

**UPSTREAM FISH PASSAGE EFFECTIVENESS STUDY
RSP 3.5**

CONOWINGO HYDROELECTRIC PROJECT

FERC PROJECT NUMBER 405



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EXECUTIVE SUMMARY

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt Conowingo Hydroelectric Project (Conowingo Project). The current license for the Conowingo Project was issued on 14 August 1980 and expires on 1 September 2014. FERC issued the final study plan determination for the Conowingo Project on 4 February 2010, approving the revised study plan with certain modifications. The final study plan determination required Exelon to conduct a Upstream Fish Passage Effectiveness Study, which is the subject of this report. The objectives of this study were: 1) to determine the fish passage efficiency of the Conowingo East Fish Lift (EFL) and 2) to identify factors, if any, that may influence efficiency on a daily or seasonal basis.

A radio telemetry study was conducted in the spring of 2010 to evaluate Upstream Passage Effectiveness of migratory adult American shad at the EFL. Fish used for the study were collected by either angling in the Conowingo Tailrace or trapping in the Conowingo West Fish Lift (WFL). A total of 151 radio tagged shad were released for the study; 102 were released in the Conowingo Tailrace and 49 were transported five miles downstream to Lapidum, Maryland and released. Shad from both release locations were combined into two run segments used for analysis; the Early-Mid shad run segment included the first 75 shad tagged and released and the Mid-Late shad run segment included the last 76 shad tagged and released.

The following three metrics were calculated: Fishway Attraction Effectiveness, Upstream Fish Passage Efficiency, and Upstream Fish Passage Effectiveness, and their definitions are given below.

Fishway Attraction Effectiveness: - The proportion of fish that enter a fishway from the number of fish available. For this study, “the number of fish available” is considered the number of radio tagged American shad detected on the eight downstream facing antennas located at the Powerhouse. The combined antenna array covered the width of the tailrace from the base of the dam to the upstream tip of Rowland Island.

Upstream Fish Passage Efficiency: - The proportion of fish that enter a fishway and pass upstream from those available. This is the definition used in the FERC (2004) review of fish passage mitigation.

Upstream Fish Passage Effectiveness : - The proportion of fish that enter a fishway, pass upstream, and remain upstream for a minimum of 48 hours from those available.

The findings of this study are summarized as follows:

Under existing Station and EFL operational conditions, 58.9% (89 of 151) of all radio tagged shad were detected in the tailrace making them accessible to the EFL. The remaining 41.1% (62 of 151) of the tagged shad dropped back to areas of the lower Susquehanna River and did not enter the tailrace. As noted by other researchers, drop back behavior related to post-tagging stress is typical of radio tagged shad and can affect migration behavior of up to 40% of the tagged fish.

Early-Mid run shad: - 68.0% (51 of 75) were detected in the tailrace.

Mid-Late run shad: - 50.0% (38 of 76) were detected in the tailrace.

Tailrace-released shad: - 68.6% (70 of 102) were detected in the tailrace.

Lapidum-released shad: - 38.8% (19 of 49) were detected in the tailrace.

Fishway Attraction Effectiveness: Of the 89 radio tagged shad detected in the tailrace, 73.0% (65 of 89) entered into the EFL.

Early-Mid run shad: - 70.6% (36 of 51 in the tailrace) entered into the EFL.

Mid-Late run shad: - 76.3% (29 of 38 in the tailrace) entered into the EFL.

Tailrace-released shad: - 72.9% (51 of 70 in the tailrace) entered into the EFL.

Lapidum-released shad: - 73.7% (14 of 19 in the tailrace) entered into the EFL.

Upstream Fish Passage Efficiency: Of the 89 radio tagged shad detected in the tailrace, 44.9% (40 of 89) completed passage through the EFL.

Early-Mid run shad: - 45.1% (23 of 51) completed passage through the EFL.

Mid-Late run shad: - 44.7% (17 of 38) completed passage through the EFL.

Tailrace-released shad: - 47.1% (33 of 70) completed passage through the EFL.

Lapidum-released shad: - 36.8% (7 of 19) completed passage through the EFL.

Of the 65 shad that entered the EFL, 61.5% (40 fish) successfully passed upstream.

Upstream Fish Passage Effectiveness: Of the 89 radio tagged shad detected in the tailrace, 43.8% (39 of 89) completed passage through the EFL and remained upstream for 48 hours or more after passage.

Early-Mid run shad: - 43.1% (22 of 51) completed passage through the EFL and remained upstream for 48 hours or more after passage.

Mid-Late run shad: - 44.7% (17 of 38) completed passage through the EFL and remained upstream for 48 hours or more after passage.

Tailrace-released shad: - 45.7% (32 of 70) completed passage through the EFL and remained upstream for 48 hours or more after passage.

Lapidum-released shad: - 36.8% (7 of 19) completed passage through the EFL and remained upstream for 48 hours or more after passage.

The 95% confidence interval was within the prespecified limits ($\pm 10\%$) for all three metrics examined.

Twenty-one of 40 (52.5%) radio tagged shad with successful passage through the EFL were manually tracked upstream of the Conowingo Dam. Eighteen of 21 shad were detected in Conowingo Pond. Three of 21 shad were also detected upstream of Safe Harbor Dam; two of these shad successfully passed the York Haven Dam.

Twenty-three of 40 (57.5%) radio tagged shad with successful upstream passage of Conowingo Dam eventually re-entered the tailrace via the turbines. Fifteen of those passing downstream via the turbines were believed alive at last detection. Signals from the other eight shad became stationary after passing downstream via the turbines and were considered dead.

This study in conjunction with the report on Conowingo East Fish Lift Attraction Flows (RSP 3.6) provides useful information about the effectiveness of the EFL and suggests areas of investigation for potential improvements. These studies did not identify any single operational parameter for the Project or the EFL that will suggest substantial improvements in fish passage effectiveness. However, the discrepancy between the number of shad that enter the EFL (73% of available fish) and the number of shad that are successfully passed upstream (45%) is striking. The studies suggest that some physical aspects (e.g., Crowder Gate) may be the cause of this discrepancy and that improvements within the EFL may hold the most promise relative to improving the effectiveness of the EFL. It is recommended that

work in 2011 focus on the physical elements of the EFL (e.g., Crowder Gate) and flow patterns within the EFL. The following are recommended for further studies:

- Analyze EFL structures and hydraulics to increase shad retention inside the structure and to improve passage from the Entrance Channels to the Hopper.
- Collect all American shad by means of angling and release immediately upon tagging.

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LIST OF ABBREVIATIONS

Agencies

FERC	Federal Energy Regulatory Commission
MDNR	Maryland Department of Natural Resources

Units of Measure

C	Celsius, Centigrade
cfs	cubic feet per second
d	day
F	Fahrenheit
fps	feet per second
hr	hour
m	meter
min	minute
MHz	megahertz
mm	millimeter
MW	megawatt
rm	river mile
sec	second

Miscellaneous

EFL	East Fish Lift
F	female
M	male
ILP	Integrated Licensing Process
NOI	Notice of Intent
PAD	Pre-Application Document
PSP	Proposed Study Plan
RSP	Revised Study Plan
WFL	West Fish Lift

DEFINITIONS FOR FISHWAY PASSAGE

Fishway Attraction Effectiveness: - The proportion of fish that enter a fishway from the number of fish available.

Upstream Fish Passage Efficiency: - The proportion of fish that enter a fishway and pass upstream from those available. This is the definition used in the FERC (2004) review of fish passage mitigation referenced in Introduction.

Upstream Fish Passage Effectiveness : - The proportion of fish that enter a fishway, pass upstream, and remain upstream for a minimum of 48 hours from those available.

Upstream Fish Passage Effectiveness is not often evaluated and perhaps difficult to define, as it builds on the Upstream Fish Passage Efficiency estimate. We define it as the effective number of fish that actually continue to migrate upstream, acknowledging that some fish that exit a fishway do not continue upstream migration.

1.0 INTRODUCTION

Exelon Generation Company, LLC (Exelon) has initiated with the Federal Energy Regulatory Commission (FERC) the process of relicensing the 573-megawatt (MW) Conowingo Hydroelectric Project (Project). Exelon is applying for a new license using the FERC's Integrated Licensing Process (ILP). The current license for the Conowingo Project was issued on 14 August 1980 and it will expire on 1 September 2014.

Exelon filed its Pre-Application Document (PAD) and Notice of Intent (NOI) with FERC on 12 March 2009. On 11 and 12 June 2009, a site visit and two scoping meetings were held at the Project for resource agencies and interested members of the public. Following these meetings, formal study requests were filed with FERC by several resource agencies. Many of these study requests were included in Exelon's Proposed Study Plan (PSP), which was filed on 24 August 2009. On 22 and 23 September 22 2009, Exelon held a meeting with resource agencies and interested members of the public to discuss the PSP.

Formal comments on the PSP were filed with FERC on 22 November 2009 by Commission staff and several resource agencies. Exelon filed a Revised Study Plan (RSP) for the Project on 22 December 2009. FERC issued the final study plan determination for the Project on 4 February 2010, approving the RSP with certain modifications.

The final determination required Exelon to conduct an Upstream Fish Passage Effectiveness study on migratory adult American shad (*Alosa sapidissima*) and to monitor their behavior below Conowingo Dam in relationship to Project operations, which is the subject of this report. Findings from this study are synthesized with findings from concurrent studies, namely RSP 3.6 Conowingo East Fish Lift Attraction Flows, to address the need of a future study.

2.0 BACKGROUND

Fishways have been installed at numerous hydroelectric projects on American shad-bearing rivers on the Atlantic coast. Direct estimates of passage efficiency or effectiveness via a specially targeted passage effectiveness study are scarce. Methodologies for reported passage effectiveness or efficiency have also differed, as has the definition of what constitutes passage efficiency. FERC (2004) reported passage efficiency of the Conowingo East Fish Lift (EFL) as the number of American shad passed as a percentage of those estimated to be available. The numerator was the number passed and the denominator was the MDNR's population estimate below Conowingo Dam. This passage-count method is also used at other sites (e.g., dams on the Connecticut River; Merrimack River; and Lehigh River), but does not take into account: (a) the effects of station operations on passage of shad that can be variable between years and within season, and (b) the variable sexual maturity state of migrating shad. Another complicating factor at the Conowingo Dam is the mixed stock of American shad from various river origins; not all fish may be destined to migrate upstream. Additionally, similar efficiency estimate studies on various rivers have not taken into account the post-tagging dropback behavior of American shad. As a result, there was some uncertainty associated with the denominator (the number available for passage) relative to the numerator (the number that actually passed the facility).

The term dropback (or fallback) describes the downstream movement of an upstream migrating anadromous fish after tagging. In a literature review of anadromous shad and herring studies using radio or acoustic tags, post-tagging dropback ranged from 8.6 to 100% (Frank *et al.*, 2009). The spatial-temporal parameters (e.g., how long after release did it take the fish to start moving downstream, how fast did the fish move downstream, how far did the fish move downstream) used to define dropback varied among studies, yet the majority of researchers (63.6%) included fish with dropback in their analysis as long as the fish eventually returned upstream.

To clarify some of the confusion over vague terminology often used interchangeably, the fishway terms and their definitions as used in this report follows:

Fishway Attraction Effectiveness: - The proportion of fish that enter a fishway from the number of fish available. For this study, "the number of fish available" is considered the number of radio tagged American shad detected on the eight downstream facing antennas located at the Powerhouse. The combined antenna array covered the width of the tailrace from the base of the dam to the upstream tip of Rowland Island.

Upstream Fish Passage Efficiency: - The proportion of fish that enter a fishway and pass upstream from those available. This is the definition used in the FERC (2004) review of fish passage mitigation.

Upstream Fish Passage Effectiveness : - The proportion of fish that enter a fishway, pass upstream, and remain upstream for a minimum of 48 hours from those available.

Upstream Fish Passage Effectiveness is not often evaluated and perhaps difficult to define, as it builds on the Upstream Fish Passage Efficiency estimate. We define it as the effective number of fish that actually continue to migrate upstream, acknowledging that some fish that exit a fishway do not continue the upstream migration.

2.1 Project and EFL Descriptions

The Conowingo Hydroelectric Project, built in 1928, is located at river mile (rm) 10 on the Susquehanna River ([Figure 2.1](#)). The powerhouse has a peaking generating capacity of 573 MW and a hydraulic capacity of approximately 86,000 cfs. Flows in excess of station capacity are spilled through two regulating and 50 crest gates. The powerhouse contains seven vertical Francis (numbered 1 through 7) and four mixed-flow Kaplan (numbered 8 through 11) turbines. The seven Francis units have been equipped with aeration systems that permit the unit to draw in air (vented mode) or operate conventionally (unvented mode). The four original Kaplan turbines installed in 1964 were replaced in the 1990's with more efficient mixed-flow Kaplan type turbines. Throughout this report, the small units will be collectively referred to as Francis units and the large units will be collectively referred to as mixed-flow Kaplan units.

The EFL, completed in 1991, is located immediately to the east of the mixed-flow Kaplan units and adjacent to the deflection wall, which separates the tailrace from the spillway ([Figure 2.2](#)). The EFL consists of two functioning Entrance Channels with independent weir gates at the downstream end of each channel to regulate flow. The Entrance Channels are 14 ft high x 10 ft wide and each can discharge 300 cfs of attraction flow, designed to provide velocities ranging from approximately three to six fps inside the entrance gate. The "A" and "C" Entrance Channels border the powerhouse and deflection wall, respectively. The specific entrance gate used to attract shad is dictated by which units are operating. When only Francis units are operating, the "A" Gate is fished; when a mixed-flow Kaplan unit is operating, the "C" Gate is fished.

The EFL Entrance Channels merge into a single Crowder Channel. Entering the Crowder Channel, the fish pass through the Crowder Gate ([Figure 2.2](#)). The gate is slightly opened in a v-shape, allowing fish to enter, but making it difficult to leave. Once a number of fish have passed through the Crowder Gate,

the gate is closed and the fish are trapped. The Crowder Screen upstream of the Crowder Gate is raised allowing the fish to move into the Hopper area at the upstream end of the Crowder Channel. With the Hopper sitting on the bottom of the Crowder Channel, the Crowder Gate is moved forward, concentrating the fish into the area immediately over the Hopper. The Crowder Screen is then lowered into position further corralling the fish, which are then lifted to the Exit Trough. As the 3,500 gallon Hopper is raised to the Exit Trough, the Crowder Gate is returned downstream into its open fishing position. When the Hopper reaches the Exit Trough, a door to the Hopper is opened and the fish and water within are released into the Exit Trough. The Exit Trough is 14 ft wide x 12 ft high x 190 ft long and maintains a water level equivalent to Conowingo Pond elevation. On their own volition, the fish swim by a viewing window situated in a constricted area of the Exit Trough before heading upstream into Conowingo Pond.

Fishing time and/or lift frequency is determined by fish abundance, but the Hopper is cycled at least hourly throughout the day. The method of lift operation is also influenced by fish abundance. When a great number of fish are in the Crowder Channel, the Crowder Screen is raised and lowered without moving the Crowder Gate to trap fish over the Hopper. This mode of operation, called “fast fish”, leaves the Crowder in the normal fishing position and raises the Hopper frequently to remove fish that accumulate in the channel. When fished normally, the entire mechanical process of a single lift cycle takes approximately 15 minutes to complete. When fast fished, the lift cycle time is reduced by a few minutes.

The West Fish Lift (WFL) is located on the west shoreline immediately downstream of the Conowingo Dam. It is similar in design to the EFL with the exception that the Hopper releases fish directly into a Sorting Tank as oppose to a pass-through Exit Trough. Fish are sorted by hand and placed into Holding Tanks (for transport or biological study) or released back into the tailrace.

3.0 METHODS

3.1 Study Objectives and Design

The objectives of this study are to determine Upstream Fish Passage Efficiency of migratory adult American shad at the Conowingo EFL and to identify factors that may influence efficiency on a daily or seasonal basis. To meet the objectives, radio tags were placed into numerous American shad caught and released downstream of Conowingo Dam, and their movements and behavior were monitored in relation to varying conditions.

3.2 Determination of Sample Size

Using a binomial model, we calculated sample sizes for various passage effectiveness levels ranging from 30% to 80%. For a passage effectiveness of 30%, a sample size of 81 fish would be required to obtain a precision of $\pm 10\%$ at a probability level of 0.95; for a 50% effectiveness a sample size of 96 fish is needed. At a passage effectiveness of 80%, a sample size of 62 fish is required to obtain the same level of precision. Consequently, a sample size of 150 fish was deemed necessary to estimate Upstream Fish Passage Effectiveness within $\pm 10.0\%$, 95% of the time. The following table shows the required sample size to needed to achieve a precision of $\pm 10.0\%$, 90% and 95% of the time.

Proportion	1- α	
	0.9	0.95
0.3	57	81
0.4	65	93
0.5	68	96
0.6	65	93
0.7	57	81
0.8	44	62

3.3 Collection of Test Specimens

A release sample size of 150 fish was proposed to encompass the two primary segments of the American shad run (early-mid and mid-late). The anticipated breakdown of these releases was 75 fish each. A subset of 25 fish in each release group was to be collected at the WFL, tagged and transported downstream five miles to Lapidum, Maryland where they would be released. The remaining 50 shad from each group would then be angled, tagged, and released directly into the tailrace. The use of 75 shad would allow an estimate of Upstream Fish Passage Effectiveness with 95% confidence intervals for each shad run segment and for the entire season.

3.3.1 Tailrace Angling and Tagging

All radio tagged shad angled for this study were caught, tagged, and released upstream of Rowland Island. Fishing locations by boat changed during tagging events as powerhouse unit combinations and discharge changed. An individual shad caught by angling was brought to the boat, netted, and assessed for tagging suitability (e.g., general well-being—no wounds, abrasions, loss of equilibrium). Suitable shad was then transferred into a tagging cooler outfitted with fine mesh to immobilize the specimen for tagging and to reduce stress; Unsuitable fish were released. After gathering biological information such as sex and length, a radio tag was orally inserted into the shad's stomach by means of a cannula, guiding it gently through the esophagus. The tagged shad was then placed back into the tailrace. On a few occasions, angled shad were also provided by MDNR biologists fishing nearby in the Conowingo Tailrace.

3.3.2 WFL Trapping and Tagging

Individual shad collected at the WFL were netted out of the Sorting Tank and assessed for tagging suitability. The tagging process and biological data collected for each fish were similar to that done while angling in the tailrace. Once tagged, the shad was placed into a Transport Truck filled with river water and the process repeated until all the shad were tagged for that group. The group of tagged shad was then driven downriver to the Lapidum Boat Launch, netted out of the truck, taken to the shoreline, and released. The process from tagging to release took just over an hour. The transport truck and driver were supplied by MDNR.

Two shad collected on 12 May at the WFL were held and tagged as part of a demonstration for Exelon. These shad were subsequently released directly into Conowingo Tailrace from the WFL Sorting Tank and treated as tailrace-released fish from the Mid-Late shad run segment.

3.4 Radio Telemetry Equipment

3.4.1 Radio Tags

Coded VHF radio transmitters (radio tags) supplied by Lotek Engineering Inc. (Lotek), Newmarket, Ontario, Canada were utilized for this study. The radio tags (model number MCFT-3EM) were digitally encoded and transmitted signals on two frequencies (channels), 150.210 and 151.540 MHz. Each radio tag contained a unique pulse train to allow for individual fish identification (codes). Each cylindrical radio tag measured 11 mm in diameter, 49 mm in length, weighed 4.3 g in water, and had a 455 mm long whip antenna. The radio tags propagated a signal every 2.5 seconds and had a minimum battery life of approximately 206 days.

3.4.2 Receivers

Lotek SRX_400 telemetry receivers installed with version W30 software were utilized to monitor American shad. Prior to release of fish, background noise levels were determined at Conowingo Dam during the calibration process. In terms of radio telemetry, background noise is any ambient electromagnetic noise detected by a receiver that is not produced by a radio tag. In general, hydroelectric facilities are noisy electromagnetic environments due to their production and distribution of electricity. Receivers were configured to exclude background noise by utilizing specific features within the receiver's software. Receivers were set to scan each channel for specific time periods, depending on location. When a signal was received, the scan program temporarily suspended and the validity of the signal was verified and logged or rejected. The receiver measured the duration of a preselected number of pulse intervals and if intervals differed significantly, the signal was rejected. All receivers were time synchronized.

Additionally, a single Lotek SRX_600 telemetry receiver installed with W32 software was used at one of the monitoring location (Rowland Island) because it could be downloaded remotely. Coupled with a Laird ConnexLink 4490 Bluetooth antenna, the receiver was downloaded from shore (Shures Landing) using Aerocomm software.

3.4.3 Antennas

Four types of antennas were used for the study: Laird P1504 four-element Yagi antenna (4-element antenna), Laird PLC1426 six-element Yagi antennas (6-element antenna), Laird PLC1429 nine-element Yagi antennas (9-element antenna), and custom-made underwater antennas (“dropper antenna”). All three types of Yagi antennas are aerial antennas that provide directionality and a large reception range (the more elements, the greater the range, i.e., 9-element antenna has greater range than 6-element antenna, which has greater range than a 4-element antenna). Dropper antennas, which are vertically deployed within the water column, are omnidirectional and provide limited reception range. They are used to determine discrete movement within a specific location of interest. Constructed by stripping the shielded end of a 50-OHM RG58A/U coaxial cable, the length of the stripped portion of cable is a multiple of half the wavelength (λ) of 150 MHz.

3.5 Monitoring Locations and Antenna Arrangement

Monitoring stations were deployed in five general areas on the Susquehanna River below Conowingo Dam: tidal Lower River, Rowland Island, Conowingo Tailrace, EFL, and East Spillway Corner (Figure 3.1). With most of the monitoring locations concentrated near Conowingo Dam, manual tracking was

needed to supply data for the four-mile stretch of river between the Rowland Island monitor and the Lower River monitor (Spencer Island).

3.5.1 Lower River Monitoring Stations

The tidal Lower River monitoring stations included Tomes Landing Marina in Port Deposit (Tomes Landing), the Derickson property in Lapidum (Lapidum), and the lower tip of Spencer Island ([Figure 3.2](#)). The stations in the Lower River were used to identify shad fall back, aid observation of potential spawning habitat around Spencer Island, and assist in determining temporal aspects of upstream forays and any potential velocity barriers affecting their movement upstream (Conowingo Study 3.7, Fish Passage Impediments Study Below Conowingo Dam).

Tomes Landing monitoring station consisted of a receiver and single 9-element antenna mounted on the Tomes Landing Marina's Gas House building and aimed across the river towards the Lapidum monitoring site on the west shoreline. The antenna covered the eastern half of the river downstream of Spencer Island.

Lapidum monitoring station (0.2 miles upstream of the Lapidum Boat Launch) consisted of a receiver and single 9-element antenna mounted on a tree overlooking the river and aimed across the river towards the Tomes Landing monitoring site on the east shoreline. The antenna covered the western half of the river downstream of Spencer Island.

Spencer Island monitoring station consisted of a receiver coupled via switchbox to two 6-element antennas mounted on trees overlooking the lower tip of the island's shoreline. Antenna 1 monitored the eastern channel between Spencer Island and Port Deposit, while Antenna 2 monitored the west channel between Spencer Island and Lapidum.

3.5.2 Rowland Island Monitoring Station

Rowland Island monitoring station was just downstream of the Conowingo Tailrace at the lower tip of Rowland Island ([Figure 3.3](#)). This station helped identify immediate fall back for shad released into the tailrace as well as assisted in detailing movements in and out of the tailrace. The Rowland Island monitoring station consisted of a remotely downloaded receiver (SRX_600) coupled via switchbox to two 6-element antennas mounted on a pole at the lower tip of the island. Antenna 1 monitored the eastern channel between Rowland Island and the cut in the spillway leading towards Octoraro Creek, while Antenna 2 monitored the west channel between Rowland Island and west shoreline near Shures Landing Boat Launch.

3.5.3 Conowingo Tailrace Monitoring Stations

The Conowingo Tailrace monitoring stations included the Francis Units station and the Mixed-flow Kaplan Units station. Together, these stations monitored the area downstream of Unit 11 to the east, to Unit 1 and the Fisherman's Wharf to the west, all the way down river to the upstream tip of Rowland Island ([Figure 3.4](#)). The stations identified tailrace presence or the "fish available" (the denominator) in the fishway attraction effectiveness and passage efficiency and effectiveness definitions (equations). In addition, the Conowingo Tailrace monitoring stations detected any fall back through the powerhouse after shad passed upstream through the EFL.

The Francis Units station consisted of a receiver coupled via switchbox to four 4-element antennas mounted on the tailrace catwalk railing and distributed equally over the Francis units. Antenna 1 was mounted at Unit 1, Antenna 2 was mounted at Unit 3, Antenna 3 was mounted at Unit 5, and Antenna 4 was mounted at Unit 7.

The Mixed-flow Kaplan Units station consisted of a receiver coupled via switchbox to four 4-element antennas mounted on the upper tailrace catwalk railing and distributed equally over the Mixed-flow Kaplan units. Antenna 1 was mounted at Unit 8, Antenna 2 was mounted at Unit 9, Antenna 3 was mounted at Unit 10, and Antenna 4 was mounted at Unit 11.

3.5.4 EFL Monitoring Stations

EFL monitoring stations included "A" Gate Aerial, "A" Gate Channel, "C" Gate Aerial, "C" Gate Channel, and Exit Trough ([Figure 3.5](#)). The Aerial monitoring stations identified shad near the EFL. The Channel monitoring stations identified shad presence in the EFL, or the "proportion of fish" (the numerator) in the Fishway Attraction Effectiveness definition (equation). The Exit Trough monitoring station identified shad passage through the EFL, or the "proportion of fish" (the numerator) in the Upstream Fish Passage Efficiency definition (equation).

"A" Gate Aerial monitoring station consisted of a receiver and single 4-element antenna mounted onto "A" Gate Entrance perpendicular to the powerhouse discharge. The antenna was calibrated to have very limited range (< 75 ft.) so that it detected only fish in front of the "A" Gate Entrance.

"A" Gate Channel monitoring station consisted of a receiver coupled via switchbox to two dropper antennas. Antenna 1 monitored shad entering the "A" Gate Entrance. Antenna 2 monitored shad further upstream in the "A" Gate Entrance Channel closer to the EFL Crowder Gate.

“C” Gate Aerial monitoring station consisted of a receiver and single 4-element antenna mounted onto “C” Gate Entrance parallel to the downstream deflection wall separating the tailrace from the spillway. The antenna was calibrated to have very limited range (<75 ft.) so that it detected only fish in front of the “C” Gate Entrance.

“C” Gate Channel monitoring station consisted of a receiver coupled via switchbox to two dropper antennas. Antenna 1 monitored shad entering the “C” Gate Entrance. Antenna 2 monitored shad further upstream in the “C” Gate Entrance Channel closer to the EFL Crowder Gate.

The Exit Trough monitoring station consisted of a receiver and a single dropper antenna mounted upstream of the Exit Trough Viewing Window. The antenna was calibrated to detect only those shad in the upstream portion of the Exit Trough.

3.5.5 East Spillway Corner Monitoring Station

The East Spillway Corner monitoring station was deployed at the far eastern corner of the spillway ([Figure 3.4](#)). This station helped identify fish moving into the spillway as well as movement along its periphery to and from the tailrace. The East Spillway Corner monitoring station consisted of a receiver and a single 6-element antenna mounted on a fence. The antenna was oriented across the spillway toward just downstream of the deflection wall and upstream of Rowland Island. The coverage of the far-field antenna array reached across the entire width of the spillway including a small portion of the tailrace downstream of the EFL. Due to limited boat access, the coverage of the near-field antenna array could not be calibrated, but was estimated at roughly half the far-field distance.

3.6 Data Collection and Analysis

Data were stored in receivers as either a single event or a period of multiple events. If a shad was detected and remained in the reception area for a given period of time, it was recorded as a continuous event. Single events or events occurring greater than five minutes apart were recorded individually. Data stored for each event included start date, start time, channel, code, average pulse rate, average signal strength, end date, and end time.

Data were off-loaded from receivers three times a week throughout the study period with a laptop computer and stored on harddrive and flashdrive. Backup copies of all telemetry data were made prior to receiver initialization. Data were consolidated into a PC database for review and verification.

3.7 Manual Tracking

Manual tracking by boat was done for all release groups to supplement the data collected from the fixed monitoring locations. A crew surveyed the river weekly below Conowingo Dam from the tailrace to the I-

95 Bridge, approximately 1.5 miles downstream of the Lower River monitors. When a tagged shad was located, GPS coordinates, date, and time were recorded to supplement the fixed monitor data. After all releases were made, manual tracking was expanded to incorporate a weekly survey of Conowingo Pond from the Baltimore Water Intake to the Norman Wood Bridge, approximately 0.2 to 13.4 miles upstream of the dam, respectively.

4.0 RESULTS

4.1 Tagging and Release Data

A total of 151 radio tagged adult American shad were released in six groups. At the time of release water temperature ranged from 14.5°C to 20.8°C (58.1 to 69.4°F). A water temperature less than 21.1°C (70.0°F) was desirable to avoid inclusion of partially spent and post-spawned fish. At the time of release plant discharge ranged from 7,500 to 62,510 cfs. No spill occurred during the study. A listing of all radio tagged adult American shad released downstream of the Conowingo Dam during the spring of 2010 is presented in [Appendix A](#).

One hundred American shad were collected by angling in the Conowingo tailrace on four separate occasions ([Table 4.1](#)). Release Group 1 on 20 April (18 shad) and Release Group 2 on 22 April (32 shad) were part of the early-mid shad run segment. Release Group 4 on 7 May (27 shad) and Release Group 5 on 10 May (23 shad) were part of the mid-late shad run segment. An additional two shad caught at the WFL on 12 May (Release Group 6L) were tagged with previously recovered radio tags and released directly into the tailrace from the WFL. For analysis purposes, these two shad were added to the 100 shad angled in the tailrace for a total of 102 tailrace-released shad.

Fifty-one American shad (including the two ultimately released into the tailrace) were collected by trapping in the WFL on two separate occasions ([Table 4.1](#)). One shad from the second Lapidum release group was disoriented after transport and removed from the study. The remaining 49 radio tagged fish were transported five miles downriver to the Lapidum Boat Launch and released. Release Group 3 on 28 April (25 shad) was part of the early-mid shad run segment. Release Group 6 on 12 May (24 shad) was part of the mid-late shad run segment.

Overall, 77 (51.0%) males and 74 (49.0%) females were radio tagged for the 2010 study. Tailrace-released shad consisted of 59 (57.8%) males and 43 (42.2%) females, while Lapidum-released shad consisted of 18 (36.7%) males and 31 (63.3%) females ([Table 4.1](#)). No regurgitation of tags occurred.

4.2 Fish Passage Statistics

Detection rates and known disposition of released shad were high. The data that address the principal objective of the study are as follows ([Table 4.2](#)):

Total Shad Released

N = 151

Early-Mid 75 (49.7%)

Mid-Late 76 (50.3%)

Shad Detected in Tailrace (post drop-back)

N = 89 Early-Mid 51 (57.3%) Mid-Late 38 (42.7%)

Fishway Attraction Effectiveness

N = 65 Early-Mid 36 (55.4%) Mid-Late 29 (44.6%)

Upstream Fish Passage Efficiency

N = 40 Early-Mid 23 (57.5%) Mid-Late 17 (42.5%)

Upstream Fish Passage Effectiveness

N = 39 Early-Mid 22 (56.4%) Mid-Late 17 (43.6%)

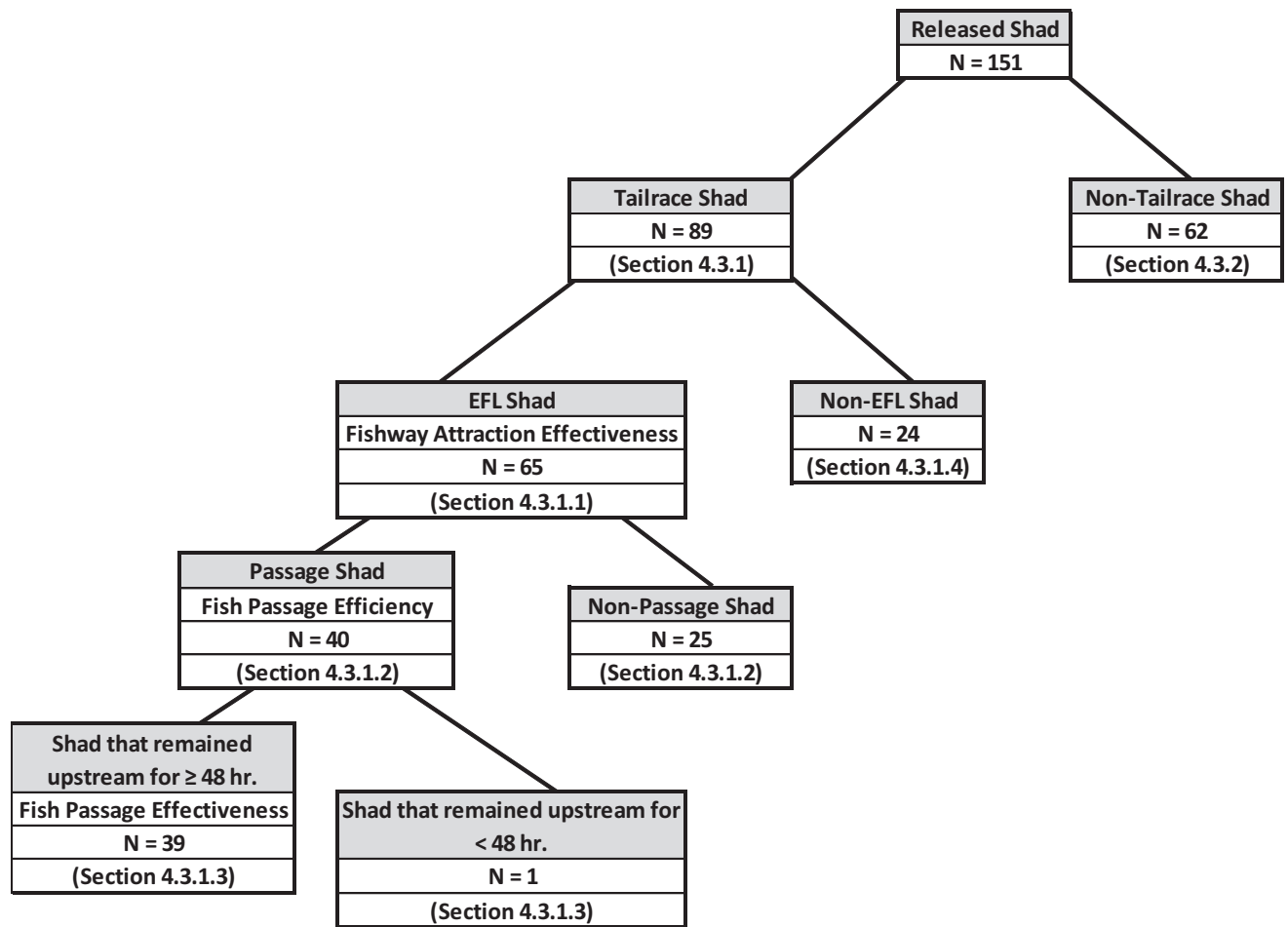
Non-tailrace

N = 62 Early-Mid 24 (38.7%) Mid-Late 38 (61.3%)

4.3 Shad Behavior in the Study Area

To facilitate behavioral descriptions for the groups of shad identified above, all released shad were broken into two groups based on their observed behavior: Tailrace Shad (N = 89) and Non-Tailrace Shad (N = 62). The Tailrace Shad group consisted of two sub-groups: EFL Shad (N = 65) and Non-EFL Shad (N = 24). Within the EFL Shad sub-group, there were two divisions: Passage Shad (N = 40) and Non-Passage Shad (N = 25). Finally, the Passage Shad sub-division was partitioned into shad that remained upstream for 48 hours (N = 39) and shad that did not remain upstream for 48 hours (N = 1).

The following key is an aid designed to help the reader better recognize the interconnected relationship between the various groups and sub-groups (movement classifications) as they are described within the following report sections.



The composition of each movement classification is presented in [Table 4.3](#).

4.3.1 Tailrace Shad

A total of 89 of the 151 radio tagged American shad was detected in the Conowingo Tailrace. These 89 shad represented the fish available for passage and formed the denominator for the Fishway Attraction Effectiveness, Upstream Fish Passage Efficiency, and Upstream Fish Passage Effectiveness calculations. Seventy were tailrace-released fish and 19 were Lapidum-released fish. Average travel time to the tailrace after initial drop back for tailrace-released fish was 6 days 22 hours 37 minutes ([Table 4.4](#)). Average travel time to initial tailrace detection for Lapidum-released fish was 11 days 6 hours 21 minutes. In general, shad tagged earlier in the season took longer to move back into the tailrace than those shad tagged later in the season. For a comparison of travel times to the tailrace between movement classifications by release location, refer to [Table 4.5](#) and [Appendix B](#).

Tailrace residency was greatest downstream of the Francis units. The greatest residency was on antennas located mid-dam, at Unit 5 and Unit 7, and to a lesser extent Unit 3. The greatest residency on the mixed-flow Kaplan units was on the antenna located at Unit 8, adjacent to the Francis units. Tagged fish actively moved throughout the tailrace and were detected on all antennas, but tended to congregate near the Francis units that were running. Fish avoided the area immediately downstream of the mixed-flow Kaplan units when operating, preferring to stay to the periphery of flow. A series of accompanying animations were created to visually illustrate radio tagged shad movement in relationship to generation (see accompanying DVR).

4.3.1.1 EFL Shad (Fishway Attraction Effectiveness)

A total of 65 (65 of 89, 73.0%) radio tagged American shad was detected in the EFL. These shad formed the numerator of the calculation of Fishway Attraction Effectiveness. Fifty-one were tailrace-released fish and 14 were Lapidum-released fish. Average travel time from release to initial detection inside the EFL for tailrace-released fish was 11 days 5 hours 17 minutes. Average travel time from release to initial detection inside the EFL for Lapidum-released fish was 13 days 19 hours 35 minutes ([Table 4.5](#)).

A total of 102 forays were made into the EFL by the 65 radio tagged shad ([Table 4.6](#)). Two shad made only a single foray as far as the Entrance Gate dropper antennas before leaving the EFL. Sixty-three fish were detected on the Entrance Channel's upper dropper antennas as they continued upstream, well within the EFL and only feet away from the Crowder Gate. Time spent in the EFL for all 65 shad that entered were generally short. The average duration within the EFL downstream of the Crowder Gate prior to ascent to the Exit Trough was 29 minutes 18 seconds. The median duration prior to lifting was 16 minutes 9 seconds (data for these calculation are provided in Appendices D, E, and F).

4.3.1.2 Passage Shad (Upstream Fish Passage Efficiency)

A total of 40 (40 of 89, 44.9%) radio tagged American shad was successfully passed upstream of Conowingo Dam through the EFL. These shad formed the numerator of the calculation of Upstream Fish Passage Efficiency. Thirty-three were tailrace-released fish and seven were Lapidum-released fish. These 40 shad were 61.5% of the 65 shad that entered the EFL. Average travel time from release to passage for tailrace-released fish was 13 days 5 hours 35 minutes. Average travel time from release to passage for Lapidum-released fish was 11 days 14 hours 3 minutes.

Twenty-nine of 40 (72.5%) shad made successful passage on their first foray attempt into the EFL. Eleven of 40 (27.5%) shad that later passed the EFL had unsuccessful initial forays into the EFL. These 11 shad

made a combined 19 unsuccessful forays into the EFL prior to passage. The remaining 25 radio tagged shad detected in the EFL but never passed, made a total of 42 foray into the EFL without passage.

Average foray duration within the EFL (downstream of the Crowder Gate) for successful passage was 26 minutes compared to 33 and 32 minutes for unsuccessful forays of fish that later passed and never passed, respectively. The median foray duration within the EFL (downstream of the Crowder Gate) for successful passage was 12 minutes compared to 20 and 16 minutes for unsuccessful forays of fish that later passed and never passed, respectively ([Table 4.6](#), [Figure 4.1](#)).

Overall, the average time it took a shad to make a repeat foray into the EFL was 2 days and 19 hours with a median time of 1 day and 22 hours. For the 11 shad that later passed, the average time it took a fish to make a repeat foray into the EFL was 2 days and 8 hours with a median time of 1 day and 23 hours. Only seven of the 25 radio tagged shad that never passed the EFL made repeat forays. The average time it took these fish to make a repeat foray into the EFL was 3 day and 9 hours with a median time of 1 day and 23 hours (data for these calculations are provided in [Appendices D](#), [E](#), and [F](#)).

Collectively, 58.5% of the radio tagged shad that successfully passed upstream entered the EFL through the “A” Gate Entrance, which was operated 43.0% of the time in 2010. The “A” Gate is only used when no mixed-flow Kaplan units are operating. Conversely, 41.5% of the radio tagged shad that successfully passed upstream entered the EFL through the “C” Gate Entrance, which was operated 57.0% of the time in 2010. Forays into the EFL were evenly distributed among the gate entrances with 50 and 52 of the forays occurring at the “A” and “C” Gate Entrances, respectively ([Table 4.7](#)). For a complete listing of generation (cfs) during each foray into the EFL, see [Appendix C](#).

Radio tagged shad passage at the Conowingo EFL occurred at temperatures ranging from 13.9 to 20.9°C (57.0 to 69.6°F). Nearly two-thirds of the radio tagged shad (27) passed at water temperatures of 15.5 to 15.9°C (59.9 to 60.6°F) and 20.5 to 20.9°C (68.9 to 69.6°F, [Figure 4.2](#)). Radio tagged shad made successful and unsuccessful forays into the EFL under various water temperatures. When all forays into the EFL are plotted against water temperatures, no relationship was apparent ([Figure 4.3](#)).

Shad passage at the Conowingo EFL occurred at plant discharges ranging from 7,500 to 85,000 cfs ([Figure 4.4](#)). Over one-third of the radio tagged shad passed at the May minimum flow of 7,500 cfs, while 58.5% did so under plant discharge of less than 22,500 cfs. The third most successful flow range for passage was 60,000 to 74,499 cfs, with 19.5% of the shad passing under these conditions.

Thirty two percent of forays were made at prevailing minimum flow, while 47.1% were made under plant discharge of less than 22,500 cfs. Nonetheless, forays were made under higher flows as well; 22.5% of forays occurred at flows ranging from 30,000 to 44,499 cfs and 20.6% of forays were made at flows ranging from 60,000 to 74,999 cfs ([Figure 4.5](#)).

Radio tagged American shad with successful passage at the EFL did so under 10 of 16 various Conowingo turbine-generating combinations available during the study. Conowingo powerhouse and EFL operational conditions for individual fish entering the EFL are listed in Appendices. Refer to [Appendix D](#) for successful forays, [Appendix E](#) for unsuccessful forays of fish that later passed upstream through the EFL, and [Appendix F](#) for unsuccessful forays of fish that never passed upstream through the EFL.

One shad was lifted by the Hopper to the Exit Trough, but died in the trough before completing passage. The radio tag from this shad was ultimately used to tag one of the shad procured for the WFL demonstration and later released into the tailrace (see above). This shad is one of the 25 shad that entered the EFL without successful passage.

Radio tagged shad passed the dam on 15 different days between 30 April and 24 May. The best day for passage of radio tagged shad was 12 May when nine shad passed the dam ([Figure 4.6](#)). Passage occurred between 0800 and 1800 hours with the most successful forays occurring between 1000-1200 hours and 1500-1800 hours ([Figure 4.7](#)). For a further examination of Conowingo and EFL operations during tagged shad forays and passage through the EFL, refer to Conowingo RSP Study 3.6, Conowingo EFL Attraction Flows.

There did not appear to be a single variable that consistently provided the best fish passage conditions or guaranteed high rates of successful upstream passage based on Pearson Correlation analysis (RSP 3.6 Conowingo East Fish Lift Attraction Flows). Radio tagged shad passed upstream over a wide range of turbine-generation combinations, water temperatures, EFL settings, and attraction flow water velocities. On several occasions, forays leading to successful passage of radio tagged American shad occurred simultaneously with unsuccessful forays of both shad that later passed and shad that never passed the EFL. The fishway attraction effectiveness value (73%), clearly shows that American shad are successfully entering the EFL, but not all are passing through the Crowder Gate and being lifted up to the Exit Trough. Sixty-three of 65 shad (97%) that entered the EFL moved within a few feet of the Crowder Gate.

4.3.1.3 Shad that remained upstream for ≥ 48 hours (Upstream Fish Passage Effectiveness)

A total of 39 (39 of 89, 43.8%) radio tagged American shad made passage through the EFL and remained upstream for greater than 48 hours. These shad formed the numerator of the calculation of Upstream Fish Passage Effectiveness. One fish passed into Conowingo Pond, but returned to the tailrace through Unit 5, five hours after leaving the Exit Trough. Units 2, 3, 4, 5, 6, 7, 8, and 9 were operating at the time the fish re-entered the tailrace. The fish moved downstream to the Lower River monitors before returning to the EFL and successfully passing a second time within 22 hours of its first passage.

The study objective of determining Upstream Fish Passage Effectiveness at the Conowingo EFL was accomplished. Thirty-nine shad passed through the EFL and remained upstream for at least 48 hours out of the 89 shad accessible in the tailrace. Overall Upstream Fish Passage Effectiveness is $P = 0.4382$ ($L95=0.33455$ $U95=0.54723$). Twenty-three of the 51 Early-Mid run segment shad that were present in the tailrace passed through the EFL, but only 22 remained upstream for at least 48 hours. Upstream Fish Passage Effectiveness for the Early-Mid segment is $P = 0.4314$ ($L95=0.29628$ $U95=0.57680$). Seventeen of the 38 Mid-Late run segment shad that were present in the tailrace passed through the EFL, all 17 remained upstream for at least 48 hours. Upstream Fish Passage Effectiveness for the Mid-Late is $P = 0.4474$ ($L95=0.28997$ $U95=0.61525$). Precision estimates for Fishway Attraction Effectiveness and Upstream Fish Passage Efficiency calculations can be found in [Table 4.2](#).

4.3.1.4 Non-EFL Shad (In the Tailrace)

A total of 24 radio tagged American shad were detected in the tailrace without making a foray into the EFL. The proximity to the EFL for these fish is as follows: 62.5% (15 of 24) were detected on EFL aerial antennas mounted on the Entrance Gate structures. Ten were detected on both aerial antennas; three were detected on only the “C” Gate Aerial antenna and two were detected on only the “A” Gate Aerial antenna. The EFL aerial antennas were setup to have a limited detection range of less than 75 ft. The remaining 37.5% (9 of 24) Non-EFL shad were detected closest to the fishway on tailrace antennas; two were detected on Unit 10 antenna, five were detected on Unit 9 antenna, one was detected on Unit 8 antenna, and one was detected on Unit 7 antenna.

Nineteen of the 24 Non-EFL shad were released in the Conowingo Tailrace. Fifteen of the nineteen (79.0%) made at least one trip downstream to the Lower River antennas and returned to the tailrace. Fourteen made multiple trips, with one shad making eight trips downstream to the Lower River monitors and returning to the tailrace seven times. The remaining five Non-EFL shad were released at the Lapidum Boat Launch. All five made trips from the tailrace downstream to the Lower River monitors, but only one made a return trip to the tailrace.

One of the 24 Non-EFL shad made 10 trips downstream to the Rowland Island monitor, including two trips to the Lower River monitors before being caught in the WFL and used in a hormone trial study. Its closest encounter with the EFL had been on the “C” Gate Aerial antenna having just left the Unit 10 antenna array.

Collectively, the 24 Non-EFL shad moved downstream to the Rowland Island monitor 127 times and on 50 of those occasions continued downstream to the Lower River monitors. The average number of tailrace to Rowland Island trips per shad was 5.3 and the average number of tailrace to Lower River trips per shad was 2.1 ([Appendix H](#)). In comparison, the average number of tailrace to Rowland Island trips per shad was 5.9 and 6.7 for Passage shad and Non-Passage shad in EFL, respectively. The average number of tailrace to Lower River trips per shad was 1.3 and 2.6 for Passage shad and Non-Passage shad in EFL, respectively. While not the focus of the study, it is interesting to note that the median dropback time for Non-EFL shad leaving the tailrace was 2 hours and 21 minutes, considerably longer than the median dropback times of 51 minutes and 48 minutes for Passage shad and Non-Passage shad in EFL, respectively.

4.3.2 Non-Tailrace Shad

A total of 62 (41.1%) radio tagged American shad were never detected in the Conowingo Tailrace after initial release. The Non-Tailrace group included eight tagged shad that were never detected on any of the fixed monitors or by weekly mobile tracking efforts after release at Lapidum Boat Launch. Literature review indicates that a certain proportion of radio tagged shad migrate little or dropback shortly after tag and release (e.g., Leggett 1976; RMC 1990; Sprankle 2005; Olney *et al.* 2006). Depending upon site-specific characteristics and prevailing hydrological conditions, post-tagging stress can affect migrational behavior of up to 40 % of American shad. Released shad departed the tailrace within 1 hour, exhibiting drop back behavior typically noted for tagged shad in other studies, notably work by Leggett (1976). Many of the tailrace-released shad from this group spent some time around Rowland Island before moving downriver, but none of them returned to Rowland Island after detection on the Lower River monitors ([Table 4.8](#)). One Lapidum-released shad was detected on the west side of Rowland Island five days after release and resided there for 27 minutes before returning downriver. There was no change in generation for more than four hours after the fish left the monitoring site.

Movement of the Non-Tailrace Shad among the Lower River monitors was common. For example, a total of 32 (51.6%) shad moved upriver to the Spencer Island monitor at least once after detection downriver at

either the Lapidum or Tomes Landing monitors ([Table 4.9](#)). A complete listing of radio tagged shad presence on Non-Tailrace monitors is presented in [Appendix I](#).

4.4 Animation

Animations were prepared to accompany this report to show visually the movement of 89 radio tagged shad within the study area in relationship to Conowingo Station operations. These animations will be provided on DVR with the final report.

4.5 Manual Tracking of Tagged Shad Upstream of Conowingo Dam

Manual tracking of radio tagged American shad upstream of Conowingo Dam started on 21 May and continued on a weekly basis through 2 August. The upstream surveys covered an area of the river from the Baltimore Water Intakes to the Norman Wood Bridge, approximately 13 miles. Weekly surveys of the Conowingo Pond were supplemented by additional manual tracking upriver of Norman Wood Bridge through another radio telemetry study that ran concurrently. This study surveyed only portions of the river from Safe Harbor Dam (rm 31) to York Haven Dam (rm 55), approximately 24 miles.

Twenty-one of 40 (52.5%) radio tagged shad with successful passage through the EFL were manually tracked upstream of the Conowingo Dam. Nineteen of 33 (57.6%) tailrace-released fish with successful passage were detected upstream and two of seven (28.6%) Lapidum-released fish with successful passage were detected upstream. Nine of 23 (39.1%) Early-Mid run shad with successful passage were detected upstream and 12 of 17 (70.6%) Mid-Late run shad with successful passage were detected upstream. It should be noted that surveys in the Conowingo Pond started after all radio tagged shad were released. Three shad had already re-entered the Conowingo Tailrace prior to the start of manual tracking surveys in the Conowingo Pond.

Eighteen of 21 shad detected upstream of Conowingo Dam were detected in Conowingo Pond, eight were detected exclusively upstream of MRPSS and eight were detected exclusively downstream of MRPSS. The remaining two shad detected in Conowingo Pond were detected both upstream and downstream of MRPSS. No radio tagged shad were detected in the MRPSS reservoir during the two boat surveys conducted on 7 June and 14 June. Three of 21 shad detected upstream of Conowingo Dam were also detected upstream of Safe Harbor Dam; two of these shad successfully passed the York Haven Dam.

Manual tracking of radio tagged American shad downstream of Conowingo Dam started on 27 April and continued on a weekly basis through 2 August. The downstream surveys covered an area of the river from the Conowingo Dam to the I-95 Bridge, approximately 6.5 miles. Data collected on downstream surveys

enhanced data collected from fixed monitor detections, and is not discussed independently from the fixed monitor data in this report.

4.6 Final Disposition of Tagged Shad

The fate of 143 out of 151 (94.7%) fish tagged and released was known with a high degree of certainty, including all 102 tailrace-released fish. Twenty-three of 40 (57.5%) radio tagged shad with successful upstream passage of Conowingo Dam eventually re-entered the tailrace via the turbines after remaining upstream for at least 48 hr; the earliest return to the tailrace was 3 days 21 hr after exiting the trough ([Appendix G](#)). Average and median residency upstream of the Conowingo Dam was 20 and 21 days for these 23 shad, respectively. Seventeen of the 40 shad that passed upstream (42.5%) were last detected upstream of the dam. The fate of the remaining shad is provided in [Appendix J](#).

Eighteen (78%) of the 23 shad that ultimately passed downstream through the turbines utilized the Francis units. Four shad (17%) passed downstream via the mixed-flow Kaplan units. The route utilized by one shad was unknown. Fifteen of those passing downstream via the turbines were believed alive at last detection. Signals from the other eight shad became stationary after passing downstream via the turbines and were considered dead. One of these tags was recovered near Reuben Island, along the west shore above Deer Creek.

Radio tagged shad passed the Conowingo Dam via turbines throughout the spring and early summer. With river flows well within Conowingo Dam's hydraulic capacity by late April, no spill gates were opened.

Eight (5.3%) shad were never detected after release at Lapidum Boat Launch. Some of the fish that left the study area or failed to migrate upstream may have resulted from handling, tagging, or transport stress. These findings are similar to those reported in earlier studies on the Susquehanna River and elsewhere (RMC 1990). The shad literature indicates that post-tagging stress can affect upstream migrational behavior of up to 40% of American shad (Olney *et al.* 2006).

5.0 CONCLUSION

The primary objective of this study was to estimate the Upstream Fish Passage Effectiveness of migratory adult American shad at the Conowingo EFL, which was achieved. A total of 151 adult American shad was radio tagged and released downstream of Conowingo Dam. Eighty-nine shad (58.9%) entered the Conowingo Tailrace and were accessible to the EFL. As is typical with radio tagged shad, a substantial portion (62 fish, 41.1%) dropped back; these fish did not return to the tailrace and were not available for the determination of the effectiveness of the EFL.

Sixty-five of 89 shad in the tailrace (73.0%) entered the EFL and 63 of the 65 fish (96.9%) were detected immediately downstream of the Crowder Gate. Overall, 40 of 89 shad (44.9%) passed the EFL into the Conowingo Pond. Thirty-nine of 89 shad (43.8%) remained upstream for at least 48 hours after leaving the Exit Trough. One shad re-entered the tailrace within 48 hours of passage, but re-entered the EFL and successfully passed it for a second time.

Twenty-three of 40 (57.5%) shad with successful passage eventually re-entered the Conowingo Tailrace. The average residency upstream of the Conowingo Dam was 21 days for these 23 shad. Seventeen of 40 (42.5%) shad with successful passage were last detected upstream of the Conowingo Dam. Two shad passed all four dams on the Lower Susquehanna River.

This study in conjunction with the report on Conowingo East Fish Lift Attraction Flows (RSP 3.6) provides information relative to factors that may influence the lift's effectiveness on a daily or seasonal basis. There did not appear to be a single variable that consistently provided the best fish passage conditions or guaranteed high rates of successful upstream passage. Radio tagged shad passed upstream over a wide range of turbine-generation combinations, water temperatures, EFL settings, and attraction flow water velocities. On several occasions, forays leading to successful passage of radio tagged American shad occurred simultaneously with unsuccessful forays of both shad that later passed and shad that never passed the EFL. The fishway attraction effectiveness value (73.0%) clearly shows that American shad are successfully entering the EFL with 97% of these fish moving to within a few feet of the Crowder Gate. However, only 63% of the fish passed through the Crowder Gate and completed passage to Conowingo Pond.

6.0 DISCUSSION

The overall success of a fishway ultimately comes down to three components: get fish to the fishway, get fish through the fishway, and keep fish continuing on their way. Each of these components of the EFL is discussed below.

- Get fish to fishway

Of the 89 shad in the tailrace, 80 fish (90%) either entered the EFL (65 fish) or were detected less than 75 feet from an Entrance Gate (15 fish). Only 9 of the 89 shad (10%) did not approach the EFL.

While there remains frustration that not all shad in the tailrace approached the EFL Entrance Gates, it is encouraging to see so many of them approach and/or enter the EFL. As mentioned in the East Fish Lift Attraction Flow study, Units 10 and 11, Units 8 and 9 were run a disproportional amount of time in 2010 due to mechanical difficulties, and visual observations were made that the units created a large eddy that may affect EFL attraction flows. If these units were run less often (alone and in combination with the other mixed-flow Kaplan units), there may be the potential for more effective attraction flow that may draw more of the tailrace fish into the EFL.

- Get fish through fishway

The fishway attraction effectiveness value (73.0%), clearly shows that American shad are successfully entering the EFL, but not all are passing through the Crowder Gate and being lifted up to the Exit Trough. Sixty-three of 65 shad (97%) that entered the EFL moved within a few feet of the Crowder Gate.

While the exact cause of this inability of all fish in the EFL to successfully pass upstream is not understood, it is symptomatic of current fish lift designs for American shad ([Table 6.1](#)). Possible factors affecting shad in the EFL could be the structural bend or turn that shad have to make from either Entrance Channel to access the Crowder Gate Channel. The potential hydraulics created by the attraction flow being forced around this bend or turn could impede some shads progress while not affecting others. The obstacle of the Crowder Gate itself and the nature of shad to be startled easily when moving in tight quarters could also be a contributing factor. The spatial distribution or orientation of the individual shad in relationship to other fish when approaching the Crowder Gate may influence their behavior.

Another factor that may have influenced shad in the area of the EFL immediately downstream of the Crowder Gate in 2010 was continual flow through Diffuser "A". Diffuser "A" provides supplemental attraction flow to the "A" Gate Entrance Channel by upwelling water from the floor of the EFL downstream of the Crowder Gate. Diffuser "A" became locked in a fixed position of 10% open on 27

April and was not repaired for the remainder of the season. This unintended flow may have affected the behavior of shad in the vicinity of the Crowder Gate.

- Keep fish continuing on their way

Once shad successfully exited the EFL into Conowingo Pond, they were successful in continuing migration. One shad passed into Conowingo Pond, but returned to the tailrace five hours after leaving the Exit Trough, but it re-entered the EFL after five hours and successfully continued its migration.

7.0 RECOMMENDATIONS

Although review of literature shows inconsistency in terminology usage of various passage metrics, reported passage rates of radio tagged shad at fish lifts have been less than 60% (Barry *et al.* 1986; Kleinschmidt 1999; Sprankle 2005; Normandeau 2001; Normandeau 2008; RMC 1994).

This study in conjunction with the report on Conowingo East Fish Lift Attraction Flows (RSP 3.6) provides useful information about the effectiveness of the EFL and suggests areas of investigation for potential improvements. These studies did not identify any single operational parameter for the Project or the EFL that will suggest substantial improvements in fish passage effectiveness. However, the discrepancy between the number of shad that enter the EFL (73% of available fish) and the number of shad that are successfully passed upstream (45%) is striking. The studies suggest that some physical aspects (e.g., Crowder Gate) may be the cause of this discrepancy and that improvements within the EFL may hold the most promise relative to improving the effectiveness of the EFL. It is recommended that work in 2011 focus on the physical elements of the EFL (e.g., Crowder Gate) and flow patterns within the EFL.

Based on the findings of the 2010 study, we recommend the following:

- Analyze EFL structures and hydraulics to increase shad retention inside the structure and to improve passage from the Entrance Channels to the Hopper.

Surveillance of shad within the EFL should focus on the threshold of the Crowder Gate to improve passage efficiency. In lieu of other technologies, limited range antennas should be placed in and around the Crowder Gate to gain a better understanding of shad behavior at this constricted area. A thorough review of hydraulics near the Crowder Gate is recommended to develop steps to improve retention in the EFL and passage through the Crowder Gate. With Diffuser “A” fixed, the 2011 study can evaluate if its repair made a difference in shad passing the Crowder Gate area.

- Collect all American shad by means of angling and release immediately upon tagging.

With so many of the tailrace-released shad making forays to the Lower River monitors and returning to the tailrace, little additional information was gained by transporting fish downriver to be released. To reduce stress of test specimens and increase sample size within the tailrace, it is recommended that all shad be radio tagged and released directly into the tailrace and not transported downriver.

8.0 REFERENCES

- Barry, T., and B. Kynard. 1986. Attraction of adult American shad to fish lifts at Holyoke Dam, Connecticut River. *North American Journal of Fisheries Management* 6:233-241.
- Federal Energy Regulatory Commission (FERC). 2004. Evaluation of mitigation effectiveness at hydropower projects: fish passage. Division of Hydropower Administration and Compliance, Office of Energy Projects.
- Frank, H. J., Mather, M. E., Smith, J. M., Muth, R. M., Fin, J. T., and McCormick, S. D. 2009. What is “fallback”? metrics needed to assess telemetry tag effects on anadromous fish behavior. *Hydrobiologia* (2009) 635:237-249.
- Kleinschmidt Associates. 1999. 1996-1998 Evaluations of Upstream and Downstream Fish Passage Facilities. Final Report. Greenville Dam Project (FERC No. 2441). City of Norwich, CT, Department of Public Utilities.
- Leggett, W. C. 1976. The American shad (*Alosa sapidissima*) with special reference to its migration and population dynamics in the Connecticut River, pages 169-225 *In* D. Merriman and L. M. Thorpe (editors). The Connecticut River ecological study. Monograph No. 1, American Fisheries Society, Bethesda, MD.
- Olney J. E., Latour R. J., Watkins B. E., 2006. Migratory Behavior of American Shad in the York River, Virginia, with Implications for Estimating In-River Exploitation from Tag Recovery Data. *Transactions of the American Fisheries Society* 135:889-896.
- Normandeau Associates, Inc. 2001. Adult American shad movement in the vicinity of Conowingo and Holtwood Hydroelectric stations, Susquehanna River, during spring 2001. Prepared for U.S. Fish and Wildlife Service, PPL Holtwood, LLC, and Exelon (Susquehanna Electric Company), 9 pp + Tables, Figures, Appendix.
- Normandeau Associates 2008. Assessing the Impact of Muddy Run Pumped Storage Station and Holtwood Hydroelectric Station Operations on the Upstream Migration of adult American shad (*Alosa sapidissima*) in Conowingo Pond, Susquehanna River, spring 2008. Draft prepared for Exelon Corporation.
- RMC. 1990. Migration of radio tagged adult American shad through Conowingo Pond to the Holtwood Hydroelectric Station. Prepared for Susquehanna River Anadromous Fish Restoration Committee, Harrisburg, PA
- RMC. 1994. Report on the distribution of telemetered shad in the tailwaters and spillage areas of the Holtwood, Safe Harbor, and York Haven Hydroelectric Projects, Susquehanna River, Pennsylvania. Report prepared for Pennsylvania Power and Light Company, Safe Harbor Water Power Corporation, and Metropolitan Edison Company.
- Sprankle, K. 2005. Interdam movements and passage attraction of American shad in the Lower Merrimack River mainstem. *N. Amer. Jour. Fish. Manage.* 25:1456-1466.

TABLE 4.1: SUMMARY OF TAGGED AND RELEASED ADULT AMERICAN SHAD DOWNSTREAM OF THE CONOWINGO DAM, SPRING 2010.

Release Group	Shad Run Segment	Collection Method	Release Date	Release Location	Number Released	Sex		Water Temperature °C	Plant Discharge (cfs)
						M	F		
1	Early-Mid	1 Angled	20 April	Tailrace	18	M	15	14.7	10,000 to 34,000
						F	3		10,000 to 45,000
2	Early-Mid	2 Angled	22 April	Tailrace	32	M	21	14.5	10,000 to 45,000
						F	11		10,000 to 45,000
3	Early-Mid	3 Trapped	28 April	Lapidum	25	M	13	14.8	10,000 to 45,000
						F	12		10,000 to 45,000
4	Mid-Late	4 Angled	7 May	Tailrace	27	M	16	20.8	34,000 to 68,000
						F	11		34,000 to 68,000
5	Mid-Late	5 Angled	10 May	Tailrace	23	M	7	18.1	7,500 to 22,500
						F	16		7,500 to 22,500
6L*	Mid-Late	6L Trapped	12 May	Lapidum	24	M	5	15.7	17,000
						F	19		17,000
6T	Mid-Late	6T Trapped	12 May	Tailrace	2	M	0	15.7	17,000
						F	2		17,000
					Total			Percentage	Range
					151	M	77	51.0%	7,500 to 68,000
						F	74	49.0%	68,000

*Footnote: One shad transported to Lapidum was removed from the study and is not included in this table.

TABLE 4-2: MATRICES EXAMINED AT THE CONOWINGO EFL, SPRING 2010.

2010 Shad Run	Matrices	N	No. Affected	P	L95	U95
Overall	In Tailrace	89				
	Fishway Attraction Effectiveness		65	0.7303	0.62405	0.81636
	Fish Passage Efficiency		40	0.4494	0.34502	0.55819
	Fish Passage Effectiveness		39	0.4382	0.33455	0.54723
Early-Mid Segment	In Tailrace	51				
	Fishway Attraction Effectiveness		36	0.7059	0.55986	0.82093
	Fish Passage Efficiency		23	0.4510	0.31384	0.59550
	Fish Passage Effectiveness		22	0.4314	0.29628	0.57680
Mid-Late Segment	In Tailrace	38				
	Fishway Attraction Effectiveness		29	0.7436	0.57566	0.86400
	Fish Passage Efficiency		17	0.4474	0.28997	0.61525
	Fish Passage Effectiveness		17	0.4474	0.28997	0.61525

TABLE 4.3: COMPOSITION OF MOVEMENT CLASSIFICATIONS, SPRING 2010.

	Passage Shad		Non-Passage Shad (In EFL)		Non-EFL Shad (In Tailrace)		Non-Tailrace Shad		Totals	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Overall Totals and Percentages	40	26.5%	25	16.6%	24	15.9%	62	41.1%	151	100.0%
Release Location										
Tailrace	33	82.5%	18	72.0%	19	79.2%	32	51.6%	102	67.5%
Lapidum	7	17.5%	7	28.0%	5	20.8%	30	48.4%	49	32.5%
Sex										
Male	24	60.0%	16	64.0%	8	33.3%	29	46.8%	77	51.0%
Female	16	40.0%	9	36.0%	16	66.7%	33	53.2%	74	49.0%
Size (mm)										
Minimum	427		430		445		415			
Maximum	514		540		540		525			
Average	474.5		479.0		487.4		475.2			
Median	475		478		487.5		475			
Release Group										
Release Group 1	10	25.0%	1	4.0%	3	12.5%	4	6.5%	18	11.9%
Release Group 2	10	25.0%	7	28.0%	8	33.3%	7	11.3%	32	21.2%
Release Group 3	3	7.5%	5	20.0%	4	16.7%	13	21.0%	25	16.6%
Release Group 4	8	20.0%	4	16.0%	4	16.7%	11	17.7%	27	17.9%
Release Group 5	5	12.5%	5	20.0%	4	16.7%	9	14.5%	23	15.2%
Release Group 6L	4	10.0%	2	5.0%	1	2.5%	17	42.5%	24	15.9%
Release Group 6T	0	0.0%	1	2.5%	0	0.0%	1	2.5%	2	1.3%
Tailrace Released										
R1 and R2	20	50.0%	8	32.0%	11	45.8%	11	17.7%	50	49.0%
v										
R4 and R5 + R6T	13	32.5%	10	40.0%	8	33.3%	21	33.9%	52	51.0%
Lapidum released										
R3	3	7.5%	5	20.0%	4	16.7%	13	21.0%	25	51.0%
v										
R6L	4	10.0%	2	8.0%	1	4.2%	17	27.4%	24	49.0%
Early-Mid Release	23	30.7%	13	17.3%	15	20.0%	24	32.0%	75	49.7%
v										
Mid-Late Release	17	22.4%	12	15.8%	9	11.8%	38	50.0%	76	50.3%

TABLE 4.4: TRAVEL TIMES TO BENCHMARK LOCATIONS BY RELEASE LOCATION AND MOVEMENT CLASSIFICATION, SPRING 2010.

Travel time to Tailrace by movement classification (Days-hr:min:sec)	Travel time to EFL by movement classification (Days-hr:min:sec)	Travel time to Passage by movement classification (Days-hr:min:sec)
<u>Passage Shad averages</u> 40 Angled Passage 07-19:56:03 Lapidum Passage 09-10:03:14 All Fish Passage 08-02:36:18	<u>Passage Shad averages</u> 40 Angled Passage 11-15:27:53 Lapidum Passage 11-15:16:51 All Fish Passage 11-15:25:58	<u>Passage Shad averages</u> 40 Angled Passage 13-05:35:51 Lapidum Passage 11-14:03:33 All Fish Passage 12-22:40:42
<u>Non-Passage Shad (In EFL)</u> 25 Angled Forays without passage 05-21:51:11 Lapidum Forays without passage 12-00:23:31 All Fish Forays without passage 07-14:53:02	<u>Non-Passage Shad (In EFL)</u> 25 Angled Forays without passage 10-09:30:14 Lapidum Forays without passage 15-23:52:29 All Fish Forays without passage 12-00:41:43	
<u>Non-EFL Shad (In Tailrace)</u> 24 Angled Tailrace without foray 07-21:09:20 Lapidum Tailrace without foray 12-19:05:33 All Fish Tailrace without foray 07-17:09:43		
Overall Travel time to Tailrace (Days-hr:min:sec)	Overall Travel time to EFL (Days-hr:min:sec)	Overall Travel time to Passage (Days-hr:min:sec)
89 Overall average travel time to tailrace 07-20:45:58	65 Overall average travel time to EFL 11-18:54:22	40 Overall average travel time to passage 12-22:40:42
69 Tailrace released average travel time to tailrace 06-22:37:22	51 Tailrace released average travel time to EFL 11-05:16:41	33 Tailrace released average travel time to passage 13-05:35:51
20 Lapidum released average travel time to tailrace 11-06:20:47	14 Lapidum released average travel time to EFL 13-19:34:40	7 Lapidum released average travel time to passage 11-14:03:33

TABLE 4.5: TRAVEL TIME TO TAILRACE COMPARISON BETWEEN MOVEMENT CLASSIFICATIONS BY RELEASE LOCATION, SPRING 2010.

Passage Shad Individual Release Groups	Return to Tailrace average (Days-hr:min:sec)	Return to Tailrace median (Days-hr:min:sec)
Release Group 1 = 10	10-11:39:56	12-05:10:59
Release Group 2 = 10	09-14:50:30	08-15:36:18
Release Group 3 = 3	10-04:41:10	09-13:38:18
Release Group 4 = 8	05-23:12:21	05-19:46:00
Release Group 5 = 5	01-22:13:19	01-19:58:50
Release Group 6 = 4	08-20:04:47	08-04:43:40
Early v. Late Release Group	average	median
R1 and R2 (Tailrace Early-Mid) v	10-01:15:13	11-05:08:37
R4 and R5 (Tailrace Mid-Late)	04-09:54:15	03-05:18:34
R3 (Lapidum Early-Mid) v	10-04:41:10	09-13:38:18
R6 (Lapidum Mid-Late)	08-20:04:47	08-04:43:40
Non-Passage Shad (In EFL) Individual Release Groups	Return to Tailrace average (Days-hr:min:sec)	Return to Tailrace median (Days-hr:min:sec)
Release Group 1 = 1	06-17:24:16	06-17:24:16
Release Group 2 = 7	07-05:26:44	04-15:25:04
Release Group 3 = 5	12-01:27:40	15-04:45:45
Release Group 4 = 4	07-08:40:20	07-12:36:09
Release Group 5 = 5	02-16:11:09	02-10:58:06
Release Group 6 = 3	07-08:27:20	09-01:08:50
Early v. Late Release Group	average	median
R1 and R2 (Tailrace Early-Mid) v	07-03:56:25	05-16:24:40
R4 and R5 (Tailrace Mid-Late)	04-18:10:47	04-20:13:30
R3 (Lapidum Early-Mid) v	12-01:27:40	15-04:45:45
R6 (Lapidum Mid-Late)	10-00:33:00	09-01:08:50
Non-EFL Shad (In Tailrace) Individual Release Groups	Return to Tailrace average (Days-hr:min:sec)	Return to Tailrace median (Days-hr:min:sec)
R1 = 3	09-18:53:16	08-13:56:42
R2 = 8	08-03:14:53	01-14:53:48
R3 = 4	13-03:08:06	12-00:09:49
R4 = 4	02-11:28:35	01-00:17:10
R5 = 4	04-04:58:02	03-21:00:38
R6 = 1	11-10:55:22	07-17:09:43
Early v. Late Release Group	average	median
R1 and R2 (Tailrace Early-Mid) v	06-03:35:29	08-14:03:32
R4 and R5 (Tailrace Mid-Late)	03-08:13:19	02-11:04:52
R3 (Lapidum Early-Mid) v	13-03:08:06	12-00:09:49
R6 (Lapidum Mid-Late)	11-10:55:22	07-17:09:43

TABLE 4.6: FORAY DURATIONS FOR BOTH SUCCESSFUL AND UNSUCCESSFUL FORAYS, SPRING 2010.

EFL Foray Resulting in Successful Passage				
Number of Forays 41*	Foray Durations (Days-hr:min:sec)	Date of Forays	Water Temp °C	Non-Tagged Hourly Shad Count
Min	00-00:00:29	4/30/10	16.0	12
Median	00-00:12:24	5/12/10	19.5	144
Average	00-00:25:37	5/12/10	19.5	214
Max	00-01:56:39	5/24/10	21.5	677
EFL Foray Resulting in Unsuccessful Passage (Shad Later Passed)				
Number of Forays 19	Foray Durations (Days-hr:min:sec)	Date of Forays	Water Temp °C	Non-Tagged Hourly Shad Count
Min	00-00:01:27	5/1/10	16.5	0
Median	00-00:19:34	5/17/10	17.5	33
Average	00-00:32:54	5/15/10	18.0	87
Max	00-02:14:29	5/24/10	20.1	439
EFL Foray Resulting in Unsuccessful Passage (Shad Never Passed)				
Number of Forays 42	Foray Durations (Days-hr:min:sec)	Date of Forays	Water Temp °C	Non-Tagged Hourly Shad Count
Min	00-00:00:05	4/24/10	16.5	0
Median	00-00:16:06	5/19/10	19.5	37
Average	00-00:31:44	5/18/10	20.5	86
Max	00-04:21:43	6/1/10	26.3	495
Total Forays				
Total Number of Forays		Successful Foray		Unsuccessful Foray
102		41 40.2%		61 59.8%
Total Number of Fish				
Fish		Successful Foray		Unsuccessful Foray
65		40 61.5%		25 38.5%

*Footnote: Includes Fish 54-208's second successful foray through EFL.

TABLE 4.7: TURBINE-OPERATING COMBINATIONS DURING EFL OPERATIONS, SPRING 2010.

Turbine-Operating Combinations		Percentage of Time Turbine-Operating Combination Occurred	Number of Fish Passed	Percentage of Fish Passed (N=41)	Forays Made into EFL
Small units	Large units				
"A" Gate Entrance Operating					
2	0	<u>31.9%*</u>	14	<u>34.1%*</u>	33
3	0	<u>3.6%*</u>	10	<u>24.4%*</u>	15
4	0	7.4%	0	0.0%	4
5	0	0.1%	0	0.0%	0
Subtotal		43.0%	24	58.5%	52
*Top Two Turbine-Operating Combinations for fish passage through "A" Gate Entrance. Operated (35.5%) and Passed (58.5%)					
"C" Gate Entrance Operating					
3	1	2.1%	0	0.0%	0
4	1	<u>7.7%*</u>	4	<u>9.8%*</u>	9
4	2	15.9%	0	0.0%	6
4	3	1.7%	1	2.4%	1
5	1	0.2%	0	0.0%	0
5	4	0.6%	0	0.0%	0
6	1	5.0%	1	2.4%	7
6	2	2.1%	1	2.4%	3
6	3	<u>5.6%*</u>	5	<u>12.2%*</u>	7
6	4	<u>4.3%</u>	2	<u>4.9%</u>	11
7	3	7.1%	1	2.4%	3
7	4	4.7%	2	4.9%	3
Subtotal		57.0%	17	41.5%	50
*Top Two Turbine-Operating Combinations for fish passage through "C" Gate Entrance. Operated (13.3%) and Passed (22.0%)					
Overall Top Combinations for both "A" and "C" gate entrance. Operated (48.8%) and Passed (80.5%)					

TABLE 4.8: SHAD COUNT AND PERCENTAGE ON NON-TAILRACE MONITORS BY MOVEMENT CLASSIFICATIONS, SPRING 2010.

	Lower River			Rowland Island		East Spillway	
	Spencer Island	Lapidum	Tomes Landing	Island	Far-field array	Near-field array	
Passage Shad							
N = 40	33	32	24	40	13	5	
Count							
Percentage	82.5%	80.0%	60.0%	100.0%	32.5%	12.5%	
Non-Passage Shad (In EFL)							
N = 25	24	24	18	25	7	1	
Count							
Percentage	96.0%	96.0%	72.0%	100.0%	28.0%	4.0%	
Non-EFL Shad (In Tailrace)							
N = 24	23	22	11	24	5	1	
Count							
Percentage	95.8%	91.7%	45.8%	100.0%	20.8%	4.2%	
Non-tailrace Shad							
N = 62	42	46	20	32	1	0	
Count							
Percentage	67.7%	74.2%	32.3%	51.6%	1.6%	0.0%	
Combined Total							
N = 151	122	124	73	121	26	7	
Count							
Percentage	80.8%	82.1%	48.3%	80.1%	17.2%	4.6%	

TABLE 4.9: UPSTREAM MOVEMENT FROM TOMES LANDING AND LAPIDUM MONITORS, SPRING 2010.

		Returned Upstream to		
		Spencer Island	Rowland Island	Tailrace
<u>Passage Shad</u> N = 40	Count	33	33	33
	Percentage	82.5%	82.5%	82.5%
<u>Non-Passage Shad (In EFL)</u> N = 25	Count	23	22	22
	Percentage	92.0%	88.0%	88.0%
<u>Non-EFL Shad (In Tailrace)</u> N = 24	Count	17	16	15
	Percentage	70.8%	66.7%	62.5%
<u>Non-tailrace Shad</u> N = 62	Count	32	1	0
	Percentage	51.6%	1.6%	0.0%
<u>Combined Total</u> N = 151	Count	105	72	70
	Percentage	69.5%	47.7%	46.4%

TABLE 6.1: SUMMARY OF REPORTED PASSAGE RATES OF AMERICAN SHAD AT FISH LIFTS.

Fish Lifted	Passage Efficiency %	Fish in Fish Lift	Fishway Attraction Effectiveness %	Fish Available in Tailrace	Dams and Dates of Studies	Rivers and States	Authors
9	50.0%	NA	NA	18	Holyoke Dam, 1986	Connecticut River, MA	Barry, T., and B. Kynard
5	41.7%	8	66.7%	12	Cataract Dam, 1994	Saco River, ME	RMC Environmental Services
66	55.5%	NA	NA	119	Greenville Dam, 96-98	Shetucket River, CT	Kleinschmidt Associates
46	33.8%	86	63.2%	136	Holtwood Dam, 2001	Susquehanna River, PA	Normandeau Associates
4	11.1%	NA	NA	36	Boott Hydro Dam, 2005	Merrimack River, MA	Spankle, K
14	10.9%	96	75.0%	128	Holtwood Dam, 2008	Susquehanna River, PA	Normandeau Associates
144	32.1%	190	68.8%	449	Total without 2010 study		
40	44.9%	65	73.0%	89	Conowingo Dam, 2010	Susquehanna River, MD	Normandeau Associates
184	34.2%	255	69.9%	538	Total with 2010 study		

FIGURE 2.1: CONOWINGO DAM AND THE LOCATIONS OF HYDROELECTRIC STATIONS WITH FISHWAYS AND YEAR OF INSTALLATION ON THE LOWER SUSQUEHANNA RIVER.

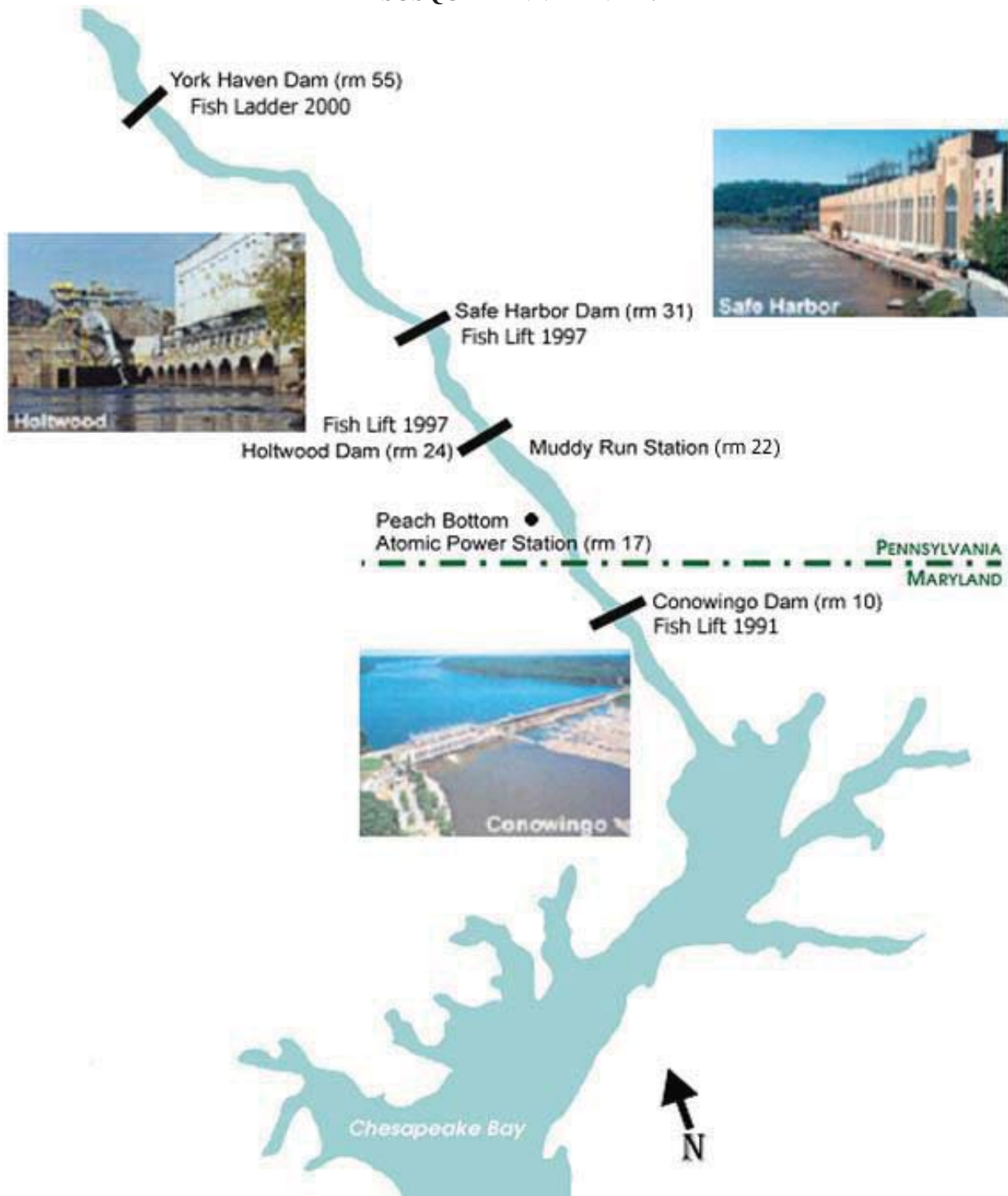
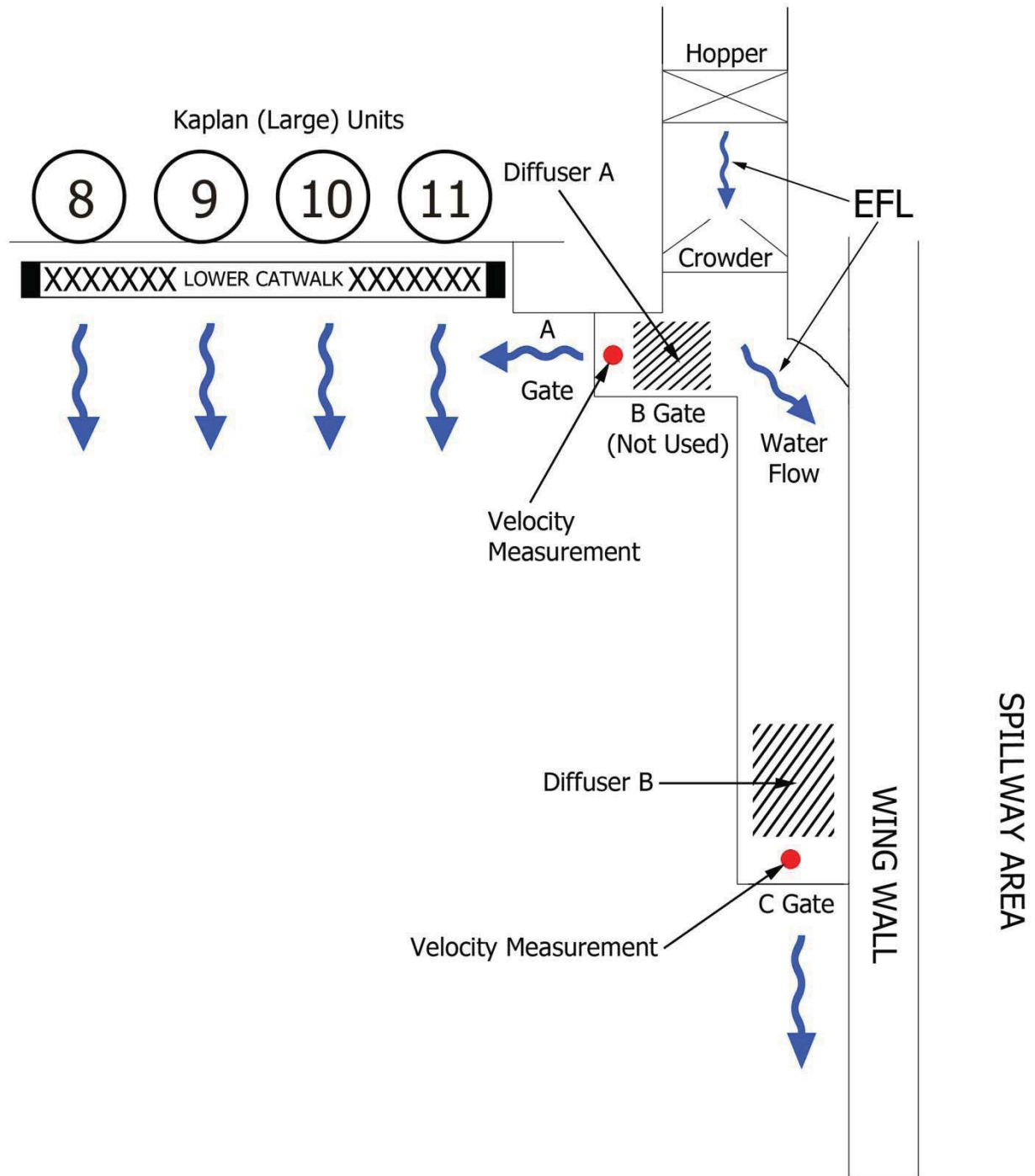
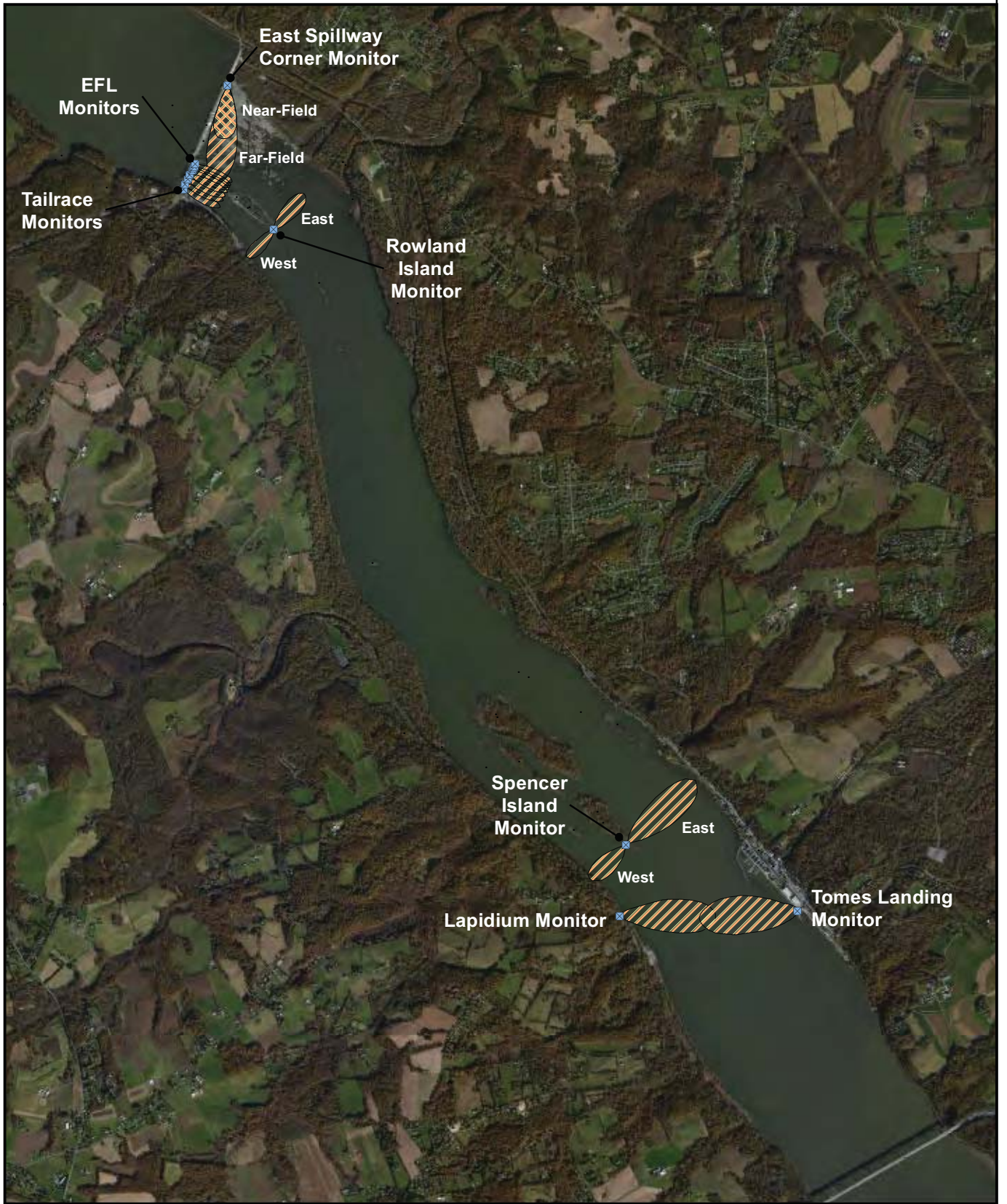


FIGURE 2.2: SCHEMATICS OF EFL (HOW IT FUNCTIONS).

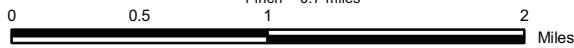




EXELON GENERATION COMPANY, LLC

**RSP STUDY 3.5
CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405**

1 inch = 0.7 miles



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Figure 3.1

**Figure Title: General Map of Study Area
Showing Location of
Monitoring Stations**

FIGURE 3.2: MAP OF LOWER RIVER MONITORS.

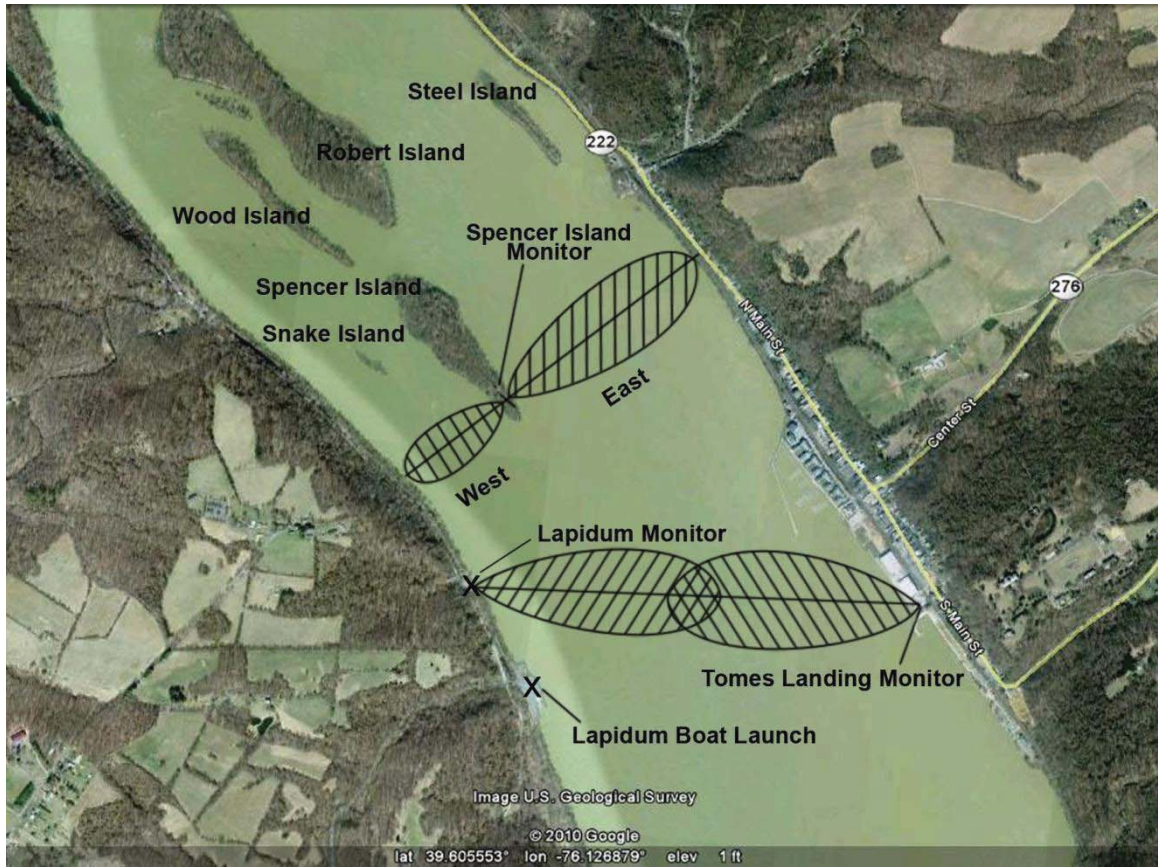


FIGURE 3.3: MAP OF ROWLAND ISLAND AND EAST SPILLWAY CORNER MONITORS.

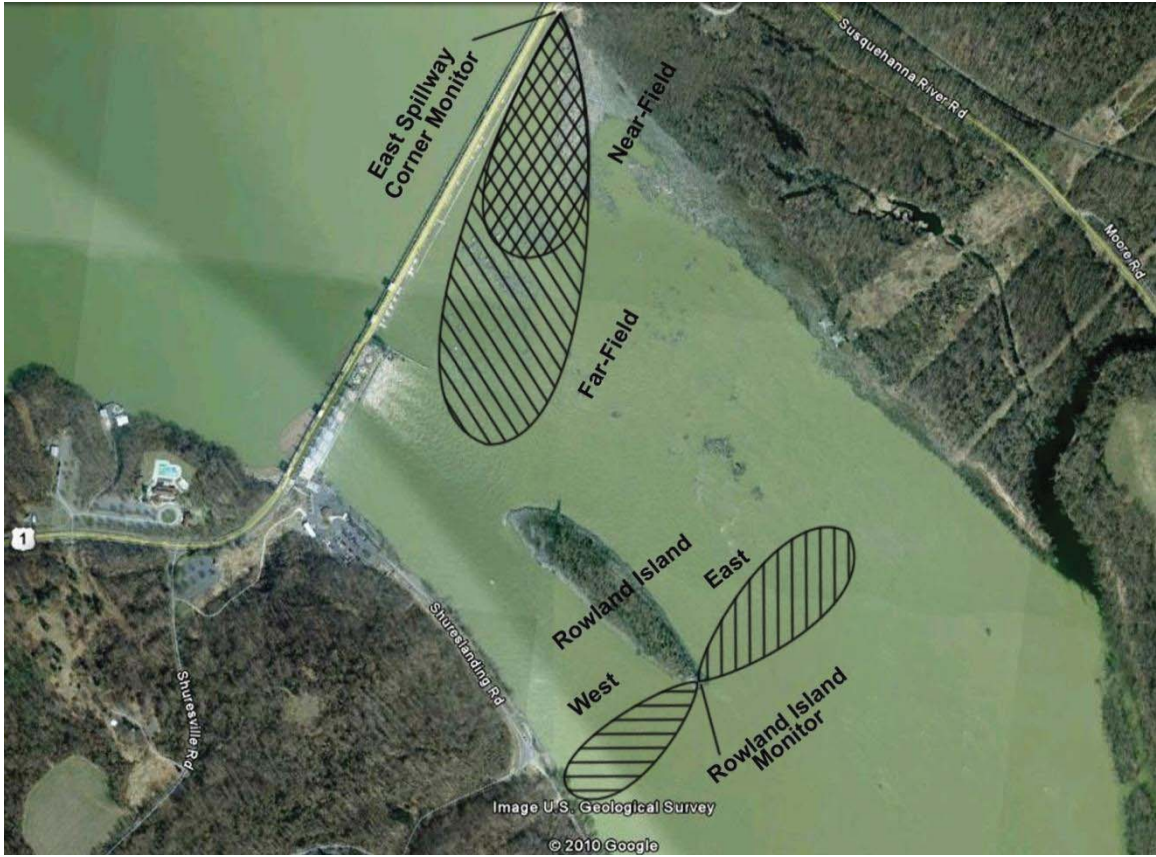


FIGURE 3.4: MAP OF TRAILRACE MONITORS.



FIGURE 3.5: EFL MONITORS.

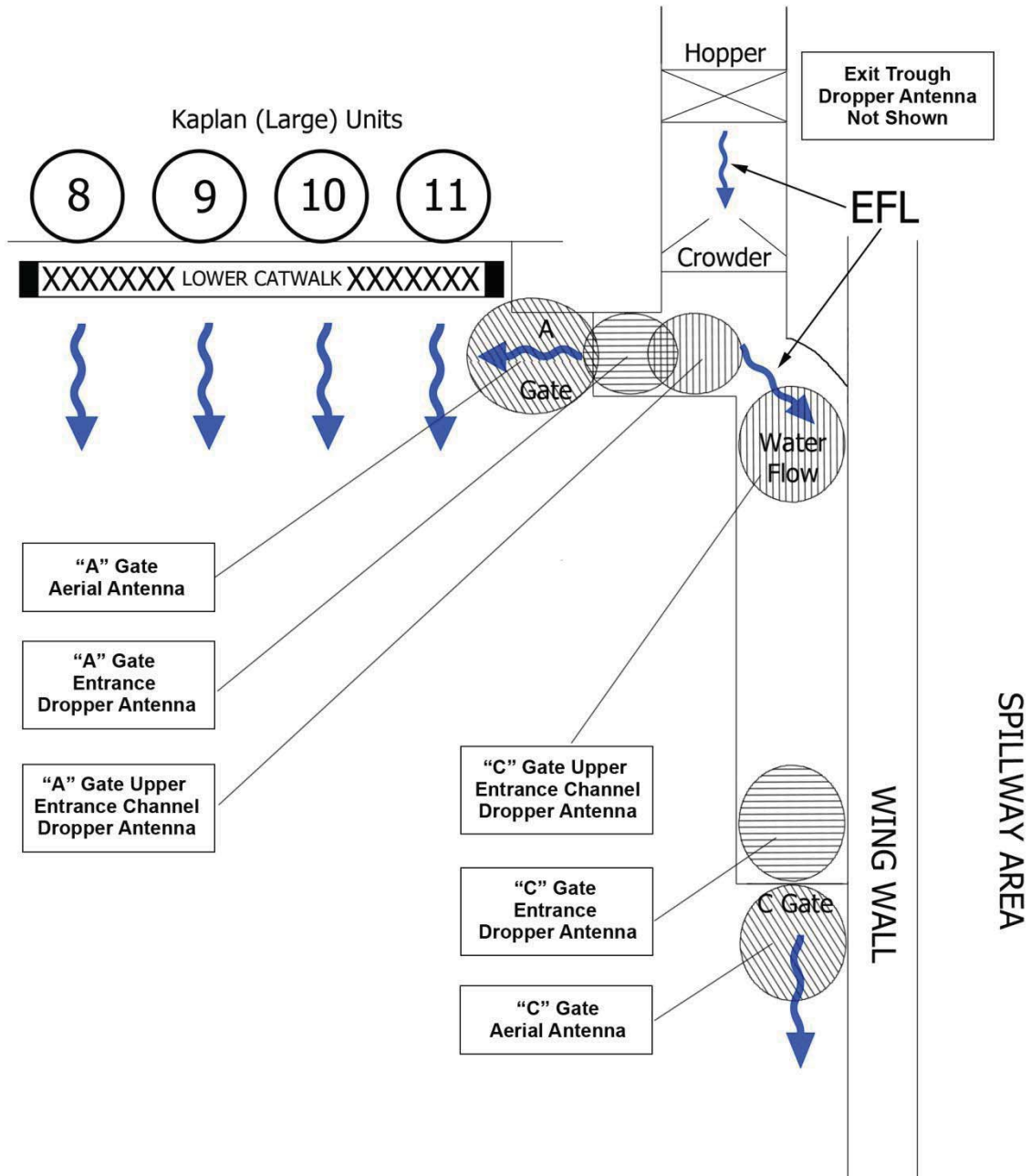


FIGURE 4.1: SUCCESSFUL AND UNSUCCESSFUL EFL FORAYS, SPRING 2010.

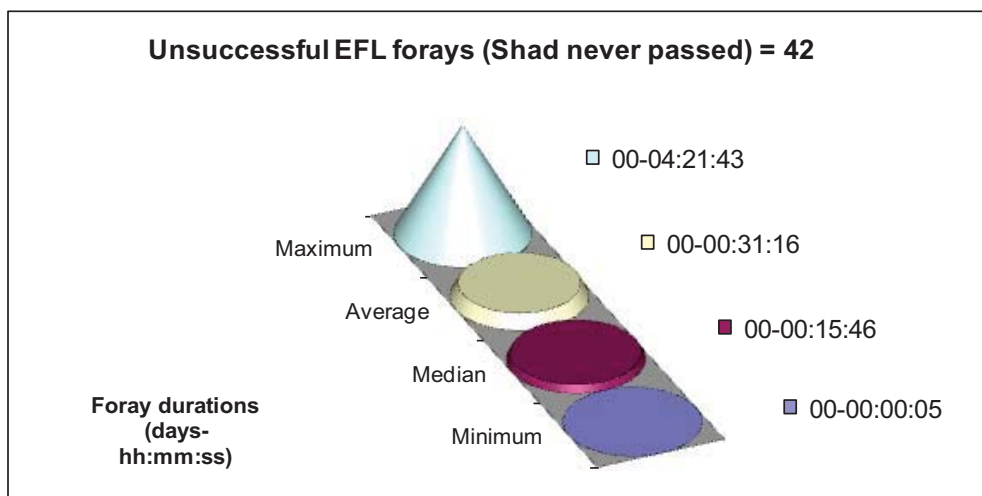
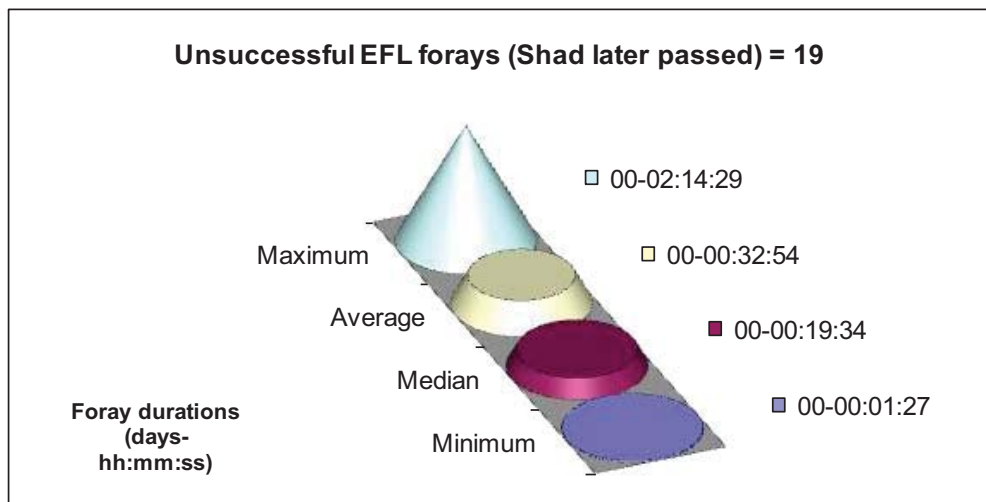
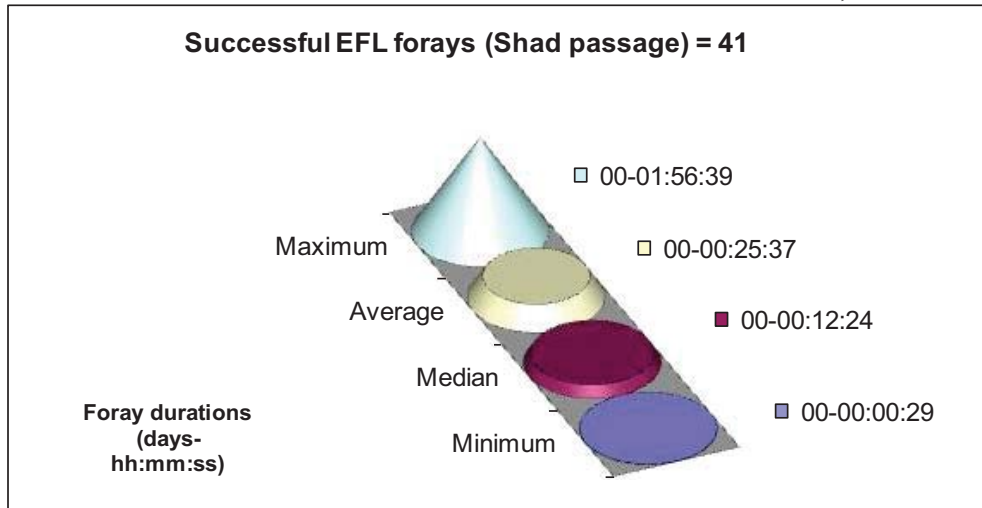


FIGURE 4.2: TEMPERATURE DURING TAGGED SHAD PASSAGE, SPRING 2010.

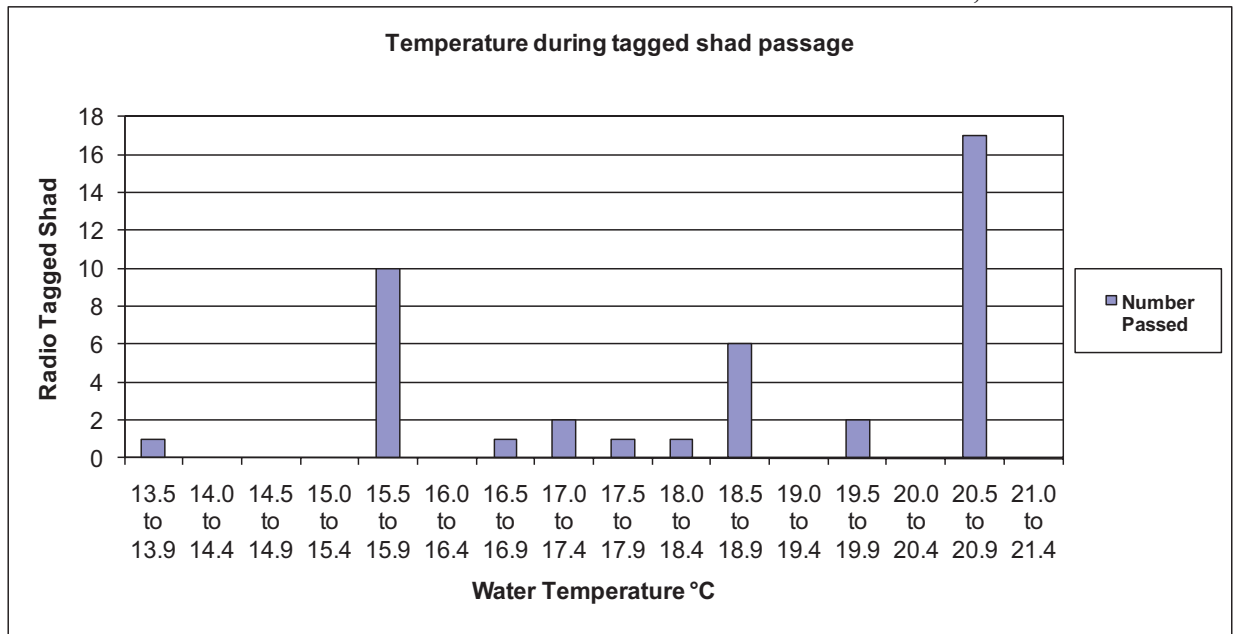


FIGURE 4.3: TEMPERATURE DURING FORAYS INTO EFL, SPRING 2010.

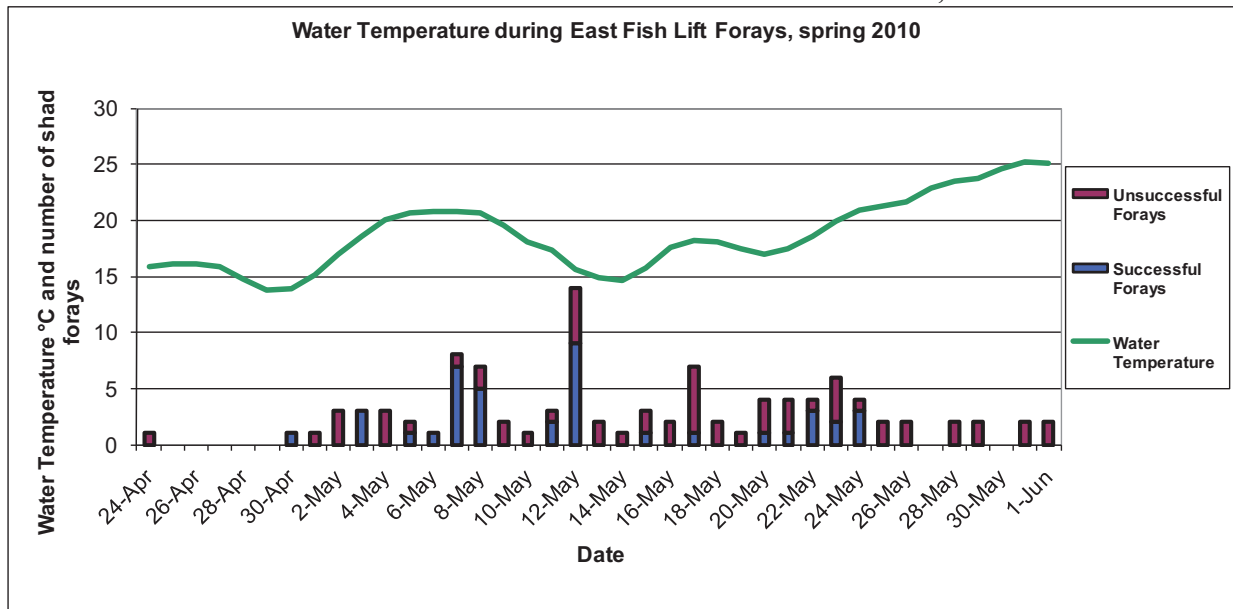


FIGURE 4.4: GENERATION DURING TAGGED SHAD PASSAGE, SPRING 2010.

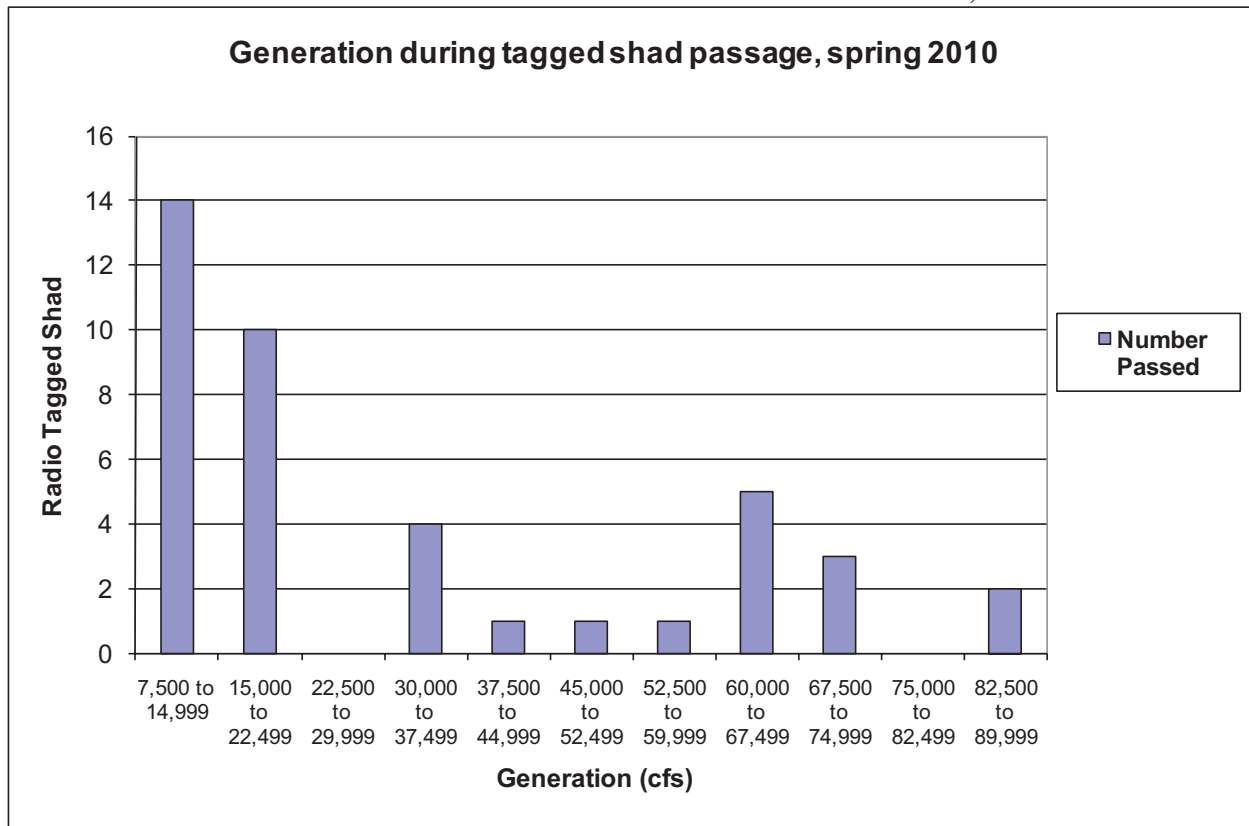


FIGURE 4.5: GENERATION DURING EFL FORAYS, SPRING 2010.

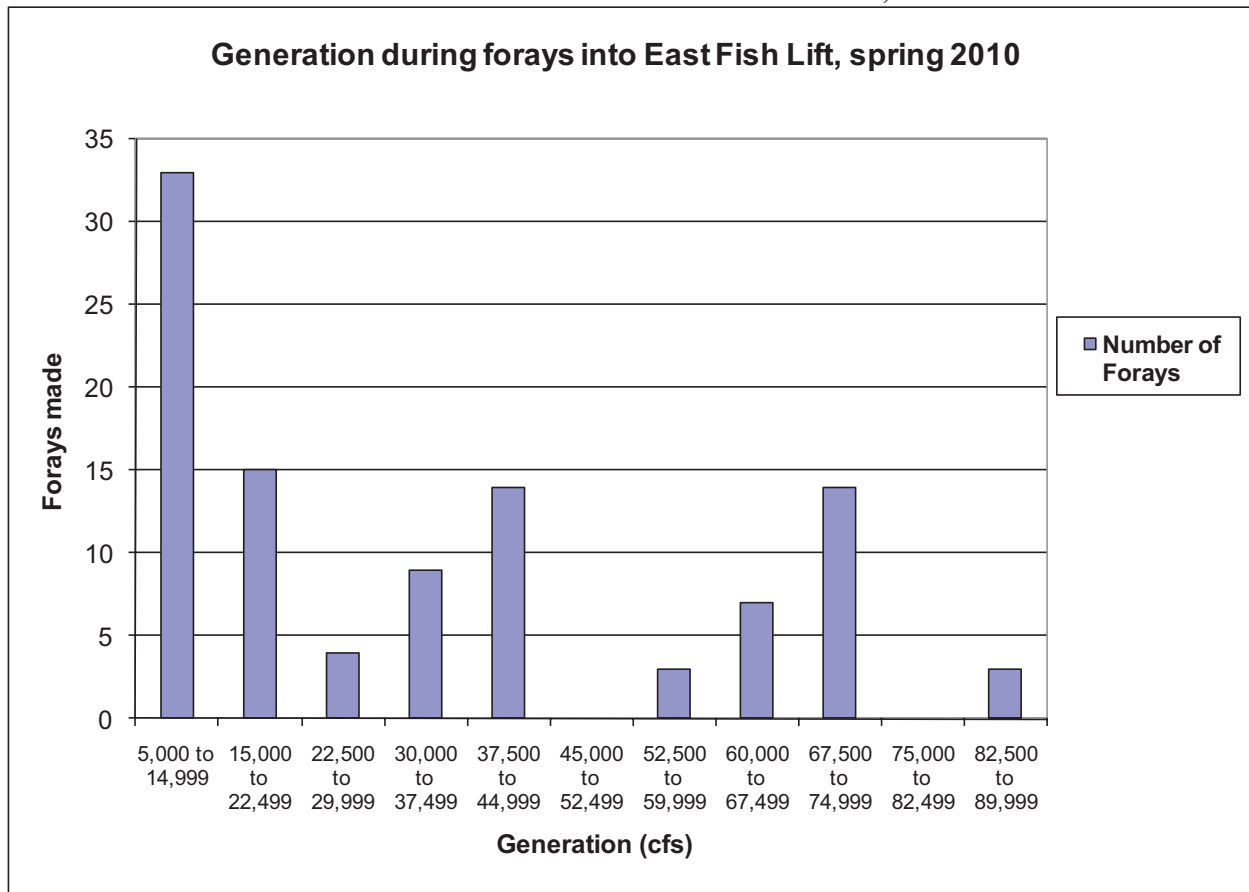


FIGURE 4.6: DATES OF EFL FORAYS, SPRING 2010.

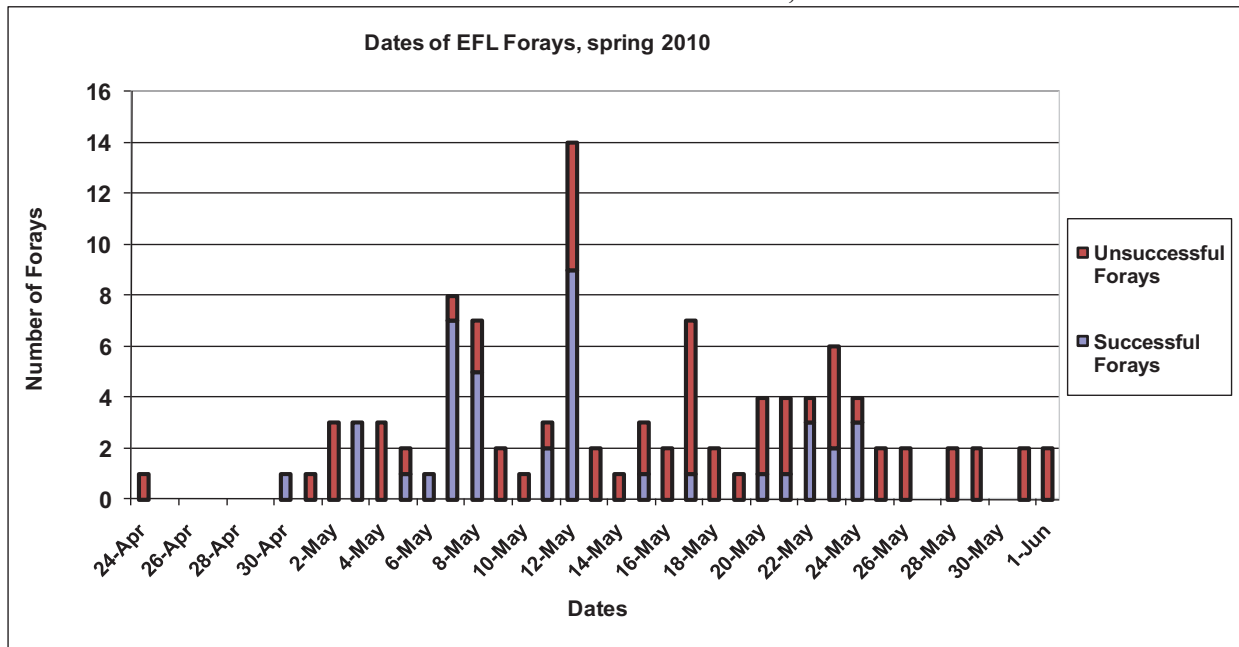
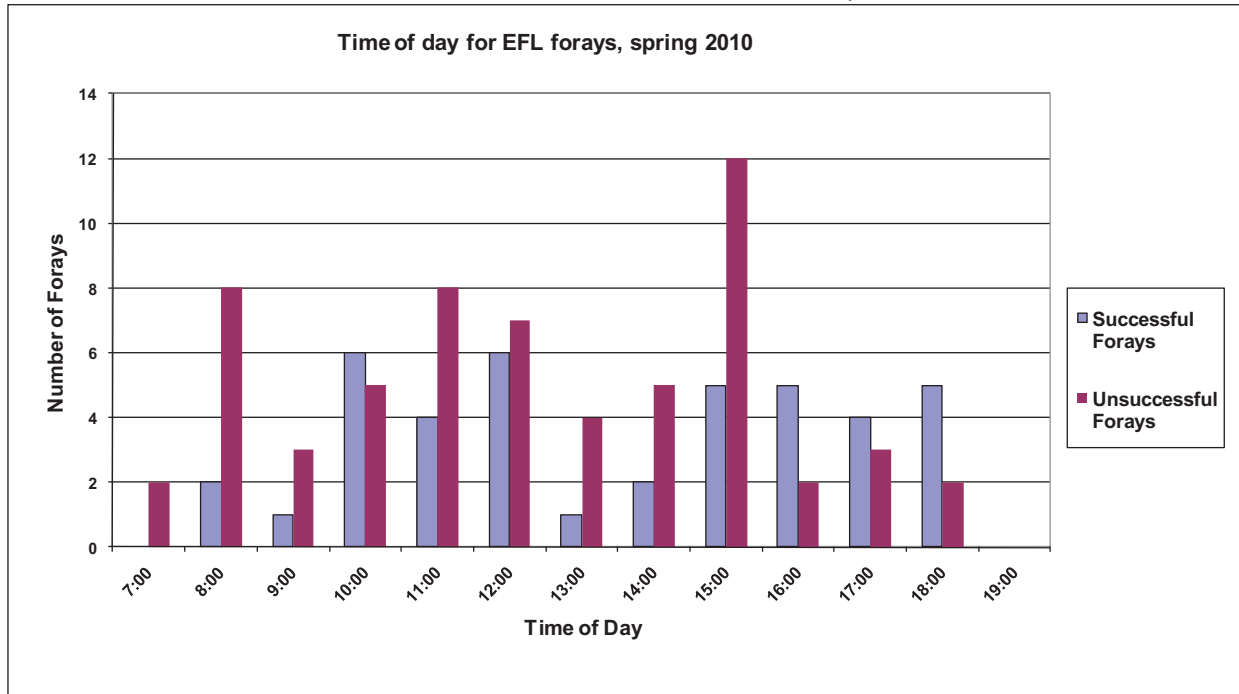


FIGURE 4.7: TIME OF DAY FOR EFL FORAYS, SPRING 2010.



**APPENDIX A: SUMMARY OF TAGGED AND RELEASED ADULT AMERICAN SHAD
DOWNSTREAM OF THE CONOWINGO DAM, SPRING 2010.**

Appendix A
Summary of tagged and released adult American shad downstream of the Conowingo dam, spring 2010.

Fish	Sex	Length (mm)	Capture Method	Group	Release			River Flow (cfs)	Water Temperature (°C)
					Date and Time	Location	Location Description		
54-192	F	515	Angled	R1	4/20/2010 7:53:00 AM	Tailrace	Downstream of "C" Gate	34,000	14.7
54-190	M	463	Angled	R1	4/20/2010 10:11:00 AM	Tailrace	Downstream of "C" Gate	34,000	14.7
54-191	M	473	Angled	R1	4/20/2010 10:24:00 AM	Tailrace	Downstream of "C" Gate	34,000	14.7
54-193	M	465	Angled	R1	4/20/2010 1:08:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-194	M	486	Angled	R1	4/20/2010 1:09:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-195	M	468	Angled	R1	4/20/2010 1:15:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-196-1	M	474	Angled	R1	4/20/2010 1:24:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-197	M	475	Angled	R1	4/20/2010 1:29:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-198	M	499	Angled	R1	4/20/2010 1:36:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-199	M	432	Angled	R1	4/20/2010 1:52:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-200-1	M	478	Angled	R1	4/20/2010 1:54:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-201	F	468	Angled	R1	4/20/2010 2:08:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-202	M	469	Angled	R1	4/20/2010 2:12:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-203	M	463	Angled	R1	4/20/2010 2:16:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-204	F	491	Angled	R1	4/20/2010 2:20:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-205	M	423	Angled	R1	4/20/2010 2:30:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-206	M	450	Angled	R1	4/20/2010 2:35:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
54-207	M	463	Angled	R1	4/20/2010 2:41:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.7
21-100	M	468	Angled	R2	4/22/2010 10:36:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-101	M	478	Angled	R2	4/22/2010 10:47:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-102	F	445	Angled	R2	4/22/2010 10:55:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-103	M	415	Angled	R2	4/22/2010 11:00:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-104	M	430	Angled	R2	4/22/2010 11:06:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-136	M	506	Angled	R2	4/22/2010 11:22:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-105	M	480	Angled	R2	4/22/2010 11:26:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-106	M	451	Angled	R2	4/22/2010 11:29:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-107	F	496	Angled	R2	4/22/2010 11:34:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-109	M	459	Angled	R2	4/22/2010 11:34:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-110	F	518	Angled	R2	4/22/2010 11:35:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-111	F	460	Angled	R2	4/22/2010 11:38:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-112	M	481	Angled	R2	4/22/2010 11:44:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-113	F	510	Angled	R2	4/22/2010 11:51:00 AM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-114	M	462	Angled	R2	4/22/2010 12:03:00 PM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-115	M	480	Angled	R2	4/22/2010 12:10:00 PM	Tailrace	Downstream of "C" Gate	45,000	14.5
21-116	M	510	Angled	R2	4/22/2010 12:34:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5
21-117	F	484	Angled	R2	4/22/2010 12:37:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5

Fish	Sex	Length (mm)	Capture		Release				River Flow		Water Temperature (°C)
			Method	Group	Date and Time	Location	Location Description	(cfs)	Temperature (°C)		
21-108	F	499	Angled	R2	4/22/2010 12:45:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-135	M	452	Angled	R2	4/22/2010 12:56:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-118	F	505	Angled	R2	4/22/2010 1:00:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-119	M	491	Angled	R2	4/22/2010 1:02:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-120	F	532	Angled	R2	4/22/2010 1:10:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-121	M	427	Angled	R2	4/22/2010 1:11:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-122	M	471	Angled	R2	4/22/2010 1:20:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-123	M	468	Angled	R2	4/22/2010 1:21:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-124	F	514	Angled	R2	4/22/2010 1:26:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-125	F	493	Angled	R2	4/22/2010 1:28:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-126	M	440	Angled	R2	4/22/2010 1:31:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-127	M	462	Angled	R2	4/22/2010 1:34:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-128	M	461	Angled	R2	4/22/2010 1:35:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-129	M	472	Angled	R2	4/22/2010 1:37:00 PM	Tailrace	Downstream Units 5 & 7	10,000	14.5		
21-130	F	505	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
21-131	F	480	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
21-132	F	485	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
21-133	F	495	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
21-134	F	505	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-174	F	475	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-175	M	465	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-176	M	485	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-177	M	455	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-178	M	435	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-179	M	480	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-180	F	515	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-181	F	490	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-182	M	415	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-183	M	490	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-184	M	475	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-185	F	525	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-186	M	455	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-187	F	505	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-188	M	480	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-189	M	450	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-208	F	475	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-209	M	450	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-210	F	495	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		
54-211	M	460	West Fish Lift	R3	4/28/2010 11:35:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	45,000	14.8		

Fish	Sex	Length (mm)	Capture		Release				River Flow (cfs)	Water Temperature (°C)
			Method	Group	Date and Time	Location	Location Description			
54-172	F	510	Angled	R4	5/7/2010 9:28:00 AM	Tailrace	Between Units 3 & 5	34,000	20.8	
54-173	F	490	Angled	R4	5/7/2010 9:34:00 AM	Tailrace	Between Units 3 & 5	34,000	20.8	
54-171	F	500	Angled	R4	5/7/2010 10:13:00 AM	Tailrace	Between Units 3 & 5	34,000	20.8	
54-168	M	470	Angled	R4	5/7/2010 10:15:00 AM	Tailrace	Between Units 3 & 5	34,000	20.8	
54-169	F	490	Angled	R4	5/7/2010 10:33:00 AM	Tailrace	Between Units 3 & 5	34,000	20.8	
54-170	M	470	Angled	R4	5/7/2010 10:55:00 AM	Tailrace	Between Units 3 & 5	34,000	20.8	
54-137	M	440	Angled	R4	5/7/2010 11:16:00 AM	Tailrace	Between Units 3 & 5	34,000	20.8	
54-136	M	450	Angled	R4	5/7/2010 11:28:00 AM	Tailrace	Between Units 3 & 5	34,000	20.8	
54-135	M	440	Angled	R4	5/7/2010 11:39:00 AM	Tailrace	Downstream of "C" Gate	34,000	20.8	
54-139	F	510	Angled	R4	5/7/2010 11:44:00 AM	Tailrace	Downstream of "C" Gate	34,000	20.8	
54-138	M	440	Angled	R4	5/7/2010 12:05:00 PM	Tailrace	Downstream of "C" Gate	34,000	20.8	
54-142	M	500	Angled	R4	5/7/2010 12:09:00 PM	Tailrace	Downstream of "C" Gate	34,000	20.8	
54-141	M	445	Angled	R4	5/7/2010 12:41:00 PM	Tailrace	Downstream of "C" Gate	34,000	20.8	
54-140	M	480	Angled	R4	5/7/2010 12:55:00 PM	Tailrace	Downstream of "C" Gate	34,000	20.8	
54-144	F	500	Angled	R4	5/7/2010 1:10:00 PM	Tailrace	Downstream of "C" Gate	34,000	20.8	
54-167	F	505	Angled	R4	5/7/2010 1:26:00 PM	Tailrace	Downstream of "C" Gate	34,000	20.8	
54-164	M	440	Angled	R4	5/7/2010 1:28:00 PM	Tailrace	Downstream of "C" Gate	34,000	20.8	
54-160	M	480	Angled	R4	5/7/2010 1:33:00 PM	Tailrace	Downstream of "C" Gate	34,000	20.8	
54-158	F	510	Angled	R4	5/7/2010 2:03:00 PM	Tailrace	Downstream of "C" Gate	34,000	20.8	
54-166	M	440	Angled	R4	5/7/2010 3:03:00 PM	Tailrace	Downstream of "C" Gate	68,000	20.8	
54-149	M	470	Angled	R4	5/7/2010 3:20:00 PM	Tailrace	Downstream of "C" Gate	68,000	20.8	
54-150	F	500	Angled	R4	5/7/2010 3:20:00 PM	Tailrace	Downstream of "C" Gate	68,000	20.8	
54-148	M	475	Angled	R4	5/7/2010 3:27:00 PM	Tailrace	Downstream of "C" Gate	68,000	20.8	
54-145	M	450	Angled	R4	5/7/2010 3:45:00 PM	Tailrace	Downstream of "C" Gate	68,000	20.8	
54-151	M	525	Angled	R4	5/7/2010 4:14:00 PM	Tailrace	Downstream of "C" Gate	68,000	20.8	
54-153	F	510	Angled	R4	5/7/2010 5:13:00 PM	Tailrace	Downstream of "C" Gate	68,000	20.8	
54-152	F	515	Angled	R4	5/7/2010 8:02:00 PM	Tailrace	Downstream of "C" Gate	68,000	20.8	
21-137	F	495	Angled	R5	5/10/2010 10:29:00 AM	Tailrace	Between Units 7 & 8	22,500	18.1	
21-138	F	460	Angled	R5	5/10/2010 10:44:00 AM	Tailrace	Between Units 7 & 8	22,500	18.1	
21-139	M	450	Angled	R5	5/10/2010 10:52:00 AM	Tailrace	Between Units 7 & 8	22,500	18.1	
21-140	F	468	Angled	R5	5/10/2010 10:55:00 AM	Tailrace	Between Units 7 & 8	22,500	18.1	
21-141	F	470	Angled	R5	5/10/2010 11:02:00 AM	Tailrace	Between Units 7 & 8	22,500	18.1	
21-174	F	482	Angled	R5	5/10/2010 11:17:00 AM	Tailrace	Between Units 7 & 8	22,500	18.1	
21-142	F	495	Angled	R5	5/10/2010 11:45:00 AM	Tailrace	Off of "A" Gate discharge	22,500	18.1	
21-143	F	480	Angled	R5	5/10/2010 12:00:00 PM	Tailrace	Off of "A" Gate discharge	22,500	18.1	
21-144	M	440	Angled	R5	5/10/2010 12:08:00 PM	Tailrace	Off of "A" Gate discharge	22,500	18.1	
21-145	F	475	Angled	R5	5/10/2010 12:12:00 PM	Tailrace	Off of "A" Gate discharge	22,500	18.1	
21-173	F	505	Angled	R5	5/10/2010 12:33:00 PM	Tailrace	Off of "A" Gate discharge	22,500	18.1	
21-149	F	445	Angled	R5	5/10/2010 12:34:00 PM	Tailrace	Off of "A" Gate discharge	22,500	18.1	

Fish	Sex	Length (mm)	Capture		Release			River Flow (cfs)	Water Temperature (°C)
			Method	Group	Date and Time	Location	Location Description		
21-146	F	505	Angled	R5	5/10/2010 12:36:00 PM	Tailrace	Off of "A" Gate discharge	22,500	18.1
21-147	F	503	Angled	R5	5/10/2010 12:54:00 PM	Tailrace	Off of "A" Gate discharge	22,500	18.1
21-148	F	480	Angled	R5	5/10/2010 2:22:00 PM	Tailrace	Between Units 3 & 5	7,500	18.1
21-150	M	475	Angled	R5	5/10/2010 2:35:00 PM	Tailrace	Between Units 3 & 5	7,500	18.1
21-151	F	540	Angled	R5	5/10/2010 2:54:00 PM	Tailrace	Between Units 3 & 5	7,500	18.1
21-170	M	445	Angled	R5	5/10/2010 3:05:00 PM	Tailrace	Between Units 3 & 5	7,500	18.1
21-152	M	440	Angled	R5	5/10/2010 4:14:00 PM	Tailrace	Between Units 3 & 5	7,500	18.1
21-153	F	445	Angled	R5	5/10/2010 4:24:00 PM	Tailrace	Between Units 3 & 5	7,500	18.1
21-154	M	465	Angled	R5	5/10/2010 5:14:00 PM	Tailrace	Between Units 3 & 5	7,500	18.1
21-155	M	480	Angled	R5	5/10/2010 5:21:00 PM	Tailrace	Between Units 3 & 5	7,500	18.1
21-156	F	540	Angled	R5	5/10/2010 5:30:00 PM	Tailrace	Between Units 3 & 5	7,500	18.1
21-157	F	520	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-158	F	480	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-159	F	505	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-160	F	485	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-161	F	495	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-162	F	515	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-163	F	505	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-164	F	490	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-165	F	455	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-166	F	500	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-168	F	490	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-169	F	475	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-171	F	485	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
21-172	F	475	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
54-147	M	465	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
54-154	F	480	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
54-155	M	430	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
54-156	F	490	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
54-157	F	510	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
54-159	F	475	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
54-161	M	435	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
54-162	M	460	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
54-163	M	460	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
54-165	F	465	West Fish Lift	R6L	5/12/2010 11:40:00 AM	Lapillum Boat Launch	Lapillum Boat Launch	17,000	15.7
54-196-2	F	510	West Fish Lift	R6T	5/12/2010 11:00:00 AM	West Fish Lift Tailrace	West Fishlift Sorting Tank	17,000	15.7
54-200-2	F	500	West Fish Lift	R6T	5/12/2010 11:00:00 AM	West Fish Lift Tailrace	West Fishlift Sorting Tank	17,000	15.7

**APPENDIX B: INITIAL POST TAGGING RETURN DATES AND TIMES TO CONOWINGO
TAILRACE, SPRING 2010.**

Appendix B
Initial post tagging return dates and times to Conowingo Tailrace, spring 2010.

Fish	Release		Movement Classification	Release		Initial Return to Tailrace		Time to Initial Tailrace days-hrs:min:sec
	Group	Location		Date	Time	Date	Time	
21-112	R2	Downstream of "C" Gate	Passage	22-Apr-10	11:44:00	27-Apr-10	0:06:14	05-00:06:14
21-113	R2	Downstream of "C" Gate	Passage	22-Apr-10	11:51:00	27-Apr-10	18:12:15	05-18:12:15
21-114	R2	Downstream of "C" Gate	Passage	22-Apr-10	12:03:00	27-Apr-10	14:26:10	05-14:26:10
21-119	R2	Downstream Units 5 & 7	Passage	22-Apr-10	13:02:00	28-Apr-10	13:02:27	06-13:02:27
21-121	R2	Downstream Units 5 & 7	Passage	22-Apr-10	13:11:00	03-May-10	20:47:53	11-20:47:53
21-122	R2	Downstream Units 5 & 7	Passage	22-Apr-10	13:20:00	05-May-10	5:01:22	13-05:01:22
21-123	R2	Downstream Units 5 & 7	Passage	22-Apr-10	13:21:00	07-May-10	16:30:03	15-16:30:03
21-124	R2	Downstream Units 5 & 7	Passage	22-Apr-10	13:26:00	07-May-10	23:49:13	15-23:49:13
21-127	R2	Downstream Units 5 & 7	Passage	22-Apr-10	13:34:00	27-Apr-10	18:19:14	05-18:19:14
21-135	R2	Downstream Units 5 & 7	Passage	22-Apr-10	12:56:00	02-May-10	18:10:08	10-18:10:08
21-146	R5	Off of "A" Gate discharge	Passage	10-May-10	12:36:00	11-May-10	8:39:35	01-08:39:35
21-149	R5	Off of "A" Gate discharge	Passage	10-May-10	12:34:00	12-May-10	7:46:50	02-07:46:50
21-154	R5	Between Units 3 & 5	Passage	10-May-10	17:14:00	11-May-10	19:58:50	01-19:58:50
21-170	R5	Between Units 3 & 5	Passage	10-May-10	15:05:00	12-May-10	14:17:15	02-14:17:15
21-174	R5	Between Units 7 & 8	Passage	10-May-10	11:17:00	11-May-10	12:24:03	01-12:24:03
54-138	R4	Downstream of "C" Gate	Passage	07-May-10	12:05:00	09-May-10	6:20:25	02-06:20:25
54-140	R4	Downstream of "C" Gate	Passage	07-May-10	12:55:00	19-May-10	4:12:22	12-04:12:22
54-142	R4	Downstream of "C" Gate	Passage	07-May-10	12:09:00	10-May-10	10:07:43	03-10:07:43
54-158	R4	Downstream of "C" Gate	Passage	07-May-10	14:03:00	10-May-10	19:21:34	03-05:18:34
54-160	R4	Downstream of "C" Gate	Passage	07-May-10	13:33:00	14-May-10	9:02:00	07-09:02:00
54-164	R4	Downstream of "C" Gate	Passage	07-May-10	13:28:00	14-May-10	15:05:41	07-15:05:41
54-168	R4	Between Units 3 & 5	Passage	07-May-10	10:15:00	11-May-10	12:04:41	04-12:04:41
54-169	R4	Between Units 3 & 5	Passage	07-May-10	10:33:00	14-May-10	3:27:19	07-03:27:19
54-191	R1	Downstream of "C" Gate	Passage	20-Apr-10	10:24:00	08-May-10	16:44:12	18-16:44:12
54-194	R1	Downstream Units 5 & 7	Passage	20-Apr-10	13:09:00	24-Apr-10	2:05:23	04-02:05:23
54-197	R1	Downstream Units 5 & 7	Passage	20-Apr-10	13:29:00	01-May-10	16:07:06	11-16:07:06
54-198	R1	Downstream Units 5 & 7	Passage	20-Apr-10	13:36:00	04-May-10	13:12:38	14-13:12:38
54-199	R1	Downstream Units 5 & 7	Passage	20-Apr-10	13:52:00	06-May-10	0:53:22	16-00:53:22
54-201	R1	Downstream Units 5 & 7	Passage	20-Apr-10	14:08:00	22-Apr-10	5:53:31	02-05:53:31
54-202	R1	Downstream Units 5 & 7	Passage	20-Apr-10	14:12:00	02-May-10	18:14:52	12-18:14:52
54-203	R1	Downstream Units 5 & 7	Passage	20-Apr-10	14:16:00	27-Apr-10	15:52:44	07-15:52:44
54-204	R1	Downstream Units 5 & 7	Passage	20-Apr-10	14:20:00	22-Apr-10	14:58:25	02-14:58:25
54-207	R1	Downstream Units 5 & 7	Passage	20-Apr-10	14:41:00	04-May-10	12:37:08	14-12:37:08
21-132	R3	Lapidum Boat Launch	Passage	28-Apr-10	11:35:00	07-May-10	13:38:18	09-13:38:18
21-158	R6L	Lapidum Boat Launch	Passage	12-May-10	11:40:00	20-May-10	6:16:26	08-06:16:26
21-169	R6L	Lapidum Boat Launch	Passage	12-May-10	11:40:00	20-May-10	3:10:55	08-03:10:55
21-171	R6L	Lapidum Boat Launch	Passage	12-May-10	11:40:00	24-May-10	3:28:35	12-03:28:35
54-159	R6L	Lapidum Boat Launch	Passage	12-May-10	11:40:00	18-May-10	19:23:13	06-19:23:13
54-208	R3	Lapidum Boat Launch	Passage	28-Apr-10	11:35:00	04-May-10	14:02:40	06-14:02:40
54-210	R3	Lapidum Boat Launch	Passage	28-Apr-10	11:35:00	12-May-10	10:22:32	14-10:22:32
21-100	R2	Downstream of "C" Gate	Foray without Passage	22-Apr-10	10:36:00	22-Apr-10	14:00:00	00-14:00:00
21-104	R2	Downstream of "C" Gate	Foray without Passage	22-Apr-10	11:06:00	23-Apr-10	12:29:42	01-12:29:42
21-109	R2	Downstream of "C" Gate	Foray without Passage	22-Apr-10	11:34:00	01-May-10	14:02:03	09-14:02:03
21-115	R2	Downstream Units 5 & 7	Foray without Passage	22-Apr-10	12:10:00	12-May-10	19:18:19	20-19:18:19
21-116	R2	Downstream Units 5 & 7	Foray without Passage	22-Apr-10	12:34:00	26-Apr-10	15:25:04	04-15:25:04
21-120	R2	Downstream Units 5 & 7	Foray without Passage	22-Apr-10	13:10:00	03-May-10	8:05:34	11-08:05:34
21-129	R2	Downstream Units 5 & 7	Foray without Passage	22-Apr-10	13:37:00	24-Apr-10	2:46:24	02-02:46:24
21-141	R5	Between Units 7 & 8	Foray without Passage	10-May-10	11:02:00	14-May-10	20:13:30	04-20:13:30
21-142	R5	Off of "A" Gate discharge	Foray without Passage	10-May-10	11:45:00	12-May-10	6:25:44	02-06:25:44
21-143	R5	Off of "A" Gate discharge	Foray without Passage	10-May-10	12:00:00	12-May-10	10:58:06	02-10:58:06
21-144	R5	Off of "A" Gate discharge	Foray without Passage	10-May-10	12:08:00	12-May-10	11:42:47	02-11:42:47
21-156	R5	Between Units 3 & 5	Foray without Passage	10-May-10	17:30:00	11-May-10	7:35:38	01-07:35:38
54-137	R4	Between Units 3 & 5	Foray without Passage	07-May-10	11:16:00	15-May-10	18:20:15	08-18:20:15
54-149	R4	Downstream of "C" Gate	Foray without Passage	07-May-10	15:20:00	14-May-10	15:52:57	07-15:52:57
54-151	R4	Downstream of "C" Gate	Foray without Passage	07-May-10	16:14:00	12-May-10	15:08:49	05-15:08:49
54-167	R4	Downstream of "C" Gate	Foray without Passage	07-May-10	13:26:00	14-May-10	9:19:20	07-09:19:20
54-200-1	R1	Downstream Units 5 & 7	Foray without Passage	20-Apr-10	13:54:00	26-Apr-10	17:24:16	06-17:24:16
54-200-2	R6T	West Fish Lift Sorting Tank	Foray without Passage	12-May-10	11:00:00	18-May-10	6:12:44	06-06:12:44
21-159	R6L	Lapidum Boat Launch	Foray without Passage	12-May-10	11:40:00	21-May-10	1:08:50	09-01:08:50
54-156	R6L	Lapidum Boat Launch	Foray without Passage	12-May-10	11:40:00	26-May-10	18:17:26	14-18:17:26
54-176	R3	Lapidum Boat Launch	Foray without Passage	28-Apr-10	11:35:00	04-May-10	9:55:47	06-09:55:47
54-178	R3	Lapidum Boat Launch	Foray without Passage	28-Apr-10	11:35:00	05-May-10	17:06:14	07-17:06:14
54-186	R3	Lapidum Boat Launch	Foray without Passage	28-Apr-10	11:35:00	13-May-10	4:45:45	15-04:45:45
54-209	R3	Lapidum Boat Launch	Foray without Passage	28-Apr-10	11:35:00	13-May-10	7:02:35	15-07:02:35
54-211	R3	Lapidum Boat Launch	Foray without Passage	28-Apr-10	11:35:00	13-May-10	16:27:57	15-16:27:57
21-101	R2	Downstream of "C" Gate	Tailrace without Foray	22-Apr-10	10:47:00	07-May-10	9:20:31	15-09:20:31
21-102	R2	Downstream of "C" Gate	Tailrace without Foray	22-Apr-10	10:55:00	22-Apr-10	18:44:24	00-18:44:24
21-105	R2	Downstream of "C" Gate	Tailrace without Foray	22-Apr-10	11:26:00	04-May-10	18:46:21	12-18:46:21

21-110	R2	Downstream of "C" Gate	Tailrace without Foray	22-Apr-10	11:35:00	23-Apr-10	10:02:00	01-10:02:00
21-111	R2	Downstream of "C" Gate	Tailrace without Foray	22-Apr-10	11:38:00	23-Apr-10	10:57:03	01-10:57:03
21-117	R2	Downstream Units 5 & 7	Tailrace without Foray	22-Apr-10	12:37:00	22-May-10	15:07:29	30-15:07:29
21-118	R2	Downstream Units 5 & 7	Tailrace without Foray	22-Apr-10	13:00:00	23-Apr-10	18:50:34	01-18:50:34
21-128	R2	Downstream Units 5 & 7	Tailrace without Foray	22-Apr-10	13:35:00	22-Apr-10	20:10:46	00-20:10:46
21-137	R5	Between Units 7 & 8	Tailrace without Foray	10-May-10	10:29:00	11-May-10	18:55:09	01-18:55:09
21-145	R5	Off of "A" Gate discharge	Tailrace without Foray	10-May-10	12:12:00	13-May-10	3:14:34	03-03:14:34
21-147	R5	Off of "A" Gate discharge	Tailrace without Foray	10-May-10	12:54:00	14-May-10	14:46:43	04-14:46:43
21-151	R5	Between Units 3 & 5	Tailrace without Foray	10-May-10	14:54:00	17-May-10	6:55:41	07-06:55:41
54-141	R4	Downstream of "C" Gate	Tailrace without Foray	07-May-10	12:41:00	07-May-10	18:35:00	00-18:35:00
54-144	R4	Downstream of "C" Gate	Tailrace without Foray	07-May-10	13:10:00	14-May-10	4:50:26	07-04:50:26
54-172	R4	Between Units 3 & 5	Tailrace without Foray	07-May-10	9:28:00	07-May-10	16:29:36	00-16:29:36
54-173	R4	Between Units 3 & 5	Tailrace without Foray	07-May-10	9:34:00	08-May-10	5:59:20	01-05:59:20
54-192	R1	Downstream of "C" Gate	Tailrace without Foray	20-Apr-10	7:53:00	04-May-10	15:07:37	14-15:07:37
54-193	R1	Downstream Units 5 & 7	Tailrace without Foray	20-Apr-10	13:08:00	28-Apr-10	13:56:42	08-13:56:42
54-196-1	R1	Downstream Units 5 & 7	Tailrace without Foray	20-Apr-10	13:24:00	26-Apr-10	3:35:29	06-03:35:29
21-130	R3	Lapidum Boat Launch	Tailrace without Foray	28-Apr-10	11:35:00	05-May-10	12:15:33	07-12:15:33
21-133	R3	Lapidum Boat Launch	Tailrace without Foray	22-Apr-10	11:35:00	28-Apr-10	9:38:00	06-09:38:00
21-160	R6L	Lapidum Boat Launch	Tailrace without Foray	12-May-10	11:40:00	23-May-10	10:55:22	11-10:55:22
54-179	R3	Lapidum Boat Launch	Tailrace without Foray	28-Apr-10	11:35:00	14-May-10	12:04:05	16-12:04:05
54-183	R3	Lapidum Boat Launch	Tailrace without Foray	28-Apr-10	11:35:00	20-May-10	2:34:47	22-02:34:47

**APPENDIX C: GENERATION (CFS) DURING FORAYS INTO EAST FISH LIFT, SPRING
2010.**

Appendix C

Generation (cfs) during forays into EFL, spring 2010.

Initial Foray into EFL Date and Time	Generation Total Discharge (cfs)	Turbine Operating Combination Description	Units Operating	Foray Outcome
6/01/10 11:32:26	5,000	2 & 0	2,5	Unsuccessful
5/03/10 08:11:13	7,500	2 & 0	2,5	Successful
5/03/10 08:21:30	7,500	2 & 0	2,5	Successful
5/06/10 09:27:31	7,500	2 & 0	2,5	Successful
5/08/10 08:31:22	7,500	2 & 0	2,5	Successful
5/08/10 09:21:56	7,500	2 & 0	2,5	Unsuccessful
5/08/10 09:28:41	7,500	2 & 0	2,5	Successful
5/08/10 10:30:03	7,500	2 & 0	2,5	Successful
5/08/10 10:45:22	7,500	2 & 0	2,5	Successful
5/08/10 10:46:35	7,500	2 & 0	2,5	Successful
5/09/10 08:26:12	7,500	2 & 0	2,5	Unsuccessful
5/10/10 13:11:09	7,500	2 & 0	2,5	Unsuccessful
5/11/10 12:20:06	7,500	2 & 0	2,5	Unsuccessful
5/11/10 13:52:40	7,500	2 & 0	2,5	Successful
5/11/10 16:12:34	7,500	2 & 0	2,5	Successful
5/13/10 12:06:37	7,500	2 & 0	2,5	Unsuccessful
5/13/10 15:42:00	7,500	2 & 0	2,5	Unsuccessful
5/18/10 10:14:15	7,500	2 & 0	2,5	Unsuccessful
5/21/10 08:57:34	7,500	2 & 0	2,5	Unsuccessful
5/22/10 08:25:37	7,500	2 & 0	2,5	Unsuccessful
5/22/10 08:54:27	7,500	2 & 0	2,5	Successful
5/23/10 07:22:37	7,500	2 & 0	2,5	Unsuccessful
5/23/10 07:59:50	7,500	2 & 0	2,5	Unsuccessful
5/23/10 08:26:46	7,500	2 & 0	2,5	Unsuccessful
5/24/10 08:01:09	7,500	2 & 0	2,5	Unsuccessful
5/24/10 09:30:53	7,500	2 & 0	2,5	Successful
5/24/10 09:35:33	7,500	2 & 0	2,5	Successful
5/24/10 09:38:18	7,500	2 & 0	2,5	Successful
5/24/10 10:34:45	7,500	2 & 0	2,5	Unsuccessful
5/31/10 08:05:56	7,500	2 & 0	2,5	Unsuccessful
5/31/10 12:20:22	7,500	2 & 0	2,5	Unsuccessful
5/21/10 09:10:50	7,500	2 & 0	2,5	Unsuccessful
4/24/10 15:19:21	10,000	2 & 0	5,7	Unsuccessful
5/12/10 10:13:46	17,210	3 & 0	2,5,7	Successful
5/12/10 10:31:37	17,210	3 & 0	2,5,7	Unsuccessful
5/12/10 10:39:03	17,210	3 & 0	2,5,7	Successful
5/12/10 10:55:18	17,210	3 & 0	2,5,7	Successful
5/12/10 11:14:04	17,210	3 & 0	2,5,7	Unsuccessful
5/12/10 13:08:06	17,210	3 & 0	2,5,7	Successful
5/12/10 13:57:50	17,210	3 & 0	2,5,7	Successful

Initial Foray into EFL Date and Time	Generation Total Discharge (cfs)	Turbine Operating Combination Description	Units Operating	Foray Outcome
5/12/10 14:24:15	17,210	3 & 0	2,5,7	Unsuccessful
5/12/10 15:16:18	17,210	3 & 0	2,5,7	Successful
5/12/10 15:17:10	17,210	3 & 0	2,5,7	Successful
5/12/10 15:41:01	17,210	3 & 0	2,5,7	Successful
5/12/10 16:38:08	17,210	3 & 0	2,5,7	Unsuccessful
5/12/10 17:11:00	17,210	3 & 0	2,5,7	Successful
5/20/10 16:54:03	17,210	3 & 0	2,5,6	Successful
5/20/10 17:46:06	17,210	3 & 0	2,5,6	Unsuccessful
5/19/10 12:40:00	23,080	4 & 0	2,5,6,7	Unsuccessful
5/04/10 08:03:25	23,080	4 & 0	2,5,6,7	Unsuccessful
5/04/10 10:02:40	23,080	4 & 0	2,5,6,7	Unsuccessful
5/04/10 11:43:47	23,080	4 & 0	2,5,6,7	Unsuccessful
5/23/10 14:36:53	32,080	4 & 1	2,5,6,7,8	Successful
5/23/10 14:53:40	32,080	4 & 1	2,5,6,7,8	Successful
5/23/10 15:21:25	32,080	4 & 1	2,5,6,7,8	Unsuccessful
5/28/10 14:05:46	32,080	4 & 1	2,5,6,7,8	Unsuccessful
5/28/10 15:47:39	32,080	4 & 1	2,5,6,7,8	Unsuccessful
5/07/10 11:57:50	32,080	4 & 1	2,5,6,7,8	Successful
5/07/10 12:05:39	32,080	4 & 1	2,5,6,7,8	Successful
5/07/10 13:58:43	32,080	4 & 1	2,5,6,7,8	Unsuccessful
5/14/10 11:16:33	32,280	4 & 1	4,5,6,7,8	Unsuccessful
5/21/10 11:27:50	41,200	4 & 2	2,5,6,7,8,9	Unsuccessful
5/08/10 15:25:06	41,200	4 & 2	2,5,6,7,8,9	Unsuccessful
5/20/10 10:39:21	41,200	4 & 2	2,5,6,7,8,9	Unsuccessful
5/20/10 11:49:03	41,200	4 & 2	2,5,6,7,8,9	Unsuccessful
5/29/10 13:47:42	41,200	4 & 2	2,5,6,7,8,9	Unsuccessful
5/29/10 14:34:23	41,200	4 & 2	2,5,6,7,8,9	Unsuccessful
5/09/10 12:04:17	43,820	6 & 1	2,3,4,5,6,7,8	Unsuccessful
5/15/10 08:42:00	43,820	6 & 1	2,3,4,5,6,7,8	Unsuccessful
5/15/10 11:21:56	43,820	6 & 1	2,3,4,5,6,7,8	Unsuccessful
5/15/10 11:29:20	43,820	6 & 1	2,3,4,5,6,7,8	Successful
5/16/10 15:33:05	43,820	6 & 1	2,3,4,5,6,7,8	Unsuccessful
5/16/10 15:46:54	43,820	6 & 1	2,3,4,5,6,7,8	Unsuccessful
5/17/10 09:54:21	43,820	6 & 1	2,3,4,5,6,7,8	Unsuccessful
4/30/10 09:14:05	50,520	4 & 3	4,5,6,7,8,9,11	Successful
5/22/10 14:27:46	52,940	6 & 2	1,2,3,4,5,6,8,9	Successful
5/26/10 11:41:02	52,940	6 & 2	2,3,4,5,6,7,8,11	Unsuccessful
5/26/10 12:10:53	52,940	6 & 2	2,3,4,5,6,7,8,11	Unsuccessful
5/07/10 15:46:21	62,060	6 & 3	2,3,4,5,6,7,8,9,11	Successful
5/07/10 16:15:34	62,060	6 & 3	2,3,4,5,6,7,8,9,11	Successful
5/07/10 16:42:31	62,060	6 & 3	2,3,4,5,6,7,8,9,11	Successful
5/07/10 17:34:15	62,060	6 & 3	2,3,4,5,6,7,8,9,11	Successful
5/07/10 18:10:22	62,060	6 & 3	2,3,4,5,6,7,8,9,11	Successful
5/25/10 14:35:28	62,060	6 & 3	2,3,4,5,6,7,8,9,11	Unsuccessful

Initial Foray into EFL Date and Time	Generation Total Discharge (cfs)	Turbine Operating Combination Description	Units Operating	Foray Outcome
5/25/10 15:59:33	62,060	6 & 3	2,3,4,5,6,7,8,9,11	Unsuccessful
5/05/10 14:12:25	67,930	7 & 3	1,2,3,4,5,6,7,8,9,11	Successful
5/05/10 15:34:06	67,930	7 & 3	1,2,3,4,5,6,7,8,9,11	Unsuccessful
6/01/10 14:15:39	67,930	7 & 3	1,2,3,4,5,6,7,8,9,11	Unsuccessful
5/01/10 17:21:34	71,180	6 & 4	2,3,4,5,6,7,8,9,10,11	Unsuccessful
5/02/10 17:16:53	71,180	6 & 4	2,3,4,5,6,7,8,9,10,11	Unsuccessful
5/02/10 18:14:09	71,180	6 & 4	2,3,4,5,6,7,8,9,10,11	Unsuccessful
5/02/10 18:18:34	71,180	6 & 4	2,3,4,5,6,7,8,9,10,11	Successful
5/02/10 18:20:00	71,180	6 & 4	2,3,4,5,6,7,8,9,10,11	Unsuccessful
5/17/10 12:39:00	71,180	6 & 4	2,3,4,5,6,7,8,9,10,11	Successful
5/17/10 12:58:15	71,180	6 & 4	2,3,4,5,6,7,8,9,10,11	Unsuccessful
5/17/10 13:17:31	71,180	6 & 4	2,3,4,5,6,7,8,9,10,11	Unsuccessful
5/17/10 15:12:38	71,180	6 & 4	2,3,4,5,6,7,8,9,10,11	Unsuccessful
5/17/10 15:42:06	71,180	6 & 4	2,3,4,5,6,7,8,9,10,11	Unsuccessful
5/17/10 16:40:18	71,180	6 & 4	2,3,4,5,6,7,8,9,10,11	Unsuccessful
5/21/10 14:46:09	85,400	Full House	1,2,3,4,5,6,7,8,9,10,11	Successful
5/21/10 16:45:50	85,400	Full House	1,2,3,4,5,6,7,8,9,10,11	Successful
5/18/10 15:00:06	85,400	Full House	1,2,3,4,5,6,7,8,9,10,11	Unsuccessful

**APPENDIX D: SUCCESSFUL PASSAGE FORAY AND CORRESPONDING OPERATIONAL
CONDITIONS, SPRING 2010.**

Appendix D
Successful passage foray and corresponding operational conditions, spring 2010.

Foray ID	Passage Date and Time	Foray Duration	Day of Week	Water Temp.	Hourly Shad biomass	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11	Water Gate	Wind's Open	Flow Velocity	Flattish Operational Conditions	Pond Area	Gate %	Thruance Level H	Thruance Level R	Spillway Attraction Flow Setting	Diffuser Setting	How Many Other Times in Facility?	Previously Entered in Facility?	Previously Entered in Facility?	Initial Entrance Date and Time	Initial Entrance NA
54-20	04/20/10 08:15 1st Lower Farnhill Dtl. Ext. Trough	00:38:14	Friday	60.8	38	0	0	0	0	0	0	0	0	0	0	0	C	45%	3.65	26%	106.2	18.5	14	50	14	no	no	NA	NA		
54-20A	05/03/10 08:21:30 2nd Lower Farnhill Dtl. Ext. Trough	00:18:42	Monday	63.5	148	0	0	0	0	0	0	0	0	0	0	0	A	97%	4.70	30%	107.2	18.5	14	50	14	no	no	NA	NA		
54-197	05/03/10 08:11:13 3rd Lower Farnhill Dtl. Ext. Trough	00:32:33	Monday	63.5	148	0	0	0	0	0	0	0	0	0	0	0	A	97%	4.70	30%	107.2	18.5	14	50	14	yes	yes	1	#REF!	C	
54-194	05/02/10 18:58:34 4th Lower Farnhill Dtl. Ext. Trough	00:07:03	Monday	63.5	69	0	1	1	1	1	1	1	1	1	1	1	C	47%	3.60	35%	107.4	23.0	14	50	14	no	no	NA	NA		
54-202	05/05/10 14:12:25 5th Lower Farnhill Dtl. Ext. Trough	00:01:38	Wednesday	66.3	38	0	1	1	1	1	1	1	1	1	1	1	C	48%	3.50	30%	108.0	22.8	14	50	14	yes	yes	1	#REF!	A	
54-203	05/06/10 09:27:31 6th Lower Farnhill Dtl. Ext. Trough	00:40:40	Thursday	66.5	133	0	1	1	1	1	1	1	1	1	1	1	A	8%	4.00	30%	106.7	18.5	14	50	14	no	no	NA	NA		
21-158	05/07/10 12:09:39 7th Lower Farnhill Dtl. Ext. Trough	00:08:51	Friday	70.0	79	0	0	0	1	1	1	1	1	1	1	1	C	65%	4.30	35%	107.5	21.0	14	50	14	yes	yes	1	#REF!	A	
21-127	05/07/10 11:57:50 8th Lower Farnhill Dtl. Ext. Trough	00:03:01	Friday	70.0	414	0	1	1	1	1	1	1	1	1	1	1	C	65%	4.50	30%	107.2	21.0	14	50	14	yes	no	NA	NA		
54-198	05/07/10 15:48:21 9th Lower Farnhill Dtl. Ext. Trough	00:07:24	Friday	70.0	308	0	1	1	1	1	1	1	1	1	1	1	C	48%	3.80	40%	107.7	23.0	14	50	14	yes	no	NA	NA		
54-200	05/07/10 16:42:31 10th Lower Farnhill Dtl. Ext. Trough	00:10:26	Friday	70.0	500	0	1	1	1	1	1	1	1	1	1	1	C	48%	3.90	40%	107.7	23.0	14	50	14	no	no	NA	NA		
21-119	05/07/10 16:15:34 11th Lower Farnhill Dtl. Ext. Trough	00:46:56	Friday	70.0	488	0	1	1	1	1	1	1	1	1	1	1	C	48%	3.90	40%	107.7	23.0	14	50	14	yes	no	NA	NA		
21-127	05/07/10 18:13:15 12th Lower Farnhill Dtl. Ext. Trough	00:04:03	Friday	70.0	498	0	1	1	1	1	1	1	1	1	1	1	C	48%	3.90	40%	107.7	23.0	14	50	14	yes	no	NA	NA		
54-193	05/07/10 18:10:22 13th Lower Farnhill Dtl. Ext. Trough	00:00:29	Friday	70.0	498	0	1	1	1	1	1	1	1	1	1	1	C	48%	3.60	40%	107.5	23.0	14	50	14	yes	no	NA	NA		
21-112	05/08/10 08:31:22 14th Lower Farnhill Dtl. Ext. Trough	00:06:28	Saturday	70.7	233	0	1	1	1	1	1	1	1	1	1	1	C	48%	4.10	30%	106.6	19.0	14	50	14	yes	no	NA	NA		
21-132	05/08/10 08:25:43 15th Lower Farnhill Dtl. Ext. Trough	00:40:59	Saturday	70.7	677	0	1	1	1	1	1	1	1	1	1	1	C	48%	4.10	30%	106.6	19.0	14	50	14	yes	no	NA	NA		
21-114	05/08/10 10:30:03 16th Lower Farnhill Dtl. Ext. Trough	00:23:12	Saturday	70.7	548	0	1	1	1	1	1	1	1	1	1	1	C	48%	4.70	30%	107.0	19.0	14	50	14	yes	no	NA	NA		
21-122	05/08/10 10:46:35 17th Lower Farnhill Dtl. Ext. Trough	00:10:20	Saturday	70.7	586	0	1	1	1	1	1	1	1	1	1	1	C	48%	4.70	30%	107.0	19.0	14	50	14	yes	no	NA	NA		
21-124	05/08/10 10:49:22 18th Lower Farnhill Dtl. Ext. Trough	00:26:53	Saturday	70.7	134	0	1	1	1	1	1	1	1	1	1	1	C	48%	4.50	30%	107.5	19.0	14	50	14	yes	no	NA	NA		
54-208	05/11/10 13:42:40 19th Lower Farnhill Dtl. Ext. Trough	00:50:15	Tuesday	67.1	97	0	1	1	1	1	1	1	1	1	1	1	C	82%	4.40	30%	107.4	19.0	14	50	14	yes	no	NA	NA		
54-199	05/11/10 16:12:34 20th Lower Farnhill Dtl. Ext. Trough	01:36:51	Tuesday	67.1	61	0	1	1	1	1	1	1	1	1	1	1	C	82%	4.30	30%	108.0	19.0	14	50	14	yes	no	NA	NA		
21-154	05/12/10 10:55:18 21st Lower Farnhill Dtl. Ext. Trough	00:51:00	Wednesday	65.7	400	0	1	1	1	1	1	1	1	1	1	1	C	80%	4.00	30%	106.4	19.5	14	50	14	yes	no	NA	NA		
54-158	05/12/10 10:13:46 22nd Lower Farnhill Dtl. Ext. Trough	00:12:24	Wednesday	65.7	400	0	1	1	1	1	1	1	1	1	1	1	C	80%	4.00	30%	106.6	19.5	14	50	14	yes	no	NA	NA		
54-168	05/12/10 10:39:00 23rd Lower Farnhill Dtl. Ext. Trough	01:31:57	Wednesday	65.7	400	0	1	1	1	1	1	1	1	1	1	1	C	80%	4.00	30%	106.4	19.5	14	50	14	yes	no	NA	NA		
21-113	05/12/10 13:38:06 24th Lower Farnhill Dtl. Ext. Trough	00:10:26	Wednesday	65.7	203	0	1	1	1	1	1	1	1	1	1	1	C	80%	4.30	30%	106.6	19.4	14	50	14	yes	yes	1	#REF!	A	
21-174	05/12/10 13:57:50 25th Lower Farnhill Dtl. Ext. Trough	00:10:25	Wednesday	65.7	286	0	1	1	1	1	1	1	1	1	1	1	C	80%	4.30	30%	106.6	19.4	14	50	14	yes	no	NA	NA		
21-148	05/12/10 15:08:18 26th Lower Farnhill Dtl. Ext. Trough	00:23:55	Wednesday	65.7	217	0	1	1	1	1	1	1	1	1	1	1	C	80%	4.40	30%	107.7	19.3	14	50	14	yes	no	NA	NA		
54-210	05/12/10 15:41:01 27th Lower Farnhill Dtl. Ext. Trough	00:07:46	Wednesday	65.7	312	0	1	1	1	1	1	1	1	1	1	1	C	80%	4.40	30%	107.7	19.3	14	50	14	no	no	NA	NA		
21-170	05/12/10 17:11:00 28th Lower Farnhill Dtl. Ext. Trough	00:06:23	Wednesday	65.7	312	0	1	1	1	1	1	1	1	1	1	1	C	80%	4.90	30%	109.3	19.3	14	50	14	no	no	NA	NA		
54-205	05/12/10 15:17:16 29th Lower Farnhill Dtl. Ext. Trough	01:56:39	Wednesday	65.7	182	0	1	1	1	1	1	1	1	1	1	1	C	87%	4.90	30%	108.3	19.3	14	50	14	yes	yes - accessibility	1	#REF!	A	
54-138	05/15/10 11:29:20 30th Lower Farnhill Dtl. Ext. Trough	00:40:47	Saturday	64.4	64	0	1	1	1	1	1	1	1	1	1	1	C	55%	4.00	20%	107.4	22.0	14	50	14	yes	no	NA	NA		
21-149	05/17/10 12:39:00 31st Lower Farnhill Dtl. Ext. Trough	00:06:41	Monday	63.5	121	0	1	1	1	1	1	1	1	1	1	1	C	42%	3.90	25%	107.2	23.0	14	50	14	yes	no	NA	NA		
54-160	05/20/10 16:54:03 32nd Lower Farnhill Dtl. Ext. Trough	00:16:50	Thursday	65.7	74	0	1	1	1	1	1	1	1	1	1	1	C	91%	4.30	30%	107.1	19.5	14	50	14	yes	no	NA	NA		

**APPENDIX E: UNSUCCESSFUL PASSAGE FORAY FOR SHAD THAT LATER PASSED AND
CORRESPONDING OPERATIONAL CONDITIONS, SPRING 2010.**

**APPENDIX F: UNSUCCESSFUL PASSAGE FORAY FOR SHAD THAT NEVER PASSED AND
CORRESPONDING OPERATIONAL CONDITIONS, SPRING 2010.**

Appendix E
 Unsuccessful passage foray for shad that never passed and corresponding operational conditions, spring 2010.

Fish ID	Number of Unsuccessful Forays	Unsuccessful Forays	Foray Date and Time	Foray Duration (hh:mm:ss)	Generational Conditions											Fishlift Operational Conditions					Spillway Attraction Flow Setting			If Only a Single Foray Into Fishlift, Was it ever again detected on Fishlift Aerial Gate Antenna?				
					Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10	Unit 11	Weir Gate	Weir % Open	Flow Velocity	Fishlift Crowder Area Gate %	Pond Level ft.	Tailrace Level ft.	A	B		A	B		
21-104	1	Foray 1 Initial Lift Detection	05/24/10 15:19:21	00:00:21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	14	14	No	
54-200-1	1	Foray 1 Initial Lift Detection	05/20/10 17:16:53	00:1:23	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10	50	14	No - died in Exit Trough	
54-176	2	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection	05/04/10 10:32:40 05/04/10 10:32:45	00:1:35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	Not Applicable	
54-176	2	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection	05/14/10 11:16:33 05/14/10 11:30:32	00:1:35	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10	50	14	No	
21-100	1	Foray 1 Initial Lift Detection	05/04/10 11:43:37	01:35:19	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10	50	14	No	
21-116	3	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection Foray 3 Initial Lift Detection	05/05/10 15:36:32 05/07/10 14:19:54 05/07/10 14:19:54	00:22:26 00:21:11	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10	50	14	Not Applicable
54-178	1	Foray 1 Initial Lift Detection	05/06/10 09:21:56	00:04:10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	Not Applicable	
21-109	1	Foray 1 Initial Lift Detection	05/08/10 15:25:08	00:18:25	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10	50	14	Yes, multiple times 5/9 thru 5/10 - initial return	
21-129	1	Foray 1 Initial Lift Detection	05/08/10 12:04:17	01:27:46	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10	50	14	05/28/10 08:07:57	
21-156	1	Foray 1 Initial Lift Detection	05/11/10 12:20:06	00:08:57	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	15	No	
21-143	2	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection	05/11/10 12:29:03 05/20/10 11:28:07	00:09:13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	Not Applicable	
21-143	2	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection	05/18/10 12:40:00 05/18/10 12:40:27	00:00:27	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	Not Applicable	
21-144	3	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection Foray 3 Initial Lift Detection	05/12/10 14:24:15 05/12/10 14:52:22 05/12/10 16:54:42	00:18:34	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	Not Applicable	
21-144	3	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection Foray 3 Initial Lift Detection	05/18/10 10:14:15 05/18/10 10:57:43 04:43:28	00:04:32	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	Not Applicable	
21-142	3	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection Foray 3 Initial Lift Detection	05/13/10 12:06:37 05/13/10 12:28:06 05/25/10 16:11:51	00:21:29	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10	50	14	Not Applicable	
54-209	1	Foray 1 Initial Lift Detection	05/31/10 15:42:00	00:1:23	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	No	
54-151	1	Foray 1 Initial Lift Detection	05/31/10 15:42:05	00:00:05	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	No	
54-167	1	Foray 1 Initial Lift Detection	05/15/10 13:33:43	04:21:43	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10	50	14	No	
54-167	1	Foray 1 Initial Lift Detection	05/16/10 15:46:54	00:27:15	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	10	50	14	Yes, multiple times 5/17 thru 5/19 - initial return	
21-141	2	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection	05/20/10 11:49:03 05/20/10 12:23:58	00:34:47	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	Not Applicable	
54-137	1	Foray 1 Initial Lift Detection	05/21/10 09:10:50	00:00:29	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	Not Applicable	
54-206-2	1	Foray 1 Initial Lift Detection	05/21/10 11:27:50	02:48:50	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	Yes, once, initial return	
54-178	1	Foray 1 Initial Lift Detection	05/21/10 11:36:00	00:08:10	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	No	
54-178	1	Foray 1 Initial Lift Detection	05/21/10 08:25:42	00:00:05	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	No	
54-167	9	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection Foray 3 Initial Lift Detection Foray 4 Initial Lift Detection Foray 5 Initial Lift Detection Foray 6 Initial Lift Detection Foray 7 Initial Lift Detection Foray 8 Initial Lift Detection Foray 9 Initial Lift Detection	05/22/10 07:22:37 05/22/10 08:09:13 05/22/10 11:31:25 05/22/10 15:41:53 05/23/10 14:46:53 05/28/10 14:05:46 05/28/10 15:47:39 05/28/10 16:15:37 05/29/10 14:03:48	00:46:36 00:20:06 00:11:25 00:08:23 00:27:58 00:16:08	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	Not Applicable
54-167	9	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection Foray 3 Initial Lift Detection Foray 4 Initial Lift Detection Foray 5 Initial Lift Detection Foray 6 Initial Lift Detection Foray 7 Initial Lift Detection Foray 8 Initial Lift Detection Foray 9 Initial Lift Detection	05/31/10 08:05:56 05/31/10 08:09:06 06/01/10 11:32:26 06/01/10 13:51:52 06/01/10 14:18:53 05/24/10 11:00:45 05/26/10 11:41:02 05/26/10 12:03:56 05/26/10 14:24:11	00:03:10 00:02:46 00:03:14 00:28:00 00:19:52	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	Yes, multiple times 5/26 thru 5/29 - initial return	
54-167	9	Foray 1 Initial Lift Detection Foray 2 Initial Lift Detection Foray 3 Initial Lift Detection Foray 4 Initial Lift Detection Foray 5 Initial Lift Detection Foray 6 Initial Lift Detection Foray 7 Initial Lift Detection Foray 8 Initial Lift Detection Foray 9 Initial Lift Detection	05/29/10 14:34:23 05/29/10 15:18:26	02:13:18 00:44:03	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	50	14	No	

**APPENDIX G: RADIO TAGGED SHAD PRESENCE ON NON-TAILRACE MONITORS BY
MOVEMENT CLASSIFICATIONS, SPRING 2010.**

Appendix G
Post passage re-entry dates and times into Conowingo Tailrace, spring 2010.

Fish	Release		Movement	Re-entry into Conowingo tailrace			
	Group	Location		Classification	Unit	Comment	Date
54-191	R1	Downstream of "C" Gate	Passage Shad	None	Remained upstream of Conowingo	NA	NA
54-194	R1	Downstream Units 5 & 7	Passage Shad	Unit 5	Confirmed	02-Jun-10	17:00:39
54-197	R1	Downstream Units 5 & 7	Passage Shad	None	Remained upstream of Conowingo	NA	NA
54-198	R1	Downstream Units 5 & 7	Passage Shad	Unit 9	Confirmed	30-May-10	16:49:23
54-199	R1	Downstream Units 5 & 7	Passage Shad	Unit 7	Confirmed	23-May-10	11:11:27
54-201	R1	Downstream Units 5 & 7	Passage Shad	Unit 3	Confirmed	05-May-10	12:48:06
54-202	R1	Downstream Units 5 & 7	Passage Shad	Unit 8	Confirmed	06-Jun-10	15:00:19
54-203	R1	Downstream Units 5 & 7	Passage Shad	Unit 1-3	Confirmed	24-May-10	21:13:11
54-204	R1	Downstream Units 5 & 7	Passage Shad	None	Remained upstream of Conowingo	NA	NA
54-207	R1	Downstream Units 5 & 7	Passage Shad	Unit 1	Confirmed	01-Jun-10	13:29:10
21-112	R2	Downstream of "C" Gate	Passage Shad	Unit 5 or 7	Confirmed	02-Jun-10	19:24:23
21-113	R2	Downstream of "C" Gate	Passage Shad	Unknown	Missed tailrace re-entry/detected downstream	31-May-10	Unknown
21-114	R2	Downstream of "C" Gate	Passage Shad	Unit 9	Confirmed	28-May-10	15:53:47
21-119	R2	Downstream Units 5 & 7	Passage Shad	None	Remained upstream of Conowingo	NA	NA
21-121	R2	Downstream Units 5 & 7	Passage Shad	Unit 8	Confirmed	12-May-10	20:58:13
21-122	R2	Downstream Units 5 & 7	Passage Shad	Unit 7	Confirmed	31-May-10	15:50:26
21-123	R2	Downstream Units 5 & 7	Passage Shad	Unit 2 or 3	Confirmed	03-Jun-10	8:13:58
21-124	R2	Downstream Units 5 & 7	Passage Shad	Unit 5	Confirmed	02-Jun-10	12:25:02
21-127	R2	Downstream Units 5 & 7	Passage Shad	Unit 5 or 7	Confirmed	26-May-10	18:24:29
21-135	R2	Downstream Units 5 & 7	Passage Shad	Unit 3 or 4	Confirmed	28-May-10	15:57:29
21-132	R3	Lapidum Boat Launch	Passage Shad	Unit 5	Confirmed	23-May-10	9:32:55
54-208	R3	Lapidum Boat Launch	Passage Shad	Unit 5	Confirmed	11-May-10	20:25:14
54-210	R3	Lapidum Boat Launch	Passage Shad	None	Remained upstream of Conowingo	NA	NA
54-138	R4	Downstream of "C" Gate	Passage Shad	None	Remained upstream of Conowingo	NA	NA
54-140	R4	Downstream of "C" Gate	Passage Shad	None	Remained upstream of Conowingo	NA	NA
54-142	R4	Downstream of "C" Gate	Passage Shad	None	Remained upstream of Conowingo	NA	NA
54-158	R4	Downstream of "C" Gate	Passage Shad	None	Remained upstream of Conowingo	NA	NA
54-160	R4	Downstream of "C" Gate	Passage Shad	None	Remained upstream of Conowingo	NA	NA
54-164	R4	Downstream of "C" Gate	Passage Shad	None	Remained upstream of Conowingo	NA	NA
54-168	R4	Between Units 3 & 5	Passage Shad	Unit 5	Confirmed	01-Jun-10	15:09:35
54-169	R4	Between Units 3 & 5	Passage Shad	None	Remained upstream of Conowingo	NA	NA
21-146	R5	Off of "A" Gate discharge	Passage Shad	None	Remained upstream of Conowingo	NA	NA
21-149	R5	Off of "A" Gate discharge	Passage Shad	Unit 7	Confirmed	19-Jun-10	18:12:37
21-154	R5	Between Units 3 & 5	Passage Shad	None	Remained upstream of Conowingo	NA	NA
21-170	R5	Between Units 3 & 5	Passage Shad	Unit 7	Confirmed	11-Jun-10	19:14:19
21-174	R5	Between Units 7 & 8	Passage Shad	Unit 4 or 5	Confirmed	03-Jun-10	12:00:14
21-158	R6L	Lapidum Boat Launch	Passage Shad	None	Remained upstream of Conowingo	NA	NA
21-169	R6L	Lapidum Boat Launch	Passage Shad	None	Remained upstream of Conowingo	NA	NA
21-171	R6L	Lapidum Boat Launch	Passage Shad	Unit 2 or 5	Confirmed	28-May-10	9:14:54
54-159	R6L	Lapidum Boat Launch	Passage Shad	None	Remained upstream of Conowingo	NA	NA

**APPENDIX H: DOWNSTREAM MOVEMENT OF TAILRACE FISH WITHOUT EAST FISH
LIFT FORAYS, SPRING 2010.**

Appendix H
Downstream movement of tailrace fish without EFL forays, spring 2010.

Fish	Start Date	Start Time	Location	Travel Time	Downstream foray
21-101	22-Apr-10	1:07:52 PM	Conowingo Tailrace Unit 3 (Mid-Field)		Initial
21-101	22-Apr-10	1:49:02 PM	Rowland Island West (Near-Field)	00-00:41:10	Tailrace to Rowland
21-101	22-Apr-10	6:22:20 PM	Rowland Island West (Near-Field)		Initial
21-101	22-Apr-10	8:01:31 PM	Spencer Island West (Near-Field)	00-01:39:11	Rowland to Spencer
21-101	7-May-10	4:55:17 PM	Conowingo Tailrace Units 1-7 Master		
21-101	7-May-10	5:12:13 PM	Rowland Island West (Near-Field)	00-00:16:56	Tailrace to Rowland
21-101	7-May-10	7:15:50 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-101	8-May-10	7:21:21 AM	Rowland Island West (Near-Field)	00-12:03:01	Tailrace to Rowland
21-101	10-May-10	5:15:47 PM	Rowland Island West (Near-Field)		
21-101	10-May-10	9:48:34 PM	Spencer Island West (Near-Field)	00-04:25:17	Rowland to Spencer
21-101	20-May-10	8:09:42 AM	Conowingo Tailrace Unit 1 (Mid-Field)		
21-101	24-Jun-10	4:56:16 PM	Lapidum (West Shore) (Near-Field)	04-08:46:34	Tailrace to Lapidum
21-102	22-Apr-10	12:25:52 PM	Conowingo Tailrace Unit 5 (Mid-Field)		Initial
21-102	22-Apr-10	2:09:44 PM	Rowland Island West (Near-Field)	00-01:43:52	Tailrace to Rowland
21-102	22-Apr-10	10:53:38 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-102	22-Apr-10	11:00:04 PM	Rowland Island West (Near-Field)	00-00:06:26	Tailrace to Rowland
21-102	22-Apr-10	11:11:28 PM	Conowingo Tailrace Unit 3 (Mid-Field)		
21-102	22-Apr-10	11:12:47 PM	Rowland Island West (Near-Field)	00-00:01:19	Tailrace to Rowland
21-102	23-Apr-10	12:00:50 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-102	23-Apr-10	12:12:00 AM	Rowland Island West (Near-Field)	00-00:10:41	Tailrace to Rowland
21-102	23-Apr-10	12:15:06 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-102	23-Apr-10	12:17:38 AM	Rowland Island West (Near-Field)	00-00:02:32	Tailrace to Rowland
21-102	23-Apr-10	1:12:53 AM	Conowingo Tailrace Unit 3 (Mid-Field)		
21-102	23-Apr-10	1:15:22 AM	Rowland Island West (Near-Field)	00-00:02:29	Tailrace to Rowland
21-102	23-Apr-10	1:16:36 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-102	23-Apr-10	1:17:40 AM	Rowland Island West (Near-Field)	00-00:01:04	Tailrace to Rowland
21-102	23-Apr-10	1:26:49 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-102	23-Apr-10	1:36:19 AM	Rowland Island West (Near-Field)	00-00:09:30	Tailrace to Rowland
21-102	23-Apr-10	1:53:33 AM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-102	23-Apr-10	1:55:06 AM	Rowland Island West (Near-Field)	00-00:01:33	Tailrace to Rowland
21-102	23-Apr-10	2:36:11 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-102	23-Apr-10	2:43:09 AM	Rowland Island West (Near-Field)	00-00:04:39	Tailrace to Rowland
21-102	23-Apr-10	3:07:45 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-102	23-Apr-10	3:11:58 AM	Rowland Island West (Near-Field)	00-00:04:13	Tailrace to Rowland
21-102	23-Apr-10	6:41:49 AM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-102	23-Apr-10	7:08:17 AM	Rowland Island West (Near-Field)	00-00:26:28	Tailrace to Rowland
21-102	26-Apr-10	7:10:39 PM	Conowingo Tailrace Unit 7 (Mid-Field)		

Fish	Start Date	Start Time	Location	Travel Time	Downstream foray
21-102	26-Apr-10	7:34:22 PM	Rowland Island West (Near-Field)	00-00:23:43	Tailrace to Rowland
21-102	27-Apr-10	6:08:25 AM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-102	27-Apr-10	6:16:00 AM	Rowland Island West (Near-Field)	00-00:07:35	Tailrace to Rowland
21-102	27-Apr-10	3:59:20 PM	Conowingo Tailrace Unit 8 (Mid-Field)		
21-102	27-Apr-10	4:30:17 PM	Rowland Island West (Near-Field)	00-00:30:57	Tailrace to Rowland
21-102	27-Apr-10	6:30:22 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-102	27-Apr-10	11:07:27 PM	Rowland Island East (Near-Field)	00-04:37:05	Tailrace to Rowland
21-102	30-Apr-10	4:37:54 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-102	30-Apr-10	5:20:32 PM	Rowland Island West (Near-Field)	00-00:42:38	Tailrace to Rowland
21-102	3-May-10	6:50:30 PM	Rowland Island West (Near-Field)		Initial
21-102	3-May-10	8:53:02 PM	Lapidum (West Shore) (Near-Field)	00-02:02:06	Rowland to Lapidum
21-105	22-Apr-10	4:52:48 PM	Conowingo Tailrace Unit 5 (Mid-Field)		Initial
21-105	22-Apr-10	5:26:12 PM	Rowland Island West (Near-Field)	00-00:33:24	Tailrace to Rowland
21-105	22-Apr-10	7:37:25 PM	Rowland Island West (Near-Field)		Initial
21-105	22-Apr-10	9:05:19 PM	Spencer Island West (Near-Field)	00-01:27:54	Rowland to Spencer
21-105	30-Apr-10	4:52:42 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-105	30-Apr-10	5:05:15 PM	Rowland Island West (Near-Field)	00-00:12:33	Tailrace to Rowland
21-105	30-Apr-10	5:05:15 PM	Rowland Island West (Near-Field)		
21-105	30-Apr-10	8:14:27 PM	Spencer Island West (Near-Field)	00-03:09:12	Rowland to Spencer
21-105	4-May-10	7:25:39 PM	Conowingo Tailrace Unit 1 (Mid-Field)		
21-105	4-May-10	7:47:21 PM	Rowland Island West (Near-Field)	00-00:21:42	Tailrace to Rowland
21-105	4-May-10	7:47:21 PM	Rowland Island West (Near-Field)		
21-105	5-May-10	5:41:09 AM	Lapidum (West Shore) (Near-Field)	00-09:53:21	Rowland to Lapidum
21-105	5-May-10	5:53:49 PM	Conowingo Tailrace Unit 9 (Mid-Field)		
21-105	5-May-10	6:14:58 PM	Rowland Island West (Near-Field)	00-00:21:09	Tailrace to Rowland
21-105	6-May-10	6:32:39 PM	Conowingo Tailrace Unit 8 (Mid-Field)		
21-105	6-May-10	6:44:47 PM	Rowland Island West (Near-Field)	00-00:12:08	Tailrace to Rowland
21-105	7-May-10	6:47:21 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-105	7-May-10	7:06:01 AM	Rowland Island West (Near-Field)	00-00:16:03	Tailrace to Rowland
21-105	7-May-10	9:38:03 AM	Conowingo Tailrace Unit 8 (Mid-Field)		
21-105	7-May-10	10:09:05 AM	Rowland Island East (Near-Field)	00-00:31:02	Tailrace to Rowland
21-105	7-May-10	5:13:39 PM	Conowingo Tailrace Unit 3 (Mid-Field)		
21-105	7-May-10	8:57:36 PM	Spencer Island West (Near-Field)	00-03:43:57	Tailrace to Spencer
21-110	22-Apr-10	1:24:42 PM	Conowingo Tailrace Unit 7 (Mid-Field)		Initial
21-110	22-Apr-10	2:07:21 PM	Rowland Island West (Near-Field)	00-00:39:35	Tailrace to Rowland
21-110	23-Apr-10	12:14:55 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-110	23-Apr-10	12:35:08 PM	Rowland Island West (Near-Field)	00-00:17:54	Tailrace to Rowland
21-110	23-Apr-10	5:31:53 PM	Conowingo Tailrace Unit 9 (Mid-Field)		
21-110	23-Apr-10	5:58:54 PM	Rowland Island West (Near-Field)	00-00:27:01	Tailrace to Rowland
21-110	23-Apr-10	6:18:42 PM	Rowland Island West (Near-Field)		

Fish	Start Date	Start Time	Location	Travel Time	Downstream foray
21-110	23-Apr-10	7:40:40 PM	Spencer Island West (Near-Field)	00-01:21:58	Rowland to Spencer
21-110	30-Apr-10	5:24:19 AM	Conowingo Tailrace Unit 3 (Mid-Field)		
21-110	3-May-10	1:34:36 AM	Lapidum (West Shore) (Near-Field)	02-20:10:17	Tailrace to Lapidum
21-111	22-Apr-10	2:22:13 PM	Conowingo Tailrace Unit 5 (Mid-Field)		Initial
21-111	22-Apr-10	6:31:09 PM	Rowland Island West (Near-Field)	00-04:08:56	Tailrace to Rowland
21-111	23-Apr-10	7:21:57 PM	Conowingo Tailrace Unit 8 (Mid-Field)		
21-111	23-Apr-10	7:50:41 PM	Rowland Island West (Near-Field)	00-00:28:44	Tailrace to Rowland
21-111	24-Apr-10	8:17:57 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-111	24-Apr-10	8:49:53 PM	Rowland Island West (Near-Field)	00-00:31:00	Tailrace to Rowland
21-111	25-Apr-10	6:53:11 PM	Conowingo Tailrace Unit 3 (Mid-Field)		
21-111	25-Apr-10	7:16:35 PM	Rowland Island West (Near-Field)	00-00:23:24	Tailrace to Rowland
21-111	26-Apr-10	4:29:19 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-111	27-Apr-10	4:07:02 AM	Rowland Island West (Near-Field)	00-11:37:43	Tailrace to Rowland
21-111	27-Apr-10	7:04:26 PM	Conowingo Tailrace Unit 3 (Mid-Field)		
21-111	27-Apr-10	7:13:36 PM	Rowland Island West (Near-Field)	00-00:09:10	Tailrace to Rowland
21-111	28-Apr-10	8:43:13 AM	Conowingo Tailrace Unit 3 (Mid-Field)		
21-111	28-Apr-10	10:11:33 AM	Rowland Island West (Near-Field)	00-01:28:20	Tailrace to Rowland
21-111	29-Apr-10	5:22:02 PM	Conowingo Tailrace Unit 3 (Mid-Field)		Initial
21-111	29-Apr-10	6:58:33 PM	Spencer Island West (Near-Field)	00-01:35:29	Tailrace to Spencer
21-111	5-May-10	8:10:39 PM	Conowingo Tailrace Unit 3 (Mid-Field)		
21-111	5-May-10	8:23:46 PM	Rowland Island West (Near-Field)	00-00:12:00	Tailrace to Rowland
21-111	6-May-10	6:42:11 PM	Conowingo Tailrace Unit 8 (Mid-Field)		
21-111	6-May-10	6:50:12 PM	Rowland Island West (Near-Field)	00-00:08:01	Tailrace to Rowland
21-111	6-May-10	6:51:53 PM	Rowland Island West (Near-Field)		
21-111	6-May-10	7:52:29 PM	Spencer Island West (Near-Field)	00-01:00:10	Rowland to Spencer
21-111	7-May-10	7:38:01 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-111	7-May-10	7:44:57 PM	Rowland Island West (Near-Field)	00-00:06:56	Tailrace to Rowland
21-111	8-May-10	5:37:17 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-111	8-May-10	5:53:55 PM	Rowland Island West (Near-Field)	00-00:14:19	Tailrace to Rowland
21-111	8-May-10	6:59:26 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-111	8-May-10	7:13:37 PM	Rowland Island West (Near-Field)	00-00:14:11	Tailrace to Rowland
21-111	8-May-10	7:18:04 PM	Rowland Island West (Near-Field)		
21-111	8-May-10	8:49:00 PM	Spencer Island West (Near-Field)	00-01:25:51	Rowland to Spencer
21-111	9-May-10	5:41:04 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-111	9-May-10	5:55:39 PM	Rowland Island West (Near-Field)	00-00:11:37	Tailrace to Rowland
21-111	9-May-10	6:53:01 PM	Rowland Island West (Near-Field)		
21-111	9-May-10	8:48:20 PM	Spencer Island West (Near-Field)	00-01:55:19	Rowland to Spencer
21-111	10-May-10	8:00:42 PM	Conowingo Tailrace Unit 9 (Mid-Field)		
21-111	10-May-10	8:21:35 PM	Rowland Island West (Near-Field)	00-00:20:53	Tailrace to Rowland
21-111	11-May-10	12:11:26 PM	Conowingo Tailrace Unit 3 (Mid-Field)		

Fish	Start Date	Start Time	Location	Travel Time	Downstream foray
21-111	11-May-10	12:56:06 PM	Rowland Island West (Near-Field)	00-00:44:40	Tailrace to Rowland
21-111	11-May-10	7:20:45 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-111	12-May-10	2:35:31 AM	Rowland Island West (Near-Field)	00-07:14:46	Tailrace to Rowland
21-111	12-May-10	1:16:54 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-111	12-May-10	1:40:14 PM	Rowland Island West (Near-Field)	00-00:19:47	Tailrace to Rowland
21-111	12-May-10	1:52:12 PM	Rowland Island West (Near-Field)		
21-111	12-May-10	3:49:31 PM	Spencer Island West (Near-Field)	00-01:54:09	Rowland to Spencer
21-111	14-May-10	6:08:13 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-111	15-May-10	1:33:19 AM	Rowland Island West (Near-Field)	00-07:25:06	Tailrace to Rowland
21-111	15-May-10	6:41:51 PM	Conowingo Tailrace Unit 10 (Mid-Field)		
21-111	15-May-10	6:51:15 PM	Rowland Island West (Near-Field)	00-00:09:24	Tailrace to Rowland
21-111	16-May-10	6:51:14 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-111	17-May-10	12:59:30 AM	Spencer Island West (Near-Field)	00-06:08:16	Tailrace to Spencer
21-111	17-May-10	6:14:15 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-111	17-May-10	8:00:21 PM	Spencer Island West (Near-Field)	00-01:46:06	Tailrace to Spencer
21-111	19-May-10	6:18:03 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-111	20-May-10	4:48:03 AM	Rowland Island West (Near-Field)	00-10:29:02	Tailrace to Rowland
21-111	20-May-10	11:44:53 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-111	20-May-10	12:01:28 PM	Rowland Island West (Near-Field)	00-00:16:35	Tailrace to Rowland
21-111	20-May-10	12:01:28 PM	Rowland Island West (Near-Field)		
21-111	20-May-10	2:39:41 PM	Spencer Island West (Near-Field)	00-02:31:01	Rowland to Spencer
21-117	22-Apr-10	1:19:08 PM	Conowingo Tailrace Unit 8 (Mid-Field)		Initial
21-117	22-Apr-10	2:10:42 PM	Rowland Island West (Near-Field)	00-00:47:12	Tailrace to Rowland
21-117	22-Apr-10	5:57:32 PM	Rowland Island West (Near-Field)		Initial
21-117	23-Apr-10	6:27:38 AM	Spencer Island East (Near-Field)	00-12:30:06	Rowland to Spencer
21-117	7-May-10	6:05:33 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-117	11-May-10	1:03:32 PM	Lapidum (West Shore) (Near-Field)	03-18:57:59	Tailrace to Lapidum
21-118	22-Apr-10	7:35:13 PM	Conowingo Tailrace Unit 7 (Mid-Field)		Initial
21-118	22-Apr-10	7:44:09 PM	Rowland Island West (Near-Field)	00-00:06:30	Tailrace to Rowland
21-118	23-Apr-10	7:59:49 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-118	24-Apr-10	5:17:13 AM	Rowland Island West (Near-Field)	00-09:17:24	Tailrace to Rowland
21-118	24-Apr-10	12:58:34 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-118	24-Apr-10	1:08:08 PM	Rowland Island West (Near-Field)	00-00:09:34	Tailrace to Rowland
21-118	24-Apr-10	8:25:20 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-118	24-Apr-10	8:28:10 PM	Rowland Island West (Near-Field)	00-00:02:50	Tailrace to Rowland
21-118	25-Apr-10	9:59:08 AM	Conowingo Tailrace Unit 3 (Mid-Field)		
21-118	25-Apr-10	10:03:26 AM	Rowland Island West (Near-Field)	00-00:04:18	Tailrace to Rowland
21-118	25-Apr-10	8:02:55 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-118	25-Apr-10	8:17:07 PM	Rowland Island East (Near-Field)	00-00:12:21	Tailrace to Rowland
21-118	26-Apr-10	6:46:40 PM	Conowingo Tailrace Unit 7 (Mid-Field)		

Fish	Start Date	Start Time	Location	Travel Time	Downstream foray
21-118	26-Apr-10	7:36:13 PM	Rowland Island West (Near-Field)	00-00:49:33	Tailrace to Rowland
21-118	28-Apr-10	8:05:14 PM	Conowingo Tailrace Unit 5 (Mid-Field)		Initial
21-118	28-Apr-10	11:27:10 PM	Spencer Island West (Near-Field)	00-03:21:56	Tailrace to Spencer
21-118	6-May-10	4:13:10 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-118	6-May-10	5:26:44 PM	Rowland Island West (Near-Field)	00-01:13:34	Tailrace to Rowland
21-118	6-May-10	5:26:44 PM	Rowland Island West (Near-Field)		
21-118	6-May-10	11:02:02 PM	Lapidum (West Shore) (Near-Field)	00-05:34:02	Rowland to Lapidum
21-128	22-Apr-10	1:35:00 PM	Conowingo Tailrace		Initial
21-128	22-Apr-10	1:55:06 PM	Rowland Island West (Near-Field)	00-00:20:06	Tailrace to Rowland
21-128	23-Apr-10	1:02:45 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-128	23-Apr-10	1:05:31 AM	Rowland Island West (Near-Field)	00-00:02:46	Tailrace to Rowland
21-128	23-Apr-10	5:02:28 PM	Rowland Island West (Near-Field)		Initial
21-128	23-Apr-10	8:36:00 PM	Spencer Island West (Near-Field)	00-03:33:32	Rowland to Lapidum
21-130	5-May-10	6:35:55 PM	Conowingo Tailrace Unit 7 (Mid-Field)		Initial
21-130	5-May-10	7:15:40 PM	Rowland Island West (Near-Field)	00-00:39:45	Tailrace to Rowland
21-130	6-May-10	12:35:52 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-130	6-May-10	12:51:40 PM	Rowland Island West (Near-Field)	00-00:15:48	Tailrace to Rowland
21-130	6-May-10	6:39:19 PM	Conowingo Tailrace Unit 8 (Mid-Field)		Initial
21-130	7-May-10	6:03:05 AM	Spencer Island West (Near-Field)	00-11:23:46	Tailrace to Spencer
21-130	10-May-10	7:28:55 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-130	10-May-10	7:37:06 AM	Rowland Island West (Near-Field)	00-00:08:11	Tailrace to Rowland
21-130	10-May-10	9:00:25 AM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-130	10-May-10	9:12:12 AM	Rowland Island West (Near-Field)	00-00:11:47	Tailrace to Rowland
21-130	10-May-10	11:55:17 AM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-130	10-May-10	12:24:00 PM	Rowland Island East (Near-Field)	00-00:28:43	Tailrace to Rowland
21-130	10-May-10	4:25:03 PM	Rowland Island West (Near-Field)		
21-130	11-May-10	1:48:31 AM	Spencer Island West (Near-Field)	00-09:23:28	Rowland to Spencer
21-133	28-Apr-10	9:53:49 AM	Conowingo Tailrace Unit 3 (Mid-Field)		Initial
21-133	28-Apr-10	9:59:15 AM	Rowland Island West (Near-Field)	00-00:03:11	Tailrace to Rowland
21-133	28-Apr-10	10:13:16 AM	Conowingo Tailrace Units 1-7 Master		
21-133	28-Apr-10	10:16:53 AM	Rowland Island West (Near-Field)	00-00:03:37	Tailrace to Rowland
21-133	28-Apr-10	10:54:31 AM	Conowingo Tailrace Unit 7 (Mid-Field)		Initial
21-133	28-Apr-10	11:22:53 AM	Tomes Landing (East Shore) (Near-Field)	00-00:28:22	Tailrace to Tomes Landing
21-137	10-May-10	7:23:12 PM	Conowingo Tailrace Unit 9 (Mid-Field)		Initial
21-137	10-May-10	8:51:50 PM	Rowland Island West (Near-Field)	00-01:28:38	Tailrace to Rowland
21-137	11-May-10	7:27:25 PM	Conowingo Tailrace Unit 3 (Mid-Field)		
21-137	12-May-10	5:51:23 AM	Rowland Island West (Near-Field)	00-10:23:58	Tailrace to Rowland
21-137	12-May-10	7:18:27 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-137	12-May-10	8:25:49 PM	Rowland Island West (Near-Field)	00-01:03:41	Tailrace to Rowland
21-137	13-May-10	6:04:15 AM	Rowland Island West (Near-Field)		Initial

Fish	Start Date	Start Time	Location	Travel Time	Downstream foray
21-137	13-May-10	6:36:24 PM	Spencer Island West (Near-Field)	00-12:28:13	Tailrace to Tomes Landing
21-145	10-May-10	5:15:00 PM	Conowingo Tailrace Unit 7 (Mid-Field)		Initial
21-145	10-May-10	5:28:42 PM	Rowland Island West (Near-Field)	00-00:13:42	Tailrace to Rowland
21-145	13-May-10	5:17:38 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-145	13-May-10	5:32:06 AM	Rowland Island West (Near-Field)	00-00:14:28	Tailrace to Rowland
21-145	13-May-10	7:20:12 PM	Conowingo Tailrace Unit 3 (Mid-Field)		Initial
21-145	17-May-10	12:02:22 AM	Spencer Island West (Near-Field)	03-04:42:10	Tailrace to Spencer
21-147	10-May-10	1:06:06 PM	Conowingo Tailrace Unit 5 (Mid-Field)		Initial
21-147	10-May-10	1:25:55 PM	Rowland Island West (Near-Field)	00-00:19:49	Tailrace to Rowland
21-147	10-May-10	5:59:06 PM	Rowland Island West (Near-Field)		Initial
21-147	10-May-10	7:41:32 PM	Spencer Island West (Near-Field)	00-01:42:26	Tailrace to Tomes Landing
21-147	14-May-10	5:54:51 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-147	14-May-10	6:01:48 PM	Rowland Island West (Near-Field)	00-00:06:57	Tailrace to Rowland
21-147	14-May-10	6:01:48 PM	Rowland Island West (Near-Field)		
21-147	14-May-10	8:31:43 PM	Spencer Island West (Near-Field)	00-02:27:33	Rowland to Spencer
21-147	17-May-10	8:45:38 AM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-147	17-May-10	9:57:38 AM	Rowland Island West (Near-Field)	00-01:12:00	Tailrace to Rowland
21-147	18-May-10	3:18:33 PM	Conowingo Tailrace Unit 9 (Mid-Field)		
21-147	18-May-10	3:57:42 PM	Rowland Island West (Near-Field)	00-00:39:09	Tailrace to Rowland
21-147	18-May-10	6:58:56 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-147	18-May-10	7:13:40 PM	Rowland Island West (Near-Field)	00-00:14:44	Tailrace to Rowland
21-147	18-May-10	7:13:40 PM	Rowland Island West (Near-Field)		
21-147	18-May-10	8:26:09 PM	Spencer Island West (Near-Field)	00-01:10:08	Rowland to Spencer
21-147	22-May-10	4:51:13 PM	Conowingo Tailrace Unit 8 (Mid-Field)		
21-147	22-May-10	5:16:36 PM	Rowland Island West (Near-Field)	00-00:23:32	Tailrace to Rowland
21-147	25-May-10	2:14:17 PM	Conowingo Tailrace Unit 3 (Mid-Field)		
21-147	25-May-10	9:17:40 PM	Rowland Island West (Near-Field)	00-07:03:23	Tailrace to Rowland
21-151	10-May-10	6:16:39 PM	Conowingo Tailrace Unit 5 (Mid-Field)		Initial
21-151	10-May-10	7:27:08 PM	Rowland Island West (Near-Field)	00-01:10:29	Tailrace to Rowland
21-151	10-May-10	7:27:08 PM	Rowland Island West (Near-Field)		initial
21-151	10-May-10	9:30:23 PM	Lapidum (West Shore) (Near-Field)	00-02:03:15	Rowland to Lapidum
21-151	17-May-10	3:03:26 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
21-151	17-May-10	11:23:03 PM	Spencer Island West (Near-Field)	00-08:19:37	Tailrace to Spencer
21-160	23-May-10	8:26:11 PM	Conowingo Tailrace Unit 7 (Mid-Field)		Initial
21-160	23-May-10	8:41:34 PM	Rowland Island West (Near-Field)	00-00:15:23	Tailrace to Rowland
21-160	24-May-10	6:19:34 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
21-160	24-May-10	7:01:01 PM	Rowland Island West (Near-Field)	00-00:41:27	Tailrace to Rowland
21-160	24-May-10	7:11:01 PM	Rowland Island West (Near-Field)		initial
21-160	24-May-10	10:22:18 PM	Tomes Landing (East Shore) (Near-Field)	00-03:05:41	Rowland to Lapidum
54-141	7-May-10	4:50:46 PM	Conowingo Tailrace Unit 7 (Mid-Field)		Initial

Fish	Start Date	Start Time	Location	Travel Time	Downstream foray
54-141	7-May-10	5:26:22 PM	Rowland Island East (Near-Field)	00-00:35:36	Tailrace to Rowland
54-141	7-May-10	8:29:34 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-141	7-May-10	8:39:09 PM	Rowland Island West (Near-Field)	00-00:09:35	Tailrace to Rowland
54-141	8-May-10	2:51:38 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-141	8-May-10	5:46:00 PM	Rowland Island West (Near-Field)	00-02:54:22	Tailrace to Rowland
54-141	8-May-10	8:25:07 PM	Conowingo Tailrace Unit 3 (Mid-Field)		
54-141	8-May-10	8:39:15 PM	Rowland Island West (Near-Field)	00-00:14:08	Tailrace to Rowland
54-141	8-May-10	8:39:47 PM	Rowland Island East (Near-Field)		initial
54-141	8-May-10	9:59:18 PM	Spencer Island West (Near-Field)	00-01:19:31	Rowland to Spencer
54-141	11-May-10	2:15:13 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-141	11-May-10	2:29:50 PM	Rowland Island West (Near-Field)	00-00:14:37	Tailrace to Rowland
54-141	11-May-10	6:49:22 PM	Conowingo Tailrace Unit 8 (Mid-Field)		
54-141	11-May-10	7:34:09 PM	Rowland Island West (Near-Field)	00-00:43:50	Tailrace to Rowland
54-141	12-May-10	1:37:12 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-141	12-May-10	1:58:43 PM	Rowland Island East (Near-Field)	00-00:21:31	Tailrace to Rowland
54-141	12-May-10	3:46:27 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-141	12-May-10	4:03:03 PM	Rowland Island West (Near-Field)	00-00:16:36	Tailrace to Rowland
54-141	12-May-10	6:00:01 PM	Conowingo Tailrace Unit 8 (Mid-Field)		
54-141	12-May-10	6:10:52 PM	Rowland Island West (Near-Field)	00-00:10:51	Tailrace to Rowland
54-141	13-May-10	3:21:53 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-141	13-May-10	3:50:52 AM	Rowland Island West (Near-Field)	00-00:28:59	Tailrace to Rowland
54-141	13-May-10	6:58:36 AM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-141	13-May-10	7:29:29 AM	Rowland Island West (Near-Field)	00-00:30:53	Tailrace to Rowland
54-141	13-May-10	7:57:16 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-141	13-May-10	8:43:50 PM	Rowland Island West (Near-Field)	00-00:46:34	Tailrace to Rowland
54-141	14-May-10	12:12:42 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-141	14-May-10	4:14:35 AM	Rowland Island West (Near-Field)	00-04:01:53	Tailrace to Rowland
54-141	14-May-10	5:55:35 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-141	14-May-10	7:39:20 PM	Spencer Island West (Near-Field)	00-01:43:45	Tailrace to Spencer
54-141	17-May-10	4:07:54 PM	Conowingo Tailrace Unit 1 (Mid-Field)		
54-141	17-May-10	8:21:48 PM	Rowland Island West (Near-Field)	00-04:13:54	Tailrace to Rowland
54-141	18-May-10	9:11:36 AM	Conowingo Tailrace Unit 3 (Mid-Field)		
54-141	18-May-10	9:50:48 AM	Rowland Island West (Near-Field)	00-00:39:12	Tailrace to Rowland
54-141	18-May-10	6:20:54 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-141	18-May-10	7:46:37 PM	Spencer Island West (Near-Field)	00-01:25:43	Tailrace to Spencer
54-144	7-May-10	1:10:00 PM	Conowingo Tailrace		Initial
54-144	7-May-10	2:27:55 PM	Rowland Island West (Near-Field)	00-01:17:55	Tailrace to Rowland
54-144	7-May-10	2:48:18 PM	Rowland Island East (Near-Field)		initial
54-144	8-May-10	4:32:58 PM	Lapidum (West Shore) (Near-Field)	01-01:44:40	Rowland to Lapidum
54-144	15-May-10	5:20:40 PM	Conowingo Tailrace Unit 5 (Mid-Field)		

Fish	Start Date	Start Time	Location	Travel Time	Downstream foray
54-144	15-May-10	5:21:01 PM	Rowland Island West (Near-Field)	00-00:00:21	Tailrace to Rowland
54-144	16-May-10	7:02:41 AM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-144	16-May-10	7:25:46 AM	Rowland Island West (Near-Field)	00-00:23:05	Tailrace to Rowland
54-144	17-May-10	3:03:06 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-144	17-May-10	3:23:02 PM	Rowland Island West (Near-Field)	00-00:19:56	Tailrace to Rowland
54-144	17-May-10	3:23:02 PM	Rowland Island West (Near-Field)		
54-144	17-May-10	5:17:07 PM	Spencer Island West (Near-Field)	00-01:50:05	Rowland to Spencer
54-172	7-May-10	11:16:29 AM	Conowingo Tailrace Unit 7 (Mid-Field)		Initial
54-172	7-May-10	11:42:24 AM	Rowland Island West (Near-Field)	00-00:25:55	Tailrace to Rowland
54-172	7-May-10	7:39:48 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-172	7-May-10	8:22:28 PM	Rowland Island West (Near-Field)	00-00:42:40	Tailrace to Rowland
54-172	7-May-10	8:29:33 PM	Rowland Island West (Near-Field)		initial
54-172	8-May-10	10:36:26 AM	Spencer Island West (Near-Field)	00-14:06:53	Rowland to Spencer
54-173	7-May-10	1:55:43 PM	Conowingo Tailrace Unit 7 (Mid-Field)		Initial
54-173	8-May-10	4:43:15 AM	Rowland Island West (Near-Field)	00-14:47:32	Tailrace to Rowland
54-173	8-May-10	10:36:48 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-173	8-May-10	12:51:37 PM	Rowland Island West (Near-Field)	00-02:13:36	Tailrace to Rowland
54-173	9-May-10	5:19:03 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-173	9-May-10	10:57:29 PM	Rowland Island West (Near-Field)	00-05:38:26	Tailrace to Rowland
54-173	10-May-10	2:36:30 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-173	10-May-10	2:51:24 PM	Rowland Island West (Near-Field)	00-00:14:54	Tailrace to Rowland
54-173	10-May-10	6:29:32 PM	Conowingo Tailrace Unit 10 (Mid-Field)		
54-173	10-May-10	10:32:50 PM	Rowland Island West (Near-Field)	00-04:03:18	Tailrace to Rowland
54-173	11-May-10	2:09:35 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-173	11-May-10	2:32:28 PM	Rowland Island West (Near-Field)	00-00:22:53	Tailrace to Rowland
54-173	11-May-10	2:32:28 PM	Rowland Island West (Near-Field)		initial
54-173	11-May-10	7:41:24 PM	Spencer Island West (Near-Field)	00-05:08:01	Rowland to Spencer
54-173	14-May-10	2:57:00 PM	Conowingo Tailrace Unit 3 (Mid-Field)		
54-173	14-May-10	4:45:30 PM	Rowland Island West (Near-Field)	00-01:48:30	Tailrace to Rowland
54-173	16-May-10	7:43:35 AM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-173	16-May-10	8:58:47 AM	Rowland Island West (Near-Field)	00-01:14:06	Tailrace to Rowland
54-173	16-May-10	3:17:20 PM	Rowland Island West (Near-Field)		
54-173	16-May-10	4:58:17 PM	Spencer Island West (Near-Field)	00-01:40:57	Rowland to Spencer
54-179	14-May-10	6:48:53 PM	Conowingo Tailrace Unit 10 (Mid-Field)		initial
54-179	16-May-10	9:53:17 PM	Spencer Island West (Near-Field)	02-03:04:24	Rowland to Spencer
54-183	20-May-10	5:07:27 PM	Conowingo Tailrace Unit 3 (Mid-Field)		initial
54-183	20-May-10	9:31:44 PM	Lapidum (West Shore) (Near-Field)	00-04:21:57	Tailrace to Lapidum
54-192	20-Apr-10	7:53:00 AM	Conowingo Tailrace		Initial
54-192	20-Apr-10	10:00:11 AM	Rowland Island East (Near-Field)	00-02:07:11	Tailrace to Rowland
54-192	20-Apr-10	4:17:13 PM	Conowingo East Spillway Corner (Near-Field)		

Fish	Start Date	Start Time	Location	Travel Time	Downstream foray
54-192	20-Apr-10	5:20:18 PM	Rowland Island East (Near-Field)	00-01:03:05	Tailrace to Rowland
54-192	20-Apr-10	5:28:27 PM	Rowland Island East (Near-Field)	initial	initial
54-192	21-Apr-10	4:10:09 AM	Spencer Island East (Near-Field)	00-10:41:42	Rowland to Spencer
54-192	4-May-10	6:45:08 PM	Conowingo Tailrace Unit 1 (Mid-Field)	00-00:17:44	Tailrace to Rowland
54-192	4-May-10	7:02:52 PM	Rowland Island West (Near-Field)		
54-192	4-May-10	7:02:52 PM	Rowland Island West (Near-Field)		
54-192	4-May-10	9:29:43 PM	Lapidum (West Shore) (Near-Field)	00-02:21:00	Rowland to Lapidum
54-193	20-Apr-10	1:08:00 PM	Conowingo Tailrace	Initial	Initial
54-193	20-Apr-10	7:52:38 PM	Rowland Island West (Near-Field)	00-06:44:38	Tailrace to Rowland
54-193	20-Apr-10	7:58:19 PM	Rowland Island West (Near-Field)	initial	initial
54-193	21-Apr-10	6:33:55 PM	Spencer Island West (Near-Field)	00-22:35:36	Rowland to Spencer
54-193	30-Apr-10	5:47:13 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-193	1-May-10	6:30:27 PM	Lapidum (West Shore) (Near-Field)	01-12:43:14	Tailrace to Lapidum
54-196-2	20-Apr-10	1:24:00 PM	Conowingo Tailrace	Initial	Initial
54-196-2	20-Apr-10	2:49:30 PM	Rowland Island West (Near-Field)	00-01:25:30	Tailrace to Rowland
54-196-2	20-Apr-10	3:44:01 PM	Rowland Island West (Near-Field)	initial	initial
54-196-2	21-Apr-10	12:58:19 AM	Spencer Island West (Near-Field)	00-09:14:18	Rowland to Spencer
54-196-2	25-Apr-10	10:29:33 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-196-2	25-Apr-10	10:49:02 PM	Rowland Island West (Near-Field)	00-00:19:29	Tailrace to Rowland
54-196-2	26-Apr-10	5:03:33 AM	Conowingo Tailrace Unit 3 (Mid-Field)		
54-196-2	26-Apr-10	5:08:53 AM	Rowland Island West (Near-Field)	00-00:05:20	Tailrace to Rowland
54-196-2	26-Apr-10	8:25:39 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-196-2	26-Apr-10	8:46:03 AM	Rowland Island West (Near-Field)	00-00:20:24	Tailrace to Rowland
54-196-2	26-Apr-10	7:56:35 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-196-2	26-Apr-10	8:24:32 PM	Rowland Island West (Near-Field)	00-00:26:00	Tailrace to Rowland
54-196-2	27-Apr-10	4:17:54 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-196-2	27-Apr-10	4:27:24 PM	Rowland Island West (Near-Field)	00-00:09:30	Tailrace to Rowland
54-196-2	27-Apr-10	6:40:27 PM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-196-2	27-Apr-10	7:20:29 PM	Rowland Island West (Near-Field)	00-00:40:02	Tailrace to Rowland
54-196-2	30-Apr-10	5:22:40 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-196-2	30-Apr-10	8:12:56 PM	Rowland Island West (Near-Field)	00-02:50:16	Tailrace to Rowland
54-196-2	30-Apr-10	8:12:56 PM	Rowland Island West (Near-Field)		
54-196-2	30-Apr-10	9:31:23 PM	Spencer Island West (Near-Field)	00-01:15:28	Rowland to Spencer
54-196-2	4-May-10	11:58:57 PM	Conowingo Tailrace Unit 7 (Mid-Field)		
54-196-2	5-May-10	12:13:07 AM	Rowland Island West (Near-Field)	00-00:14:10	Tailrace to Rowland
54-196-2	5-May-10	6:14:20 AM	Conowingo Tailrace Unit 5 (Mid-Field)		
54-196-2	5-May-10	6:21:09 AM	Rowland Island West (Near-Field)	00-00:06:49	Tailrace to Rowland

**APPENDIX I: POST PASSAGE RE-ENTRY DATES AND TIMES INTO CONOWINGO
TAILRACE, SPRING 2010.**

Appendix I
Radio tagged shad presence on non-tailrace monitors by movement classifications, spring 2010.

Fish	Release		Movement Classification	Lower River		Rowland Island	East Spillway Corner	
	Group	Location		Spencer	Lapidum		Far-field	Near-field
54-191	R1	Downstream of "C" Gate	Passage Shad	yes	yes	yes	no	no
54-194	R1	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	yes	no
54-197	R1	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	no	no
54-198	R1	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	yes	no
54-199	R1	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	no	no
54-201	R1	Downstream Units 5 & 7	Passage Shad	no	no	yes	no	no
54-202	R1	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	no	no
54-203	R1	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	yes	yes
54-204	R1	Downstream Units 5 & 7	Passage Shad	no	no	yes	no	no
54-207	R1	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	yes	yes
21-112	R2	Downstream of "C" Gate	Passage Shad	yes	yes	yes	yes	yes
21-113	R2	Downstream of "C" Gate	Passage Shad	yes	yes	yes	yes	no
21-114	R2	Downstream of "C" Gate	Passage Shad	yes	yes	yes	yes	no
21-119	R2	Downstream Units 5 & 7	Passage Shad	no	no	yes	no	no
21-121	R2	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	yes	no
21-122	R2	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	yes	no
21-123	R2	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	yes	no
21-124	R2	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	yes	no
21-127	R2	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	no	no
21-135	R2	Downstream Units 5 & 7	Passage Shad	yes	yes	yes	no	no
21-132	R3	Lapidum Boat Launch	Passage Shad	yes	yes	yes	no	no
54-208	R3	Lapidum Boat Launch	Passage Shad	yes	yes	yes	no	no
54-210	R3	Lapidum Boat Launch	Passage Shad	yes	yes	yes	no	no
54-138	R4	Downstream of "C" Gate	Passage Shad	no	no	yes	no	no
54-140	R4	Downstream of "C" Gate	Passage Shad	yes	yes	yes	no	no
54-142	R4	Downstream of "C" Gate	Passage Shad	yes	yes	yes	no	no
54-158	R4	Downstream of "C" Gate	Passage Shad	yes	no	yes	no	no
54-160	R4	Downstream of "C" Gate	Passage Shad	yes	yes	yes	yes	yes
54-164	R4	Downstream of "C" Gate	Passage Shad	yes	yes	yes	no	no
54-168	R4	Between Units 3 & 5	Passage Shad	yes	yes	yes	no	no
54-169	R4	Between Units 3 & 5	Passage Shad	yes	yes	yes	no	no
21-146	R5	Off of "A" Gate discharge	Passage Shad	no	no	yes	no	no
21-149	R5	Off of "A" Gate discharge	Passage Shad	yes	yes	yes	no	no
21-154	R5	Between Units 3 & 5	Passage Shad	no	no	yes	no	no
21-170	R5	Between Units 3 & 5	Passage Shad	yes	yes	yes	no	no
21-174	R5	Between Units 7 & 8	Passage Shad	no	no	yes	no	no

Fish	Release		Movement Classification	Lower River		Rowland Island	East Spillway Corner	
	Group	Location		Spencer	Lapidum		Tomes	Far-field
21-158	R6L	Lapidum Boat Launch	Passage Shad	yes	yes	yes	no	no
21-169	R6L	Lapidum Boat Launch	Passage Shad	yes	yes	yes	no	no
21-171	R6L	Lapidum Boat Launch	Passage Shad	yes	yes	yes	yes	yes
54-159	R6L	Lapidum Boat Launch	Passage Shad	yes	yes	yes	no	no
54-200-1	R1	Downstream Units 5 & 7	Non-Passage Shad (in EFL)	yes	yes	yes	yes	no
21-100	R2	Downstream of "C" Gate	Non-Passage Shad (in EFL)	yes	yes	yes	yes	no
21-104	R2	Downstream of "C" Gate	Non-Passage Shad (in EFL)	no	no	yes	no	no
21-109	R2	Downstream of "C" Gate	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
21-115	R2	Downstream Units 5 & 7	Non-Passage Shad (in EFL)	yes	yes	yes	yes	yes
21-116	R2	Downstream Units 5 & 7	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
21-120	R2	Downstream Units 5 & 7	Non-Passage Shad (in EFL)	yes	yes	yes	yes	no
21-129	R2	Downstream Units 5 & 7	Non-Passage Shad (in EFL)	yes	yes	yes	yes	no
54-176	R3	Lapidum Boat Launch	Non-Passage Shad (in EFL)	yes	yes	yes	yes	no
54-178	R3	Lapidum Boat Launch	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
54-186	R3	Lapidum Boat Launch	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
54-209	R3	Lapidum Boat Launch	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
54-211	R3	Lapidum Boat Launch	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
54-137	R4	Between Units 3 & 5	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
54-149	R4	Downstream of "C" Gate	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
54-151	R4	Downstream of "C" Gate	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
54-167	R4	Downstream of "C" Gate	Non-Passage Shad (in EFL)	yes	yes	yes	yes	no
21-141	R5	Between Units 7 & 8	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
21-142	R5	Off of "A" Gate discharge	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
21-143	R5	Off of "A" Gate discharge	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
21-144	R5	Off of "A" Gate discharge	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
21-156	R5	Between Units 3 & 5	Non-Passage Shad (in EFL)	yes	yes	yes	yes	no
21-159	R6L	Lapidum Boat Launch	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
54-156	R6L	Lapidum Boat Launch	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
54-200-2	R6T	West Fish Lift Sorting Tank	Non-Passage Shad (in EFL)	yes	yes	yes	no	no
54-192	R1	Downstream of "C" Gate	Non-EFL Shad (in Tailrace)	yes	yes	yes	yes	no
54-193	R1	Downstream Units 5 & 7	Non-EFL Shad (in Tailrace)	yes	yes	yes	no	no
54-196-1	R1	Downstream Units 5 & 7	Non-EFL Shad (in Tailrace)	yes	yes	yes	no	no
21-101	R2	Downstream of "C" Gate	Non-EFL Shad (in Tailrace)	yes	yes	yes	no	no
21-102	R2	Downstream of "C" Gate	Non-EFL Shad (in Tailrace)	no	no	yes	no	no
21-105	R2	Downstream of "C" Gate	Non-EFL Shad (in Tailrace)	yes	yes	yes	no	no
21-110	R2	Downstream of "C" Gate	Non-EFL Shad (in Tailrace)	yes	yes	yes	yes	no
21-111	R2	Downstream of "C" Gate	Non-EFL Shad (in Tailrace)	yes	yes	yes	yes	no
21-117	R2	Downstream Units 5 & 7	Non-EFL Shad (in Tailrace)	yes	yes	yes	yes	yes
21-118	R2	Downstream Units 5 & 7	Non-EFL Shad (in Tailrace)	yes	yes	yes	yes	no

Fish	Release		Movement Classification	Lower River			Rowland Island	East Spillway Corner	
	Group	Location		Spencer	Lapidum	Tomes		Far-field	Near-field
21-128	R2	Downstream Units 5 & 7	Non-EFL Shad (in Tailrace)	yes	yes	no	yes	no	no
21-130	R3	Lapidum Boat Launch	Non-EFL Shad (in Tailrace)	yes	yes	yes	yes	no	no
21-133	R3	Lapidum Boat Launch	Non-EFL Shad (in Tailrace)	yes	yes	yes	yes	no	no
54-179	R3	Lapidum Boat Launch	Non-EFL Shad (in Tailrace)	yes	yes	no	yes	no	no
54-183	R3	Lapidum Boat Launch	Non-EFL Shad (in Tailrace)	yes	yes	yes	yes	no	no
54-141	R4	Downstream of "C" Gate	Non-EFL Shad (in Tailrace)	yes	yes	no	yes	no	no
54-144	R4	Downstream of "C" Gate	Non-EFL Shad (in Tailrace)	yes	yes	no	yes	no	no
54-172	R4	Between Units 3 & 5	Non-EFL Shad (in Tailrace)	yes	yes	no	yes	no	no
54-173	R4	Between Units 3 & 5	Non-EFL Shad (in Tailrace)	yes	yes	no	yes	no	no
21-137	R5	Between Units 7 & 8	Non-EFL Shad (in Tailrace)	yes	yes	no	yes	no	no
21-145	R5	Off of "A" Gate discharge	Non-EFL Shad (in Tailrace)	yes	no	no	yes	no	no
21-147	R5	Off of "A" Gate discharge	Non-EFL Shad (in Tailrace)	yes	yes	yes	yes	no	no
21-151	R5	Between Units 3 & 5	Non-EFL Shad (in Tailrace)	yes	yes	no	yes	no	no
21-160	R6L	Lapidum Boat Launch	Non-EFL Shad (in Tailrace)	yes	yes	yes	yes	no	no
54-190	R1	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	no	yes	no	no
54-195	R1	Downstream Units 5 & 7	Non-Tailrace Shad	yes	yes	yes	yes	no	no
54-205	R1	Downstream Units 5 & 7	Non-Tailrace Shad	yes	yes	yes	yes	no	no
54-206	R1	Downstream Units 5 & 7	Non-Tailrace Shad	yes	yes	no	yes	no	no
21-103	R2	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	yes	yes	no	no
21-106	R2	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	no	yes	no	no
21-107	R2	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	yes	yes	no	no
21-108	R2	Downstream Units 5 & 7	Non-Tailrace Shad	yes	yes	yes	yes	yes	no
21-125	R2	Downstream Units 5 & 7	Non-Tailrace Shad	yes	yes	yes	yes	no	no
21-126	R2	Downstream Units 5 & 7	Non-Tailrace Shad	yes	no	yes	yes	no	no
21-136	R2	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	no	yes	no	no
21-131	R3	Lapidum Boat Launch	Non-Tailrace Shad	no	no	no	no	no	no
21-134	R3	Lapidum Boat Launch	Non-Tailrace Shad	yes	yes	yes	yes	no	no
54-174	R3	Lapidum Boat Launch	Non-Tailrace Shad	no	no	yes	no	no	no
54-175	R3	Lapidum Boat Launch	Non-Tailrace Shad	no	no	no	no	no	no
54-177	R3	Lapidum Boat Launch	Non-Tailrace Shad	no	no	yes	no	no	no
54-180	R3	Lapidum Boat Launch	Non-Tailrace Shad	no	no	no	no	no	no
54-181	R3	Lapidum Boat Launch	Non-Tailrace Shad	no	no	no	no	no	no
54-182	R3	Lapidum Boat Launch	Non-Tailrace Shad	no	no	yes	no	no	no
54-184	R3	Lapidum Boat Launch	Non-Tailrace Shad	no	yes	no	no	no	no
54-185	R3	Lapidum Boat Launch	Non-Tailrace Shad	yes	yes	yes	no	no	no
54-187	R3	Lapidum Boat Launch	Non-Tailrace Shad	no	no	no	no	no	no
54-188	R3	Lapidum Boat Launch	Non-Tailrace Shad	no	no	yes	no	no	no
54-189	R3	Lapidum Boat Launch	Non-Tailrace Shad	no	no	no	no	no	no
54-135	R4	Downstream of "C" Gate	Non-Tailrace Shad	no	no	no	no	no	no

Fish	Release		Movement Classification	Lower River		Rowland Island	East Spillway Corner	
	Group	Location		Spencer	Lapidum		Tomes	Far-field
54-136	R4	Between Units 3 & 5	Non-Tailrace Shad	yes	yes	no	yes	no
54-139	R4	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	yes	yes	no
54-145	R4	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	no	yes	no
54-148	R4	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	no	yes	no
54-150	R4	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	no	yes	no
54-152	R4	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	yes	yes	no
54-153	R4	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	no	yes	no
54-166	R4	Downstream of "C" Gate	Non-Tailrace Shad	yes	yes	no	yes	no
54-170	R4	Between Units 3 & 5	Non-Tailrace Shad	yes	yes	no	yes	no
54-171	R4	Between Units 3 & 5	Non-Tailrace Shad	yes	yes	yes	yes	no
21-138	R5	Between Units 7 & 8	Non-Tailrace Shad	yes	yes	no	yes	no
21-139	R5	Between Units 7 & 8	Non-Tailrace Shad	no	no	no	yes	no
21-140	R5	Between Units 7 & 8	Non-Tailrace Shad	yes	yes	no	yes	no
21-148	R5	Between Units 3 & 5	Non-Tailrace Shad	yes	yes	no	yes	no
21-150	R5	Between Units 3 & 5	Non-Tailrace Shad	yes	yes	no	yes	no
21-152	R5	Between Units 3 & 5	Non-Tailrace Shad	yes	yes	no	yes	no
21-153	R5	Between Units 3 & 5	Non-Tailrace Shad	yes	yes	yes	yes	no
21-155	R5	Between Units 3 & 5	Non-Tailrace Shad	yes	yes	no	yes	no
21-173	R5	Off of "A" Gate discharge	Non-Tailrace Shad	yes	yes	no	yes	no
54-147	R6	Lapidum Boat Launch	Non-Tailrace Shad	yes	yes	no	no	no
21-157	R6L	Lapidum Boat Launch	Non-Tailrace Shad	yes	yes	no	no	no
21-161	R6L	Lapidum Boat Launch	Non-Tailrace Shad	yes	yes	no	no	no
21-162	R6L	Lapidum Boat Launch	Non-Tailrace Shad	yes	yes	no	no	no
21-163	R6L	Lapidum Boat Launch	Non-Tailrace Shad	yes	no	no	no	no
21-164	R6L	Lapidum Boat Launch	Non-Tailrace Shad	no	yes	no	no	no
21-165	R6L	Lapidum Boat Launch	Non-Tailrace Shad	yes	yes	yes	no	no
21-166	R6L	Lapidum Boat Launch	Non-Tailrace Shad	yes	yes	no	no	no
21-168	R6L	Lapidum Boat Launch	Non-Tailrace Shad	no	yes	no	no	no
21-172	R6L	Lapidum Boat Launch	Non-Tailrace Shad	no	yes	no	no	no
54-154	R6L	Lapidum Boat Launch	Non-Tailrace Shad	no	yes	no	no	no
54-155	R6L	Lapidum Boat Launch	Non-Tailrace Shad	no	no	no	no	no
54-157	R6L	Lapidum Boat Launch	Non-Tailrace Shad	no	no	no	no	no
54-161	R6L	Lapidum Boat Launch	Non-Tailrace Shad	yes	yes	no	no	no
54-162	R6L	Lapidum Boat Launch	Non-Tailrace Shad	no	yes	no	no	no
54-163	R6L	Lapidum Boat Launch	Non-Tailrace Shad	yes	yes	yes	no	no
54-165	R6L	Lapidum Boat Launch	Non-Tailrace Shad	yes	yes	no	no	no
54-196-2	R6T	West Fish Lift Sorting Tank	Non-Tailrace Shad	yes	yes	yes	yes	no

**APPENDIX J: LAST DETECTION AND PRIOR MOVEMENT OF RADIO TAGGED SHAD,
SPRING 2010.**

Appendix J
Last detection and prior movement of radio tagged shad, spring 2010.

Fish	Group	Release		Movement Classification	Location	Last Detection	
		Date and Time	Location			Prior movement or action	Date and Time
54-191	R1	04/20/10 10:24:00 AM	Downstream of "C" Gate	Passage Shad	Holtwood	Unknown direction	07/22/10 15:30:00
54-194	R1	04/20/10 01:09:00 PM	Downstream Units 5 & 7	Passage Shad	Tag stationary in Tailrace Downstream Unit 5	Through Conowingo Dam	07/05/10 09:54:00
54-197	R1	04/20/10 01:29:00 PM	Downstream Units 5 & 7	Passage Shad	Conowingo EFL Exit Trough	Conowingo Fishway Exit Trough	05/03/10 10:20:17
54-198	R1	04/20/10 01:36:00 PM	Downstream Units 5 & 7	Passage Shad	Lapidum (West Shore) (Near-Field)	Downstream from East Spencer	05/30/10 18:36:42
54-199	R1	04/20/10 01:52:00 PM	Downstream Units 5 & 7	Passage Shad	Lapidum (West Shore) (Near-Field)	Downstream from Tailrace	05/23/10 13:45:47
54-201	R1	04/20/10 02:08:00 PM	Downstream Units 5 & 7	Passage Shad	Lapidum (West Shore) (Near-Field)	Downstream from Rowland	05/24/10 21:24:16
54-202	R1	04/20/10 02:12:00 PM	Downstream Units 5 & 7	Passage Shad	Spencer Island West (Near-Field)	Downstream from Tailrace	06/11/10 15:14:29
54-203	R1	04/20/10 02:16:00 PM	Downstream Units 5 & 7	Passage Shad	Lapidum (West Shore) (Near-Field)	Downstream from Tailrace	05/24/10 23:08:02
54-204	R1	04/20/10 02:20:00 PM	Downstream Units 5 & 7	Passage Shad	Conowingo EFL Exit Trough	Conowingo Fishway Exit Trough	05/03/10 10:13:20
54-207	R1	04/20/10 02:41:00 PM	Downstream Units 5 & 7	Passage Shad	Lapidum (West Shore) (Near-Field)	Downstream from East Spencer	06/01/10 16:48:41
21-112	R2	04/22/10 11:44:00 AM	Downstream of "C" Gate	Passage Shad	Lapidum (West Shore) (Near-Field)	Downstream from East Spencer	06/03/10 02:55:05
21-113	R2	04/22/10 11:51:00 AM	Downstream of "C" Gate	Passage Shad	Tomes Landing (East Shore) (Near-Field)	Downstream from East Spencer	05/31/10 21:20:44
21-114	R2	04/22/10 12:03:00 PM	Downstream of "C" Gate	Passage Shad	Spencer Island West (Near-Field)	Milling about Spencer	05/28/10 17:33:39
21-119	R2	04/22/10 01:02:00 PM	Downstream Units 5 & 7	Passage Shad	Conowingo EFL Exit Trough	Conowingo Fishway Exit Trough	05/07/10 18:13:15
21-121	R2	04/22/10 01:11:00 PM	Downstream Units 5 & 7	Passage Shad	Lapidum (West Shore) (Near-Field)	Downstream from West Spencer	05/12/10 23:44:23
21-122	R2	04/22/10 01:20:00 PM	Downstream Units 5 & 7	Passage Shad	Tomes Landing (East Shore) (Near-Field)	Downstream from Tailrace	05/31/10 17:46:00
21-123	R2	04/22/10 01:21:00 PM	Downstream Units 5 & 7	Passage Shad	Conowingo Tailrace Unit 5 (Mid-Field)	Through Conowingo Dam	06/03/10 22:28:57
21-124	R2	04/22/10 01:26:00 PM	Downstream Units 5 & 7	Passage Shad	Conowingo Tailrace Unit 5 (Mid-Field)	Milling about Tailrace	06/24/10 05:14:18
21-127	R2	04/22/10 01:34:00 PM	Downstream Units 5 & 7	Passage Shad	Rowland Island West (Near-Field)	Milling about Rowland Island	07/20/10 14:41:05
21-135	R2	04/22/10 12:56:00 PM	Downstream Units 5 & 7	Passage Shad	Spencer Island West (Near-Field)	Downstream from Rowland	05/28/10 17:37:18
21-132	R3	04/28/10 11:35:00 AM	Lapidum Boat Launch	Passage Shad	Conowingo Tailrace Unit 7 (Mid-Field)	Milling about Tailrace	05/23/10 16:45:00
54-208	R3	04/28/10 11:35:00 AM	Lapidum Boat Launch	Passage Shad	Tag stationary (west Bird Is) Upstream Fish Pot Falls	Unknown direction	07/16/10 10:30:00
54-210	R3	04/28/10 11:35:00 AM	Lapidum Boat Launch	Passage Shad	Conowingo EFL Exit Trough	Conowingo Fishway Exit Trough	05/12/10 17:25:44
54-138	R4	05/07/10 12:05:00 PM	Downstream of "C" Gate	Passage Shad	Downstream of Norman Wood Bridge	Unknown direction	05/21/10 11:40:00
54-140	R4	05/07/10 12:55:00 PM	Downstream of "C" Gate	Passage Shad	Conowingo EFL Exit Trough	Conowingo Fishway Exit Trough	05/22/10 16:00:39
54-142	R4	05/07/10 12:09:00 PM	Downstream of "C" Gate	Passage Shad	Tag stationary Downstream of PBAPS	Downstream from Sicily Is	07/02/10 12:30:00
54-158	R4	05/07/10 02:03:00 PM	Downstream of "C" Gate	Passage Shad	Downstream York Haven	Unknown direction	07/29/10 10:21:00
54-160	R4	05/07/10 01:33:00 PM	Downstream of "C" Gate	Passage Shad	Just Downstream MRPSS	Downstream from Holtwood	05/28/10 14:34:00
54-164	R4	05/07/10 01:28:00 PM	Downstream of "C" Gate	Passage Shad	Holtwood	Unknown direction	07/02/10 15:40:00
54-168	R4	05/07/10 10:15:00 AM	Between Units 3 & 5	Passage Shad	Lapidum (West Shore) (Near-Field)	Downstream from East Spencer	06/01/10 19:45:09
54-169	R4	05/07/10 10:33:00 AM	Between Units 3 & 5	Passage Shad	Conowingo EFL Exit Trough	Conowingo Fishway Exit Trough	05/23/10 16:07:50
21-146	R5	05/10/10 12:36:00 PM	Off of "A" Gate discharge	Passage Shad	Downstream of Sicily Island	Downstream from Wissler's Run	06/03/10 12:35:00
21-149	R5	05/10/10 12:34:00 PM	Off of "A" Gate discharge	Passage Shad	(Recovered Tag Only) Upstream Reuben Island	Unknown direction	06/21/10 14:15:00
21-154	R5	05/10/10 05:14:00 PM	Between Units 3 & 5	Passage Shad	Downstream of Sicily Island	Unknown direction	06/03/10 09:35:00
21-170	R5	05/10/10 03:05:00 PM	Between Units 3 & 5	Passage Shad	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	06/24/10 02:04:13
21-174	R5	05/10/10 11:17:00 AM	Between Units 7 & 8	Passage Shad	Conowingo Tailrace Unit 5 (Mid-Field)	Milling about Tailrace	06/24/10 09:45:55
21-158	R6L	05/12/10 11:40:00 AM	Lapidum Boat Launch	Passage Shad	Conowingo EFL Exit Trough	Conowingo Fishway Exit Trough	05/22/10 08:22:53
21-169	R6L	05/12/10 11:40:00 AM	Lapidum Boat Launch	Passage Shad	Upstream of Safe Harbor Dam	Unknown direction	06/24/10 11:07:00
21-171	R6L	05/12/10 11:40:00 AM	Lapidum Boat Launch	Passage Shad	Tag stationary off Upstream tip of Rowland Is.	Milling about Tailrace	06/21/10 12:40:00
54-159	R6L	05/12/10 11:40:00 AM	Lapidum Boat Launch	Passage Shad	Upstream Conowingo Dam, Downstream of PBAPS	Unknown direction	06/18/10 13:00:00
54-200-1	R1	04/20/10 01:54:00 PM	Downstream Units 5 & 7	Non-Passage Shad (in EFL)	Died in Conowingo EFL Exit Trough	Milling about Tailrace	05/08/10 10:31:23
21-100	R2	04/22/10 10:36:00 AM	Downstream of "C" Gate	Non-Passage Shad (in EFL)	Lapidum (West Shore) (Near-Field)	East from Tomes Landing	04/28/10 10:42:00
21-104	R2	04/22/10 11:06:00 AM	Downstream of "C" Gate	Non-Passage Shad (in EFL)	Rowland Island West (Near-Field)	Milling about Rowland	05/11/10 05:00:52
21-109	R2	04/22/10 11:34:00 AM	Downstream of "C" Gate	Non-Passage Shad (in EFL)	Lapidum (West Shore) (Near-Field)	Downstream from West Spencer	06/04/10 09:51:57
21-115	R2	04/22/10 12:10:00 PM	Downstream Units 5 & 7	Non-Passage Shad (in EFL)	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/12/10 20:19:45
21-116	R2	04/22/10 12:34:00 PM	Downstream Units 5 & 7	Non-Passage Shad (in EFL)	Tomes Landing (East Shore) (Near-Field)	Downstream from Rowland	05/05/10 19:13:24
21-120	R2	04/22/10 01:10:00 PM	Downstream Units 5 & 7	Non-Passage Shad (in EFL)	Conowingo Tailrace Unit 7 (Mid-Field)	Milling about Tailrace	05/10/10 19:32:42
21-129	R2	04/22/10 01:37:00 PM	Downstream Units 5 & 7	Non-Passage Shad (in EFL)	Lapidum (West Shore) (Near-Field)	Downstream from West Spencer	05/24/10 00:08:27
54-176	R3	04/28/10 11:35:00 AM	Lapidum Boat Launch	Non-Passage Shad (in EFL)	Lapidum (West Shore) (Near-Field)	Downstream from East Spencer	05/31/10 22:43:35
54-178	R3	04/28/10 11:35:00 AM	Lapidum Boat Launch	Non-Passage Shad (in EFL)	Spencer Island West (Near-Field)	Downstream from Rowland	05/25/10 09:11:01
54-186	R3	04/28/10 11:35:00 AM	Lapidum Boat Launch	Non-Passage Shad (in EFL)	Lapidum (West Shore) (Near-Field)	Downstream from West Spencer	05/18/10 21:46:37
54-209	R3	04/28/10 11:35:00 AM	Lapidum Boat Launch	Non-Passage Shad (in EFL)	Lapidum (West Shore) (Near-Field)	Downstream from West Spencer	06/03/10 14:47:46
54-211	R3	04/28/10 11:35:00 AM	Lapidum Boat Launch	Non-Passage Shad (in EFL)	Rowland Island West (Near-Field)	Downstream from Tailrace	06/01/10 14:00:51

Fish	Group	Release		Movement Classification		Last Detection		
		Date and Time	Location	Classification	Location	Prior movement or action	Date and Time	
54-137	R4	05/07/10 11:16:00 AM	Between Units 3 & 5	Non-Passage Shad (In EFL)	Lapidium (West Shore) (Near-Field)	Downstream from Tailrace	05/21/10 21:33:15	
54-149	R4	05/07/10 03:20:00 PM	Downstream of "C" Gate	Non-Passage Shad (In EFL)	Lapidium (West Shore) (Near-Field)	Downstream from Rowland	05/26/10 18:00:02	
54-151	R4	05/07/10 04:14:00 PM	Downstream of "C" Gate	Non-Passage Shad (In EFL)	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	05/26/10 01:43:03	
54-167	R4	05/07/10 01:26:00 PM	Downstream of "C" Gate	Non-Passage Shad (In EFL)	Lapidium (West Shore) (Near-Field)	Downstream from East Spencer	05/29/10 19:17:31	
21-141	R5	05/10/10 11:02:00 AM	Between Units 7 & 8	Non-Passage Shad (In EFL)	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	06/02/10 19:51:12	
21-142	R5	05/10/10 11:45:00 AM	Off of "A" Gate discharge	Non-Passage Shad (In EFL)	Lapidium (West Shore) (Near-Field)	Downstream from East Spencer	05/03/10 04:03:38	
21-143	R5	05/10/10 12:00:00 PM	Off of "A" Gate discharge	Non-Passage Shad (In EFL)	Conowingo East Spillway Corner (Far-Field)	West from Tailrace	05/09/10 04:57:01	
21-144	R5	05/10/10 12:08:00 PM	Off of "A" Gate discharge	Non-Passage Shad (In EFL)	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	05/03/10 01:16:34	
21-156	R5	05/10/10 05:30:00 PM	Between Units 3 & 5	Non-Passage Shad (In EFL)	Lapidium (West Shore) (Near-Field)	Downstream from East Spencer	05/02/10 17:29:23	
21-159	R6L	05/12/10 11:40:00 AM	Lapidum Boat Launch	Non-Passage Shad (In EFL)	Tomes Landing (East Shore) (Near-Field)	Milling about Tomes Landing	05/30/10 12:50:57	
54-156	R6L	05/12/10 11:40:00 AM	Lapidum Boat Launch	Non-Passage Shad (In EFL)	Tomes Landing (East Shore) (Near-Field)	Downstream from Tailrace	05/18/10 07:14:33	
54-200-2	R6T	05/12/10 11:00:00 AM	West Fish Lift Sorting Tank	Non-Passage Shad (In EFL)	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	05/25/10 19:09:54	
54-192	R1	04/20/10 07:53:00 AM	Downstream of "C" Gate	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	05/20/10 08:09:42	
54-193	R1	04/20/10 01:08:00 PM	Downstream Units 5 & 7	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	05/09/10 08:36:04	
54-196-1	R1	04/20/10 01:24:00 PM	Downstream Units 5 & 7	Non-EFL Shad (In Tailrace)	Fish Caught in West Fish Lift	Milling about Tailrace	05/08/10 00:44:33	
21-101	R2	04/22/10 10:47:00 AM	Downstream of "C" Gate	Non-EFL Shad (In Tailrace)	Conowingo Tailrace Unit 1 (Mid-Field)	Milling about Tailrace	05/04/10 06:56:20	
21-102	R2	04/22/10 10:55:00 AM	Downstream of "C" Gate	Non-EFL Shad (In Tailrace)	Conowingo Tailrace Unit 5 (Mid-Field)	Milling about Tailrace	05/20/10 15:08:24	
21-105	R2	04/22/10 11:26:00 AM	Downstream of "C" Gate	Non-EFL Shad (In Tailrace)	Spencer Island West (Near-Field)	Milling about Spencer	06/11/10 01:21:18	
21-110	R2	04/22/10 11:35:00 AM	Downstream of "C" Gate	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	05/16/10 14:22:11	
21-111	R2	04/22/10 11:38:00 AM	Downstream of "C" Gate	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	04/23/10 20:56:19	
21-117	R2	04/22/10 12:37:00 PM	Downstream Units 5 & 7	Non-EFL Shad (In Tailrace)	Conowingo Tailrace Unit 5 (Mid-Field)	Milling about Tailrace	05/16/10 01:30:44	
21-118	R2	04/22/10 01:00:00 PM	Downstream Units 5 & 7	Non-EFL Shad (In Tailrace)	Rowland Island West (Near-Field)	Milling about Rowland	05/08/10 20:02:19	
21-120	R2	04/22/10 01:35:00 PM	Downstream Units 5 & 7	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	05/13/10 18:55:53	
21-130	R3	04/28/10 11:35:00 AM	Lapidum Boat Launch	Non-EFL Shad (In Tailrace)	Tomes Landing (East Shore) (Near-Field)	East from Lapidum	05/17/10 00:07:18	
21-133	R3	04/22/10 11:35:00 AM	Lapidum Boat Launch	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	05/26/10 00:35:36	
54-179	R3	04/28/10 11:35:00 AM	Lapidum Boat Launch	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	05/18/10 02:21:32	
54-183	R3	04/28/10 11:35:00 AM	Lapidum Boat Launch	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Downstream from East Spencer	05/24/10 22:31:39	
54-141	R4	05/07/10 12:41:00 PM	Downstream of "C" Gate	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	05/16/10 19:57:41	
54-144	R4	05/07/10 01:10:00 PM	Downstream of "C" Gate	Non-EFL Shad (In Tailrace)	Spencer Island West (Near-Field)	Downstream from Rowland	05/17/10 17:17:07	
54-172	R4	05/07/10 09:28:00 AM	Between Units 3 & 5	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	05/08/10 10:59:41	
54-173	R4	05/07/10 09:34:00 AM	Between Units 3 & 5	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	05/16/10 17:10:15	
21-137	R5	05/10/10 10:29:00 AM	Between Units 7 & 8	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	05/16/10 22:11:51	
21-145	R5	05/10/10 12:12:00 PM	Off of "A" Gate discharge	Non-EFL Shad (In Tailrace)	Spencer Island West (Near-Field)	Downstream from Rowland	05/30/10 21:32:22	
21-147	R5	05/10/10 12:54:00 PM	Off of "A" Gate discharge	Non-EFL Shad (In Tailrace)	Rowland Island West (Near-Field)	Milling about Rowland	05/09/10 04:59:21	
21-151	R5	05/10/10 02:54:00 PM	Between Units 3 & 5	Non-EFL Shad (In Tailrace)	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	05/02/10 01:51:35	
21-160	R6L	05/12/10 11:40:00 AM	Lapidum Boat Launch	Non-EFL Shad (In Tailrace)	Tomes Landing (East Shore) (Near-Field)	Downstream from Rowland	05/05/10 09:59:46	
54-190	R1	4/20/2010 10:11:00 AM	Downstream of "C" Gate	Non-Tailrace Shad	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	04/20/10 20:32:23	
54-195	R1	4/20/2010 1:15:00 PM	Downstream Units 5 & 7	Non-Tailrace Shad	Spencer Island East (Near-Field)	Milling about Spencer	04/22/10 04:38:19	
54-205	R1	4/20/2010 2:30:00 PM	Downstream Units 5 & 7	Non-Tailrace Shad	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	05/23/10 01:23:53	
54-206	R1	4/20/2010 2:35:00 PM	Downstream Units 5 & 7	Non-Tailrace Shad	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	04/27/10 05:46:29	
21-103	R2	4/22/2010 11:00:00 AM	Downstream of "C" Gate	Non-Tailrace Shad	Spencer Island West (Near-Field)	Milling about Spencer	04/27/10 05:40:48	
21-106	R2	4/22/2010 11:29:00 AM	Downstream of "C" Gate	Non-Tailrace Shad	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	04/22/10 19:57:28	
21-107	R2	4/22/2010 11:34:00 AM	Downstream of "C" Gate	Non-Tailrace Shad	Lapidium (West Shore) (Near-Field)	Downstream from West Spencer	05/12/10 04:20:55	
21-108	R2	4/22/2010 12:45:00 PM	Downstream Units 5 & 7	Non-Tailrace Shad	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	04/28/10 04:30:14	
21-125	R2	4/22/2010 1:28:00 PM	Downstream Units 5 & 7	Non-Tailrace Shad	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	05/05/10 05:09:06	
21-126	R2	4/22/2010 1:31:00 PM	Downstream Units 5 & 7	Non-Tailrace Shad	Tomes Landing (East Shore) (Near-Field)	Downstream from Rowland	04/24/10 02:16:12	
21-136	R2	4/22/2010 11:22:00 AM	Downstream of "C" Gate	Non-Tailrace Shad	Lapidium (West Shore) (Near-Field)	Downstream from East Spencer	04/23/10 01:20:48	
21-131	R3	4/28/2010 11:35:00 AM	Lapidum Boat Launch	Non-Tailrace Shad	Release at Lapidum Boat Launch	Presumed to have moved Downstream	04/28/10 11:35:00	
21-134	R3	4/28/2010 11:35:00 AM	Lapidum Boat Launch	Non-Tailrace Shad	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	05/15/10 23:19:52	
54-174	R3	4/28/2010 11:35:00 AM	Lapidum Boat Launch	Non-Tailrace Shad	Tomes Landing (East Shore) (Near-Field)	East from Lapidum Boat Launch	04/28/10 11:37:15	
54-175	R3	4/28/2010 11:35:00 AM	Lapidum Boat Launch	Non-Tailrace Shad	Release at Lapidum Boat Launch	Presumed to have moved Downstream	04/28/10 11:35:00	
54-177	R3	4/28/2010 11:35:00 AM	Lapidum Boat Launch	Non-Tailrace Shad	Tomes Landing (East Shore) (Near-Field)	East from Lapidum Boat Launch	04/28/10 11:42:05	
54-180	R3	4/28/2010 11:35:00 AM	Lapidum Boat Launch	Non-Tailrace Shad	Release at Lapidum Boat Launch	Presumed to have moved Downstream	04/28/10 11:35:00	
54-181	R3	4/28/2010 11:35:00 AM	Lapidum Boat Launch	Non-Tailrace Shad	Release at Lapidum Boat Launch	Presumed to have moved Downstream	04/28/10 11:35:00	
54-182	R3	4/28/2010 11:35:00 AM	Lapidum Boat Launch	Non-Tailrace Shad	Tomes Landing (East Shore) (Near-Field)	Milling about Tomes Landing	04/28/10 15:03:01	
54-184	R3	4/28/2010 11:35:00 AM	Lapidum Boat Launch	Non-Tailrace Shad	Lapidium (West Shore) (Near-Field)	Milling about Lapidum	04/28/10 13:36:53	

Fish	Release		Movement Classification	Last Detection		Date and Time
	Group	Date and Time		Location	Prior movement or action	
54-185	R3	4/28/2010 11:35:00 AM	Non-Tailrace Shad	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/10/10 11:32:30
54-187	R3	4/28/2010 11:35:00 AM	Non-Tailrace Shad	Release at Lapidum Boat Launch	Presumed to have moved Downstream	04/28/10 11:35:00
54-188	R3	4/28/2010 11:35:00 AM	Non-Tailrace Shad	Lapidum Boat Launch	Tomes Landing (East Shore) (Near-Field)	04/30/10 14:31:57
54-189	R3	4/28/2010 11:35:00 AM	Non-Tailrace Shad	Lapidum Boat Launch	Release at Lapidum Boat Launch	04/28/10 11:35:00
54-135	R4	5/7/2010 11:39:00 AM	Downstream of "C" Gate	Downstream of "C" Gate	Conowingo Tailrace Unit 5 (Mid-Field)	05/10/10 13:47:32
54-136	R4	5/7/2010 11:28:00 AM	Between Units 3 & 5	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/08/10 15:43:23
54-139	R4	5/7/2010 11:44:00 AM	Downstream of "C" Gate	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/08/10 19:29:31
54-145	R4	5/7/2010 3:45:00 PM	Downstream of "C" Gate	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/13/10 15:56:07
54-148	R4	5/7/2010 3:27:00 PM	Downstream of "C" Gate	Lapidum (West Shore) (Near-Field)	Downstream from West Spencer	05/07/10 18:23:13
54-150	R4	5/7/2010 3:20:00 PM	Downstream of "C" Gate	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/15/10 01:25:11
54-152	R4	5/7/2010 8:02:00 PM	Downstream of "C" Gate	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/08/10 18:29:47
54-153	R4	5/7/2010 5:13:00 PM	Downstream of "C" Gate	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/10/10 15:38:12
54-166	R4	5/7/2010 3:03:00 PM	Downstream of "C" Gate	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/07/10 21:48:25
54-170	R4	5/7/2010 10:55:00 AM	Between Units 3 & 5	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/18/10 05:03:55
54-171	R4	5/7/2010 10:13:00 AM	Between Units 3 & 5	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/14/10 15:43:22
21-138	R5	5/10/2010 10:44:00 AM	Between Units 7 & 8	Spencer Island West (Near-Field)	Milling about Spencer	05/13/10 05:56:11
21-139	R5	5/10/2010 10:52:00 AM	Between Units 7 & 8	Rowland Island West (Near-Field)	Milling about Rowland	05/10/10 19:18:23
21-140	R5	5/10/2010 10:55:00 AM	Between Units 7 & 8	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/20/10 21:35:26
21-148	R5	5/10/2010 2:22:00 PM	Between Units 3 & 5	Lapidum (West Shore) (Near-Field)	Downstream from West Spencer	05/10/10 22:35:31
21-150	R5	5/10/2010 2:35:00 PM	Between Units 3 & 5	Lapidum (West Shore) (Near-Field)	Downstream from West Spencer	05/11/10 19:49:09
21-152	R5	5/10/2010 4:14:00 PM	Between Units 3 & 5	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/11/10 00:29:33
21-153	R5	5/10/2010 4:24:00 PM	Between Units 3 & 5	Lapidum (West Shore) (Near-Field)	Downstream from West Spencer	05/10/10 20:19:22
21-155	R5	5/10/2010 5:21:00 PM	Between Units 3 & 5	Lapidum (West Shore) (Near-Field)	Downstream from West Spencer	05/11/10 01:56:45
21-173	R5	5/10/2010 12:33:00 PM	Off of "A" Gate discharge	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/18/10 10:41:08
21-157	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Spencer Island West (Near-Field)	Upstream from Lapidum	05/17/10 03:42:18
21-161	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Spencer Island West (Near-Field)	Upstream from Lapidum	05/12/10 15:34:22
21-162	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/12/10 19:45:06
21-163	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Spencer Island West (Near-Field)	Upstream from Lapidum Boat Launch	05/12/10 11:47:49
21-164	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/12/10 15:50:56
21-165	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Tomes Landing (East Shore) (Near-Field)	West from Lapidum	05/21/10 06:02:26
21-166	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Spencer Island West (Near-Field)	Upstream from Lapidum	05/12/10 12:31:43
21-168	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/12/10 19:07:19
21-172	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/12/10 13:58:58
54-147	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	West Channel, Robert Island	Upstream from Lapidum	05/13/10 19:35:00
54-154	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/12/10 13:24:49
54-155	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Release at Lapidum Boat Launch	Presumed to have moved Downstream	05/12/10 11:40:00
54-157	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Release at Lapidum Boat Launch	Presumed to have moved Downstream	05/12/10 11:40:00
54-161	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/12/10 13:48:34
54-162	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/12/10 13:46:35
54-163	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	06/03/10 01:11:01
54-165	R6L	5/12/2010 11:40:00 AM	Lapidum Boat Launch	Lapidum (West Shore) (Near-Field)	Downstream from West Spencer	05/12/10 19:25:36
54-196-2	R6T	5/12/2010 11:00:00 AM	West Fish Lift Sorting Tank	Lapidum (West Shore) (Near-Field)	Milling about Lapidum	05/30/10 12:13:41