MUDDY RUN PUMPED STORAGE PROJECT EVALUATION OF TEMPORARY AMERICAN EEL COLLECTION FACILITY IN OCTORARO CREEK, (YEAR 3)

FERC PROJECT NO. 2355

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January 2018

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 included as a condition of the Pennsylvania 401 Water Quality Certification (WQC) (DEP 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.

Pursuant to the FERC License and the Pennsylvania Department of Environmental Protection (PADEP) 401 WQC, Exelon began operation of a temporary eel trapping facility at Octoraro Creek in 2015. The temporary eel trapping facility at Octoraro Creek is required to operate for three season – 2015, 2016, and 2017. Reports for 2015 and 2016 have been previously submitted to PADEP and FERC. This report has been prepared to review the operation of the temporary eel trapping facility for 2017, which is the third year of the three-year study. Eels collected in Octoraro Creek were transported to and held at the Conowingo Eel Collection Facility (CECF) at Conowingo Dam and subsequently transported and released at designated points in the Susquehanna River watershed. This temporary facility has the potential to become a permanent trapping facility dependent upon the success of this three-year evaluation.

The purpose of this three-year study is to determine if Octoraro Creek is a practical/successful source of juvenile eels for stocking and, to evaluate the effectiveness of the temporary eel ramp. Specifically, the PADEP 401 WQC states that:

> *"If, after three years of operation, PADEP in consultation with EPAG determines the temporary eel trapping facility at Octoraro Creek is successful, Exelon will design, install, and operate a permanent eel trapping facility at this location in accordance with a schedule established by PADEP in consultation with the other Resource Agencies."*

The report will also provide details on the following objectives for the 2017 field investigation and will summarize the findings across the three years of study:

- Reinstall a temporary eel collection facility on Octoraro Creek immediately downstream of Chester Water Authority's (CWA) Pine Grove Low-Head Dam;
- Operate, maintain, and monitor the temporary eel collection facility (daily or as needed basis) from May 1 through September 15, 2017;
- Collect catch and length data (by substrate type), water quality, stream flow, and moon phase data during the entire sampling period;
- Stock at designated sites or deliver eels collected by the temporary ramps to the CECF at Conowingo Dam;
- 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 and eel attraction capability.

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, with monitoring checks occurring on 86 days.

A total of 11,347 juvenile eels were collected; 5,801 from the Enkamat substrate and 5,546 from the Milieu substrate. The greatest number of juvenile eels were collected during the two-day sample period of July 14-16 (3,238 eels and comprised 28.5% of the season total). The first peak occurred between June 25 and 27, accounting for 1,504 of the 11,347 (13.3%) juvenile eels collected at the facility. The second and largest peak (July 16-18) yielded 6,989 of the 11,347 (61.6%) juvenile eels. The third peak occurred between August 20 and 23, accounting for 1,705 of the 11,347 (15.0%) juvenile eels collected at the facility. Nearly 90% of the juvenile eels collected at this facility occurred during these 10 days (10,198 of the 11,347, 89.9%).

Increases in flow in the Octoraro Creek were associated with increases in juvenile eel catch in 2017. During periods of time when flows increased, the number of juvenile eels collected within a day or so also increased. The three peaks in capture occurred during periods of relatively low lunar fraction (new moons) which co-occurred with increases in creek flow.

A total of 11,339 live juvenile eels collected at the facility were transported within 48 hours of capture to the CECF at Conowingo Dam where they were held before transport. Of the 11,347 juvenile eels that were captured at this facility, 6 eels died in one of the collection tanks (99.95% survival). Two juvenile eels (0.02% mortality) died during transport to the CECF at Conowingo Dam.

Cleaning and calibration of the trapping facility was performed weekly. Scrubbing of the barrel that held the pump and the spray bars occurred prior to any calibration. The pump, manifold, and garden hoses were also cleaned or changed as needed during the season.

Exelon submits the findings from the 2017 study along with the information submitted in 2015 and 2016 for the eel trapping facility. Based on previous assessments of alternative locations and the results of the three years of this study, we believe the Octoraro Creek Eel Facility is a highly suitable and preferable location for installation of a permanent trapping facility. The facility was successful in capturing a substantial number of eels for supplementing Exelon's trap and transport program at the CECF at Conowingo Dam, and even greatly surpassed the catch at the CECF during one of the study years. Additionally, the location of the facility is suitable for the construction and consistent operation of a permanent trapping facility. We therefore encourage PADEP in consultation with the EPAG to consider all of these factors and information for determining the success of the Octoraro Creek temporary trapping facility.

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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
hr	hour
Km	Kilometer
L	Liter
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, *Anguilla rostrata*, Passage Plan (Eel Plan) was developed by Exelon and included as a condition of the Pennsylvania 401 Water Quality Certification (DEP File No. EA 36-033; dated 10 December 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 investigate the feasibility of installing and operating a juvenile eel trapping facility on Octoraro Creek. The evaluation was conducted at a location identified on Octoraro Creek immediately downstream of the Chester Water Authority (CWA) Pine Grove Low-Head Dam (Dam). This site was approved by the Pennsylvania Department of Environmental Protection (PADEP) and other members of the Eel Passage Advisory Group (EPAG)[1].

In 2015, Exelon designed, installed, and operated the temporary eel trapping facility adjacent to CWA's small hydroelectric site on Octoraro Creek. The trap was operated in 2016 and again in 2017 making this the third year of a three-year evaluation. Eels collected in Octoraro Creek were transported directly to and held at the Conowingo Eel Collection Facility (CECF) at Conowingo Dam and subsequently transported and released at designated points in the Susquehanna River watershed. This temporary facility has the potential to become a permanent trapping facility dependent upon the success of this three year evaluation.

The purpose of this three year study is to determine if Octoraro Creek is a viable source of juvenile eels for stocking and to evaluate the effectiveness of the temporary eel ramp. Specifically the PADEP 401 WQC states that:

> *"If, after three years of operation, PADEP in consultation with EPAG determines the temporary eel trapping facility at Octoraro Creek is successful, Exelon will design, install, and operate a permanent eel trapping facility at this location in accordance with a schedule established by PADEP in consultation with the other Resource Agencies."*

The report provides details relative to the following objectives for the 2017 field investigation and provides a summary of the 2015-2017 studies:

- Reinstall a temporary eel collection facility on Octoraro Creek immediately downstream of CWA's Pine Grove Low-Head Dam;
- Operate, maintain, and monitor the temporary eel collection facility (daily or as needed basis) from May 1 through September 15, 2017;
- Collect catch and length data (by substrate type), water quality, stream flow, and moon phase data during the sampling period;
- Stock at designated sites or deliver eels collected by the temporary ramps to the CECF at Conowingo Dam;

[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.

- 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 and eel attraction capability.

2 BACKGROUND

Areas of lower Octoraro Creek up to and including the area near CWA's Pine Grove Low-Head Dam were surveyed over a 13 week period from June 16 through September 10, 2014, using fyke nets, red-light headlamps, and fine mesh dip nets (Figure 2.0-1 and Normandeau Associates and Gomez and Sullivan 2014). Based on the information gathered during the 2014 survey, eels were consistently found in the north corner of the spillway adjacent to the Dam, whereas eels did not seem to be as abundant at the downstream sites during the same period. The report recommended that a site near the Dam be considered for future juvenile eel trapping (Normandeau Associates and Gomez and Sullivan 2014). Exelon and EPAG discussed the possibility of utilizing this north corner of the spillway site for the temporary eel collection facility in 2015. However, due to concerns by the CWA relating to existing structures at the site, an alternative site along the south shore of the Dam was selected and approved by the CWA and EPAG. The alternative site is located immediately downstream of the Art Building (Figure 2.0-2).

Recent 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

The 2017 temporary trapping facility was identical to the 2015 and 2016 trapping facility (Appendix A, Normandeau Associates and Gomez and Sullivan 2015 and 2016). The juvenile eel ramps were constructed of two aluminum cable trays. One 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 CECF at Conowingo Dam (Figure 3.1-1). This substrate consisted of a dense, three-dimensional mesh of fused filaments, which provided a climbing surface for the juvenile eels. The other cable tray contained Milieu small substrate, with staggered vertical tubes that the eels push against as they climb the substrate (Figure 3.1-1). Milieu small substrate (25 millimeter diameter pipes) was chosen instead of Akwadrain, as it has proven very effective for similar size eels at other sites (Roanoke-Gaston Hydropower Project 2011). Each ramp consisted of approximately 7 meter (m) x 305 millimeter (mm) wide cable trays positioned at a 30° 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 separate holding tanks, one for each substrate type. The base of each ramp was underwater during all flow conditions, and the base allowed for a smooth transition from the existing riverbed adjacent to a quiescent pool located in the creek. Ramps were held in place by three T-shaped solid metal braces, evenly spread across the length of the ramp, and driven into the ground beneath the ramps (Figure 3.1-2). On either side of these braces, a hole was drilled into the flat bar and a piece of threaded rod bent to fasten the ramps to these braces using wing nuts. Ramps were covered from the top down to near the tail water median flow height to protect juvenile eels when ascending (Figure 3.1-3).

Water flow to each ramp was supplied via a 38 mm water line from a ½ horsepower submersible pump (Gorman Rupp Model 2XH5) (rated at approx. 250 liters/minute), installed in a 114 liter (L) barrel, submerged about 1.2 m below the water surface in the forebay above CWA's Pine Grove Low-Head Dam. The barrel contained 50 holes, (38 mm diameter), that were covered with one mm mesh screen to prevent any material from entering the pump, hose lines, and manifold that could cause clogging. The barrel was secured by cable to a railing. The original trash rack for the old pump house (Art Building) was used to keep the barrel away from the shoreline. The depth of the water at this trash rack is approximately three meters. The underground 38 mm water line was encased in 101 mm PVC to protect the line from being crushed under the driveway. The 38 mm water line was attached to a manifold with seven garden spigots that supplied water to the spray bars and additional attraction flow lines (Figure 3.1-4). Water was continuously discharged down the ramp and into the collection tanks via a spray bar, keeping the substrate moist and creating a flow to attract juvenile eels (Figure 3.1-5). Climbing ramp flow was augmented by additional attraction flow from the overflow of the collection tanks via a gravity feed garden hose. Two additional attraction flow hoses were attached to the cover near the entrance of the ramp at the water's edge. One of these hoses was turned upward to create a splashing effect while the other original hose created a laminar attraction flow (Figure 3.1-3).

The facility contained two collection tanks, one for each of the two ramp substrate types. Each collection tank was 292 mm wide with a length of 432 mm. The depth of the water in the collection tank for the Enkamat substrate was about 330 mm, with a volume of approximately 41.65 Liters (L) (Figure 3.1-6). The depth of the water in the collection tank for the Milieu substrate was about 305 mm, with a volume of

approximately 38.44 L. The collection tanks were filled by allowing some of the spray bar flow to enter the collection tanks, thus providing a constant flow of freshwater to each tank. Each collection tank contained a drain comprised of a 51 mm PVC pipe with holes drilled through it and wrapped in one mm mesh to prevent juvenile eel escapement (Figure 3.1-5). Each collection tank drain line 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 bend of each ramp was custom fitted into the collection tank and ended about 50 mm above the high water mark in the tank. Each collection tank was custom fitted with a lid that was held down by a C-clamp. When the dissolved oxygen (DO) approached 5.0 milligram per Liter (mg/L) in the forebay, an air stone from an aerator was added to each tank to supply additional aeration. The aerator was connected to a deep cycle marine battery connected to a portable solar panel by a trickle charger. (Figure 3.1-7)

3.2 Data Collection

All sample data, including eel counts and lengths were recorded, verified, tabulated, and entered into an electronic format for each ramp. Water quality and environmental conditions (including stream flow, moon phase, and weather condition) were recorded, verified, tabulated, and entered into an electronic format during each sampling event.

Eel count data included actual counts or volumetric estimates. Volumetric estimates were performed by placing 200 milliliters (mL) of water into 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 known liter of water was 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 indicates the 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 was then added to the known number in 200 mL displacement to provide a total number of eels in the sample. The volumetric estimates were performed for each of the collection tanks due to the size difference seen in the eels.

Length measurements were taken, with a maximum of 25 individuals per substrate (when available) per sampling event. Eels were measured to the nearest millimeter (mm) after being anesthetized (Figure 3.2-3).

Water quality (temperature and DO) was measured in each of the collection tanks, and also in the head pond near the pump during each sampling event, with a YSI© 550A water quality meter that was calibrated prior to each sampling event. A Hobo Water Temp Pro© monitor was also installed inside the water supply manifold that recorded hourly water temperature. The Hobo monitor was downloaded at season end.

[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.

3.3 Juvenile Eel Transport

All juvenile eels that were captured from the Octoraro Creek eel facility were transported to the CECF at Conowingo Dam where they were held before subsequent transport and release at designated locations in the Susquehanna River watershed.

When less than 50 eels were collected during a sampling event, the eels were transported in aerated 19-liter buckets with lids that contained the maximum amount of water to prevent sloshing. When counts of juvenile eels were greater than 50 individuals, a small enclosed transport tank (250 L) that was filled completely to prevent sloshing and equipped with supplemental oxygen to maintain DO levels in the tank, was used.

4 RESULTS

The Exelon juvenile eel trapping facility on Octoraro Creek was installed and put into service May 1, with continued operation through September 15, 2017. The facility operated 138 days with monitoring checks occurring on 86 days. Daily checks were initially scheduled, but due to low numbers of individuals (<100 juvenile eels per collection tank/per day) during portions of the sampling season, every other day checks were instituted with the concurrence of the EPAG. The every other day checks occurred from May 13-June 25, June 28–July 14, July 19-23, August 1-19, and August 24 through season end (September 15). The greatest number of juvenile eels was collected during the two-day sample period of July 14-16 (3,238 eels and comprised 28.5% of the season total). A total of 11,347 juvenile eels were collected during the 2017 season (Table 4.0-1).

4.1 Juvenile Eel Collection and Length Distribution by Substrate Type

Enkamat

Of the 11,347 juvenile eels collected, 51.1% (5,801 eels) were caught in the ramp containing Enkamat substrate (Table 4.1-1). The average length of juvenile eels from this substrate was 130.0 mm, with a median size of 129 mm. The length of juvenile eels ranged from 99 – 165 mm. Only one juvenile eel measured less than 100 mm and zero eels measured greater than 175 mm (Table 4.1-2). The highest one-day total of 1,495 juvenile eels occurred on July 18 (Table 4.0-1). During the sample period of July 14-16 (two-day collection), this substrate collected 1,606 individuals. Volumetric estimates were taken from the Enkamat substrate on June 26 as well as from July 16-18. For the 2017 season, only nine (roughly 10%) of the monitoring checks for the Enkamat substrate recorded juvenile eel numbers greater than 100 individuals.

Milieu

A total of 5,546 (48.9% of 11,347) juvenile eels were collected in the ramp with the Milieu substrate (Table 4.0-1 and Table 4.1-1). The average length of eels caught by this substrate was 141.4 mm, with a median size of 139 mm. The smallest eel caught was 110 mm; the largest was 245 mm (Table 4.1-1). No juvenile eels using this substrate measured less than 100 mm, but 16 juvenile eels measured greater than 175 mm (Table 4.1-2). The highest one-day collection of juvenile eels occurred on July 18 with 1,215 individuals (Table 4.0-1). During the two-day sample period of July 14-16, this substrate collected 1,632 juvenile eels. Volumetric estimates were taken from the Milieu substrate on June 26 as well as from July 16-18.

4.2 Juvenile Eel Collection by Week

The majority (62.3%, 7,067 individuals) of the juvenile eels were caught during Week 12 (July 16-22, Table 4.2-1 and Figure 4.2-1). A total of 3,486 juvenile eels were collected in the Enkamat substrate during this week, accounting for 60.1% of the season total for that substrate type. A total of 3,581 juvenile eels were collected from the Milieu substrate during the same week accounting for 64.6% of the total eels collected during the season for that substrate type.

Week 17 (August 20-26) and Week 9 (June 25-July 1) of sampling collected the next greatest percentage of eels, 15.8% (1,793 individuals) and 13.8% (1,565 individuals), respectively (Table 4.2-1 and Figure 4.2-1).Weeks 13 and 19 ranked fourth and fifth, respectively, in numbers of eels caught and were the only two other weeks that collected over 100 eels. Ten of the weeks (50%) collected less than 20 eels per week,

which included the first three weeks and the last week of operation. Weekly catch data are also provided in Appendix B.

4.3 Peak Periods of Eel Collections

During the season, there were some obvious peak periods, each occurring over a two or three day period. The first peak occurred between June 25 and 27, accounting for 1,504 of the 11,347 (13.3%) juvenile eels collected at the facility (Table 4.0-1). The second peak and the largest (July 16-18) yielded 6,989 of the 11,347 (61.6%) juvenile eels. The third peak occurred between August 20 and 23, accounting for 1,705 of the 11,347 (15.0%) juvenile eels collected at the facility. Nearly 90% of the juvenile eels collected at this facility occurred during these 10 days (10,198 of the 11,347, 89.9%).

4.4 Juvenile Eel Catch in Relation to Environmental Factors

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

Creek Flow

Creek flow and juvenile eel catch appeared to be directly related during the 2017 season. When flows increased, the number of juvenile eels collected within a day or so also increased. The United States Geological Survey (USGS) 01578475 Octoraro Creek near Richardsmere, MD gage is located approximately 21 km downstream of CWA's Pine Grove Low-Head Dam. The highest daily average creek flow value per the USGS gage station occurred on July 14, 2017 (557 cubic feet per second, cfs, Table 4.4-1). This single highest daily average creek flow value occurred at the end of Week 11 just prior to the highest collection of eels that occurred in the beginning of Week 12. Week 16 had the highest average weekly flows but only 68 juvenile eels were captured. Week 17 ranked second in number of eels captured (Figure 4.4-1). The two lowest daily average creek flow weeks (Weeks 7 and 6) correspond with the two lowest eel collection weeks, 2 and 7 eels captured, respectively. A slight increase of creek flow occurred during Week 19 which corresponds to increases in juvenile eel collection for this time period. The higher catch numbers during Week 9 of the study and without an increase of flow may be a function of other variables (e.g., migration timing).

Lunar Cycle

The two peaks in eel abundance also occurred near the new moon (Table 4.4-2 and Figure 4.4-2). Increases in stream flow and the lower illuminance associated with a new moon have been reported to be associated 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. When temperatures were below 19.0°C, Weeks 1 through 5 corresponded with some of the lowest eel catches of the season (Table 4.4-3). Over the course of the study, the average weekly water temperature ranged from a high of 26.9°C during Week 12 to a low of 14.2°C during Week 2 (Table 4.4-3 and Figure 4.4-3).

Dissolved Oxygen

Eel collection numbers and DO did not appear to be related this season. The data indicated that the water above the dam was not stratified and the readings were similar to those observed in the collection tanks

prior to the installation of the aerator which occurred on June 13 prior to any high eel catch days (Figure 4.4-4). The high eel catches during Week 12 coincide with the weekly lowest average DO readings. Detailed DO readings are presented in Table 4.4-4 and weekly averages are displayed in Figure 4.4-5. Measurements of DO were usually taken in the morning when the lowest DO would be more likely to be observed.

4.5 Juvenile Eel Transport and Mortality

See Table 4.5-1 for detailed information of transport, and mortality data.

Transport

Juvenile eels collected at the Octoraro Creek eel facility were transported within 48 hours of capture. All live juvenile eels were observed to be free of fungus and injury. Transport time from Octoraro Creek Eel Facility to the CECF at Conowingo Dam was about 30 minutes.

Mortality

Of the 11,347 juvenile eels that were captured at this facility, six eels were found dead in the collection tank (99.95% survival). The mortality occurred on two occasions from the Milieu collection tank, four juvenile eels on July 16 and two juvenile eels on July 18. These two events happened when the greatest number of eels was observed in the collection tank. The other collection tank (Enkamat) had no mortality, despite there being similar or more eels in that tank during these two occasions. The number of eels observed in the Milieu collection tank on July 16 was the highest observed this year and was not checked the day before because only seven eels were collected during the prior check on July 14. The temperature was 25.9 °C, and the head pond DO reading was 6.4 mg/L, but the DO reading in the tank was 1.3 mg/L (Table 4.5-2). Two juvenile eels were found dead in the Milieu collection tank on July 18. This occurred on the greatest one day collection of eels for the Milieu ramp. The water temperature was 25.9 °C and the DO was 2.0 mg/L with aeration and a head pond DO reading of 5.3 mg/L. As seen on Table 4.5-1, on July 16, two juvenile eels died during the transport from the Octoraro facility to the CECF (2 of 11,341, 0.02% mortality).

4.6 Quality Control Activities

Cleaning and calibration activities were conducted at least weekly during the season. Scrubbing of the barrel housing the pump, along with the spray bars, was performed prior to performing any calibrations. Garden hoses, pump, barrel, and the manifold were cleaned as needed during the season. Quality control was also performed on the volumetric eel estimates.

Calibration of the ramp flow was executed each week after cleaning, using a 19-liter graduated bucket. Three different locations of each ramp were checked for calibration purposes - the spray bar, the collection tank drain, and the additional attraction flows at the entrance of each ramp. The attraction flow at the top of the ramp (top attraction flow) was calculated by subtracting the spray bar amount from the drain of the collection tank. Details and calibration records are listed in Table 4.6-1.

The amount of algae growth within the hoses and spray bar increased throughout the season. In an effort to increase the flow of attraction water to the ramps, the pump was exchanged four times with the same horsepower and model submersible pump on June 5, July 3, August 1, and August 21, 2017. The inside of the barrel was cleaned of caddisfly casings and biofilm during these times. The attraction flow hoses were

replaced or snaked clean on three days when the pump was replaced. On four other occurrences (May 29, June 19, July 25, and August 28), the hoses were cleaned without exchanging the pump.

Volumetric eel estimates were performed on each ramp during the season to check the estimated counts compared to actual counts. On July 17, 2017, a quality control check was performed on this method. The estimate for juvenile eels from the Enkamat substrate was 68 in the 200 mL displacement equaling 340 per liter. The total amount of displacement in the 19-liter container was 0.8 L which equaled 272 eels. The displaced eels (272) plus the 68 eel in the 200 mL sample totaled 340 estimated eels compared to the actual count of 337 eels. The estimate for juvenile eels from the Milieu substrate was 40 in the 200 mL displacement equaling 200 per liter. The total amount of displacement in the 19-liter container was 3.15 L which equaled 630 eels. The displaced eels (630) plus the 40 eel in the 200 mL sample plus an additional 31 eels totaled 701 estimated eel compared to the actual count of 695 eels. Due to the small differences in numbers, we believe this method is accurate and no changes are warranted.

4.7 Other Species Caught

Two additional aquatic species were caught in addition to American Eel. Thirteen River Crayfish (Cambaridae family) were netted from the collection tank of the Enkamat substrate on ten occasions during the season. Sixteen River Crayfish were netted from the collection tank of the Milieu substrate on twelve occasions during the season. A Northern Water Snake (*Nerodia sipedon*) was also removed from the Milieu substrate collection tank on July 12, 2017. Two other northern water snakes were observed near the entrance of the Octoraro ramps on May 15, 2017.

5 DISCUSSION

The purpose of this three-year study is to evaluate the effectiveness of the temporary eel ramp(s) and to determine if Octoraro Creek is a viable source of juvenile eels for stocking. 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 eel facility. During this time, the size range of the juvenile eels caught at the CECF at Conowingo Dam facility was 77-192 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 facility was similar with a size range of 99-165 mm and an average length of 130.0 mm. Juvenile eels that were captured using the Milieu substrate were larger (average size 141.1 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 facility collected a wider size range of eels, but the CECF at Conowingo Dam collected much smaller eels.

The attraction flow to the ramps during the season was less than the design specifications for the system although the pump was sized to meet the specified parameters. The design specifications of the ramps were to have a total attraction flow of 210-230 L/min, and the actual total attraction flows were between 54.6 and 92.2 L/min (average 74.1 L/min). The distance that the pump must push the source water to the facility may be the reason for the lower attraction flow volume. The hardiness of this species and its ability to adjust to parameters outside of those developed was evidenced by the numbers captured here.

The scaffolding, collection tanks, and hoses are not shaded at this time. Collections tanks were cleaned, hoses inspected, and spray bars checked during each sample to ensure flow. Due to the algae build up inside the hoses, a routine (weekly) clean-out of the hoses and manifolds helped maintain a more consistent attraction flow.

Additional water temperature and DO readings were taken on sample days in the head pond at the pump level. The data indicated that the water above the dam was not stratified and these readings were similar to those observed in the collection tanks prior to the installation of the aerator which occurred on June 13 (Table 4.5-2). Unlike in 2016, when mortality of over 400 juvenile eels occurred on a single day, only six juvenile eels total were found dead this season. On July 16 and 18, 2017, mortality was observed in the Milieu collection tank, but not all individuals in this tank were morbid, and the Enkamat collection tank which contained nearly the same number of individuals during these two days and circulated with the same river water showed no mortality. A DO level of 1.3 and 2.0 mg/L was observed in the collection tanks during these two days. Aeration was added to help supplement the DO levels in the collection tanks on June 13 and continued constantly until the end of the season. Most of the temperature and DO readings were taken early in the morning, possibly correlating to a DO sag that is usually observed in the early morning hours. The DO values were generally higher after the aeration was added to supplement the collection tank's DO values (Figure 4.4-4). During the end of July and August, the observed DO values were higher from the head pond due to the increased number of eels in the collection tanks.

The highest daily average stream flow value per the USGS gage station occurred on June 14, 2017 (557 cubic feet per second, cfs) compared to the highest daily average stream flow value of 1,490 cfs in 2015

and 512 cfs in 2016 (Table 4.4-1 and Normandeau Associates and Gomez and Sullivan 2015 and 2016). Similar to the 2015 season, the CWA operated their small hydro infrequently. CWA only operated this facility on 3 of the 86 monitoring check days this year when creek flows were high enough. With the creek flow below normal on some monitoring check days, water was flowing only through the minimum flow notch adjacent to the Art Building and not through the hydro on the other side of the river (Appendix A). No differences in eel catches were noted when either of the above situations occurred.

Over the three years when the flow in the Creek has increased, the catch of juvenile eels has also increased within a few days of the flow increase. The average creek flow in 2015 was greater than any other year and has a larger range of creek flow throughout the season (Table 5.0-1). Figure 5.0-1 shows comparison of 2015, 2016, and 2017 weekly catch and average creek flow data. In 2016 and 2017, the high flow events co-occurred with a new moon phase. See Appendix C for additional weekly data comparing 2015, 2016, and 2017. During the 2017 Octoraro Creek eel season, Octoraro Creek had a lower than normal river flow. Shortly after an episode of increased flow (from 62 cfs to over 500 cfs) in the creek (July 13-19), a pulse of eels was evident in the collection tanks at the eel facility, resulting in the highest four day (7,057 eels collected between July 16 – July 19) total observed during the entire season. This high water event after a low creek flow was much like the six day period (July 31-August 5) in 2016 when over 9,213 juvenile eels were collected. The average size of eels has also increased over the three years by six mm (129.4 to 135.4 mm, Table 5.0-1). The Octoraro Creek eel ramp caught juvenile eels smaller than 100 mm all three years. The size range of these eels have been roughly the same except some much larger eels were captured in 2017 with the Milieu ramp.

6 CONCLUSIONS AND RECOMMENDATIONS

The underlying purpose of this three-year study was to determine if Octoraro Creek is a viable source of juvenile eels to supplement eels collected at the CECF at Conowingo Dam for subsequent stocking upriver. Specifically, the PADEP 401 WQC states that:

> *"If, after three years of operation, PADEP in consultation with EPAG determines the temporary eel trapping facility at Octoraro Creek is successful, Exelon will design, install, and operate a permanent eel trapping facility at this location in accordance with a schedule established by PADEP in consultation with the other Resource Agencies."*
>
> OR
>
> *"If, after three years of operation, PADEP in consultation with EPAG determines the temporary eel trapping facility at Octoraro Creek is unsuccessful, site-determination studies for an additional permanent trap will be performed beginning in 2017."*

Operation of the Octoraro Creek eel facility resulted in a substantial number of eels captured, coupled with high survival of eels trapped and transported from the facility. Trapping at the Octoraro Creek eel facility during 2015, 2016, and 2017 resulted in the capture of 39,638 eels, of which approximately 98.6% survived collection, holding, and transport. In comparison, 183,428 eels were captured at the CECF at Conowingo Dam during the same three years. On an annual basis, the Catch per Unit Effort (CPUE = number of eels per operational day) of the Octoraro Creek eel facility ranged between 80.9 and 154 eels per operating day, and the CPUE at the CECF ranged between 21.3 and 886.2 eels per operating day. The CPUE at the Octoraro Creek eel facility was approximately 15.5%, 722.8%, and 9.3% of the CPUE for the CECF for 2015, 2016, and 2017, respectively, with a 3-year total CPUE of 22.3% relative to the CECF (Table 6.0-1 and 6.0-2).

Though the 3-year combined catch and CPUE was lower at Octoraro Creek relative to the CECF at Conowingo, the catch at Octoraro Creek accounted for 17.8% of the juvenile eels initially captured for stocking in the Susquehanna watershed. This number is substantial, especially considering that Octoraro Creek has a drainage area of 540 km^2, which is less than 1% of the size of the drainage area of the Susquehanna River at Conowingo Dam (71,250.6 km^2).

Importantly, the Octoraro Creek eel trapping facility may also provide the benefit of capturing relatively large numbers of eels at times when the CECF at Conowingo Dam may not capture many eels. For example, in 2016, the Octoraro Creek eel facility captured 21,094 eels compared to only 2,684 eels at the CECF. Of the three years of study, this was the highest annual catch observed at the Octoraro Creek eel facility and the lowest annual catch observed at the CECF. Though the reasons for this occurrence are not known, periods of high catch in Octoraro Creek when catches are low at the CECF could be an important component for providing eels to Exelon's eel trap and transport program during certain passage seasons. Operation of the Octoraro Creek eel facility could therefore offer resilience to the trap and transport program during conditions when eels are either not actively migrating in the main-stem Susquehanna, or are not successfully attracted to a trap in the Conowingo Dam area.

It is Exelon's opinion, the eel trapping facility on Octoraro Creek is at a suitable location for capturing eels because:

- Octoraro Creek is one of the two major tributaries on the lower Susquehanna River (the other being Deer Creek), with the potential for large numbers of juvenile eels to enter during upstream migration
- The Chester Water Authority's (CWA's) Pine Grove Dam is a barrier for passage where eels passing upstream would congregate and be susceptible to capture in a trap. This was confirmed during Exelon's fyke net and night-time visual surveys on Octoraro Creek in 2014 as part of PADEP 401 WQC requirements (Normandeau Associates and Gomez and Sullivan 2014)

In addition to the Octoraro Creek eel facility location being conducive for eel capture, it was also determined to be feasible for the installation of a permanent trap based on land ownership, access, construction space, and power supply (Normandeau Associates and Gomez and Sullivan 2014).

Trapping of juvenile eels has been previously evaluated at several locations, all of which have exhibited low catch rates and were subject to physical issues which would limit operation of a permanent trap in the future. Sites for an eel trap were evaluated by the USFWS in 2008 (May 13 through August 4) and by Exelon in 2010 (June 15 to September 30) and 2011 (June 23 to September 5). The USFWS eel sampling captured 824 eels in the east corner of the Conowingo Dam spillway, compared to 43,182 eels on the west shoreline (Minkkinen and Park 2008), which prompted trapping during subsequent years at the current location of the CECF. The locations evaluated by Exelon included the placement of temporary ramp-style traps adjacent to the dividing wall between the tailrace and East Fish Lift (EFL) and on the east abutment end of the Conowingo Dam Spillway (Spillway Bay 50) (Gomez and Sullivan and Normandeau Associates 2012). The purpose of the 2011 study was to improve on the ramp attraction and design from the 2010 study. Relatively low numbers of eels (158 and 539 eels/season at Spillway Bay 50 in 2010 and 2011 respectively; 8 to 569 eels/season at the EFL spillway area in 2010 and 2011 respectively). It should be noted that the studies were hindered by high flow events, which resulted in damage to the trapping equipment and/or periods when trapping was not safe to perform. The areas near the spillway and EFL can be extremely volatile with regard to changing flows; attracting eels to a trap there was not effective, and maintaining operation of a permanent trap is not feasible for consistent and safe collection of eels. Alternatively, the Octoraro Creek eel facility is at a far more suitable location for trapping eels during a range of stream flows. An eel trap here would operate more often and more effectively than areas near the Conowingo Dam spillway or EFL.

The area inside of the Conowingo EFL has been discussed on several occasions as a potential site for the collection of juvenile eels. At this time, we can only speculate as to this area's potential for being a successful location. It should be noted that the west-side spillway area adjacent to the EFL was sampled as part of Exelon's 2010 and 2011 studies with limited success. Additionally, the EFL, though not designed to collect eels, seldom passes eels during its operating period. To properly consider the EFL as a potential site, a similar type of evaluation as what was done for the Octoraro Creek eel facility would need to be performed. An evaluation of this type would be difficult in the near future as Exelon moves forward with its commitments to modify the EFL for American Shad and river herring passage as part of its settlement agreement with the DOI. Also, due to the annual EFL operations for the passage of American Shad and river herring, an eel trapping facility could not be installed and operated until after June 15th each year at the earliest, resulting in a 45-day shorter season for eel collection each year. Alternatively, the Octoraro Creek eel facility can be installed safely and efficiently to meet the May 1st start date each year, as is mandated for operation of trapping facilities in the PADEP 401 WQC.

Therefore, based on previous assessments of alternative locations and the results of the three years of this study, we believe the Octoraro Creek Eel Facility is a highly suitable and preferable location for installation of a permanent trapping facility. The facility was successful in capturing a substantial number of eels for supplementing Exelon's trap and transport program at the CECF at Conowingo Dam, and even greatly surpassed the catch at the CECF during one of the study years. Additionally, the location of the facility is suitable for the construction and consistent operation of a permanent trapping facility. We therefore encourage PADEP in consultation with the EPAG to consider all of these factors and information for determining the success of the Octoraro Creek temporary trapping facility.

7 REFERENCES

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8 TABLES AND FIGURES

Table 4.0-1: Daily Number of Juvenile Eels Caught by Substrate

Date	Substrate Type		Total
	Enkamat	Milieu	
5/1/2017	0	0	0
5/2/2017	0	0	0
5/3/2017	2	2	4
5/4/2017	3	2	5
5/5/2017	0	1	1
5/6/2017	5	2	7
5/7/2017	2	1	3
5/8/2017	1	1	2
5/9/2017	0	0	0
5/10/2017	0	2	2
5/11/2017	0	0	0
5/12/2017	0	1	1
5/13/2017	1	0	1
5/15/2017	2	1	3
5/17/2017	2	0	2
5/19/2017	2	2	4
5/21/2017	5	4	9
5/22/2017	1	0	1
5/24/2017	1	4	5
5/26/2017	18	6	24
5/28/2017	5	4	9
5/30/2017	6	2	8
6/1/2017	0	1	1
6/3/2017	3	0	3
6/5/2017	3	1	4
6/7/2017	0	0	0
6/9/2017	1	2	3
6/11/2017	1	0	1
6/13/2017	0	1	1
6/15/2017	0	0	0
6/17/2017	0	0	0
6/19/2017	1	2	3
6/21/2017	28	8	36
6/23/2017	19	3	22
6/25/2017	172	243	415
6/26/2017	*620*	*279*	899
6/27/2017	120	70	190

Date	Substrate Type		Total
	Enkamat	Milieu	
6/28/2017	32	20	52
6/30/2017	6	3	9
7/2/2017	4	1	5
7/4/2017	3	0	3
7/6/2017	4	1	5
7/8/2017	3	3	6
7/10/2017	1	5	6
7/12/2017	0	0	0
7/14/2017	5	2	7
7/16/2017	***1606***	***1632***	**3238**
7/17/2017	***340***	***701***	**1041**
7/18/2017	***1495***	***1215***	**2710**
7/19/2017	41	27	68
7/21/2017	4	6	10
7/23/2017	14	5	19
7/24/2017	29	27	56
7/25/2017	108	175	283
7/26/2017	25	23	48
7/28/2017	4	5	9
7/29/2017	4	0	4
7/30/2017	5	3	8
7/31/2017	10	5	15
8/1/2017	2	1	3
8/3/2017	5	14	19
8/5/2017	3	0	3
8/6/2017	10	1	11
8/7/2017	3	0	3
8/9/2017	2	0	2
8/11/2017	0	0	0
8/13/2017	0	1	1
8/15/2017	0	0	0
8/17/2017	0	0	0
8/19/2017*	28	40	68
8/20/2017*	362	230	592
8/21/2017*	24	35	59
8/23/2017	**520**	**534**	**1054**
8/24/2017	32	53	85
8/26/2017	2	1	3

Date	Substrate Type		Total
	Enkamat	Milieu	
8/28/2017	2	5	7
8/30/2017	1	4	5
9/1/2017	0	0	0
9/3/2017	23	28	51
9/4/2017	3	2	5
9/5/2017	2	0	2
9/7/2017	2	3	5
9/9/2017	2	84	86
9/11/2017	3	3	6
9/13/2017	3	0	3
9/15/2017	0	3	3
	5,801	5,546	11,347

Volumetric Estimates are in italics
***Bolded** numbers are peak days
**The peak periods are shown in boxes

Table 4.1-1: Number of Juvenile Eel Captured and Length Measurements

Substrate	Enkamat	Milieu	Total
Number eels collected	5,801	5,546	11,347
% per substrate	51.1%	48.9%	
Range on lengths (mm)	99 - 165	110 - 245	
Average length (mm)	130	141.4	
Number measured	643	573	1,216

Table 4.1-2: Juvenile Eel Length Frequency, 2017

TL (mm)	Enkamat	Milieu	Total
90-94	-	-	0
95-99	1	-	1
100-104	3	-	3
105-109	21	-	21
110-114	28	6	34
115-119	76	19	95
120-124	81	39	120
125-129	122	59	181
130-134	100	84	184
135-139	68	82	150
140-144	63	80	143
145-149	33	49	82
150-154	25	53	78
155-159	14	36	50
160-164	7	20	27
165-169	1	19	20
170-174	-	9	9
175-179	-	5	5
180-184	-	4	4
185-189	-	1	1
190-194	-	1	1
195-199	-	1	1
200-204	-	4	4
205-209	-	-	0
210-214	-	-	0
215-219	-	-	0
220-224	-	1	1
225-229	-	-	0
230-234	-	-	0
235-239	-	-	0
240-244	-	-	0
245-249	-	1	1
Total	**643**	**573**	**1,216**

Table 4.2-1: Weekly Juvenile Eel Collection by Week and Ranks

	Wk 1	**Wk 2**	**Wk 3**	**Wk 4**	**Wk 5**	**Wk 6**	**Wk 7**	**Wk 8**	**Wk 9**	**Wk 10**
Enkamat	10	4	6	25	14	4	1	48	950	14
Milieu	7	5	3	14	7	3	1	13	615	5
Total	17	9	9	39	21	7	2	61	1565	19
Rank	12	T-17	T-17	9	10	19	20	7	3	11
# Sampling Days	6	7	3	4	4	3	4	3	5	4
	Wk 11	**Wk 12**	**Wk 13**	**Wk 14**	**Wk 15**	**Wk 16**	**Wk 17**	**Wk 18**	**Wk 19**	**Wk 20**
Enkamat	6	3486	184	25	15	28	940	3	32	6
Milieu	7	3581	235	23	1	41	853	9	117	6
Total	13	7067	419	48	16	69	1793	12	149	12
Rank	14	1	4	8	13	6	2	T-15	5	T-15
# Sampling Days	3	5	6	5	4	4	5	3	5	3

Top 3 ranked weeks are shown in boxes.

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

Table 4.4-1: USGS 01578475 - Octoraro Creek at Richardmere, MD Gage Flows (cfs)

Day	May	June	July	August	September
1	141	110	81	119	93
2	130	98	138	80	104
3	122	87	118	84	222
4	108	80	92	85	172
5	155	79	87	244	134
6	201	84	83	223	280
7	167	96	106	161	283
8	141	93	120	172	195
9	124	84	98	125	145
10	116	74	79	107	123
11	111	67	68	102	113
12	112	62	64	95	107
13	237	58	62	91	106
14	349	55	**557**	86	114
15	223	52	**440**	142	111
16	166	51	179	172	
17	143	58	188	132	
18	130	66	171	**476**	
19	122	83	131	**479**	
20	114	178	98	241	
21	106	129	86	210	
22	108	101	83	180	
23	118	86	88	137	
24	117	220	251	77	
25	142	251	238	70	
26	348	137	158	70	
27	233	116	119	72	
28	154	101	87	75	
29	139	87	111	85	
30	129	78	111	107	
31	122		101	102	

Bolded value represent the highest daily average river flow
*Daily average river flows are represented in cubic feet per second (cfs)

Table 4.4-2: 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 4.4-3: Water Temperature (Daily Average, °C) HOBO Water Temp Pro

Day	May	June	July	August	September
1	19.8	19.3	24.2	25.7	17.8
2	19.0	19.8	25.6	24.8	15.2
3	17.7	19.6	27.0	25.3	19.4
4	15.9	19.5	26.3	25.9	20.1
5	16.1	19.8	25.7	24.0	19.6
6	15.9	20.3	24.1	24.8	21.2
7	14.6	19.7	25.3	23.9	21.6
8	14.0	20.0	25.8	24.6	21.3
9	14.1	20.7	25.3	24.7	20.6
10	15.5	21.3	24.9	23.9	20.4
11	14.1	22.0	25.2	23.7	20.3
12	14.2	21.2	25.9	23.2	20.5
13	12.8	21.6	25.8	24.2	19.9
14	16.3	21.8	25.2	21.4	21.4
15	16.6	21.4	27.0	23.0	20.0
16	17.8	21.4	26.7	25.4	
17	19.1	21.9	25.7	24.0	
18	20.7	22.7	26.0	24.0	
19	21.8	23.0	27.4	26.2	
20	19.5	25.0	27.5	23.0	
21	18.0	25.2	27.4	21.5	
22	17.2	24.9	27.4	24.6	
23	18.2	24.5	26.2	24.4	
24	18.5	25.3	26.1	23.6	
25	18.0	26.3	27.4	23.0	
26	19.1	25.6	26.7	23.0	
27	18.7	25.0	26.3	22.0	
28	18.6	24.7	25.7	21.2	
29	18.5	24.2	25.0	21.1	
30	18.0	24.1	24.9	22.0	
31	18.5		25.7	22.2	

Table 4.4-4: Dissolved Oxygen (mg/L) Reading Taken in Collection Tank

Day	May	June	July	August	September
1	16.5	6.5		3.1	3.8
2	6.4		5.9		
3		5.5		2.5	6.5
4	8.4		3.7		6.0
5	7.8	5.5		5.5	5.8
6	8.3		3.8	5.5	
7	8.6	5.62		4.3	7.1
8	9.8		4.5		
9	8.4	5.9		4.5	6.0
10	8.2		2.8		
11	7.7	4.6		3.8	5.3
12	7.7		2.2		
13	7.5	4.5		4.3	5.9
14			1.8	4.3	
15	8.6	4.2		4.3	5.3
16			6.4		
17	7.3	4.2	6.0	5.5	
18			5.3		
19	6.6	4.5	4.9	6.5	
20				3.4	
21	6.8	5.5	3.1	1.9	
22	6.9				
23		4.6	4.2	3.6	
24	7.8		6.4	3.8	
25		6.6	6.0		
26	8.5	5.4	5.6	2.3	
27		6.1			
28	6.7	3.6	4.1	3.5	
29			3.8		
30	6.9	3.6	4.3	4.6	
31			4.5		

Table 4.5-1: Eel Transport/Stocking Data, 2017

Location of Capture	Collected	Died in Collection Tank	Died in Holding	Transported to Conowingo Eel Collection Facility	Died in Transport to Conowingo Eel Collection Facility	Removed for Analysis	Mortality %	Available for Stocking
Octoraro Creek	11,347	6 (0.05%)	0	11,341	2 (0.02%)	0	0.07%	11,339
Conowingo	122,300	17 (0.01%)	**3,447** (2.82%)	n/a	n/a	193	2.83%	118,643
Total								129,982

Bolded value is assumed as the worst case scenario. These eels could be from Octoraro or Conowingo.

Table 4.5-2: Water Quality Parameters at Associated Locations at Octoraro Creek, 2017

Date	Time	Enkamat		Milieu		Head Pond	
		Temp	DO	Temp	DO	Temp	DO
5/1/2017	1040	17.7	16.4	17.1	16.8	17.6	16.5
5/2/2017	1040	19.0	8.6	18.0	8.6	18.1	6.4
5/3/2017	1010	17.9	--	17.9	--	18.2	--
5/4/2017	1132	18.1	8.6	17.8	8.7	17.2	8.4
5/5/2017	1040	16.4	8.3	16.4	8.3	17.0	7.8
5/6/2017	815	16.9	9.0	16.9	8.8	17.1	8.3
5/7/2017	1000	16.0	9.0	15.8	9.1	16.2	8.6
5/8/2017	1110	16.2	10.2	16.1	10.3	16.1	9.8
5/9/2017	1025	14.7	7.5	14.9	8.2	15.5	8.4
5/10/2017	915	15.9	7.8	15.9	9.2	15.8	8.2
5/11/2017	938	16.2	8.3	16.3	8.2	16.3	7.7
5/12/2017	745	15.8	8.2	15.7	8.3	15.9	7.7
5/13/2017	800	15.2	7.6	15.1	7.9	15.5	7.5
5/15/2017	1000	16.1	8.5	26.2	8.5	16.1	8.6
5/17/2017	745	16.5	7.6	16.5	7.7	16.6	7.3
5/19/2017	740	19.3	6.9	19.2	6.9	19.2	6.6
5/21/2017	815	18.4	6.8	18.4	6.7	18.5	6.8
5/22/2017	930	17.8	7.4	17.7	7.5	17.7	6.9
5/24/2017	730	18.0	7.4	18.0	7.5	18.0	7.8
5/26/2017	800	18.6	8.2	18.6	8.3	18.8	8.5
5/28/2017	900	18.6	5.9	18.4	6.3	18.3	6.7
5/30/2017	1100	17.7	7.7	17.7	7.8	17.9	6.9
6/1//2017	805	18.1	8.0	18.1	7.6	18.2	6.5
6/3/2017	700	18.4	5.9	18.4	6.3	18.7	5.5
6/5/2017	1025	19.7	6.2	19.6	6.5	19.5	5.5
6/7/2017	815	19.4	6.3	19.4	6.4	19.6	5.6
6/9/2017	1525	19.7	6.2	19.8	6.4	19.6	5.9
6/11/2017	800	20.3	6.2	20.2	6.3	20.2	4.6
6/13/2017	800	21.2	5.6	21.2	5.6	21.0	4.5
6/15/2017	815	21.0	5.2	21.0	5.2	20.9	4.2
6/17/2017	757	21.7	4.8	21.6	5.0	--	--
6/19/2017	815	23.0	5.2	22.9	5.3	22.7	4.5
6/21/2017	830	24.3	5.6	24.3	5.6	24.4	5.5
6/23/2017	840	24.0	6.2	24.0	6.2	23.9	4.6
6/25/2017	715	25.4	7.0	25.3	6.1	25.5	6.6
6/26/2017	800	24.5	5.4	24.4	3.7	24.5	5.4
6/27/2017	930	24.3	7.6	24.4	7.4	24.3	6.1

Date	Time	Enkamat		Milieu		Head Pond	
		Temp	DO	Temp	DO	Temp	DO
6/28/2017	725	23.5	6.4	23.4	6.6	23.7	3.6
6/30/2017	700	23.4	6.9	23.4	7.0	23.5	3.6
7/2/2017	710	24.9	7.0	24.8	7.3	25.0	5.9
7/4/2017	704	25.5	6.9	25.5	6.9	25.7	3.7
7/6/2017	848	24.7	6.2	24.7	6.6	24.8	3.8
7/8/2017	700	24.5	6.7	24.9	6.8	25.1	4.5
7/10/2017	720	24.6	4.1	24.5	6.2	24.7	2.8
7/12/2017	833	25.0	5.3	25.0	5.2	24.8	2.2
7/14/2017	800	25.2	4.9	25.2	5.0	25.1	1.8
7/16/2017	845	25.9	3.0	25.9	1.3	26.0	6.4
7/17/2017	1125	26.9	5.9	26.9	3.7	26.6	6.0
7/18/2017	815	25.8	1.8	25.9	2.0	25.6	5.3
7/19/2017	813	26.1	5.9	26.0	5.8	26.1	4.9
7/21/2017	706	26.7	5.9	26.5	6.3	26.8	3.1
7/23/2017	800	26.6	5.3	26.4	5.4	26.2	4.2
7/24/2017	842	26.5	7.3	26.6	7.2	26.9	6.4
7/25/2017	759	27.1	6.1	27.2	6.0	27.3	6.0
7/26/2017	730	26.6	6.4	26.4	7.0	26.2	5.6
7/28/2017	845	25.4	4.9	25.4	5.7	25.3	4.1
7/29/2017	630	25.2	4.7	25.0	5.3	25.3	3.8
7/30/2017	650	24.3	6.3	24.3	7.1	24.5	4.3
7/31/2017	1000	25.0	5.6	25.1	5.8	24.8	4.5
8/1/2017	805	24.5	6.1	24.4	6.1	25.0	3.1
8/3/2017	840	24.3	4.7	24.3	4.9	24.3	2.5
8/5/2017	710	24.3	4.7	24.3	4.9	24.4	5.5
8/6/2017	730	24.6	6.1	24.7	5.9	25.1	5.5
8/7/2017	845	24.5	5.2	24.5	5.0	24.6	4.3
8/9/2017	800	23.4	5.6	23.4	5.3	23.7	4.5
8/11/2017	845	23.8	5.6	23.9	5.2	23.8	3.8
8/13/2017	715	23.8	5.5	23.8	5.2	23.9	4.3
8/14/2017	1140	24.3	6.2	24.2	5.8	24.1	4.3
8/15/2017	800	23.9	7.0	23.9	6.5	23.9	4.3
8/17/2017	1007	24.0	9.6	23.9	9.4	24.2	5.5
8/19/2017	700	24.9	6.9	24.7	6.1	24.9	6.5
8/20/2017	1030	24.4	4.1	24.4	4.0	24.2	3.4
8/21/2017	830	23.4	4.8	23.3	5.5	23.4	1.9
8/23/2017	950	23.8	4.5	23.8	3.2	23.6	3.6
8/24/2017	1045	23.8	5.9	23.9	5.8	23.7	3.8
8/26/2017	745	23.2	4.9	22.9	5.6	23.2	2.3

Date	Time	Enkamat		Milieu		Head Pond	
		Temp	DO	Temp	DO	Temp	DO
8/28/2017	800	22.8	5.0	22.7	5.4	22.7	3.8
8/30/2017	944	22.4	5.1	22.4	5.2	22.4	4.6
9/1/2017	800	22.3	5.6	21.7	5.7	22.7	3.8
9/3/2017	815	21.7	6.3	21.6	7.4	21.9	6.5
9/4/2017	745	20.6	6.9	20.8	7.3	21.4	6.0
9/5/2017	920	21.5	7.2	21.4	7.1	21.4	5.8
9/7/2017	947	21.3	7.4	21.3	7.1	21.4	7.1
9/9/2017	905	20.3	6.5	20.1	6.6	20.3	6.0
9/11/2017	900	19.7	5.7	19.7	5.7	19.9	5.3
9/13/2017	915	20.2	6.1	20.2	7.1	20.2	5.9
9/15/2017	745	20.7	6.2	20.6	7.0	20.7	5.3

No reading was from problem with the meter or did not have access to obtain a reading 6/13/17, started using the aerator and continued until the end of the season.

Table 4.6-1: Calibration of Flows (Liters per Minute) in the Eel Collection Facility, 2017

	DATE									
	5/8	**5/15**	**5/22**	**5/29 ***	**6/5 ****	**6/12**	**6/19 ***	**6/26**	**7/3 ****	**7/10**
Enkamat Ramp										
Spray bar	17.8	16.8	17.2	15.6	17.6	15.8	16.0	20.0	13.8	17.4
Collection tank drain	5.2	3.4	2.8	1.9	2.4	2.0	1.8	4.1	1.3	3.0
Top Attraction flow	12.6	13.4	14.4	13.7	15.2	13.8	14.2	15.9	12.5	14.4
Bottom Attraction flow	27.2	27.3	20.6	30.0	29.1	27.0	24.6	14.0	32.7	21.0
Total Attraction Flow	**45.0**	**44.1**	**37.8**	**45.6**	**46.7**	**42.8**	**40.6**	**34.0**	**46.5**	**38.4**
Milieu Ramp										
Spray bar	18.4	17.0	18.4	15.8	18.0	13.8	16.2	20.0	14.4	18.0
Collection tank drain	3.8	2.4	3.0	2.1	2.4	1.8	1.4	3.2	1.6	2.4
Top Attraction flow	14.6	14.6	15.4	13.7	15.6	12.0	14.8	16.8	12.8	15.6
Bottom Attraction flow	28.8	29.4	22.4	26.7	25.8	26.4	24.0	14.0	24.0	15.0
Total Attraction Flow	**47.2**	**46.4**	**40.8**	**42.5**	**43.8**	**40.2**	**40.2**	**34.0**	**38.4**	**33.0**
Overall Attraction Flows	92.2	90.5		88.1	90.5	83.0	80.8	68.0	84.9	71.4

* Cleaned hoses to increase flow

** Pump and/or hoses were changed to increase flow

(continued)

Table 4.6-1: (Continued)

	DATE								
	7/17	**7/24 ***	**8/1 ****	**8/7**	**8/14**	**8/21 ****	**8/28 ***	**9/5**	**9/11**
Enkamat Ramp									
Spray bar	12.4	11.8	14.0	12.2	15.6	13.0	12.4	12.4	13.4
Collection tank drain	1.1	2.1	1.7	1.0	5.4	1.7	1.8	2.5	1.6
Top Attraction flow	11.3	9.7	12.3	11.2	10.2	11.3	10.6	9.9	11.8
Bottom Attraction flow	20.7	27.0	21.0	19.8	9.3	18.6	18.6	18.0	16.6
Total Attraction Flow	**33.1**	**38.8**	**35.0**	**32.0**	**24.9**	**31.6**	**31.0**	**30.4**	**30.0**
Milieu Ramp									
Spray bar	14.4	12.0	13.6	12.2	15.3	15.4	13.2	13.6	13.6
Collection tank drain	2.0	1.9	1.8	1.0	5.7	1.4	1.8	2.1	1.8
Top Attraction flow	12.4	10.1	11.8	11.2	9.6	14.0	11.4	11.5	11.8
Bottom Attraction flow	23.4	24.0	18.0	19.2	14.4	21.0	18.9	16.0	14.0
Total Attraction Flow	**37.8**	**36.0**	**31.6**	**31.4**	**29.7**	**36.4**	32.1	**29.6**	**27.6**
Overall Attraction Flows	70.9	74.8	66.6	63.4	54.6	68.0	63.1	60.0	57.6

* Cleaned hoses to increase flow

** Pump and/or hoses were changed to increase flow

Table 5.0-1: Comparison of Octoraro Creek Eel Ramps, 2015-2017

Watershed area 540 km^2

Approximate Distance from Ocean to ramp 341 km

	2015	2016	2017	Average
Eels Collected	7,197	21,094	11,347	13,213
Average Size (mm)	129.4	130.9	135.4	131.9
Range of Sizes (mm)	95-232	99-202	99-245	
Days of Operation	89	138	138	122
Average eels per day	80.9	152.9	82.2	105.3
Average creek flow (cfs)	180.9	121.3	138.0	146.7
Range of flows (cfs)	60-1,490	43-512	51-557	

Table 6.0-1: Octoraro and Conowingo Juvenile Eel Collection, 2015-2017

Facility Data	2015		2016		2017	
	Conowingo	Octoraro	Conowingo	Octoraro	Conowingo	Octoraro
Operation Start Date	05/20	06/16	05/11	05/01	05/01	05/01
Operation End Date	09/09	09/15	09/14	09/15	09/15	09/15
Eel Catch (n)	58,444	7,197	2,684	21,094	122,300	11,347
Total Operating Days	112	89	126	137	138	138
CPUE (n/day)	521.8	80.9	21.3	154.0	886.2	82.2
CPUE Octoraro/Conowingo	0.155		7.228		0.093	

Table 6.0-2: Combined Octoraro and Conowingo Juvenile Eel Collection, 2015-2017

Facility Data (2015-2017)	Conowingo	Octoraro
Total Catch	183,428	39,638
Operating Days	376	364
CPUE (n/day)	487.8	108.9
CPUE Octoraro/Conowingo	0.223	

EXELON GENERATION COMPANY, LLC

CONOWINGO HYDROELECTRIC PROJECT
PROJECT NO. 405

0 0.5 1 2
Miles

N

Figure 2.0-1: Lower Octoraro Creek From Pine Grove Dam to the Mouth at the Susquehanna River, Octoraro Creek (Stone Masonry Dam As Known As Pine Grove Low-Head Dam)

Path: X:\GISMaps\project_maps\eel_study_plan\2017_octoraro_creek_location_map.mxd

Figure 2.0-2: Location of the Juvenile Eel Collection Facility on South Shore (Left Bank) Of Octoraro Creek Downstream of Art Building

Figure 2.0-3: Peak Timing of Historical Eel Passage at Conowingo, 2008-2016

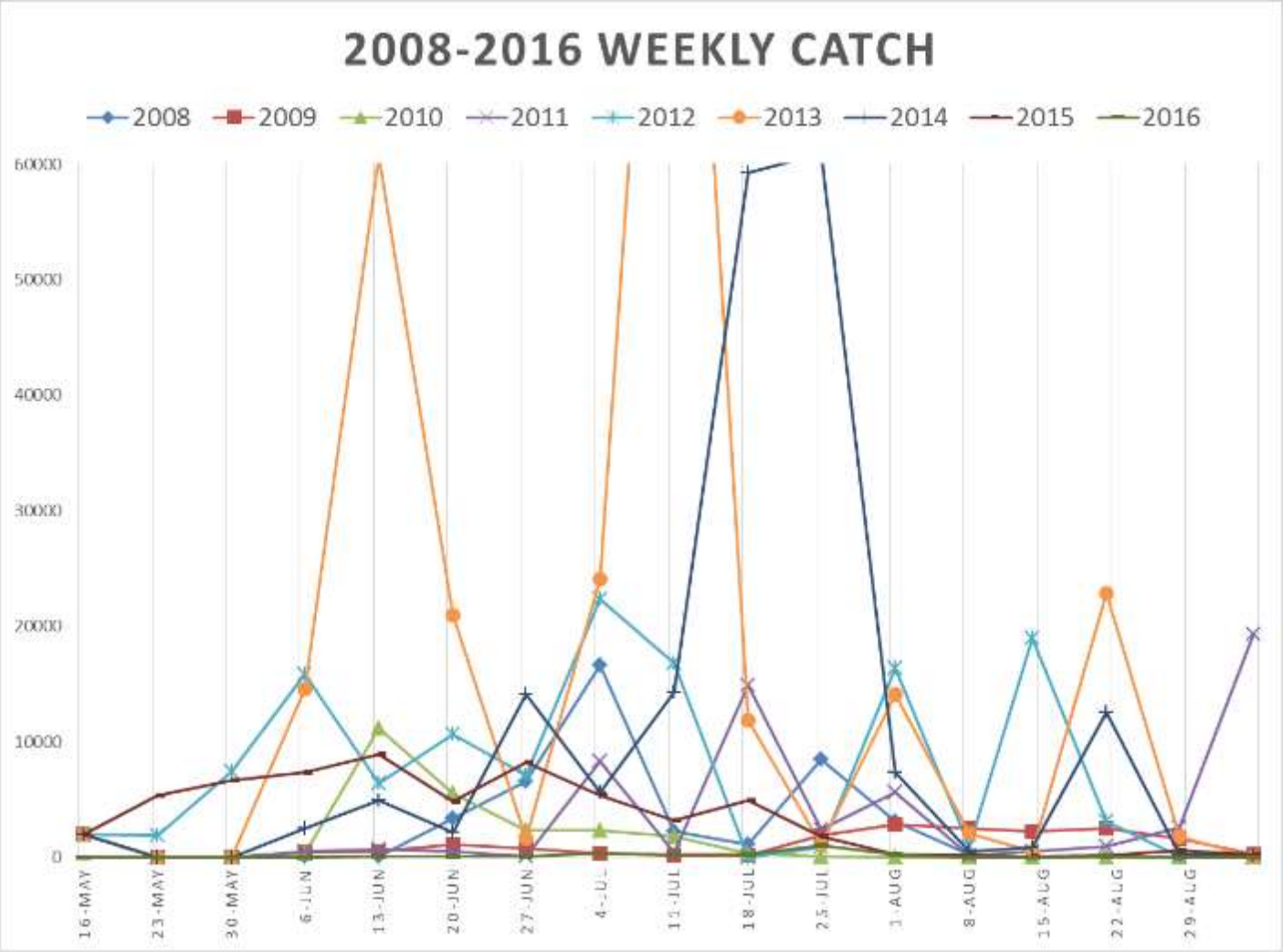


Figure 3.1-1: Photo of Enkamat and Milieu Substrate Installed in Ramps, Octoraro Creek

Figure 3.1-2: T-Bar Support for Ramp Support, Octoraro Creek

Figure 3.1-3: Additional Attraction Flow Hose Added to Entrance, Octoraro Creek

Figure 3.1-4: Manifold for Garden Hose Supply Lines for Attraction Flows, Octoraro Creek

Figure 3.1-5: Overview Photo of Spray Bar, and Screened Drain in Collection Tank, Octoraro Creek

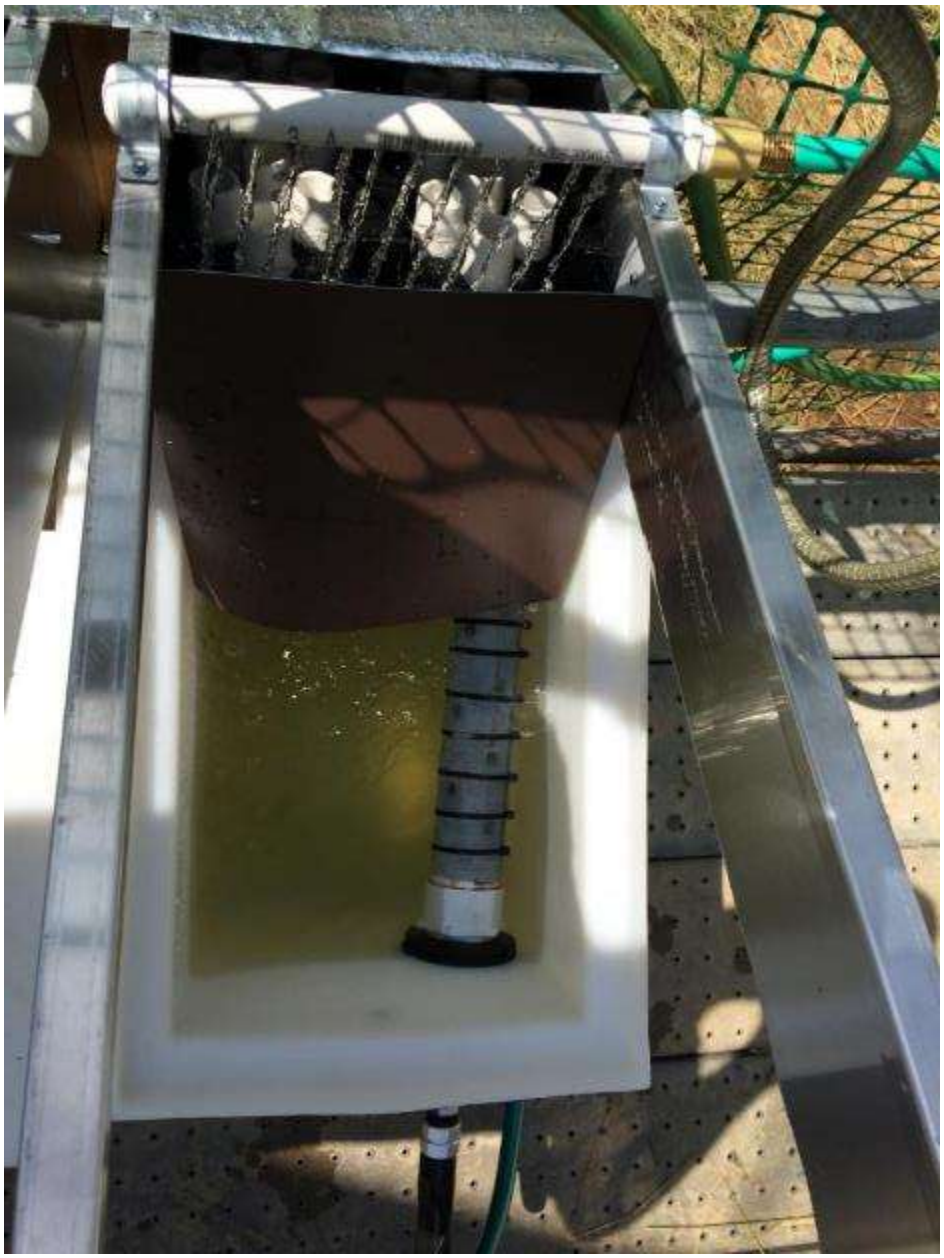


Figure 3.1-6: Individual Collection Tanks for Each Substrate, Octoraro Creek

Figure 3.1-7: Aerator Powered by a Marine Battery and Charged by a Solar Panel, Octoraro Creek

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, Octoraro Creek

Figure 4.2-1: Percent Eel Catch per Week, Octoraro Creek, 2017

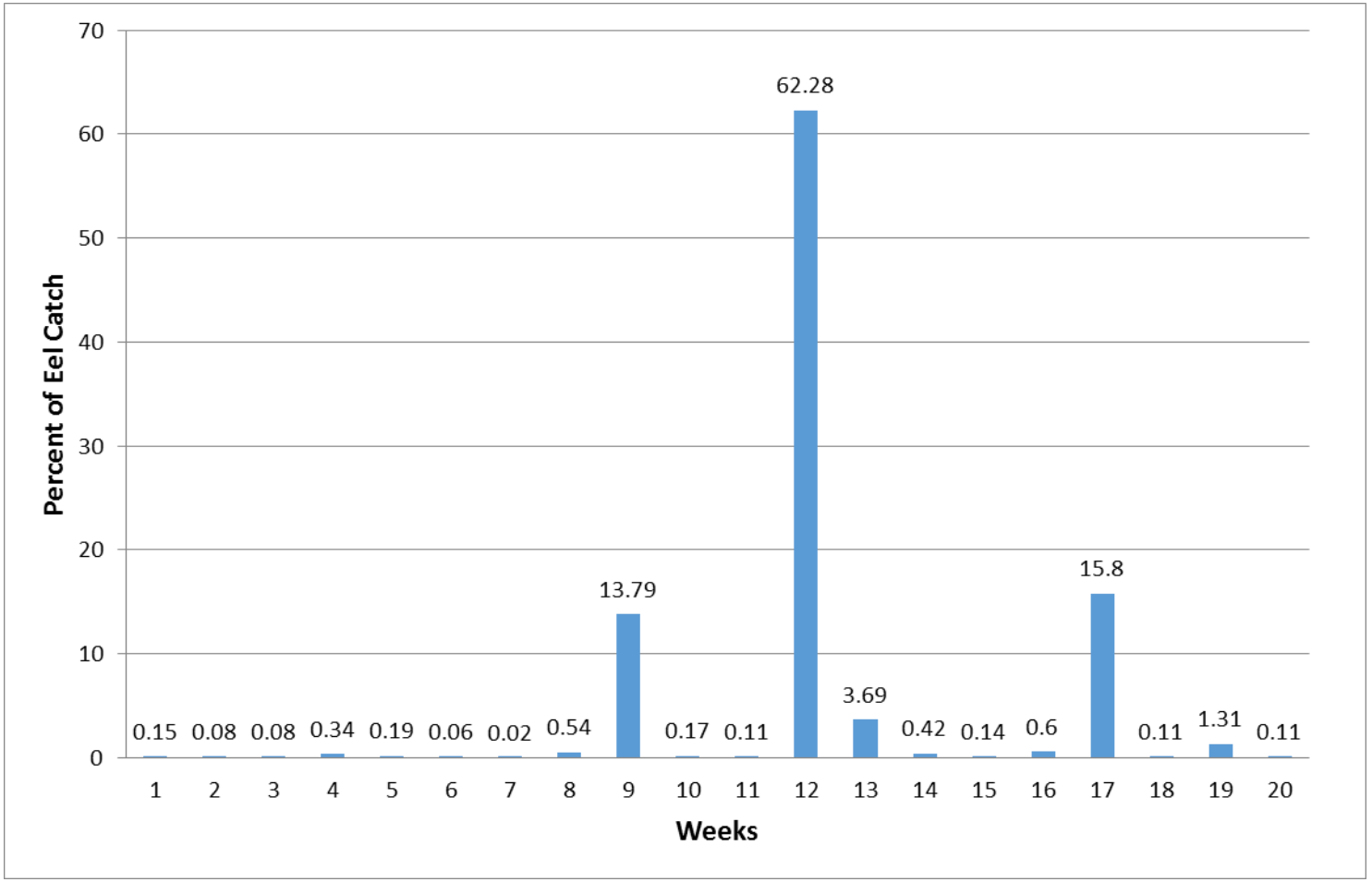


Figure 4.4-1: Weekly Eel Catch to Weekly Average Creek Flow, Octoraro Creek, 2017

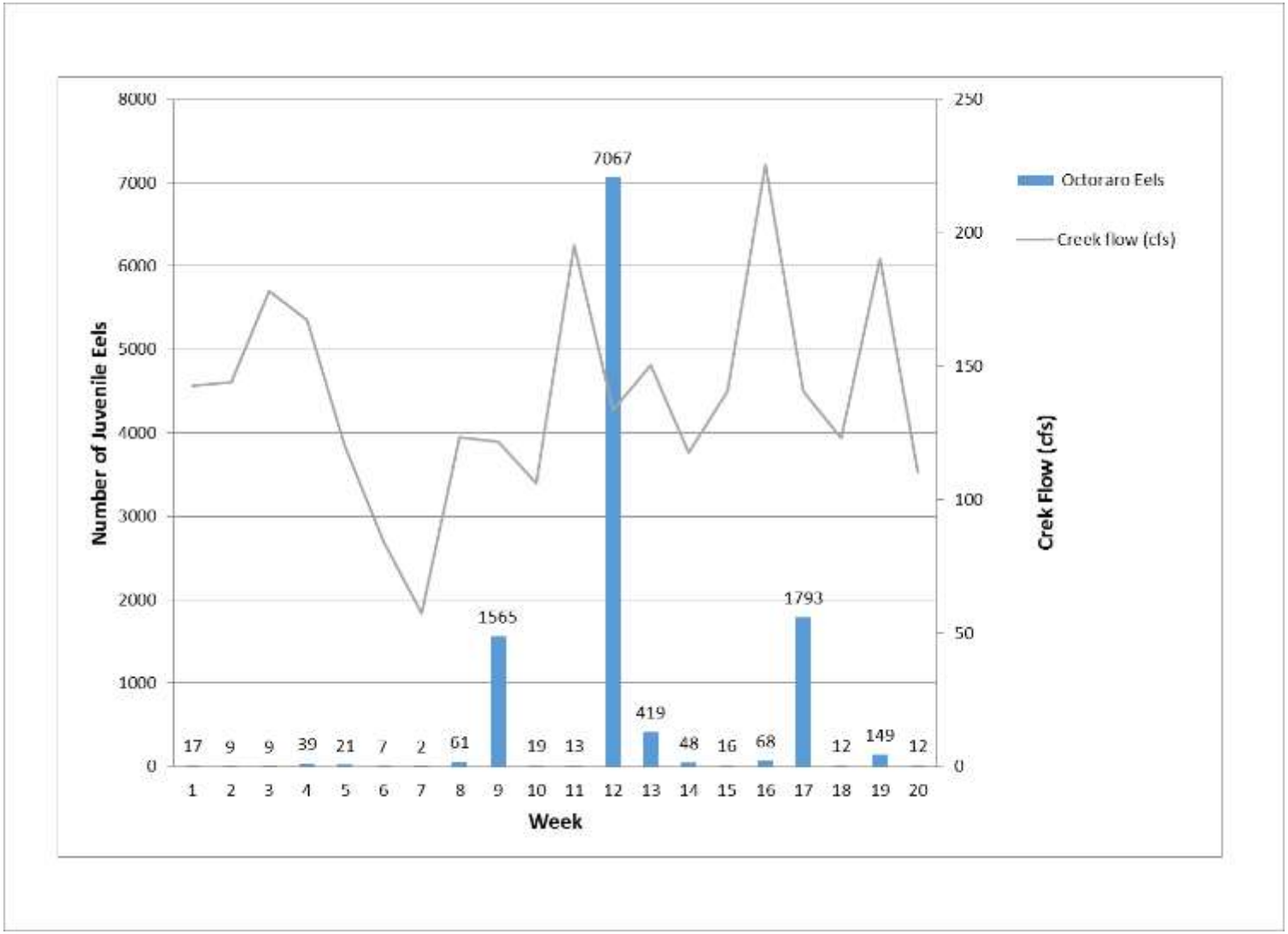


Figure 4.4-2: Weekly Eel Catch to Weekly Average Lunar Fraction, Octoraro Creek, 2017 *(1.0 Equals Full Moon)*

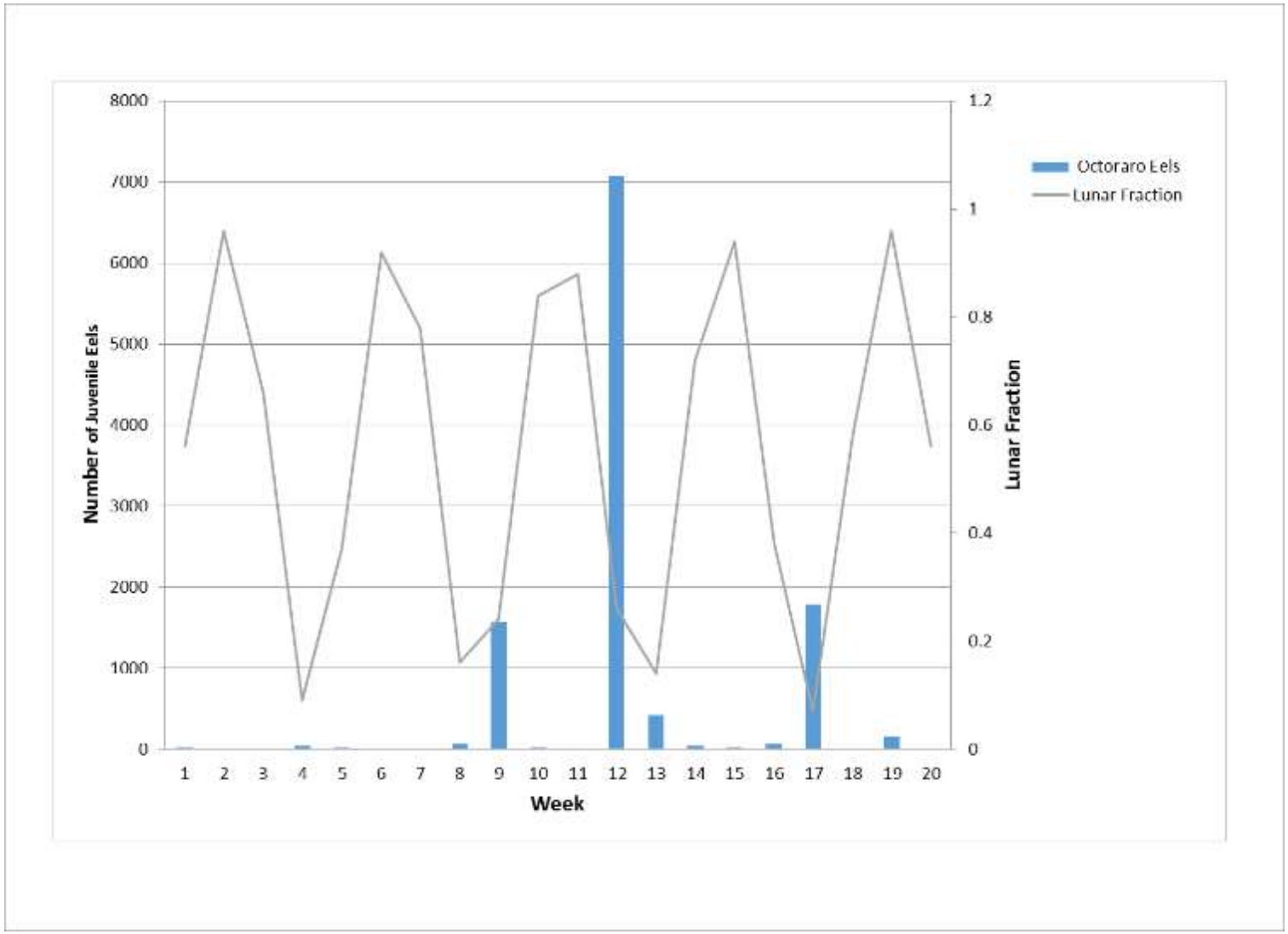


Figure 4.4-3: Weekly Eel Catch to Weekly Average Water Temperature, Octoraro Creek, 2017

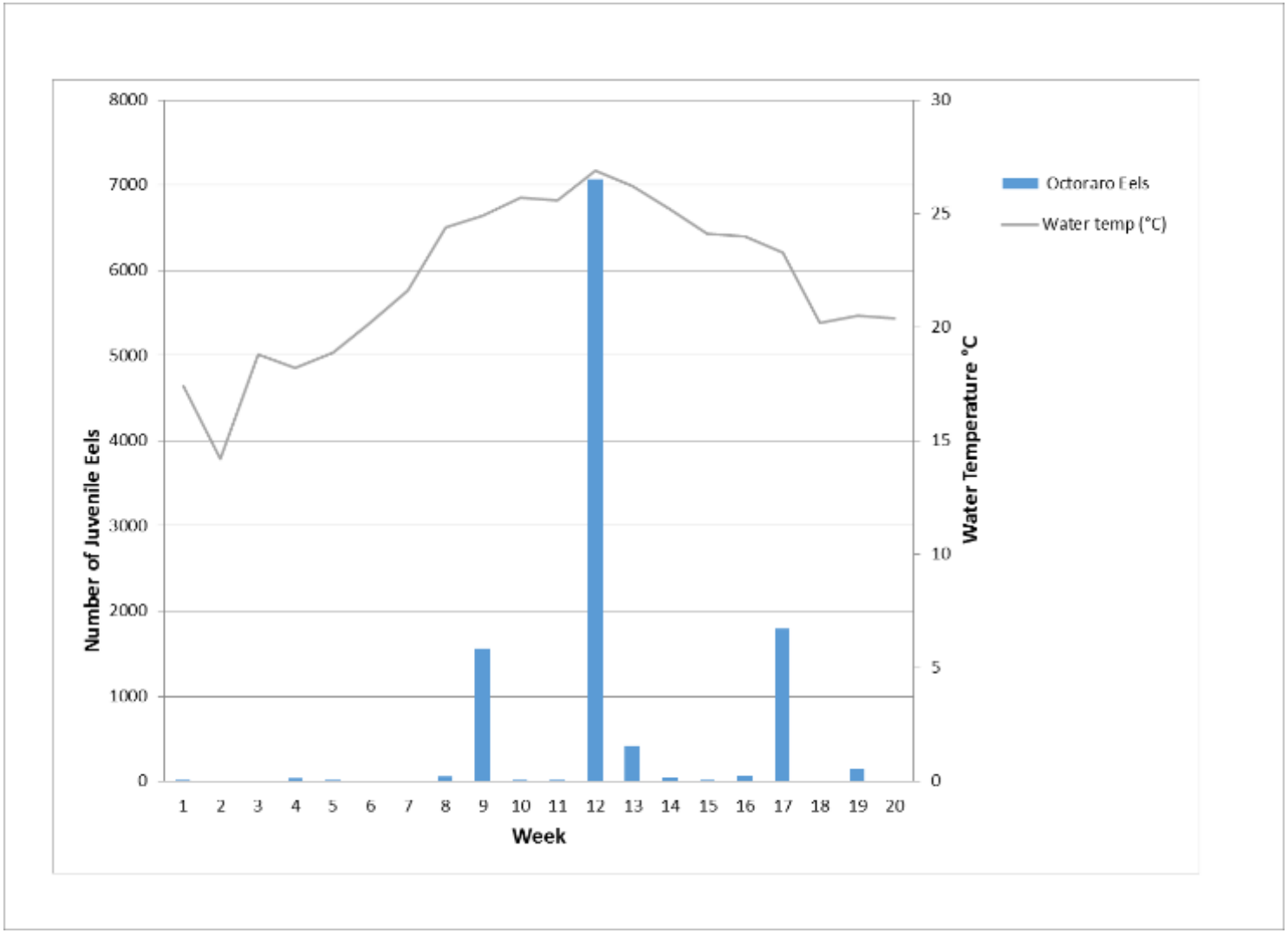


Figure 4.4-4: Comparison of Dissolved Oxygen Readings in Collection Tanks and Head Pond, Octoraro Creek, 2017

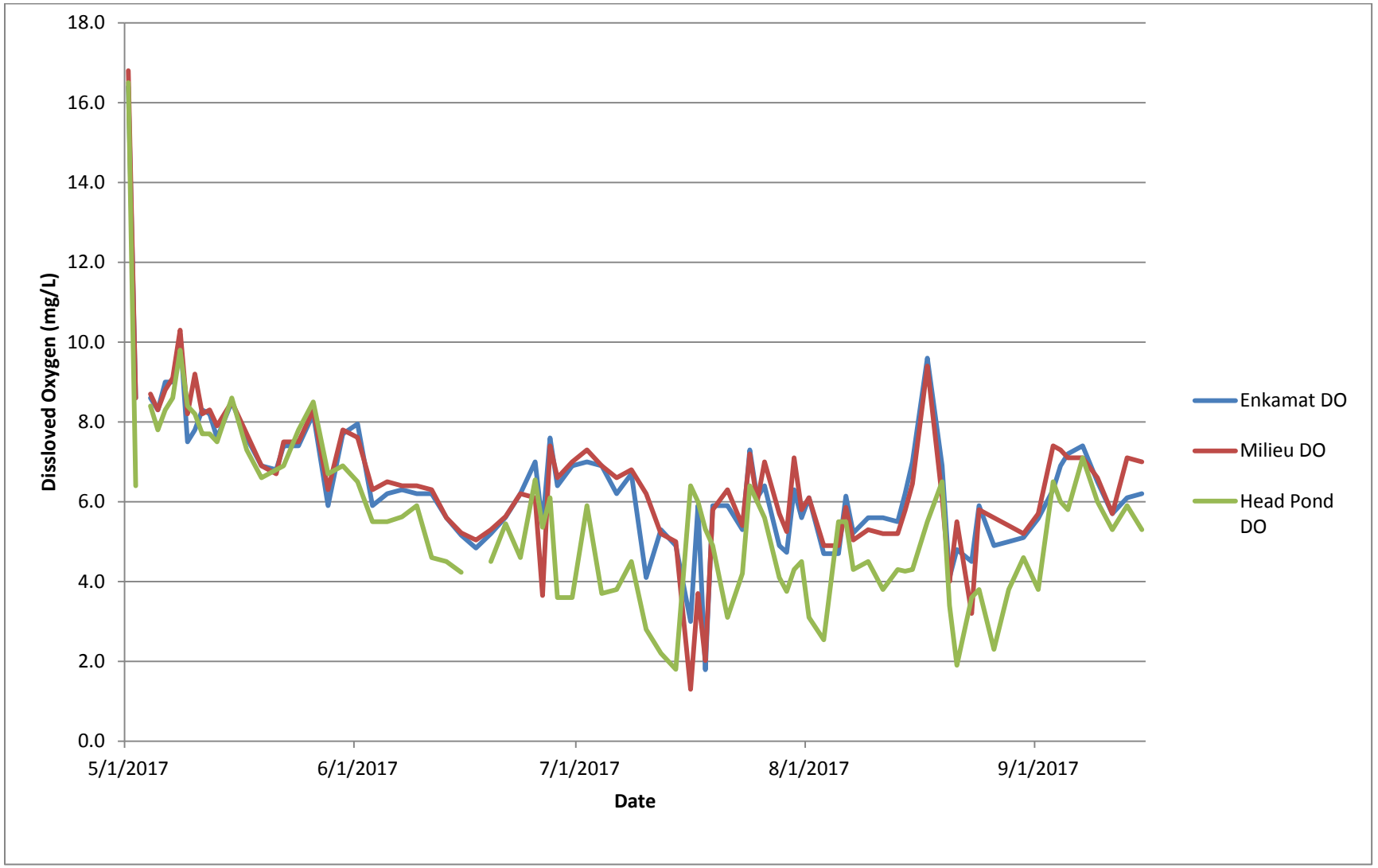


Figure 4.4-5: Weekly Eel Catch to Weekly Average Dissolved Oxygen, Octoraro Creek Eel Facility Collection Tanks, 2017

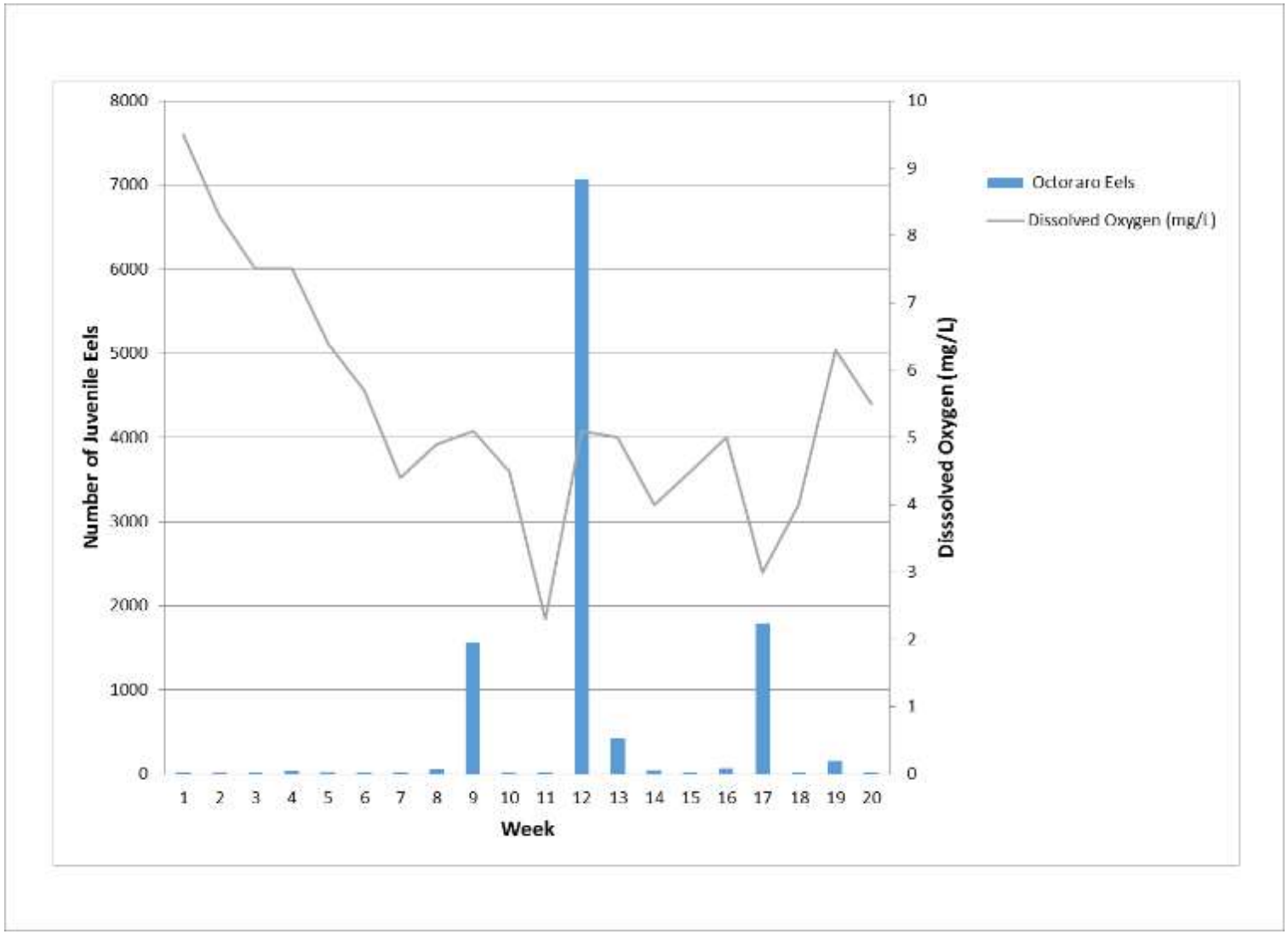
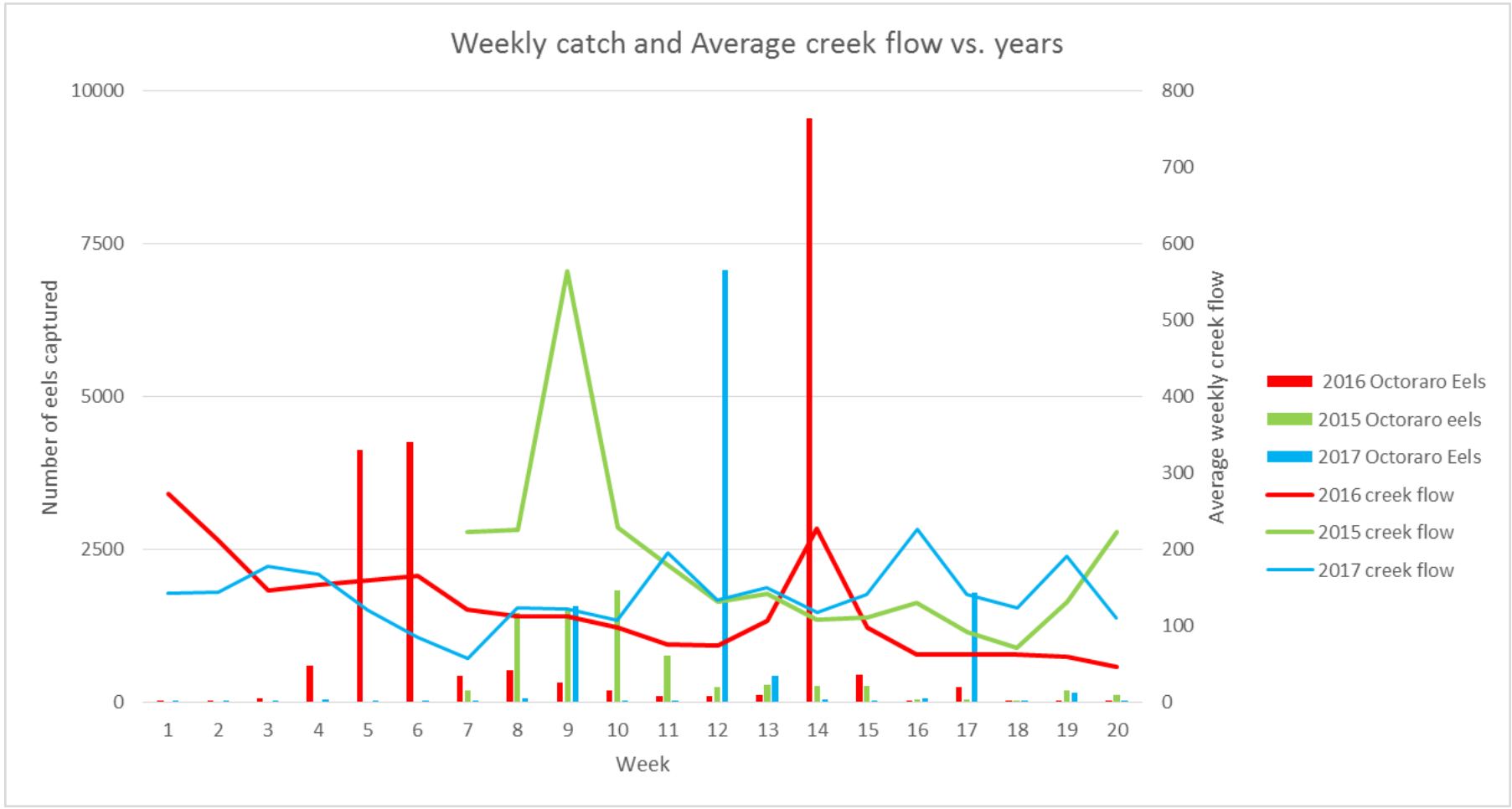
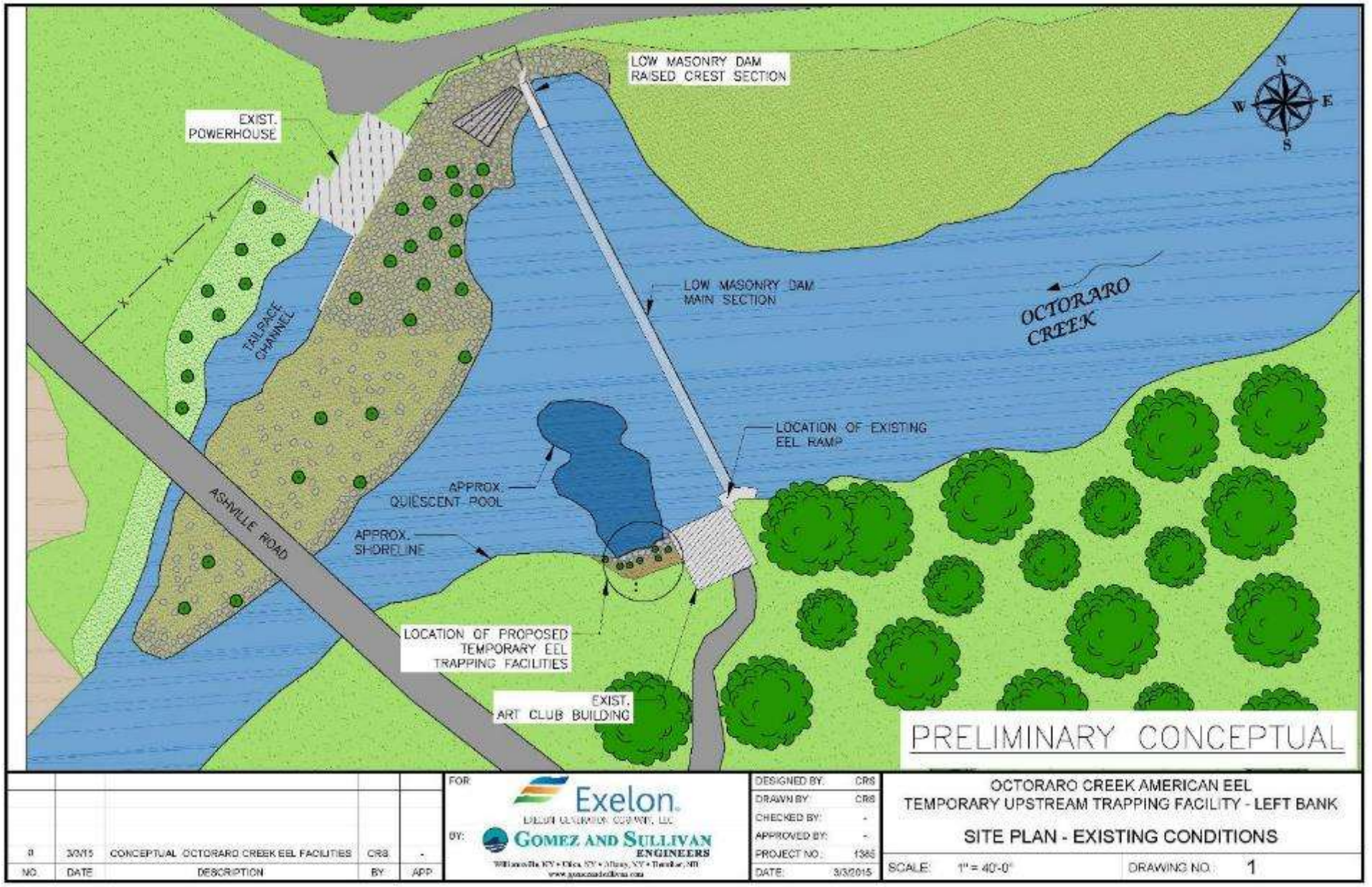


Figure 5.0-1: Weekly Catch and Average Creek Flow, Octoraro Creek, 2015-2017



Appendix A:
Conceptual Design of Trapping Facility on South Shore of Octoraro Creek, 2015


LOW MASONRY DAM
RAISED CREST SECTION
EXIST.
POWERHOUSE
N
W
E
S
LOW MASONRY DAM
MAIN SECTION
OCTORARO
CREEK
TAILRACE
CHANNEL
LOCATION OF EXISTING
EEL RAMP
APPROX.
QUIESCENT POOL
APPROX.
SHORELINE
ASHVILLE ROAD
LOCATION OF PROPOSED
TEMPORARY EEL
TRAPPING FACILITIES
EXIST.
ART CLUB BUILDING
PRELIMINARY CONCEPTUAL
NO
DATE
DESCRIPTION
BY
APP
0
3/3/15
CONCEPTUAL OCTORARO CREEK EEL FACILITIES
CRS
-
FOR:
Exelon.
BY:
GOMEZ AND SULLIVAN
ENGINEERS
DESIGNED BY: CRS
DRAWN BY: CRS
CHECKED BY: -
APPROVED BY: -
PROJECT NO.: 1385
DATE: 3/3/2015
OCTORARO CREEK AMERICAN EEL
TEMPORARY UPSTREAM TRAPPING FACILITY - LEFT BANK
SITE PLAN - EXISTING CONDITIONS
SCALE: 1" = 40'-0"
DRAWING NO.: 1

Appendix A-2

PHOTO 1: VIEW OF ART BUILDING AND "QUIESCENT POOL" FROM RIGHT BANK

NO.	DATE	DESCRIPTION	BY	APP
0	8/2015	CONCEPTUAL OCTORARO CREEK EEL FACILITIES	CRS	-

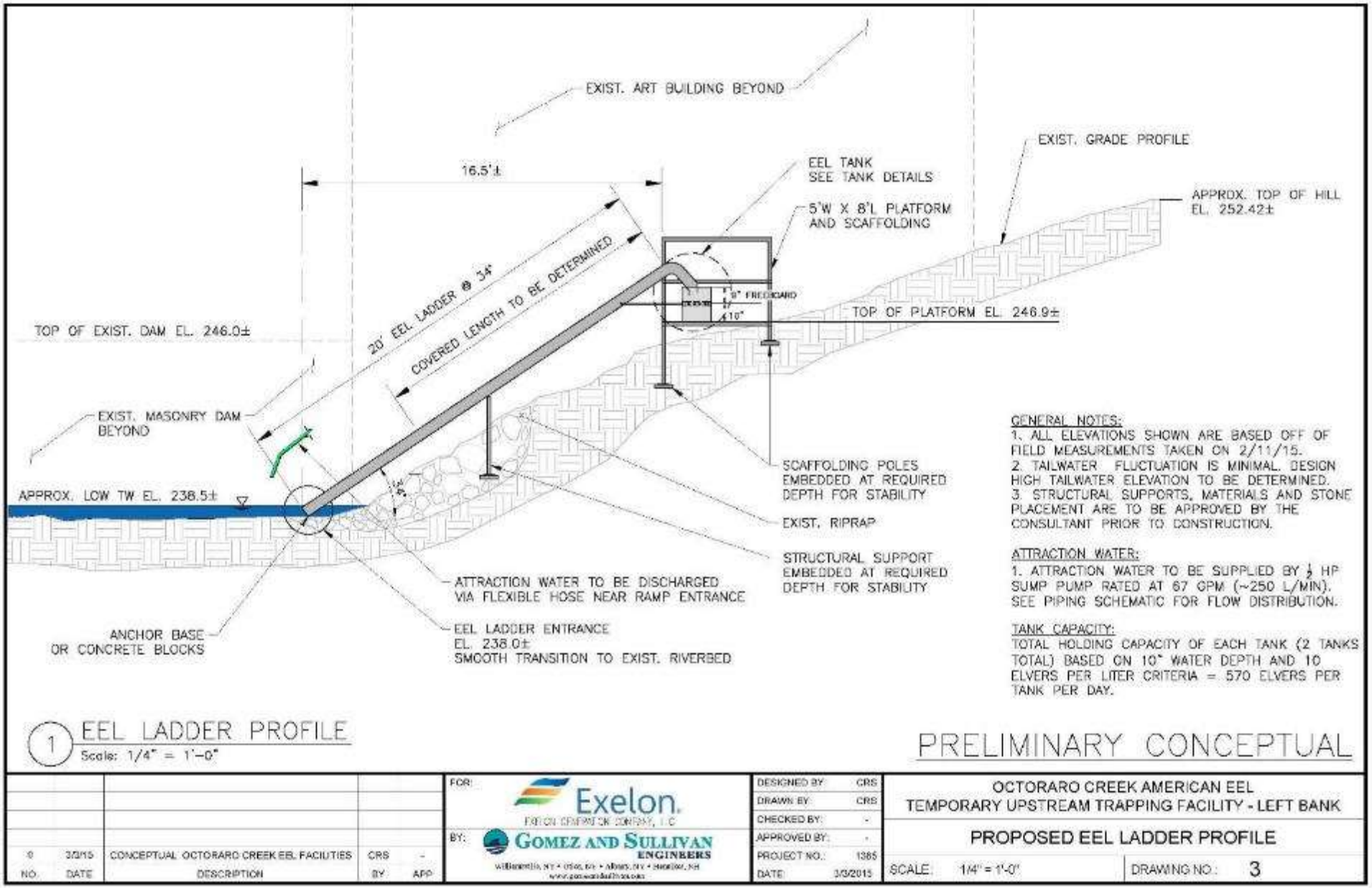
FOR: Exelon. EXELON GENERATION COMPANY, LLC
BY: GOMEZ AND SULLIVAN ENGINEERS

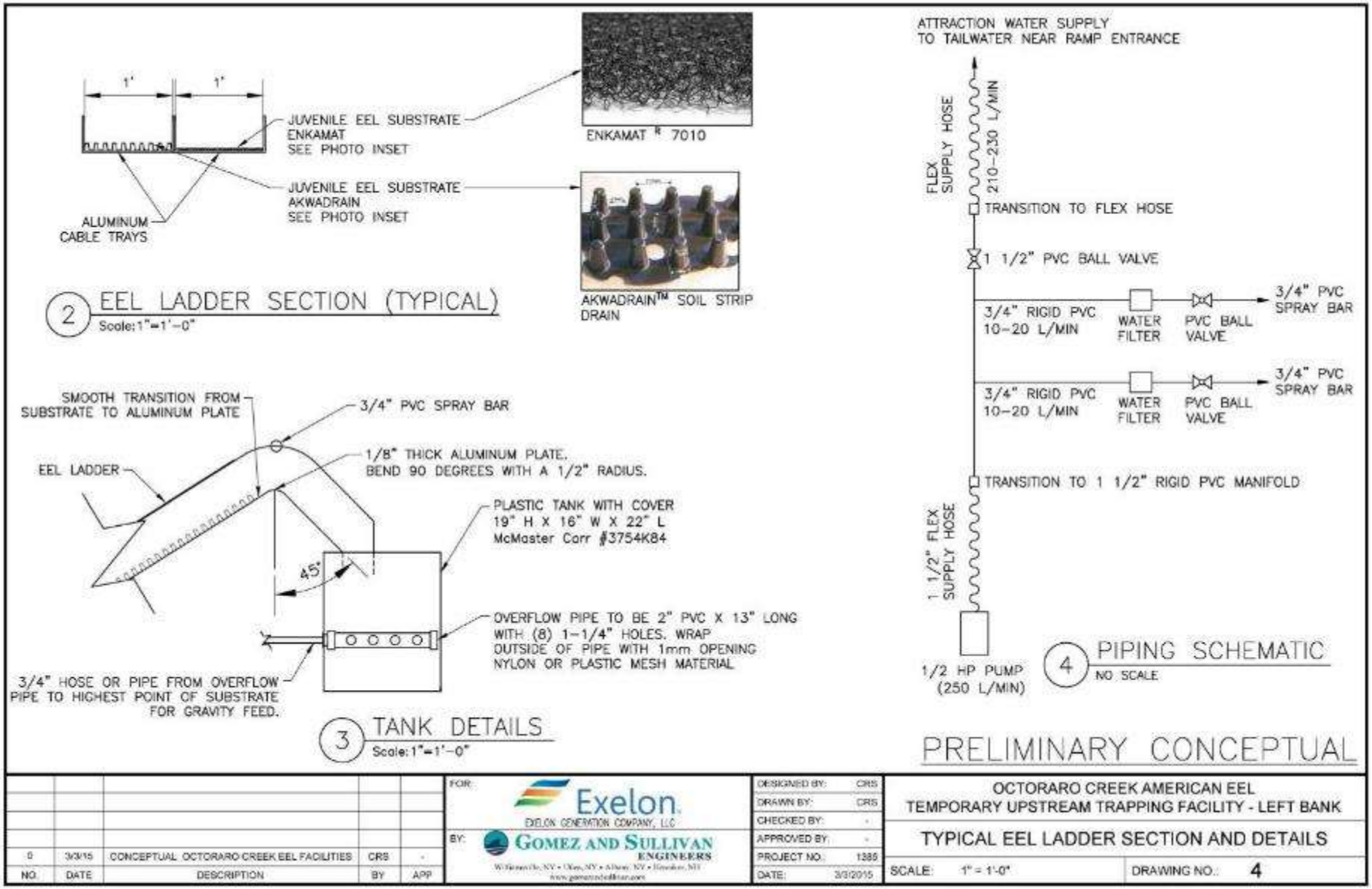
DESIGNED BY	CRS
DRAWN BY	CRS
CHECKED BY	-
APPROVED BY	-
PROJECT NO.	1381
DATE	8/3/2015

OCTORARO CREEK AMERICAN EEL
TEMPORARY UPSTREAM TRAPPING FACILITY - LEFT BANK

PLAN: 34' EEL LADDER ALONG DAM

SCALE: 1" = 10'-0" DRAWING NO.: 2


EXIST. ART BUILDING BEYOND
EXIST. GRADE PROFILE
16.5'±
EEL TANK
SEE TANK DETAILS
5'W X 8'L PLATFORM
AND SCAFFOLDING
APPROX. TOP OF HILL
EL. 252.42±
20' EEL LADDER @ 34°
COVERED LENGTH TO BE DETERMINED
8" FREEBOARD
10"
TOP OF PLATFORM EL. 246.9±
TOP OF EXIST. DAM EL. 246.0±
EXIST. MASONRY DAM
BEYOND
APPROX. LOW TW EL. 238.5±
SCAFFOLDING POLES
EMBEDDED AT REQUIRED
DEPTH FOR STABILITY
EXIST. RIPRAP
STRUCTURAL SUPPORT
EMBEDDED AT REQUIRED
DEPTH FOR STABILITY
ATTRACTION WATER TO BE DISCHARGED
VIA FLEXIBLE HOSE NEAR RAMP ENTRANCE
ANCHOR BASE
OR CONCRETE BLOCKS
EEL LADDER ENTRANCE
EL. 238.0±
SMOOTH TRANSITION TO EXIST. RIVERBED
GENERAL NOTES:
1. ALL ELEVATIONS SHOWN ARE BASED OFF OF FIELD MEASUREMENTS TAKEN ON 2/11/15.
2. TAILWATER FLUCTUATION IS MINIMAL. DESIGN HIGH TAILWATER ELEVATION TO BE DETERMINED.
3. STRUCTURAL SUPPORTS, MATERIALS AND STONE PLACEMENT ARE TO BE APPROVED BY THE CONSULTANT PRIOR TO CONSTRUCTION.
ATTRACTION WATER:
1. ATTRACTION WATER TO BE SUPPLIED BY ½ HP SUMP PUMP RATED AT 67 GPM (~250 L/MIN). SEE PIPING SCHEMATIC FOR FLOW DISTRIBUTION.
TANK CAPACITY:
TOTAL HOLDING CAPACITY OF EACH TANK (2 TANKS TOTAL) BASED ON 10" WATER DEPTH AND 10 ELVERS PER LITER CRITERIA = 570 ELVERS PER TANK PER DAY.
1 EEL LADDER PROFILE
Scale: 1/4" = 1'-0"
PRELIMINARY CONCEPTUAL
NO. DATE DESCRIPTION BY APP
0 3/3/15 CONCEPTUAL OCTORARO CREEK EEL FACILITIES CRS -
FOR: Exelon
BY: GOMEZ AND SULLIVAN ENGINEERS
DESIGNED BY CRS
DRAWN BY CRS
CHECKED BY -
APPROVED BY -
PROJECT NO. 1385
DATE 3/3/2015
OCTORARO CREEK AMERICAN EEL
TEMPORARY UPSTREAM TRAPPING FACILITY - LEFT BANK
PROPOSED EEL LADDER PROFILE
SCALE: 1/4" = 1'-0"
DRAWING NO.: 3


1'
1'
JUVENILE EEL SUBSTRATE
ENKAMAT
SEE PHOTO INSET
ENKAMAT ® 7010
JUVENILE EEL SUBSTRATE
AKWADRAIN
SEE PHOTO INSET
ALUMINUM
CABLE TRAYS
AKWADRAIN™ SOIL STRIP
DRAIN
2 EEL LADDER SECTION (TYPICAL)
Scale: 1"=1'-0"
SMOOTH TRANSITION FROM
SUBSTRATE TO ALUMINUM PLATE
3/4" PVC SPRAY BAR
1/8" THICK ALUMINUM PLATE.
BEND 90 DEGREES WITH A 1/2" RADIUS.
EEL LADDER
PLASTIC TANK WITH COVER
19" H X 16" W X 22" L
McMaster Carr #3754K84
45°
OVERFLOW PIPE TO BE 2" PVC X 13" LONG
WITH (8) 1-1/4" HOLES. WRAP
OUTSIDE OF PIPE WITH 1mm OPENING
NYLON OR PLASTIC MESH MATERIAL
3/4" HOSE OR PIPE FROM OVERFLOW
PIPE TO HIGHEST POINT OF SUBSTRATE
FOR GRAVITY FEED.
3 TANK DETAILS
Scale: 1"=1'-0"
ATTRACTION WATER SUPPLY
TO TAILWATER NEAR RAMP ENTRANCE
FLEX
SUPPLY HOSE
210-230 L/MIN
TRANSITION TO FLEX HOSE
1 1/2" PVC BALL VALVE
3/4" RIGID PVC
10-20 L/MIN
WATER
FILTER
PVC BALL
VALVE
3/4" PVC
SPRAY BAR
3/4" RIGID PVC
10-20 L/MIN
WATER
FILTER
PVC BALL
VALVE
3/4" PVC
SPRAY BAR
TRANSITION TO 1 1/2" RIGID PVC MANIFOLD
1 1/2" FLEX
SUPPLY HOSE
1/2 HP PUMP
(250 L/MIN)
4 PIPING SCHEMATIC
NO SCALE
PRELIMINARY CONCEPTUAL
NO. | DATE | DESCRIPTION | BY | APP
0 | 3/3/15 | CONCEPTUAL OCTORARO CREEK EEL FACILITIES | CRS | -
FOR: Exelon. EXELON GENERATION COMPANY, LLC
BY: GOMEZ AND SULLIVAN ENGINEERS
DESIGNED BY: CRS
DRAWN BY: CRS
CHECKED BY: -
APPROVED BY: -
PROJECT NO. 1385
DATE: 3/3/2015
OCTORARO CREEK AMERICAN EEL
TEMPORARY UPSTREAM TRAPPING FACILITY - LEFT BANK
TYPICAL EEL LADDER SECTION AND DETAILS
SCALE: 1" = 1'-0"
DRAWING NO.: 4

Appendix B:
Weekly Biological Data and Environmental Conditions for Octoraro Creek, 2017

	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
Creek flow (cfs))	142.8	144	178.1	167.4	119.9	84.3	57.6	123.3	121.6	106.3
Lunar Fraction	0.56	0.96	0.66	0.09	0.37	0.92	0.78	0.16	0.24	0.84
Water temp (°C)	17.4	14.2	18.8	18.2	18.9	20.2	21.6	24.4	24.9	25.7
Dissolved Oxygen (mg/L)	9.5	8.3	7.5	7.5	6.4	5.7	4.4	4.9	5.1	4.5
Percent of Catch	0.2	0.1	0.1	0.3	0.2	0.1	0.0	0.5	13.8	0.2
	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
Creek flow (cfs))	195.4	133.7	150.3	117.7	140.7	225.4	140.7	122.9	190.3	110.2
Lunar Fraction	0.88	0.26	0.14	0.72	0.94	0.38	0.07	0.58	0.96	0.56
Water temp (°C)	25.6	26.9	26.2	25.2	24.1	24	23.3	20.2	20.5	20.4
Dissolved Oxygen (mg/L)	2.3	5.1	5	4.	4.5	5	3	4	6.3	5.5
Percent of Catch	0.1	62.3	3.7	0.4	0.1	0.6	15.8	0.1	1.3	0.1

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
Wk 15: August 6 - August 12

Appendix C:
Weekly Data for 2015-2017

Weekly Eel Catch Data Over the Three Trail Years (2015-2017)

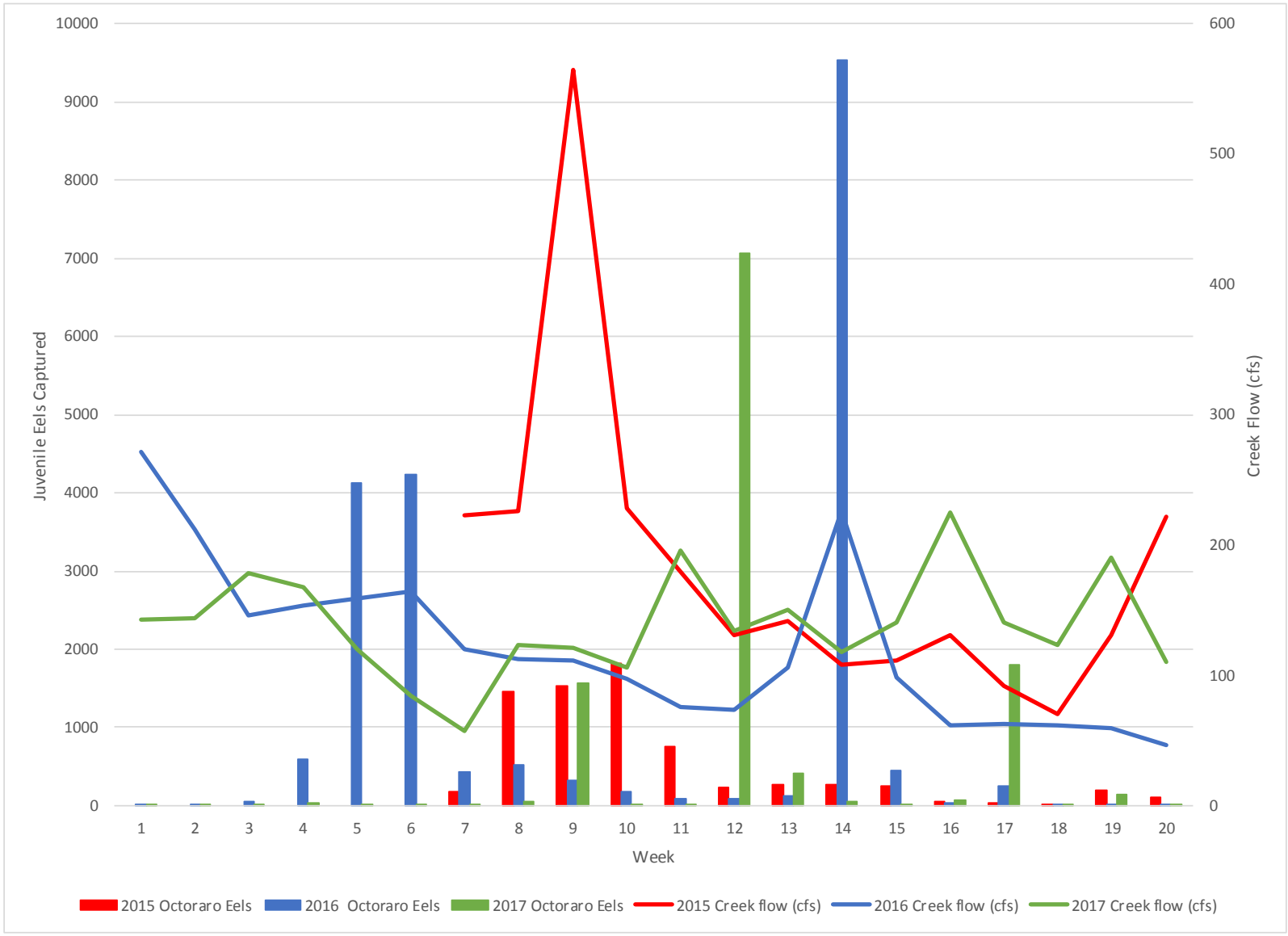
2015 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2015 Octoraro Eels							183	1458	1524	1819	765	240	273	271	258	50	42	13	194	107
2015 Creek flow (cfs)							222.8	225.9	564	228.6	179.7	131	141.9	108.1	111.1	130.4	91.9	70.6	130.6	221.7
2015 Lunar Fraction							0.05	0.48	0.94	0.57	0.05	0.33	0.89	0.69	0.09	0.2	0.8	0.8	0.18	0.01
2015 Water temp (°C)							25.1	23.3	22.7	24.4	24.5	25.3	25.7	25	24.3	24.3	22.8	24.9	23.3	19
Dissolved Oxygen (mg/L)							6.7	7	8.8	7.3	5.1	4.5	4.1	3.3	3.1	5.1	4.3	3.5	5.4	6.8
Percent of Catch							2.5	20.3	21.2	25.3	10.6	3.3	3.8	3.8	3.6	0.7	0.6	0.2	2.7	1.5
Conowingo Eels							2439	8200	5400	3166	4930	1794	284	190	128	327	469	267	59	

Note: Facility was not in operation during 2015 Weeks 1-6.

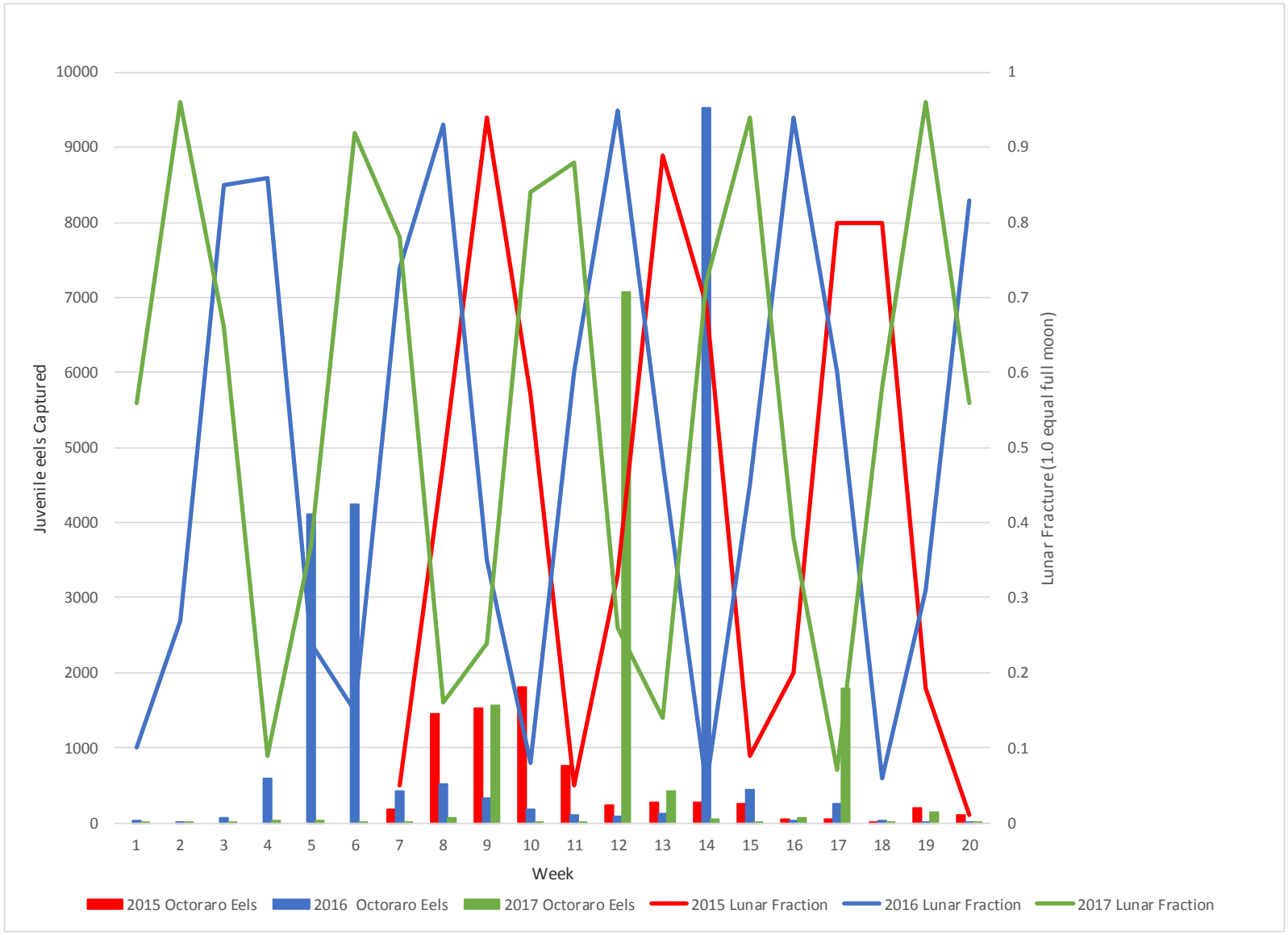
2016 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2016 Octoraro Eels	23	13	58	585	4124	4243	431	516	323	183	97	90	121	9540	443	28	247	25	2	2
2016 Creek flow (cfs)	271.7	211.9	145.9	153	158.7	164.7	120.4	112.3	111.4	97.6	76	73.7	106.1	226.3	98.1	61.6	62.7	61.4	59.7	46.6
2016 Lunar Fraction	0.1	0.27	0.85	0.86	0.24	0.15	0.74	0.93	0.35	0.08	0.6	0.95	0.48	0.05	0.45	0.94	0.6	0.06	0.31	0.83
2016 Water temp (°C)	14.5	14.9	15.8	19.3	23.9	22.7	22.8	24.3	24.5	25.7	26.2	27.2	27.7	25.4	26.7	26.7	24.3	24.8	24.8	23.4
Dissolved Oxygen (mg/L)	9.8	10	9.1	7.8	5.3	5.4	6.9	6.3	5.6	5.9	5.6	5	4.7	3	3.9	3.7	3.8	4.4	4	3.8
Percent of Catch	0.1	0.1	0.3	2.8	19.6	20.1	2.0	2.4	1.5	0.9	0.5	0.4	0.6	45.2	2.1	0.1	1.2	0.1	0.0	0.0
Conowingo Eels				5	95	100	113	353	252	247	1061	280	26	25	53	14	31	20	6	3

2017 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2017 Octoraro Eels	17	9	9	39	21	7	2	61	1565	19	13	7067	419	48	16	68	1793	12	149	12
2017 Creek flow (cfs)	142.8	144	178.1	167.4	119.9	84.3	57.6	123.3	121.6	106.3	195.4	133.7	150.3	117.7	140.7	225.4	140.7	122.9	190.3	110.2
2017 Lunar Fraction	0.56	0.96	0.66	0.09	0.37	0.92	0.78	0.16	0.24	0.84	0.88	0.26	0.14	0.72	0.94	0.38	0.07	0.58	0.96	0.56
2017 Water temp (°C)	17.4	14.2	18.8	18.2	18.9	20.2	21.6	24.4	24.9	25.7	25.6	26.9	26.2	25.2	24.1	24	23.3	20.2	20.5	20.4
Dissolved Oxygen (mg/L)	9.5	8.3	7.5	7.5	6.4	5.7	4.4	4.9	5.1	4.5	2.3	5.1	5	4	4.5	5	3	4	6.3	5.5
Percent of Catch	0.2	0.1	0.1	0.3	0.2	0.1	0.0	0.5	13.8	0.2	0.1	62.3	3.7	0.4	0.1	0.6	15.8	0.1	1.3	0.1
Conowingo Eels																				

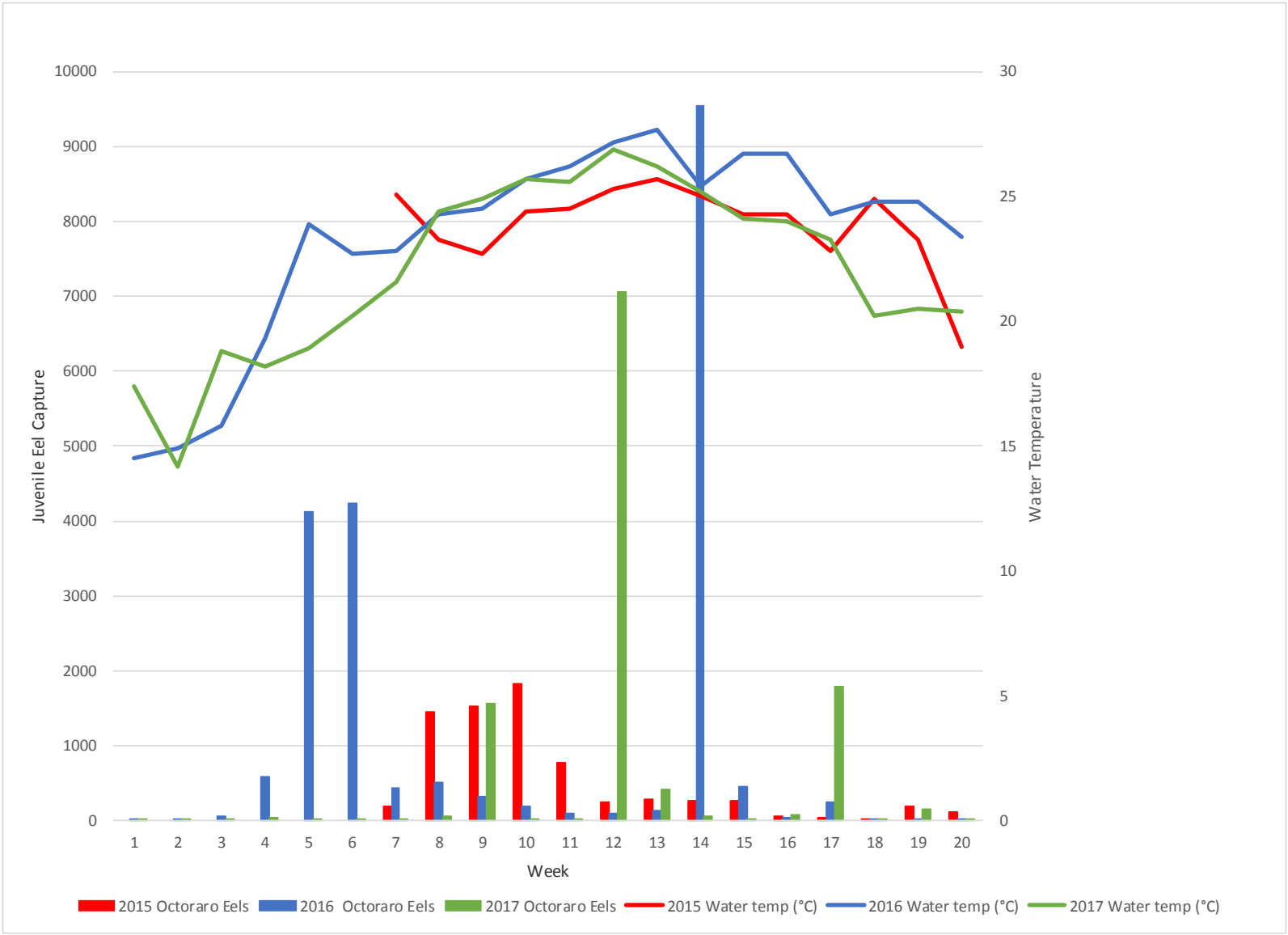
Eel Catch (Collection) to Creek Flow Over the Three Trial Years (2015-2017)



Eel Catch (Collection) to Lunar Fraction Over the Three Trial Years (2015-2017)



Eel Catch (Collection) to Water Temperature Over the Three Trial Years (2015-2017)



Appendix D:
Agency Comments on Draft 2017 Octoraro Creek 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

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.

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    - 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.
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        - 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.

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    - No comments

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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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- 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)
Gomez and Sullivan Engineers, D.P.C.
1961 Wehrle Dr.
Suite 12
Williamsville, NY 14221
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, December 11, 2017 4:54 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 Octoraro Eel Ramp Collection Report
Attachments: 2017_Octoraro_Creek_Eel_Ramp_Collection_Report.pdf

Hello,

Attached please find Exelon's 2017 Draft Octoraro Eel Ramp Collection Report.

If possible, 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.

Erin Redding
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