

**SUMMARY OF OPERATIONS AT THE
SAFE HARBOR FISH PASSAGE FACILITY
SPRING 2011**

October 2011

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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 2011 operation were to (1) monitor passage of migratory and resident fishes through the fishway; (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 (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 2011 season utilized a combination of entrances A and C (Table 2).

2.2.2 Fishway Operation

Safe Harbor fishway operation normally commences soon after passage of approximately 500 American shad via the Holtwood fishway. Due to high river flow events, Holtwood did not begin operation after the Conowingo East Fish Lift passed 1,000 American shad (Figure 1). These flow events deposited large amounts of rock debris and mud into the Holtwood Fish Lift's crowder channel and hopper pit. A specialized work crew utilizing divers was needed to remove the debris before the Holtwood Fish Lift commenced operations on 20 May, 2011. Safe Harbor Fish Lift operations commenced on 26 May, 2011, one day after Holtwood passed 5 American shad into Lake Aldred. The Safe Harbor fishway ended operations on 6 June. Lift operations ended, with agency concurrence, due to the sub-par passage of American shad and abnormally high river flows.

Throughout the 2011 season, operation of the Safe Harbor fishway was based on methods established during previous spring migration seasons and guidelines approved by the Safe Harbor Fish Passage Technical Advisory Committee (SHFPTAC). 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 2011 by the Safe Harbor fishway is presented in Table 1. A total of 8,059 fish of 10 species passed upstream into Lake Clarke. Gizzard shad (3,216) was the dominant species passed and comprised 40% of the catch. Eight American shad were passed upstream through the fishway and comprised less than one percent of the catch. Other predominant fishes passed included channel catfish (2,323) and quillback (2,037). The highest day of fish passage occurred on 27 May, when 1,305 fish, (31% quillback and 28% channel catfish), were passed.

3.2 American Shad Passage

The Safe Harbor fishway passed 8 American shad during 9 days of operation in 2011 (Table 1). This year's operating season was approximately 5 weeks shorter than last season, resulting in the lowest number of American shad passed since operations commenced in 1997 (Table 4). Safe Harbor managed to pass 38% of the American shad passed at Holtwood Dam and less than one percent of the American shad passed by Conowingo Dam, (Table 4). In the 2011 season, there was no peak passage of American shad. Four of the nine days of operation resulted in the passage of two American shad, which comprised the season total of eight American shad.

American shad were passed at water temperatures of 64.5°F to 73.5°F and river flows of 37,500 to 85,000 cfs (Table 2 and Figure 2). Water temperatures were within the historically observed range during the 2011 season.

The number of American shad observed passing through the trough by hour is shown in Table 3. Due to the lack of American shad available for passage, no significant patterns of fish passage were observed. Passage of 3 of the 8 American shad passed at Safe Harbor occurred between 1400 hrs and 1459 hrs.

4.0 SUMMARY

The 2011 Safe Harbor fishway operating season was conducted with minimal disruptions to operations due to mechanical problems.

A total of 8 American shad were passed into Lake Clarke, or 38% of the American shad that were passed into Lake Aldred by the Holtwood fishway (Table 4). Six of the 8 American shad were passed at Safe Harbor on or after 1 June. Due to the high river flows experienced during 2011 American shad passage was well below average at all lower Susquehanna River fish passage facilities.

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 2011.**

<i>Date:</i>	<i>26-May</i>	<i>27-May</i>	<i>28-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 Total</i>
<i>Hours of Operation:</i>	7.3	3.2	6.8	8.5	2.8	6.1	6.8	7.6	6.9	55.9
<i>Viewing Start Time:</i>	8:00	13:00	8:00	7:45	12:30	8:40	8:00	7:25	8:00	
<i>Viewing End Time:</i>	15:17	16:13	14:50	16:12	15:15	14:45	14:45	15:00	14:55	
<i>Number of Lifts:</i>	8	4	7	10	4	7	7	7	7	61
<i>Water Temperature (°F):</i>	64.5	68.7	70.5	73.5	74.3	73.4	73	73	72.5	
American Shad	0	2	0	2	2	2	0	0	0	8
Gizzard shad	115	383	519	505	115	420	574	349	236	3,216
Carp	97	108	56	27	0	8	8	4	6	314
Quillback	458	410	174	374	160	105	115	211	30	2,037
Shorthead redhorse	1	15	2	1	5	0	0	0	0	24
Channel catfish	187	365	356	104	205	305	421	290	90	2,323
Bluegill	0	0	0	0	1	1	0	0	0	2
Smallmouth bass	9	12	26	3	3	6	6	4	1	70
Largemouth bass	0	1	0	0	0	1	0	1	1	4
Walleye	9	9	14	3	4	4	4	9	5	61
Daily Total	876	1,305	1,147	1,019	495	852	1,128	868	369	8,059

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 2011.

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)
26-May	81	64.5	20	11	A & C	500	175.7	226.6
27-May	76	68.7	20	10	A & C	500	175	226.3
28-May	79	70.5	20	9	A & C	500	174.6	226.9
1-Jun	85	73.5	10	12	A & C	500	175.4	226.7
2-Jun	77	73.5	10	9	A & C	500	173.9	227.3
3-Jun	62	73.4	12	9	A & C	500	173.1	226.6
4-Jun	56	73	12	7	A & C	500	168.8	227.1
5-Jun	45	73	12	6	A & C	500	171.6	226.8
6-Jun	37.5	72.5	12	6	A & C	500	172	226.8

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 2011.

<i>Date:</i>	<i>26-May</i>	<i>27-May</i>	<i>28-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>	8:00	8:10	7:40	7:40	8:20	8:00	8:20	7:45	7:40	<i>Total</i>
<i>Observation Time-End:</i>	17:23	17:45	17:30	16:30	16:30	16:35	16:30	16:40	17:40	
Military Time (hrs)										
0700 to 0759	--	--	--	--	--	--	--	--	--	0
0800 to 0859	--	--	--	--	--	--	--	--	--	0
0900 to 0959	--	--	--	--	--	--	--	--	--	0
1000 to 1059	--	--	--	1	--	1	--	--	--	2
1100 to 1159	--	--	--	1	--	--	--	--	--	1
1200 to 1259	--	--	--	--	1	1	--	--	--	2
1300 to 1359	--	--	--	--	--	--	--	--	--	0
1400 to 1459	--	2	--	--	1	--	--	--	--	3
1500 to 1559	--	--	--	--	--	--	--	--	--	0
1600 to 1659	--	--	--	--	--	--	--	--	--	0
1700 to 1759	--	--	--	--	--	--	--	--	--	0
1800 to 1859	--	--	--	--	--	--	--	--	--	0
1900 to 1959	--	--	--	--	--	--	--	--	--	0
Total	0	2	0	2	2	2	0	0	0	8

Table 4**Summary of American shad passage counts and percent passage values at Susquehanna River dams, 1997-2011.**

	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%
2011	20,517	21	0.1%	8	38.1%	0	0.0%

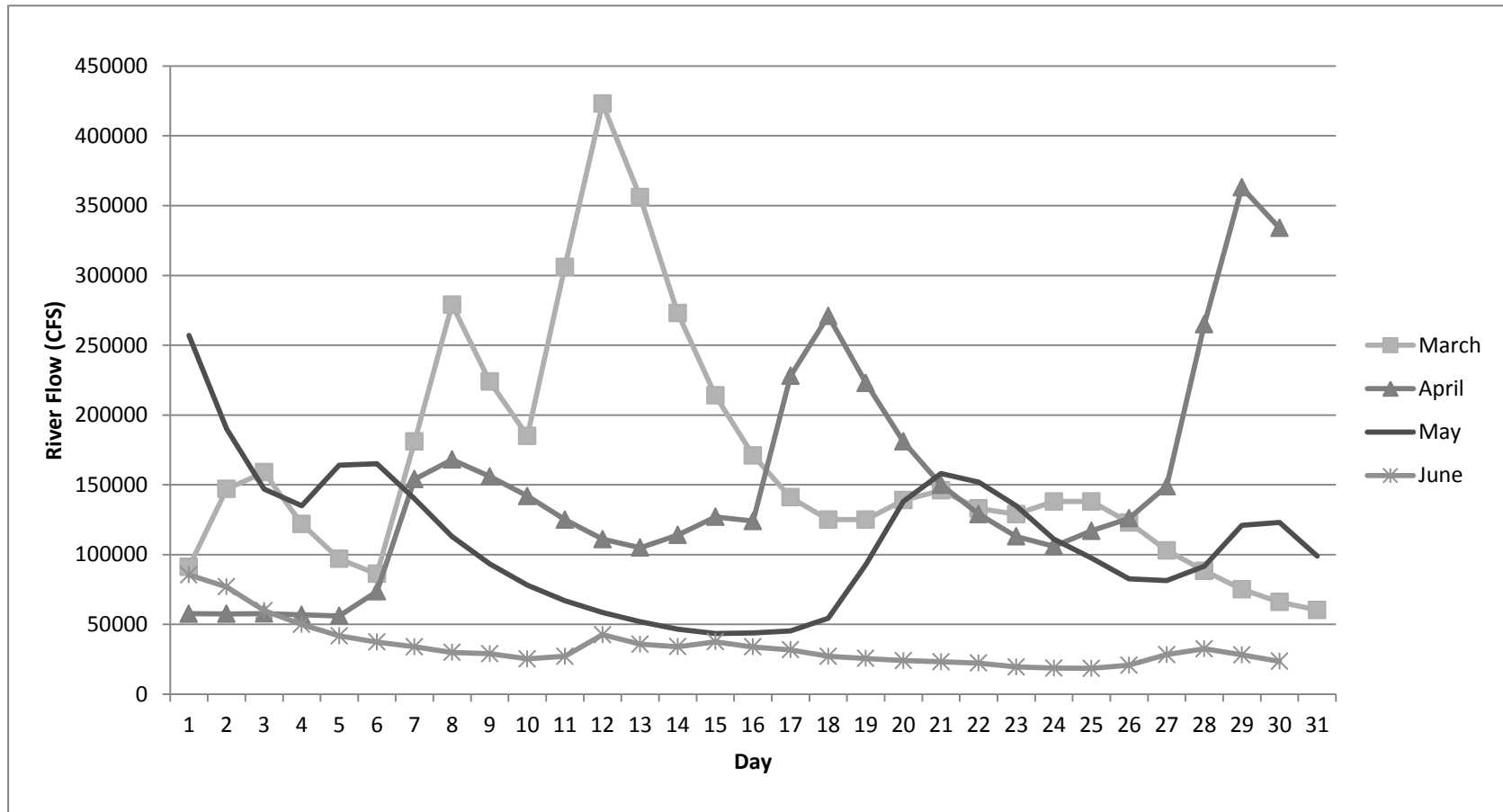


Figure 1.
Plot of River Flow (as measured at Holtwood Dam) March through June 2011.

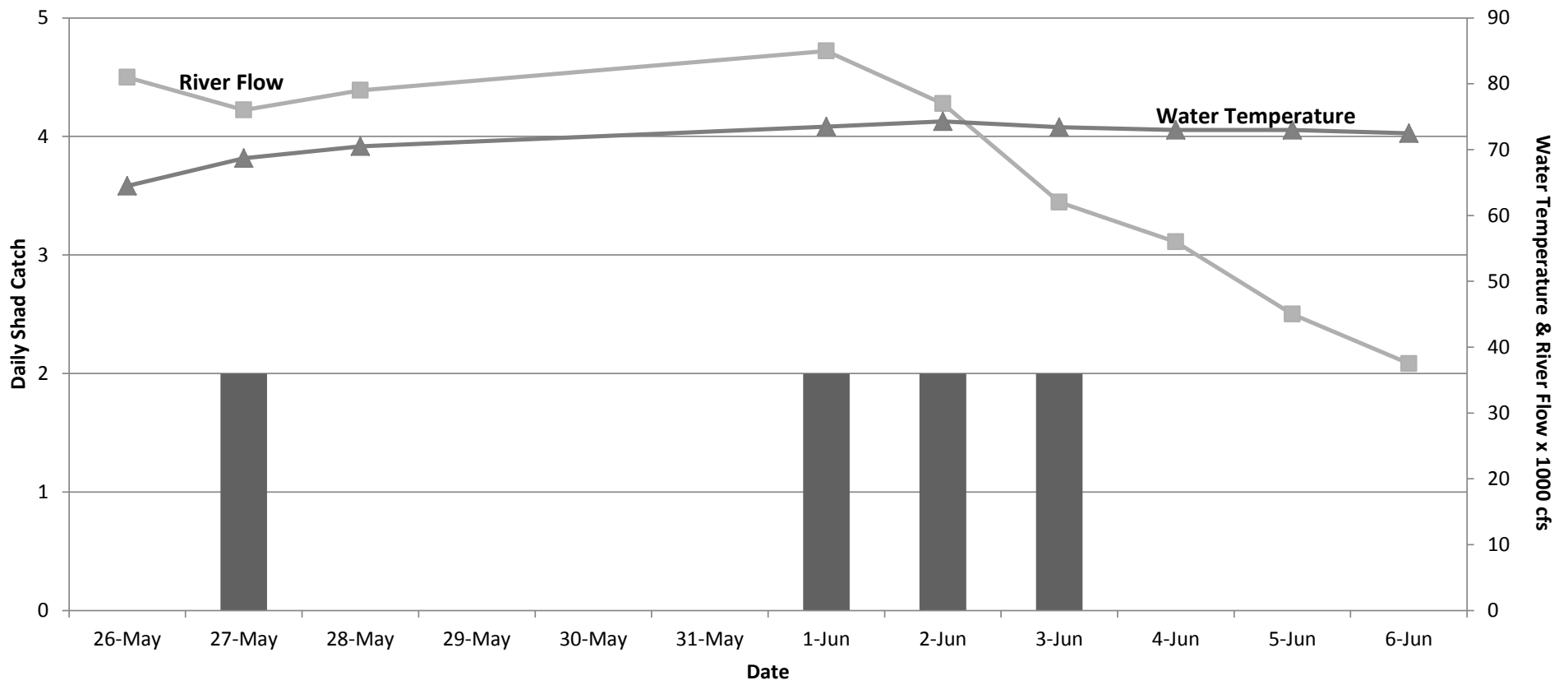


Figure 2

A plot of river flow (x 1000cfs) 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 2011.