

**SUMMARY OF OPERATIONS AT THE
CONOWINGO DAM EAST FISH PASSAGE FACILITY
SPRING 2011**

October 2011

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Prepared for

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EXECUTIVE SUMMARY

Operation of the Conowingo East Fish Lift (EFL) was delayed for most of April, 2011 due to river water temperatures less than 50.0°F (1 to 11 April) and the onset of high river flows in excess of 100,000 cfs on 7 April, (Figure 1). The EFL operated for 15 days in 2011. EFL operations were terminated on 19 May per request of the resource agencies. The resource agencies requested that Exelon cease EFL operations until a significant number of American shad previously passed by the EFL into Conowingo Pond successfully pass upstream of the Holtwood facility. The 2011 fish passage season marks the twenty-first season of overall operation and the fifteenth year of volitional passage operation at the Conowingo EFL.

The EFL passed 289,453 fish of 24 species. Gizzard shad (257,522), American shad (20,571), channel catfish (10,087), walleye (360) and carp (253), dominated the catch, and comprised nearly 100% of the total fish collected and passed.

A total of 20,571 American shad were passed. The highest daily shad catch occurred on 14 May when 5,013 shad were passed upstream. On 7 of the 15 days of operation, American shad passage exceeded 1,000 fish. On a daily basis, overall shad passage was strongest through the fishway between 1000 hrs and 1659 hrs.

Fishway operations were conducted at water temperatures ranging from 53.1°F to 65.4°F and river flows between 43,500 and 145,200 cfs. Spillage occurred on 5 of the 15 days of operation, (one third of the season). River flows were high throughout the passage season.

The 2011 fish passage season marks the first time operations under spill conditions were documented with photographs. Based on information gained in previous years, the standard operating procedure when spill conditions are in effect is to cease operation of the EFL until spill conditions end. This SOP was put into effect because of very low American shad and other fish passage counts during spill conditions.

For most of the season, water clarity was adequate, which did allow the viewing technicians to identify American shad with attached Maryland DNR floy tags. The number of floy tags observed at the Conowingo EFL in 2011 was 24.

Future operations of the EFL will build on the past fifteen years of operation experience.

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Photograph 1 EFL crowder area: 2 spill gates open, spring 2011.

Photograph 2 EFL crowder area: 4 spill gates open, spring 2011.

Photograph 3 EFL gate A closed: water pouring over top: 6 spill gates open, spring 2011.

1.0 INTRODUCTION

Exelon Generation Company, LLC, formerly the Susquehanna Electric Company (SECO), has operated a fish passage facility (West lift) at its Conowingo Hydroelectric Station since 1972. Lift operations are part of a cooperative private, state, and federal effort to restore American shad (*Alosa sapidissima*) and other migratory fishes to the Susquehanna River. In accordance with the restoration plan, the operational goal had been to monitor fish populations below Conowingo Dam and transport pre-spawned migratory fishes upriver.

In 1988, the former PECO Energy Company negotiated an agreement with state and federal resource agencies and private organizations to enhance restoration of American shad and other anadromous species to the Susquehanna River. A major element of this agreement was for PECO Energy Company to construct an East Fish Lift Passage Facility (EFL) at Conowingo Dam. Construction of the EFL commenced in April 1990 and it was operational by spring 1991.

With the completion of fishways at Holtwood, Safe Harbor, and York Haven dams, the EFL has been operated to pass fish directly into Conowingo Pond since spring 1997.

Objectives of 2011 operation were: (1) monitor passage of migratory and resident fishes through the fishway; (2) assess fishway and trough effectiveness and make modifications as feasible; and (3) assist in the conduction of studies relating to Conowingo Relicensing issues.

2.0 CONOWINGO OPERATION

2.1 Project Operation

The Conowingo Hydroelectric Station, built in 1928, is located at river mile 10 on the Susquehanna River (RMC 1992). The powerhouse has a peaking generating capacity of 549.5 MW and a hydraulic capacity of approximately 85,000 cfs. Flows in excess of station draft are spilled through two regulating and 50 crest gates. The powerhouse contains seven vertical Francis (numbered 1 through 7) and four Kaplan (numbered 8 through 11) turbines. The seven Francis units have been equipped with aeration systems that permit a unit to draw air into the unit (vented mode) or operate conventionally (unvented mode). The four original Kaplan turbines installed in 1964 were replaced over a period of four years (1992 to 1996), with more efficient mixed-flow Kaplan type turbines.

Minimum flow releases from the station during the spring spawning and fishway operating season follow the schedule outlined in the settlement agreement. Minimum flows of 10,000 cubic feet per second (cfs) or natural river flow, whichever is less, as measured at the United States Geological Survey (USGS) gage at Marietta, PA were maintained for the period 1 to 30 April. A minimum flow of 7,500 cfs or natural river (as previously noted) was maintained for the period 1 to 31 May. A minimum flow of 5,000 cfs or natural river (as previously noted) is maintained when fish lift operations occur in June.

2.2 Fishway Operation

The start of operation for the EFL in 2011 began on 25 April. EFL operations were limited in April, 2011 due to water temperatures less than 50.0°F (1 to 11 April) and river flows that exceeded 100,000 cfs from 7 April through 8 May, (Figure 1). The first four American shad were passed on 8 May. Everyday operation began on 8 May, and continued through 19 May. On 19 May, the Agencies requested that Exelon cease operations of the EFL until a significant number of shad passed by the EFL into Conowingo Pond successfully passed upstream of the Holtwood facility. EFL operations did not resume due to the lack of successful shad passage at Holtwood in 2011. The EFL operated a total of 15 days during the 2011 season.

Daily operation times were planned during optimal fish passage parameters. This year, operational methodologies were influenced by natural river flows, water temperatures, generation and spill conditions, and daily/hourly fish passage numbers. EFL operation was conducted by a staff of three people: a lift operator, a supervising biologist, and a biological technician.

The mechanical aspects of East lift operation in 2011 were similar to those described in RMC (1992) and Normandeau Associates, Inc. (1999). Fishing time and/or lift frequency was determined by fish abundance, but the hopper was cycled at least hourly throughout the day. The method of lift operation was also influenced by fish abundance. When a great number of fish were in the fishing channel, the crowder was not operated; instead the crowder screen was raised and then lowered trapping fish over the hopper. This mode of operation, called “fast fish”, involved leaving the crowder in the normal fishing position and raising the hopper frequently to remove fish that accumulated in the holding channel.

The specific entrance(s) used to attract fishes was dictated by the station discharge and which turbine units were operating. For example, when turbine units 8, 9, 10, and 11 or any combination of large turbines were operating, entrance C was the primary entrance used to attract fishes. Under these conditions the attraction flow through the other entrances is negated or disrupted. Depending on flow, and or generation, entrance A, B, or C was utilized throughout the 2011 season to attract fishes.

2.3 Fish Counts

Fish that were lifted and sluiced into the trough were guided by a series of fixed screens. The fixed screens directed the fish to swim up and through a 3 ft wide channel and past a 4 ft by 10 ft counting window located on the west wall of the trough. Fish passing the counting window were identified to species and enumerated by a biologist and/or technician. Passage of fish by the window and out of the trough system was controlled by a set of gates located downstream of the counting window. During periods of peak passage, two people were used to identify and count fish.

At the end of each hour, fish passage data were recorded on data sheets and entered into a Microsoft Excel worksheet on a Personal Computer. Data processing and reporting were PC based and accomplished by program scripts, or macros, created within Microsoft Excel software. After the technician verified the correctness of the raw data, a daily summary of fish passage was produced and distributed in hard copy to plant personnel. Each day’s data were backed up to a diskette and stored off site. Daily reports and weekly summaries of fish passage were electronically distributed to plant personnel and other cooperators.

3.0 RESULTS

3.1 Relative Abundance

The number of fishes collected and passed by the Conowingo Dam East fish lift is presented in Table 1. A total of 289,453 fish of 24 species passed upstream into Conowingo Pond. Gizzard shad (257,522), American shad (20,571), channel catfish (10,087), walleye (360), and carp (253) were the dominant species passed. Gizzard shad and American shad comprised 89% and 7% respectively of the season total; the two species together accounted for 96% of the total fish passed. Other common fishes included shorthead redhorse (184), quillback (167), and smallmouth bass (146). Alosids, (American shad and river herring) comprised about 7% of the total catch. Peak passage occurred on 11 May when 66,490 fish, (95% gizzard shad), were passed.

3.2 American Shad Passage

The East lift collected and passed 20,571 American shad (Table 1). The first four American shad passed on 8 May. Collection and passage of shad varied daily with 1.9% (383) of the shad passed

from 25 April to 10 May, 87% (17,900) passed from 11 May to 16 May, and 11% (2,288) passed from 17 May to 19 May (Figures 2 and 3). On 7 of the 15 days of operation, American shad passage exceeded 1,000 fish. Peak passage occurred on 14 May when 5,013 American shad were passed.

American shad were collected at water temperatures of 53.1 to 65.4°F and at natural river flows of 43,500 to 145,200 cfs (Table 2 and Figure 2). The natural river flow and water temperature during the three highest days of shad passage, (14, 15, and 16 May), ranged from 43,500 cfs to 46,700 cfs and 64.5°F to 65.0°F, respectively. The average daily river flow on those days when American shad passage exceeded 1,000 fish was approximately 51,171 cfs. The average daily river flow during the operational season was 78,047 cfs.

The hourly passage of American shad at the EFL is given in Table 3. Generally, 66% (13,584) of all American shad passed between 1000 and 1659 hours. The highest hourly passage rate occurred from 1100 to 1159 hours.

3.3 Alosids

A small number of river herring, (2 alewife and 17 blueback herring) were passed during the 2011 season. Twenty hickory shad were also passed in spring 2011.

3.4 Maryland tag-recapture

During the 2011 season, the EFL passed a total of 24 American shad that were captured, floy-tagged and released downstream of Conowingo dam by the MDDNR. Of these floy-tagged fish, 4 tags were pink (2010 hook and line) and 20 were green (2011 hook and line).

SUMMARY

EFL operation was initiated on 25 April with the first four American shad passed on 8 May. EFL operations were limited in April, 2011 due to cold water temperatures (< 50.0°F) and river flows above 100,000 cfs. The EFL passed 20,571 American shad from 8 May through 19 May. The total number of American shad passed during the 2011 season was lower than passage values recorded in 2009 and 2010, (Tables 4 and 5), due possibly to the cessation of EFL operations on 19 May at the request of the resource agencies. It is also the fifth consecutive year in which the EFL passed less than 50,000 American shad.

The 2011 fish passage season marks the first time operations under spill conditions were documented with photographs (Appendix A). Based on information gained in previous years, the standard operating procedure when spill conditions are in effect is to cease operation of the EFL until spill conditions end. This SOP was put into effect because of very low American shad and other fish passage counts during spill conditions. Photo 1 portrays the EFL in operation with 2 spill gates open. Photo 2 portrays the EFL operating with 4 spill gates open. Photo 3 displays entrance gate A in the “full closed” position with water pouring out of the gate. Spill conditions have a direct, negative effect on the EFL’s ability to generate a strong and efficient attraction flow.

Modifications made to the fish trough, particularly the valve grating and hopper trough chute since 1999 have diminished the potential for the valve grating to clog with various types of debris and have decreased the number of American shad lift mortalities observed throughout the last several fish passage seasons. Since the valve grating was modified prior to the start of the 2000 season, loss of water flow in the trough has not occurred, particularly during high river flow periods when large

amounts of debris may enter the trough through the fish exit area. An aeration system was also installed prior to the 2000 passage season to diminish low dissolved oxygen levels when the American shad population is heavy in the trough. Prior to fishway operations in 2002, a 30 inch diameter fiberglass elbow was attached to the hopper extension chute, which had been installed in 2001. The modification allows fish to enter the trough center stream, instead of being directed toward the east trough wall. A decrease in lift mortalities has also been observed since the fiberglass elbow was installed. A total of 119 American shad lift mortalities, (0.6% of the total shad passed), was observed in 2011, similar to lift mortalities observed in recent years (0.2% to 1.0%) and less than values observed during trap and transport operations (1.5% to 10.5%).

4.0 RECOMMENDATIONS

- 1) Continue to operate the EFL at Conowingo Dam per annual guidelines developed and approved by the Susquehanna River Technical Committee. Lift operation should adhere to the guidelines; however, flexibility must remain with operating personnel to maximize fishway performance and fish passage.
- 2) Continue the use of two fish counters during periods of increased fish passage to accurately reflect the number of fish that pass through the EFL.
- 3) Continue to inspect cables, limit switches, and lift components to enhance season operability, and continue to evaluate effectiveness of fish trough modifications.

5.0 LITERATURE CITED

- RMC. 1992. Summary of the operations of the Conowingo Dam fish passage facilities in spring 1991. Prepared for Susquehanna Electric Company, Darlington, MD.
- Normandeau Associates, Inc. 1999. Summary of the operations at the Conowingo Dam East fish passage facility in spring, 1998. Prepared for Susquehanna Electric Company, Darlington, MD.

TABLES AND FIGURES

APPENDIX A

Table 1**Summary of the daily number of fish passed by the Conowingo Dam East Fish Passage Facility in 2011.**

<i>Date:</i>	4/25	4/27	5/4	5/8	5/9	5/10	5/11	5/12
<i>Start Fishing Time:</i>	9:00	8:00	8:00	9:00	8:00	8:15	7:30	7:30
<i>End Fishing Time:</i>	15:00	14:00	13:00	13:00	15:00	17:30	19:15	19:20
<i>Hours of Operation:</i>	6.0	6.0	5.0	4.0	7.0	9.3	11.8	11.8
<i>Number of Lifts:</i>	12	11	5	6	8	19	23	23
<i>Water Temperature (°F):</i>	55	58	58.1	58.8	58.3	60.8	61.7	61.9
American Shad	0	0	0	4	7	372	1,337	2,435
Blueback herring	0	0	0	0	0	0	0	0
Alewife	0	0	0	0	0	2	0	0
Gizzard shad	5,764	4,654	355	1,750	10,196	29,992	63,176	50,480
Hickory shad	0	0	0	0	0	1	0	19
Striped bass	0	1	0	0	1	0	8	0
White perch	0	0	0	0	0	0	0	1
Sea lamprey	0	0	0	0	0	0	2	4
Rainbow trout	0	0	0	0	0	0	0	0
Brown trout	0	0	0	0	0	0	0	0
Muskellunge	0	0	0	0	0	0	0	0
Carp	0	2	2	2	1	6	7	25
Quillback	4	2	1	0	3	1	3	5
White sucker	0	0	0	0	0	0	0	0
Shorthead redhorse	3	16	0	4	3	0	0	1
Brown bullhead	0	0	1	0	0	0	0	0
Channel catfish	291	515	284	369	841	982	1,899	26
Rock bass	0	0	0	0	0	0	0	1
Bluegill	0	0	2	2	0	5	2	0
Smallmouth bass	0	2	0	0	0	13	20	25
Largemouth bass	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0
Walleye	0	2	0	0	3	9	36	11
Atlantic Needlefish	0	0	0	0	0	0	0	0
TOTAL	6,062	5,194	645	2,131	11,055	31,383	66,490	53,033

Table 1**Continued.**

<i>Date:</i>	5/13	5/14	5/15	5/16	5/17	5/18	5/19	<i>Season</i>
<i>Start Fishing Time:</i>	7:30	6:45	7:00	7:30	7:30	7:30	7:30	Total
<i>End Fishing Time:</i>	19:30	19:30	19:15	19:45	19:15	19:15	16:00	
<i>Hours of Operation:</i>	12.0	12.8	12.3	12.3	11.8	11.8	8.5	142.4
<i>Number of Lifts:</i>	22	21	24	24	23	22	16	259.0
<i>Water Temperature (°F):</i>	63.5	64.1	65.3	66.1	66.9	66.7	66.9	
American Shad	2,182	5,013	3,326	3,607	1,188	713	387	20,571
Blueback herring	0	5	5	1	0	6	0	17
Alewife	0	0	0	0	0	0	0	2
Gizzard shad	28,859	4,772	14,800	15,617	10,267	7,984	8,856	257,522
Hickory shad	0	0	0	0	0	0	0	20
Striped bass	3	0	0	2	0	1	5	21
White perch	0	0	1	0	2	0	2	6
Sea lamprey	0	9	1	2	1	0	1	20
Rainbow trout	0	0	0	1	0	1	0	2
Brown trout	0	1	0	0	1	0	0	2
Muskellunge	0	0	1	0	0	0	0	1
Carp	13	7	70	79	11	15	13	253
Quillback	13	1	59	32	23	15	5	167
White sucker	0	1	1	2	0	0	0	4
Shorthead redhorse	0	0	53	83	2	9	10	184
Brown bullhead	0	0	3	1	0	0	0	5
Channel catfish	59	459	446	661	1,609	1,067	579	10,087
Rock bass	0	0	7	5	0	1	1	15
Bluegill	1	1	9	5	3	1	0	31
Smallmouth bass	5	0	28	27	13	3	10	146
Largemouth bass	0	1	3	0	0	0	0	4
Yellow perch	0	0	4	3	0	0	0	7
Walleye	9	3	123	51	56	28	29	360
Atlantic Needlefish	0	0	0	6	0	0	0	6
TOTAL	31,144	10,273	18,940	20,185	13,176	9,844	9,898	289,453

Table 2.

Summary of American shad catch, Maryland DNR recaptures, daily average river flow, water temperature, turbidity (secchi), unit operation, entrance gates utilized, attraction flow, and project water elevations during operation of the Conowingo Dam East fish passage facility in 2011.

Date	American Shad Catch	MD DNR Recaptures*	Holtwood River Flow (cfs)	Water Temp. (°F)	Secchi (in)	Maximum Units in Operation	Entrance Gates Utilized	Attraction Flow (cfs)	Tailrace Elevation (ft)	Forebay Elevation (ft)	Crest Gates
4/25	0	0	111,700	53.1	18	11	C/B	310	25.4	108.5	3
4/27	0	0	145,200	57.9	18	11	C/B	310	25.2	108.3	6
5/4	0	0	132,300	59.0	4	11	C/B	310	24.6	108.6	3
5/8	4	0	109,200	57.2	8	11	C	310	24.3	108.5	11
5/9	7	0	90,700	58.4	10	11	C	310	24.5	108.3	11
5/10	372	0	74,800	60.1	22	11	C	310	23.3	108.2	0
5/11	1337	0	64,900	61.6	18	11	C	310	23.4	106.7	0
5/12	2435	1	58,200	63.1	24	11	C	310	22.5	106.5	0
5/13	2182	1	51,500	64.7	24	11	A/C	310	23.0	106.3	0
5/14	5013	6	46,700	65.0	24	5	A	310	19.3	105.8	0
5/15	3326	2	43,500	64.6	24	7	C	310	22.0	106.2	0
5/16	3607	10	45,100	64.5	26	11	C	310	22.8	107.2	0
5/17	1188	1	48,300	65.3	20	8	C	310	22.8	106.8	0
5/18	713	2	55,500	65.4	12	11	C	310	23.0	105.8	0
5/19	387	1	93,100	64.3	20	11	C	310	23.3	107.7	0

Table 3

Hourly summary of American shad passage at the Conowingo Dam East Fish Passage Facility in 2011.

<i>Date:</i>	4/25	4/27	5/4	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	5/16
<i>Observation Time-Start:</i>	9:00	8:00	8:10	8:30	8:10	8:15	8:15	7:30	7:45	7:20	7:40	8:00
<i>Observation Time-End:</i>	15:15	14:15	13:10	13:15	15:10	18:00	19:35	19:45	19:45	19:50	19:30	20:00
Military Time (hrs)												
0700 to 0759	--	--	--	--	--	--	--	25	--	21	38	--
0800 to 0859	--	--	--	--	--	3	64	68	186	8	247	191
0900 to 0959	--	--	--	1	2	2	20	212	135	127	271	466
1000 to 1059	--	--	--	--	--	2	30	147	229	515	474	537
1100 to 1159	--	--	--	1	2	16	53	302	287	543	359	515
1200 to 1259	--	--	--	1	--	16	76	230	194	442	255	318
1300 to 1359	--	--	--	1	--	44	93	269	120	583	292	373
1400 to 1459	--	--	--	--	1	32	105	251	224	546	319	282
1500 to 1559	--	--	--	--	2	80	100	211	199	495	211	189
1600 to 1659	--	--	--	--	--	75	211	121	108	603	375	158
1700 to 1759	--	--	--	--	--	102	282	143	182	495	217	168
1800 to 1859	--	--	--	--	--	--	205	212	190	467	178	226
1900 to 1959	--	--	--	--	--	--	98	244	128	168	90	184
Total	0	0	0	4	7	372	1,337	2,435	2,182	5,013	3,326	3,607

<i>Date:</i>	5/17	5/18	5/19	<i>Season</i>
<i>Observation Time-Start:</i>	7:40	7:40	7:45	<i>Total</i>
<i>Observation Time-End:</i>	19:30	19:30	16:45	
Military Time (hrs)				
0700 to 0759	63	12	2	161
0800 to 0859	118	39	67	991
0900 to 0959	90	116	70	1,512
1000 to 1059	117	58	71	2,180
1100 to 1159	130	82	18	2,308
1200 to 1259	108	67	20	1,727
1300 to 1359	57	25	28	1,885
1400 to 1459	84	25	22	1,891
1500 to 1559	107	60	46	1,700
1600 to 1659	114	85	43	1,893
1700 to 1759	90	82	--	1,761
1800 to 1859	68	50	--	1,596
1900 to 1959	42	12	--	966
Total	1,188	713	387	20,571

Table 4**Summary of selected operation and fish catch statistics at the Conowingo Dam East Fish Passage Facility, 1991 to 2011.**

Year	Number of Days Operated	Number of Lifts	Operating Time (hrs)	Catch (millions)	Number of Species	American shad	Blueback herring	Alewife	Hickory shad
1991	60	1168	647.2	0.651	42	13,897	13,149	323	0
1992	49	599	454.1	0.492	35	26,040	261	3	0
1993	42	848	463.5	0.53	29	8,203	4,574	0	0
1994	55	955	574.8	1.062	36	26,715	248	5	1
1995	68	986	706.2	1.796	36	46,062	4,004	170	1
1996	49	599	454.1	0.492	35	26,040	261	3	0
1997	64	652	640.0	0.719	36	90,971	242,815	63	0
1998	50	652	640.0	0.713	33	39,904	700	6	0
1999	52	610	467.0	1.184	31	69,712	130,625	14	0
2000	45	570	367.8	0.494	30	153,546	14,963	2	0
2001	43	559	359.8	0.922	30	193,574	284,921	7,458	0
2002	49	560	440.7	0.657	31	108,001	2,037	74	6
2003	44	645	416.6	0.589	25	125,135	530	21	0
2004	44	590	390.3	0.716	30	109,360	101	89	0
2005	52	541	434.3	0.378	30	68,926	4	0	0
2006	61	619	429.8	0.715	32	56,899	0	0	4
2007	39	479	335.3	0.539	31	25,464	460	429	0
2008	51	483	407.0	0.944	29	19,914	1	4	0
2009	57	618	496	0.915	30	29,272	71	160	0
2010	59	685	526	0.857	38	37,757	4	1	0
2011	15	259	142.4	0.021	24	20,571	17	2	20

Table 5

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

	Conowingo	Holtwood		Safe Harbor		York Haven	
	East	Number	% of C.E.L.	Number	% of Holt.	Number	% of S.H.
1997	90,971	28,063	30.8%	20,828	74.2%	-	-
1998	39,904	8,235	20.6%	6,054	73.5%	-	-
1999	69,712	34,702	49.8%	34,150	98.4%	-	-
2000	153,546	29,421	19.2%	21,079	71.6%	4,687	22.2%
2001	193,574	109,976	56.8%	89,816	81.7%	16,200	18.0%
2002	108,001	17,522	16.2%	11,705	66.8%	1,555	13.3%
2003	125,135	25,254	20.2%	16,646	65.9%	2,536	15.2%
2004	109,360	3,428	3.1%	2,109	61.5%	219	10.4%
2005	68,926	34,189	49.6%	25,425	74.4%	1,772	7.0%
2006	56,899	35,968	63.2%	24,929	69.3%	1,913	7.7%
2007	25,464	10,338	40.6%	7,215	69.8%	192	2.7%
2008	19,914	2,795	14.0%	1,252	44.8%	21	1.7%
2009	29,272	10,896	37.2%	7,994	73.4%	402	5.0%
2010	37,757	16,472	43.6%	12,706	77.1%	907	7.1%
2011	20,571	21	0.1%	8	38.1%	0	0.0%

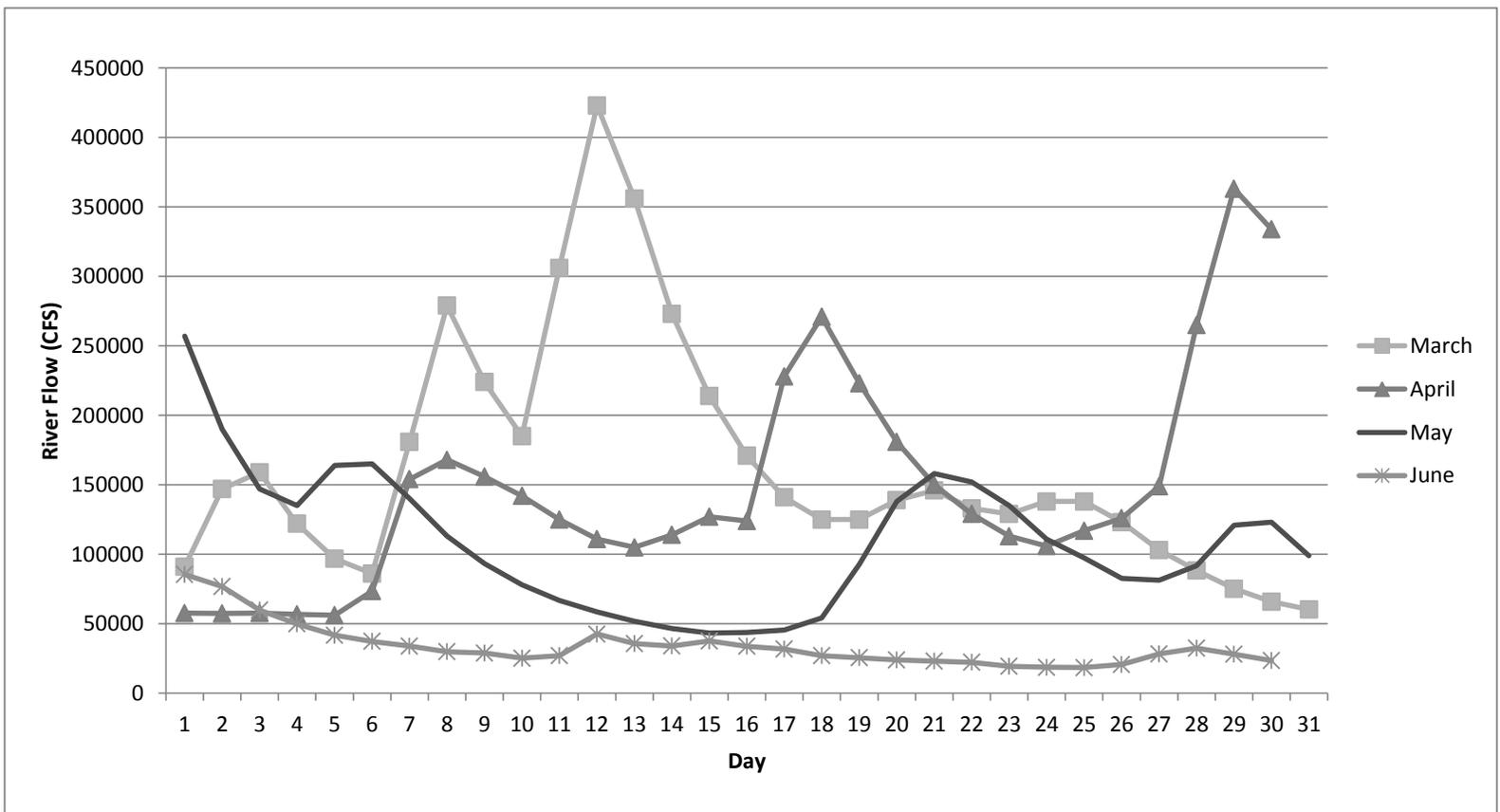


Figure 1
Plot of River Flow (as measured at Holtwood Dam) March through June 2011.

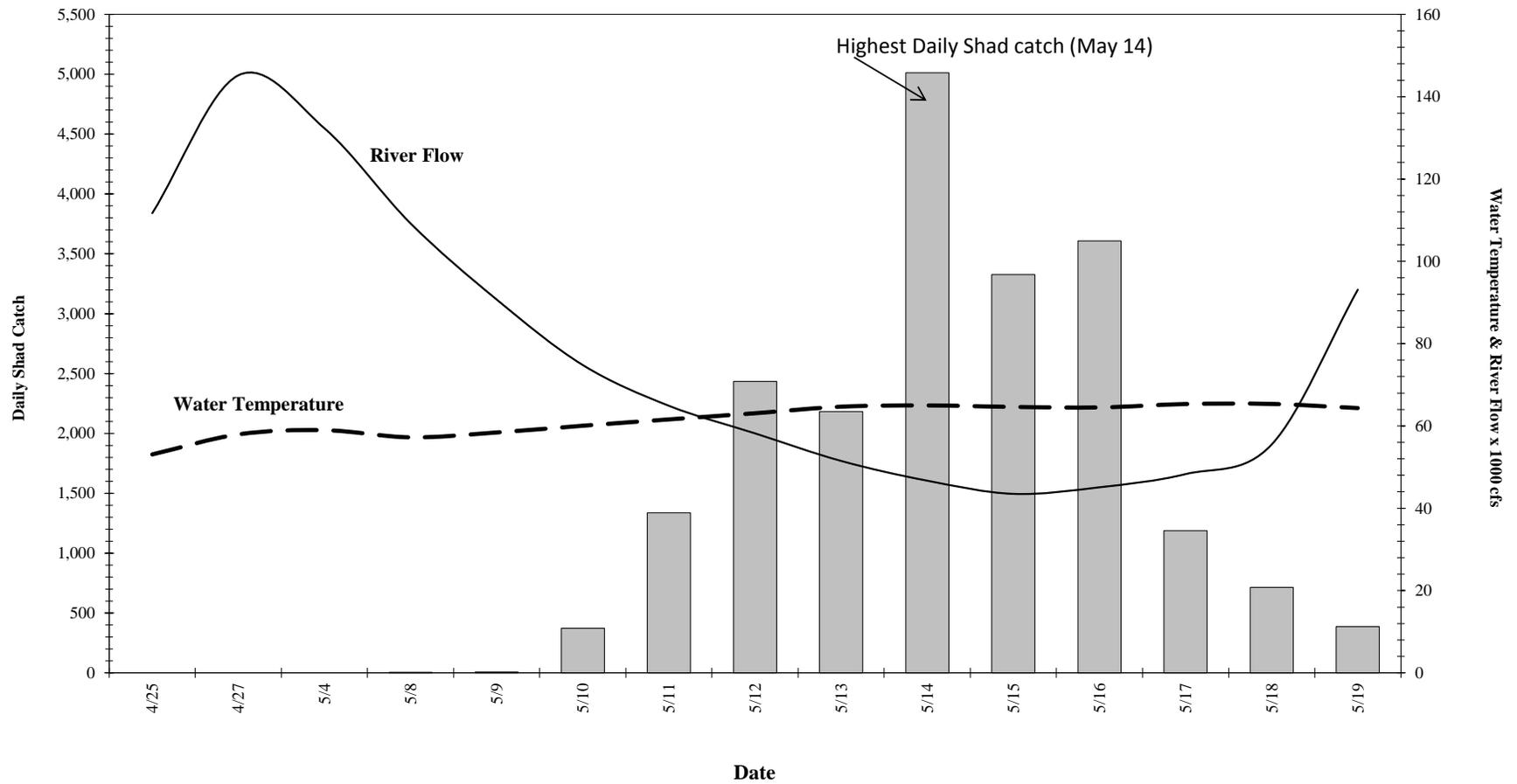


Figure 2

A plot of river flow (x 1000 cfs) and water temperature (°F) as measured at Holtwood Dam, in relationship to the daily American shad catch at the Conowingo East Fish Lift, spring 2011.

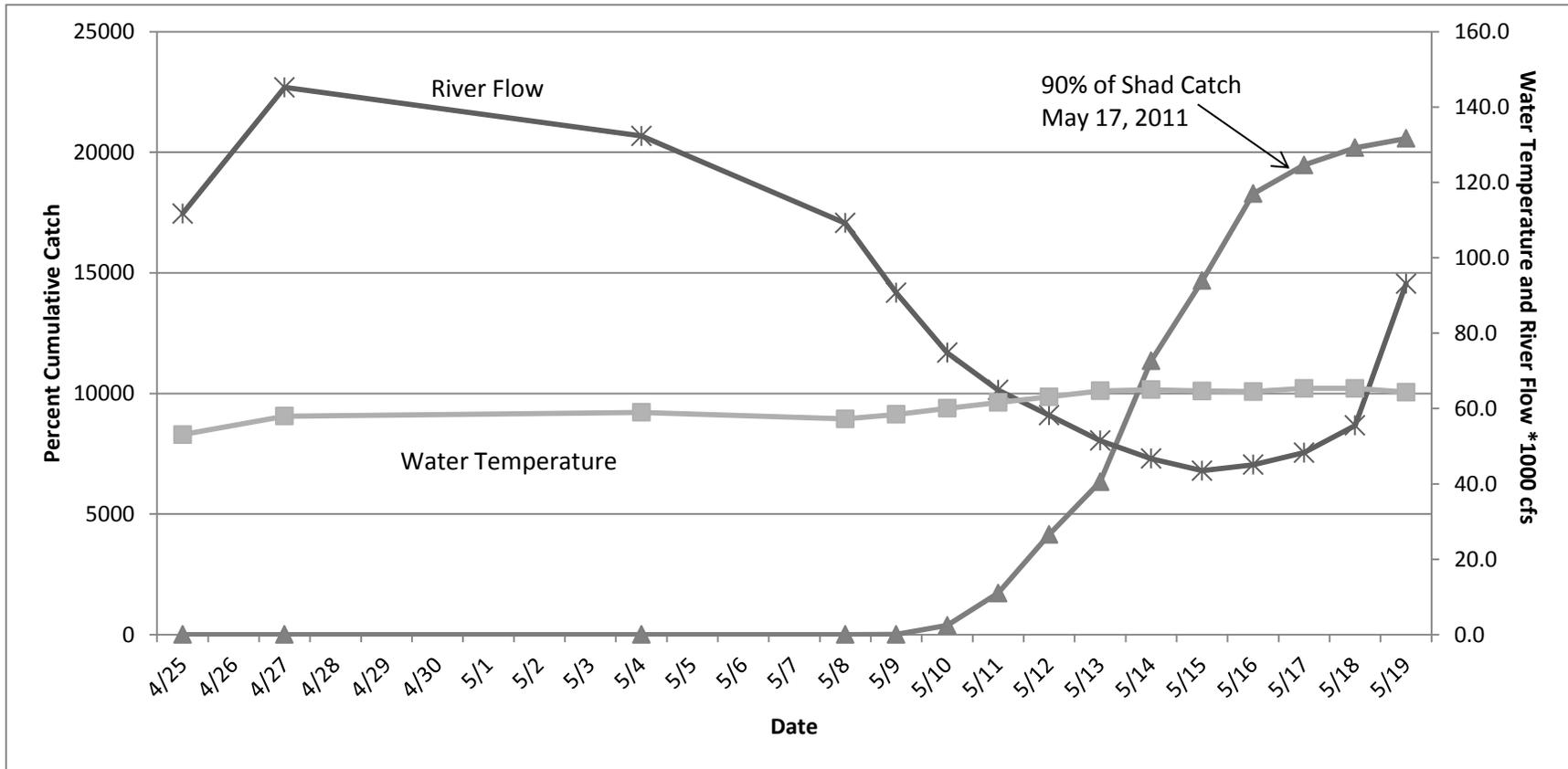
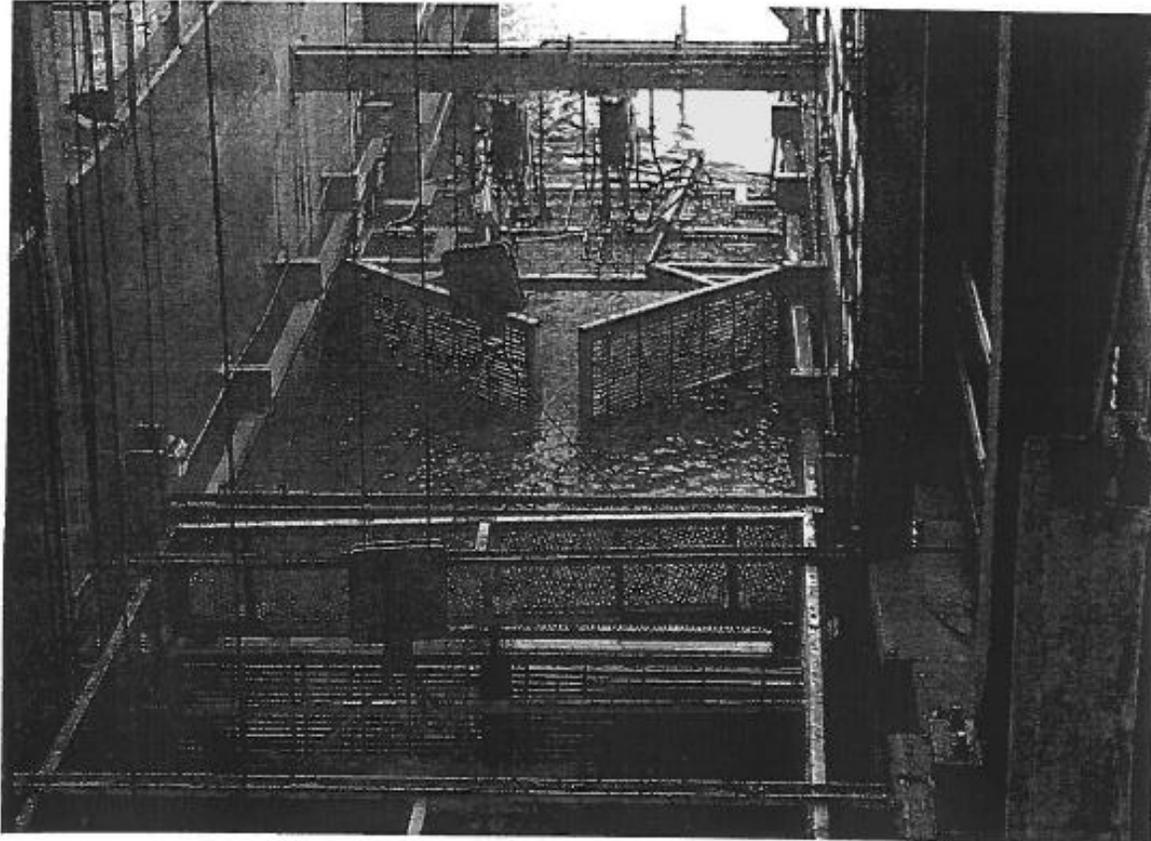


Figure 3

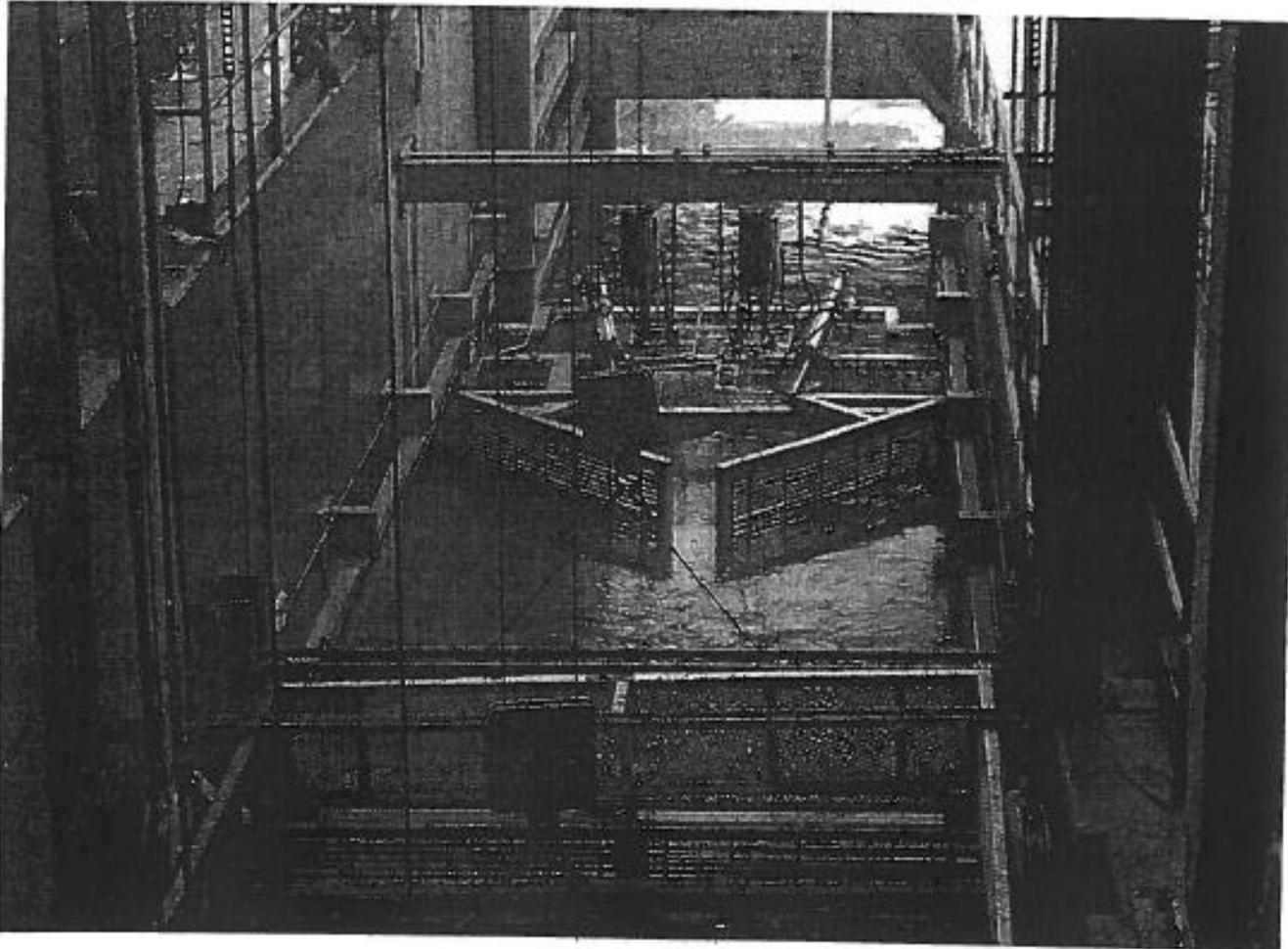
A plot of river flow (x 1000 cfs) and water temperature (°F) as measured at Holtwood Dam, in relationship to the percent cumulative American shad catch at the Conowingo East Fish Lift, spring 2011.

APPENDIX A



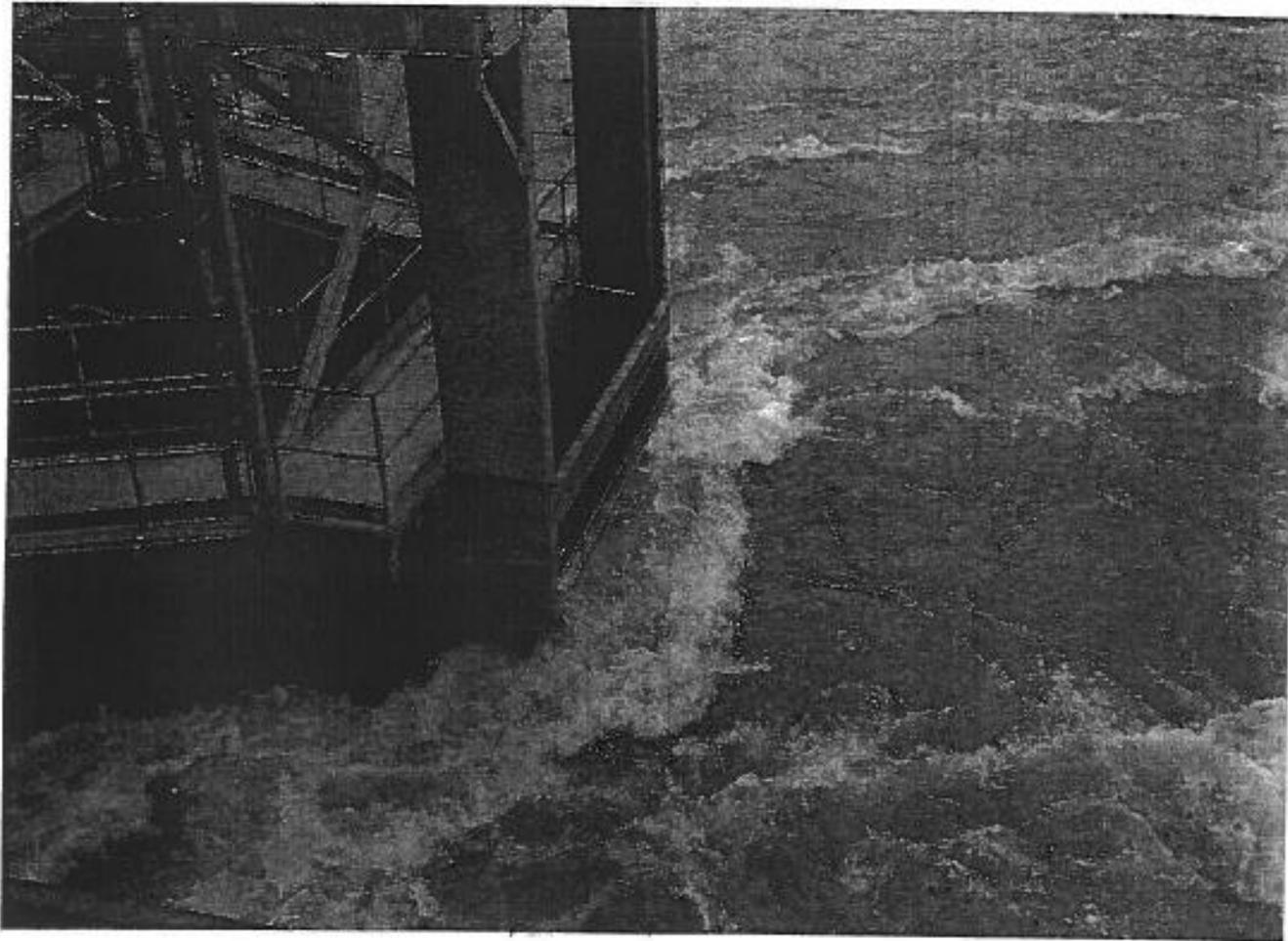
Photograph 1

EFL crowder area with 2 spill gates open, Spring 2011



Photograph 2

EFL crowder area with 4 spill gates open, Spring 2011



Photograph 3

EFL gate A closed: water pouring over top: 6 spill gates open, Spring 2011