Crappie	3	0	1	0	0	0	0	0	0	0	0
Walleye	105	73	170	61	107	64	68	40	24	43	21
Daily Total	**5,675**	**3,725**	**3,779**	**2,178**	**2,781**	**2,037**	**2,711**	**856**	**2,295**	**1,807**	**703**

Table 1

Continued.

Date:	*6-Jun*	*7-Jun*	*8-Jun*	*9-Jun*	*10-Jun*	*11-Jun*	***Season Total***
Hours of Operation:	*10.0*	*8.8*	*7.3*	*8.1*	*8.2*	*4.0*	**456.5**
Viewing Start Time:	*7:40*	*8:05*	*9:00*	*8:10*	*8:10*	*8:00*	
Viewing End Time:	*17:40*	*16:55*	*16:20*	*16:15*	*16:21*	*12:00*	
Number of Lifts:	*10*	*9*	*7*	*10*	*9*	*5*	**498.0**
Water Temperature (°F):	*80*	*79.2*	*77.5*	*77.5*	*73.8*	*73.6*	
American Shad	170	41	12	18	26	12	**12,706**
Gizzard shad	871	278	43	189	520	120	**130,482**
Striped Bass	0	0	0	0	0	0	**5**
Hybrid striped bass	0	1	0	0	0	0	**1**
Sea lamprey	0	0	0	0	0	0	**1**
Brown trout	0	0	0	0	0	0	**1**
Muskellunge	0	0	0	0	0	0	**1**
Carp	1	10	1	2	2	0	**667**
Quillback	9	3	0	0	0	0	**5,586**
Shorthead redhorse	2	1	0	1	0	0	**1,952**
Channel catfish	257	115	38	83	30	31	**4,130**
Flathead catfish	0	0	1	1	0	1	**5**
Rock bass	0	0	0	0	1	1	**74**
Bluegill	3	1	1	2	2	1	**129**
Smallmouth bass	2	4	1	2	1	0	**754**
Largemouth bass	1	0	0	0	0	1	**32**
White Crappie	1	0	0	0	0	0	**7**
Walleye	55	16	5	26	18	4	**2,355**
Daily Total	**1,372**	**470**	**102**	**324**	**600**	**171**	**158,888**

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 2010.

Date	River Flow[1] (mcfs)	Water Temp (°F)	Secchi (in)	Maximum # of Units Operating	Entrance Gates Utilized	Attraction Flow (cfs)	Tailrace Elevation (ft)	Forebay Elevation (ft)
23-Apr	23.5	59.7	18-20	6	A & C	500	170.8	226.2
24-Apr	23.2	60.6	20	5	A & C	500	169.9	226.1
25-Apr	21.1	61.0	24	6	A & C	500	169.9	226.9
26-Apr	24.4	60.9	20-18	6	A & C	500	169.1	226.6
27-Apr	26.8	60.6	18-20	5	A & C	500	226.3	170.7
28-Apr	30.0	58.7	18	8	A & C	500	170.7	226.3
29-Apr	38.9	56.8	20	11	A & C	500	170.3	226.3
30-Apr	45.5	57.1	20	8	A & C	500	173.6	226.2
1-May	43.4	59.1	22	8	A & C	500	173.0	226.5
2-May	37.6	62.5	22	5	A & C	500	171.2	226.3
3-May	45.7	65.5	24	8	A & C	500	172.4	226.6
4-May	45.4	68.1	22-18	9	A & C	500	172.6	226.0
5-May	38.5	69.2	16-18	9	A & C	500	172.3	226.0
6-May	33.1	69.5	24	No Data	A & C	500	172.8	225.8
7-May	30.4	69.4	24	No Data	A & C	500	171.8	226.7
8-May	27.2	69.2	24-16	No Data	A & C	500	168.0	226.7
9-May	27.4	67.2	23	No Data	A & C	500	170.2	226.4
10-May	25.4	64.5	20	5	A & C	500	169.3	226.4
11-May	26.3	63.2	20	6	A & C	500	171.4	226.4
12-May	28.6	60.2	20	6	A & C	500	172.1	226.5
13-May	30.2	58.8	22	12	A & C	500	170.9	226.1
14-May	39.6	58.4	18	12	A & C	500	172.6	226.5
15-May	46.0	60.4	18-24	8	A & C	500	170.8	226.6
16-May	47.6	63.3	18	9	A & C	500	173.6	226.4
17-May	43.5	64.7	20	No Data	A & C	500	173.1	226.9
18-May	40.2	64.5	20	10	A & C	500	172.3	226.1
19-May	35.4	63.4	20	8	A & C	500	173.9	226.7
20-May	34.8	62.5	20	7	A & C	500	171.5	226.6
21-May	32.3	63.5	20	7	A & C	500	171.3	226.5
22-May	29.9	65.4	20	6	A & C	500	172.4	226.1
23-May	28.4	67.9	20	4	A & C	500	170.5	226.4
24-May	30.3	69.6	22	9	A & C	500	170.8	226.1
25-May	37.1	70.2	20-16	7	A & C	500	172.2	226.8
26-May	31.1	71.0	20	7	A & C	500	170.8	226.6
27-May	27.2	73.1	20	5	A & C	500	169.3	226.7
28-May	24.5	74.3	18	No Data	A & C	500	170.1	226.4
29-May	22.5	74.7	18	No Data	A & C	500	171.4	227
30-May	19	76.2	16	6	A & C	500	169.7	226.9
31-May	20.2	77.4	16-14	5	A & C	500	169.8	226.4
1-Jun	20	77.3	16	5	A & C	500	170.8	226.7
2-Jun	17.6	78	14	4	A & C	500	169.8	226.7
3-Jun	16	79	14	4	A & C	500	169.3	226.4
4-Jun	16.5	80.2	16	5	A & C	500	169.3	225.7
5-Jun	18.7	80.7	14	2	A & C	500	169	226.6
6-Jun	19.6	80.9	16	4	A & C	500	169.5	226.9
7-Jun	16.8	80.3	14	5	A & C	500	169.9	226.5
8-Jun	15.1	79.1	14	4	A & C	500	169.1	226.8
9-Jun	15.7	77.5	12	2	A & C	500	168.8	226.5
10-Jun	20.3	75.9	12	7	A & C	500	168.3	226.6
11-Jun	25.2	74.9	12	2	A & C	500	169.1	226.1

1 River flow and temperature measured at Holtwood Dam.

Table 3

Hourly summary of American shad passage at the Safe Harbor fish passage facility in 2010.

Date:	*23-Apr*	*24-Apr*	*25-Apr*	*26-Apr*	*27-Apr*	*28-Apr*	*29-Apr*	*30-Apr*	*1-May*	*2-May*	*3-May*	*4-May*
Observation Time-Start:	*9:05*	*8:30*	*8:00*	*8:00*	*8:00*	*8:00*	*9:00*	*8:00*	*8:00*	*7:40*	*7:30*	*7:25*
Observation Time-End:	*18:40*	*18:30*	*18:50*	*18:30*	*18:00*	*17:59*	*16:15*	*16:30*	*17:15*	*17:45*	*17:55*	*17:45*
Military Time (hrs)												
0700 to 0759	--	--	--	--	--	--	--	--	--	0	1	18
0800 to 0859	--	84	44	36	2	63	--	6	29	23	23	17
0900 to 0959	15	178	109	54	0	9	1	9	26	48	2	29
1000 to 1059	0	139	188	96	0	16	0	3	47	46	25	51
1100 to 1159	0	136	106	56	0	10	0	3	129	24	45	27
1200 to 1259	0	100	179	71	6	10	0	14	68	31	33	26
1300 to 1359	0	186	152	42	90	15	0	25	181	58	32	39
1400 to 1459	35	130	134	107	56	13	4	28	131	48	74	26
1500 to 1559	187	139	60	111	40	13	7	34	112	79	65	25
1600 to 1659	155	139	111	106	56	12	0	48	68	58	9	31
1700 to 1759	163	98	32	55	43	12	--	--	24	63	11	23
1800 to 1859	79	61	56	24	0	--	--	--	--	--	--	--
1900 to 1959	--	--	--	--	--	--	--	--	--	--	--	--
Total	**634**	**1,390**	**1171**	**758**	**293**	**173**	**12**	**170**	**815**	**478**	**320**	**312**

Date:	*5-May*	*6-May*	*7-May*	*8-May*	*9-May*	*10-May*	*11-May*	*12-May*	*13-May*	*14-May*	*15-May*	*16-May*
Observation Time-Start:	*8:00*	*7:30*	*8:00*	*7:40*	*7:30*	*7:40*	*7:40*	*8:05*	*7:40*	*8:00*	*8:00*	*7:40*
Observation Time-End:	*16:45*	*16:50*	*17:30*	*17:20*	*17:45*	*17:20*	*16:05*	*16:15*	*17:00*	*17:20*	*18:45*	*17:45*
Military Time (hrs)												
0700 to 0759	--	46	--	1	9	--	32	--	3	--	--	2
0800 to 0859	68	26	26	6	22	16	6	14	0	17	14	16
0900 to 0959	45	39	6	14	27	19	1	7	4	1	24	20
1000 to 1059	26	79	7	45	26	5	0	7	11	2	37	22
1100 to 1159	13	19	3	19	23	16	0	0	6	16	18	17
1200 to 1259	17	7	8	16	13	26	0	11	6	4	42	24
1300 to 1359	22	12	9	10	14	14	56	0	13	0	60	24
1400 to 1459	30	16	8	8	17	21	69	2	10	44	66	41
1500 to 1559	41	19	12	14	20	2	28	14	8	23	53	27
1600 to 1659	21	2	3	5	12	5	5	5	6	1	55	6
1700 to 1759	--	--	14	4	6	1	--	--	--	4	23	17
1800 to 1859	--	--	--	--	--	--	--	--	--	--	50	18
1900 to 1959	--	--	--	--	--	--	--	--	--	--	--	--
Total	**283**	**265**	**96**	**142**	**189**	**125**	**197**	**60**	**67**	**112**	**442**	**234**

Table 3

Continued.

Date:	*17-May*	*18-May*	*19-May*	*20-May*	*21-May*	*22-May*	*23-May*	*24-May*	*25-May*	*26-May*	*27-May*	*28-May*
Observation Time-Start:	*8:00*	*8:10*	*8:00*	*8:30*	*8:00*	*8:00*	*8:00*	*8:00*	*7:45*	*8:00*	*8:10*	*7:40*
Observation Time-End:	*13:00*	*17:15*	*17:00*	*17:00*	*17:00*	*16:45*	*17:50*	*17:35*	*17:00*	*17:23*	*17:45*	*17:30*
Military Time (hrs)												
0700 to 0759	--	--	--	--	--	--	--	--	--	--	--	--
0800 to 0859	9	0	4	0	1	6	0	16	24	179	14	14
0900 to 0959	1	5	28	9	6	4	4	28	128	65	14	49
1000 to 1059	8	0	0	12	11	5	20	70	52	40	0	34
1100 to 1159	9	0	4	11	13	5	11	49	53	36	0	3
1200 to 1259	6	0	1	8	7	2	5	65	31	40	8	4
1300 to 1359	--	10	10	11	6	2	41	48	25	26	12	4
1400 to 1459	--	7	3	6	0	6	23	27	53	77	12	5
1500 to 1559	--	7	5	17	23	10	12	49	79	29	13	9
1600 to 1659	--	5	5	11	17	14	5	17	61	32	27	14
1700 to 1759	--	3	--	--	--	--	6	8	--	8	5	1
1800 to 1859	--	--	--	--	--	--	--	--	--	--	--	--
1900 to 1959	--	--	--	--	--	--	--	--	--	--	--	--
Total	**33**	**37**	**60**	**85**	**84**	**54**	**127**	**377**	**506**	**532**	**105**	**137**

Date:	*29-May*	*30-May*	*31-May*	*1-Jun*	*2-Jun*	*3-Jun*	*4-Jun*	*5-Jun*	*6-Jun*	*7-Jun*	*8-Jun*	*9-Jun*
Observation Time-Start:	*7:45*	*7:30*	*7:15*	*7:40*	*8:20*	*8:00*	*8:20*	*7:45*	*7:40*	*8:05*	*9:00*	*8:10*
Observation Time-End:	*16:50*	*16:30*	*16:30*	*16:30*	*16:30*	*16:35*	*16:30*	*16:40*	*17:40*	*16:55*	*16:20*	*16:15*
Military Time (hrs)												
0700 to 0759	19	49	13	13	--	--	--	--	--	--	--	--
0800 to 0859	32	46	30	32	25	51	14	16	25	15	--	6
0900 to 0959	19	27	33	2	15	53	26	7	24	7	2	6
1000 to 1059	36	43	65	0	4	26	21	9	19	2	1	1
1100 to 1159	12	43	22	32	10	17	10	8	4	3	0	1
1200 to 1259	2	37	14	31	14	2	20	3	32	3	1	0
1300 to 1359	15	30	12	9	29	6	28	5	26	2	6	4
1400 to 1459	14	53	7	10	12	18	11	10	4	8	0	0
1500 to 1559	21	54	5	52	9	40	6	22	16	1	2	0
1600 to 1659	7	21	4	7	4	10	2	16	2	0	--	0
1700 to 1759	--	--	--	--	--	--	--	--	18	--	--	--
1800 to 1859	--	--	--	--	--	--	--	--	--	--	--	--
1900 to 1959	--	--	--	--	--	--	--	--	--	--	--	--
Total	**177**	**403**	**205**	**188**	**122**	**223**	**138**	**96**	**170**	**41**	**12**	**18**

Table 3

Continued.

Date:	*10-Jun*	*11-Jun*	
Observation Time-Start:	*8:10*	*8:00*	***Season***
Observation Time-End:	*16:21*	*12:00*	***Total***
Military Time (hrs)			
0700 to 0759	--	--	**206**
0800 to 0859	1	4	**1,122**
0900 to 0959	6	2	**1,257**
1000 to 1059	3	6	**1,366**
1100 to 1159	3	0	**1,045**
1200 to 1259	1	0	**1,049**
1300 to 1359	4	--	**1,425**
1400 to 1459	3	--	**1,487**
1500 to 1559	4	--	**1,618**
1600 to 1659	1	--	**1,201**
1700 to 1759	--	--	**642**
1800 to 1859	--	--	**288**
1900 to 1959	--	--	**0**
Total	**26**	**12**	**12,706**

Table 4

Summary of American shad passage counts and percent passage values at Susquehanna River dams, 1997-2010.

	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**	**43.63%**	**12,706**	**77.14%**	**907**	**7.14%**

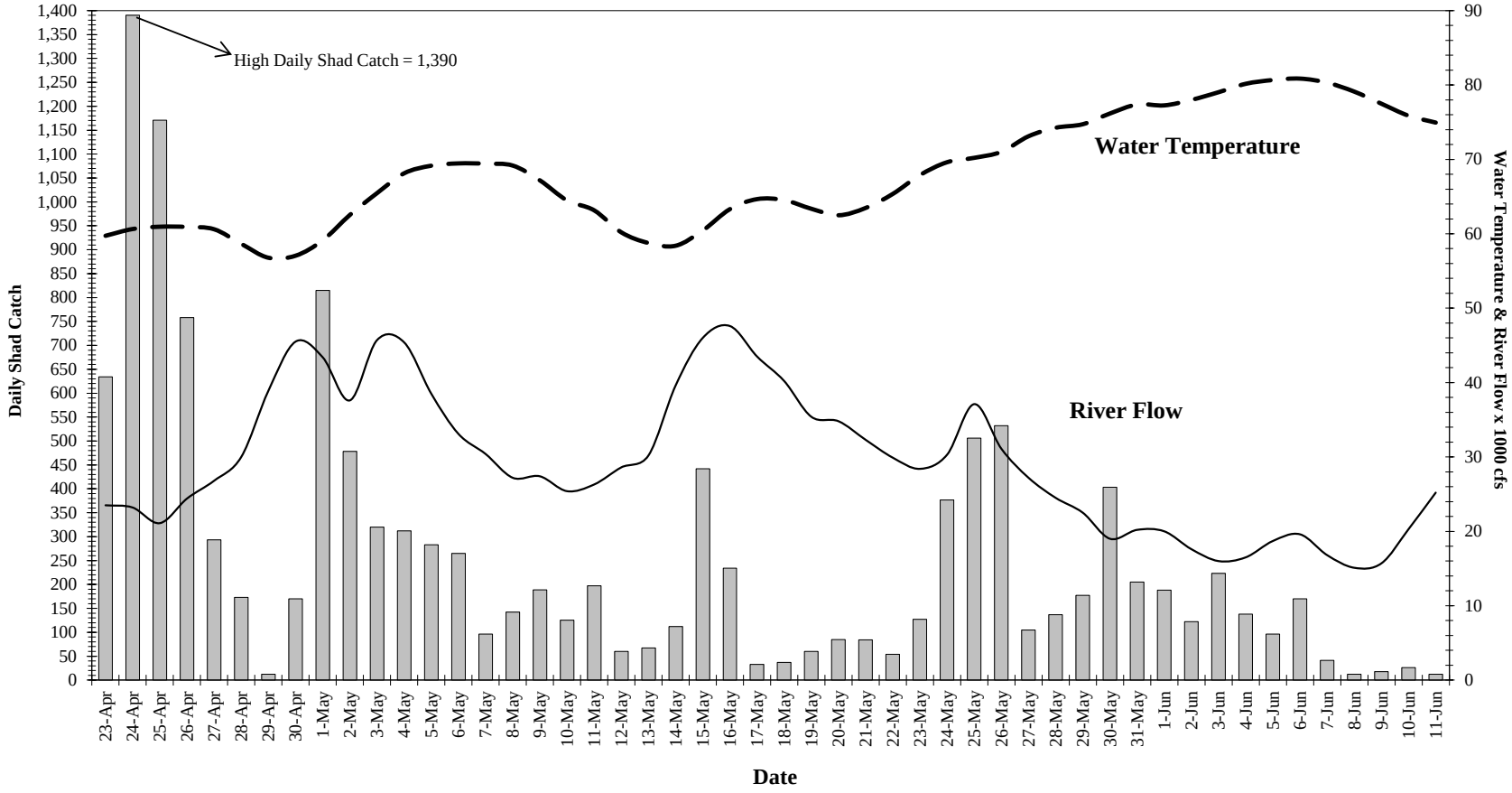

Figure 1

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 2010.

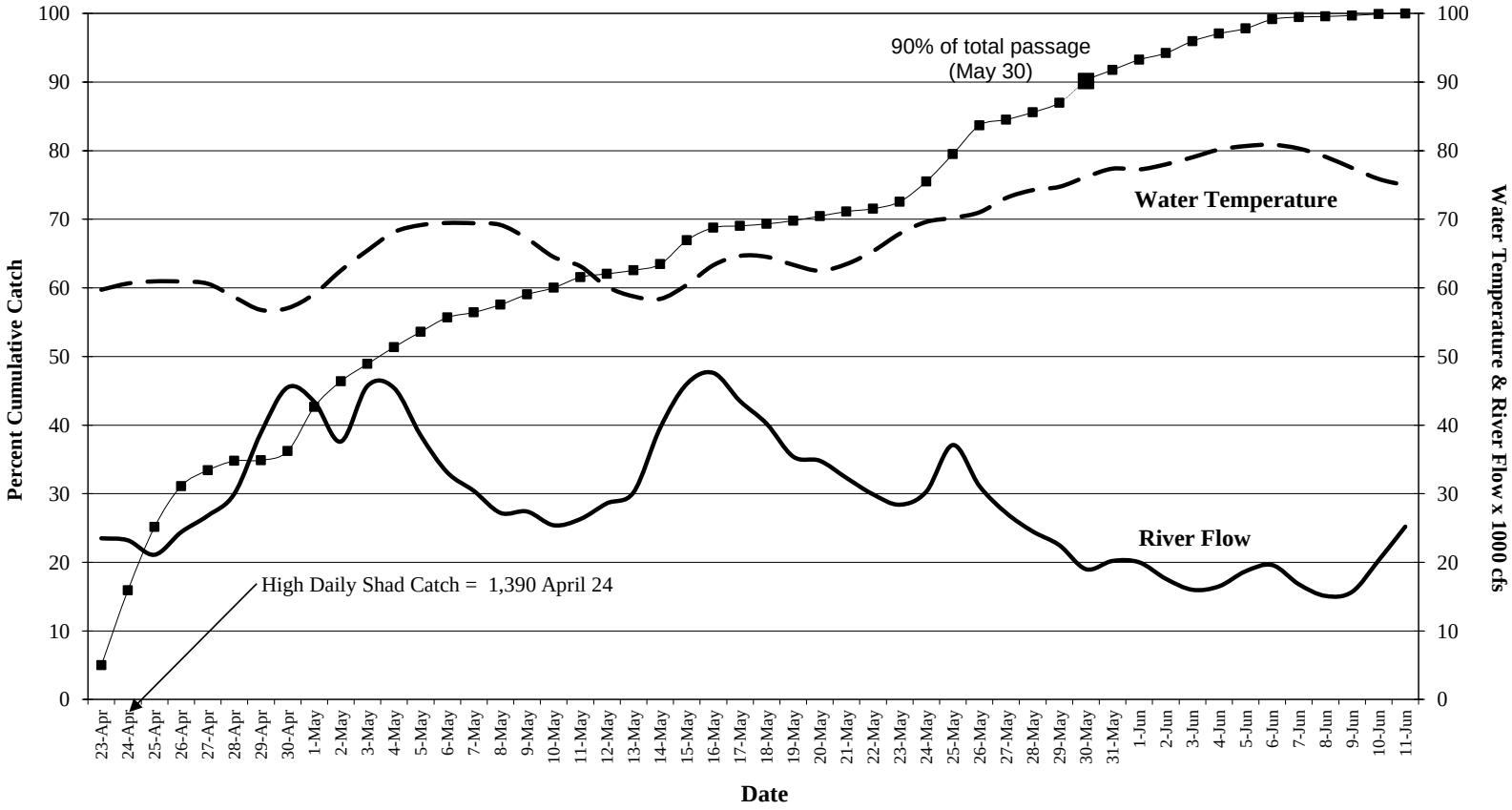

Figure 2

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 2010.