SUMMARY OF OPERATIONS AT THE HOLTWOOD FISH PASSAGE FACILITY SPRING AND FALL, 2014

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Normandeau Associates' Project Number 23240.001

December 2014

EXECUTIVE SUMMARY

Per the settlement agreement for the Holtwood Redevelopment Project, 2014 marks the initial year of fish passage operations for both resident and migratory fish species. The Holtwood fish passage facility is to commence resident fish passage operations on April 1 for six hours per day (river flow permitting), switching to ten hour days of operation when American shad are observed in the catch, then back to the six hour operating schedule for resident fish passage after the official end of the American shad season (per concurrence with Resource Agencies) until June 30. The fall season component of resident fish passage is to occur from September 1 through October 15 (5 days per week if river flow allows). Part of the settlement agreement also calls for Holtwood to suspend fish passage operations when river flows are ≥ 100,000 cfs during any fish passage season.

We were unable to start spring fish passage operations on April 1 as river flow ranged between 103,000 and 172,000 cfs from April 1 through April 11. Operations at the Holtwood fish passage facility began on April 9, 2014 although river flow was 103,000 cfs as measured at the USGS Marietta gauge. The facility was operated daily, (except for April 11, 17, 18; May 17 through 21, and May 24 due to high flows) for 74 days (Tailrace lift = 74 days; Spillway lift = 70 days). The American shad passage season began on April 27 when the first three shad were passed, and ended, with agency concurrence, on June 8, 2014. The fish lift facility continued to operate in resident fish passage mode until June 30, 2014. Fall fish passage operation occurred from September 2 through October 15 without interruption due to high river flow. This fish passage season marks the eighteenth year of operation at Holtwood.

During the American shad passage season (37 days of operation between April 27 to June 8), the lifts passed 312,106 fish of 30 taxa and 2 hybrids. Gizzard shad, comely shiner, American shad, shorthead redhorse, walleye, and quillback dominated the catch, and comprised 99.3% of the total fish collected and passed. American shad and alewife (residualized) represented the two *Alosa* species collected and passed at Holtwood in 2014.

A total of 2,625 American shad were passed by the Holtwood fishway in 2014 (2,589 during the "official" shad passage season and 36 during resident fish passage operations in June). Some 1,641 American shad (63% of total shad catch) were passed in the spillway lift while the tailrace lift accounted for 984 American shad (37% of total shad catch). Collection and passage of shad varied daily with nearly 91% of total shad (2,386) passed prior to May 17. The highest daily American shad catch occurred on May 14 when 604 shad moved upstream during 10.9 hours of operation. On a daily basis, overall shad passage was consistent through the fishway between 0900 hrs and 1659 hrs.

Fishway operations in spring, 2014 (April 9 through June 30) were conducted at water temperatures ranging from 46.0°F to 81.1°F and river flows between 22,800 and 106,000 cfs. Spillage occurred on 43 of the 74 days of operation, (58% of the season) and on 21 of the 37-day long American shad passage season (56.7% of the shad season). River water temperatures were < 60°F until May 10 and river flows did not stabilize and remain below 40,000 cfs until June 1. American shad of advanced or post-spawned condition were observed during fish passage operations from late-May to the end of the shad season.

For most of the spring season, water clarity was variable, with visibility at the viewing window ranging from 5 to 30 inches. The viewing technicians identified 3 American shad with attached Maryland DNR floy tags in 2014. All 3 floy tags were yellow, from this year's tagging efforts downstream of Conowingo Dam, and all were observed on the same day (May 14).

The 2014 American shad passage rate at Holtwood (24.8% of American shad passing Conowingo passed Holtwood) was below the historical average of 29.6% (1997-2013). However, passage of American shad by the spillway lift in 2012, 2013, and 2014 has been higher than previous years,

possibly due to modifications completed in the Piney Channel as part of redevelopment activities, redirecting the Unit 1 turbine discharge to the Piney Channel and improvements to Entrance Gate "C". This year was also the first time since fish passage operations commenced at Holtwood (1997) that the spillway lift collected and passed a higher percentage of American shad than the tailrace lift.

A low, stable, river flow appears to be critical for enhancing American shad passage rates. We documented 87% of American shad passed Holtwood at river flows less than 40,000 cfs, with 12% passing at river flows greater than 40,000 cfs but less than 60,000 cfs.

During spring, 2014, resident fish passage operations occurred from April 9 to April 26 and from June 9 to June 30 (37 days). The facility operated 6 hours per day from 0900 to 1500 hrs per the settlement agreement. A total of 54,548 fish of 15 taxa plus one hybrid was collected and passed during resident fish passage operations this spring. Resident passage in April accounted for 10,932 fish of 8 species plus one hybrid while resident fish passage in June accounted for 43,616 fish of 14 taxa plus one hybrid. Gizzard shad comprised 99% of the catch in April with gizzard shad and comely shiner comprising 98% of the catch in June. The majority of channel catfish (99%) and walleye (81%) passed during resident fish passage operations occurred in June. We compared the passage of 7 resident species (gizzard shad, channel catfish, smallmouth bass, walleye, shorthead redhorse, quillback, and carp) passed during resident passage periods to passage of those same species during the migratory passage season. Except for channel catfish, 90% or more of the total resident fish observed this spring were passed during the migratory fish passage season.

Fall resident fish passage operations occurred on 34 days from September 2 through October 15. The facility was operated 5 days per week (including one week-end day) from 0900 hrs to 1500 hrs per the settlement agreement. A total of 1,597,162 fish of 16 taxa plus one hybrid were estimated as passing through the facility. Gizzard shad and various species of minnows comprised 99.9% of the total fish passed. Please note that the gizzard shad and minnow counts were estimated due to their small size and large quantities that quickly passed by the viewing window. Approximately 99% of the gizzard shad observed were young-of-the-year (YOY) fish and were 2 to 4 inches in length. A total of 550 channel catfish and 232 walleye passed upstream during fall resident fish passage operations.

This year was the eighteenth year of fish passage operations at the Holtwood fish passage facility. Future operation of the fishway will build on these past years of operation as we continue to refine operations due to modifications made to the fishway and the overall area as part of the redevelopment of the Holtwood Hydroelectric Project.

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1.0 INTRODUCTION

On June 1, 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 (PPL Holtwood LLC) 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 April 1, 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 has been successfully operated each spring since 1997, as well as in fall, 2014. This year marked the eighteenth operational season.

Objectives of 2014 upstream fishway operation were to (1) monitor and maximize passage of migratory fishes through the fishway; (2) minimize interruptions to fish passage operations due to equipment breakdowns or malfunctions and (3) initiate resident fish passage operations in spring and fall per the redevelopment settlement agreement.

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 now consists of a concrete gravity overflow dam 2,392 ft long by 55 ft high, the legacy powerhouse with ten turbine units having a combined generating capacity of 107 MW, the new powerhouse containing 2 large Kaplan turbines (100 MW capacity) and a reservoir (Lake Aldred) of 2,400 acres surface area. Each legacy unit is capable of passing approximately 3,000 cfs with each Kaplan turbine passing approximately 15,000 cfs. Spills occur at the project when river flow or project inflow exceeds the station hydraulic capacity of approximately 62,000 cfs.

Hydraulic conditions in the Holtwood spillway are controlled by numerous factors that change hourly, daily and throughout the fishway operating season. The primary factors are natural river flows, operation of the power station, installation and integrity of the flash boards along with two Obermeyer gates, and operation of the Safe Harbor Hydroelectric Project.

In 2014, all rubber dams were inoperable (not inflated) due to irreparable damage that occurred in previous years prior to current redevelopment activities. Two Obermeyer gates have been installed; one closest to the fishway exit, with the other adjacent to the west shoreline to provide water to the new recreational kayaking facility. Wooden flashboards have been installed in place of the old rubber dam sections. Operations began at the Holtwood Fish Lift facility on April 9, to initiate passage of resident fish species prior to passage of American shad at Conowingo Dam. Since river flows were greater than station capacity on several occasions, spill occurred on 43 of 74 days during spring fish passage operations for resident and migratory fish species, (Table 1). In 2014, passage operations for migratory fish (American shad, etc.) ended on June 8, with agency concurrence, due to increasing water temperatures, and low American shad passage. Spring passage operations for resident fish species continued through June 30, and operations for fall resident fish passage occurred from September 2 through October 15, 2014.

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 one trough through which the fish swim into Lake Aldred. Attraction flows, throughout the entire facility, 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 eight 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, had been an integral component of effective spillway lift operation. Prior to fish lift operations in 2013, the rubber dam closest to the fishway exit was replaced with an Obermeyer gate, with flashboards installed upstream of the other three damaged rubber dams to maintain forebay water levels.

Design guidelines for fishway operation include seven entrance combinations. These are: (1) entrances A, B, and C; (2) entrances A and B; (3) entrances A and C; (4) Entrances B and C; (5) Entrance A only; (6) Entrance B only; and (7) Entrance C only. 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 2014, after installation of an additional attraction water supply pipe and valve (MOV 8), a new operating matrix has been developed, but testing and fine-tuning of the new matrix is ongoing. The following gate combinations were utilized in spring, 2014: Entrances A, B, and C (26 days); Entrances A and C (37 days); Entrances A and B (3 days); Entrance A only (3 days); and Entrance C only (5 days). The spillway lift, (Entrance gate C), is used less frequently when spillage occurs or flashboard sections are damaged/missing because spillage may mask or interfere with the attraction flow from spillway entrance gate C.

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. Per the Holtwood redevelopment settlement agreement, the fish passage facility is to be operated daily each year in spring from April 1to June 30 for passage of both resident and migratory fish species and again in fall (5 days per week; 6 hours per day) from September 1 through October 15 for passage of resident fish species. Fish passage operations will be suspended when and if river flows are $\geq$ 100,000 cfs and will resume when flows fall below 100,000 cfs.

Holtwood fish passage operations in spring, 2014 commenced on April 9 although river flows were above 100,000 cfs (103,000 cfs per USGS Marietta gauge) and ended on June 30 (total days of

operation = 74). The migratory fish passage season (based on presence of American shad in the catch) ran from April 27 to June 8 (37 days of operation). For the entire spring fish passage season, the tailrace lift operated on all 74 days while the spillway lift operated on 70 days. Resident fish passage operational hours were 0900 to 1500 hrs in spring and fall, and we operated from 0800 to 1800 hrs during the migratory fish passage season per the redevelopment settlement agreement.

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, a supervising biologist, and biological technician manned the facility 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/estimated 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 flash drive and stored on-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 MIGRATORY FISH PASSAGE RESULTS

3.1 Relative Abundance

The diversity and abundance of fishes collected and passed daily in the Holtwood fishway during the spring 2014 migratory fish passage period is presented in Table 2. A total of 312,106 fish of 30 taxa plus two hybrids passed upstream into Lake Aldred. Gizzard shad (293,935), comely shiner (8,940), American shad (2,589), shorthead redhorse (1,799), walleye (1,517), and quillback (1,227) comprised 94% of all fishes passed. Other abundant fishes passed included carp (799), channel catfish (695), and smallmouth bass (489). The peak one-day passage of all species occurred on May 13, when 22,576 fish were passed, comprised mostly of gizzard shad (21,651), American shad (477), quillback (127), walleye (119), and shorthead redhorse (105).

3.2 American Shad Passage

A total of 2,589 American shad were passed at Holtwood during the 2014 official migratory fish passage season (April 27 to June 8); 962 American shad passed in the tailrace lift while the spillway lift accounted for 1,627 American shad (Table 3). An additional 36 American shad were passed after the official end of the migratory fish passage season. Collection and passage of shad varied daily with nearly 91% of total shad (2,386) passed prior to May 17. The highest daily American shad catch occurred on May 14 when 604 shad moved upstream during 10.9 hours of operation. On a daily basis, overall shad passage was consistent through the fishway between 0900 hrs and 1659 hrs, (Table 4). Migratory fish passage operations were conducted at water temperatures ranging from 53.4°F to 74.1°F and river flows between 23,700 and 106,000 cfs. Spillage occurred on 21 of the 37 days of operation, (56.7% of the season). River water temperatures were < 60°F until May 10 and river flows did not stabilize and remain below 40,000 cfs until June 1.

The capture of American shad at the fishway occurred over a relatively wide range of station operation and discharge conditions (Table 1). Shad were attracted to the tailrace lift at tailrace water elevations ranging from 110 ft to 118 ft. Tailrace elevations correspond to unit operation, which varied from 2 to 11 units. During spring 2014, tailrace fishway operation generally coincided with 6 to 11 turbines operating. Spillway lift operation now occurs with Unit #1 discharging into the spillway and with the activation of the additional attraction water supply pipe on May 5, simultaneous operation of both the spillway and tailrace fish lifts should occur frequently compared to previous years.

Passage of American shad into Lake Aldred occurred at Holtwood forebay elevations ranging from 164 ft to 171 ft (Table 1). Forebay elevations during migratory fish passage operations ranged from 164 ft to 169 ft for approximately 86% of the 2014 season. Spillage occurred often in 2014, due to high flow events and damaged flashboards. Spillage occurs, with all flashboards intact, at forebay elevations greater than 169.75 ft.

The hourly passage numbers of American shad at Holtwood are provided in Table 4. American shad passage was consistent throughout the day; a total of 1,080 American shad passed through the fishway between 0800 hrs and 1159 hrs, while 1,062 shad passed from 1300 to 1659 hrs. The two highest hours of shad passage occurred from 0900 to 1059 hrs.

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. 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, 1,641 and 984 shad were captured in the spillway and tailrace lifts over the total operating period in 2014, respectively (Table 3). The percentage of American shad passed by the spillway lift in 2012, 2013, and 2014 was higher than previous years dating back to 2003, possibly due to modifications made to the Piney Channel during redevelopment activities. This year was also the first time since fish passage operations commenced at Holtwood in spring, 1997 that the spillway lift collected and passed a higher percentage of American shad than the tailrace lift.

3.3 Other Alosids

A small number of residualized alewife (2) was passed at Holtwood this season. No other herring or hickory shad were observed.

3.4 Maryland DNR tag-recapture

For most of the spring season, water clarity was variable, with visibility at the viewing window ranging from 5 to 30 inches. The viewing technicians identified 3 American shad with attached Maryland DNR floy tags in 2014. All 3 floy tags were yellow, from this year's tagging efforts downstream of Conowingo Dam, and all were observed on the same day (May 14).

3.5 American Shad Passage Evaluation

In spring 2014, 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. A low, stable, river flow appears to be critical for enhancing American shad passage rates. We documented 87% of American shad passed at river flows less than 40,000 cfs, with 12% passing at river flows greater than 40,000 cfs but less than 60,000 cfs. During migratory fish passage operations in 2014, river flows ranged from 23,700 cfs to 106,000 cfs. The 2014 American shad passage rate at Holtwood (24.8% of American shad passed at Conowingo were passed by Holtwood), was below the historical average of 29.6% observed at Holtwood from 1997 to 2013 (Table 6).

We seek to optimize future migratory fish passage operations by utilizing knowledge gained through these eighteen 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.

4.0 RESIDENT FISH PASSAGE

4.1 Spring

During spring, 2014, resident fish passage operations occurred from April 9 to April 26 and from June 9 to June 30 (37 days). The facility operated 6 hours per day from 0900 to 1500 hrs per the settlement agreement. A total of 54,548 fish of 15 taxa plus one hybrid was collected and passed during resident fish passage operations this spring. Resident fish passage in April accounted for 10,932 fish of 8 species plus one hybrid while resident fish passage in June accounted for 43,616 fish of 14 taxa plus one hybrid. Gizzard shad comprised 99% of the catch in April with gizzard shad and comely shiner comprising 98% of the catch in June. The majority of channel catfish (99%) and walleye (81%) passed during resident fish passage operations occurred in June. We compared the passage of 7 resident species (gizzard shad, channel catfish, smallmouth bass, walleye, shorthead redhorse, quillback, and carp) passed during resident passage periods to passage of those same species during the migratory passage season, (Tables 7,8). Except for channel catfish, 90% or more of the total resident fish observed this spring were passed during the migratory fish passage season.

4.2 Fall

Fall resident fish passage operations occurred on 34 days from September 2 through October 15, (Tables 9, 10). The facility was operated 5 days per week (including one week-end day) from 0900 hrs to 1500 hrs per the settlement agreement. During fall operations, the river flow was low, and due to dredging operations in the tailrace, turbine operation was limited. A total of 1,597,162 fish of 16 taxa plus one hybrid were estimated as passing through the facility. Gizzard shad and various species of minnows comprised 99.9% of the total fish passed. Please note that the gizzard shad and minnow counts were estimated due to their small size and large quantities that quickly passed by the viewing

window. Approximately 99% of the gizzard shad observed were young-of-the-year (YOY) fish and were 2 to 4 inches in length. A total of 550 channel catfish and 232 walleye passed during fall resident fish passage operations.

5.0 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 and additional operating requirements) 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, inspections of picket screens, and daily checks of crowder and hopper doors. Routine maintenance activities minimize disruption of fishway operation.

4) Implement protocols/guidelines to spill trash through gates 7 and 9 or the Obermeyer gate adjacent to the fish trough exit. This should be done on an as needed basis prior to or after daily scheduled fishway operations.

6.0 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 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 spring, 2014.

	River Flow	Ave.Water	Secchi	Number	Weir Gate Operation			Elevation (ft)		
Date	(cfs)	Temp. (°F)	(in)	of Units	A	B	C*	Tailrace	Spillway	Forebay
9 Apr	103000	46.0	6	12	X	X	X	120	Spill	170
10 Apr	105000	47.0	6	12	X	X		120.5	Spill	170
11 Apr	103000								Spill	
12 Apr	90500	49.0	6-10				X		Spill	170
13 Apr	82000	49.4	6-10				X		Spill	169.7
14 Apr	78400	51.9	10-12				X		Spill	169.4
15 Apr	75800	55.5	12-16	12	X		X	117	Spill	169
16 Apr	91500	55.3	12-16	12	X		X	118.5	Spill	170
17 Apr	115000								Spill	
18 Apr	114000								Spill	
19 Apr	100000	51.2	12-16	12	X	X		119	Spill	171
20 Apr	84300	51.4	6	12	X		X	118.5	Spill	170.8
21 Apr	71400	51.9	6	12	X		X	118	Spill	170
22 Apr	61600	53.1	6	12	X	X	X	116.5	Spill	170
23 Apr	54900	54.5	15	12	X		X	116	Spill	166
24 Apr	49400	54.0	15	6	X		X	113	Spill	165.3
25 Apr	46100	53.5	18	12	X		X	118.5	Spill	165.4
26 Apr	43100	53.9	18	4	X		X	108.5	Spill	166
27 Apr	40200	55.5	24	10	X		X	113.5	Spill	165.7
28 Apr	37700	56.4	24				X		119.5	164
29 Apr	35500	57.6	30	7	X		X	110	118.5	165,5
30 Apr	47600	56.5	30				X		119.5	164.5
1 May	76,100	53.4	24	12	X		X	113	Spill	168
2 May	70,800	53.4	6	2	X		X	109.5	Spill	168.5
3 May	67,700	56.2	6	12	X		X	113	Spill	168.5
4 May	67,900	56.5	10-12	12	X		X	118	Spill	166

Continued.

	River Flow	Water	Secchi	Number	Weir Gate Operation			Elevation (ft)		
Date	**(cfs)**	**Temp. (°F)**	**(in)**	**of Units**	**A**	**B**	**C***	**Tailrace**	**Spillway**	**Forebay**
5 May	63,100	55.3	22	12	X		X	118	119	165
6 May	57,000	55.2	22	12	X		X	117.5	120	165
7 May	52,200	57.3	24	12	X	X	X	116.5	Spill	166
8 May	47,200	58.2	24	12	X	X	X	116.5	Spill	165
9 May	42,700	59.5	24	10	X	X	X	115	119.1	164
10 May	39,300	61.0	28	9	X		X	113.5	119.4	164
11 May	37,800	63.3	28	12	X	X	X	113	119	167
12 May	34,800	65.3	28	12	X	X	X	114.5	119.5	166.5
13 May	34,400	66.5	30	10	X		X	115.5	119	166
14 May	34,400	68.4	30	10	X		X	112.5	119	166
15 May	32,500	68.3	30	11	X	X	X	112	Spill	168.5
16 May	47,600	68.5	28	11	X		X	116	Spill	170
17 May	158,000								Spill	
18 May	193,000								Spill	
19 May	177,000								Spill	
20 May	138,000								Spill	
21 May	112,000								Spill	
22 May	95,800	59.3	6	10	X		X	118	Spill	171
23 May	106,000	60.9	5	12	X			119	Spill	172
24 May	103,000								Spill	
25 May	85,000	62.0	6-8	11	X			117	Spill	171
26 May	70,300	63.7	10	12	X			116.5	Spill	171
27 May	58,900	65.5	18-22	12	X	X	X	117	Spill	168.5
28 May	53,200	67.6	18-23	10	X	X	X	116	Spill	169
29 May	47,600	68.8	18-24	11	X	X	X	115.5	Spill	168.5
30 May	44,000	67.3	24-18	10	X	X	X	116.5	Spill	168.5
31 May	41,400	66.7	24	5	X		X	112.5	Spill	168.5
1 Jun	36,400	67.1	18-20	6	X		X	112.5	Spill	168.5
2 Jun	31,900	69.0	20	7	X		X	111.5	Spill	168.5
3 Jun	28,800	70.5	24	12	X		X	112	Spill	168.6
4 Jun	26,800	72.1	24	11	X		X	114.8	119.5	164.2
5 Jun	25,100	73.9	24	10	X	X	X	113	120.3	168.5
6 Jun	26,200	73.9	24	9	X		X	113.5	119.5	169
7 Jun	25,700	74.1	18	6	X		X	110.5	119.5	168.5
8 Jun	23,700	72.6	18	6	X		X	111	119.5	169
9 Jun	22,800	75.1	18-20	6	X		X	111.5	119	169
10 Jun	24,500	75.0	20	6	X		X	110.5	118.5	168.6
11 Jun	25,200	76.0	20	9	X		X	111	119.8	168.2

Table 1

Continued.

	River Flow	Water	Secchi	Number	Weir Gate Operation			Elevation (ft)		
Date	(cfs)	Temp. (°F)	(in)	of Units	A	B	C*	Tailrace	Spillway	Forebay
12 Jun	30,300	76.0	18	12	X		X	114.5	119.5	168.9
13 Jun	37,700	75.3	18	7	X		X	115	118.5	169
14 Jun	58,700	73.1	10-12	12	X		X	115.5	Spill	170.5
15 Jun	56,800	71.8	8	12	X	X		116	Spill	171
16 Jun	44,500	71.1	8	12	X	X	X	115	119.5	169
17 Jun	39,200	72.5	8	12	X		X	115.5	Spill	169.5
18 Jun	41,000	74.1	8	11	X		X	116.8	Spill	169
19 Jun	35,200	78.0	6-8	8	X	X	X	113.5	119.6	169
20 Jun	31,400	78.2	16-18	12	X	X	X	112.7	120	168.8
21 Jun	28,900	78.2	18	12	X	X	X	114	119	169
22 Jun	30,500	76.8	14	9	X	X	X	114.2	119.6	168.5
23 Jun	31,300	76.8	14	8	X	X	X	113	118.3	169
24 Jun	27,800	75.7	16	9	X	X	X	111.6	119	169.2
25 Jun	24,200	77.1	14	10	X	X	X	111	119.5	168
26 Jun	24,900	78.1	14	8	X	X	X	112.5	120	169
27 Jun	28,400	78.9	14	4	X	X	X	111.3	118.8	169.6
28 Jun	27,400	79.4	18	10	X	X	X	115	Spill	169.3
29 Jun	35,900	80.8	16	8	X	X	X	114.6	Spill	169.3
30 Jun	32,600	81.1	18	12	X	X	X	107	Spill	171

*C Gate set at Elevation 115' for entire season

Table 2

Summary of daily fish passage at Holtwood during the American shad passage season (April 27 to June 8) in spring, 2014.

Date	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6
Hours of Operation- Tailrace:	5.3	0.0	3.2	0.0	5.3	3.4	5.6	3.6	6.1	9.8
Number of Lifts - Tailrace	7	0	4	0	8	5	9	5	10	13
Hours of Operation - Spillway:	5.4	7.8	6.3	3.9	3.6	3.4	5.7	8.9	4.5	10.0
Number of Lifts -Spillway:	9	13	12	6	4	4	5	18	9	14
Water Temperature (F)	55.5	56.4	57.6	56.5	53.4	53.4	56.2	56.5	55.3	55.2
AMERICAN SHAD	3	7	65	0	1	0	6	18	2	25
ALEWIFE (residualized)	0	0	0	0	0	0	0	0	0	0
GIZZARD SHAD	2,478	2,191	1,685	17	2,917	174	1,950	8,258	4,827	4,304
STRIPED BASS	1	0	0	0	0	0	0	0	0	0
SEA LAMPREY	0	0	0	0	0	0	0	0	0	0
RAINBOW TROUT	0	0	0	0	0	0	0	0	0	0
BROWN TROUT	0	0	0	0	0	0	0	0	0	0
MUSKELLUNGE	0	0	0	0	0	0	1	1	0	1
TIGER MUSKIE	0	0	0	0	0	0	0	0	0	0
CARP	0	0	0	0	0	0	2	2	2	0
QUILLBACK	0	0	0	0	0	0	0	0	0	0
S. REDHORSE	19	57	17	0	8	0	29	23	1	0
CHANNEL CATFISH	0	0	0	0	0	1	1	1	0	0
WHITE PERCH	0	0	0	0	0	0	0	0	0	0
HYBRID STRIPED BASS	0	0	0	0	0	0	0	0	0	0
ROCK BASS	0	0	0	0	0	0	0	0	0	0
REDBREAST 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	0	0	0	0
SMALLMOUTH BASS	9	46	27	2	3	0	8	15	9	25
LARGEMOUTH BASS	0	0	1	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	1	1	3	2	2	1	12	4	1	2
AMERICAN EEL	0	0	0	0	0	0	0	0	0	0
COMELY SHINER	0	0	0	0	0	0	0	0	0	0
NORTHERN HOGSUCKER	0	0	0	0	0	0	0	0	0	0
GREENSIDE DARTER	0	0	0	0	0	0	2	0	0	0
FLATHEAD CATFISH	0	0	0	0	0	0	2	0	0	0
BROOK TROUT	0	0	0	0	0	0	0	0	0	0
LONG NOSE GAR	0	0	0	0	0	0	0	0	0	0
Daily Totals	2,511	2,302	1,798	21	2,931	176	2,013	8,322	4,842	4,357

Table 2 (Continued)

Date	5/7	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	5/16
Hours of Operation- Tailrace:	6.0	10.0	9.6	10.0	10.3	9.7	10.4	10.9	9.9	9.8
Number of Lifts - Tailrace	8	16	13	17	13	14	17	18	15	17
Hours of Operation - Spillway:	9.8	10.0	9.7	10.0	10.0	9.6	10.5	10.9	10.0	9.7
Number of Lifts -Spillway:	15	15	14	16	19	16	16	7	18	14
Water Temperature (F)	57.3	58.2	59.5	61	63.3	65.3	66.5	68.4	68.3	68.5
AMERICAN SHAD	27	45	21	25	323	392	477	604	160	185
ALEWIFE (residualized)	0	0	0	0	1	0	0	1	0	0
GIZZARD SHAD	4,234	13,655	9,335	6,842	17,283	19,221	21,651	16,887	16,024	10,365
STRIPED BASS	0	0	0	0	0	0	0	0	0	0
SEA LAMPREY	0	0	0	0	2	0	0	2	0	0
RAINBOW TROUT	1	0	0	0	1	0	1	0	1	2
BROWN TROUT	0	0	0	0	0	0	0	0	1	1
MUSKELLUNGE	0	0	0	0	0	0	0	0	0	1
TIGER MUSKIE	0	0	0	1	0	0	0	0	0	0
CARP	15	34	132	15	16	180	59	91	43	36
QUILLBACK	112	6	34	25	46	80	127	191	242	204
S. REDHORSE	164	49	42	4	261	203	105	106	76	32
CHANNEL CATFISH	0	0	0	0	4	6	5	16	9	6
WHITE PERCH	0	0	0	0	0	0	0	0	0	0
HYBRID STRIPED BASS	0	0	0	0	0	0	0	0	0	0
ROCK BASS	0	0	0	0	2	0	0	1	0	2
REDBREAST 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	2	1	2	2	0	0
SMALLMOUTH BASS	20	27	18	19	60	96	29	17	25	3
LARGEMOUTH BASS	2	1	0	1	0	3	0	1	2	0
WHITE CRAPPIE	0	0	1	0	0	0	0	0	0	0
BLACK CRAPPIE	0	0	0	0	0	0	1	0	0	0
YELLOW PERCH	0	1	0	0	0	0	0	0	0	0
WALLEYE	4	1	2	2	126	134	119	100	237	135
AMERICAN EEL	0	0	0	0	0	0	0	0	0	0
COMELY SHINER	0	0	0	0	0	0	0	0	0	0
NORTHERN HOGSUCKER	0	0	0	0	0	0	0	0	0	0
GREENSIDE DARTER	0	0	0	0	0	0	0	0	0	0
FLATHEAD CATFISH	0	0	0	0	0	0	0	0	0	0
BROOK TROUT	0	0	0	0	0	0	0	1	0	0
LONG NOSE GAR	0	0	0	0	0	0	0	0	0	0
Daily Totals	4,579	13,819	9,585	6,934	18,127	20,316	22,576	18,020	16,820	10,972

Table 2 (Continued)

Date	5/22	5/23	5/25	5/26	5/27	5/28	5/29	5/30	5/31	6/1
Hours of Operation- Tailrace:	8.0	9.7	9.7	9.7	9.9	9.6	9.1	9.6	10.1	9.6
Number of Lifts - Tailrace	10	12	14	13	14	15	14	14	13	13
Hours of Operation - Spillway:	2.0	0.0	0.0	0.0	10.0	7.6	9.6	9.5	10.3	9.8
Number of Lifts -Spillway:	2	0	0	0	14	13	12	12	13	14
Water Temperature (F)	59.3	60.9	62	63.7	65.5	67.6	68.8	67.3	66.7	67.1
AMERICAN SHAD	0	0	0	0	0	1	0	3	4	10
ALEWIFE (residualized)	0	0	0	0	0	0	0	0	0	0
GIZZARD SHAD	251	1,641	3,276	4,236	16,820	14,309	10,613	9,161	2,951	4,359
STRIPED BASS	0	0	0	0	0	0	0	0	0	0
SEA LAMPREY	0	0	0	0	0	0	1	0	0	0
RAINBOW TROUT	0	1	0	0	0	1	0	0	0	0
BROWN TROUT	0	0	0	0	0	0	0	0	0	0
MUSKELLUNGE	0	0	0	0	1	0	0	2	0	0
TIGER MUSKIE	0	0	0	0	0	0	0	0	0	0
CARP	0	5	6	3	30	11	7	6	5	2
QUILLBACK	0	0	0	0	7	41	2	4	0	0
S. REDHORSE	0	0	0	0	4	33	28	13	6	11
CHANNEL CATFISH	0	3	5	5	19	58	116	19	17	8
WHITE PERCH	0	0	0	1	0	0	0	0	0	0
HYBRID STRIPED BASS	0	0	0	0	0	0	0	0	0	0
ROCK BASS	0	0	0	1	1	0	0	0	0	0
REDBREAST SUNFISH	0	0	0	0	0	0	0	0	0	0
PUMPKINSEED	0	0	0	0	0	0	0	0	1	0
BLUEGILL	0	0	0	0	0	0	1	3	0	1
SMALLMOUTH BASS	0	0	0	0	1	1	2	0	2	1
LARGEMOUTH BASS	0	0	0	0	1	2	0	0	0	2
WHITE CRAPPIE	0	0	0	0	0	0	0	0	0	0
BLACK CRAPPIE	0	0	0	0	0	0	1	0	0	0
YELLOW PERCH	0	0	0	0	0	0	0	0	0	0
WALLEYE	0	0	0	0	25	37	61	37	22	34
AMERICAN EEL	0	1	0	0	0	0	0	0	0	0
COMELY SHINER	0	0	0	0	0	0	0	0	0	0
NORTHERN HOGSUCKER	0	0	0	0	0	0	0	0	1	0
GREENSIDE DARTER	0	0	0	0	0	0	0	0	0	0
FLATHEAD CATFISH	1	4	1	0	1	1	0	0	1	0
BROOK TROUT	0	0	0	0	0	0	0	0	1	0
LONG NOSE GAR	0	0	0	0	0	0	0	0	0	0
Daily Totals	252	1,655	3,288	4,246	16,910	14,495	10,832	9,248	3,011	4,428

Date	6/2	6/3	6/4	6/5	6/6	6/7	6/8	***Season Totals***
Hours of Operation- Tailrace:	10.2	10.2	9.2	9.2	10.1	9.6	9.6	**301.7**
Number of Lifts - Tailrace	12	14	10	11	12	13	14	**427**
Hours of Operation - Spillway:	10.3	10.2	9.1	9.2	10.1	9.6	9.7	**286.2**
Number of Lifts -Spillway:	14	14	11	15	15	14	14	**421**
Water Temperature (F)	69	70.5	72.1	73.9	73.9	74.1	72.6	
AMERICAN SHAD	33	25	16	23	14	13	61	**2,589**
ALEWIFE (residualized)	0	0	0	0	0	0	0	**2**
GIZZARD SHAD	6,328	9,275	9,120	8,961	10,999	10,086	7,251	**293,935**
STRIPED BASS	0	0	0	0	0	0	0	**1**
SEA LAMPREY	0	0	0	0	0	0	0	**5**
RAINBOW TROUT	0	1	0	0	0	0	0	**9**
BROWN TROUT	0	0	0	0	0	0	0	**2**
MUSKELLUNGE	0	0	0	0	0	0	0	**7**
TIGER MUSKIE	0	0	0	0	0	0	0	**1**
CARP	13	20	8	19	20	4	13	**799**
QUILLBACK	7	31	11	31	7	18	1	**1,227**
S. REDHORSE	21	12	28	147	150	91	59	**1,799**
CHANNEL CATFISH	24	60	40	76	70	40	86	**695**
WHITE PERCH	0	0	0	0	0	0	0	**1**
HYBRID STRIPED BASS	0	0	1	0	0	0	0	**1**
ROCK BASS	0	0	0	0	0	0	0	**7**
REDBREAST SUNFISH	1	0	0	0	0	0	0	**1**
PUMPKINSEED	0	0	0	0	0	0	0	**1**
BLUEGILL	4	1	1	0	1	5	6	**30**
SMALLMOUTH BASS	5	3	2	1	2	7	4	**489**
LARGEMOUTH BASS	1	2	2	0	0	0	0	**21**
WHITE CRAPPIE	0	0	0	0	0	0	0	**1**
BLACK CRAPPIE	0	0	1	0	0	0	0	**3**
YELLOW PERCH	0	0	0	0	0	0	0	**1**
WALLEYE	51	34	31	105	85	65	41	**1,517**
AMERICAN EEL	0	0	0	0	0	0	0	**1**
COMELY SHINER	0	0	900	225	1,000	6,000	815	**8,940**
NORTHERN HOGSUCKER	0	0	0	0	0	0	0	**1**
GREENSIDE DARTER	0	0	0	0	0	0	0	**2**
FLATHEAD CATFISH	0	0	0	0	0	2	1	**14**
BROOK TROUT	0	0	0	0	0	0	0	**2**
LONG NOSE GAR	0	0	1	0	0	1	0	**2**
Daily Totals	6,488	9,464	10,162	9,588	12,348	16,332	8,338	**312,106**

Table 3

Visually derived estimate of the American shad catch in the tailrace and spillway lifts at the Holtwood Power Station in 2014.

	Shad	Number Collected		Percent Collected	
Date	Catch	Tailrace	Spillway	Tailrace	Spillway
9-Apr	0	0	0	0%	0%
10-Apr	0	0	0	0%	0%
11-Apr*					
12-Apr	0	0	0	0%	0%
13-Apr	0	0	0	0%	0%
14-Apr	0	0	0	0%	0%
15-Apr	0	0	0	0%	0%
16-Apr	0	0	0	0%	0%
17 Apr*					
18 Apr*					
19-Apr	0	0	0	0%	0%
20-Apr	0	0	0	0%	0%
21-Apr	0	0	0	0%	0%
22-Apr	0	0	0	0%	0%
23-Apr	0	0	0	0%	0%
24-Apr	0	0	0	0%	0%
25-Apr	0	0	0	0%	0%
26-Apr	0	0	0	0%	0%
27-Apr**	3	0	3	0%	100%
28-Apr	7	0	7	0%	100%
29-Apr	65	1	64	2%	98%
30-Apr	0	0	0	0%	0%
1-May	1	1	0	100%	0%
2-May	0	0	0	0%	0%
3-May	6	3	3	50%	50%
4-May	18	0	18	0%	100%
5-May	2	0	2	0%	100%
6-May	25	0	25	0%	100%
7-May	27	1	26	4%	96%
8-May	45	2	43	4%	96%
9-May	21	0	21	0%	100%
10-May	25	3	22	12%	88%
11-May	323	48	275	15%	85%
12-May	392	59	333	15%	85%
13-May	477	191	286	40%	60%
14-May	604	403	201	67%	33%
15-May	160	48	112	30%	70%
16-May	185	92	93	50%	50%
17-May*	--	--	--	--	--
18-May*	--	--	--	--	--
19-May*	--	--	--	--	--
20-May*	--	--	--	--	--
21-May*	--	--	--	--	--
22-May	0	0	0	0%	0%
23-May	0	0	--	0%	--
24-May*					
25-May	0	0	--	0%	--
26-May	0	0	--	0%	--

Table 3
(Continued)

Date	Shad Catch	Number Collected		Percent Collected	
		Tailrace	Spillway	Tailrace	Spillway
27-May	0	0	--	0%	--
28-May	1	0	1	0%	100%
29-May	0	0	0	0%	0%
30-May	3	3	0	100%	0%
31-May	4	2	2	50%	50%
1-Jun	10	5	5	50%	50%
2-Jun	33	8	25	24%	76%
3-Jun	25	15	10	60%	40%
4-Jun	16	8	8	50%	50%
5-Jun	23	6	17	26%	74%
6-Jun	14	5	9	36%	64%
7-Jun	13	3	10	23%	77%
8-Jun**	61	55	6	90%	10%
9-Jun	19	14	5	74%	26%
10-Jun	4	2	2	50%	50%
11-Jun	4	2	2	50%	50%
12-Jun	3	2	1	67%	33%
13-Jun	4	1	3	25%	75%
14-Jun	0	0	0	0%	0%
15-Jun	0	0	0	0%	0%
16-Jun	1	0	1	0%	100%
17-Jun	0	0	0	0%	0%
18-Jun	0	0	0	0%	0%
19-Jun	1	1	0	100%	0%
20-Jun	0	0	0	0%	0%
21-Jun	0	0	0	0%	0%
22-Jun	0	0	0	0%	0%
23-Jun	0	0	0	0%	0%
24-Jun	0	0	0	0%	0%
25-Jun	0	0	0	0%	0%
26-Jun	0	0	0	0%	0%
27-Jun	0	0	0	0%	0%
28-Jun	0	0	0	0%	0%
29-Jun	0	0	0	0%	0%
30-Jun	0	0	0	0%	0%
Total	***2,625***	***984***	***1,641***	***37%***	***63%***

* Shut Down due to High Flow Event (> 100,000 cfs)

**Denotes start and end of American shad passage season (2,589 Am. Shad)

Table 4

Hourly summary of American shad passage at the Holtwood fish pasage facility in 2014 (April 27 to June 19).

DATE	4/27	4/28	4/29	4/30	5/1	5/2	5/3	5/4	5/5	5/6	5/7	5/8	5/9	5/10
Viewing Time (Start)	9:15	9:00	9:00	11:30	10:25	12:00	11:25	8:30	8:00	8:20	8:00	8:10	8:00	8:10
Viewing Time (End)	15:00	16:55	15:30	15:30	15:25	16:00	17:15	17:55	17:55	18:15	18:00	18:10	18:00	18:10
Viewing Time (hrs)	5.8	7.9	6.5	4.0	5.0	4.0	5.8	9.4	9.9	9.9	10.0	10.0	10.0	10.0
Water Temp.(°F)	55.5	56.4	57.6	56.5	53.4	53.4	56.2	56.5	55.3	55.2	57.3	58.2	59.5	61
Military Time (hrs)														
0600 to 0659														
0700 to 0759														
0800 to 0859									0	0	3	7	1	0
0900 to 0959	0	0	4					2	0	1	2	23	2	2
1000 to 1059	0	0	13	0	0			2	1	0	0	4	2	8
1100 to 1159	1	0	15	0	1		0	6	0	1	3	0	6	0
1200 to 1259	1	0	19	0	0	0	1	3	0	1	4	2	4	0
1300 to 1359	1	1	7	0	0	0	0	1	0	2	1	0	0	1
1400 to 1459	0	3	4	0	0	0	0	2	0	5	2	3	5	7
1500 to 1559		2	3	0	0	0	0	1	0	2	5	3	1	6
1600 to 1659		1					0	1	0	8	6	2	0	1
1700 to 1759							5	0	1	3	1	1	0	0
1800 to 1859										2		0		0
1900 to 1959														
2000 to 2059														
Total	**3**	**7**	**65**	**0**	**1**	**0**	**6**	**18**	**2**	**25**	**27**	**45**	**21**	**25**

DATE	5/11	5/12	5/13	5/14	5/15	5/16	5/22	5/23	5/25	5/26	5/27	5/28	5/29	5/30
Viewing Time (Start)	8:00	8:00	8:00	8:00	8:00	8:05	10:20	8:00	8:00	8:00	8:10	8:00	8:10	8:00
Viewing Time (End)	18:30	18:00	18:15	18:45	18:12	18:00	17:45	18:00	17:45	18:00	17:52	18:00	18:00	18:00
Viewing Time (hrs)	10.5	10.0	10.3	10.8	10.2	9.9	7.4	10.0	9.8	10.0	9.7	10.0	9.8	10.0
Water Temp.(°F)	63.3	65.3	66.5	68.4	68.3	68.5	59.3	60.9	62	63.7	65.5	67.6	68.8	67.3
Military Time (hrs)														
0600 to 0659														
0700 to 0759														
0800 to 0859	15	11	52	40	17	9					0	1	0	
0900 to 0959	14	87	90	52	13	14					0		0	
1000 to 1059	30	77	41	71	12	16	0				0		0	
1100 to 1159	59	48	10	54	3	19	0				0		0	2
1200 to 1259	31	65	28	39	5	17	0				0		0	1
1300 to 1359	29	52	38	73	18	19	0				0		0	
1400 to 1459	37	29	56	56	27	40	0				0		0	
1500 to 1559	39	12	35	97	7	11	0				0		0	
1600 to 1659	42	10	56	50	23	26	0				0		0	
1700 to 1759	21	1	53	33	31	14	0				0		0	
1800 to 1859	6		18	39	4									
1900 to 1959														
2000 to 2059														
Total	**323**	**392**	**477**	**604**	**160**	**185**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**3**

Table 4 (Continued)

DATE	5/31	6/1	6/2	6/3	6/4	6/5	6/6	6/7	6/8	6/9	6/10	6/11	6/12	6/13
Viewing Time (Start)	8:45	8:00	8:00	7:55	8:30	8:30	7:45	8:00	8:00	9:00	9:00	9:00	9:00	9:00
Viewing Time (End)	18:00	18:00	18:00	17:55	18:00	18:00	17:50	18:00	18:00	15:00	15:00	15:00	15:00	15:00
Viewing Time (hrs)	9.3	10.0	10.0	10.0	9.5	9.5	10.1	10.0	10.0	6.0	6.0	6.0	6.0	6.0
Water Temp.(°F)	66.7	67.1	69	70.5	72.1	73.9	73.9	74.1	72.6	75.1	75	76	76	75.3
Military Time (hrs)														
0600 to 0659														
0700 to 0759														
0800 to 0859	0		0	4	0	4	4	1	0					
0900 to 0959	0		1	7	1	1	2	1	7	3	0	2	0	0
1000 to 1059	0	1	0	5	0	0	3		31	7	0	1	0	1
1100 to 1159	1		1	0	3	4	1	1	8	4	1	0	1	0
1200 to 1259	0		3	5	2	4		2	6	2	1	0	1	2
1300 to 1359	1	1	8	1	3	2	3	5	4	1	2	1	0	1
1400 to 1459	0	2	10	2	4	2	1	1	3	2	0	0	1	0
1500 to 1559	1		4	1	1	5		1	2					
1600 to 1659	1	6	5	0	2	1		1	0					
1700 to 1759	0		1	0	0	0			0					
1800 to 1859														
1900 to 1959														
2000 to 2059														
Total	**4**	**10**	**33**	**25**	**16**	**23**	**14**	**13**	**61**	**19**	**4**	**4**	**3**	**4**

DATE	6/14	6/15	6/16	6/17	6/18	6/19	***Season Totals***
Viewing Time (Start)	9:00	9:00	9:00	9:00	9:00	9:00	
Viewing Time (End)	15:00	15:00	15:00	15:00	15:00	15:00	
Viewing Time (hrs)	6.0	6.0	6.0	6.0	6.0	6.0	**400.9**
Water Temp.(°F)	73.1	71.8	71.1	72.5	74.1	78	
Military Time (hrs)							
0600 to 0659							**0**
0700 to 0759							**0**
0800 to 0859							**169**
0900 to 0959	0	0	0		0	1	**332**
1000 to 1059	0	0	0		0	0	**326**
1100 to 1159	0	0	0		0	0	**253**
1200 to 1259	0	0	0		0	0	**249**
1300 to 1359	0	0	1		0	0	**277**
1400 to 1459	0	0	0		0	0	**304**
1500 to 1559							**239**
1600 to 1659							**242**
1700 to 1759							**165**
1800 to 1859							**69**
1900 to 1959							**0**
2000 to 2059							**0**
Total	**0**	**0**	**1**	**0**	**0**	**1**	**2,625**

Table 5

Holtwood fishway summary table evaluating American shad passage at three river flow ranges (1997-2014).

	1997	1998*	1999	2000*	2001	2002*	2003*	2004*	2005
Migration season start date	18 Apr	27 Apr	25 Apr	06 May	27 Apr	15 Apr	28 Apr	26 Apr	27 Apr
Migration season end date	14 Jun	12 Jun	03 Jun	14 Jun	08 Jun	07 Jun	02 Jun	03 Jun	10 Jun
Season duration (days)	58	47	40	40	43	55	36	39	45
Number of days of operation	55	41	40	36	42	35	34	39	36
Am. shad season total (Conowingo)	90,971	39,904	69,712	153,546	193,574	108,001	125,135	109,360	68,926
Am. shad season total (Holtwood)	28,063	8,235	34,702	29,421	109,976	17,522	25,254	3,428	34,189
River flow ≤40,000 cfs									
Number of days	48	22	34	19	40	19	15	2	33
Percent of season	87%	54%	85%	53%	95%	54%	44%	5%	92%
No. of Am. shad passed	26,201	7,512	34,069	19,712	109,342	10,322	20,229	2	34,060
Daily ave. of Am. shad passed	546	341	1,002	1,037	2,733	543	1,348	1	1,032
Percent of total passage	93%	91%	98%	67%	99%	59%	80%	0%	99.6%
River flow 40,001 to 60,000 cfs									
Number of days	7	2	6	12	2	14	18	20	3
Percent of season	13%	5%	15%	33%	5%	40%	53%	51.3%	8%
No. of Am. shad passed	1,862	230	633	9,536	634	7,029	5,019	1,943	129
Daily ave. of Am. shad passed	266	115	106	795	317	502	279	97	43
Percent of Total Passage	7%	3%	2%	32%	1%	40%	19.8%	56.7%	0.4%
River flow >60,000 cfs									
Number of days	0	17	0	5	0	2	1	17	0
Percent of season	0%	41%	0%	14%	0%	6%	3%	43.6%	0%
No. of Am. shad passed	0	493	0	173	0	171	6	1,483	0
Daily ave. of Am. shad passed	0	29	0	35	0	86	6	87	0
Percent of total passage	0%	6%	0%	1%	0%	1%	0.02%	43.3%	0.0%

* Denotes seasons of high river flow or frequent spillage.

Holtwood fishway summary table evaluating American shad passage at three river flow ranges (1997-2014).

	2006	2007	2008*	2009*	2010	2011	2012	2013	2014*
Migration season start date	11 Apr	01 May	21 Apr	03 May	21 Apr	20 May	07 Apr	29-Apr	27-Apr
Migration season end date	06 Jun	04 Jun	09 Jun	07 Jun	09 Jun	05 Jun	05 Jun	5-Jun	8-Jun
Season duration (days)	57	35	50	36	50	17	60	38	43
Number of days of operation	57	35	49	36	48	10	58	38	37
Am. shad season total (Conowingo)	56,899	25,464	19,914	29,272	37,757	20,571	22,143	12,733	
Am. shad season total (Holtwood)	35,968	10,338	2,795	10,896	16,472	21	4,238	2,503	2,589**
River flow ≤40,000 cfs									
Number of days	48	27	20	20	40	0	31	34	16
Percent of season	84%	77%	40%	56%	83%	0%	53%	89%	37%
No. of Am. shad passed	35,302	9,549	2,242	8,939	15,606	0	3260	2,355	2248
Daily ave. of Am. shad passed	735	354	112	447	372	0	105	70	141
Percent of total passage	98.1%	92.3%	80.2%	82%	95%	0%	77%	94%	87%
River flow 40,001 to 60,000 cfs									
Number of days	5	8	22	14	8	2	18	4	12
Percent of season	9%	23%	44%	39%	17%	12%	30.0%	11%	28%
No. of Am. shad passed	566	789	533	1,846	866	0	967	148	314
Daily ave. of Am. shad passed	113	99	24	132	108	0	54	37	26
Percent of Total Passage	1.6%	7.6%	19.0%	17.0%	5%	0.0%	22.8%	5.9%	12.0%
River flow >60,000 cfs									
Number of days	4	0	8	2	0	15	4	0	15
Percent of season	7%	0%	16%	5%	0%	88%	6.7%	0.0%	34.9%
No. of Am. shad passed	100	0	20	111	0	21	11	0	27
Daily ave. of Am. shad passed	25	0	2	55	0	2	3	0	2
Percent of total passage	0.3%	0.0%	0.7%	1.0%	0%	100%	0.3%	0.0%	1.0%

* Denotes seasons of high river flow or frequent spillage.

**"Official American shad passage season (April 27-June 8).

Table 6

Summary of American shad passage counts and percent passage values at Susquehanna River dams, 1997-2014.

	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	43.6%	12,706	77.1%	907	7.1%
2011	20,571	21	0.1%	8	38.1%	0	0.0%
2012	22,143	4,238	19.1%	3,089	72.9%	224	7.3%
2013	12,733	2,503	19.7%	1,927	77.0%	202	10.5%
2014	**10,425**	**2,589***	**24.8%**	**1,336**	**51.6%**	**8**	**0.6%**

*Am. Shad passed at Holtwood from April 27 to June 8.

Table 7

Daily summary of Holtwood resident fish passage prior to and after the American shad passage season (9 to 26 April; 9 to 30 June) in spring, 2014.

DATE	4/9	4/10	4/12	4/13	4/14	4/15	4/16	4/19	4/20	4/21	4/22	4/23	4/24	4/25	4/26	**Totals (9-26 Apr.)**
Hours of Operation - Tailrace	2.7	5.7	0.0	0.0	0.0	5.4	4.4	5.9	5.9	5.9	5.9	5.8	3.0	5.8	5.8	62.0
Number of Lifts - Tailrace	5	8	0	0	0	9	6	8	8	8	9	7	4	8	9	89
Hours of Operation - Spillway	2.0	0.0	5.8	5.8	5.9	5.8	6.0	0.0	5.7	5.9	5.8	5.8	3.0	5.9	5.9	69.3
Number of Lifts - Spillway	2	0	9	10	9	9	8	0	8	7	7	6	3	9	9	96
Water Temperature (°F)	46	47	49	49.4	51.9	55.5	55.3	51.2	51.4	51.9	53.1	54.5	54	53.5	53.9	
AMERICAN SHAD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GIZZARD SHAD	10	6	13	34	111	256	291	755	1,704	758	1,267	2,226	1,613	1,320	473	10,837
CARP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
QUILLBACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WHITE SUCKER	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
S. REDHORSE	0	0	0	1	3	9	1	0	1	0	0	3	0	4	1	23
CHANNEL CATFISH	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	3
GREEN SUNFISH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BLUEGILL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SMALLMOUTH BASS	0	0	0	0	0	0	0	0	0	0	0	5	5	8	12	30
LARGEMOUTH BASS	0	0	0	0	0	3	0	0	0	0	0	0	0	0	1	4
WALLEYE	0	0	0	6	4	8	3	1	1	4	1	2	0	0	0	30
COMELY SHINER	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FLATHEAD CATFISH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
FALLFISH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HYBRID STRIPED BASS	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	2
Totals	**10**	**6**	**14**	**41**	**118**	**280**	**295**	**756**	**1,708**	**762**	**1,268**	**2,236**	**1,618**	**1,332**	**488**	**10,932**

Table 7 (Continued)

DATE	6/9	6/10	6/11	6/12	6/13	6/14	6/15	6/16	6/17	6/18	6/19	6/20
Hours of Operation - Tailrace	5.7	6.0	5.6	5.6	5.6	6.0	5.7	5.3	5.9	5.6	5.6	5.7
Number of Lifts - Tailrace	9	8	9	8	9	7	9	8	6	8	8	9
Hours of Operation - Spillway	5.8	6.0	5.6	5.6	5.6	5.0	0.0	5.4	5.9	5.8	5.6	2.6
Number of Lifts - Spillway	10	8	9	9	10	6	0	9	6	10	7	4
Water Temperature (°F)	75.1	75	76	76	75.3	73.1	71.8	71.1	72.5	74.1	78	78.2
AMERICAN SHAD	19	4	4	3	4	0	0	1	0	0	1	0
GIZZARD SHAD	2,664	3,344	4,426	842	2,677	459	140	1,289	520	1,102	193	445
CARP	5	2	10	5	7	0	0	1	1	1	0	0
QUILLBACK	0	3	28	32	11	2	1	1	1	1	1	3
WHITE SUCKER	0	0	0	0	0	0	0	0	0	0	0	0
S. REDHORSE	7	16	26	20	13	5	10	5	1	0	1	4
CHANNEL CATFISH	16	22	50	22	15	36	12	4	5	5	30	5
GREEN SUNFISH	0	0	0	0	0	0	1	0	0	0	0	0
BLUEGILL	0	2	0	1	1	1	3	1	0	0	0	2
SMALLMOUTH BASS	1	6	1	1	0	0	0	0	0	2	0	1
LARGEMOUTH BASS	0	0	0	0	1	0	0	0	0	0	0	0
WALLEYE	14	14	21	11	8	2	4	4	5	1	0	10
COMELY SHINER	0	0	985	370	0	15	0	0	0	370	550	1,900
FLATHEAD CATFISH	0	0	0	0	2	7	0	1	1	0	0	0
FALLFISH	0	0	0	0	0	0	0	1	0	0	0	0
HYBRID STRIPED BASS	0	0	0	0	0	0	0	0	0	0	0	0
Totals	**2,726**	**3,413**	**5,551**	**1,307**	**2,739**	**527**	**171**	**1,308**	**534**	**1,482**	**776**	**2,370**

Table 7 (Continued)

DATE	6/21	6/22	6/23	6/24	6/25	6/26	6/27	6/28	6/29	6/30	**Totals (9-30 June)**	**Totals (9-26 Apr; 9-30 June)**
Hours of Operation - Tailrace	5.9	5.6	5.6	5.9	5.9	5.7	5.9	6.1	5.9	6.0	126.5	188.5
Number of Lifts - Tailrace	6	8	8	6	8	8	8	6	7	6	169	258
Hours of Operation - Spillway	5.8	5.6	5.5	5.8	5.8	5.6	5.8	6.0	5.8	6.0	116.4	185.7
Number of Lifts - Spillway	6	8	7	6	8	8	7	6	6	4	154	250
Water Temperature (°F)	78.2	76.8	76.8	75.7	77.1	78.1	78.9	79.4	80.8	81.1		
AMERICAN SHAD	0	0	0	0	0	0	0	0	0	0	36	36
GIZZARD SHAD	599	517	331	214	396	306	378	159	121	184	21,306	32,143
CARP	0	2	1	0	1	0	0	1	1	1	39	39
QUILLBACK	0	2	1	0	1	3	17	3	3	15	129	129
WHITE SUCKER	0	0	0	0	0	0	0	0	0	0	0	2
S. REDHORSE	0	3	5	0	2	0	3	1	0	0	122	145
CHANNEL CATFISH	5	21	22	4	5	6	18	3	9	10	325	328
GREEN SUNFISH	0	1	0	0	0	0	0	0	0	0	2	2
BLUEGILL	0	0	1	0	1	0	0	0	0	0	13	13
SMALLMOUTH BASS	0	2	0	1	1	1	3	2	2	0	24	54
LARGEMOUTH BASS	0	0	0	0	0	0	1	0	0	0	2	6
WALLEYE	1	6	3	4	5	6	5	6	2	1	133	163
COMELY SHINER	2,600	0	0	600	500	0	5,000	2,580	800	5,200	21,470	21,470
FLATHEAD CATFISH	0	0	0	0	0	0	0	1	0	1	13	14
FALLFISH	0	0	0	0	0	0	0	0	0	0	1	1
HYBRID STRIPED BASS	0	0	0	0	0	1	0	0	0	0	1	3
Totals	**3,205**	**554**	**364**	**823**	**912**	**323**	**5,425**	**2,756**	**938**	**5,412**	**43,616**	**54,548**

Table 8

Comparison of resident fish passage prior to, during, and after American shad passage operations at Holtwood Dam, spring 2014

Total Resident Fish Passed (April 9-June 30)		Res. Fish passed in Am. Shad Season (April 27-June 8)		Total Resident Passage Season (April 9-26: June 9-30)		Resident Passage (April 9-26)		Resident Passage (June 9-30)	
Species	Total Passed	# Passed	% of Total Passed	# Passed	% of Total Passed	# Passed	% of Total Passed	# Passed	% of Total Passed
Smallmouth Bass	543	489	90.1%	54	9.9%	30	5.5%	24	4.4%
Walleye	1,680	1,517	90.3%	163	9.7%	30	1.8%	133	7.9%
Channel Catfish	1,023	695	67.9%	328	32.1%	3	0.3%	325	31.8%
Shorthead Redhorse	1,944	1,799	92.5%	145	7.5%	23	1.2%	122	6.3%
Quillback	1,356	1,227	90.5%	129	9.5%	0	0.0%	129	9.5%
Carp	838	799	95.3%	39	4.7%	0	0.0%	39	4.7%
Gizzard shad	326,079	293,936	90.1%	32,143	9.9%	10,837	3.3%	21,306	6.5%

Table 9

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 Fall, 2014 (Sept. 2 - Oct.15).

	River Flow	Ave.Water	Secchi	Number	Weir Gate Operation			Elevation (ft)		
Date	(cfs)	Temp. (°F)	(in)	of Units	A	B	C	Tailrace	Spillway	Forebay
2-Sep	10,800	77.5	22	1	X	X	X	105	118	170
3-Sep	10,500	77.8	30	1	X	X	X	106	120	169
4-Sep	10,200	78.2	30	6	X	X	X	105	119	168
5-Sep	10,900	78.6	30	6	X	X	X	108	119	169
6-Sep	10,600	78.9	32	4	X	X	X	108	119	169
8-Sep	12,000	78.4	32	3	X	X	X	108	120	169
9-Sep	10,700	78.0	32	3	X	X	X	107	120	169
10-Sep	10,600	77.5	32	6	X	X	X	107	119	169
11-Sep	9,720	76.0	32	2	X	X	X	107	117	170
13-Sep	8,320	75.6	32	1	X	X	X	107	118	168
15-Sep	8,060	73.5	32	2	X	X	X	106	120	169
17-Sep	8,070	71.6	32	2	X	X	X	107	120	165
18-Sep	7,740	71.0	32	3	X	X	X	107	120	166
19-Sep	7,250	70.2	32	2	X	X	X	107	120	166
20-Sep	6,980	69.8	32	2	X	X	X	107	118	168
22-Sep	7,040	69.4	32	1	*	*	X	106	119	167
24-Sep	6,550	68.5	32	2	*	*	X	108	119	165
25-Sep	6,740	68.1	32	2	X	X	X	108	119	165
26-Sep	6,640	67.3	32	2	X	X	X	108	119	166
27-Sep	6,300	67.8	32	1	X	X	X	106	118	168
28-Sep	6,030	68.6	32	1	X	X	X	106	120	168
30-Sep	6,000	68.2	32	1	X	X	X	107	116	168
1-Oct	6,000	68.8	32	2	X	X	X	107	116	168
2-Oct	6,590	68.8	32	1	X	X	X	106	116	168
3-Oct	6,170	68.4	32	2	X	X	X	106	116	168
5-Oct	6,640	67.3	32	2	X	X	X	106	118	168
7-Oct	6,480	66.5	32	4	X	X	X	107	120	169
8-Oct	6,640	65.4	32	2	X	X	X	107	120	169
9-Oct	6,340	65.2	32	2	X	X	X	108	120	170
10-Oct	6,200	64.8	32	1	X	X	X	107	120	169
12-Oct	6,770	63.5	32	1	X	X	X	106	118	167
13-Oct	6,750	62.2	32	1	X	x	X	107	120	167
14-Oct	6,540	62.3	32	5	X	X	X	107	120	169
15-Oct	6,720	62.4	32	2	X	X	X	108	120	166

* No operation of tailrace lift due to replacement of hopper shieve bearing.

Table 10

Daily summary of resident fish passage at the Holtwood Fish Passage Facility in fall, 2014 (Sept. 2 - October 15).

Date:	*2 Sep*	*3 Sep*	*4 Sep*	*5 Sep*	*6 Sep*	*8 Sep*	*9 Sep*	*10 Sep*	*11 Sep*	*13 Sep*
Hours of Operation - Tailrace:	5.5	5.9	6.0	6.0	5.7	5.9	5.9	5.6	5.6	6.0
Number of Lifts - Tailrace:	1	9	7	7	8	7	7	7	8	7
Hours of Operation - Spillway:	5.8	5.8	6.0	5.9	5.6	6.0	6.0	5.7	5.7	0.8
Number of Lifts - Spillway:	9	8	6	6	7	6	6	7	7	1
Water Temperature (°F):	77.5	77.8	78.2	78.6	78.9	78.4	78	77.5	76	75.6
Gizzard shad (est.)	51,772	5,660	245,000	250,000	295,000	195,000	65,000	55,000	43,500	20,000
Rainbow Trout	0	0	0	0	0	0	0	0	0	0
Carp	0	5	9	7	3	2	2	18	2	2
Minnnows (Notropis sp.)(est.)	0	2,700	19,500	19,500	41,000	36,000	5,000	8,000	2,500	100
Shorthead Redhorse	0	0	0	1	0	0	0	0	0	0
Channel Catfish	78	99	14	71	72	59	12	36	41	11
Flathead Catfish	0	0	0	1	0	0	0	0	0	0
Striped Bass	0	0	0	0	0	0	0	0	0	0
Rock Bass	0	0	0	0	0	1	0	0	0	0
Pumpkinseed	0	1	0	0	0	0	0	0	1	0
Bluegill	2	3	0	3	1	12	2	4	4	0
Smallmouth Bass	1	1	0	3	3	3	0	2	0	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	1	0	0	0	0
Walleye	1	7	2	2	1	2	1	0	1	1
Hybrid Striped bass	0	0	1	0	0	0	0	0	0	0
Daily Total	**51,854**	**8,476**	**264,526**	**269,588**	**336,080**	**231,080**	**70,017**	**63,060**	**46,049**	**20,114**

Date:	*15 Sep*	*17 Sep*	*18 Sep*	*19 Sep*	*20 Sep*	*22 Sep*	*24 Sep*	*25 Sep*	*26 Sep*	*27 Sep*
Hours of Operation - Tailrace:	6.0	5.8	6.0	5.6	4.4	0.0	0.0	5.8	5.8	5.7
Number of Lifts - Tailrace:	7	7	7	8	6	0	0	7	7	8
Hours of Operation - Spillway:	6.1	5.8	6.0	5.5	5.8	5.7	5.8	5.8	5.8	5.8
Number of Lifts - Spillway:	6	6	6	7	8	9	7	6	6	9
Water Temperature (°F):	73.5	71.6	71	70.2	69.8	69.4	68.5	68.1	67.3	67.8
Gizzard shad (est.)	46,000	30,000	15,500	1,500	12,000	850	165	6,700	1,000	1,800
Rainbow Trout	0	0	0	0	0	0	0	0	0	0
Carp	0	1	0	0	0	0	0	2	0	0
Minnnows (Notropis sp.)(est.)	1,000	600	1,200	500	100	1,100	0	0	20	100
Shorthead Redhorse	0	0	0	0	0	0	0	0	0	0
Channel Catfish	10	3	6	5	3	0	4	0	3	0
Flathead Catfish	0	0	0	0	0	0	0	0	0	0
Striped Bass	0	0	0	0	0	0	0	1	0	0
Rock Bass	0	0	0	0	0	0	0	0	0	0
Pumpkinseed	0	0	0	0	0	0	0	0	0	0
Bluegill	2	0	5	0	1	1	0	1	0	0
Smallmouth Bass	4	0	1	2	2	0	0	1	0	1
Largemouth bass	0	0	0	0	0	0	0	0	0	0
White Crappie	0	0	0	1	0	0	0	0	1	0
Black Crappie	0	0	0	0	0	0	0	0	0	0
Walleye	6	1	5	5	4	5	2	5	11	0
Hybrid Striped bass	0	0	1	0	0	0	0	0	0	0
Daily Total	**47,022**	**30,605**	**16,718**	**2,013**	**12,110**	**1,956**	**171**	**6,710**	**1,035**	**1,901**

Table 10 (Continued)

Date:	*28 Sep*	*30 Sep*	*1 Oct*	*2 Oct*	*3 Oct*	*5 Oct*	*7 Oct*	*8 Oct*	*9 Oct*	*10 Oct*
Hours of Operation - Tailrace:	5.8	4.5	5.8	5.9	5.6	5.7	5.8	5.8	5.6	5.8
Number of Lifts - Tailrace:	7	7	7	5	7	8	6	6	8	6
Hours of Operation - Spillway:	5.8	5.7	5.9	6.0	5.6	5.7	5.8	5.9	5.5	5.8
Number of Lifts - Spillway:	6	7	5	4	7	8	5	6	6	5
Water Temperature (°F):	68.6	68.2	68.8	68.8	68.4	67.3	66.5	65.4	65.2	64.8
Gizzard shad (est.)	21,000	1,000	300	60	4,000	500	13,000	8,400	17,000	17,500
Rainbow Trout	0	1	0	0	0	0	0	0	0	0
Carp	1	0	0	0	0	0	0	0	0	0
Minnnows (Notropis sp.)(est.)	8,500	0	0	0	300	200	0	0	0	0
Shorthead Redhorse	0	0	0	0	0	0	0	0	0	1
Channel Catfish	0	1	0	0	5	2	8	4	0	0
Flathead Catfish	0	0	0	0	0	0	0	0	0	0
Striped Bass	0	0	0	0	0	0	0	0	0	0
Rock Bass	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	1	1	1	2	1	0
Smallmouth Bass	0	0	0	0	1	2	1	0	0	0
Largemouth bass	0	0	0	1	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
Walleye	6	4	0	1	0	15	29	22	22	18
Hybrid Striped bass	0	0	0	1	0	0	0	0	0	0
Daily Total	**29,507**	**1,006**	**300**	**63**	**4,307**	**720**	**13,039**	**8,428**	**17,023**	**17,519**

Date:	*12 Oct*	*13 Oct*	*14 Oct*	*15 Oct*	*TOTAL*
Hours of Operation - Tailrace:	5.6	5.7	5.5	5.7	182.0
Number of Lifts - Tailrace:	8	8	8	8	224
Hours of Operation - Spillway:	5.6	5.6	5.6	5.6	191.5
Number of Lifts - Spillway:	7	7	7	7	220
Water Temperature (°F):	63.5	62.2	62.3	62.4	
Gizzard shad (est.)	400	5,000	9,700	9,000	1,448,307
Rainbow Trout	0	0	0	0	1
Carp	0	1	1	1	57
Minnnows (Notropis sp.)(est.)	0	0	0	0	147,920
Shorthead Redhorse	0	0	2	0	4
Channel Catfish	0	1	0	2	550
Flathead Catfish	0	0	0	0	1
Striped Bass	0	0	0	0	1
Rock Bass	0	0	0	0	1
Pumpkinseed	0	0	0	0	2
Bluegill	0	0	0	0	47
Smallmouth Bass	1	2	0	0	31
Largemouth bass	0	0	0	1	2
White Crappie	0	0	0	0	2
Black Crappie	0	0	0	0	1
Walleye	16	18	9	10	232
Hybrid Striped bass	0	0	0	0	3
Daily Total	**417**	**5,022**	**9,712**	**9,014**	**1,597,162**

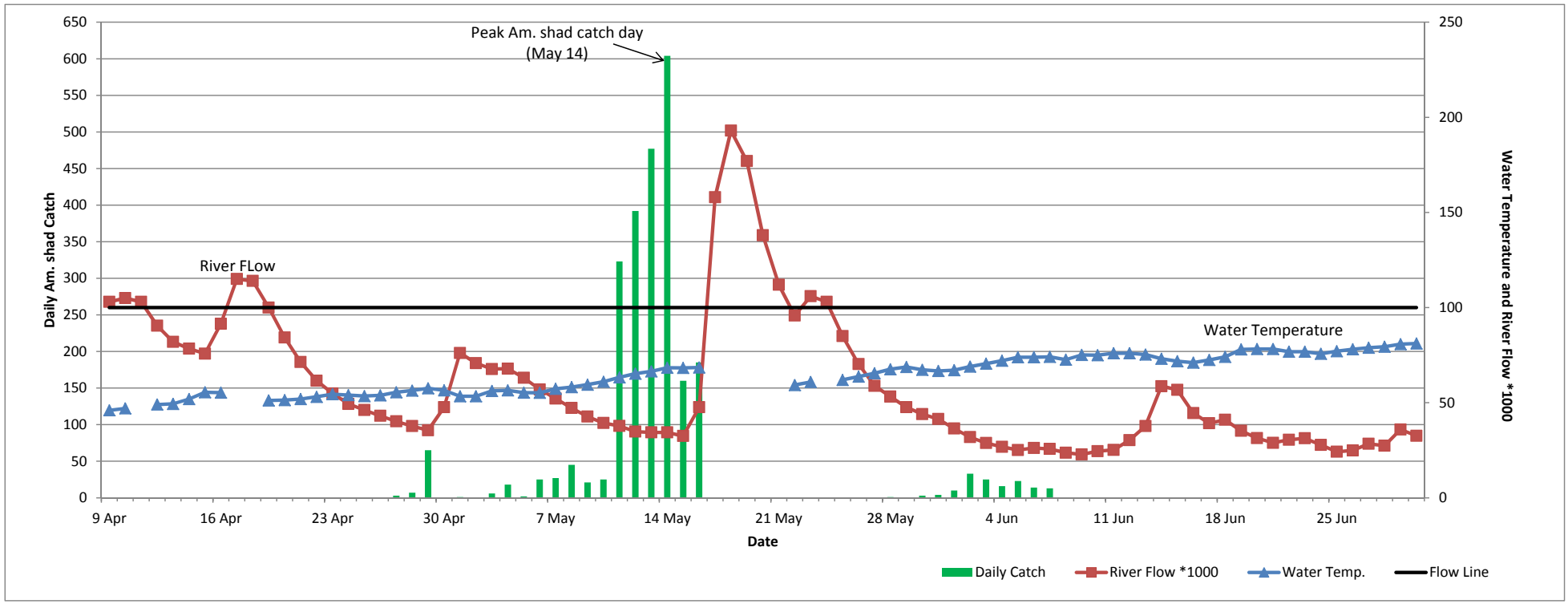

Figure 1

A plot of river flow (USGS Marietta Gauge) and water temperature (°F) in relation to the daily American shad catch at the Holtwood Fish Passage Facilty, spring 2014.

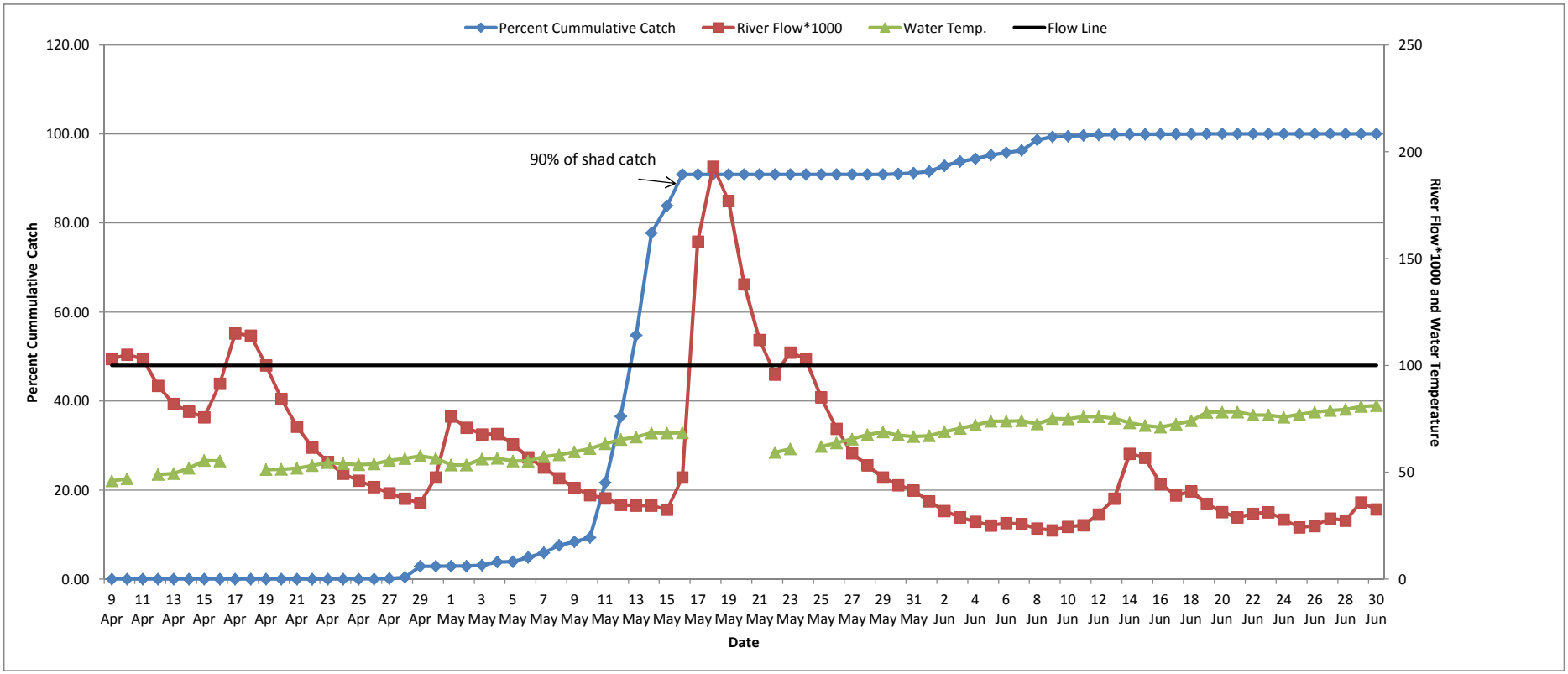

Figure 2

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 2014.