

**SUMMARY OF OPERATIONS AT THE
SAFE HARBOR FISH PASSAGE FACILITY
SPRING 2008**

September 2008

**SUMMARY OF OPERATIONS AT THE
SAFE HARBOR FISH PASSAGE FACILITY
SPRING 2008**

Prepared for

SAFE HARBOR WATER POWER CORPORATION

1 Powerhouse Road
Conestoga, Pennsylvania 17516

Prepared by

NORMANDEAU ASSOCIATES, INC.

1921 River Road
Drumore, Pennsylvania 17518

Normandeau Associates' Project Number 21245

September 2008

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 Alosids..... 3

4.0 SUMMARY 3

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 by the Safe Harbor fishway in 2008.

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 2008.

Table 3 Hourly summary of American shad passage at the Safe Harbor fish passage facility in 2008.

Table 4 Summary of American shad passage counts and percent passage values at Susquehanna River dams, 1997-2008.

Figure 1 A plot of river flow and water temperature as measured at Holtwood Dam in relation to the daily American shad catch at the Safe Harbor fish passage facility, spring 2008.

Figure 2 A plot of river flow and water temperature as measured at Holtwood Dam in relation to the percent cumulative American shad catch at the Safe Harbor fish passage facility, spring 2008.

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 2008 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 2008 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 2008, operations commenced on 28 April, two days after Holtwood achieved passage of 500 American shad into Lake Aldred.

The Safe Harbor fishway began operation on 28 April, with operations ending on 11 June. No shut downs of the facility occurred during operations in spring, 2008. Lift operations ended due to the dwindling fish catch and very warm water temperatures; indications that the migration run was ending.

Throughout the 2008 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 distributed in hard copy 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 2008 by the Safe Harbor fish way is presented in Table 1. A total of 179,136 fish of 22 species and 1 hybrid passed upstream into Lake Clarke. Gizzard shad (163,354) was the dominant species passed and comprised 91% of the catch. Some 1,252 American shad were passed upstream through the fish way and comprised less than 1% of the catch. Other predominant fishes passed included walleye (5,122), channel catfish (3,039), Quillback (2,917), and shorthead redhorse (1,617). Peak passage occurred on 2 June, when 15,365 fish, (98% gizzard shad), were passed.

3.2 American Shad Passage

The Safe Harbor fishway passed 1,252 American shad in 2008 during 45 days of operation (Table 1). This year's operating season was the third longest since 1997 and collection and passage of shad varied daily. The Conowingo and Holtwood fishways also had relatively long seasons, but American shad passage was low at all facilities. Safe Harbor managed to pass nearly 45% of the American shad passed at Holtwood Dam and 6% of the American shad passed by Conowingo Dam. Peak shad passage occurred on 4 June when 180 shad were captured and passed during 9.9 hours of operation.

American shad were passed at water temperatures of 57.5°F to 81.5°F and river flows of 16,300 to 64,600 cfs (Table 2 and Figures 1 and 2). Water temperature and river flow on the 5 best days of American shad passage, (2 to 6 June), averaged 72.9°F (71.0°F to 73.5°F) and 22,260 cfs, (20,400 cfs to 24,800 cfs), respectively.

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 showed a morning peak from 0800 to 1200 hr, followed by a slight reduction in rates from 1200 to 1359 hr. Another peak was then observed from 1400 to 1500 hr with a steady decrease in catch from 1500 to day's end. The peak passage hour for American shad during the entire season was observed between 0800-0859 hrs, with a total of 213 American shad passed. The highest hourly passage (56) occurred between 0800 and 0859 hr on 4 June.

During the 2008 season, the Safe Harbor fishway did not pass any MD DNR tagged American shad 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 2008.

4.0 SUMMARY

The 2008 Safe Harbor fishway operating season was conducted with no disruptions to operations due to mechanical problems. The forty-five days of operation in 2008 marks the third longest migration season at Safe Harbor since operations commenced in 1997. A total of 1,252 American shad were passed into Lake Clarke, or nearly 45% of the American shad that were passed into Lake Aldred by the Holtwood fishway (Table 4). Nearly 50% of the total American shad passed at Safe Harbor occurred from 2 to 6 June, shortly after Holtwood completed the installation of new flashboards. Future operations of the fishway will build on the past twelve 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 2008.

<i>Date:</i>	<i>28-Apr</i>	<i>29-Apr</i>	<i>30-Apr</i>	<i>1-May</i>	<i>2-May</i>	<i>3-May</i>	<i>4-May</i>	<i>5-May</i>	<i>6-May</i>	<i>7-May</i>	<i>8-May</i>
<i>Hours of Operation:</i>	8.5	0.3	7.8	8.4	8.7	7.5	7.8	7.8	7.8	5.8	7.5
<i>Viewing Start Time:</i>	8:35	16:00	8:20	8:00	8:00	8:00	8:00	9:35	8:00	9:35	8:35
<i>Viewing End Time:</i>	16:10	16:15	16:10	16:00	16:15	15:40	15:35	15:30	15:45	15:50	15:50
<i>Number of Lifts:</i>	9	8	7	8	8	6	7	7	4	6	7
<i>Water Temperature (°F):</i>	64.0	60.0	58.0	57.2	58.0	57.9	58.6	59.5	62.1	63.0	63.9
American Shad	83	46	18	31	18	4	3	10	12	13	19
Gizzard shad	6,250	3,783	1,956	2,770	757	543	1,072	2,170	1,847	3,865	4,245
Striped bass	1	0	0	0	0	0	0	0	1	0	0
Sea lamprey	0	0	0	0	0	0	0	0	0	0	0
Brook trout	0	0	0	0	0	0	0	0	0	0	0
Rainbow trout	0	0	0	0	0	0	0	0	0	0	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	0
Tiger muskellunge	0	0	0	0	0	0	0	0	0	0	0
Carp	16	7	4	29	9	0	11	45	75	12	13
Quillback	152	3	3	6	13	94	106	105	174	197	250
Shorthead redhorse	108	15	10	7	21	170	108	270	248	203	174
Brown bullhead	0	0	0	0	0	0	0	0	0	0	0
Channel catfish	28	7	6	4	0	1	1	1	9	35	31
Flathead catfish	0	0	0	0	0	0	0	0	0	0	3
Rock bass	1	3	0	0	0	0	0	0	1	5	4
Pumpkinseed	0	0	0	0	0	0	0	0	0	0	0
Bluegill	10	2	0	0	0	1	0	0	2	1	1
Smallmouth bass	236	3	13	30	24	0	44	75	55	47	39
Largemouth bass	2	0	0	1	1	0	0	0	3	2	2
White Crappie	0	0	0	0	0	0	0	0	0	0	0
Black Crappie	0	0	1	0	0	0	0	0	0	0	0
Walleye	159	16	13	27	17	50	57	90	66	195	327
Daily Total	7,046	3,885	2,024	2,905	860	864	1,402	2,766	2,493	4,575	5,108

Table 1: Number and disposition of fish passed by the Safe Harbor fishway in 2008 (continued).

<i>Date:</i>	<i>9-May</i>	<i>10-May</i>	<i>11-May</i>	<i>12-May</i>	<i>13-May</i>	<i>14-May</i>	<i>15-May</i>	<i>16-May</i>	<i>17-May</i>	<i>18-May</i>	<i>19-May</i>
<i>Hours of Operation:</i>	8.0	9.2	8.8	8.5	8.2	8.3	8.3	8.7	8.1	7.8	8.0
<i>Viewing Start Time:</i>	7:40	8:00	8:00	7:40	7:40	8:00	7:40	7:45	8:00	8:00	7:45
<i>Viewing End Time:</i>	15:45	15:50	15:30	15:30	15:35	15:30	15:35	16:00	15:30	15:45	15:42
<i>Number of Lifts:</i>	8	7	7	7	9	8	8	8	8	8	7
<i>Water Temperature (°F):</i>	64.5	65.0	64.0	60.8	60.0	58.8	60.8	61.6	61.0	61.0	63.0
American Shad	5	27	17	6	12	4	6	13	6	11	0
Gizzard shad	4,239	4,110	5,696	1,353	1,371	3,245	4,340	3,014	2,940	2,045	255
Striped bass	0	1	0	0	0	0	0	0	0	0	0
Sea lamprey	0	0	1	0	0	0	1	0	0	0	0
Brook trout	0	0	0	0	0	0	0	0	0	0	0
Rainbow trout	0	0	0	0	0	0	0	0	0	0	0
Brown trout	0	0	1	0	0	1	1	0	0	0	0
Muskellunge	0	0	0	0	0	0	1	0	0	0	0
Tiger muskellunge	0	0	0	0	0	0	0	0	0	0	0
Carp	17	9	2	1	0	1	4	8	2	1	1
Quillback	343	96	20	1	0	0	40	76	9	3	0
Shorthead redhorse	46	59	10	1	1	5	17	12	9	1	0
Brown bullhead	0	0	0	1	0	0	0	0	0	0	0
Channel catfish	80	45	13	6	9	13	13	51	7	16	13
Flathead catfish	0	22	0	0	0	0	0	0	0	0	0
Rock bass	5	4	0	0	0	0	0	2	1	2	0
Pumpkinseed	0	0	0	0	0	0	0	0	0	0	0
Bluegill	0	0	4	0	0	0	2	1	0	3	0
Smallmouth bass	42	60	34	2	5	3	14	7	4	6	1
Largemouth bass	0	1	0	0	0	0	1	0	0	0	0
White Crappie	0	0	0	0	0	0	0	0	0	0	0
Black Crappie	0	0	0	0	0	0	0	0	0	0	0
Walleye	438	252	81	20	7	9	34	72	53	29	8
Daily Total	5,215	4,686	5,879	1,391	1,405	3,281	4,474	3,256	3,031	2,117	278

Table 1: Number and disposition of fish passed by the Safe Harbor fishway in 2008 (continued).

<i>Date:</i>	20-May	21-May	22-May	23-May	24-May	25-May	26-May	27-May	28-May	29-May	30-May
<i>Hours of Operation:</i>	7.8	8.0	7.4	7.5	8.0	8.5	8.5	8.5	8.8	8.0	7.9
<i>Viewing Start Time:</i>	7:30	8:00	7:40	8:00	8:00	8:00	8:00	7:40	8:00	7:45	7:30
<i>Viewing End Time:</i>	15:35	15:30	15:10	15:25	15:30	15:30	15:20	15:30	16:00	15:50	15:50
<i>Number of Lifts:</i>	6	6	7	5	5	7	7	7	8	8	9
<i>Water Temperature (°F):</i>	58.1	57.2	55.5	56.1	57.2	59.9	61.0	65.0	67.0	68.5	69.8
American Shad	0	0	1	0	1	0	1	25	20	33	62
Gizzard shad	237	250	173	274	1,168	2,367	3,650	4,021	12,775	10,260	6,003
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
Brook trout	0	0	1	0	0	0	0	0	0	0	0
Rainbow trout	0	0	0	0	0	0	0	0	0	0	0
Brown trout	0	0	0	1	2	0	0	0	1	3	0
Muskellunge	0	0	0	0	0	0	0	0	0	0	0
Tiger muskellunge	0	0	0	0	0	0	0	0	0	0	0
Carp	1	0	1	2	0	9	68	34	67	6	5
Quillback	0	0	0	0	7	91	394	199	74	25	1
Shorthead redhorse	0	0	0	0	7	17	52	18	14	1	0
Brown bullhead	0	0	0	0	0	0	0	0	0	0	0
Channel catfish	8	9	2	2	2	3	37	103	73	93	18
Flathead catfish	0	0	0	0	0	0	0	0	0	0	0
Rock bass	0	0	0	0	0	1	2	6	19	2	1
Pumpkinseed	0	0	0	0	0	0	0	2	4	0	0
Bluegill	0	0	0	0	1	1	3	4	6	7	4
Smallmouth bass	2	2	1	1	0	3	10	23	33	10	4
Largemouth bass	0	0	0	1	0	2	2	0	2	0	0
White Crappie	0	0	0	0	0	0	1	0	1	0	0
Black Crappie	0	0	0	0	0	0	0	0	0	0	0
Walleye	3	0	3	1	36	156	377	578	395	265	142
Daily Total	251	261	182	282	1,224	2,650	4,597	5,013	13,484	10,705	6,240

Table 1: Number and disposition of fish passed by the Safe Harbor fishway in 2008 (continued).

<i>Date:</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>7-Jun</i>	<i>8-Jun</i>	<i>9-Jun</i>	<i>10-Jun</i>
<i>Hours of Operation:</i>	8.2	7.8	8.8	8.3	9.9	9.9	9.1	7.5	8.3	8.4	7.9
<i>Viewing Start Time:</i>	7:30	7:45	7:30	7:45	8:05	7:25	7:45	8:00	8:00	7:40	7:40
<i>Viewing End Time:</i>	15:45	15:30	16:20	15:45	17:15	17:15	16:30	15:30	15:55	15:45	15:40
<i>Number of Lifts:</i>	7	7	9	9	13	14	9	9	10	6	5
<i>Water Temperature (°F):</i>	69.0	69.0	71.0	73.0	73.4	73.5	73.4	75.2	75.2	81.0	81.5
American Shad	43	26	90	110	180	124	101	28	24	17	2
Gizzard shad	2,652	7,775	15,094	10,528	5,865	5,885	4,429	3,219	3,863	474	251
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
Brook trout	0	0	0	0	0	0	0	0	0	0	0
Rainbow trout	1	0	0	0	0	0	0	0	0	0	0
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
Tiger muskellunge	0	0	0	1	0	0	0	0	0	0	0
Carp	18	7	20	19	17	1	102	30	12	9	2
Quillback	11	93	56	44	118	20	34	24	20	11	2
Shorthead redhorse	1	5	0	1	3	2	0	1	0	0	0
Brown bullhead	0	0	0	0	0	0	0	0	0	0	0
Channel catfish	41	158	42	29	574	476	264	29	63	278	156
Flathead catfish	0	0	0	0	0	1	0	0	0	0	0
Rock bass	0	13	4	1	5	0	0	0	0	0	0
Pumpkinseed	0	0	0	0	3	1	1	0	0	0	0
Bluegill	3	8	7	7	9	3	4	8	0	4	2
Smallmouth bass	4	8	3	0	0	3	2	0	1	2	0
Largemouth bass	0	2	0	0	2	1	0	1	0	0	0
White Crappie	0	1	0	0	0	0	0	0	0	0	0
Black Crappie	0	0	0	0	0	0	0	0	0	0	0
Walleye	158	326	49	53	220	154	65	30	56	16	13
Daily Total	2,933	8,422	15,365	10,793	6,996	6,671	5,002	3,370	4,039	811	428

Table 1: Number and disposition of fish passed by the Safe Harbor fishway in 2008 (continued).

	<i>Date: 11-Jun</i>	<i>Season Total</i>
<i>Hours of Operation:</i>	<i>8.1</i>	<i>360.5</i>
<i>Viewing Start Time:</i>	<i>8:10</i>	
<i>Viewing End Time:</i>	<i>15:30</i>	<i>344.9 hours of viewing</i>
<i>Number of Lifts:</i>	<i>6</i>	<i>341</i>
<i>Water Temperature (°F):</i>	<i>84.2</i>	
American shad	0	1,252
Gizzard shad	275	163,354
Striped bass	0	3
Sea lamprey	0	2
Brook trout	0	1
Rainbow trout	0	1
Brown trout	0	12
Muskellunge	0	1
Tiger muskellunge	0	1
Carp	2	699
Quillback	2	2,917
Shorthead redhorse	0	1,617
Brown bullhead	0	1
Channel catfish	190	3,039
Flathead catfish	0	26
Rock bass	0	82
Pumpkinseed	0	11
Bluegill	1	109
Smallmouth bass	0	856
Largemouth bass	0	26
White Crappie	0	3
Black Crappie	0	1
Walleye	6	5,122
Daily Total	476	179,136

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 2008.

Date	River Flow ¹ (mcfs)	Water Temp (°F)	Secchi (in)	Maximum Units in Operation	Units Generated	Entrance Gates Utilized	Attraction Flow (cfs)	Tailrace Elevation (ft)	Forebay Elevation (ft)
28 Apr	61.5	60.3	20	8	1 to 5, 7, 8, 9	A & C	500	171.6	226.9
29 Apr	61.9	61.9	6	10	1 to 5, 7 to 11	A & C	500	170.6	226.4
30 Apr	59.7	59.0	12	10	1 to 10	A & C	500	175.1	226.3
01 May	53.0	57.5	20	9	1 to 4, 8 to 12	A & C	500	173.8	226.1
02 May	50.5	57.5	16	9	1 to 5, 7 to 10	A & C	500	173.3	226.6
03 May	44.5	58.6	16	7	1, 3 to 5, 7 to 9	A & C	500	169.8	226.6
04 May	45.5	59.7	18	9	1 to 9	A & C	500	171.8	226.1
05 May	50.5	60.8	24	9	1 to 5, 7 to 10	A & C	500	170.7	226.8
06 May	52.6	62.7	24	8	1 to 5, 8 to 10	A & C	500	172.3	226.4
07 May	47.7	64.2	21	7	1 to 5, 8, 9	A & C	500	171.6	226.3
08 May	43.3	65.2	21	7	1 to 5, 8, 9	A & C	500	171.4	226.5
09 May	39.8	65.5	20	8	1 to 5, 8 to 10	A & C	500	173.1	226.2
10 May	41.5	64.9	18	7	1, 3 to 5, 8 to 10	A & C	500	170.1	226.5
11 May	39.2	63.2	22	7	1, 3 to 5, 8 to 10	A & C	500	168.3	225.7
12 May	47.3	61.4	20	9	1 to 6, 8 to 10	A & C	500	170.8	226.6
13 May	62.6	59.3	18-14	9	1 to 3, 5, 7 to 11	A & C	500	173.1	226.6
14 May	64.6	59.1	22	9	1, 2, 5, 7 to 11	A & C	500	174.3	226.5
15 May	54.8	60.7	20	9	1 to 3, 5, 7 to 11	A & C	500	172.8	226.7
16 May	52.7	61.7	16	8	1 to 3, 5, 7 to 10	A & C	500	173.3	225.8
17 May	55.1	61.7	16	6	1, 3, 4, 7 to 9	A & C	500	171.1	226.1
18 May	59.3	61.1	14	9	1, 3, 4, 7 to 12	A & C	500	174.2	226.9
19 May	63.9	59.7	20-12	9	1 to 4, 8 to 12	A & C	500	174.1	226.0
20 May	66.4	58.4	18-14	9	1 to 5, 8 to 10, 12	A & C	500	174.1	226.5
21 May	66.1	56.6	14	10	1 to 5, 8 to 12	A & C	500	174.6	226.4
22 May	62.8	56.6	20	8	1 to 4, 8 to 11	A & C	500	172.3	226.5
23 May	56.9	56.7	24	10	1 to 5, 8 to 12	A & C	500	173.7	226.3
24 May	49.3	58.2	24	4	1, 3 to 5	A & C	500	169.9	226.0
25 May	43.4	60.4	24	9	1, 2 to 5, 8 to 12	A & C	500	171.5	226.8
26 May	38.9	63.0	24	8	1, 3-5, 8, 9, 10, 12	A & C	500	170.4	226.4
27 May	36.3	65.7	24	Data	Not Recorded	A & C	500	170.5	226.5
28 May	35.5	67.9	36	Data	Not Recorded	A & C	500	168.9	226.5
29 May	29.7	69.4	20	5	2, 8 to 11	A & C	500	172.0	226.2
30 May	27.6	70.8	20	4	1 to 3, 9	A & C	500	169.8	225.9
31 May	28.1	71.1	18	4	1, 3, 5, 8	A & C	500	168.8	225.9
01 Jun	24.2	71.1	18	3	1, 3, 5	A & C	500	169.3	226.2
02 Jun	22.5	72.3	20	8	1 to 3, 5, 8 to 11	A & C	500	170.0	226.5
03 Jun	20.4	72.9	22	4	1 to 3, 5	A & C	500	169.7	226.8
04 Jun	21.7	73.8	30	4	1 to 3, 5	A & C	500	169.3	226.7
05 Jun	21.9	74.1	28	4	1 to 3, 5	A & C	500	169.5	226.5
06 Jun	24.8	75.2	26	6	1 to 2, 5, 9, 11	A & C	500	169.3	226.3
07 Jun	20.1	76.0	10-12	Data	Not Recorded	A & C	500	169.9	226.6
08 Jun	19.0	78.3	8	1	1	A & C	500	168.7	226.2
09 Jun	17.8	80.5	20	3	1 to 3	A & C	500	168.6	226.8
10 Jun	16.3	81.0	14	2	1, 2	A & C	500	169.2	226.4
11 Jun	14.7	83.5	14-16	2	1, 2	A & C	500	169.5	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 2008.

<i>Date:</i>	28-Apr	29-Apr	30-Apr	1-May	2-May	3-May	4-May	5-May	6-May	7-May	8-May	9-May
<i>Observation Time-Start:</i>	8:35	16:00	8:20	8:00	8:00	8:00	8:00	9:35	8:00	9:35	8:35	7:40
<i>Observation Time-End:</i>	16:10	16:15	16:10	16:00	16:15	15:40	15:35	15:30	15:45	15:50	15:50	15:45
Military Time (hrs)												
0700 to 0759												0
0800 to 0859	2	15	0	6	0	0	0		4		2	2
0900 to 0959	15	2	0	2	2	0	0	1	5	0	2	0
1000 to 1059	17	8	5	2	3	0	1	0	1	0	4	0
1100 to 1159	14	6	1	9	4	0	0	1	0	0	1	1
1200 to 1259	8	7	0	1	1	0	1	1	1	0	0	1
1300 to 1359	8	5	2	4	1	0	0	2	0	0	2	0
1400 to 1459	4	2	5	5	2	1	0	4	1	7	4	1
1500 to 1559	6	1	4	2	4	3	1	1	0	6	4	0
1600 to 1659	9	0	1		1							
1700 to 1759												
1800 to 1859												
1900 to 1959												
Total	83	46	18	31	18	4	3	10	12	13	19	5

<i>Date:</i>	10-May	11-May	12-May	13-May	14-May	15-May	16-May	17-May	18-May	19-May	20-May	21-May
<i>Observation Time-Start:</i>	8:00	8:00	7:40	7:40	8:00	7:40	7:45	8:00	8:00	7:45	7:30	8:00
<i>Observation Time-End:</i>	15:50	15:30	15:30	15:35	15:30	15:35	16:00	15:30	15:45	15:42	15:35	15:30
Military Time (hrs)												
0700 to 0759			0	0		0	0			0	0	
0800 to 0859	5	1	2	2	0	0	1	1	1	0	0	0
0900 to 0959	3	0	0	2	0	1	3	1	3	0	0	0
1000 to 1059	2	0	1	1	0	0	1	0	2	0	0	0
1100 to 1159	9	2	0	0	1	2	2	0	4	0	0	0
1200 to 1259	3	3	1	0	0	1	2	1	1	0	0	0
1300 to 1359	1	3	0	2	1	1	1	1	0	0	0	0
1400 to 1459	3	3	2	2	1	1	2	2	0	0	0	0
1500 to 1559	1	5	0	3	1	0	1	0	0	0	0	0
1600 to 1659												
1700 to 1759												
1800 to 1859												
1900 to 1959												
Total	27	17	6	12	4	6	13	6	11	0	0	0

Table 3: Hourly summary of American shad passage at the Safe Harbor fish passage facility in 2008 (continued).

<i>Date:</i>	<i>22-May</i>	<i>23-May</i>	<i>24-May</i>	<i>25-May</i>	<i>26-May</i>	<i>27-May</i>	<i>28-May</i>	<i>29-May</i>	<i>30-May</i>	<i>31-May</i>	<i>1-Jun</i>	<i>2-Jun</i>
<i>Observation Time-Start:</i>	7:40	8:00	8:00	8:00	8:00	7:40	8:00	7:45	7:30	7:30	7:45	7:30
<i>Observation Time-End:</i>	15:10	15:25	15:30	15:30	15:20	15:30	16:00	15:50	15:50	15:45	15:30	16:20
Military Time (hrs)												
0700 to 0759	0					1		2	0	4	0	0
0800 to 0859	0	0	0	0	0	6	2	8	10	7	3	8
0900 to 0959	0	0	0	0	1	4	1	4	14	11	1	10
1000 to 1059	1	0	0	0	0	0	1	6	16	8	2	9
1100 to 1159	0	0	0	0	0	1	1	4	3	7	4	11
1200 to 1259	0	0	0	0	0	1	2	0	4	0	5	10
1300 to 1359	0	0	1	0	0	10	4	4	7	4	3	11
1400 to 1459	0	0	0	0	0	2	0	5	7	2	6	16
1500 to 1559	0	0	0	0	0	0	9	0	1	0	2	6
1600 to 1659												9
1700 to 1759												
1800 to 1859												
1900 to 1959												
Total	1	0	1	0	1	25	20	33	62	43	26	90

<i>Date:</i>	<i>3-Jun</i>	<i>4-Jun</i>	<i>5-Jun</i>	<i>6-Jun</i>	<i>7-Jun</i>	<i>8-Jun</i>	<i>9-Jun</i>	<i>10-Jun</i>	<i>11-Jun</i>	<i>Season</i>
<i>Observation Time-Start:</i>	7:45	8:05	7:25	7:45	8:00	8:00	7:40	7:40	8:10	<i>Total</i>
<i>Observation Time-End:</i>	15:45	17:15	17:15	16:30	15:30	15:55	15:45	15:40	15:30	
Military Time (hrs)										
0700 to 0759	1		11	0			3	0		22
0800 to 0859	0	56	17	32	4	9	7	0	0	213
0900 to 0959	6	18	12	31	3	2	0	1	0	161
1000 to 1059	20	21	33	12	7	4	0	0	0	188
1100 to 1159	23	11	8	9	4	2	1	0	0	146
1200 to 1259	15	18	3	2	6	2	1	0	0	102
1300 to 1359	17	23	8	3	3	0	0	1	0	133
1400 to 1459	23	11	12	7	0	2	5	0	0	150
1500 to 1559	5	11	13	4	1	3	0	0	0	98
1600 to 1659		8	3	1						32
1700 to 1759		3	4							7
1800 to 1859										0
1900 to 1959										0
Total	110	180	124	101	28	24	17	2	0	1252

Table 4: Summary of American shad passage counts and percent passage values at Susquehanna

	Conowingo	Holtwood		Safe Harbor		York Haven	
	East	Number	Passed	Number	Passed	Number	Passed
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%	4,675	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	6.9%
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%

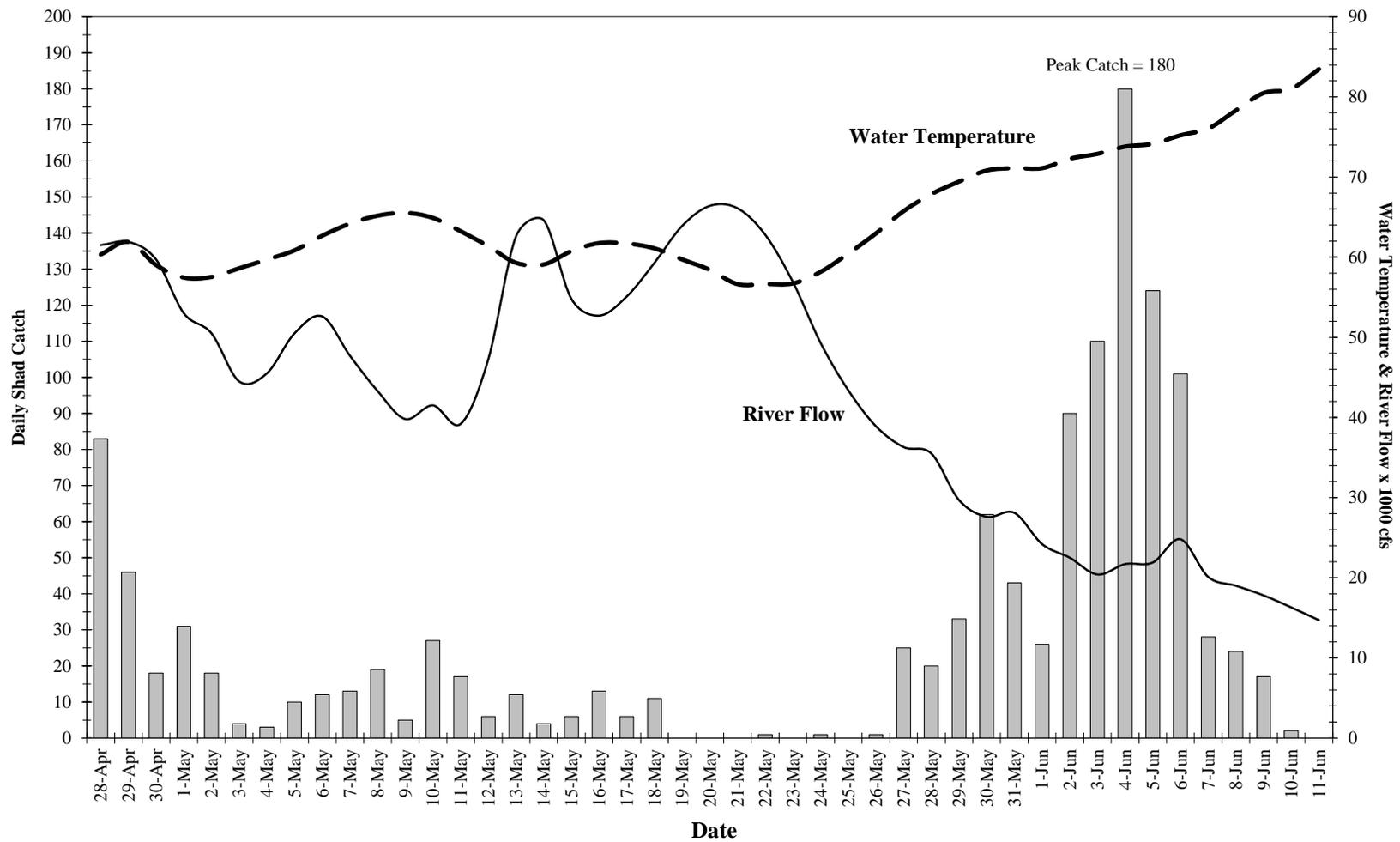


Fig. 1

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 2008.

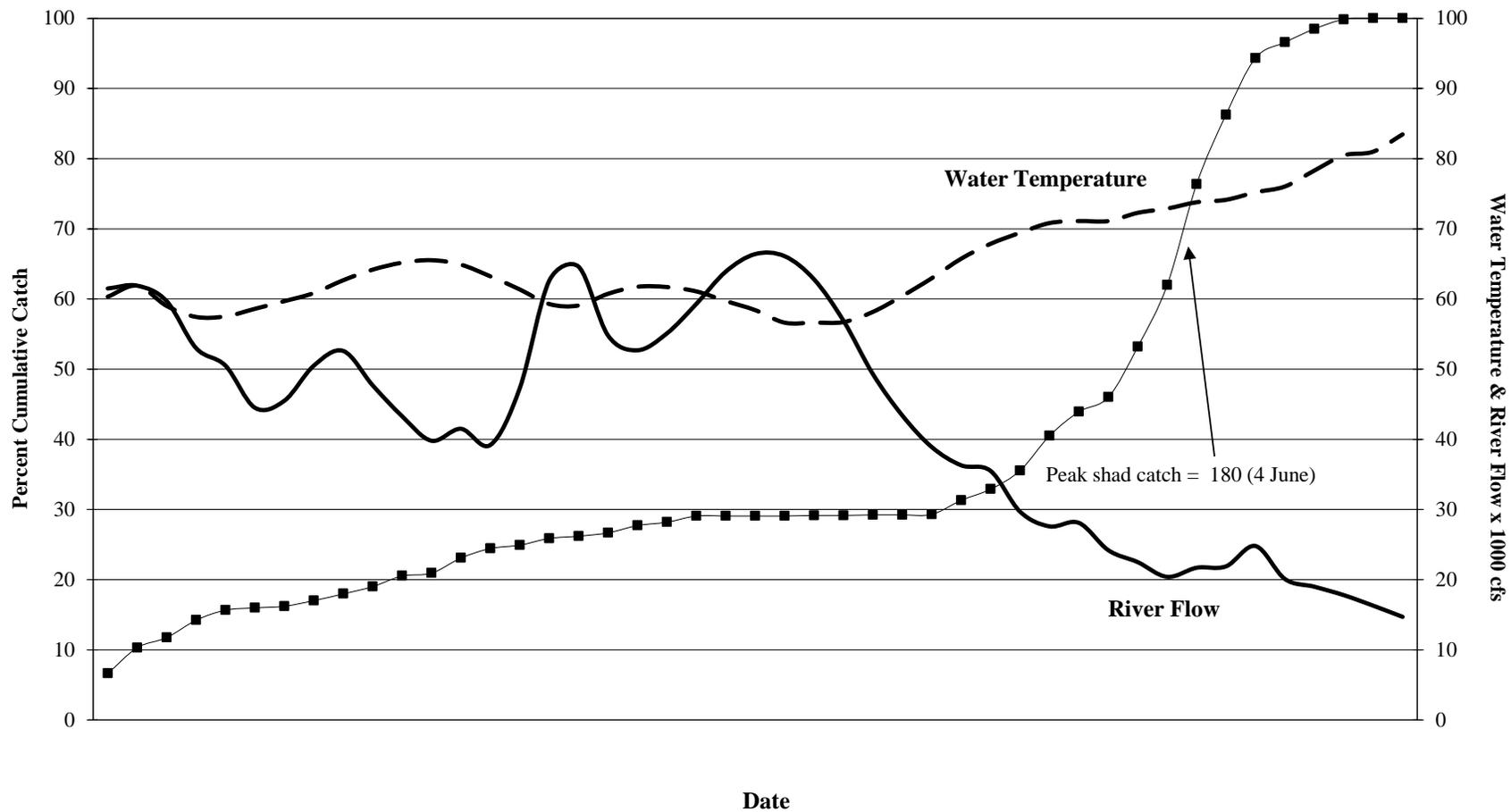


Fig. 2

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 2008.