

**SUMMARY OF OPERATIONS AT THE
HOLTWOOD DAM FISH PASSAGE FACILITY
SPRING 2008**

November 2008

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Prepared for

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EXECUTIVE SUMMARY

Fishway operations at Holtwood Dam began on 21 April, 2008. The tailrace lift was operated for 49 days while the spillway lift operated on 13 days. Lift operations were terminated for the season, with agency concurrence, on 9 June. The tailrace lift operated with minimal maintenance issues during the passage season, resulting in one lost day of fishing time and the passage of 2,792 American shad. The operation of the spillway lift resulted in the passage of only 3 American shad. The 2008 fish passage season marks the twelfth year of operation at Holtwood.

The lifts passed 248,980 fish of 25 taxa. Gizzard shad, walleye, and American shad dominated the catch, and comprised nearly 99% of the total fish collected and passed. American shad represented the sole *Alosa* species captured. No river herring were observed at Holtwood in 2008.

A total of 2,792 American shad (99% of total shad catch) was passed in the tailrace lift while the spillway lift accounted for 3 American shad (less than 1% of total shad catch). Collection and passage of shad varied daily with 38% of total shad (1,050) passed during the 3 day period from 1 through 3 June (immediately after flashboard installation and river flows dropped below station capacity). The highest daily shad catch occurred on 1 June when 462 shad moved upstream during 11.4 hours of operation. On a daily basis, shad passage was consistent through the fishway between 1000 hrs and 1759 hrs.

Fishway operations were conducted at water temperatures ranging from 56.6°F to 80.4°F and river flows between 17,800 and 66,400 cfs. Spillage occurred on 39 of the 49 days of operation, with only one spillage event observed after flashboard installation. River water temperatures and river flows fluctuated between 56° F and 63° F and 38,900 cfs to 66,400 cfs, respectively, from 21 April to 26 May. After 26 May, water temperatures rose steadily, attaining the 80° F mark on 9 June, (the last day of operation).

For most of the season, water clarity was decent, thus allowing the viewing technicians to identify any American shad with attached Maryland DNR floy tags. The number of floy tags observed at Holtwood in 2008 was low, and included 1 green tag, (2008 Hook & Line), and 1 pink tag, (2007 Hook & Line).

The 2008 American shad passage total was the lowest number of fish observed since operations began in 1997. It should be noted that the number of American shad passed at Conowingo Dam in 2008 was the lowest total since 1993. Compared with the Conowingo passage numbers, Holtwood passed 14% of the Conowingo catch – the second lowest passage percentage rate recorded in the twelve years of fish lift operations at Holtwood.

A low, stable, river flow appears to be critical for enhancing shad passage rates. Spillage occurred nearly 80% of the time this season and appeared to delay the movement of some American shad into the project area. River water temperatures and river flows fluctuated between 56° F and 63° F and 38,900 cfs to 66,400 cfs, respectively, from 21 April to 26 May. After 26 May, water temperatures rose steadily, attaining the 80° F mark on 9 June, (the last day of operation). American shad of advanced or post-spawned condition were observed during fish passage operations from late-May to the end of season. Future operations of the fishway will build on the past twelve years of operation experience.

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1.0 INTRODUCTION

On 1 June 1993 representatives of PPL, two other upstream utilities, various state and federal resource agencies, and two sportsmen clubs signed the 1993 Susquehanna River Fish Passage Settlement Agreement. This agreement committed the Holtwood Hydroelectric Project (Holtwood) and the two other upstream hydroelectric projects to provide migratory fish passage at their facilities by the spring of 2000. A major element of this agreement was for PPL, the owner/operator of Holtwood, to construct and place a fishway into operation by 1 April 1997. PPL started construction on the fishway in April 1995, and met the spring 1997 operational target. The upstream passage facility consisting of a tailrace and spillway lift successfully operated during spring 1997 through spring 2008. This year marked the twelfth operational season.

Objectives of 2008 upstream fishway operation were (1) monitor and maximize passage of migratory and resident fishes through the fishway; and (2) minimize interruptions to fish passage operations due to equipment breakdowns or malfunctions.

2.0 HOLTWOOD OPERATION

2.1 Project Operation

Holtwood, built in 1910, is situated on the Susquehanna River (river mile 24) in Lancaster and York counties, Pennsylvania (see figure in Normandeau Associates, Inc. 1998). It is the second upstream hydroelectric facility on the river. The project consists of a concrete gravity overflow dam 2,392 ft long by 55 ft high, a powerhouse with ten turbine units having a combined generating capacity of 107 MW, and a reservoir (Lake Aldred) of 2,400 acres surface area. Each unit is capable of passing approximately 3,000 cfs. Spills occur at the project when river flow or project inflow exceeds the station hydraulic capacity of approximately 32,000 cfs.

Hydraulic conditions in the spillway at the project are controlled by numerous factors that change hourly, daily and throughout the fishway operating season. The primary factors are river flows, operation of the power station, installation and integrity of the flash boards, operation of four rubber dams installed as part of the fishway project, and operation of the Safe Harbor Hydroelectric Station.

In spring 2008, rubber dams 2 and 3 were inoperable (not inflated) due to irreparable damage that occurred in March and April of 2007. Flashboards that were installed during Spring 2007 were missing or severely damaged from high water events prior to start-up operations in April 2008. The passage of over one-thousand shad at Conowingo Dam on 19 April triggered the start of fish lift operations on 21 April at Holtwood Dam. Due to damaged flashboards, inoperability of two rubber dams, and river flows greater than station capacity, spill occurred daily at Holtwood from 21 April to 29 May. Flashboard installation occurred on 30 and 31 May. Spillage occurred once on 2 June after flashboard installation activities were completed. Passage operations ended on 9 June, with agency concurrence, due to a period of high water temperatures and a lack of pre-spawned shad available for passage.

2.2 Fishway Design and Operation

2.2.1 Fishway Design

The Holtwood fishway is sized to pass a design population of 2.7 million American shad and 10 million river herring. The design incorporates numerous criteria established by the USFWS and state resource agencies. Physical design parameters for the fishway are given in Normandeau Associates, Inc. (1998).

The fish passage facility at Holtwood is comprised of a tailrace and spillway lift (see figure in Normandeau Associates, Inc. 1998). The tailrace lift has two entrances (gates A and B) and the spillway lift has one entrance (gate C). Each lift has its own fish handling system that includes a mechanically operated crowder, picket screen(s), hopper, and hopper trough gate. Fishes captured in the lifts are sluiced into the trough through which the fish swim into Lake Aldred. Attraction flows, in, through, and from the lifts are supplied via a piping system and five diffusers that are gravity fed from two trough intakes. Generally, water conveyance and attraction flow is controlled by regulating the three entrance gates and seven motor-operated valves. Fish that enter the tailrace and/or spillway entrances are attracted by water flow into the mechanically operated crowder chambers. Once inside, fish are crowded into the hoppers (6,700 gal capacity). Fish are then lifted in the hoppers and sluiced into the trough. Fish swim upstream through the trough past a counting facility and into the forebay through a 14 ft wide fish lift exit gate.

Four inflatable rubber dams, operated from the hydro control room, are an integral component of effective spillway lift operation. During fish lift operations in 2008, only two of the four rubber crest dams were operational and flashboards were installed upstream of the two damaged rubber dams when river flows permitted, (30 and 31 May).

Design guidelines for fishway operation include three entrance combinations. These are: (1) entrance A, B, and C; (2) entrance A and B; and (3) entrance C. Completion of the attraction water system after the 1997 season resulted in the drafting of operating protocols and guidelines that are flexible and utilize experience gained during previous years of fish lift operation. In 2008, entrance gate A was used almost exclusively in the tailrace to attract American shad, while spillway gate C was operated on a limited basis due to sustained river flows between 40,000 and 60,000 cfs. The spillway lift is also used less frequently when flashboard sections are damaged/missing or rubber dams are deflated because spillage may mask or interfere with the attraction flow from the spillway entrance gate.

2.2.2 Fishway Operation

Daily operation of the Holtwood fishway was based on the American shad catch, and managed to maximize that catch. Constant oversight by PPL and Normandeau staff ensured that maintenance activities and mechanical or electrical problems were dealt with immediately to minimize fish lift operational interruptions. Pre-season equipment preparations began in March, and were completed before season start-up.

The catch of shad at Conowingo Dam triggered the start of Holtwood operations on 21 April. This year we recorded 49 days of operation. Operation did not occur on 5 May due to a malfunction of the motor operator on Gate 7, (trash sluice gate). As mentioned previously in this report, the spillway lift was operated on a limited basis (14 days) in spring 2008. The tailrace lift was operated everyday during this year's fish passage operation and encountered only minor mechanical problems which were quickly resolved with no loss of operational time.

The 2008 American shad passage rate at Holtwood versus Conowingo (14.0% of fish passing Conowingo passed Holtwood) was well below the 10-year average of 33%. It should be noted that the number of American shad passed at Conowingo Dam in 2008 was the lowest total since 1993. Operational hours varied throughout the season in an attempt to maximize the catch of American shad.

Operation of the Holtwood fishway followed methods established during the 1997 and 1998 spring fish migration seasons. A three person staff consisting of a lift operator, supervising biologist, and biological technician manned the lifts daily. A detailed description of the fishway's major

components and their operation are found in the 1997 and 1998 summary reports (Normandeau Associates, Inc. 1998 and 1999).

2.3 Fish Counts

Fish passing the counting window are identified to species and counted by a biologist or biological technician. The counting area is located immediately downstream of the main attraction water supply area in the trough. 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, 12 ft long channel on the west side of the trough. The channel is adjacent to a 4 ft by 10 ft window located in the counting room where fish are identified and counted. Passage from the fishway is controlled by two different gates. During the day, fish passage rates are controlled by the technician who opens/closes a set of gates downstream of the viewing window. At night fish are denied passage from the fishway by closing this gate. When necessary, flow is maintained through the exit channel to insure that adequate water quality exists for fish held overnight.

Fish passage data is handled by a single system that records and processes the data. The data (species and numbers passed) is recorded on a worksheet by the biologist or biological technician as fish pass the viewing window. At the end of each hour, fish passage data is entered into a Microsoft Excel spreadsheet and saved. Data processing and reporting is PC-based and accomplished by program scripts, or macros, created within Microsoft Excel spreadsheet software.

At day's end, the data is checked and verified by the biologist or biological technician. After data verification is completed, a daily summary of fish passage is produced and distributed to plant personnel. Each day's data is backed up to a diskette and stored off-site. Daily reports and weekly summaries of fish passage numbers are electronically distributed to members of the Holtwood FPTAC and other co-operators.

3.0 RESULTS

3.1 Relative Abundance

The diversity and abundance of fishes collected and passed in the Holtwood fishway during the spring 2008 operational period is presented in Table 1. A total of 248,980 fish of 25 taxa passed upstream into Lake Aldred. Gizzard shad (235,699), walleye (7,042), and American shad (2,795) comprised nearly 99% of the fishes passed. The 2008 American shad passage total was the lowest observed based on actual numbers of fish, and based on Conowingo results, this was the second lowest passage percentage rate recorded in the twelve years of fish lift operations at Holtwood, although the operation season was the third longest (Tables 1, 5, and 6). Other abundant fishes passed included shorthead redhorse (1,736), channel catfish (468), smallmouth bass (334), and quillback (333). The peak one-day passage of all species occurred on 1 June, when 25,211 fish were passed, comprised mostly of gizzard shad (24,179), walleye (537), and American shad (462).

For most of the season, water clarity was decent, thus allowing the viewing technicians to identify American shad with attached Maryland DNR floy tags. The number of floy tags observed at Holtwood in 2008 was low, and included 1 green tag, (2008 Hook & Line), and 1 pink tag, (2007 Hook & Line).

3.2 American Shad Passage

A total of 2,795 American shad were passed at Holtwood during 2008; 2,792 American shad passed in the tailrace lift while the spillway lift accounted for only 3 American shad (Table 4). Collection and passage of shad varied daily with nearly 38% of total shad (1,050) passed during the 3 day period from 1 through 3 June, (immediately after flashboard installation and river flows dropped below

station capacity). The highest daily shad catch occurred on 1 June when 462 shad moved upstream during 11.4 hours of operation. On a daily basis, shad passage was consistent through the fishway between 1000 hrs and 1759 hrs with the highest passage occurring from 1300 hrs to 1659 hrs (Table 3). Fishway operations were conducted at water temperatures ranging from 56.6°F to 80.4°F and river flows between 17,800 and 66,400 cfs, (Table 2). Spillage occurred on 39 of the 49 days of operation, (79% of the season), with only one light spillage event observed after flashboard installation. River water temperatures and river flows fluctuated between 56° F and 63° F and 38,900 cfs to 66,400 cfs, respectively, from 21 April to 26 May. After 26 May, water temperatures rose steadily, attaining the 80° F mark on 9 June, (the last day of operation). American shad of advanced or post-spawned condition were observed during fish passage operations from late-May to the end of season.

The capture of shad at the fishway occurred over a narrower range of station operation and discharge conditions (Table 2) than observed in other years due to river flows ranging consistently between 45,000 cfs and 65,000 cfs for most of the season. Shad were attracted to the tailrace lift at water elevations ranging from 114 ft. to 119 ft. Tailrace elevations correspond to unit operation, which varies from 0 to 10 units. During spring 2008, tailrace fishway operation generally coincided with a ten turbine operation/generation scenario due to consistent river flows greater than station capacity. Spillway lift operation usually occurs during periods of no or minimal spillage, (spillway water elevation 116 ft), or when the forebay level was high enough to allow simultaneous operation of both the spillway and tailrace fish lifts. Spillage occurred during 39 of the 49 days of operation, with all but one spill event occurring before installation of new flashboards.

Passage of shad into Lake Aldred occurred at Holtwood forebay elevations ranging from 165 ft to 170 ft (Table 2). Visual observations indicated that shad passed through the fishway into Lake Aldred at this range of forebay elevations. After the new flashboards were installed, river flows decreased steadily and forebay elevations during passage operations generally ranged between 168 ft to 169 ft.

The hourly passage numbers of American shad at Holtwood are provided in Table 3. Most shad, (2,400 or nearly 86% of shad passage total) passed through the fishway between 1000 hrs and 1759 hrs. Generally, shad passage was consistent from 1000 hrs to 1759 hrs, then gradually declined until operation was ended each evening. The highest hourly passage rates occurred from 1300 hrs to 1659 hrs, accounting for the passage of 1,485 American shad (53% of total shad passage).

Each year, we attempt to qualitatively assess the relative number of shad using the tailrace and spillway lifts by viewing each hopper of fish and estimating the number of shad in each lift as they are sluiced into the trough. The spillway lift was operated on thirteen days in an effort to pass any shad attracted into the spillway area adjacent to the fishlift. We summarized this information by lift, and applied results to the daily shad passage count. We determined the number of shad captured by each lift and/or the percentage of daily passage that was attributable to each lift. Based on this assessment, 2,792 and 3 shad were captured in the tailrace and spillway lifts over the total operating period in 2008, respectively (Table 4).

3.3 Passage Evaluation

In spring 2008, our fishway evaluation efforts focused on maximizing the passage of American shad at both the tailrace and spillway lifts with minimal interruptions to passage operations due to equipment breakdowns or malfunctions.

We present a summary of American shad passage at three river flow ranges in Table 5. As stated in previous reports, low, stable river flows are more conducive to fish passage at Holtwood. In 2008, spill events occurred during 39 of the 49 days of fishway operation. We documented 80.2% of

American shad passed at river flows less than 40,000 cfs, with 19.0% passing at river flows greater than 40,000 cfs but less than 60,000 cfs, (Table 5 and Figure 2). During fish lift operations in 2008, river flows ranged from 17,800 cfs to 66,400 cfs. The 2008 American shad passage rate at Holtwood versus Conowingo (14.0% of American shad passed at Conowingo were passed by Holtwood), was below the 11-year average of 33% observed at Holtwood from 1997 to 2007.

We hope to optimize future fishway operations by utilizing knowledge gained through these twelve years of operation. Debugging of the fishway occurred as needed throughout the season, and operation was modified based on conditions encountered on a daily basis. Fish survival in the fishways was excellent; we observed 1shad mortality, less than 0.1% of total American shad passage.

4.0 RECOMMENDATIONS

- 1) Continue the current maintenance program to identify additional equipment maintenance inspection and testing activities to reduce in-season disruptions to operation. Unusual conditions, (e.g. severe flood events) require a more thorough review of the impacts to the equipment.
- 2) Operate the fishway at Holtwood Dam under annual operational guidelines developed and approved by the HFPTAC. Fishway operation should adhere to these guidelines; however, personnel must retain the ability to make “on-the-spot” modifications to maximize fishway performance.
- 3) Continue, as a routine part of fishway operation, a maintenance program that includes periodic scheduled drawdowns and cleaning of the exit channel as necessary, nightly inspections of picket screens, and daily checks of hopper doors. Routine maintenance activities minimize disruption of fishway operation.
- 4) As river flow conditions permit install the “Slick Bar” in front of the fishway exit channel to reduce the amount of debris entering and accumulating at the exit/entrance of the trough. After the “slick bar” is installed implement protocols/guidelines to spill trash through gates 7 and 9. This should be done on an as needed basis prior to the scheduled start of fishway operations.

5.0 LITERATURE CITED

Normandeau Associates, Inc. 1998. Summary of operation at the Holtwood Fish Passage Facility in 1997. Report prepared for PPL, Inc., Allentown, PA.

Normandeau Associates, Inc. 1999. Summary of the operation at the Holtwood Fish Passage Facility in 1998. Report prepared for PPL, Inc., Allentown, PA.

TABLES AND FIGURES

Table 1: Summary of the daily number of fish passed by the Holtwood fish passage facility in 2008.

<i>Date:</i>	<i>21 Apr</i>	<i>22 Apr</i>	<i>23 Apr</i>	<i>24 Apr</i>	<i>25 Apr</i>	<i>26 Apr</i>	<i>27 Apr</i>	<i>28 Apr</i>	<i>29 Apr</i>	<i>30 Apr</i>
<i>Hours of Operation - Tailrace:</i>	7.1	7.2	6.9	4.8	6.2	8.1	5.6	7.2	6.8	7.3
<i>Number of Lifts - Tailrace:</i>	11	10	11	8	10	13	8	8	8	9
<i>Hours of Operation - Spillway:</i>	3.9	1.3	3.5	3.0	3.0	3.5	2.4	4.2	2.7	1.5
<i>Number of Lifts - Spillway:</i>	3	2	3	4	4	3	3	4	4	2
<i>Water Temperature (*F):</i>	63.0	62.4	61.5	63.3	65.7	66.9	67.2	65.9	62.1	58.7
American shad	310	39	20	11	109	76	57	5	4	7
Gizzard shad	9,243	3,301	5,012	4,879	9,620	14,400	17,108	2,395	1,208	1,115
Rainbow trout	1	0	0	1	0	0	0	0	0	1
Brown trout	0	0	0	0	0	1	0	0	0	0
Brook trout	0	0	0	0	0	0	0	0	0	0
Muskellunge	0	0	0	0	0	2	1	0	0	0
Carp	18	5	18	4	13	17	15	1	10	4
Quillback	29	2	34	1	12	60	64	20	0	1
Northern hogsucker	0	0	0	0	0	0	1	0	0	0
Shorthead redhorse	138	230	369	187	200	158	91	30	41	12
Channel catfish	1	3	17	2	9	2	11	6	4	8
Flathead catfish	0	0	1	0	0	0	0	0	0	0
White perch	0	0	0	0	0	0	0	0	0	0
Rock bass	4	0	0	0	3	4	15	2	1	0
Redbreast sunfish	0	0	0	0	0	0	1	0	0	0
Green sunfish	0	0	0	0	0	0	0	0	0	0
Pumpkinseed	0	0	0	0	0	0	0	0	0	0
Bluegill	0	0	1	0	0	0	1	0	1	1
Smallmouth bass	46	39	23	24	41	43	28	14	1	1
Largemouth bass	0	0	0	0	0	3	0	0	0	2
White crappie	0	0	0	0	3	0	2	0	0	0
Black crappie	1	0	1	0	0	0	0	0	0	1
Yellow perch	3	0	0	0	0	0	0	0	1	0
Walleye	330	249	203	145	159	244	212	164	67	18
Spotfin shiner	0	0	0	0	0	0	0	0	0	0
Total	10,124	3,868	5,699	5,254	10,169	15,010	17,607	2,637	1,338	1,171

Table 1: Summary of the daily number of fish passed by the Holtwood fish passage facility in 2008 (continued).

<i>Date:</i>	<i>1 May</i>	<i>2 May</i>	<i>3 May</i>	<i>4 May</i>	<i>6 May</i>	<i>7 May</i>	<i>8 May</i>	<i>9 May</i>	<i>10 May</i>	<i>11 May</i>
<i>Hours of Operation - Tailrace:</i>	5.9	7.4	8.7	7.8	7.6	7.8	8.0	8.8	8.2	8.0
<i>Number of Lifts - Tailrace:</i>	7	10	10	12	10	11	11	12	12	12
<i>Hours of Operation - Spillway:</i>	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Number of Lifts - Spillway:</i>	2	0	0	0	0	0	0	0	0	0
<i>Water Temperature (*F):</i>	56.9	57.1	58.4	59.4	61.7	63.5	65.1	65.7	65.1	63.3
American shad	0	1	1	17	18	3	3	46	16	15
Gizzard shad	306	506	271	888	578	4,809	8,540	6,115	7,296	4,409
Rainbow trout	0	0	0	0	0	6	0	0	0	1
Brown trout	0	0	0	0	0	0	0	0	0	0
Brook trout	0	0	0	0	0	0	0	0	0	0
Muskellunge	0	0	0	0	0	0	1	0	0	0
Carp	0	2	5	1	0	5	3	5	1	0
Quillback	0	0	0	0	0	0	1	3	24	0
Northern hogsucker	0	0	0	0	0	0	0	0	0	0
Shorthead redhorse	0	0	7	7	24	51	38	7	13	2
Channel catfish	5	0	7	20	1	14	10	13	9	5
Flathead catfish	0	0	0	0	0	0	0	0	0	0
White perch	0	0	0	0	0	0	0	0	0	0
Rock bass	0	0	2	3	2	5	2	2	3	0
Redbreast sunfish	0	0	0	0	0	0	0	0	0	0
Green sunfish	0	0	0	0	0	0	0	0	0	0
Pumpkinseed	0	0	0	0	0	0	0	0	0	1
Bluegill	0	0	1	0	0	3	0	0	0	0
Smallmouth bass	0	1	1	13	2	4	9	7	6	5
Largemouth bass	0	0	3	0	0	0	0	0	0	0
White crappie	0	0	0	0	0	0	0	0	0	0
Black crappie	0	0	0	0	0	1	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0
Walleye	17	23	43	61	55	167	161	186	203	74
Spotfin shiner	0	0	0	0	0	0	0	0	0	0
Total	328	533	341	1,010	680	5,068	8,768	6,384	7,571	4,512

Table 1: Summary of the daily number of fish passed by the Holtwood fish passage facility in 2008 (continued).

<i>Date:</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>20 May</i>	<i>21 May</i>
<i>Hours of Operation - Tailrace:</i>	7.8	6.0	7.5	8.1	7.3	8.2	7.9	8.0	7.8	6.6
<i>Number of Lifts - Tailrace:</i>	9	4	10	10	9	10	10	10	8	10
<i>Hours of Operation - Spillway:</i>	0.0	1.7	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.5
<i>Number of Lifts - Spillway:</i>	0	2	0	0	0	4	0	0	0	1
<i>Water Temperature (*F):</i>	61.6	58.8	58.0	60.0	61.4	61.4	61.0	59.3	58.6	56.4
American shad	33	2	3	25	3	11	7	2	1	3
Gizzard shad	3,063	113	1,212	1,418	4,648	3,151	1,315	2,738	865	454
Rainbow trout	0	0	0	0	0	0	0	0	0	0
Brown trout	1	0	0	0	0	0	0	0	0	0
Brook trout	0	0	0	0	0	0	0	1	0	0
Muskellunge	0	0	0	0	0	0	0	0	0	0
Carp	1	0	0	1	0	3	1	0	0	1
Quillback	0	0	0	0	0	8	1	0	0	0
Northern hogsucker	0	0	0	0	0	0	0	0	0	0
Shorthead redhorse	0	0	4	2	0	26	2	0	0	0
Channel catfish	1	12	8	0	0	62	3	2	2	2
Flathead catfish	0	0	0	0	0	0	0	0	0	0
White perch	0	0	0	0	0	0	0	0	0	0
Rock bass	0	0	1	0	0	4	0	1	0	0
Redbreast sunfish	0	0	0	0	0	0	0	0	0	0
Green sunfish	0	0	0	0	0	0	0	0	0	0
Pumpkinseed	0	0	0	0	0	0	0	0	0	0
Bluegill	0	0	0	0	0	0	1	0	0	1
Smallmouth bass	1	0	0	0	1	1	1	0	2	0
Largemouth bass	0	0	0	0	0	0	0	0	0	0
White crappie	0	0	0	0	0	0	0	0	0	0
Black crappie	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0
Walleye	117	30	73	54	117	147	53	22	16	16
Spotfin shiner	0	0	0	0	0	0	0	0	0	0
Total	3,217	157	1,301	1,500	4,769	3,413	1,384	2,766	886	477

Table 1: Summary of the daily number of fish passed by the Holtwood 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>Hours of Operation - Tailrace:</i>	7.7	7.6	8.5	8.2	9.6	8.9	8.8	9.7	7.9	8.4
<i>Number of Lifts - Tailrace:</i>	10	9	8	11	15	13	13	16	9	9
<i>Hours of Operation - Spillway:</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Number of Lifts - Spillway:</i>	0	0	0	0	0	0	0	0	0	0
<i>Water Temperature (*F):</i>	56.2	56.0	57.2	59.7	62.6	65.9	67.8	69.2	70.6	71.3
American shad	0	0	0	8	114	73	137	155	49	46
Gizzard shad	564	259	201	1,052	5,595	11,746	21,281	7,558	2,683	7,107
Rainbow trout	0	0	0	0	0	1	1	1	0	1
Brown trout	0	0	0	0	0	1	0	1	0	0
Brook trout	0	0	0	0	0	0	0	0	0	0
Muskellunge	0	0	0	0	0	0	0	0	0	0
Carp	3	2	5	10	7	2	3	1	0	0
Quillback	0	0	0	0	5	4	0	5	1	5
Northern hogsucker	0	0	0	0	0	0	0	0	0	0
Shorthead redhorse	0	0	0	7	10	13	6	7	0	8
Channel catfish	10	0	7	5	2	2	7	2	3	18
Flathead catfish	0	0	0	0	0	0	0	0	0	0
White perch	0	0	0	0	0	0	0	0	0	0
Rock bass	0	0	0	1	0	2	1	0	0	0
Redbreast sunfish	0	0	0	0	1	0	0	0	0	0
Green sunfish	0	0	0	0	0	0	0	0	1	0
Pumpkinseed	0	0	0	0	0	0	0	0	0	0
Bluegill	0	0	1	0	0	1	1	0	1	3
Smallmouth bass	0	0	0	4	2	3	2	2	1	0
Largemouth bass	0	0	0	0	0	1	0	0	0	0
White crappie	0	0	0	0	0	0	0	0	0	0
Black crappie	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0
Walleye	18	18	48	55	154	156	158	171	46	173
Spotfin shiner	0	0	0	0	0	0	0	0	0	0
Total	595	279	262	1,142	5,890	12,005	21,597	7,903	2,785	7,361

Table 1: Summary of the daily number of fish passed by the Holtwood fish passage facility in 2008 (continued).

<i>Date:</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>TOTAL</i>
<i>Hours of Operation - Tailrace:</i>	11.4	10.0	7.6	9.1	8.4	9.3	8.7	7.7	5.3	383.4
<i>Number of Lifts - Tailrace:</i>	21	17	13	14	12	14	10	10	8	525
<i>Hours of Operation - Spillway:</i>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.8
<i>Number of Lifts - Spillway:</i>	0	0	0	0	0	0	0	0	0	41
<i>Water Temperature (*F):</i>	70.8	71.8	72.5	73.4	73.3	74.6	75.0	77.6	79.5	
American shad	462	451	137	79	76	114	35	8	3	2,795
Gizzard shad	24,179	10,577	5,648	3,774	4,303	5,119	2,345	548	184	235,699
Rainbow trout	0	4	1	0	1	2	1	0	0	23
Brown trout	1	0	0	0	1	0	0	0	0	6
Brook trout	0	0	0	0	0	0	0	0	0	1
Muskellunge	0	0	0	0	0	0	1	0	0	5
Carp	3	0	0	0	0	8	6	12	8	204
Quillback	1	3	5	5	2	19	14	4	0	333
Northern hogsucker	0	0	0	0	0	0	0	0	0	1
Shorthead redhorse	3	8	4	4	3	11	11	1	1	1,736
Channel catfish	16	14	7	15	35	11	7	36	32	468
Flathead catfish	0	0	0	0	0	0	0	0	0	1
White perch	0	0	0	0	0	2	2	0	0	4
Rock bass	1	0	0	0	0	0	0	0	0	59
Redbreast sunfish	1	0	0	0	0	0	0	0	0	3
Green sunfish	1	2	0	0	0	0	0	0	0	4
Pumpkinseed	1	0	0	0	0	0	0	0	0	2
Bluegill	5	3	0	0	0	3	4	5	1	38
Smallmouth bass	0	2	1	0	0	3	0	0	0	334
Largemouth bass	0	0	0	0	0	0	0	0	0	9
White crappie	0	0	0	0	0	0	0	0	0	5
Black crappie	0	0	0	0	0	0	0	0	0	4
Yellow perch	0	0	0	0	0	0	0	0	0	4
Walleye	537	575	293	359	307	361	119	40	28	7,042
Spotfin shiner	0	0	0	0	0	0	0	200	0	200
Total	25,211	11,639	6,096	4,236	4,728	5,653	2,545	854	257	248,980

Table 2: Summary of daily average river flow, water temperature, unit operation, fishway weir gate operation, and project water elevations during operation of the Holtwood fish passage facility in 2008.

Date	River Flow (cfs)	Ave. Water Temp. (°F)	Secchi (in)	Number of Units	Weir Gate Operation			Elevation (ft)		
					A	B*	C**	Tailrace	Spillway	Forebay
21 Apr	41,800	63.30	18	10	X		X	118	Spill	166
22 Apr	49,300	62.66	12	9	X		X	118	Spill	170
23 Apr	45,500	62.12	12	10	X		X	119	Spill	168
24 Apr	40,300	63.80	12	10	X		X	118	Spill	168
25 Apr	35,100	65.82	24	10	X		X	118	Spill	167
26 Apr	33,200	67.01	28	10	X		X	118	Spill	166
27 Apr	35,900	67.02	24	10	X		X	118	Spill	165
28 Apr	61,500	60.34	20	10	X		X	119	Spill	170
29 Apr	61,900	61.89	24	10	X		X	119	Spill	169
30 Apr	59,700	59.02	6	10	X		X	119	Spill	170
1 May	53,000	57.45	20	10	X		X	119	Spill	169
2 May	50,500	57.53	20	10	X			119	Spill	169
3 May	44,500	58.61	24	10	X			119	Spill	169
4 May	45,500	59.69	24	10	X			119	Spill	168
5 May	50,500	60.85	--	--				--	--	--
6 May	52,600	62.68	24	10	X			119	Spill	170
7 May	47,700	64.18	16	10	X			119	Spill	168
8 May	43,300	65.17	20	10	X			119	Spill	168
9 May	39,800	65.53	24	10	X			119	Spill	168
10 May	41,500	64.90	24	10	X	X		119	Spill	168
11 May	39,200	63.23	26	10	X	X		119	Spill	168
12 May	47,300	61.36	26	10	X			119	Spill	168
13 May	62,600	59.29	24	10	X		X	119	Spill	170
14 May	64,600	59.08	8-12	10	X			119	Spill	170
15 May	54,800	60.75	18	10	X			119	Spill	169
16 May	52,700	61.75	22	10	X			119	Spill	169

Table 2: Summary of daily average river flow, water temperature, unit operation, fishway weir gate operation, and project water elevations during operation of the Holtwood fish passage facility in 2008 (continued).

Date	River Flow (cfs)	Water Temp. (°F)	Secchi (in)	Number of Units	Weir Gate Operation			Elevation (ft)		
					A	B	C	Tailrace	Spillway	Forebay
17 May	55,100	61.71	22	10	X		X	118	Spill	169
18 May	59,300	61.09	18	10	X			118	Spill	170
19 May	63,900	59.72	20	10	X			118	Spill	170
20 May	66,400	58.42	20	10	X			119	Spill	170
21 May	66,100	56.64	20	10	X		X	119	Spill	170
22 May	62,800	56.64	20	10	X			119	Spill	170
23 May	56,900	56.72	22	10	X			119	Spill	170
24 May	49,300	58.17	24	10	X			119	Spill	169
25 May	43,400	60.44	30	10	X			119	Spill	169
26 May	38,900	62.96	30	10	X			119	Spill	168
27 May	36,300	65.75	30	10	X			119	Spill	168
28 May	35,500	67.87	28	10	X			119	Spill	167
29 May	29,700	69.43	30	10	X			118	Spill	166
30 May	27,600	70.82	36	2-10	X	X		114	116	164
31 May	28,100	71.11	36	0-10	X			114	116	164
1 Jun	24,200	71.11	30	10	X			116	116	168
2 Jun	22,500	72.28	32	7-10	X			116	Light spill	169
3 Jun	20,400	72.89	30	10	X			116	116	169
4 Jun	21,700	73.79	32	9-10	X			116	116	169
5 Jun	21,900	74.14	32	10	X			117	116	168
6 Jun	24,800	75.20	30	9-10	X			115	116	168
7 Jun	20,100	76.04	24	10	X			117	116	169
8 Jun	19,000	78.31	28	4-10	X			115	116	168
9 Jun	17,800	80.47	30	7-10	X			114	116	168

* Tailrace gate B used infrequently during 2008.

** Spillway entrance gate C damaged by flooding prior to 2005 season.

Table 3: Hourly summary of American shad passage at the Holtwood fish passage facility in 2008.

<i>Date:</i>	<i>21 Apr</i>	<i>22 Apr</i>	<i>23 Apr</i>	<i>24 Apr</i>	<i>25 Apr</i>	<i>26 Apr</i>	<i>27 Apr</i>
<i>Observation Time (Start):</i>	<i>11:15</i>	<i>10:05</i>	<i>9:25</i>	<i>8:45</i>	<i>8:20</i>	<i>8:45</i>	<i>8:00</i>
<i>Observation Time (End):</i>	<i>18:00</i>	<i>16:45</i>	<i>16:18</i>	<i>16:55</i>	<i>17:55</i>	<i>16:50</i>	<i>16:30</i>
Military Time (hrs)							
0700 to 0759	--	--	--	--	--	--	--
0800 to 0859	--	--	--	0	0	16	1
0900 to 0959	--	--	5	0	0	10	0
1000 to 1059	--	4	7	0	0	5	1
1100 to 1159	9	4	2	0	0	5	3
1200 to 1259	51	2	2	0	10	6	13
1300 to 1359	77	7	1	4	23	8	13
1400 to 1459	70	8	2	3	15	6	4
1500 to 1559	23	1	1	0	13	5	10
1600 to 1659	56	13	--	4	26	15	12
1700 to 1759	24	--	--	--	22	--	--
1800 to 1859	--	--	--	--	--	--	--
1900 to 1959	--	--	--	--	--	--	--
2000 to 2059	--	--	--	--	--	--	--
Total	310	39	20	11	109	76	57

<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>Observation Time (Start):</i>	<i>8:30</i>	<i>8:15</i>	<i>9:20</i>	<i>9:43</i>	<i>8:20</i>	<i>8:18</i>	<i>8:15</i>
<i>Observation Time (End):</i>	<i>15:55</i>	<i>16:00</i>	<i>15:50</i>	<i>15:40</i>	<i>15:50</i>	<i>16:45</i>	<i>16:05</i>
Military Time (hrs)							
0700 to 0759	--	--	--	--	--	--	--
0800 to 0859	2	1	--	--	0	0	2
0900 to 0959	1	0	1	0	0	0	3
1000 to 1059	0	0	2	0	1	0	0
1100 to 1159	0	0	1	0	0	0	0
1200 to 1259	1	2	3	0	0	0	0
1300 to 1359	1	1	0	0	0	0	1
1400 to 1459	0	0	0	0	0	0	7
1500 to 1559	0	0	0	0	0	1	4
1600 to 1659	--	--	--	--	--	0	0
1700 to 1759	--	--	--	--	--	--	--
1800 to 1859	--	--	--	--	--	--	--
1900 to 1959	--	--	--	--	--	--	--
2000 to 2059	--	--	--	--	--	--	--
Total	5	4	7	0	1	1	17

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

<i>Date:</i>	<i>6 May</i>	<i>7 May</i>	<i>8 May</i>	<i>9 May</i>	<i>10 May</i>	<i>11 May</i>	<i>12 May</i>
<i>Observation Time (Start):</i>	<i>10:15</i>	<i>8:16</i>	<i>8:20</i>	<i>8:10</i>	<i>8:00</i>	<i>8:00</i>	<i>8:15</i>
<i>Observation Time (End):</i>	<i>17:15</i>	<i>16:15</i>	<i>16:30</i>	<i>17:20</i>	<i>16:30</i>	<i>16:15</i>	<i>16:40</i>
Military Time (hrs)							
0700 to 0759	--	--	--	--	--	--	--
0800 to 0859	--	1	0	3	8	1	1
0900 to 0959	--	1	0	2	3	0	2
1000 to 1059	0	0	0	1	1	0	1
1100 to 1159	0	0	1	4	2	4	0
1200 to 1259	0	0	0	2	1	2	3
1300 to 1359	1	1	0	0	0	1	0
1400 to 1459	2	0	0	12	0	4	3
1500 to 1559	7	0	1	5	0	2	9
1600 to 1659	4	0	1	6	1	1	14
1700 to 1759	4	--	--	11	--	--	--
1800 to 1859	--	--	--	--	--	--	--
1900 to 1959	--	--	--	--	--	--	--
2000 to 2059	--	--	--	--	--	--	--
Total	18	3	3	46	16	15	33

<i>Date:</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>Observation Time (Start):</i>	<i>10:00</i>	<i>8:30</i>	<i>8:10</i>	<i>8:45</i>	<i>8:30</i>	<i>8:00</i>	<i>8:45</i>
<i>Observation Time (End):</i>	<i>16:25</i>	<i>16:00</i>	<i>16:56</i>	<i>15:50</i>	<i>16:15</i>	<i>16:00</i>	<i>16:20</i>
Military Time (hrs)							
0700 to 0759	--	--	--	--	--	--	--
0800 to 0859	--	0	0	0	0	1	0
0900 to 0959	--	0	0	0	0	2	0
1000 to 1059	1	2	0	0	3	1	1
1100 to 1159	0	0	0	0	0	1	0
1200 to 1259	0	0	0	0	1	0	0
1300 to 1359	0	0	4	0	4	1	0
1400 to 1459	0	1	3	1	2	1	1
1500 to 1559	1	0	9	2	1	0	0
1600 to 1659	0	--	9	--	0	--	0
1700 to 1759	--	--	--	--	--	--	--
1800 to 1859	--	--	--	--	--	--	--
1900 to 1959	--	--	--	--	--	--	--
2000 to 2059	--	--	--	--	--	--	--
Total	2	3	25	3	11	7	2

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

<i>Date:</i>	<i>20 May</i>	<i>21 May</i>	<i>22 May</i>	<i>23 May</i>	<i>24 May</i>	<i>25 May</i>	<i>26 May</i>
Observation Time (Start):	8:10	10:45	8:15	8:20	8:45	7:50	8:10
Observation Time (End):	16:10	17:15	16:10	16:00	16:40	16:10	18:00
Military Time (hrs)							
0700 to 0759	--	--	--	--	--	0	0
0800 to 0859	1	--	0	0	0	1	2
0900 to 0959	0	--	0	0	0	0	1
1000 to 1059	0	0	0	0	0	1	4
1100 to 1159	0	0	0	0	0	2	4
1200 to 1259	0	2	0	0	0	0	7
1300 to 1359	0	1	0	0	0	1	23
1400 to 1459	0	0	0	0	0	0	21
1500 to 1559	0	0	0	0	0	2	7
1600 to 1659	0	0	0	--	0	1	25
1700 to 1759	--	0	--	--	--	--	20
1800 to 1859	--	--	--	--	--	--	--
1900 to 1959	--	--	--	--	--	--	--
2000 to 2059	--	--	--	--	--	--	--
Total	1	3	0	0	0	8	114

<i>Date:</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>
Observation Time (Start):	7:50	8:15	8:05	8:00	8:45	8:00	8:45
Observation Time (End):	16:55	17:20	17:55	16:00	16:15	19:15	19:00
Military Time (hrs)							
0700 to 0759	0	--	--	--	--	--	--
0800 to 0859	7	13	1	0	0	25	2
0900 to 0959	16	10	5	1	10	30	53
1000 to 1059	9	3	16	1	14	24	78
1100 to 1159	2	5	18	7	0	26	39
1200 to 1259	2	11	36	4	6	21	26
1300 to 1359	4	34	31	14	5	55	78
1400 to 1459	11	25	15	2	5	62	64
1500 to 1559	10	28	14	20	6	32	52
1600 to 1659	12	7	8	--	0	61	23
1700 to 1759	--	1	11	--	--	71	25
1800 to 1859	--	--	--	--	--	45	11
1900 to 1959	--	--	--	--	--	10	--
2000 to 2059	--	--	--	--	--	--	--
Total	73	137	155	49	46	462	451

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

<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>Observation Time (Start):</i>	9:25	8:25	8:12	7:55	8:15	8:00	8:15	
<i>Observation Time (End):</i>	17:20	17:35	16:40	17:20	16:45	15:50	14:00	<i>Total</i>
Military Time (hrs)								
0700 to 0759	--	--	--	3	--	--	--	3
0800 to 0859	--	7	22	9	3	1	0	131
0900 to 0959	12	11	2	8	5	1	0	195
1000 to 1059	24	19	8	21	10	1	0	264
1100 to 1159	27	10	11	15	2	0	0	204
1200 to 1259	11	1	9	5	6	0	2	248
1300 to 1359	18	15	5	10	6	0	1	449
1400 to 1459	30	4	9	10	3	5	--	411
1500 to 1559	4	3	5	14	0	0	--	292
1600 to 1659	5	8	5	16	0	--	--	333
1700 to 1759	6	1	--	3	--	--	--	199
1800 to 1859	--	--	--	--	--	--	--	56
1900 to 1959	--	--	--	--	--	--	--	10
2000 to 2059	--	--	--	--	--	--	--	0
Total	137	79	76	114	35	8	3	2,795

Table 4: Visually derived estimate of the American shad catch in the tailrace and spillway lifts at the Holtwood Power Station in 2008.

Date	Shad Catch	Number Collected		Percent Collected	
		Tailrace	Spillway*	Tailrace	Spillway
21-Apr	310	309	1	100%	0%
22-Apr	39	39	0	100%	0%
23-Apr	20	20	0	100%	0%
24-Apr	11	11	0	100%	0%
25-Apr	109	108	1	99%	1%
26-Apr	76	76	0	100%	0%
27-Apr	57	56	1	98%	2%
28-Apr	5	5	0	100%	0%
29-Apr	4	4	0	100%	0%
30-Apr	7	7	0	100%	0%
1-May	0	0	0	0%	0%
2-May	1	1	--	100%	--
3-May	1	1	--	100%	--
4-May	17	17	--	100%	--
5-May	--	--	--	--	--
6-May	18	18	--	100%	--
7-May	3	3	--	100%	--
8-May	3	3	--	100%	--
9-May	46	46	--	100%	--
10-May	16	16	--	100%	--
11-May	15	15	--	100%	--
12-May	33	33	--	100%	--
13-May	2	2	--	100%	--
14-May	3	3	--	100%	--
15-May	25	25	--	100%	--
16-May	3	3	--	100%	--
17-May	11	11	0	100%	0%
18-May	7	7	--	100%	--
19-May	2	2	--	100%	--
20-May	1	1	--	100%	--
21-May	3	3	0	100%	0%
22-May	0	0	--	0%	--
23-May	0	0	--	0%	--
24-May	0	0	--	0%	--
25-May	8	8	--	100%	--
26-May	114	114	--	100%	--
27-May	73	73	--	100%	--
28-May	137	137	--	100%	--
29-May	155	155	--	100%	--
30-May	49	49	--	100%	--
31-May	46	46	--	100%	--

Table 4: Visually derived estimate of the American shad catch in the tailrace and spillway lifts at the Holtwood Power Station in 2008 (continued).

Date	Shad	Number Collected		Percent Collected	
	Catch	Tailrace	Spillway*	Tailrace	Spillway
1-Jun	462	462	--	100%	--
2-Jun	451	451	--	100%	--
3-Jun	137	137	--	100%	--
4-Jun	79	79	--	100%	--
5-Jun	76	76	--	100%	--
6-Jun	114	114	--	100%	--
7-Jun	35	35	--	100%	--
8-Jun	8	8	--	100%	--
9-Jun	3	3	--	100%	--
Total	2,795	2,792	3	100%	0%

* Spillway entrance gate severely damaged by Hurricane Ivan flooding in September, 2004.
 Operation of Spillway lift during 2008 occurred without the use of a functional entrance gate.

Table 5: Holtwood fishway summary table evaluating American shad passage at three river flow ranges.

	1997	1998*	1999	2000*	2001	2002*	2003*	2004*	2005	2006	2007	2008*
Migration season start date	18 Apr	27 Apr	25 Apr	06 May	27 Apr	15 Apr	28 Apr	26 Apr	27 Apr	11 Apr	01 May	21 Apr
Migration season end date	14 Jun	12 Jun	03 Jun	14 Jun	08 Jun	07 Jun	02 Jun	03 Jun	10 Jun	06 Jun	04 Jun	09 Jun
Season duration (days)	58	47	40	40	43	55	36	39	45	57	35	50
Number of days of operation	55	41	40	36	42	35	34	39	36	57	35	49
American shad season total (Conowingo)	90,971	39,904	69,712	153,546	193,574	108,001	125,135	109,360	68,926	56,899	25,464	19,914
American shad season total (Holtwood)	28,063	8,235	34,702	29,421	109,976	17,522	25,254	3,428	34,189	35,968	10,338	2,795
River flow ≤40,000 cfs												
Number of days	48	22	34	19	40	19	15	2	33	48	27	20
Percent of season	87%	54%	85%	53%	95%	54%	44%	5%	92%	84%	77%	40%
Number of American shad passed	26,201	7,512	34,069	19,712	109,342	10,322	20,229	2	34,060	35,302	9,549	2,242
Daily average of American shad passed	546	341	1,002	1,037	2,733	543	1,348	1	1,032	735	354	112
Percent of total passage	93%	91%	98%	67%	99%	59%	80%	0%	99.6%	98.1%	92.3%	80.2%
River flow 40,001 to 60,000 cfs												
Number of days	7	2	6	12	2	14	18	20	3	5	8	22
Percent of season	13%	5%	15%	33%	5%	40%	53%	51.3%	8%	9%	23%	44%
Number of American shad passed	1,862	230	633	9,536	634	7,029	5,019	1,943	129	566	789	533
Daily average of American shad passed	266	115	106	795	317	502	279	97	43	113	99	24
Percent of Total Passage	7%	3%	2%	32%	1%	40%	19.8%	56.7%	0.4%	1.6%	7.6%	19.0%
River flow >60,000 cfs												
Number of days	0	17	0	5	0	2	1	17	0	4	0	8
Percent of season	0%	41%	0%	14%	0%	6%	3%	43.6%	0%	7%	0%	16%
Number of American shad passed	0	493	0	173	0	171	6	1,483	0	100	0	20
Daily average of American shad passed	0	29	0	35	0	86	6	87	0	25	0	2
Percent of total passage	0%	6%	0%	1%	0%	1%	0.02%	43.3%	0.0%	0.3%	0.0%	0.7%

* Denotes seasons of high river flow.

Table 6: Summary of American shad passage counts and percent passage values at Susquehanna River dams, 1997-2008.

	Conowingo East	Holtwood		Safe Harbor		York Haven	
		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	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%

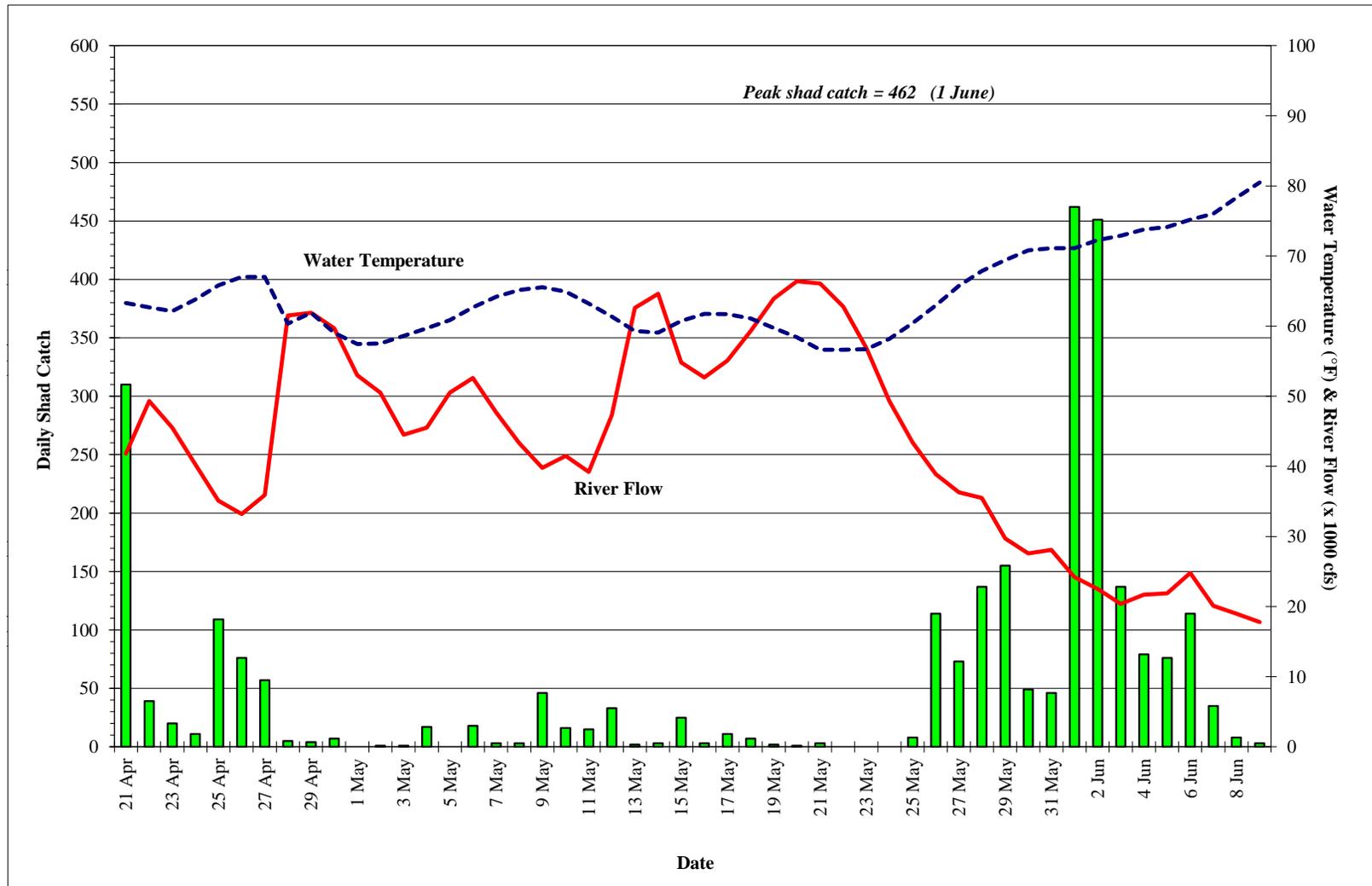


Figure 1

A plot of river flow (x 1000) and water temperature (°F) in relation to the daily American shad catch at the Holtwood Fish Passage Facility, spring 2008.

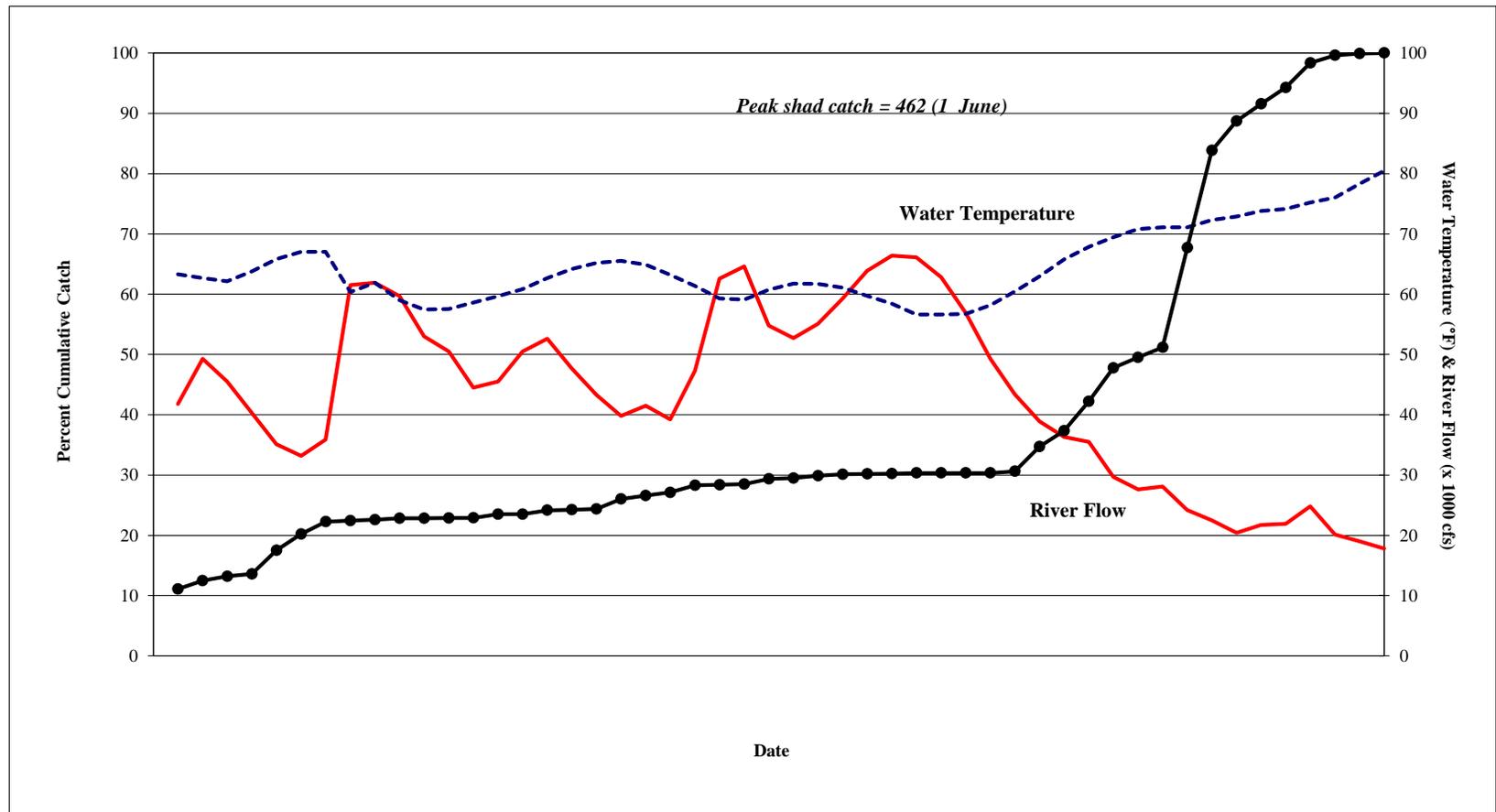


Figure 2

A plot of river flow (x 1000 cfs) and water temperature (°F) in relation to the percent cumulative American shad catch at the Holtwood Fish Passage Facility, spring 2008.