MUDDY RUN PUMPED STORAGE PROJECT
CONOWINGO EEL
COLLECTION FACILITY
FERC PROJECT NO. 2355

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EXECUTIVE SUMMARY

Exelon Generation Company, LLC (Exelon) received a license from the Federal Energy Regulatory Commission (FERC) on December 22, 2015 for the Muddy Run Pumped Storage Project (Muddy Run Project). An American Eel, *Anguilla rostrata*, Passage Plan (Eel Plan) was developed by Exelon and was included as a condition of the Pennsylvania (PADEP) 401 Water Quality Certification (PADEP File No. EA 36-033; dated December 10, 2014) for the Muddy Run Project. This plan is also a condition of the new FERC license for the Muddy Run Project. Specifically, the Eel Plan states that Exelon will trap, hold, and transport American Eels from the Conowingo Dam and transport them to designated points in the Susquehanna River watershed.

In 2017, Exelon designed, installed, and operated the permanent eel collection and holding facility (Conowingo Eel Collection Facility, CECF) at Conowingo Dam. Eels collected at Conowingo and those transported from the Octoraro Creek Eel facility were held and later transported and released at designated stocking areas in the Susquehanna River watershed as approved by PADEP and the Eel Passage Advisory Group (EPAG).

Specifically, the objectives of the 2017 field investigation were to:

- Operate, maintain, and monitor the eel collection and holding facility (daily) from May 1 through September 15, 2017;
- Collect catch, length, weight, condition factor data, water quality, stream flow, and moon phase data during the entire sampling period;
- Examine a subsample of juvenile eels for presence of swim bladder parasite and determine age from a portion of subsample;
- Transport eels from the Conowingo Eel Collection Facility (CECF) at Conowingo Dam to designated points in the Susquehanna River watershed;
- Conduct weekly quality control (QC) checks and cleaning of the eel collection facility to maintain proper attraction water flow;
- Document any modifications made to the facility during the course of the season to improve functionality.

The facility was installed and placed in service on May 1, 2017. The facility operated a total of 138 days from May 1 to September 15.

A total of 122,300 juvenile eels were collected at the CECF. Nearly 25% of the collection days recorded juvenile eel numbers greater than 1,000 individuals. The greatest number of juvenile eels were collected on July 30, 2017 with 7,280 or 6% of the total season catch. One half (61,089 of 122,300, 50.0%) of the eels were collected between 23 July and 12 August. Volumetric estimates were utilized on 40 days this year.

Length, weight, and condition factor were recorded from biweekly subsamples on 926 juvenile eels. Length of juvenile eels ranged from 78-192 mm and an average length of 122.3 mm. The average weight of juvenile eels was 2.1 grams (g) and ranged from 0.5-6 g. Only 18 of the 926 (< 2.0%) showed any form of external injury (condition factor) such as bruising, scrape, or hemorrhage.

Approximately 21% (193 of 926) eels collected were examined internally for presence of the eel swim bladder parasite (*Anguillicoloides crassus*). Parasites were found in 104 (53.9%) of the 193 sacrificed eels. The number of parasites per eel ranged from one to three. Nearly 50% (98 of 198) were examined for age and it was determined that the average age was 2.2 years old (range 1-4 years old).

Lunar fraction and eel catch appeared to be related in 2017 at the CECF. During low light periods (near new moon), the number of juvenile eels collected within a few days also increased.

The CECF collected a total of 122,300 juvenile eels in 2017 with a total of 17 eel mortalities found in the collection tank. A total of 3,447 (2.58% mortality) juvenile eels were recovered dead from the holding tanks over the entire season. Eels were held no longer than one week prior to transport from the CECF. A combined total of 129,902 eels from CECF and the Octoraro Creek eel facility were transported and released at designated locations in the Susquehanna River watershed. Stocking of the Conewago Creek (Site B) was completed on June 16, 2017 with 16,502 eels released. Beaver Creek (Site C) received a stocking of 9,738 juvenile eels and was completed on June 20, 2017. The remainder of the juvenile eels (103,662 individuals) were stocked in the Susquehanna River at Etters Boat Launch (Site 4). A total of 80 juvenile eels died during the 31 transport trips from the CECF in 2017.

Cleaning and calibration of the trapping facility was performed weekly. Scrubbing of the collection tank and the screened drain occurred daily after eels were removed. The holding tank and overflow drain were scrubbed every time the eels were removed for transport. Volumetric estimates were compared against actual counts on four occasions during the season, and due to the small differences in numbers, we believe this method is accurate and no changes are warranted.

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Agencies/Groups	
CWA	Chester Water Authority
CECF	Conowingo Eel Collection Facility
EPAG	Eel Passage Advisory Group
EXELON	Exelon Generation Company, LLC
FERC	Federal Energy Regulatory Commission
PADEP	Pennsylvania Department of Environmental Protection
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
Units of Measure	
C	Celsius
cfs	cubic feet per second
DO	dissolved oxygen
FMSL	feet mean sea level
g	gram
hr	hour
Km	kilometer
L	liter
MDE	Maryland Department of Environment
m	meter
mg/L	milligrams per liter
mL	milliliter
mm	millimeter
QC	quality control
Miscellaneous	
YSI 550A	YSI Incorporated (water quality measuring device)

1 INTRODUCTION

Exelon Generation Company, LLC (Exelon) received a license from the Federal Energy Regulatory Commission (FERC) on December 22, 2015 for the Muddy Run Pumped Storage Project (Muddy Run Project). An American Eel Passage Plan (Eel Plan) was developed by Exelon and included as a condition of the Pennsylvania 401 Water Quality Certification (PADEP File No. EA 36-033; dated December 10, 2014) for the Muddy Run Project, and is a condition of the new FERC license for the Muddy Run Project.

The Eel Plan required Exelon to install and operate a juvenile eel trapping and holding facility (Conowingo Eel Collection Facility) at Conowingo Dam. The evaluation was conducted at a location identified on the Susquehanna River immediately downstream of the West Fish Lift (WFL) where the previous USFWS eel facility was located. This site was approved by the Pennsylvania Department of Environmental Protection (PADEP) and other members of the Eel Passage Advisory Group (EPAG)[1].

In 2017, Exelon designed, installed, and operated the permanent eel collection and holding facility (CECF) at Conowingo Dam. Eels collected at Conowingo and those transported from the Octoraro Creek eel facilitywere held and later transported and released at designated points in the Susquehanna River watershed.

Specifically, the objectives of the 2017 field investigation were to:

- Operate, maintain, and monitor the eel collection and holding facility (daily) from May 1 through September 15, 2017;
- Collect catch and length data, water quality, stream flow, and moon phase data during the entire sampling period;
- Examine a subsample of juvenile eels for presence of swim bladder parasite and determine age from a portion of subsample;
- Transport eels from the CECF at Conowingo Dam to designated points in the Susquehanna River watershed;
- Conduct weekly quality control (QC) checks and cleaning of the eel collection facility to maintain proper attraction water flow;
- Document any modifications made to the facility during the course of the season to improve functionality.

[1] EPAG members include the Pennsylvania Department of Environmental Protection, United States Fish and Wildlife Service, Pennsylvania Fish and Boat Commission, Maryland Department of Natural Resources, Susquehanna River Basin Commission, and Exelon.

2 BACKGROUND

The American Eel (*Anguilla rostrata*) is the only species of freshwater eel in North America. They are catadromous, meaning they are hatched in the ocean, mature in freshwater, and then return to the sea to spawn. Throughout their life cycle, the American Eel occupies a variety of habitats and goes through multiple physical changes, known as metamorphoses. The American Eel begins its life in the Sargasso Sea. The larval eels, known as leptocephalus larvae, are transported to the eastern seaboard of North America via ocean currents, which takes about a year. Their coastal range extends as far north as Greenland and as far south as Brazil. By the time the larvae reach the coast, they have developed fins and have taken on the shape of an adult eel (Hedgepeth 1983). The glass eel is clear and is usually less than 25 millimeters (mm) and when these eels start to become pigmented they are considered juvenile eel.

Historically, in streams of the mid-Atlantic region of the United States, American Eels were so abundant that their biomass comprised greater than 25 percent of the total fish biomass (Smith and Saunders 1955; Ogden 1970). However, evidence from various scientific reports and resource agencies suggests that the American Eel population has been steadily declining in segments throughout its range (Beak 2001). There are numerous factors that have been suggested as contributing to this decline, including: overharvest of multiple life stages, poor water quality, habitat loss and fragmentation due to blockage and/or impedance of upstream migration, and turbine mortality from hydroelectric power stations during downstream migration (ASMFC 2000).

A potentially larger factor in the decline of American Eel populations is obstruction of their migration. American Eels no longer have access to much of their historic habitat due to dams and other obstructions, contributing to a fragmented habitat and migration corridor (ASMFC 2012).

Fish passage facilities on the mainstem Susquehanna River, including both lifts and ladders, were engineered in order to pass migratory fish species. They have not proven effective at passing juvenile American Eels upriver; specialized passage facilities are required to accommodate juvenile eels (Sheldon 1974).

Providing upstream passage to American Eel may benefit Eastern Elliptio (Elliptio complanata), a native freshwater mussel. The larval stage of freshwater mussels, known as glochidia, must parasitize a host fish in order to complete metamorphosis to the juvenile life stage. Some mussel species can use multiple fish species as hosts, while others rely on only one or two host fish species. American Eel may be the primary fish host for this mussel species (Lellis 2013). Eastern Elliptio has been found to be abundant throughout most of its range which spans the entire east coast. However, biologists and researchers have noticed reduced abundance and recruitment of Eastern Elliptio, in the Susquehanna River basin (Minkkinen and Park 2007). Low recruitment of Eastern Elliptio could be linked to the lack of eel passage past the four dams on the mainstem, lower Susquehanna River. Therefore, increasing eel passage within the Susquehanna River watershed could increase recruitment of Eastern Elliptio. Freshwater mussels are filter feeders and remove algae, sediment, and micronutrients, thus improving water quality (Vaughn et al. 2008). If the Eastern Elliptio is dependent on American Eel to maintain their population, then sufficient passage of the eels into upstream habitat is essential for ecosystem function.

The CECF is located on the west shore of the Susquehanna River just downstream of the WFL (Figure 2.0-1 and Figure 2.0-2). This report describes the work completed by Exelon/Normandeau Associates, Inc. with oversight from EPAG in 2017 to collect and transport juvenile American Eels past Conowingo Dam.

Previous year trapping efforts by the USFWS (Minkkinen and Park 2014 and personal communication with USFWS, Christopher Reily, October 27, 2016) on the west shore of the Susquehanna River below Conowingo Dam have shown that the bulk of the juvenile eel migration occurs from May into September with most eels collected in June and July (Figure 2.0-3).

3 METHODS

3.1 Design, Construction, and Installation of Facility

Construction and Timing

The initial step for establishing the trapping and holding facility was to prepare a conceptual design as it would exist on the west shore of the Susquehanna River just downstream of the WFL. The conceptual design was presented to Exelon and EPAG in February 2017 (Appendix A). Permits from Maryland Department of Environment (MDE) and Harford County for construction and discharge of water down the shore near the 100 year flood level were applied for shortly after the conceptual designs were distributed. A 203-mm diameter gravity feed line was installed at elevation 37 feet mean sea level (FMSL) to supply water to the WFL and the CECF from the forebay. Throughout the work performed at Conowingo, the EPAG was updated on a regular basis regarding the progress of the project.

The construction of the CECF began in early March with the gravity feed line inside the station. The collection and holding tanks were fabricated by Exelon Industrial Services during March. These tanks were positioned and the gravity feed line was finished at elevation 46 FMSL in early April. On April 6, the MDE and Harford County permits were approved. Materials were ordered and received in April. All on-site fabrication during March and April was completed by Nooter with oversight of Normandeau to the specification of the conceptual design. In mid-April, the water quality meters and the flows meters were installed and tested. During the last week in April, the complete system was tested and water was run through the system to insure that all components operated correctly. The facility includes the gravity feed line, control panels, eel ramp, collection tank, holding tanks, and an overflow tank.

Design

Gravity Feed

The 203-mm diameter gravity feed line supplies water for the WFL and the CECF (Figure 3.1-1). The water line forms a manifold at elevation 46 FMSL and contains four 51 mm globe valves for the WFL and one 76 mm gate valve for the CECF. The main water line for the CECF is 76 mm in diameter, but each fill line for each tank is 51 mm in diameter. Each fill line has one 51 mm gate valve and one 51 mm angle valve along with an inline flow meter between these valves. A separate 25 mm line with a ball valve continuously discharges water down the ramp and into the collection tank via a spray bar, keeping the substrate moist and creating a flow to attract juvenile eels (Figure 3.1-2). Climbing ramp flow was augmented by a 25-mm diameter scent line from a tap and ball valve from the collection tank drain providing additional attraction flow via this gravity feed hose (Figure 3.1-3). The overflow tank collects the water from the collection tank and the holding tanks that are in service. Two 102-mm diameter additional attraction flow pipes drain the overflow tank and are discharged near the entrance of the ramp. These additional flow pipes are discharged above the shade cloth allowing the water to disperse over a larger area and provide additional attraction. All water from the ramp and the additional attraction pipes provides the overall attraction flow down the shoreline rip-rap to the tailrace.

Control Panel

The control panels to the CECF are located just upstream of the collection tank along the railing and contain a Welchem Webmaster Controller, a Modem Millie cellular modem, switches to enable tanks, instruments that provide read-out water quality parameters (Figure 3.1-4). The webmaster and the cellular modem notify

the Conowingo control room and Normandeau of alarms if any parameter is outside of established limits. The Conowingo control room receives a general alarm, whereas Normandeau receives an e-mail or text alert with a detailed alarm message. The upstream-most control panel monitors the instrumentation for the collection tank and holding tank #1, whereas the downstream control panel controls the instrumentation for Holding Tanks #2 and #3. Each tank can be enabled/disabled inside the control panel by a toggle switch. The Analytical Technology, Inc. (ATI) dissolved oxygen optical sensor probe (Model Q46D) was used in each of the four tanks to readout this parameter, along with temperature, on a LCD display in the control panel. Due to the distance of the tanks to the control panel (over 9 m), a junction box was required for use on some cables. The DO probe was mounted to a 51-mm diameter PVC pipe clamped to the side of the tank that could be adjusted for cleaning and storage purposes. Seametrics EX800 insertion electromagnetic flow sensors were used at five locations within the CECF, with a display located on each of them. The flow sensors were connected to the alarm system if this parameter falls outside of established limits. The readout displays the flow in gallons per minutes and total flow. The main flow meter was located between the 76-mm gate valve and collection tank along the straight run of the supply pipe. Each of the other flow meters was located on the straight run of 51-mm pipe between the gate and angle valves.

Aeration

Aeration and oxygen were added to each tank to help control oxygen levels. The air blowers and blower boxes were powered through control panels (Figure 3.1-5). A linear piston blower and blower box controlled the air supplied to the collection tank and holding tank #1 through a manifold, while the other blower and blower box provided air to holding tanks #2 and #3. A compressed oxygen bottle was also supplied to each of the tanks (Figure 3.1-6). An oxygen bottle/regulator was connected to the oxygen manifold by a 9.5 mm hose. Just like the air blower, an oxygen manifold supplied oxygen to the collection tank and holding tank #1, while another oxygen manifold supplied oxygen to holding tanks #2 and #3. Both the air blower manifold and the oxygen manifold were attached to a fine pore diffuser by a 6 mm hose. Each tank had one air blower fine pore diffuser and an oxygen fine pore diffuser. These diffusers laid flat on the tank bottom to ensure that the entire diffuser was expelling bubbles. These manifolds could be adjusted to regulate the amount of air/oxygen needed for a certain tank, and could be closed if no air was needed.

Ramp

The juvenile eel ramp was constructed of an aluminum cable tray. The cable tray contained landscape fabric climbing substrate (Enkamat 7010) attached to the tray bottom, similar to that used previously by USFWS for the Conowingo Dam eel passage facility and currently at the Octoraro Creek eel facility (Figure 3.1-7). This substrate consisted of a dense three-dimensional mesh of fused filaments, which provided a climbing surface for the juvenile eels. Each ramp consisted of approximately 8.75 meter (m) long by 457 mm wide cable trays positioned at a 42.5° angle, plus a continuous length of tray that was bent and shaped at a 90° angle over a 25 mm radius at the top of the ramp to convey juvenile eels into the collection tank, one for each substrate type. The base of the ramp was at elevation 29 FMSL, which was above the normal high water line, with a smooth transition to the existing shoreline. The ramp was held in place by six metal braces, evenly spread across the length of the ramp, and attached to large substrate along the shoreline. The ramp was covered from the top down to near the entrance to protect juvenile eels when ascending (Figure 3.1-8). The large 70% shade cloth was installed below the entrance to help protect juvenile eels between the tailrace and the entrance of the ramp.

Collection Tank

The CECF contained one collection tank, which was 1.02 m wide with a length of 1.83 m. The depth of the water in the collection tank was about 686 mm, with a volume of approximately 1,274 Liter (L) (Figure 3.1-9). The collection tank had 203 mm of freeboard to keep eels from climbing out of the tank. The main flow into the collection tank came from the 51-mm fill line with the terminus of the pipe about 51 mm above the waterline providing a constant flow of freshwater to the tank. Also, some water from the spray bar flow also entered the collection tank from the backside of the ramp. The bend of each ramp was custom fitted into the collection tank and ended about 102 mm above the high water mark in the tank. The collection tank contained a drain comprised of a 102-mm diameter PVC pipe with holes drilled through it and wrapped in one mm mesh to prevent juvenile eel escapement (Figure 3.1-10). The 102 mm collection tank drain line contained a 25-mm gravity drain line with a ball valve that was directed to the highest point possible (gravity feed) of the ramp, thus providing eel scent from the eels in the collection tank to the ramp. The collection tank also contained a 76-mm drain line, positioned about 76 mm off the bottom. The drain line was attached to a ball valve that remained closed until eels were removed. The 76 and 102-mm flexible drain lines emptied into the overflow tank. The collection tank was custom fitted with a lid made from 6 mm Lexan. In addition to the in-line flow meter, the collection tank contained a water temperature and dissolved oxygen probe.

Holding Tank

The CECF contains three holding tanks, with a total holding capacity of 51,660 juvenile eels (Figure 3.1-11). Each holding tank is 1.68 m wide with a length of 1.68 m. The depth of the water in each collection tank was 0.61 m, providing approximately 1,722 liters of water in each tank. A freeboard of 203-mm was provided to prevent eels from climbing and escaping. The bottom of the holding tanks were sloped to the center drain to help flush all water and eels from the tank. The top of the center drain pipe was fitted with a 457-mm square screen drain that has a height of 203 mm. The screen drain was made of 1-mm mesh to prevent eels from escaping and allowed consistent water exchange (Figure 3.1-12). This screened box was attached to a 102-mm PVC pipe fitted into a 102 mm bulkhead fitting that is removed to drain the tank completely. The bulkhead fitting was attached to a 90° PVC fitting and attached to a 102 mm flexible hose by a cam fitting that drained into the overflow tank. The main flow into a holding tank came from the 51-mm fill line with the terminus of the pipe about 51-mm above the waterline, providing a constant flow of freshwater to the tank. Each of these holding tanks had a temperature and dissolved oxygen probe.

Overflow Tank

The overflow tank is a 568 L tank containing three 76 mm bulkhead fittings (Figure 3.1-13). These bulkhead fittings were attached to 76 mm PVC solid wall pipe that was used to provide the additional attraction flow near the entrance of the ramp. The overflow tank was filled by the collection tank and all in-service holding tank drain lines. Prior to any tank being drained, a very fine mesh bag, called an oyster spat bag, was hose-clamped to the end of the drain hose to ensure that no eels were release into the overflow tank.. The drain hose with the spat bag attached was placed into the overflow, which acted as a water cushion for the eels being collected in the bag.

3.2 Data Collection

Sample data, including eel counts and lengths were recorded, verified, tabulated, and entered into an electronic format for each day. Flow readings, water quality, and environmental conditions were recorded, verified, tabulated, and entered into an electronic format during each days sampling event.

Eel count data included actual counts or volumetric estimates (when performed). Volumetric estimates were performed by placing 200 milliliter (mL) of water in a 1000-mL graduated container, and then placing anesthetized juvenile eels in this graduated container and filling to the 400 mL mark (Figure 3.2-1). These juvenile eels were counted while placing them in the 1000 mL graduated container for a known number in the 200 mL displacement in the container of water volume. A measured liter of water was then added into a 19-liter graduated bucket, the remaining eels from the collection tank were added to the 19-liter bucket, and the resulting displacement of water would indicate the volume, and ultimately the approximate number of eels[2] (Figure 3.2-2). This process was repeated until all juvenile eels were removed from the collection tank. The bulk estimate of eels from the 19-liter container was added to the known number counted during the 200 mL displacement procedure, to provide a total number of eels collected.

Length and weight measurements, along with condition factor were recorded biweekly from a maximum of 25 individuals (when available). Eels were measured to the nearest mm and the nearest half gram after being anesthetized (Figure 3.2-3 and Figure 3.2-4). During this biweekly subsample, a portion of these eels were examined for the presence of *Anguillicoloides crassus* and others were retained for age analysis. Age analysis methodology is described in Appendix B.

Flow readings and water quality data (temperature and dissolved oxygen) were recorded daily upon arrival from the control panel readouts for the collection tank and any holding tank in service. The main flow was also recorded daily.

Environmental data including river flow, moon phase, and weather condition was also recorded daily.

3.3 Juvenile Eel Transport

A wild health screening was required prior to the transport of eels transported upstream into the Susquehanna River watershed. Juvenile eels were collected by a back pack electroshocker in March from Stone Run, a tributary of the Octoraro Creek, and sent to the USFWS Fish Health Center (Lamar, PA) for examination (Figures 3.3-1 through 3.3-3). After the results of the wild health screening were received and distributed to the EPAG, eels could be stocked in the approved locations.

All juvenile eels captured from the CECF, plus eels collected at the Octoraro Creek eel facility, were held for no longer than one week prior to transport. All eels were transported and released at designated locations in the Susquehanna River watershed.

When less than 150 eels were collected during a sampling event, transport occurred using aerated 19-liter buckets with lids, containing the maximum amount of water to prevent sloshing, with ≤ 50 eels in each bucket. When counts of juvenile eels were greater than 150 but less than 1,000 individuals, a small enclosed transport tank (250 L) with supplemental oxygen capability was used to transport eels to designated

[2] For example, if 100 eels were counted in the displaced 200 mL graduated container, the resulting ratio would be 500 eels per liter. If the displacement of water in the 19-liter bucket is four liters, then 2,000 eels are in the 19-liter bucket. A total of 2,100 were in the sample.

locations (Figure 3.3-3). When large loads (> 1,000 eels) of American Eels were transported, the custom made transport truck and tank unit was used to efficiently and safely deliver eels to designated stocking locations (Figure 3.3-4).

4 RESULTS

The CECF facility was installed and began operation May 1, with continued operation through September 15, 2017. Eels were collected daily during the 138 days that the facility was operated. A total of 122,300 juvenile eels were collected during the 2017 season (Table 4.0-1).

4.1 Juvenile Eel Collection

A total of 122,300 juvenile American Eels were captured at the CECF during the 2017 season. Daily counts or volumetric estimates were recorded daily. Volumetric estimates were taken from the CECF on 40 of the 138 days of operation (approximately 29% of the season, Table 4.0-1).

The highest one-day total of 7,280 juvenile eels occurred on July 30, when 6.0% of the total number of eels collected were captured (Table 4.0-1 and Figure 4.1-1). For the 2017 season, nearly 25% (31 days) of the monitoring checks recorded juvenile eel numbers greater than 1,000 individuals (Table 4.0-1). Only five (3.6%) of the sample days recorded eel collection greater than 5,000 individuals.

4.2 Juvenile Eel Biological Data

Biological data such as length, weight and condition factor was recorded from biweekly subsamples. A total of 926 juvenile eels was collected from these biweekly subsamples (< 1.0% of total eels collected), during 41 of the 138 sample days.

The average length of juvenile eels was 122.3 mm, with a median size of 122 mm (Table 4.2-1). The length of juvenile eels ranged from 78 – 192 mm. Sixty-five juvenile eels measured less than 100 mm and two eels measured greater than 175 mm (Table 4.2-2). The average weight of juvenile eels was 2.1 g, with a median weight of 2.0g (Table 4.2-1). The weight of juvenile eels ranged from 0.5 - 6.0 g (Table 4.2-2). Over 90% of the 926 juvenile eels weighed between 1 – 3 g (Table 4.2-3).

Eels form each biweekly subsample were examined for external injuries. Individual condition factors, date, and detailed biological data for these are shown on Table 4.2-4. Less than 2.0% (18 of 926 individuals) showed any sign of poor condition factor. Nearly all injuries were coded as a bruise, scrape, or hemorrhage, and only one showed evidence of fungus.

4.3 Eel Sacrifice and Internal Analysis

From each biweekly subsample, a portion of juvenile eels were retained and inspected for the presence of the swim bladder parasite (*Anguillicoloides crassus)*, with a portion of these examined for age determination. Roughly 21% (193 or the 926 individuals) were dissected for the parasite (Table 4.3-1 and Figure 4.3-1). Approximately 50% (98 of 193 individuals) of these eels were examined for age (Table 4.3-2).

Of the 193 juvenile eels that were inspected for the parasite, 104 (53.9%) contained the swim bladder parasite (Table 4.3-1 and Figure 4.3-2). The infected eels contained one, two, or three parasite per individual, 64, 30, and 10 eels respectively. Table 4.3-2 provides detailed information separated by length frequency (five mm groups) of the 193 sacrificed eels with information including weight, and number that were infected by the parasite. The average length of the sacrificed eels was 123.6 (range 78-192) mm, average weight of 2.2 (range 0.5-6) g, and average number of parasites 0.8 (range 0-3, Table 4.3-1).

Age of the juvenile eels were determined on 91 of the 98 juvenile eels, 5 otoliths could not be read for aging and two slides were broken and the otholiths were lost. The 91 juvenile eels analyzed for age were determined to be 1 to 4 years old (Average age = 2.2, Table 4.3-3). Detailed information of the 98 sacrificed and aged eels is shown on Table 4.3-3. Of the 91 aged eels, 13 eels (14.3%) were 1 year old, 48 eels (52.75) were aged 2 years old, 27 eels (29.7%) were aged 3 years old, and 3 eels (3.3%) were aged 4 years old. Age agreement between Normandeau biologist occurred 84.6% (77 of the 91 eels) of the time (Appendix B). The average length of the aged eels was 124.9 (range 78-192) mm, average weight of 2.3 (range 0.5-6) g, and average number of parasites 0.7 (range 0-3). Length frequency of aged eels with weights, parasites, and age data are found on Table 4.3-4.

4.4 Peak Periods of Eel Collections

The greatest percentage of juvenile eels was collected during Week 14 (July 30-August 5) when the facility collected 26.59% (32,524 individuals, Table 4.4-1 and Figure 4.4-1). During Week 8 (June 18-24) the second highest percentage of eels was collected, 19.07% (23,318 individuals).

The majority (69.0%, 84,407 individuals) of the juvenile eels were caught during Weeks 8 and 13-15 (June 18-24 and July 23-August 12, Table 4.4-1 and Figure 4.4-1) with at least 10% (roughly 13,000 individuals) being represented by any one week. Nearly 50% (61,089 individuals) of the season total was collected from the time period of July 23 - August 12.

Weeks 2, 3, 10, and 18-20 of sampling collected no greater than 1.0% of the season total, accounting for 2,357 individuals (1.9%) combined. Only 182 individuals (0.15%) were collected during the last three weeks of the season (Table 4.4-1 and Figure 4.4-1). Weekly catch data are also provided in Appendix C.

During the season, there were two major peak periods. The first major peak (June 19-22, 4 days) yielded 17,643 of the 122,300 (14.4%) juvenile eels (Table 4.0-1). The largest peak occurred between July 27 and August 4 (9 days), accounting for 42,772 of the 122,300 (35.0%) juvenile eels collected at the facility. Nearly 50% (60,415 of the 122,300) of the juvenile eels collected at this facility occurred during these 13 days or < 10% of the sampling days.

4.5 Juvenile Eel Catch in Relation to Environmental Factors

See Appendix C for weekly averages of juvenile eel capture, river flow, lunar fraction, water temperature, and DO.

River Flow

River flow and juvenile eel catch appeared to be directly related during the 2017 season. Daily average river flow was taken from The United States Geological Survey (USGS) 01578310 Susquehanna River at Conowingo, MD gage located at Conowingo Dam (Table 4.5-1). The highest daily average river flow value per the USGS gage station occurred on May 8, 2017 (178,000 cubic feet per second, cfs). This single highest daily average river flow value occurred at the end of Week 2 of eel facility operation, just prior to some of the lowest days of eel collection (Table 4.0-1). During periods of high flows (greater than station maximum unit discharge, 80,000 cfs), the juvenile American Eel capture at the CECF was low. Figure 4.5-1 shows a general trend; as the flows started to fall, an increase in the number of eels captured was observed, except during Week 13 when the weekly average flow increased. However, comparing the individual catch data to the individual daily average river flow shows that the majority of eels captured in Week 13 occurred after the river flow started to decrease (Tables 4.0-1 and 4.5-1 and Figure 4.5-1). The last three weeks of the

sampling season (Weeks 18-20) had the lowest average weekly flows and represented the lowest weekly capture totals. A slight decrease in river flow generally corresponded to increased juvenile eel collection except for Weeks 9 and 10 (Figure 4.5-1). The higher catch numbers during Weeks 8 and 13-15 of the study may be a function of other variables (e.g., migration timing).

Lunar Fraction

Juvenile eel catch appeared to be correlated to lunar fraction (cycle) during the 2017 season. Full moon is equal to 1.0. During periods of lower lunar fraction (lunar fraction near 0.0) or slightly after, the juvenile eel catch at CECF tended to increase (Table 4.5-2 and Figure 4.5-2). This increase in juvenile catch relationship was most notable during Weeks 8, 13, and 14. These two peaks in abundance also occurred near the new moon (Table 4.5-2 and Figure 4.5-2). The lower illuminance associated with a new moon has been reported with increases in eel catch at eel traps (Welsh *et al*. 2015, and Schmidt *et al*. 2009).

Water Temperature

Water temperature and eel catch did not appear to be related this season. The first and the last few weeks when average weekly temperatures were below or near 20.0°C corresponded with some of the lowest eel catches of the season (Table 4.5-3). Over the course of the study, the water temperature ranged from a high of 28.0°C during late July to a low of 12.1°C during early May. (Table 4.5-3 and Figure 4.5-3).

Dissolved Oxygen

Dissolved oxygen and eel collection numbers did not appear to be related this season. With the additional aeration and diffused compressed oxygen supplied to each of the tanks for most of the season, no relationship between eel catch and dissolved oxygen values could be derived. Daily dissolved oxygen readings are presented in Table 4.5-4 and displayed in Figure 4.5-4.

4.6 Juvenile Eel Holding and Mortality

Of the 122,300 juvenile eels that were captured at this facility, 17 eels died in the collection tank (99.9% survival, Table 4.6-1). All mortalities from the collection tank were recorded over the course of the season, and were not attributed to a single event such as low DO or loss of water flow to holding tanks.

A total of 3,447 (2.58% mortality) juvenile eels died in holding (Table 4.6-1). On August 9, an estimated total of 2,139 juvenile eels were recovered dead from holding while removing them for a transport trip. Some of these eels showed signs of fungus and individuals from a subsample of eels were examined. The eels had no obvious signs of injury, and roughly half contained the swim bladder parasite. During this occasion, none of the 1,162 eels in the collection tank that day were found dead, and there were 9,549 eels that remained in holding that were alive and free from fungus, which were ultimately transported upriver. Because of this unknown issue of mortality, this holding tank was drained, scrubbed clean, and left dewatered for a period of least two weeks to kill any bacteria that could have been in this tank. On three other transport occasions between July 29 and August 14, we observed more than 189 dead eels upon removal of eels from the holding tanks. Eels collected at the CECF and the Octoraro Creek eel facilitywere held together in the same holding tanks prior to transport, providing no opportunity to determine the source of these dead eels.

4.7 Juvenile Eel Transport and Mortality

See Table 4.7-1 for detailed information of transport, and mortality data.

On March 21, 2017, Normandeau field crew collected 60 juvenile American Eels (< 200 mm) by a back pack electroshocker from Stone Run, a tributary of Octoraro Creek near Rising Sun, Maryland. The following day, these 60 live juvenile American Eels were delivered to John Coll, a USFWS biologist at the Fish Health Center located at Lamar Fish Hatchery, Lamar, Pennsylvania. No bacterial or viral pathogens of concern were detected in the 60 eels and the Fish Health Inspection Report is presented in Appendix D.

All juvenile eels that were captured from the CECF at Conowingo Dam, plus any eels collected at the Octoraro Creek eel facility, were held for no longer than one week prior to transport. All eels were transported and released at designated locations in the Susquehanna River watershed (Figure 4.7-1). Juvenile eels transported from the CECF at Conowingo Dam were stocked as least weekly at designated stocking sites. A total of 129,982 juvenile eels were transported upstream (Table 4.6-1 and 4.7-1).

Total elapsed time from holding to each stocking location varied between trips. Eel transports from the CECF to Conewago Creek (Site B), were completed in approximately two hours (± 20 minutes). Eel transports from the holding tanks at the CECF at Conowingo Dam and stocked at Beaver Creek (Site C) were completed in approximately two hours (± 20 minutes). Eel transports from the holding tanks at the CECF at Conowingo Dam and stocked in the Susquehanna River at Etters Boat Ramp (Site 4) were accomplished within one and a half hour (± 15 minutes).

Of the 16,520 eels that were transported to Conewago Creek (Site B), 16,502 eels were stocked (Table 4.6-1 and Figure 4.7-2). In 2016, an additional 378 juvenile eels had previously been stocked in Conewago Creek for a total of 16,880 eels. The stocking was completed for Conewago Creek on June 16, 2017. Detailed transported data from each of the transports is found on Table 4.7-1.

Of the 9,739 eels that were transported to Beaver Creek (Site C), 9,738 eels were stocked (Table 4.6-1 and Figure 4.7-3). The stocking at this site commenced on June 16, and was completed on June 20, 2017. Detailed transport data from each of the transports is found on Table 4.7-1.

The majority of eels transported were stocked in the Susquehanna River at Etters Boat Launch (Site 4) in Goldsboro, PA upstream of York Haven Dam. Of the 103,723 eels that were transported to Site 4, 103,662 eels were stocked (Table 4.6-1 and Figure 4.7-4). The stocking at this site commenced on June 20, and continued until the end of the season. Detailed transported data from each of the transports is found on Table 4.7-1.

Mortality

Mortality during transport efforts from the CECF at Conowingo Dam totaled 80 eels (0.06%, 80 of 129,982, Table 4.6-1). Eighteen eels died (0.11%, 18 of 16,520 eels) during transports from the CECF to Conewago Creek (Site B). Only one eel (0.01% 1 of 9,739) died during transports to Beaver Creek (Site C). Sixty-one eels (0.06%, 61 of 103,723) died during transports to the Susquehanna River at Etters Boat Launch. Detailed data on eel transports to designated stocking sites is located on Table 4.7-1.

4.8 Quality Control Activities

Cleaning and calibration activities were conducted at least weekly during the season. Operating ranges of flow, dissolved oxygen, and temperature specifications for the CECF is located on Table 4.8-1. The collection tank and screened drain were scrubbed after eels were removed daily, whereas the holding tanks and overflow drain were scrubbed every time the eels were removed for a transport. Dissolved oxygen probes were cleaned regularly. The overflow tank was cleaned periodically. With the gravity feed line from

the forebay, the amount of algae was minimal but cleaning was still performed. Quality control checks were also performed on the volumetric eel count estimates.

Calibration of the ramp flow was executed each week after cleaning, using a 19-liter graduated bucket. Multiple locations of the facility were checked for calibration purposes - the spray bar, the collection tank fill and drain, scent line, and the drains of each of the holding tanks that were in service. Some of the water from the spray bar that was not used for attracting eels up the ramp was used to help slide eels into the collection tank was identified as the backside of ramp flow. The backside of ramp flow was calculated by adding the scent line to the collection tank drain and subtracting the collection tank fill. The attraction flow at the top of the ramp (top attraction) was calculated by subtracting the backside of ramp flow from the spray bar amount. Bottom of ramp attraction is a sum of the collection tank drain and the drains of the in-service holding tanks. Total attraction flow is equal to the collection tank fill, the spray bar and the drain of the in-service holding tanks. Details and calibration records are listed in Table 4.8-2.

Volumetric eel estimates were performed on counts during the season to check the estimated counts compared to actual counts. A quality control comparison on counts occurred on four events during the 2017 season: May 5, June 16, August 10 and August 13. The detailed estimates for juvenile eels per 200 mL, displacement, total estimated and actual counts are in Table 4.8-3. With a small difference of the four checks (< 1.0%) in counts, no further changes to this method needed to be made.

5 CONCLUSIONS AND DISCUSSION

The purpose of the eel collection facility is to collect, hold, and transport as many juvenile American Eels to designated points in the Susquehanna River watershed upstream of Conowingo Dam. The CECF at Conowingo Dam has one Enkamat ramp compared to the Octoraro Creek eel facility which contains one Enkamat and one Milieu ramp. Both ramps operated simultaneously (May 1 – September 15). Conowingo's facility captured 122,300 eels compared to the Octoraro Creek eel facility that captured 11,347 juvenile eels during the 2017 season. With both ramps operating simultaneously, the CECF at Conowingo Dam captured roughly ten times the number of eels collected by the Octoraro Creek facility. During this time, the size range of the juvenile eels caught at the CECF at Conowingo Dam facility was 78-192 mm with an average length of 122 mm (Normandeau Associates and Gomez and Sullivan 2018). The size of the juvenile eels caught in the ramp with the Enkamat substrate at the Octoraro Creek eel facilitywas similar with a size range of 99-165 mm and an average length of 130 mm. Juvenile eels that were captured using the Milieu substrate were larger (average size 141 mm), but this substrate did not capture any eels under 110 mm and captured eels as large as 245 mm. Overall, the ramps at the Octoraro Creek eel facilitycollected a wider size range of eels, but the CECF at Conowingo Dam collected much smaller eels.

The CECF was a brand new facility in 2017 and required oversight to ensure its reliability and effectiveness. The shade cloth over the rip-rap on the shoreline below the entrance of the ramp was a major help in deterring birds and animals from preying on juvenile eels as they ascended the wetted attraction flow. The alarm systems were useful, but required debugging and troubleshooting throughout the season to prevent excessive notifications and/or false alarms. Supplemental aeration from the bubblers and the compressed oxygen diffusers was a great asset during times of low dissolved oxygen levels in the water supply line from the forebay. The total attraction flow of the facility varied throughout the season dependent upon which tanks were in-service, but an attraction flow was always being discharged down the ramp and shoreline. The hardiness of this species and its ability to adjust to parameters outside of those developed for the ideal design parameters for this facility was evidenced by the numbers captured here. Future testing and adjustments to this facility in terms of attraction flows, as well as the location of the attraction flow discharge will be investigated.

The area below the entrance of the ramp was covered with a shade cloth to about the normal high water tailrace elevation to protect the juvenile eels when ascending the attraction flow over/through the rip-rap shoreline. Small areas had to be filled in to keep small birds from climbing under the cloth during the first month of the season. Herons were observed near the attraction flow and tailrace interface, which was not always covered depending on the tailrace elevation. The entire ramp was covered with a sheet of aluminum to protect the juvenile eels while climbing.

The area over collection tank, holding tanks, and hoses are partially shaded by a scaffold frame and shade cloth. The tanks were covered with a sheet of Lexan and weather stripping attached to these covers prevented most of the insect hatches from clogging the screened drains. No indications were observed of animals attempting to enter any of the tanks during the season.

The control panel to the CECF was new for the 2017 season. This control panel provided an instantaneous readout of dissolved oxygen and water temperature and connected to the flow meters for all of the tanks and fill lines. When a five minute average was outside the range of specification, an alarm would be sent to the control room, followed ten minutes later by an alarm sent to Normandeau via a text or e-mail message. The alarm to the control room would be a general alarm but the alarm to Normandeau was a detailed

message about the alarm. Conowingo operations handled most of the alarms with guidance from Normandeau. Early in the season, alarms were quite frequent but some small adjustments were made to the new gravity feed line to adjust the pressure within the pipe to obtain a constant water flow into the tanks.

Continuous water temperature and dissolved oxygen readings were taken from each tank in use. A linear piston blower and blower box controlled the air supplied to the collection and holding tank #1 through a manifold, while the other blower and blower box controlled air to holding tanks #2 and #3. An air pump was in service constantly throughout the season for all tanks that were in-service. Compressed bottled oxygen (125 cubic foot) was also supplied to each of the tanks. As for the air blower, an oxygen manifold was used for the collection and holding tank #1, while another oxygen manifold controlled holding tanks #2 and #3. After Mid-June, when DO levels became reduced to 5.0 mg/L or lower, the compressed oxygen was used for every tank in-service. Both the air blower manifold and the oxygen manifold were attached to a fine pore diffuser by a 6 mm hose. Each tank had one air blower fine pore diffuser and an oxygen fine pore diffuser. These diffuser was laid flat on the bottom to insure all the diffuser was expelling bubbles. A 125 cubic foot bottle of compressed oxygen per day which supplied oxygen to two tanks in order to keep the greater than 5.0 mg/L minimum. Mid-August the fine pore diffuser was replaced by a micro-pore diffuser to try and decrease the consumption of oxygen, but keeping the tanks with the operating range of values. After this change in diffusers the 125 cubic foot bottle of oxygen lasted nearly five days for two tanks due to the bubbles were smaller causing them to dissipate more with the same minimum DO value.

Mortality from collection, holding, and transport was well below the 5% maximum mandated for the facility. The total mortality of juvenile eels from collection/holding of juvenile eels at the CECF was 2.6% (3,464 of 133,446 eels). A total of 17 eels died in the collection tank while 3,447 dead in holding tanks. The collection tank mortalities occurred over 15 different collection days. Roughly 62% (2,139 of 3,447 eels) were found dead in the holding tank on August 9, 2017, at a time when eels were being prepared for transport. These eels had been held for less than six days. In the same holding tank, an additional 9,549 live eels were observed to be healthy and were transported upriver. Because of this unknown cause of mortality, this holding tank was drained, scrubbed clean, and left dewatered for a period of least two weeks to kill any bacteria that may have been present in this tank. Transports were also conducted more frequently due to this unknown source of mortality. Mortality of over 189 individuals from the holding tank occurred on three other transport days. Nearly 90% (3,074 of 3,447 eels) of the holding tank mortality was from these four occasions, was accounting for 5.5% (3,074 of 55,663 eels) of the total individuals in holding. Of the 129,982 juvenile eels transported, a total of 80 mortalities were observed (0.06%). In general, transport mortality was very low.

Most environmental factors aside from lunar fraction and river flow did not appear to have a measurable effect on the number of eels collected in 2017. The highest daily average river flow value per the USGS gage station occurred on May 8, 2017 (178,000 cfs) and the lowest daily average river flow occurred on September 10, 2017 (6,000 cfs). The river flow at Conowingo Dam can change hourly, sometimes even quicker, depending on demand of energy and may not be a good metric to use to compare eel collection number over a season. The dissolved oxygen is augmented by air pumps and compressed oxygen injected into the tanks. The lunar fraction was one environmental factor showing the greatest relationship to the number of eels collected at Conowingo Dam in 2017. There is a relationship in which periods of low light (near new moon) have a significantly higher collection of juvenile eels than those periods of higher illumination.

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7 TABLES AND FIGURES

Table 4.0-1: Number of Juvenile Eel Caught Daily, Conowingo Eel Collection Facility, 2017

Date	Number of Eels	Date	Number of Eels	Date	Number of Eels
5/1/2017	45	6/17/2017	1612	8/2/2017	*3916*
5/2/2017	*1401*	6/18/2017	--	8/3/2017	***5597***
5/3/2017	*1151*	6/19/2017	***5951***	8/4/2017	*3821*
5/4/2017	*936*	6/20/2017	*3225*	8/5/2017	*2715*
5/5/2017 *	*428*	6/21/2017	***5048***	8/6/2017	*4374*
5/6/2017	*426*	6/22/2017	*3419*	8/7/2017	*2427*
5/7/2017	83	6/23/2017	*2625*	8/8/2017	*2160*
5/8/2017	50	6/24/2017	*3050*	8/9/2017	*1162*
5/9/2017	5	6/25/2017	*2153*	8/10/2017	*1110*
5/10/2017	0	6/26/2017	*3720*	8/11/2017 *	791
5/11/2017	5	6/27/2017	1027	8/12/2017	*1106*
5/12/2017	1	6/28/2017	*654*	8/13/2017 *	571
5/13/2017	7	6/29/2017	220	8/14/2017	415
5/14/2017	4	6/30/2017	247	8/15/2017	564
5/15/2017	25	7/1/2017	69	8/16/2017	196
5/16/2017	27	7/2/2017	147	8/17/2017	234
5/17/2017	15	7/3/2017	112	8/18/2017	214
5/18/2017	79	7/4/2017	129	8/19/2017	460
5/19/2017	114	7/5/2017	137	8/20/2017	702
5/20/2017	*960*	7/6/2017	84	8/21/2017	637
5/21/2017	*1700*	7/7/2017	91	8/22/2017	267
5/22/2017	*936*	7/8/2017	99	8/23/2017	597
5/23/2017	543	7/9/2017	159	8/24/2017	250
5/24/2017	*936*	7/10/2017	*500*	8/25/2017	353
5/25/2017	231	7/11/2017	343	8/26/2017	125
5/26/2017	*972*	7/12/2017	205	8/27/2017	49
5/27/2017	66	7/13/2017	96	8/28/2017	21
5/28/2017	105	7/14/2017	132	8/29/2017	6
5/29/2017	312	7/15/2017	68	8/30/2017	1
5/30/2017	417	7/16/2017	49	8/31/2017	3
5/31/2017	245	7/17/2017	405	9/1/2017	2
6/1/2017	473	7/18/2017	110	9/2/2017	6
6/2/2017	343	7/19/2017	126	9/3/2017	2
6/3/2017	*301*	7/20/2017	154	9/4/2017	6
6/4/2017	*336*	7/21/2017	314	9/5/2017	7
6/5/2017	500	7/22/2017	274	9/6/2017	17
6/6/2017	200	7/23/2017	313	9/7/2017	13
6/7/2017	367	7/24/2017	440	9/8/2017	3
6/8/2017	146	7/25/2017	519	9/9/2017	3
6/9/2017	152	7/26/2017	1200	9/10/2017	3
6/10/2017	60	7/27/2017	*3136*	9/11/2017	4
6/11/2017	66	7/28/2017	***5375***	9/12/2017	6
6/12/2017	163	7/29/2017	*4452*	9/13/2017	4
6/13/2017	288	7/30/2017	***7280***	9/14/2017	19
6/14/2017	*608*	7/31/2017	*4471*	9/15/2017	7
6/15/2017	1326	8/1/2017	*4724*	--	122300
6/16/2017 *	*1136*	--	--	--	--

Volumetric estimates are in Italics
Bolded numbers are peak days
The peak periods are shown in boxes
* QC checks

Table 4.2-1: Number of Juvenile Eel Captured and Length and Weight Measurements, Conowingo Eel Collection Facility, 2017

	Total
Number eels collected	122,300
Number measured	926
Data Collecton Days	41
Range on lengths (mm)	78-192
Average length (mm)	122.3
Median length (mm)	122.0
Range on weghts (g)	0.5-6.0
Average weght (g)	2.1
Median weight (g)	2.0

Table 4.2-2: Juvenile Eel Length Frequency, Conowingo Eel Collection Facility, 2017

TL (mm)	Number
75-79	2
80-84	1
85-89	5
90-94	19
95-99	38
100-104	48
105-109	71
110-114	88
115-119	124
120-124	117
125-129	129
130-134	107
135-139	59
140-144	55
145-149	29
150-154	14
155-159	11
160-164	6
165-169	1
170-174	--
175-179	--
180-184	1
185-189	--
190-194	1
Total	926

Table 4.2-3: Juvenile Eel Weight Frequency, Conowingo Eel Collection Facility, 2017

Weight (g)	Number
0.5	13
1	153
1.5	194
2	215
2.5	164
3	110
3.5	52
4	12
4.5	8
5	4
5.5	--
6	1
Total	926

Table 4.2-4: Observed Injuries of Juvenile American Eels, Conowingo Eel Collection Facility, 2017

Date	Length	Weight	Condition Factor
5/8/2017	130	3	Mark on tail, Bruise
5/15/2017	125	2.5	Slight bruising on top of tail
	110	1	Hemorrhaging on tail (handling)
	118	1.5	Scrape on back of head
5/18/2017	138	2.5	Hemorrhaging on tail *
	115	2	Hemorrhaging on pectoral fin
	137	2.5	Hemorrhaging on pectoral fin
5/22/2017	127	2	Scrape on side *
5/29/2017	132	2	Scrape on side
6/1/2017	112	1.5	Mark on Ventral
6/5/2017	114	1.5	Pinch mark behind head
	106	1	Hemorrhaging on tail *
6/8/2017	131	2.5	Bruise around lower jaw
6/12/2017	104	1	Hemorrhaging on tail
7/3/2017	143	3	Bruise on ventral
8/21/2017	129	2.5	Fungus near vent *
	145	3.5	Scrape across back *
9/2/2017	145	3.5	Bruise on tail *

* Taken as a sacrifice

18 of 926 eels(1.9%) that were processed had injury

6 of the 18 were used as a sacrifice (33.3%)

Only 1 of the 6 that were used as a sacrifice contain a parasite (1)

5/18/2017 138 mm

Table 4.3-1: Sacrificed Eel Data, Conowingo Eel Collection Facility, 2017

Date	Length (mm)	Weight (g)	Parasite	Age
5/1/2017	124	3	0	2
	116	2.5	2	2
	108	1.5	2	2
	136	3	1	2
	86	1	0	1
5/4/2017	115	1.5	0	2
	123	2	0	2
	95	1	0	2
	109	1.5	0	2
	142	3	0	NR
5/8/2017	130	2.5	0	2
	108	1.5	0	NR
	127	2	0	2
	141	3	1	3
	114	1.5	0	2
5/13/2017	129	2.5	0	2
	117	2	2	1
5/15/2017	134	3	1	2
	142	3	0	3
	125	2.5	0	2
	118	2	0	2
	155	3.5	0	3
	106	1	0	2
5/18/2017	138	2.5	1	-
	146	2.5	1	-
	104	1.5	1	-
	111	1	0	-
	127	3	1	-
5/22/2017	105	1	0	-
	127	2	0	-
	143	3	2	-
	97	1	0	-
	135	2.5	1	-
	113	1.5	0	-
5/25/2017	132	2.5	0	-
	124	2	0	-
	107	1.5	0	-
	145	3.5	0	-
	113	2.5	1	-
5/29/2017	147	3.5	0	3
	102	1	1	2
	125	2	0	2
	114	1.5	1	2
	135	2.5	0	2
	93	1	3	1
6/1/2017	133	2.5	1	2

Date	Length (mm)	Weight (g)	Parasite	Age
	94	1	0	2
	127	2.5	0	2
	147	3	1	3
	152	4	1	3
6/5/2017	156	4	2	-
	117	1.5	0	-
	106	1	0	-
	124	2	1	-
	143	3	1	-
6/8/2017	153	3	0	-
	96	1	1	-
	154	4	1	-
	104	1.5	0	-
	89	1	1	-
6/12/2017	182	5	1	3
	158	4	0	3
	99	1	2	NR
	160	4.5	0	3
	126	2	0	2
6/15/2017	136	2	0	-
	154	5	2	-
	96	1	0	-
	142	3	2	-
	123	3	0	-
6/19/2017	102	1	1	-
	97	1	0	-
	127	1.5	2	-
	136	2	1	-
	118	1.5	2	-
6/22/2017	115	1.5	3	3
	144	3.5	2	4
	97	1	0	1
	137	3	0	2
	121	2	2	3
6/26/2017	127	2.5	2	-
	116	1.5	1	-
	117	1.5	1	-
	123	2	3	-
	107	1	2	-
	146	3.5	1	-
	117	1.5	1	-
	94	1	0	-
	145	3.5	1	-
	103	1	1	-
	137	3	2	-
	118	1.5	0	-
	114	1.5	1	-
	134	3	0	-

Date	Length (mm)	Weight (g)	Parasite	Age
6/28/2017	114	1.5	1	-
	125	2	0	-
	136	2.5	0	-
	130	2.5	1	-
	115	1.5	2	-
7/3/2017	161	4	1	3
	89	1	1	1
7/6/2017	91	1.5	3	-
	155	4.5	2	-
	107	1.5	0	-
	121	2	1	-
	135	3.5	1	-
7/10/2017	122	2	1	2
	118	2	0	2
	103	1.5	1	2
	98	1	0	1
	138	3	0	2
7/13/2017	100	1	0	-
	115	1.5	0	-
	128	2.5	0	-
	131	2.5	1	-
	97	1	2	-
7/17/2017	157	4	0	-
	112	1	0	-
	107	1	2	-
	99	1	1	-
	129	2.5	3	-
7/20/2017	78	0.5	2	1
	96	0.5	1	NR
	101	1	1	2
	131	2.5	0	3
	110	1.5	0	1
7/24/2017	133	2.5	0	-
	109	1	1	-
	118	1.5	1	-
	93	1	2	-
	86	0.5	3	-
7/27/2017	101	1	2	-
	93	1	1	-
	115	1.5	0	-
	131	2.5	0	-
	106	1.5	1	-
7/31/2017	127	2	0	2
	116	1.5	2	2
	96	1	1	2
	101	1	2	1
	134	2.5	0	3
8/3/2017	116	2	1	-

Date	Length (mm)	Weight (g)	Parasite	Age
	95	1	1	-
	131	2.5	1	-
	122	2	0	-
	104	1	1	-
8/7/2017	143	3	3	3
	102	1	2	2
	134	2.5	0	2
	94	0.5	1	1
	126	2.5	0	1
8/10/2017	140	3.5	0	-
	120	2	0	-
	115	1.5	0	-
	126	2	1	-
	148	3.5	0	-
8/15/2017	192	6	0	4
	148	3.5	0	2
	150	4	1	2
	134	3	1	3
	121	2	1	2
8/17/2017	143	3.5	1	2
	109	1	1	2
	155	4.5	0	3
	141	3.5	3	2
	152	4	1	3
8/21/2017	129	2.5	0	2
	145	3.5	0	2
	118	1.5	2	3
	132	3	2	2
	158	4.5	0	3
8/24/2017	158	3.5	0	-
	141	3.5	3	-
	154	3.5	0	-
	162	4.5	1	-
	145	3.5	0	-
8/28/2017	134	2	1	3
	163	3.5	0	3
	150	3	0	3
	122	1.5	2	3
	119	1.5	0	2
9/2/2017	78	0.5	0	2
	145	3.5	0	4
9/4/2017	95	1	2	L
	104	1	3	L
9/7/2017	84	0.5	1	1
	101	1	0	2
	149	3.5	1	3
9/11/2017	162	5	2	3
9/14/2017	151	3.5	1	NR

Date	Length (mm)	Weight (g)	Parasite	Age
9/14/2017	85	0.5	0	2
	94	0.5	1	1
	153	3	0	3
Average	123.6	2.2	0.8	2.2
Range	78-192	0.5-6	0-3	1-4

Total Sacrificed	193
Total Aged	98 (50.8%)
0 Parasites	89 (46.1%)
1 Parasite	64 (33.2%)
2 Parasites	30 (15.5%)
3 Parasites	10 (5.2%)
Parasite found	104 (53.9%)

Table 4.3-2: Sacrificed Eels Length Frequency with Detailed Info, Conowingo Eel Collection Facility, 2017

TL (mm)	Weight (g)	Number	Contained Parasite
75-79	0.5	2	1
80-84	0.5	1	1
85-89	0.5-1	5	3
90-94	0.5-1.5	8	6
95-99	0.5-1	14	8
100-104	1-1.5	14	11
105-109	1-1.5	13	6
110-114	1-2.5	9	4
115-119	1.5-2.5	21	12
120-124	1.5-3	13	7
125-129	1.5-3	17	5
130-134	2.5-3	16	8
135-139	2-3.5	11	6
140-144	3-3.5	12	9
145-149	2.5-3.5	12	5
150-154	3-5	10	6
155-159	3.5-4.5	8	2
160-164	3.5-5	5	3
165-169	-	-	-
170-174	-	-	-
175-179	-	-	-
180-184	5	1	1
185-189	-	-	-
190-194	6	1	0
Total	-	193	104

Table 4.3-3: Eel Data for Length, Weight, Parasites, and Age, Conowingo Eel Collection Facility, 2017

Length (mm)	Weight (g)	Parasite	Age
78	0.5	2	1
78	0.5	0	2
84	0.5	1	1
85	0.5	0	2
86	1	0	1
89	1	1	1
93	1	3	1
94	1	0	2
94	0.5	1	1
94	0.5	1	1
95	1	0	2
95	1	2	L
96	0.5	1	NR
96	1	1	2
97	1	0	1
98	1	0	1
99	1	2	NR
101	1	1	2
101	1	2	1
101	1	0	2
102	1	1	2
102	1	2	2
103	1.5	1	2
104	1	3	L
106	1	0	2
108	1.5	2	2
108	1.5	0	NR
109	1.5	0	2
109	1	1	2
110	1.5	0	1
114	1.5	0	2
114	1.5	1	2
115	1.5	0	2
115	1.5	3	3
116	2.5	2	2
116	1.5	2	2
117	2	2	1
118	2	0	2

Length (mm)	Weight (g)	Parasite	Age
118	2	0	2
118	1.5	2	3
119	1.5	0	2
121	2	2	3
121	2	1	2
122	2	1	2
122	1.5	2	3
123	2	0	2
124	3	0	2
125	2.5	0	2
125	2	0	2
126	2	0	2
126	2.5	0	1
127	2	0	2
127	2.5	0	2
127	2	0	2
129	2.5	0	2
129	2.5	0	2
130	2.5	0	2
131	2.5	0	3
132	3	2	2
133	2.5	1	2
134	3	1	2
134	2.5	0	3
134	2.5	0	2
134	3	1	3
134	2	1	3
135	2.5	0	2
136	3	1	2
137	3	0	2
138	3	0	2
141	3	1	3
141	3.5	3	2
142	3	0	NR
142	3	0	3
143	3	3	3
143	3.5	1	2
144	3.5	2	4
145	3.5	0	2
145	3.5	0	4

Length (mm)	Weight (g)	Parasite	Age
147	3.5	0	3
147	3	1	3
148	3.5	0	2
149	3.5	1	3
150	4	1	2
150	3	0	3
151	3.5	1	NR
152	4	1	3
152	4	1	3
153	3	0	3
155	3.5	0	3
155	4.5	0	3
158	4	0	3
158	4.5	0	3
160	4.5	0	3
161	4	1	3
162	5	2	3
163	3.5	0	3
182	5	1	3
192	6	0	4

	Length (mm)	Weight	Parasite	Age
Average	108.4	1.4	0.8	2.2
Range	78-192	0.5-6	0-3	1-4

Total Aged	98

0 Parasites	89 (46.1%)
1 Parasite	64 (33.2%)
2 Parasites	30 (15.5%)
3 Parasites	10 (5.2%)
Parasite found	104 (53.9%)

Table 4.3-4: Length Frequency of Aged Eels, Conowingo Eel Collection Facility, 2017

TL (mm)	Weight (g)	Number	Contained Parasite	Age
75-79	0.5	2	1	1,2
80-84	0.5	1	1	1
85-89	0.5-1	3	1	1, 1,2
90-94	0.5-1	4	3	1,1,1,2
95-99	0.5-1	7	4	1,1,2,2,NR,NR,L
100-104	1-1.5	7	6	1,2,2,2,2,2,L
105-109	1-1.5	5	2	2,2,2,2,NR
110-114	1.5	3	1	1,2,2
115-119	1.5-2.5	9	5	1,2,2,2,2,2,2,3,3
120-124	1.5-3	6	4	2,2,2,2,3,3
125-129	2-2.5	9	0	1,2,2,2,2,2,2,2,2
130-134	2.5-3	9	5	2,2,2,2,2,3,3,3,3
135-139	2.5-3	4	1	2,2,2,2
140-144	3-3.5	7	5	2,2,3,3,3,4,NR
145-149	3-3.5	6	2	2,2,3,3,3,4
150-154	3-4	6	4	2,3,3,3,3,NR
155-159	3.5-4.5	4	0	3,3,3,3
160-164	3.5-5	4	2	3,3,3,3
165-169	-	-	-	-
170-174	-	-	-	-
175-179	-	-	-	-
180-184	5	1	1	3
185-189	-	-	-	-
190-194	6	1	0	4
Total	-	98	48	-

NR – Otholith not readable for aging
L – Slide broken, otholith lost

Table 4.4-1: Weekly Juvenile eel Collection by Week and Ranks, Conowingo Eel Collection Facility, 2017

	Wk 1	**Wk 2**	**Wk 3**	**Wk 4**	**Wk 5**	**Wk 6**	**Wk 7**	**Wk 8**	**Wk 9**	**Wk 10**
Total	4387	151	1224	5384	2196	1761	5199	23318	8090	799
Rank	8	17	15	6	11	12	7	2	5	16
Percent Catch	3.59	0.12	1.00	4.40	1.80	1.44	4.25	19.07	6.61	0.65
	Wk 11	**Wk 12**	**Wk 13**	**Wk 14**	**Wk 15**	**Wk 16**	**Wk 17**	**Wk 18**	**Wk 19**	**Wk 20**
Total	1503	1432	15435	32524	13130	2654	2931	88	51	43
Rank	13	14	3	1	4	10	9	18	19	20
Percent Catch	1.23	1.17	12.62	26.59	10.74	2.17	2.40	0.07	0.04	0.04

Top 3 ranked weeks are shown in boxes.

Wk 1: May 1 - May 6	Wk 11: July 9 - July 15
Wk 2: May 7 - May 13	Wk 12: July 16 - July 22
Wk 3: May 14 - May 20	Wk 13: July 23 - July 29
Wk 4: May 21 - May 27	Wk 14: July 30 - August 5
Wk 5: May 28 - June 3	Wk 15: August 6 - August 12
Wk 6: June 4 - June 10	Wk 16: August 13 - August 19
Wk 7: June 11 - June 17	Wk 17: August 20 - August 26
Wk 8: June 18 - June 24	Wk 18: August 27 - September 2
Wk 9: June 25 - July 1	Wk 19: September 3 - September 9
Wk 10: July 2 - July 8	Wk 20: September 10 - September 15

Table 4.5-1: USGS 01578310 - Conowingo Dam USGS Gage Station, 2017

Day	May	June	July	August	September
1	52400	48700	21400	32100	10400
2	49600	69800	19000	23300	6490
3	62200	66900	20900	26100	6130
4	79900	57400	17700	23500	12400
5	81400	48800	20000	25400	12200
6	89100	45500	23600	22300	13300
7	147000	41000	24500	38800	26900
8	**178000**	39400	33200	26600	19500
9	173000	51000	22800	26500	6020
10	128000	51000	31800	29300	6000
11	105000	52100	19000	15900	18000
12	83100	52300	15400	25900	9830
13	76500	42100	17900	21800	10600
14	60200	27200	20300	29700	11900
15	67300	21000	22700	21000	15200
16	60500	17200	34000	19900	--
17	53100	19800	35900	18900	--
18	55100	19100	44200	17100	--
19	41300	36700	47400	17800	--
20	37300	25800	44100	19100	--
21	32800	24500	38400	17100	--
22	40900	38300	23100	17100	--
23	31500	41900	16300	18200	--
24	25700	39500	53000	13400	--
25	28300	33100	67700	13000	--
26	28300	40000	96200	18400	--
27	21100	32500	71300	9940	--
28	29300	21600	66900	13700	--
29	37800	22700	49600	15400	--
30	40100	20800	41700	12400	--
31	42600	--	38300	14400	--

Bolded value represents the highest average river flow

*Daily average river flows are respresented in cubic feet per second (cfs)

Table 4.5-2: Fraction of Moon Illumination, 2017 EST (*1.0 equals full moon*)

Day	May	June	July	August	September
1	0.29	0.47	0.52	0.65	0.76
2	0.40	0.57	0.62	0.74	0.84
3	0.51	0.67	0.71	0.82	0.90
4	0.62	0.76	0.79	0.88	0.95
5	0.72	0.84	0.86	0.94	0.99
6	0.8	0.9	0.92	0.98	1.00
7	0.88	0.95	0.96	1.00	0.99
8	0.93	0.98	0.99	1.00	0.96
9	0.97	1.00	1.00	0.98	0.90
10	0.99	0.99	0.99	0.94	0.82
11	1.00	0.97	0.96	0.88	0.73
12	0.98	0.94	0.91	0.80	0.62
13	0.95	0.88	0.85	0.70	0.51
14	0.9	0.81	0.77	0.60	0.39
15	0.84	0.73	0.67	0.48	0.29
16	0.77	0.63	0.57	0.37	--
17	0.68	0.53	0.46	0.26	--
18	0.58	0.42	0.34	0.17	--
19	0.48	0.31	0.24	0.09	--
20	0.38	0.21	0.15	0.03	--
21	0.28	0.13	0.07	0.00	--
22	0.18	0.06	0.02	0.00	--
23	0.10	0.01	0.00	0.03	--
24	0.04	0.00	0.01	0.07	--
25	0.01	0.02	0.04	0.14	--
26	0.00	0.06	0.10	0.21	--
27	0.03	0.13	0.18	0.30	--
28	0.09	0.22	0.27	0.39	--
29	0.16	0.32	0.36	0.49	--
30	0.26	0.42	0.46	0.58	--
31	0.36	--	0.56	0.67	--

Table 4.5-3: Water Temperature (°C) Taken in Collection Tank, Conowingo Eel Collection Facility, 2017

Day	May	June	July	August	September
1	17.5	19.1	26.2	24.5	26.3
2	19.1	20.5	26.7	24.7	26.1
3	18.7	20.2	27.6	25.7	25.4
4	18.0	20.5	27.4	25.2	25.1
5	16.9	20.4	27.3	25.6	25.1
6	15.9	20.3	27.4	26.6	25.1
7	14.5	20.0	27.6	26.7	25.1
8	13.0	20.3	27.7	26.4	25.1
9	12.1	20.0	28.0	26.1	24.1
10	12.5	19.9	27.7	26.0	23.8
11	12.5	20.3	27.9	25.8	23.2
12	12.9	21.2	27.5	25.4	23.4
13	12.7	21.7	27.9	25.7	23.3
14	13.5	22.3	28.3	26.0	23.4
15	13.5	22.8	28.5	25.5	23.1
16	14.1	22.9	29.0	25.5	--
17	14.6	23.4	28.6	25.8	--
18	14.8	N/A	28.9	26.0	--
19	16.5	24.9	28.7	26.0	--
20	18.0	26.0	28.2	26.6	--
21	18.7	25.9	28.3	26.9	--
22	19.3	25.8	28.3	26.8	--
23	19.6	26.0	29.4	26.8	--
24	19.8	26.8	29.4	26.7	--
25	19.2	27.1	29.4	27.7	--
26	18.9	27.1	28.5	27.7	--
27	18.8	26.6	26.9	27.5	--
28	18.7	26.4	25.3	27.1	--
29	18.3	25.7	24.5	27.1	--
30	18.8	25.8	24.7	26.1	--
31	18.9	--	24.6	26.5	--

Table 4.5-4: Dissolved Oxygen (mg/L) Reading Taken in Collection Tank, Conowingo Eel Collection Facility, 2017

Day	May	June	July	August	September
1	9.68	8.30	5.50	8.70	7.95
2	8.92	9.00	12.25	8.18	9.41
3	8.75	8.57	7.63	8.19	8.40
4	9.20	8.14	6.80	7.18	9.44
5	9.10	7.92	5.57	6.18	7.64
6	9.02	7.97	6.94	7.44	8.27
7	9.51	7.50	6.39	6.49	8.61
8	10.36	7.71	5.97	5.75	10.03
9	10.70	8.25	5.46	7.80	8.10
10	10.50	8.10	5.82	8.05	10.59
11	10.39	8.08	6.09	7.68	8.65
12	10.20	7.81	6.55	7.92	8.82
13	10.16	7.64	9.30	6.56	9.70
14	10.05	6.50	8.01	7.80	9.18
15	10.00	6.66	6.67	7.10	7.94
16	10.40	5.95	8.96	7.38	--
17	10.31	8.00	13.20	7.68	--
18	10.08	N/A	8.60	7.30	--
19	10.40	6.73	9.50	7.25	--
20	10.10	6.51	7.31	9.94	--
21	9.71	5.97	14.50	8.66	--
22	9.20	13.02	16.90	10.51	--
23	8.49	10.38	12.20	11.12	--
24	8.20	5.55	8.17	11.40	--
25	8.03	7.27	9.04	6.86	--
26	8.40	6.63	10.36	7.12	--
27	8.50	7.38	8.91	7.13	--
28	8.56	6.38	8.93	7.61	--
29	8.26	6.87	11.42	10.10	--
30	8.32	5.85	7.62	9.69	--
31	8.60	--	8.54	6.30	--

N/A – Problems with the meter

Table 4.6-1: Eel Transport/Stocking Data, 2017

Location of stocking	Number of eels	Died (Mortality)			Removed for Analysis	Number Stocked
		Collection Tank	Holding Tank	Transported		
Octoraro Creek Collection tanks	11,347	6 (0.05%)				
Transported to Conowingo Eel Collection Facility	11,341			2 (0.02%)		11,339
Conowingo Collection tank	122,300	17 (0.01%)	***3,447 (2.58%)***		193	118,643
Total Transported from Conowingo Eel Collection Facility	129,982			80 (0.06%)		129,902
Stocked in Conewago Creek (Site B)*	16,520			18 (0.11%)		16,502
Stocking in Beaver Creek (Site C)**	9,739			1 (0.01%)		9,738
Stocked in Susquehanna River,	103,723			61 (0.06%)		103,662
Etter's Boat Ramp (Site 4)***						
TOTAL Transported	141,323			82 (0.06%)		141,241

Bolded value is assumed as worst case, could be eels from Octoraro or Conowingo

* Transported to Conewago Creek (Site B) (May 6 - June 16)

** Transported to Beaver Creek (Site C) (June 16 -20)

*** Transported to Susquehanna River, Etter's Boat Ramp (Site 4) (June 20 -September 15)

Some eels were counted twice if they were transport to and from the Conowingo Eel Collection Facility

Table 4.7-1: Detailed Individual Eel Transport Data, 2017

Transport to Conewago Creek (Site B)											
Date	Number of eels stocked	Holding Facility			Loaded for Transport			Prior to Unloading			Stocking site	
		Time	Temp	DO	Time	Temp	DO	Time	Temp	DO	Temp	DO
5/6	4,393	1120	15.0	9.4	1200	17.1	11.1	1450	16.6	8.5	14.6	8.7
5/12	147	920	14.4	9.2	930	14.2	8.9	1118	14.7	9.2	13.2	12.6
5/18	150	945	19.0	8.8	1000	19.0	8.6	1201	19.5	6.0	21.6	10.4
5/25	5,427	1045	18.1	8.2	1215	18.3	10.2	1326	19.9	8.3	16.7	9.0
6/2	2,956	1145	20.8	9.1	1215	22.3	9.7	1325	22.4	11.3	20.1	9.7
6/9	1,975	1100	19.6	8.3	1130	21.8	8.0	1345	21.9	15.7	20.1	12.4
6/16	1,454	1100	22.3	6.4	1130	24.6	17.1	1330	24.6	10.7	22.5	6.9
Total	16,502											

Stocked 378 juvenile eels in 2016 for a two-year total of 16,880 eels.

Transport to Beaver Creek (Site C)											
Date	Number of eels stocked	Holding Facility			Loaded for Transport			Prior to Unloading			Stocking site	
		Time	Temp	DO	Time	Temp	DO	Time	Temp	DO	Temp	DO
6/16	2,184	1100	23.2	6.4	1130	24.6	17.8	1423	24.5	8.3	22.9	10.2
6/20	7,554	930	25.4	6.0	1002	27.2	18.8	1149	27.4	22.5	24.3	9.7
Total	9,738											

Table 4.7-1: Detailed Individual Eel Transport Data, 2017 (Cont.)

Transport to Susquehanna River, Etter's Boat Launch (Site 4)												
Date	Number of eels stocked	Holding Facility			Loaded for Transport			Prior to Unloading			Stocking site	
		Time	Temp	DO	Time	Temp	DO	Time	Temp	DO	Temp	DO
6/20	3,224	929	26.0	6.5	934	27.3	20.2	1312	27.0	16.6	27.0	7.3
6/22	7,161	840	25.1	5.5	935	26.9	16.6	1105	27.0	12.2	25.5	8.4
6/26	10,463	915	27.3	6.8	1100	27.2	17.2	1225	27.2	12.9	25.0	8.4
6/30	6,029	930	26.1	6.0	1100	26.2	16.6	1230	26.6	14.1	27.1	9.7
7/5	590	950	27.3	6.5	1015	27.0	6.2	1245	27.2	13.3	28.0	9.0
7/10	895	1000	28.2	5.0	1015	28.5	9.2	1207	28.5	11.0	25.9	9.6
7/14	775	904	28.5	7.2	1028	28.0	7.7	1230	28.0	6.6	27.8	7.6
7/17	3,348	1116	29.1	6.6	1149	28.8	8.5	1325	29.2	6.6	27.2	11.7
7/21	4,842	910	28.7	7.2	1030	29.1	8.7	1215	29.3	9.1	29.9	11.3
7/26	3,111	855	28.5	7.1	941	28.5	20.0	1129	28.4	10.7	25.0	6.9
7/31	23,343	822	24.9	8.6	950	24.8	20.9	1130	24.9	12.0	23.4	9.3
8/4	18,721	900	25.0	6.2	1000	25.4	7.1	113	25.7	13.4	27.7	12.4
8/9	10,713	918	26.4	7.9	1045	26.2	16.6	1230	26.3	14.6	24.3	12.5
8/11	1,826	1241	26.5	8.4	1315	27.3	8.2	1532	27.4	12.9	24.9	12.3
8/14	1,900	840	25.9	10.0	951	26.1	15.6	1136	26.0	16.2	22.7	6.5
8/16	752	1300	28.0	9.1	1350	27.2	8.3	1500	26.7	10.0	24.5	14.7
8/18	439	1015	26.1	6.6	1040	26.5	15.3	1220	24.9	20.0	27.4	13.3
8/21	2,503	1220	27.2	5.8	1225	27.2	6.2	1456	27.3	12.3	26.7	13.2
8/23	1,907	1220	27.3	9.8	1240	25.3	6.5	1510	25.6	17.3	27.8	14.6
8/25	683	906	27.8	5.9	948	27.8	20.0	1125	27.5	14.1	26.4	13.2
8/29	177	1330	26.6	7.4	1349	26.1	12.6	1523	25.6	14.3	22.1	11.7
9/6	103	1100	25.1	7.9	1140	25.0	12.3	1448	24.0	10.4	20.7	8.9
9/12	125	1000	23.0	7.2	1015	23.0	8.9	1130	22.9	12.9	20.3	12.9
9/15	32	1000	23.4	6.4	1020	23.4	8.3	1200	24.9	8.0	24.0	18.3
Total	103,662											

Table 4.8-1: Operating Range of Specification, Conowingo Eel Collection Facility, 2017

	Main flow	Collection Tank	Holding tank
Flow (GMP)	5 - 150	5 - 25	5 - 40
Dissolved Oxygen (mg/L)	5 - 20	5 - 20	5 - 20
Temperature (°C)	10 - 32	10 - 32	10 - 32

Table 4.8-2 Calibration of Flows (Gallons per Minute), Conowingo Eel Collection Facility, 2017

	DATE									
	5/8	5/15	5/22	5/29	6/5	6/12	6/19	6/26	7/5	7/12
Collection Tank Fill	13.5	15.0	15.0	16.5	15.0	16.8	19.8	21.0	18.9	15.0
Collection Tank Drain	12.6	13.2	16.2	16.5	15.0	16.8	19.5	20.4	18.6	13.5
Holding Tank #1 Drain	15.6	11.4	13.8	13.8	12.6	13.8	18.0	15.9	13.8	16.2
Holding Tank #2 Drain	--	--	--	--	--	--	--	--	--	--
Holding Tank #3 Drain	--	--	--	--	--	--	--	--	--	--
Spray Bar	7.2	5.6	8.1	8.4	8.4	8.25	8.3	7.5	8.25	8.1
Scent line	1.5	2.2	1.6	1.5	1.3	1.4	1.7	2.0	1.5	2.0
Backside of Ramp	0.6	0.4	2.8	1.5	1.3	1.4	1.4	1.4	1.2	0.5
Top Attraction	6.6	5.2	5.3	6.9	7.1	6.85	6.85	6.1	7.05	7.6
Bottom of Ramp Attraction	28.2	24.6	30.0	30.3	27.6	30.6	37.5	36.3	32.4	29.7
Total Attraction	36.3	32.0	36.9	38.7	36.0	38.85	46.05	44.4	40.95	39.3
	DATE									
	7/19	7/27	8/2	8/9	8/16	8/23	8/31	9/7	9/13	--
Collection Tank Fill	15.3	15.6	20.4	19.5	22.2	18.0	18.0	18.0	16.5	--
Collection Tank Drain	15.0	16.5	22.2	19.2	21.0	18.0	17.7	18.0	15.9	--
Holding Tank #1 Drain	15.0	11.4	16.8	10.8		13.8	15.6	16.8	15.0	--
Holding Tank #2 Drain	--	12.0	14.4	13.5	9.6	--	--	--	--	--
Holding Tank #3 Drain	--	--	--	--	--	--	--	--	--	--
Spray Bar	8.25	7.8	7.95	7.8	8.4	8.1	8.0	8.1	8.1	--
Scent line	1.5	1.55	2.0	2.65	2.4	2.65	1.65	1.65	1.55	--
Backside of Ramp	1.2	2.45	3.8	2.35	1.2	2.65	1.35	1.65	0.95	--
Top Attraction	7.05	5.35	4.15	5.45	7.2	5.45	6.65	6.45	7.15	--
Bottom of Ramp Attraction	30.0	39.9	53.4	43.5	30.6	31.8	33.3	34.8	30.9	--
Total Attraction	38.55	46.8	59.55	51.6	40.2	39.9	41.6	42.9	39.60	--

Table 4.8-3: Quality Control Checks on Counts, Conowingo Eel Collection Facility, 2017

Date	Number of eels in:		Displacement of Water	Volumetric Estimate	Actual Counts	Difference
	200 mL	1 L				
5/5/2017	74	370	0.8	428	462	34
6/16/2017 *	73	365	2.6	1136	1186	50
8/10/2017	88	440	2.4	1183	1110	-73
8/13/2017	77	385	1.4	616	571	-45
Total				3363	3329	-34
						-1.0%

* One dead eel in collection tank.

All estimated eel days have extra eels that were anesthetized and counted

Figure 2.0-1: Location of the Conowingo Eel Collection Facility at Conowingo Dam, 2017

Figure 2.0-2: Location of the Conowingo Eel Collection Facility Just Downstream of the West Fish Lift, Conowingo, MD, 2017

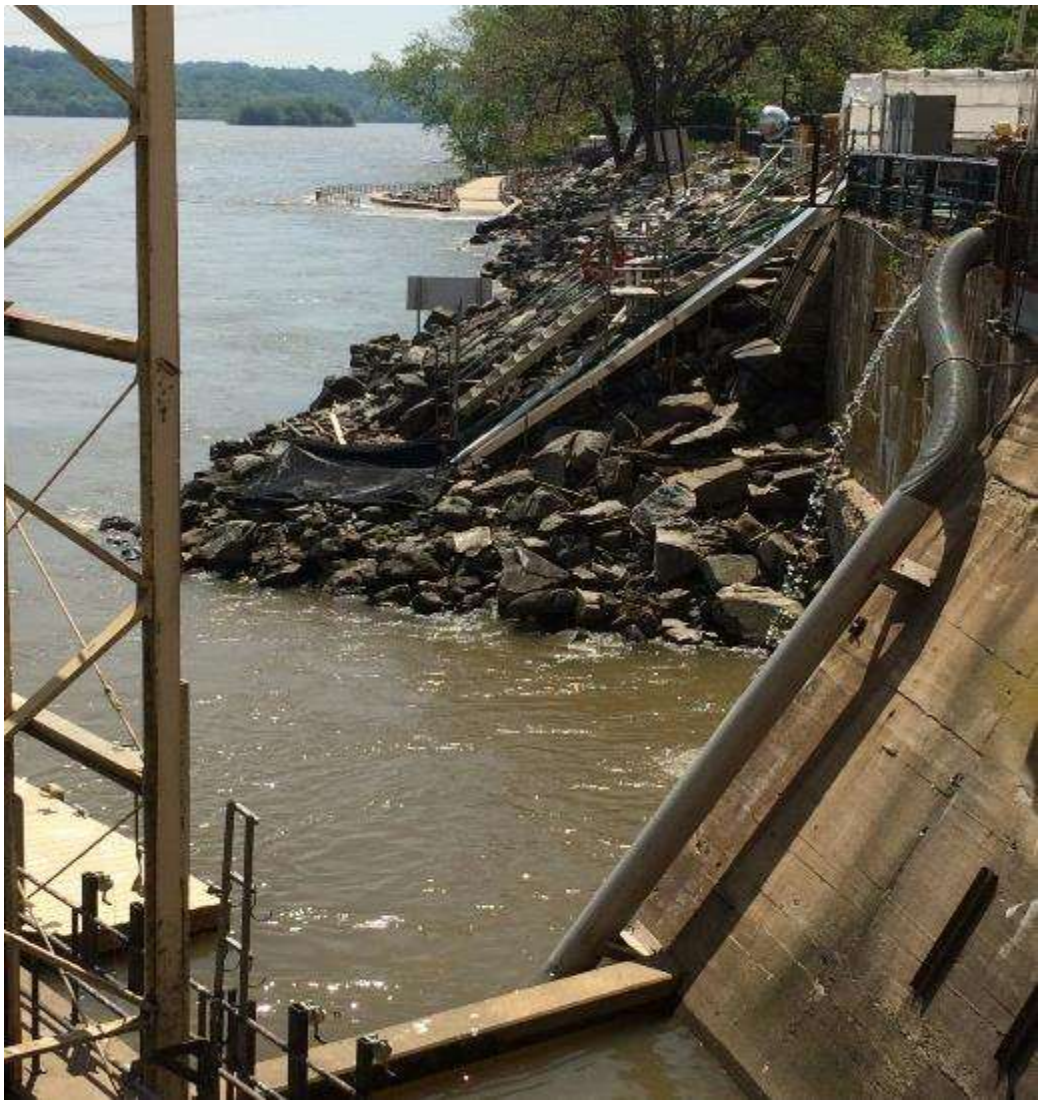


Figure 2.0-3: USFWS Weekly Catch of Juvenile American Eel at Conowingo, 2008-2016

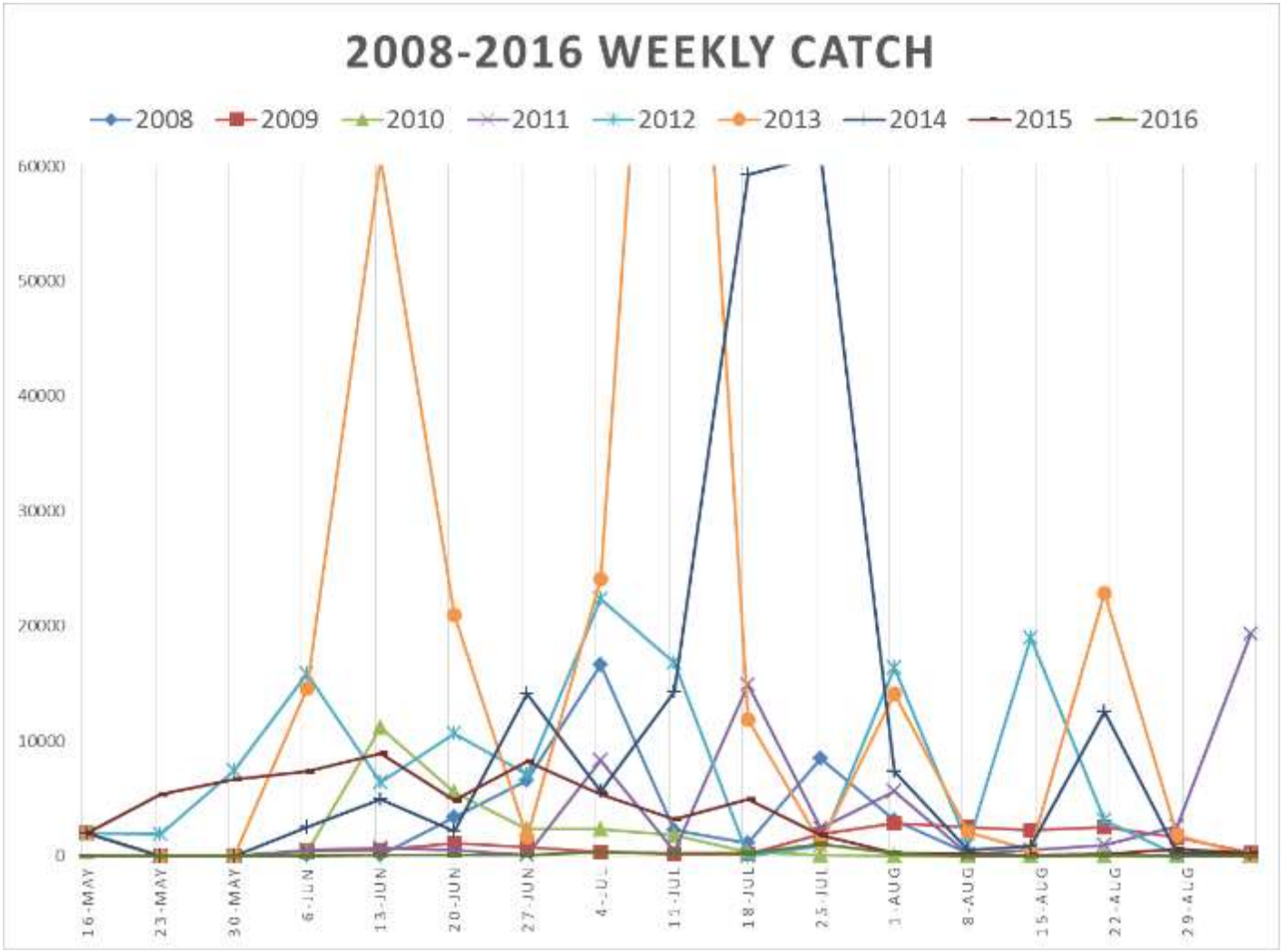


Figure 3.1-1: Gravity Feed Water Line for Conowingo Eel Collection Facility, Conowingo Dam, 2017

Figure 3.1-2: Attraction flow from Spray Bar, Conowingo Dam, 2017

Figure 3.1-3: Scent Line from Collection Tank Gravity Feed to Ramp, 2017

Figure 3.1-4: Control Panel for Read-outs, Conowingo Eel Collection Facility, 2017

Figure 3.1-5: Air Blower Oxygen Manifold for the Conowingo Eel Collection Facility, 2017

Figure 3.1-6: Air and Oxygen Diffusers for the Conowingo Eel Collection Facility Tanks, 2017

Figure 3.1-7: Juvenile Eel Ramp and Substrate (Enkamat) at the Conowingo Eel Collection Facility, 2017

Figure 3.1-8: Cover Over Eel Ramp and Rip-Rap to Protect Eels, Conowingo Eel Collection Facility, 2017

Figure 3.1-9: Collection Tank at Conowingo Eel Collection Facility, 2017

Figure 3.1-10: Screen Drain in Collection Tank, Conowingo Eel Collection Facility, 2017

Figure 3.1-11: Holding Tank at Conowingo Eel Collection Facility, 2017

Figure 3.1-12: Screened Drain for Holding Tanks, Conowingo Eel Collection Facility, 2017

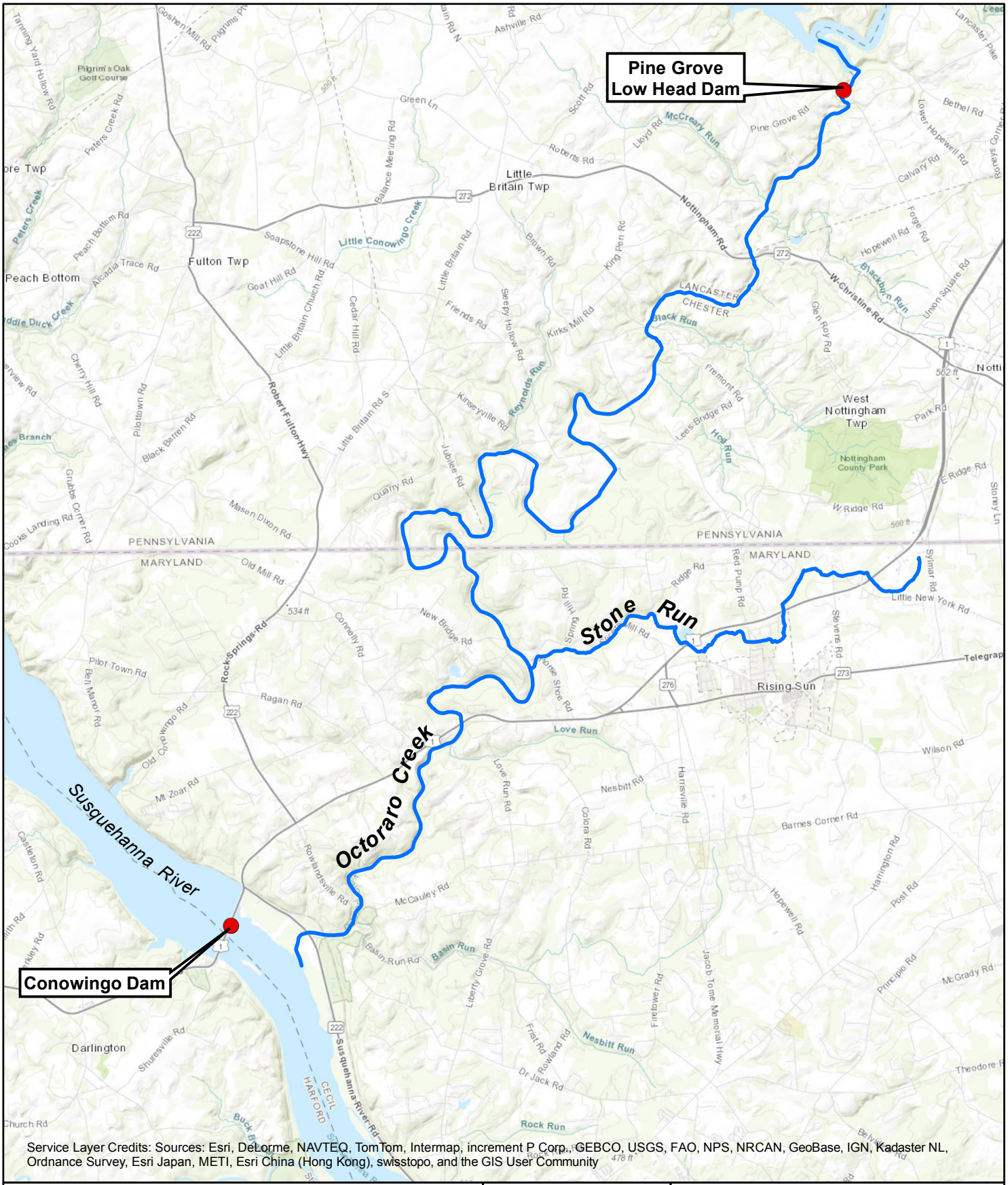
Figure 3.1-13: Over Flow Tank, Conowingo Eel Collection Facility, 2017

Figure 3.2-1: Graduated 1000 mL Container for Volumetric Estimates of Eels

Figure 3.2-2: Graduated 19-Liter Bucket for Bulk Volumetric Estimates of Eels

Figure 3.2-3: Measuring Juvenile Eels to Nearest Millimeter While Sedated, Conowingo Eel Collection Facility, 2017

Figure 3.2-4: Weighing Juvenile Eels to Nearest Half Gram While Sedated, Conowingo Eel Collection Facility, 2017



Service Layer Credits: Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

N

Muddy Run Pumped Storage Project
FERC Project Number 2355

0 0.5 1 2 Miles

NORMANDEAU ASSOCIATES
Environmental Consultants

Figure 3.3-1:
Sample Location (Stone Run) of American Eel collected for wild health screening, Conowingo Eel Collection Facility, 2017.

Date: 1/5/2018	Revised:

1921 River Road Drumore, PA 17518

PREPARED FOR: MM PROJECT: 23987.000 PREPARED BY: SAS

Path: C:\Projects\Conowingo_EelStudy_23987\MXD\Conowingo_OctoraroCr_topo_010518.mxd

Figure 3.3-2: Stone Run, a Tributary of Octoraro Creek (Looking Downstream from Horseshoe Road to confluence of Octoraro Creek) for the Wild Health Screening, Conowingo Dam, 2017

Figure 3.3-3: Stone Run, a Tributary of Octoraro Creek (Looking Upstream from Horseshoe Road) for the Wild Health Screening, Conowingo Dam, 2017

Figure 3.3-4: Small Eel Transport Tank, Conowingo Eel Collection Facility, 2017

Figure 3.3-5: Large Eel Transport Tank, Conowingo Eel Collection Facility, 2017

Figure 4.1-1: Daily Eel Catch, Conowingo Eel Collection Facility, 2017

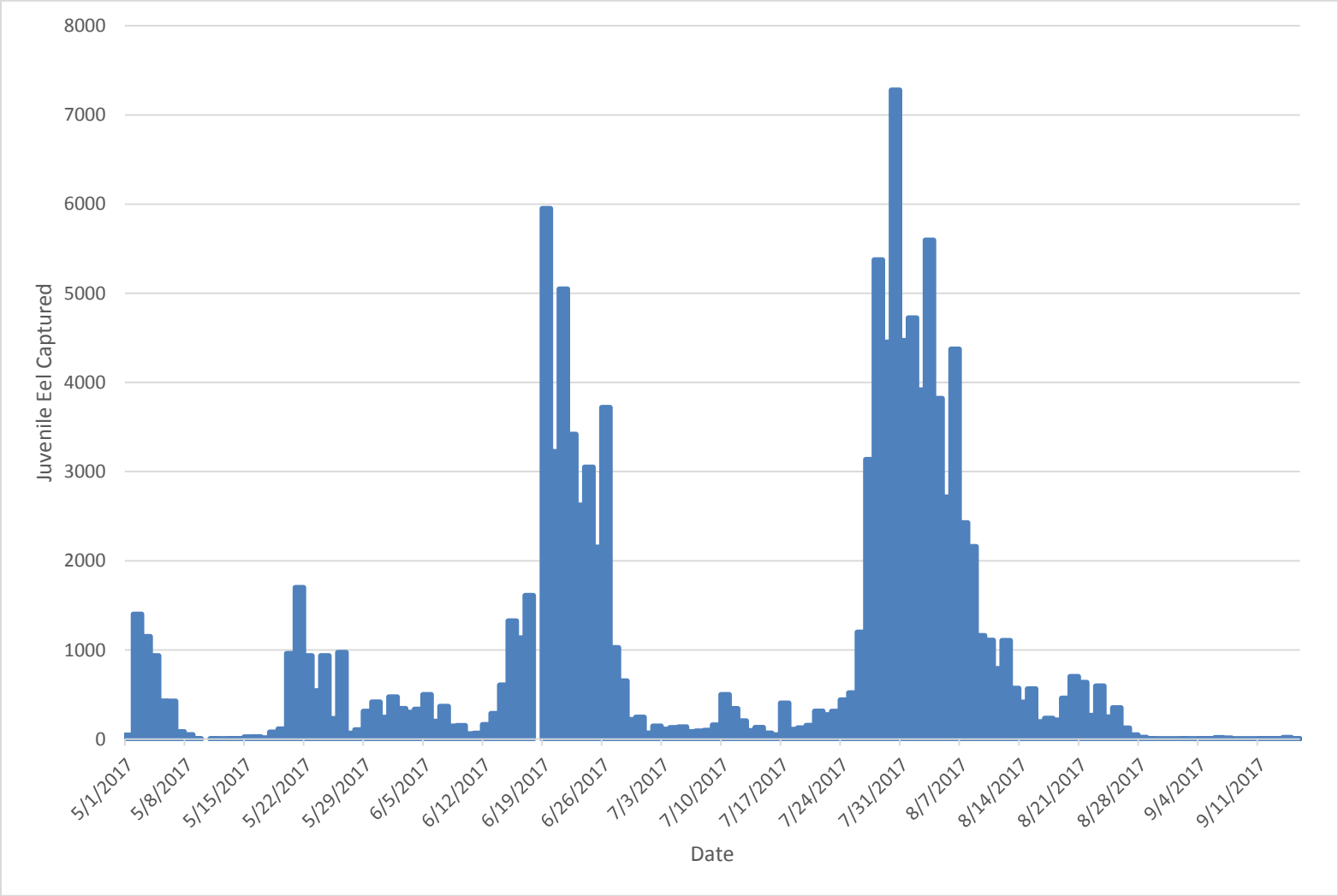


Figure 4.3-1: Examining Sacrificed Juvenile Eels for Swim Bladder Parasite, 2017

Figure 4.3-2: Swim Bladder Parasite Dissection, Conowingo Eel Collection Facility, 2017

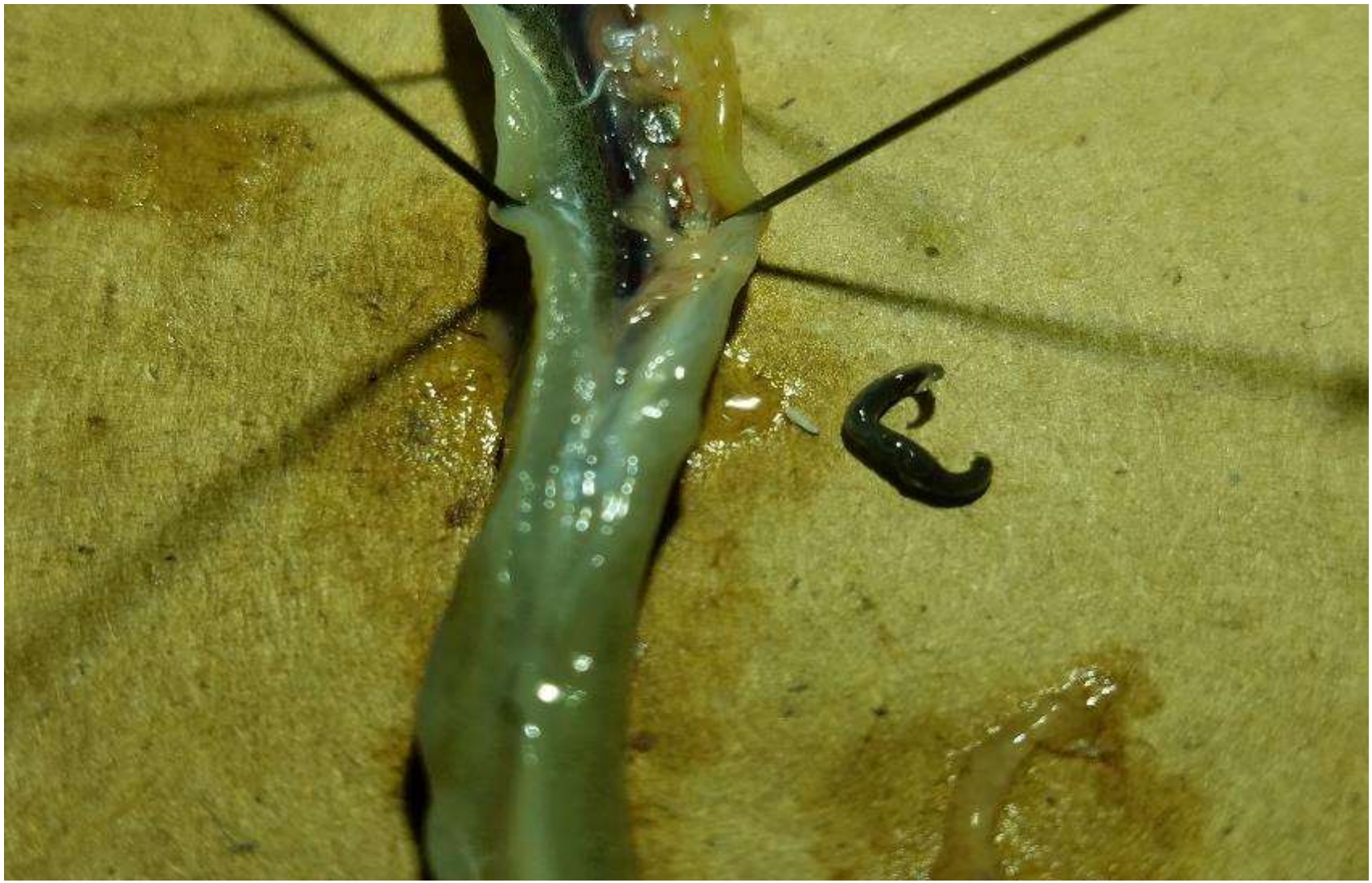


Figure 4.4-1: Percentage of Eels Collected per Week, Conowingo Eel Collection Facility, 2017

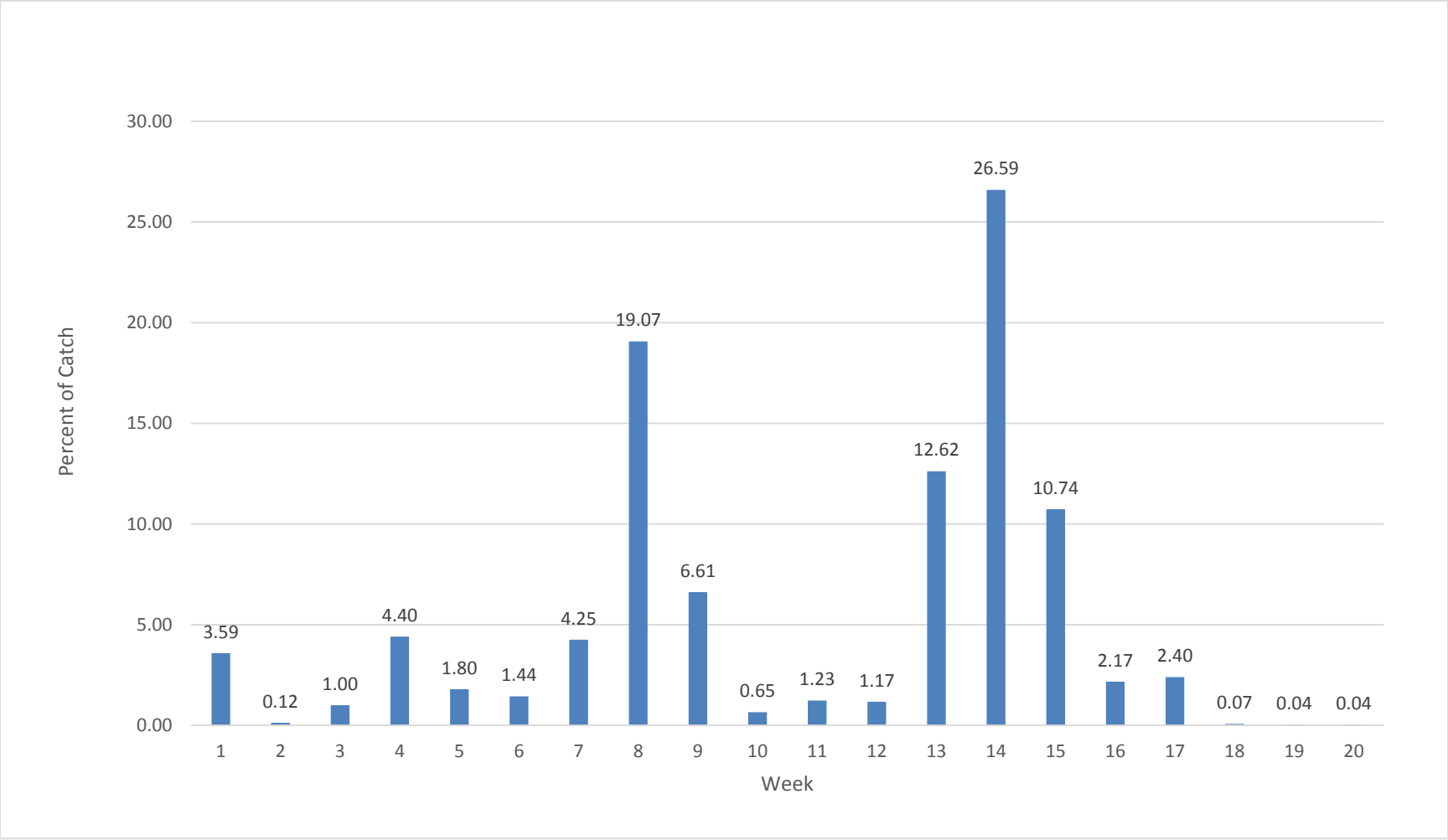


Figure 4.5-1: Eel Catch to River Flow (Daily above, Weekly Average below), Conowingo Eel Collection Facility, 2017

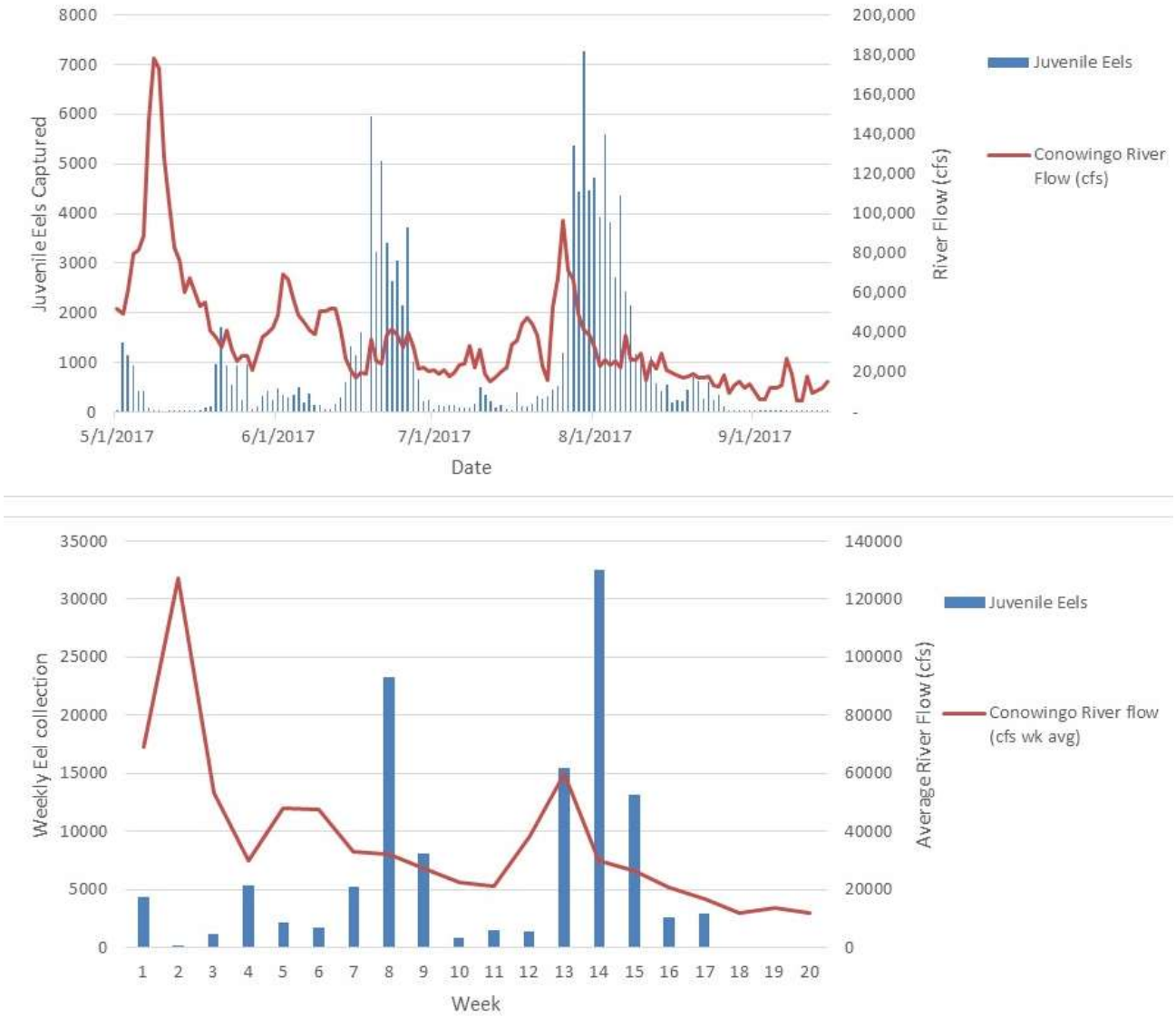


Figure 4.5-2: Eel Catch to Lunar Fraction (Daily above, Weekly Average below), Conowingo Eel Collection Facility, 2017 (*1.0 Equals Full Moon)*

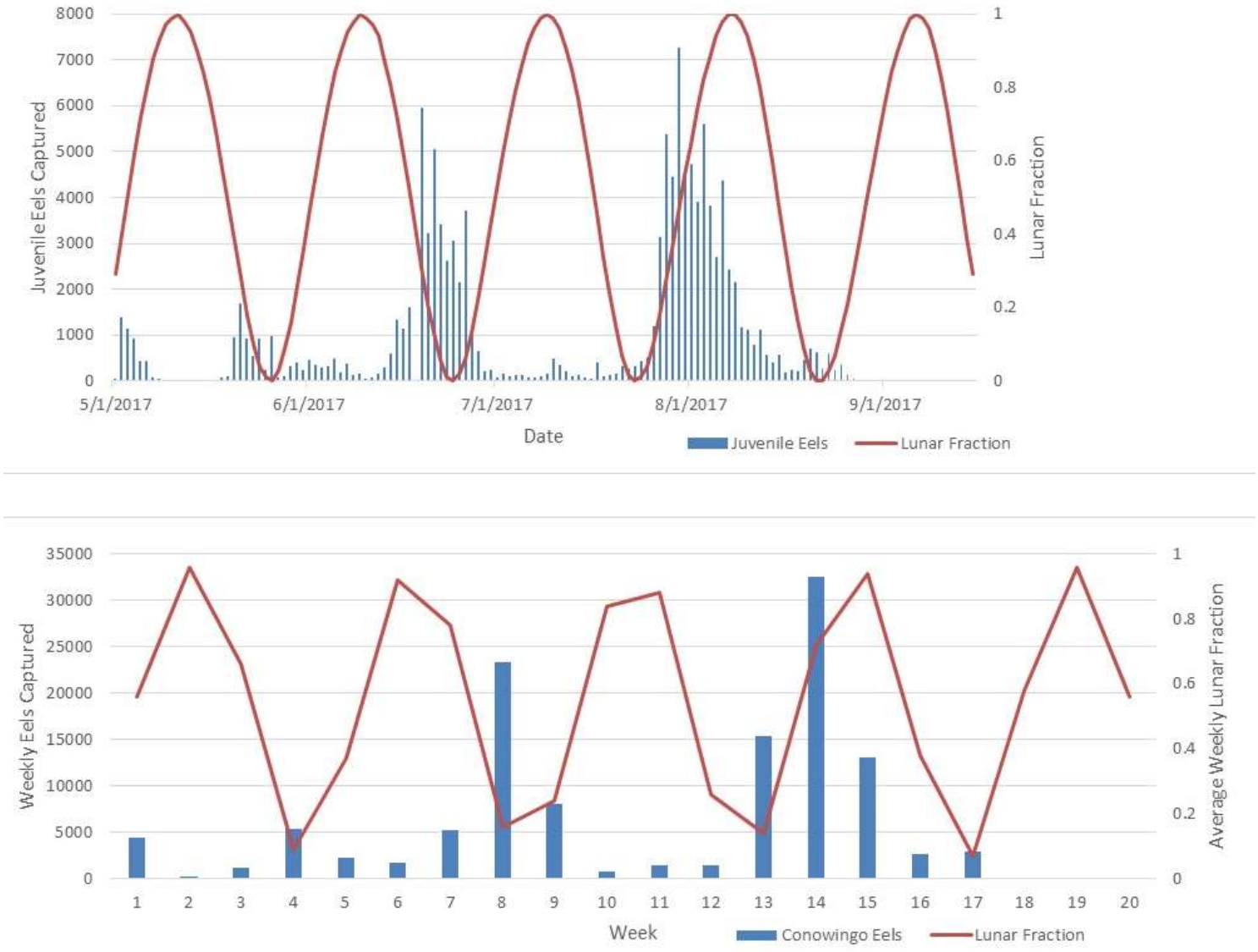


Figure 4.5-3: Eel Catch to Water Temperature, Conowingo Eel Collection Facility, 2017

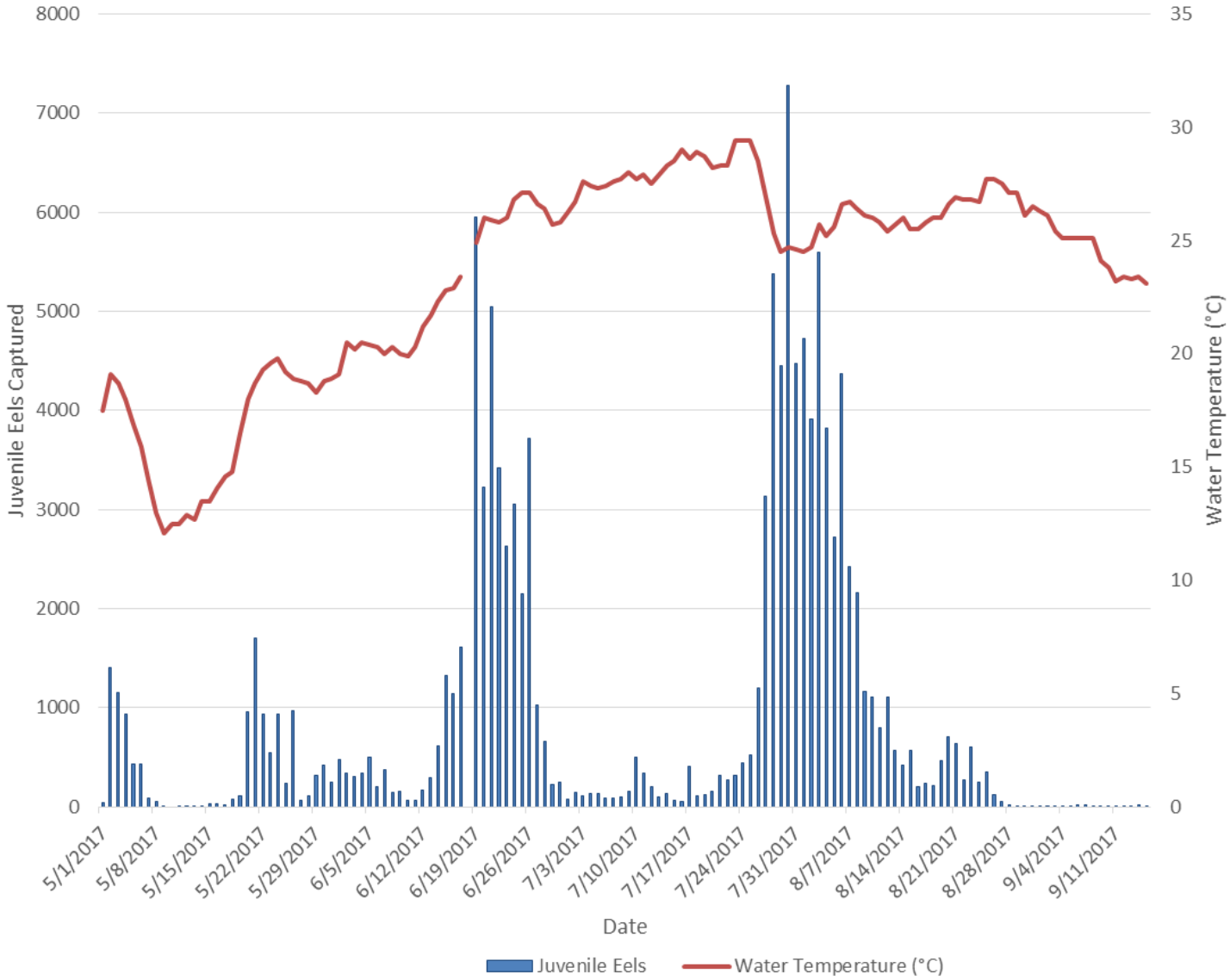
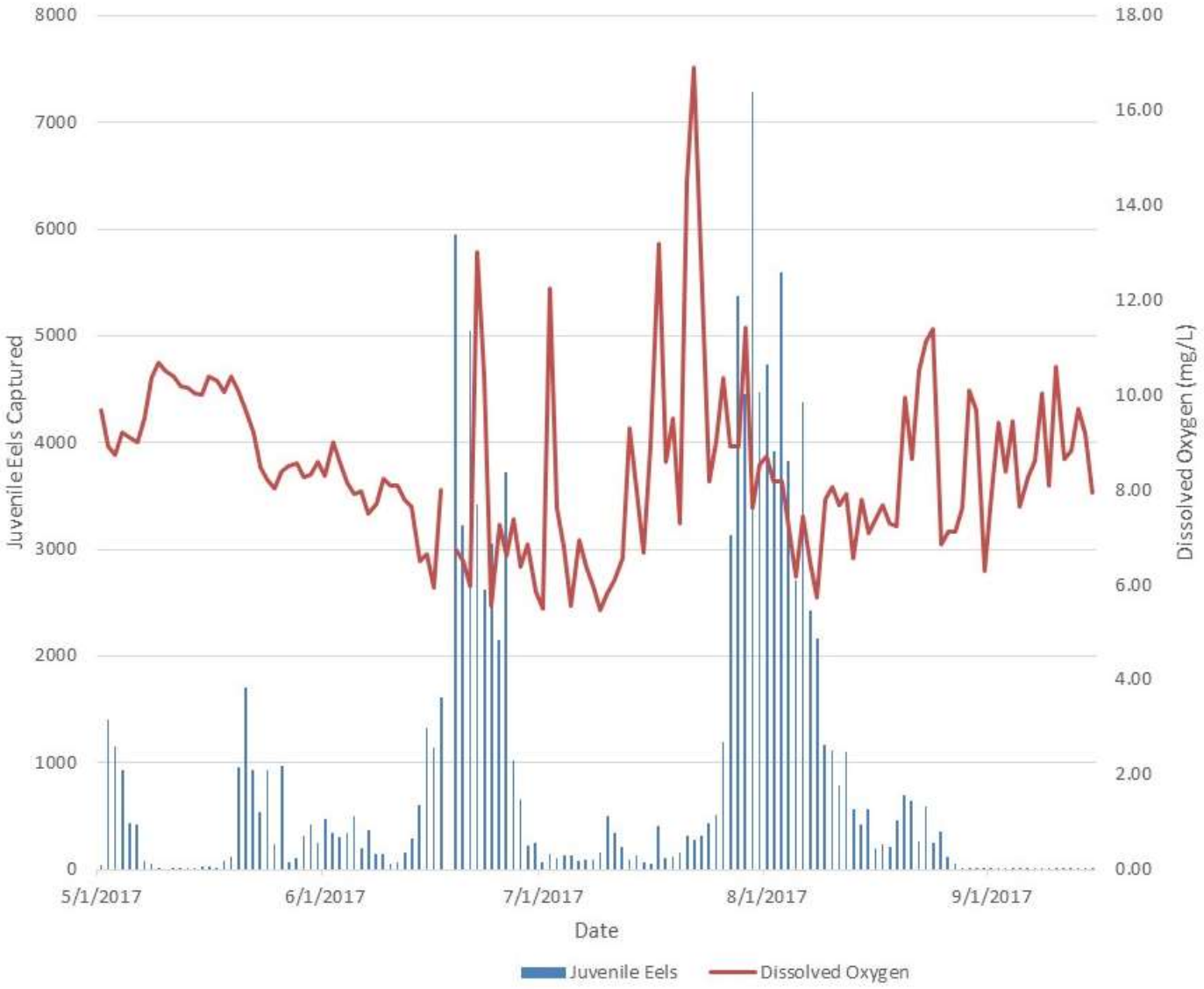
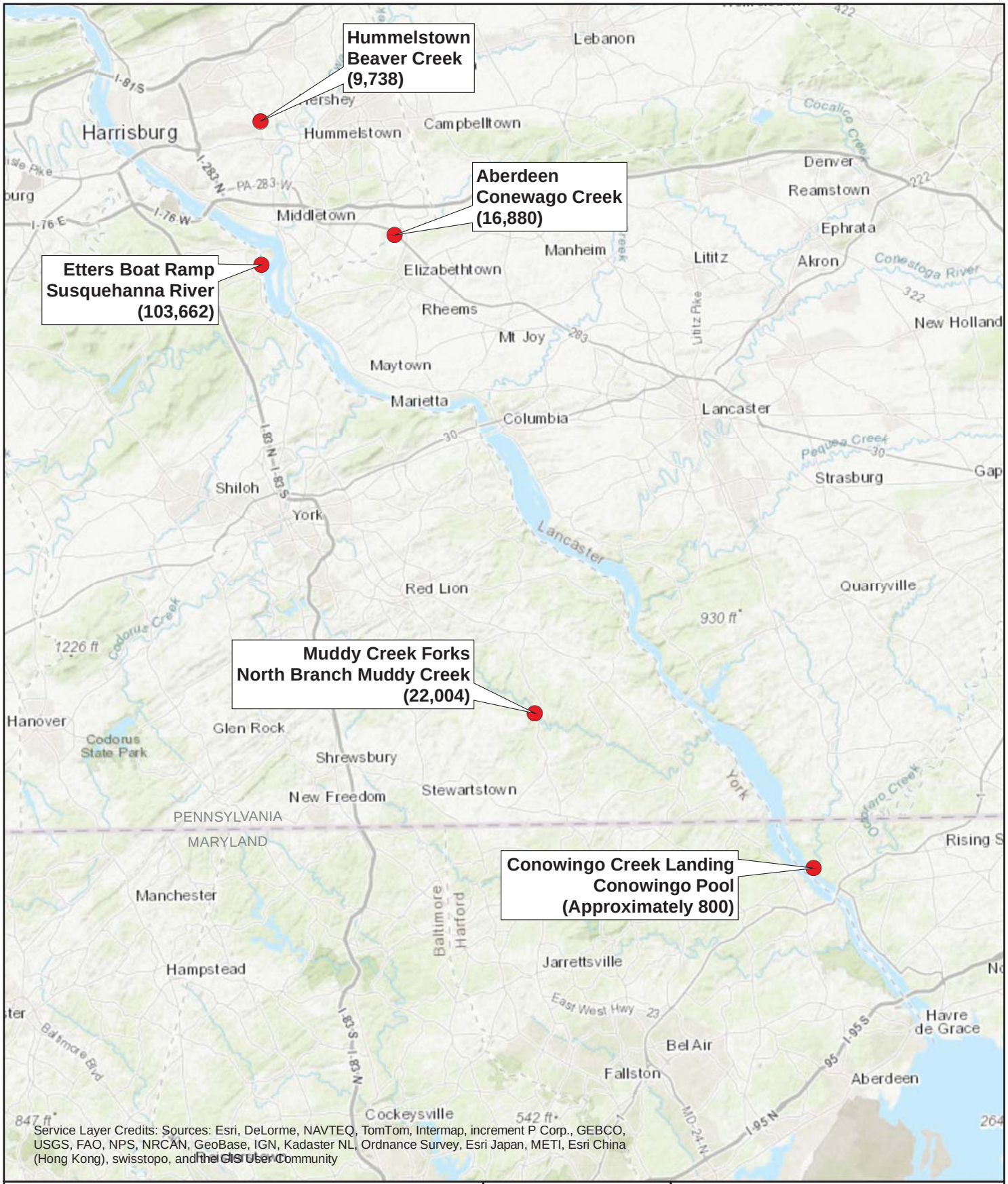


Figure 4.5-4: Eel Catch to Dissolved Oxygen, Conowingo Eel Collection Facility, 2017





N

Muddy Run Pumped Storage Project
FERC Project Number 2355

0 2.5 5 10 Miles

NORMANDEAU ASSOCIATES
Environmental Consultants

Figure 4.7-1:
Normandeau
Eel Stocking Sites 2016-2017.

Date:	Revised:
1/5/2018	

1921 River Road P.O. Box 10 Drumore, PA 17518

PREPARED FOR: DDR PROJECT: 23987.000 PREPARED BY: SAS

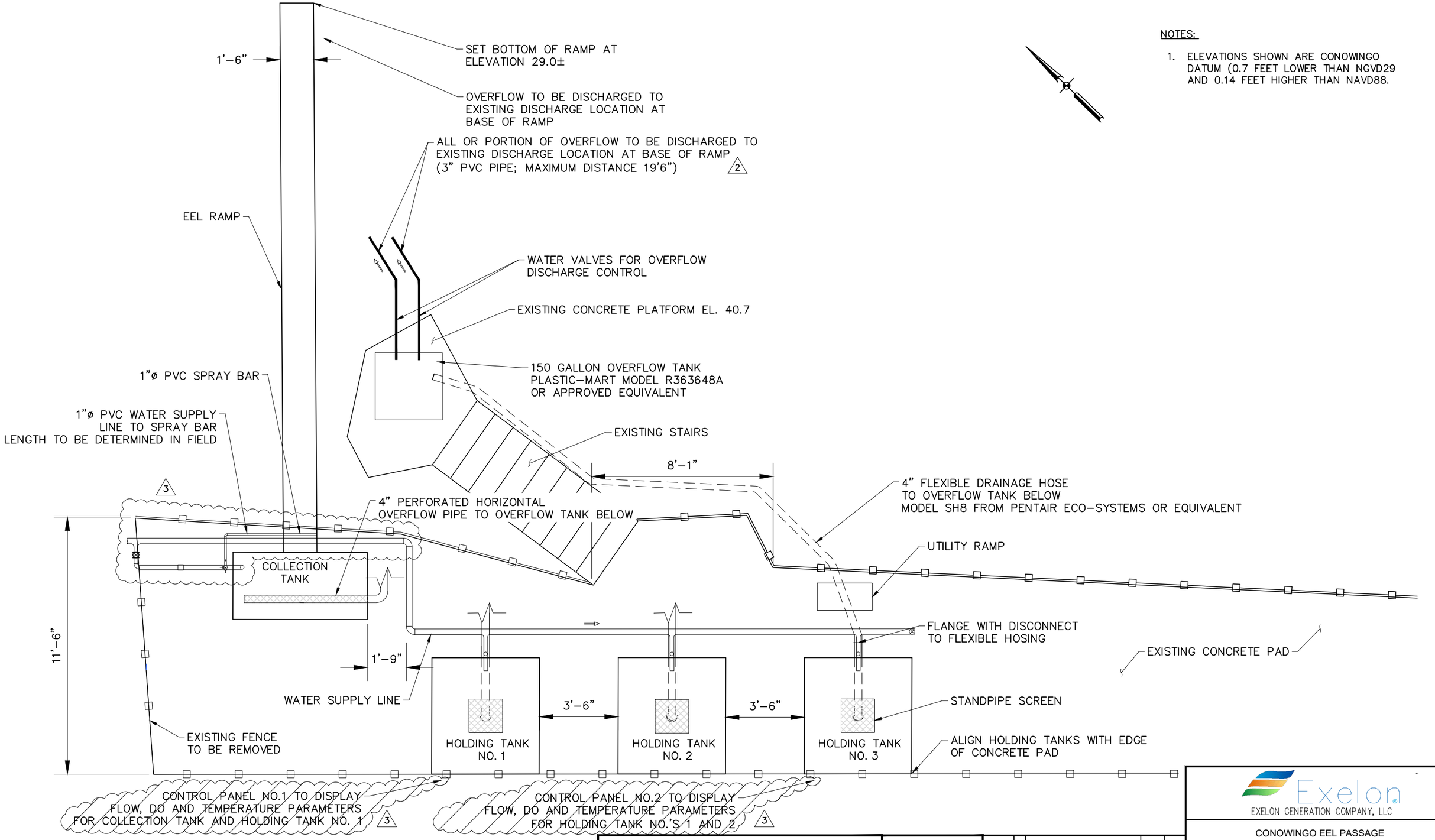
Path: C:\Projects\Conowingo_EelStudy_23987\MXD\EelStocking_Sites_010518.mxd

Figure 4.7-2: Conewago Creek (Site B) Stocking Site, 2017

Figure 4.7-3: Beaver Creek (Site C) Stocking Site, 2017

Figure 4.7-4: Susquehanna River at Etters Boat Launch (Site 4) Stocking Site, 2017

APPENDIX A:
CONCEPTUAL DESIGN OF CONOWINGO EEL COLLECTION FACILITY, 2017



NOTES:

1. ELEVATIONS SHOWN ARE CONOWINGO DATUM (0.7 FEET LOWER THAN NGVD29 AND 0.14 FEET HIGHER THAN NAVD88.

2' 0 2' 4'

SCALE: 1/2" = 1'–0"

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.

LICENSE NO.:	50486	SIGNATURE:
EXPIRATION DATE:	1-22-19	

DATE	#		BY	APP
2/28/17	3	REVISE PIPE LAYOUT	MES	DAG
2/22/17	2	DRAWING CLARIFICATIONS	MES	DAG
2/17/17	1	ISSUED FOR CONSTRUCTION	ALR	DAG

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG

GSE PROJECT NO.: 1714 DATE: 2/17/2017

Exelon

EXELON GENERATION COMPANY, LLC

CONOWINGO EEL PASSAGE

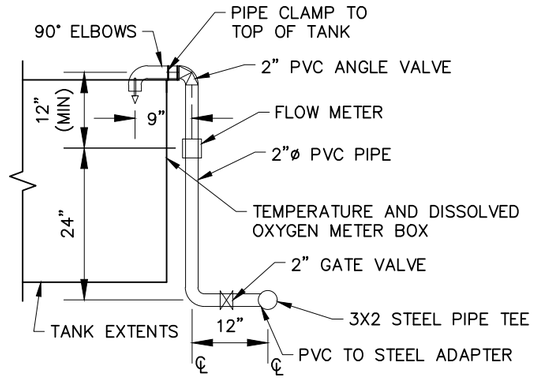
GOMEZ AND SULLIVAN ENGINEERS

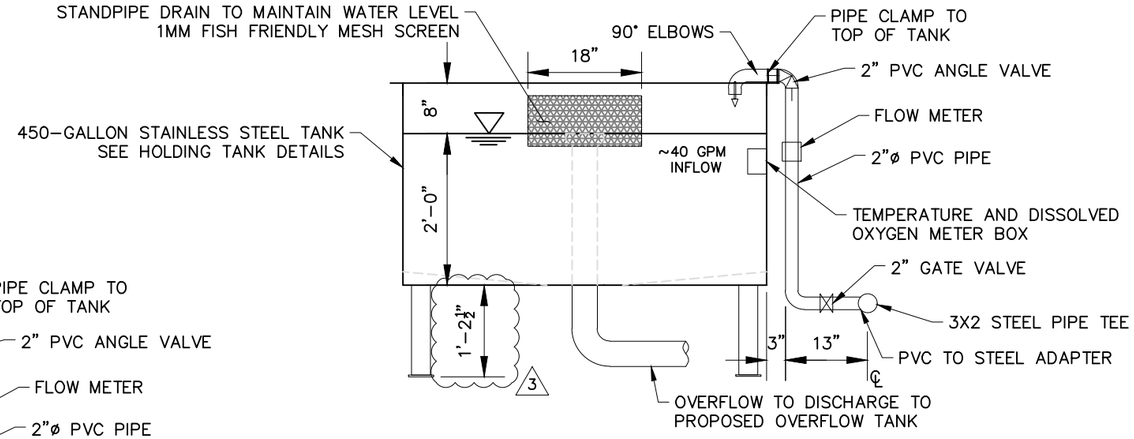
Williamsville, NY • Utica, NY • Albany, NY • Henniker, NH
www.gomezandsullivan.com

EEL FACILITY PLAN LAYOUT

SCALE: AS NOTED DRAWING NO.: 13

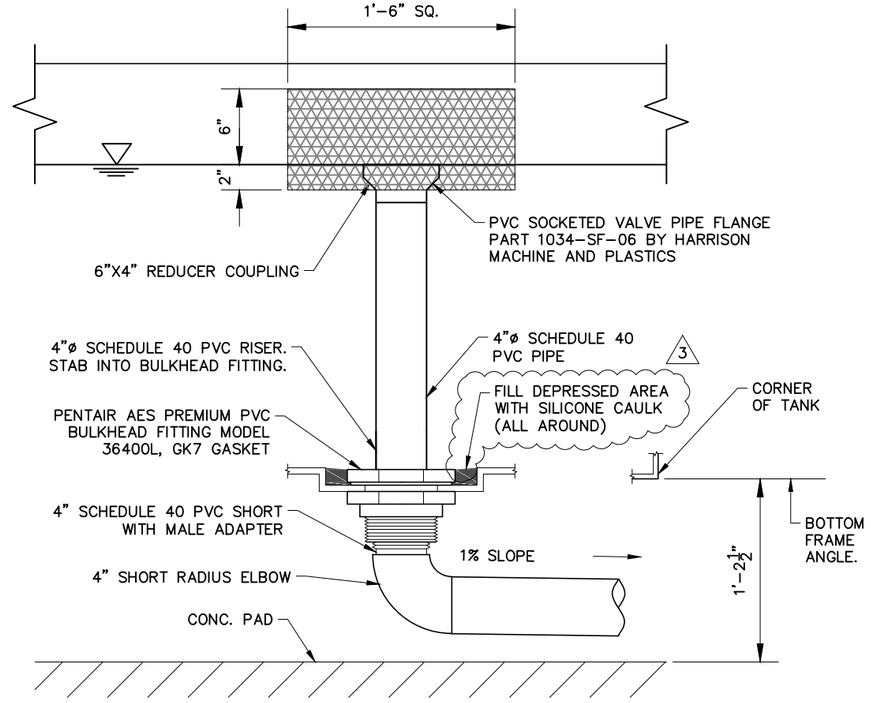
Appendix A - Figure 1: Plan View Layout of Conowingo Eel Passage Facility



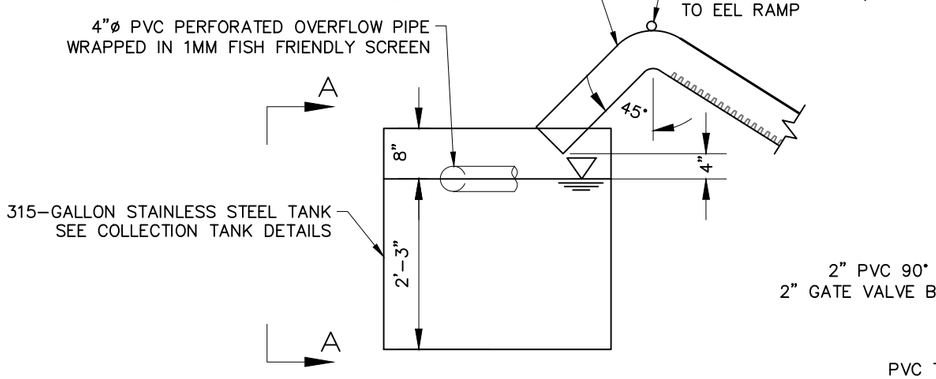


1/14 SECTION OF HOLDING TANK
1" = 1'-0" (APPROXIMATE TANK SIZE 5'6"X5'6"X2'8" TALL)

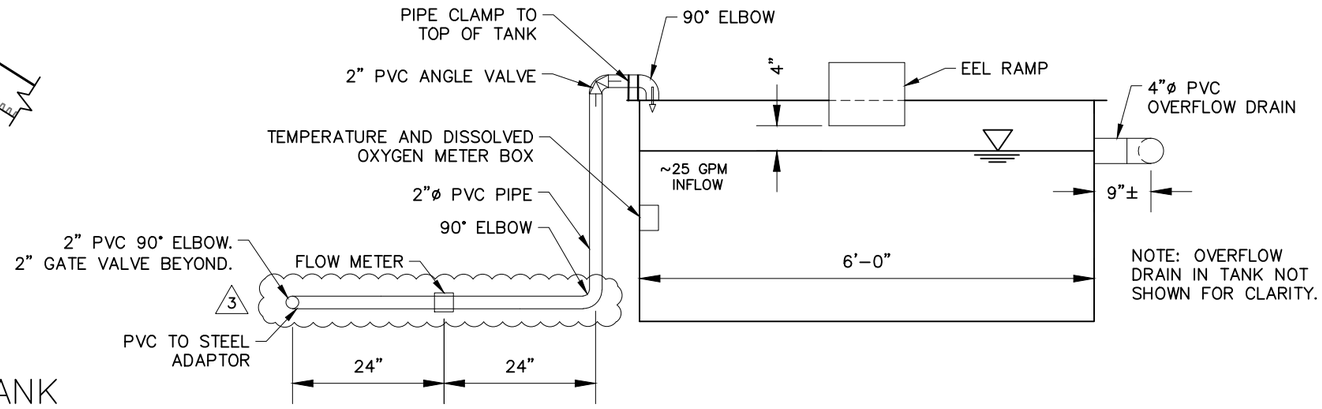
1 TYPICAL RISER DETAIL – HOLDING TANK
Scale: 1" = 1'-0"



2 STANDPIPE DETAIL – HOLDING TANK
Scale: 1" = 1'-0"



2/14 SECTION OF COLLECTION TANK
1" = 1'-0" (APPROXIMATE TANK SIZE 6'X3'4"X3'1" TALL)



A/14 ELEVATION OF COLLECTION TANK
1" = 1'-0"

NOTES

1. ELEVATIONS SHOWN ARE CONOWINGO DATUM (0.7 FEET LOWER THAN NAGVD 29 AND 0.14 FEET HIGHER THAN NAVD88).

1' 0 1' 2'
SCALE: 1" = 1'-0"

Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland.

LICENSE NO.:	50486	SIGNATURE:
EXPIRATION DATE:	1-22-19	

DATE	#		BY	APP
2/28/17	3	DRAWING AND PIPE REVISIONS	MES	DAG
2/17/17	1	ISSUED FOR CONSTRUCTION	ALR	DAG

DRAWN BY: ALR CHECKED BY: HNN APPROVED BY: DAG
GSE PROJECT NO.: 1714 DATE: 2/17/2017

Exelon
EXELON GENERATION COMPANY, LLC

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SCALE: TYPICAL TANK SECTIONS

AS NOTED | DRAWING NO.: 14

APPENDIX B:
METHOD OF AGING EEL OTOLITH AND RAW DATA, CONOWINGO EEL COLLECTION FACILITY, 2017

METHOD OF AGING

A representative sample of juvenile eels were frozen for future age determination. Aging of the preserved individuals was conducted using otolith microstructure analysis and followed established techniques for the species presented in the Proceedings of the Workshop on Aging and Sexing American Eel (ASMFC 2001). To remove the sagittal otoliths from an individual eel, a transverse cut was made through the cranium. When positioned correctly, the cut exposed the posterior part of the brain and the two cavities of the inner ear were visible on either side of the rachidian bulb. The otolith bones were then carefully removed from the inner ear cavities with a pair of tweezers, cleaned, and placed in a clean, dry, labeled glass vial. Each otolith sample was allowed to dry for a minimum of 12 hours prior to proceeding to the next step.

At the conclusion of the drying time, each otolith was embedded in a clear epoxy (e.g., 2-part West System epoxy resin) poured into a small mold and allowed adequate time to fully cure. Utilizing a double-bladed, slow speed saw, a 0.2-mm thick transverse section was cut through the nucleus perpendicular to the sulcus. The otolith section was then bonded to a glass slide using CrystalBond. Each mounted otolith sample was polished using a series of fine grade lapping films (12, 9 and 3 micron) and the sample was periodically inspected to insure no damage to the otolith section. Following polishing, the mounted sections were etched in a 5% solution of EDTA for 3-5 minutes, rinsed and then stained in a bath of toluidine blue for approximately 5 minutes to enhance visibility of each annulus.

After removal of the slide and otolith section from the staining bath, the sample was rinsed with distilled water and then ready for age determination. Sectioned otoliths were observed under a dissecting microscope using both reflected and transmitted light and an external fiberoptic light source. Each otolith sample was examined by two readers and the number of distinct annuli was determined. Following independent age determinations for each sample by both readers, the list of age estimates were compared. If the two readers agreed on the analysis, the age estimate was accepted. If readers of the slides weren't in agreement on an age, that slide was re-analyzed. If no consensus was met, the otolith was rejected. The age reported herein is the freshwater age (*i.e.,* the numbers of annuli outside the transition mark - the end of larval growth in salt water).

ASMFC (Atlantic States Marine Fisheries Commission). 2001. Proceedings of the Workshop on Aging and Sexing American Eel. ASMFC Special Report No. 72. Washington, D.C. 25 p.

Individual Eel Data, 2017

Date	Batch Number	Collection Number	Number of Eels	Within Batch ID	Total Length (mm)	Age 1 - CAF*	Age 2- ERS*	Age consensus
5/1/2017	1	MDM17001	5	1	83	1	1	1
5/1/2017	1	MDM17001	5	2	115	3	2	2
5/1/2017	1	MDM17001	5	3	104	2	2	2
5/1/2017	1	MDM17001	5	4	115	2	2	2
5/1/2017	1	MDM17001	5	5	126	2	2	2
5/4/2017	2	MDM17007	5	1	93	2	2	2
5/4/2017	2	MDM17007	5	2	104	2	2	2
5/4/2017	2	MDM17007	5	3	120	2	2	2
5/4/2017	2	MDM17007	5	4	113	2	2	2
5/4/2017	2	MDM17007	5	5	137	NR	NR	NR
5/8/2017	3	MDM17020	5	1	106	2	2	2
5/8/2017	3	MDM17020	5	2	102	NR	NR	NR
5/8/2017	3	MDM17020	5	3	120	2	2	2
5/8/2017	3	MDM17020	5	4	135	3	3	3
5/8/2017	3	MDM17020	5	5	126	2	2	2
5/13/2017	4	MDM17025	2	1	119	2	2	2
5/13/2017	4	MDM17025	2	2	111	1	1	1
5/15/2017	5	MDM17027	6	1	102	2	2	2
5/15/2017	5	MDM17027	6	2	116	2	2	2
5/15/2017	5	MDM17027	6	3	122	3	2	2
5/15/2017	5	MDM17027	6	4	146	3	3	3
5/15/2017	5	MDM17027	6	5	129	2	2	2
5/15/2017	5	MDM17027	6	6	136	3	3	3
5/29/2017	9	MDM17044	6	1	87	1	1	1
5/29/2017	9	MDM17044	6	2	97	2	2	2
5/29/2017	9	MDM17044	6	3	109	2	2	2
5/29/2017	9	MDM17044	6	4	118	2	2	2
5/29/2017	9	MDM17044	6	5	126	2	2	2
5/29/2017	9	MDM17044	6	6[1]	143	3	3	3
6/1/2017	10	MDM17047	5	1	87	2	2	2
6/1/2017	10	MDM17047	5	2	122	2	2	2
6/1/2017	10	MDM17047	5	3	128	2	2	2
6/1/2017	10	MDM17047	5	4	147	3	3	3
6/1/2017	10	MDM17047	5	5	141	3	2	3
6/12/2017	13	MDM17058	5	1	93	NR	NR	NR
6/12/2017	13	MDM17058	5	2	117	2	2	2
6/12/2017	13	MDM17058	5	3	173	3	3	3
6/12/2017	13	MDM17058	5	4	151	3	2	3
6/12/2017	13	MDM17058	5	5	151	3	3	3
6/22/2017	16	MDM17067	5	1	92	1	1	1
6/22/2017	16	MDM17067	5	2[1]	109	3	3	3
6/22/2017	16	MDM17067	5	3	128	2	4	2
6/22/2017	16	MDM17067	5	4	138	3	4	4

Date	Batch Number	Collection Number	Number of Eels	Within Batch ID	Total Length (mm)	Age 1 - CAF*	Age 2- ERS*	Age consensus
6/22/2017	16	MDM17067	5	5	115	2	3	3
7/3/2017	19	MDM17078	2	1	83	1	1	1
7/3/2017	19	MDM17078	2	2	154	3	3	3
7/10/2017	21	MDM17085	5	1	96	2	2	2
7/10/2017	21	MDM17085	5	2	93	1	1	1
7/10/2017	21	MDM17085	5	3	110	2	3	2
7/10/2017	21	MDM17085	5	4	113	2	2	2
7/10/2017	21	MDM17085	5	5	131	2	2	2
7/20/2017	24	MDM17095	5	1	74	1	1	1
7/20/2017	24	MDM17095	5	2	89	NR	NR	NR
7/20/2017	24	MDM17095	5	3	97	2	2	2
7/20/2017	24	MDM17095	5	4	103	1	1	1
7/20/2017	24	MDM17095	5	5	121	3	3	3
7/31/2017	27	MDM17106	5	1	92	2	2	2
7/31/2017	27	MDM17106	5	2	94	1	1	1
7/31/2017	27	MDM17106	5	3	110	2	2	2
7/31/2017	27	MDM17106	5	4	127	3	3	3
7/31/2017	27	MDM17106	5	5	121	2	2	2
8/7/2017	29	MDM17113	5	1	88	1	1	1
8/7/2017	29	MDM17113	5	2	96	2	2	2
8/7/2017	29	MDM17113	5	3	134	3	3	3
8/7/2017	29	MDM17113	5	4	123	2	2	2
8/7/2017	29	MDM17113	5	5	117	1	1	1
8/15/2017	31	MDM17121	5	1	113	2	2	2
8/15/2017	31	MDM17121	5	2	139	3	2	2
8/15/2017	31	MDM17121	5	3	125	3	3	3
8/15/2017	31	MDM17121	5	4[1]	140	3	2	2
8/15/2017	31	MDM17121	5	5	181	4	4	4
8/17/2017	32	MDM17123	5	1	141	3	2	2
8/17/2017	32	MDM17123	5	2	147	3	3	3
8/17/2017	32	MDM17123	5	3	121	2	2	2
8/17/2017	32	MDM17123	5	4	137	3	3	3
8/17/2017	32	MDM17123	5	5	135	2	2	2
8/21/2017	33	MDM17127	5	1	124	2	2	2
8/21/2017	33	MDM17127	5	2	114	3	3	3
8/21/2017	33	MDM17127	5	3	127	2	2	2
8/21/2017	33	MDM17127	5	4	139	2	2	2
8/21/2017	33	MDM17127	5	5	149	3	3	3
8/28/2017	35	MDM17134	5	1	113	2	2	2
8/28/2017	35	MDM17134	5	2	132	3	3	3
8/28/2017	35	MDM17134	5	3	114	3	3	3
8/28/2017	35	MDM17134	5	4	145	3	3	3
8/28/2017	35	MDM17134	5	5	152	3	2	3
9/2/2017	36	MDM17139	2	1	75	2	3	2
9/2/2017	36	MDM17139	2	2	141	4	4	4

Date	Batch Number	Collection Number	Number of Eels	Within Batch ID	Total Length (mm)	Age 1 - CAF*	Age 2- ERS*	Age consensus
9/4/2017	37	MDM17141	2	1	98			*L
9/4/2017	37	MDM17141	2	2	91			*L
9/7/2017	38	MDM17144	3	1	82	1	1	1
9/7/2017	38	MDM17144	3	2	96	2	2	2
9/7/2017	38	MDM17144	3	3	146	3	3	3
9/11/2017	39	MDM17148	1	1	153	3	3	3
9/14/2017	40	MDM17151	4	1	80	2	2	2
9/14/2017	40	MDM17151	4	2[1]	87	1	1	1
9/14/2017	40	MDM17151	4	3	145	NR	NR	NR
9/14/2017	40	MDM17151	4	4	148	3	2	3

[1] - only one otolith found during extraction

*NR - otolith not readable for aging

*L - Slide Broken Otolith Lost

APPENDIX C:
WEEKLY BIOLOGICAL DATA AND ENVIRONMENTAL CONDITIONS FOR CONOWINGO EEL COLLECTION FACILITY, 2017

Muddy Run Pumped Storage Project
FERC Project Number 2355

	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10
Octoraro Eels	17	9	9	39	21	7	2	61	1565	19
Conowingo Eels	4387	151	1224	5384	2196	1761	5199	23318	8090	799
Creek flow (cfs) (wk avg)	69100	127229	53543	29800	47886	47729	33100	32257	27443	22700
Lunar Fraction (wk avg)	0.56	0.96	0.66	0.09	0.37	0.92	0.78	0.16	0.24	0.84
Water temp (°C) (wk avg)	17.4	14.2	18.8	18.2	18.9	20.2	21.6	24.4	24.9	25.7
Dissolved Oxygen (mg/L) (wk avg)	9.5	8.3	7.5	7.5	6.4	5.7	4.4	4.9	5.1	4.5
Percent of Catch	3.59	0.12	1.00	4.40	1.80	1.44	4.25	19.07	6.61	0.65

	Wk 11	Wk 12	Wk 13	Wk 14	Wk 15	Wk 16	Wk 17	Wk 18	Wk 19	Wk 20
Octoraro Eels	13	7067	419	48	16	68	1793	12	149	12
Conowingo Eels	1503	1432	15435	32524	13130	2654	2931	88	51	43
Creek flow (cfs) (wk avg)	21414	38157	60143	30057	26471	20886	16614	11819	13779	11922
Lunar Fraction (wk avg)	0.88	0.26	0.14	0.72	0.94	0.38	0.07	0.58	0.96	0.56
Water temp (°C) (wk avg)	25.6	26.9	26.2	25.2	24.1	24	23.3	20.2	20.5	20.4
Dissolved Oxygen (mg/L) (wk avg)	2.3	5.1	5	4	4.5	5	3	4	6.3	5.5
Percent of Catch	1.23	1.17	12.62	26.59	10.74	2.17	2.40	0.07	0.04	0.04

Wk 1: May 1 - May 6
Wk 2: May 7 - May 13
Wk 3: May 14 - May 20
Wk 4: May 21 - May 27
Wk 5: May 28 - June 3
Wk 6: June 4 - June 10
Wk 7: June 11 - June 17
Wk 8: June 18 - June 24
Wk 9: June 25 - July 1
Wk 10: July 2 - July 8
Wk 11: July 9 - July 15
Wk 12: July 16 - July 22
Wk 13: July 23 - July 29
Wk 14: July 30 - August 5
Wk 15: August 6 - August 12
Wk 16: August 13 - August 19
Wk 17: August 20 - August 26
Wk 18: August 27 - September 2
Wk 19: September 3 - September 9
Wk 20: September 10 - September 15

APPENDIX D:
FISH HEALTH INSPECTION REPORT, CONOWINGO EEL COLLECTION FACILITY, 2017

DEPARTMENT OF THE INTERIOR
U.S. Fish and Wildlife Service
FISH HEALTH INSPECTION REPORT[1]

This report is NOT evidence of future disease status. To determine status, contact the inspecting biologist below.

Fish Source & Facility Contact	Fish Examined	Water Supply[2]	5 year facility classification
Octoro Creek, MD (trib of Susquehanna , below Connowingo Dam) Michael Martinek, collector Ray Bleistine, project manager, Normandeau	☐ Hatchery ☑ Wild	☑ Unsecured: Open Spring, Stream ☐ Secured: Well, sterilized	Last sample date / Classification 1 03/21/2017 2 04/20/2016 3 04/07/2015 4 04/15/2014 5 05/07/2013

Species[3]	Lot Identity	Age[4]	# in lot	Eggs (E) or fish (F) Obtained From	Pathogens inspected[3] & results[1,5]													
					EI	AS	YR	RS	MC	IH	IP	IS	LM	OM	SV	VH	A	B
AME	2017 collection	y		(F)Octoro Creek, MD	60	60	60			60	60			60		60	60	
					–	–	–	NT	NT	–	–	NT	NT	–	NT	–	+	

Remarks[6]: Lab Case 17-116; AME = American eel; A= swimbladder nematode (Anguillicola crassus)

Inspecting Biologist Signature	Concurred (signature & title)	
Print: Patricia Barbash Date: 04/21/2017	Print: John A. Coll, Project Leader, LFHC Date: 04/21/2017	Lamar Fish Health Center 400 Washington Ave; PO Box 155 Lamar, PA 16848 (570) 726-6611

[1] Done in accordance with the AFS Fish Health Section Bluebook *Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens* and the U.S. Fish and Wildlife Service Fish Health Policy 713 FW 1-5. [2] Secure = free of all aquatic pathogens or sterilized, Unsecured = aquatic pathogens may be present. [3] FWS abbreviations (see back of this page), [4] For hatchery fish give age in months; for feral fish, use symbols: e=eggs or fry; f=fingerling; y=yearlings; b=older fish. [5] Findings reported as number examined over results; (-) = undetected, (+) = positive, and NT= not tested, A,B = other pathogens as listed in remarks[6] Additional remarks can be made on back page.

DEPARTMENT OF THE INTERIOR
U.S. Fish and Wildlife Service
FISH HEALTH INSPECTION REPORT[1]
This report is NOT evidence of future disease status. To determine status, contact the inspecting biologist below.

Additional Inspection Information
Laboratory Case Number:

17 - 116, received March 22, 2017. The collection of the 60 American eels occurred on 03/21/201 by Michael Martinek.

Bacterial cultures - primary inoculum from kidney onto BHIA, negative for AS, YR, EI.

Virology exam of internal viscera on CHSE-214, EPC, BF-2, and FHM cells on microtiter, negative for IH, IP, OM, and VH.

General, gross observation for the swimbladder nematode (Anguillicola crassus) was conducted, with an incidence of 33% (20/60). This level of occurence is typical of that seen in this population the during last 5 years (15 to 19 / 60). Also typical this year was histological observation of Myxosporidian protozoan Myxidium sp.in gill tissue and a trematode cyst in the skin. These observations were also recorded in previous years.

PATHOGEN ABBREVIATIONS

AS Aeromonas salmonicida
EI Edwardsiella ictaluri
RS Renibacterium salmoninarum
YR Yersinia ruckeri
MC Myxobolus cerebralis
IH Infectious Hematopoietic Necrosis Virus
IP Infectious Pancreatic Necrosis Virus
IS Infectious Salmon Anemia Virus
LM Largemouth Bass Virus
OM Oncorhynchus masou Virus
SV Spring Viremia of Carp Virus
VH Viral Hemorrhagic Septicemia Virus

SPECIES ABBREVIATIONS

Amur Pike AMP	Colorado Pikeminnow CPM	Kokanee KUE	Rainbow Trout X Steelhead RBTSTT
Apache Trout APT	Comanche Springs pupfish CSP	Landlocked ATS LAS	Razorback Sucker RBS
Arctic Grayling ARG	Cutthroat Trout CUT	Leon Springs pupfish LSP	Redear Sunfish RSF
Atlantic Salmon ATS	Darters DAR	Lake Trout LAT	Rio Grande Silvery Minnow RGSM
Beautiful Shiner GBS	Desert Pupfish DEP	Lampreys LAY	Sonora Sucker SOS
Big Bend Gambusia BBG	Desert Sucker DES	Largemouth Bass LMB	Sauger SAR
Bigmouth Buffalo BIB	Devils Hole Pupfish DHP	Livebearers LIR	Smallmouth Buffalo SAB
Black Bullhead BLB	Dolly Varden DOV	Miscellaneous Warm Water MSC	Silver Carp SVC
Black Crappie BLC	Dolly Varden X BKT DOVBKT	Mooneyes MOE	Smallmouth Bass SMB
Blue Catfish BCF	Fall Chinook Salmon FCS	Mudminnows MUW	Sockeye Salmon SOS
Blue X Channel BCFCCF	Fathead Minnow FHM	Muskellunge MUE	Spotted Bass SPB
Bluegil BLG	Flathead Catfish FCF	Northern Pike NOP	Spring Chinook Salmon SCS
Blue Pike BLP	Freshwater Drums FRD	Ohrid Trout OHT	Steelhead Trout STT
Bluntnose Shiner PBS	Gars GAR	Other Catfishes OCF	Sticklebacks STK
Bonytail Chub BTC	Gila Topminnow GTM	Other Minnows OTM	Striped Bass STB
Bowfin BON	Gila Trout GIT	Other Pikes OTP	Sturgeons STN
Brook Trout BKT	Golden Shiner GOS	Other Salmonids OSA	Virgin Chub VRC
Brown Bullhead BRB	Golden Trout GOT	Other Suckers OTS	Walleye WAE
Brown Trout BNT	Goldfish GOF	Other Sunfishes OSF	Walleye X Sauger WAESAR
Carp CAP	Grass Carp GRC	Paddlefish PAH	Warmouth WAM
Channel Catfish CCF	Green Sunfish GSF	Pahranagat Roundtail Chub PRC	White Catfish WCF
Chihuahua Chub CCH	Guadalupe Bass GUB	Pecos Gambusia PEG	Winter Chinook Salmon WCS
Chum Salmon CHS	Herrings HEG	Pink Salmon PKS	Woundfin WDF
Coho Salmon COS	Killifishes KIH	Rainbow Trout RBT	

APPENDIX E:
AGENCY COMMENTS ON DRAFT 2017 CONOWINGO EEL RAMP COLLECTION REPORT

From: Eyler, Sheila <sheila_eyler@fws.gov>
Sent: Thursday, December 21, 2017 10:26 PM
To: Danucalov, Andrea; Erin Redding
Subject: Re: Muddy Run Pumped Storage Project - Follow-up from 12/13/2017 Meeting
Attachments: FWS Comments to Exelon 20171221.docx

Hi Andrea,

Please see the attached comments from FWS that compile the comments from the Resource Agencies regarding the documents referenced in your email. Feel free to reach out to me if you have any questions or concerns.

Have a great holiday,

Sheila

Sheila Eyler
U.S. Fish & Wildlife Service
Mid-Atlantic Fish and Wildlife Conservation Office
177 Admiral Cochrane Dr., Annapolis, MD 21401
410-573-4554 (O)
717-387-2117 (C)
Sheila_Eyler@fws.gov

On Thu, Dec 14, 2017 at 10:51 AM, Danucalov, Andrea H:(GenCo-Pwr) <Andrea.Danucalov@exeloncorp.com> wrote:

> All,
>
> As we discussed at yesterday's meeting, I am sending an email with the reports and study plans for Muddy Run Pumped Storage Project and due dates.
>
> Please send comments Jeremy and/or Sheila would send us comments next Friday, December 22, 2017 so that we can incorporate and finalize the documents for filing with FERC. The documents are in the attached zip file.

Report/Study Plan Title	Date Emailed	Comments from Resource Agencies/Submit to Exelon	FERC Filing Date
FPOP Annual Report - 2017	11/16/2017	12/22/2017	12/31/2017
2017 Conowingo Eel Ramp Collection Report	11/27/2017	12/22/2017	1/15/2018

FWS Comments on Exelon Reports and Study Plans
12/21/2017

1. FPOP Annual Report – 2017 (11/16/2017)
    - No comments, we appreciate the data being provided in an excel file

2. 2017 Conowingo Eel Ramp Collection Report (11/27/2017, revisions received 12/20/17)
    - Provide map and pictures of Stone Run health screening collection site.

3. 2017 Octoraro Creek Eel Ramp Collection Report (12/11/2017, revisions received 12/20/2017)
    - No comments

4. Study Plan to Assess Upstream Migrating Adult American Shad within the Muddy Run Pumped Storage Project (11/22/2017)
    - Tagging efforts should be combined with Holtwood's Tier II study efforts and data should be shared between studies so that all study fish are monitored at both locations. Tagged fish shall be approximately 1:1 male to female ratio overall.
    - The more stringent standard between the WQC and the Prescription must be followed in the event of a discrepancy
        - Because the implications for not meeting the passage efficiency targets are different for the WQC (mitigation) and Prescription (operational changes), it is best to report data with respect to both targets as proposed in the study plan. Actions that may be derived from not meeting those targets will be addressed separately by the agencies at a later date if needed.
        - FWS calls for 1 year study every 10 years and PADEP calls for a one-time 4-year study. To follow the more stringent requirement, this initial study will need to be 4 years duration. Presumably the initial study will be completed in 2022. FWS allows for studies >1 year to be conducted, however it does not change the requirement of 1 year every 10-year schedule. Therefore, FWS would require another evaluation in 2028.

5. Study Plan to Assess Emigrating Adult American Shad in the Vicinity of the Muddy Run Pumped Storage Project (11/22/2017)
    - No comments

6. Study Plan to Monitor Emigration and Behavior of Telemetered Juvenile American Shad in the Vicinity of the Muddy Run Pumped Storage Project (11/22/2017)
    - The proposal will apply timing of expected juvenile shad passage from Holyoke data to determine an overall entrainment rate. This is acceptable because we do not have site specific data. However, the entire spread of time for American shad immigration as reported in the referenced studies needs to be used and not just the peak hours of 1700-2200 hours when calculating entrainment rate. We agree that it is not appropriate to use straight calculations for entrainment rates from this study because they will not reflect actual conditions at the project (time of fish release will influence timing of downstream migration). As proposed, the

measured rates will need to be adjusted to reflect more "natural" conditions. However, a more explicit description of exactly how this entrainment rate will be calculated should be included in the study design. We recommend including the following information:

i. A table indicating the percentage of shad passage that would be applied to each hour of the day based on the referenced studies (ex. 50% of passage occurred at the 1700 hour). It would be helpful if you could provide us a copy of the Harza & RMC paper as well.
ii. How the entrainment rate would be derived from those estimates. For example, the observed entrainment rate would be applied to the percentage of each hour during downstream migration where pumping occurs, and then the expected hourly entrainment rate would be the product of the observed entrainment rate, the percentage of time that pumping occurs during that hour, and the expected proportion of shad to pass the project during that hour. The overall entrainment rate would then be the sum of the hourly estimates.

- For all studies, FWS request to receive electronic copies of the telemetry data (operational data will already be available through the annual FOMP report).
- Procurement of American Shad – PFBC will attempt to culture fingerling shad, as an additional source of study fish, for the 2018 RT assessment.

From: Miller, Jeremy <jeremmille@pa.gov>
Sent: Thursday, December 21, 2017 3:32 PM
To: Danucalov, Andrea; Erin Redding
Cc: Sheila Eyler; Williamson, Scott; Mccollum, Allyson
Subject: DEP comments to Exelon's Reports and Study Plans
Attachments: PADEP Comments to Exelon 20171221.docx

Andrea,

I've attached PADEP's comments in regards to Exelon's reports and study plans listed below.

Report/Study Plan Title	Date Emailed	Comments from Resource Agencies/Submit to Exelon	FERC Filing Date
FPOP Annual Report - 2017	11/16/2017	12/22/2017	12/31/2017
2017 Conowingo Eel Ramp Collection Report	11/27/2017	12/22/2017	1/15/2018
2017 Octoraro Creek Eel Ramp Collection Report	12/11/2017	12/22/2017	1/15/2018
Study Plan to Assess Upstream Migrating Adult American Shad within the Muddy Run Pumped Storage Project	11/22/2017	12/22/2017	1/15/2018
Study Plan to Assess Emigrating Adult American Shad in the Vicinity of the Muddy Run Pumped Storage Project	11/22/2017	12/22/2017	1/15/2018
Study Plan to Monitor Emigration and Behavior of Telemetered Juvenile American Shad in the Vicinity of the Muddy Run Pumped Storage Project	11/22/2017	12/22/2017	1/15/2018

If you have any additional comments or questions feel free to contact me. Happy Holidays!

Thanks,
Jeremy

Jeremy Miller | Water Pollution Biologist II
Department of Environmental Protection | Clean Water Program
Southcentral Regional Office
909 Elmerton Ave. | Hbg PA 17110
Phone: 717.705.4777 | Fax: 717.705.4760
www.dep.state.pa.us

PADEP Comments on Exelon Reports and Study Plans
12/21/2017

1. FPOP Annual Report – 2017 (11/16/2017)
    - No comments, we appreciate the data being provided in an excel file

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    - The more stringent standard between the WQC and the Prescription must be followed in the event of a discrepancy
        - Because the implications for not meeting the passage efficiency targets are different for the WQC (mitigation) and Prescription (operational changes), it is best to report data with respect to both targets as proposed in the study plan. Actions that may be derived from not meeting those targets will be addressed separately by the agencies at a later date if needed.
        - FWS calls for 1 year study every 10 years and PADEP calls for a one-time 4-year study. To follow the more stringent requirement, this initial study will need to be 4 years duration. Presumably the initial study will be completed in 2022. FWS allows for studies >1 year to be conducted, however it does not change the requirement of 1 year every 10-year schedule. Therefore, FWS would require another evaluation in 2028.

5. Study Plan to Assess Emigrating Adult American Shad in the Vicinity of the Muddy Run Pumped Storage Project (11/22/2017)
    - No comments

6. Study Plan to Monitor Emigration and Behavior of Telemetered Juvenile American Shad in the Vicinity of the Muddy Run Pumped Storage Project (11/22/2017)
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measured rates will need to be adjusted to reflect more “natural” conditions. However, a more explicit description of exactly how this entrainment rate will be calculated should be included in the study design. We recommend including the following information:

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ii. How the entrainment rate would be derived from those estimates. For example, the observed entrainment rate would be applied to the percentage of each hour during downstream migration where pumping occurs, and then the expected hourly entrainment rate would be the product of the observed entrainment rate, the percentage of time that pumping occurs during that hour, and the expected proportion of shad to pass the project during that hour. The overall entrainment rate would then be the sum of the hourly estimates.

- For all studies, FWS and PADEP request to receive electronic copies of the telemetry data (operational data will already be available through the annual FOMP report).
- Procurement of American Shad – PFBC will attempt to culture fingerling shad, as an additional source of study fish, for the 2018 RT assessment.

From: Erin Redding
Sent: Wednesday, December 20, 2017 3:17 PM
To: 'Avalos, Chris'; Elisabeth Bleistine; Bleistine, Ray; 'Mike.Cox@ERM.com'; Danucalov, Andrea; David Frazier; 'Eyler, Sheila'; 'Henning, Aaron'; Hicks, Colleen; Ian Kiraly; 'jesus_morales@fws.gov'; Martinek, Michael; 'McCollum, Allyson'; 'McCorkle, Richard'; 'Miller, Jeremy'; 'Minkkinen, Steve'; 'cheri.peifer@exeloncorp.com'; Royer, Doug; 'Sadzinski, Robert'; 'Seaman, Shawn'; 'Shank, Matt'; 'Slowik, Adam'; Smith, Fred; Kirk Smith; 'Tryninewski, Joshua'; White, Eric; 'Williamson, Scott'
Subject: Updates to the Conowingo and Octoraro Eel Ramp Reports
Attachments: 2017_Conowingo_Eel_Ramp_Collection_Report.pdf; 2017 _Conowingo_Eel_Ramp_Collection_Report_Figure_4.5-1a.pdf; 2017 _Octoraro_Creek_Eel_Ramp_Collection_Report-Appendix_C.pdf

Hello,

Following our discussions at the December 13, 2017 meeting, the Conowingo and Octoraro Creek Eel Ramp reports have been updated.

Conowingo

See the attached 2017 Conowingo Eel Ramp Collection Report (2017_Conowingo_Eel_Ramp_Collection_Report.pdf). The following changes have been made:

Table 4.3-1: Ages added
Table 4.3-3: Ages added
Table 4.3-4: Ages added
Figure 4.1-1: Dates corrected to 2017
Figure 4.5-1: Dates corrected to 2017*
Figure 4.5-2: Dates corrected to 2017
Figure 4.5-3: Dates corrected to 2017
Figure 4.5-4: Dates corrected to 2017
Appendix B: Eel ageing methodology and individual eel raw data included
Additional data included on the wild health screening in method and results section
Checked for “ramp” or “ramps” throughout the report

*Mike Martinek also prepared a figure showing the Marietta and Conowingo flows. This is attached as Figure 4.5-1a (2017_Conowingo_Eel_Ramp_Collection_Report_Figure_4.5-1a.pdf). We have kept the figure with only Conowingo River flows in the report as it best shows the conditions at Conowingo.

Octoraro

See the attached Appendix C (2017_Octoraro_Creek_Eel_Ramp_Collection_Report-Appendix_C.pdf). This appendix includes graphs comparing eel catch to creek flow, to lunar fraction, and to water temperature over the three trail years. Data are also included in tables.

Erin Redding
Certified Ecologist (Ecological Society of America)
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1961 Wehrle Dr.
Suite 12
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716-250-4960

From: Danucalov, Andrea H:(GenCo-Pwr) <Andrea.Danucalov@exeloncorp.com>
Sent: Thursday, December 14, 2017 10:52 AM
To: Erin Redding; Bleistine, Ray; David Frazier; Hicks, Colleen; Ian Kiraly; Martinek, Michael; Royer, Doug; 'Sadzinski, Robert'; Smith, Fred; Kirk Smith; White, Eric; 'Avalos, Chris'; 'Eyler, Sheila'; 'Henning, Aaron'; 'McCollum, Allyson'; 'McCorkle, Richard'; 'Miller, Jeremy'; 'Minkkinen, Steve'; Peifer, Cheri A:(GenCo-Pwr); 'Seaman, Shawn'; 'Shank, Matt'; 'Slowik, Adam'; 'Tryninewski, Joshua'; 'Williamson, Scott'; Mike.Cox@ERM.com
Subject: Muddy Run Pumped Storage Project - Follow-up from 12/13/2017 Meeting
Attachments: FPOP_Annual_Report_2017.zip

All,

As we discussed at yesterday's meeting, I am sending an email with the reports and study plans for Muddy Run Pumped Storage Project and due dates.

Please send comments Jeremy and/or Sheila would send us comments next Friday, December 22, 2017 so that we can incorporate and finalize the documents for filing with FERC. The documents are in the attached zip file.

Report/Study Plan Title	Date Emailed	Comments from Resource Agencies/Submit to Exelon	FERC Filing Date
FPOP Annual Report - 2017	11/16/2017	12/22/2017	12/31/2017
2017 Conowingo Eel Ramp Collection Report	11/27/2017	12/22/2017	1/15/2018
2017 Octoraro Creek Eel Ramp Collection Report	12/11/2017	12/22/2017	1/15/2018
Study Plan to Assess Upstream Migrating Adult American Shad within the Muddy Run Pumped Storage Project	11/22/2017	12/22/2017	1/15/2018
Study Plan to Assess Emigrating Adult American Shad in the Vicinity of the Muddy Run Pumped Storage Project	11/22/2017	12/22/2017	1/15/2018
Study Plan to Monitor Emigration and Behavior of Telemetered Juvenile American Shad in the Vicinity of the Muddy Run Pumped Storage Project	11/22/2017	12/22/2017	1/15/2018

Please let me know if you have any comments.

Thanks

Andrea

Andrea Danucalov
FERC License Compliance Manager

Exelon.

Exelon Generation
300 Exelon Way
Kennett Square, PA 19348

From: Erin Redding
Sent: Monday, November 27, 2017 5:01 PM
To: Bleistine, Ray; Danucalov, Andrea; David Frazier; Hicks, Colleen; Ian Kiraly; Martinek, Michael; Royer, Doug; 'Sadzinski, Robert'; Smith, Fred; Kirk Smith; White, Eric; 'McCorkle, Richard'; 'Avalos, Chris'; 'Eyler, Sheila'; 'Henning, Aaron'; 'McCollum, Allyson'; 'Miller, Jeremy'; 'Minkkinen, Steve'; 'cheri.peifer@exeloncorp.com'; 'Seaman, Shawn'; 'Shank, Matt'; 'Slowik, Adam'; 'Tryninewski, Joshua'; 'Williamson, Scott'; 'Mike.Cox@ERM.com'; jesus_morales@fws.gov
Subject: 2017 Conowingo Eel Ramp Collection Report
Attachments: 2017_Conowingo_Eel_Ramp_Collection_Report.pdf

Hello,

Attached please find Exelon's 2017 Draft Conowingo Eel Ramp Collection Report. Note that there are placeholders for age data, which are still being analyzed.

Please review this document before our December 13, 2017 meeting. We will discuss the report at that meeting and then request final comments before December 19, 2017. This schedule will allow Exelon to finalize the report and file it with FERC and PADEP before December 31, 2017.

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