

# Muddy Run Pumped Storage Project American Eel Collection Facility in Octoraro Creek, 2021

FERC Project No. 2355



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Prepared By:  
Normandeau Associates, Inc.  
482 Old Holtwood Road  
Holtwood, Pennsylvania 17532

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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 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 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 operated for three seasons – 2015, 2016, and 2017. An annual report was developed and filed with FERC and resource agencies after each year of operation. On March 1, 2018, FERC issued a letter indicating that the reports met the requirements of the PADEP 401 WQC and United States (U.S.) Department of the Interior fishway prescription for the Muddy Run Project. The eel facility location has been considered permanent since 2018. Exelon completed upgrades (larger submersible pump and waterline, manifold, collection tank, and attraction flow lines) to the Octoraro Creek Eel Facility in support of eel passage prior to the 2019 season. The remaining work left to be completed addresses aesthetics, safety (stairs), and erosion, which is an ongoing issue due to storm events during 2018, 2019, 2020, and 2021. During each monthly Eel Passage and Restoration Group (EPAG) call, the remaining work has been communicated.

In early 2020, Chester Water Authority (CWA) notified Exelon to the existence of a buried, abandoned tailrace structure below the existing eel collection facility. The upgrades to the eel collection structure and the erosion control concerned CWA with the design drawing showing the footers to be placed on top of or through the underground buried structure. An underground survey needed to be completed prior to installing this structure. The survey was postponed until mid-May 2020 due to the COVID-19 pandemic. The 2020 season was also delayed due to the COVID-19 pandemic. Due to the results of the 2020 underground survey, which confirmed a void under the current location of the eel facility, the eel collection facility was constructed at the top of the hill with agreement from the EPAG and contained one longer ramp of Enkamat substrate. The Octoraro Creek Eel Facility in 2021 contained two longer ramps (12.3 meters compared to 7 meters), one with Enkamat substrate and one with Milieu substrate as were used from 2015 through 2019.

The Conowingo Hydroelectric Project license was issued by FERC on March 19, 2021. Article 419 of this license required Exelon to prepare an American Eel Passage and Restoration Plan, which was developed in consultation with the U.S. Fish and Wildlife Service, Maryland Department of Environment, and other members of the EPAG and was filed with FERC on September 16, 2021. The American Eel Passage and Restoration Plan discusses eel passage at Conowingo Dam and also on the east side of the Susquehanna River which includes the Octoraro Creek Eel Facility.

Each year, American Eels, *Anguilla rostrata*, collected in Octoraro Creek are transported to and held at the Conowingo West Eel Collection Facility (CWECF) at Conowingo Dam and subsequently transported and released at designated points in the Susquehanna River watershed.

The report provides details on the following objectives for the 2021 field investigation:

- § Install seasonal components of the Octoraro Creek Eel Facility immediately downstream of CWA Pine Grove Low-Head Dam;
- § Document any modifications made to the facility during the course of the season to improve functionality and eel attraction capability.
- § Operate, maintain, and monitor the eel collection facility daily from May 1 through September 15, 2021;
- § Collect catch and length data, water quality, creek flow, and moon phase data during the entire sampling period;
- § Transport eels collected by the facility to the CWECF at Conowingo Dam;
- § Conduct weekly quality control checks and cleaning of the eel collection facility to maintain proper attraction water flow;

Seasonal components of the Octoraro Creek Eel Facility included: longer juvenile eel ramps (12.3 meters compared to 7 meters), a one horsepower submersible pump and waterline, manifold, 80 gallon collection tank, and one inch attraction flow lines. The seasonal components were installed and placed in service on May 1, 2021. The facility operated a total of 124 days from May 1 to September 1, 2021. The eel ramp was removed prior to Tropical Storm Ida on September 1, 2021, which resulted in record flows on the Octoraro Creek and damaged the shoreline near the eel facility. The erosion damage prevented the ramp from being placed back in service after the creek flow subsided. Exelon conducted a topographic land survey on October 18, 2021 and is developing a plan for this facility according to those results.

A total of 45,230 juvenile eels was collected at the Octoraro Creek Eel Facility. The greatest number of juvenile eels was collected on August 27, 2021 with 8,776 eels or 19.4% of the total season catch. Two major peaks occurred during the periods of July 14-16 and August 27-28, accounting for 25,358 of the 45,230 (56.1%) juvenile eels collected at the facility. Daily juvenile eel collections numbering less than 10 individuals were recorded on 55 (44.4%) of the 124 collection days. Eel collections greater than 1,000 individuals occurred on 12 of the 124 collection days (9.7%). Volumetric estimates were utilized on seven days during the 2021 season at the Octoraro Creek Eel Facility.

Length, weight, and injuries (condition factor) were recorded from biweekly subsamples on 484 juvenile eels. Length of juvenile eels ranged from 90-190 mm with an average length of 123.5 mm. The average weight of juvenile eels was 2.2 grams (g) and ranged from 0.6-8.1 g. Only five of the 484 (1.0%) showed any form of external injury such as abrasion, lesion, or hemorrhage.

A total of 42,319 juvenile eels of the 45,230 eels (93.6%) collected at the facility were transported within 24 hours of capture to the CWECF at Conowingo Dam or the main stem Susquehanna River where they were held before transport. A single dead eel was removed from the collection tank (0.2% of the day's collection) on July 17, 2021 when 599 eels were collected. On August 27, 2021, a total of 2,910 juvenile eels were removed from the collection tank dead, the remaining live eels (5,866 individuals) were transported to the main stem Susquehanna River. Only five of the 5,866 eels (0.9%) died during the transports directly from the Octoraro Creek Eel Facility to the main stem Susquehanna River on August 27, 2021.

Cleaning and calibration of the facility was performed weekly. Cleaning of the collection tank, screened drains, and spray bars occurred daily after all eels were removed for transport. Scrubbing of the barrel that held the pump and the spray bars occurred prior to any calibration. The pump, manifold, and attraction flow lines were also cleaned as needed during the season. CWA operated the small hydroelectric facility on three (2.4%) of the 124 sampling days.



## List of Abbreviations

### Agencies/Groups

CWA	Chester Water Authority
CWECF	Conowingo West Eel Collection Facility
EPAG	Eel Passage Advisory Group
Exelon	Exelon Generation Company, LLC
FERC	Federal Energy Regulatory Commission
MDE	Maryland Department of Environment
PADEP	Pennsylvania Department of Environmental Protection
Plant	CWA water treatment plant
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
gpm	gallons per minute
in	Inches
km	Kilometer
L	Liter
mg/L	milligrams per liter
mm	Millimeter

### Miscellaneous

WQC	Water Quality Certification
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 (DEP File No. EA 36-033; dated 10 December 2014) for the Muddy Run Project, and is a condition of the 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. This site was approved by the Pennsylvania Department of Environmental Protection (PADEP) and other members of the Eel Passage Advisory Group (EPAG)<sup>1</sup>.

The Conowingo Hydroelectric Project license was issued by FERC on March 19, 2021. Article 419 of this license required Exelon to prepare an American Eel Passage and Restoration Plan, which was developed in consultation with the U.S. Fish and Wildlife Service, Maryland Department of Environment, and other members of the EPAG and was filed with FERC on September 16, 2021. The American Eel Passage and Restoration Plan discusses eel passage at Conowingo Dam and also on the east side of the Susquehanna River which includes the Octoraro Creek Eel Facility.

American Eel, *Anguilla rostrata*, collected in Octoraro Creek were transported directly to and held at the Conowingo West Eel Collection Facility (CWECF) at Conowingo Dam and subsequently transported and released at designated points in the Susquehanna River watershed.

The report provides details relative to the following objectives for the 2021 field investigation:

- § Installation of seasonal components to the eel collection facility on Octoraro Creek immediately downstream of CWA Pine Grove Low-Head Dam;
- § Document any modifications made to the facility during the course of the season to improve functionality and eel attraction capability.
- § Operate, maintain, and monitor the eel collection facility daily from May 1 through September 15, 2021;
- § Collect catch and length data, water quality, creek flow, and moon phase data during the entire sampling period;
- § Transport eels collected by the facility to the CWECF at Conowingo Dam;
- § Conduct weekly quality control checks and cleaning of the eel collection facility to maintain proper attraction water flow;

Seasonal components of the Octoraro Creek Eel Facility included: new longer juvenile eel ramps, a one horsepower submersible pump and waterline, two inch manifold, 80 gallon collection tank, and

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<sup>1</sup> 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. MDE was added to the EPAG group on March 19, 2021.

one inch attraction flow lines. The seasonal components were installed and placed in service prior to the 2021 eel collection season.

## 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 Pine Grove Low-Head 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](#)).

The temporary eel trapping facility adjacent to CWA's small hydroelectric site on Octoraro Creek was operated for three seasons – 2015, 2016, and 2017. An annual report was developed and filed with FERC and resource agencies after each year of operation. On March 1, 2018, FERC issued a letter indicating that the reports met the requirements of the PADEP 401 Water Quality Certification (WQC) and U.S. Department of the Interior fishway prescription for the Muddy Run Project<sup>2</sup>. The eel facility location has been considered permanent since 2018.

Prior to the 2019 eel season, Exelon completed upgrades to the Octoraro Creek Eel Facility related to eel passage (larger submersible pump and waterline, manifold, collection tank, and attraction flow lines). Work related to facility aesthetics and safety (stairs) and erosion remains to be completed. This remaining work requires a PADEP Chapter 105 Wetland and Waterway Obstruction and Encroachment Permit and, therefore, a signed agreement from CWA (the landowner) was necessary so that Exelon could apply for this permit. Exelon received the CWA signed agreement on December 2, 2019 and applied for the Chapter 105 permit on December 27, 2019. On January 16, 2020, the PADEP Chapter 105 Wetland and Waterway Obstruction and Encroachment Permit application package was deemed complete by PADEP and the permitting public comment period closed on March 2, 2020. Exelon received a permit on May 8, 2020. Meanwhile, in March 2020, CWA reviewed the facility project plans again and had concerns with the proposed upgraded eel structure plans along the left bank of Octoraro Creek due to an abandoned underground buried tailrace that runs below the proposed gazebo platform. The existing facility was revised and improvement plans were reconsidered for safety and constructability. Exelon planned on having an underground survey crew perform studies to identify the exact location of this structure and if it created a void. In early May 2020, the underground survey was scheduled, completed, and the results of the survey distributed to the EPAG prior to a conference call on June 2, 2020. During this conference call, alternative options for the eel facility were discussed, and a decision was made and agreed to by all parties, to construct a longer ramp with the collection tank and scaffolding placed at the top of the hill near the driveway. With the scaffolding at the top of the hill and the existing waterline exiting

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<sup>2</sup> On March 1, 2018, FERC issued a Letter that stated "Review of your filing indicates that it fulfils the pertinent WQC and fishway prescription requirements. Pursuant to the Pennsylvania DEP's WQC, because you have determined the Octoraro facility to be successful, " This approval was on the Octoraro Creek Eel Facility being successful and determining it as a permanent installation (Accession number: 20180301-3083; [FERC, 2018](#))

the at the mid hillside level near the old scaffolding, Exelon agreed to address the waterline and have it exit at the top of the hill near the new scaffolding to decrease the head loss and increase the total attraction flow of the Octoraro Creek Eel Facility which was completed on August 13, 2021.

The Octoraro Creek Eel Facility began operations on May 1, 2021 and was scheduled to cease on September 15, 2021. The eel facility in 2021 contained two longer ramps, one with Enkamat substrate and one with Milieu substrate as used from 2015-2019. The waterline was changed to exit at the top of the hill near the new scaffolding and not at the existing exiting point near the old scaffolding at the mid hillside scaffolding. This change decreases the head difference and length of buried waterline helping to increase the total attraction flow to the Octoraro Creek Eel Facility.

## 3 Methods

### 3.1 Design, Construction, and Installation of Facility

In 2021, modifications were made to the existing eel facility to safely operate the facility with the underground buried tailrace void underneath. These modifications included: a collection tank platform at the top of the hill, an Enkamat substrate juvenile eel ramp, a Milieu substrate juvenile eel ramp, a longer waterline with increased head, and longer attraction water flow lines.

A scaffolding was added to the top of the hill in line with the previous year's scaffolding. The size of the scaffolding platform was identical to the other platform utilized in previous seasons ([Figure 3.1-1](#)). The collection tank, manifold, and aeration system remained the same as the previous years ([Normandeau Associates and Gomez and Sullivan 2020](#)). The scaffolding was added to the top of the hill to address safety concerns due to the presence of a buried tailrace structure creating a void under the previous year's scaffolding. The rainfall gauge was reinstalled on the corner of the scaffolding to capture and record daily rainfall events ([Figure 3.1-2](#)).

The longer juvenile eel ramps were constructed and installed with the identical entrance location to the previous ramps ([Figure 3.1-1](#)). The ramps consisted of approximately 12.3 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 the collection tank. The entrance of the ramps were underwater during all flow conditions, which allowed for a smooth transition from the existing riverbed adjacent to a quiescent pool located in the creek. The ramps were supported by the previous scaffolding and held in place by four T-shaped solid metal braces, evenly spread across the length of the ramps, and driven into the ground beneath the ramps ([Figure 3.1-3](#)). On either side of these braces, a hole was drilled into the flat bar and a bungee cord was used to fasten the ramp to these braces. The ramps were covered from the top down to near the tail water median flow height to protect juvenile eels when ascending. A hinged cover was added to the ramps over the spray bar to decrease light inside the ramp at the top of the ramp.

The 51 mm water line exited the hillside at the previous year's collection level, so an additional length of 51 mm water line was extended back to the top of the hill from where the collection tank was located ([Figure 3.1-4](#)). The 51 mm water line was attached to a 51 mm manifold with seven 25 mm ball valves that supplied water to the spray bars and additional attraction flow lines.

The collection tank is 660 mm wide with a length of 1,575 mm. The depth of the water in the collection tank is about 299 mm, with a volume of approximately 310.4 Liters (L). Like prior years, the collection tank was filled by allowing some of the spray bar flow to enter the collection tank, thus providing a constant flow of freshwater. The collection tank contained two drains comprised of a 76 mm PVC pipe with holes drilled through it and wrapped in one mm mesh to prevent juvenile eel escapement. The collection tank drain lines were 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 was custom fitted with a lid that was held down by clamps. The air stones from an aerator were added to the collection tank to supply additional aeration when dissolved oxygen concentrations approached 5.0 milligrams per liters throughout the 2021 season. The aerator was connected to a deep cycle marine battery connected to a portable solar panel and a trickle charger.

### **3.2 Data Collection**

Sample data including date, time of sample, weather, eel counts, water temperature, dissolved oxygen (DO), and rainfall were recorded daily. The data was verified, tabulated, and entered into an electronic format each week as part of a quality control and quality assurance protocol.

Environmental conditions such as creek flow and lunar fraction were also recorded, verified, and entered into an electronic format.

Length and weight measurements, along with condition factor were recorded biweekly from a maximum of 25 individuals (when available). Eels were measured and weighed after being anesthetized ([Figures 3.2-1](#) and [3.2-2](#)).

Water temperature and DO were measured in the collection tank, and also in the head pond near the pump during each sampling event, with an YSI® 550A water quality meter that was calibrated prior to each sampling event.

### **3.3 Juvenile Eel Transport**

All juvenile eels captured in the Octoraro Creek Eel Facility were transported to the CWECF at Conowingo Dam where they were held before subsequent transport and release at designated locations in the Susquehanna River watershed or to the main stem Susquehanna River daily.

When less than 150 eels were collected during a sampling event, the eels were transported in aerated 19 L buckets with lids that contained the maximum amount of water to prevent sloshing, with  $\leq 50$  eels in each bucket. When counts of juvenile eels were greater than 150 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 ([Figure 3.3-1](#)). When counts of juvenile eels were greater than 2500 individuals, the large transport tank (2,500 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 Octoraro Creek Eel Facility commenced operation on May 1 and shut down operation on September 1, 2021. The eel ramp was removed prior to Tropical Storm Ida after the daily check on September 1, 2021. Record flows on the Octoraro Creek from Tropical Storm Ida caused erosion damage to the shoreline near the eel facility, preventing the ramp from being placed back in service. Exelon conducted a topographic land survey on October 18, 2021 and is developing a plan for this facility according to those results. No eel collection occurred during Weeks 20 and 21 since eel collection ended during Week 19. The facility was checked daily during the 124 day season to ensure that the facility was attracting eels. A total of 45,230 juvenile eels were collected during the 2021 season ([Table 4.0-1](#)). Daily checks were conducted as a condition of the facility's permanent status.

### 4.1 Juvenile Eel Collection

A total of 45,230 juvenile American Eels were captured at the Octoraro Creek Eel Facility during the 2021 season. The highest one-day total of 8,776 juvenile eels occurred on August 27, accounting for 19.4% of the season total ([Table 4.0-1](#) and [Figure 4.1-1](#)). Volumetric estimates were utilized on seven of the 124 days (5.6%), while individual counts were recorded the remaining 117 days of the daily checks ([Table 4.0-1](#)). Eel collections greater than 1,000 individuals occurred on 12 of the 124 collection days (9.7%). Daily juvenile eel collections numbering less than 10 individuals were recorded on 55 (44.4%) of the 124 collection days.

### 4.2 Juvenile Eel Biological Data

Biological data (length, weight and condition factor) was recorded from biweekly subsamples. A total of 484 juvenile eels was collected from these biweekly subsamples (1.1% of total eels collected), during 32 of the 124 sample days ([Table 4.2-1](#)).

The average length of juvenile eels was 123.5 mm, with a median size of 121.0 mm ([Table 4.2-1](#)). The length of juvenile eels ranged from 90 - 190 mm, with only six juvenile eels measuring less than 100 mm. During the 2021 season, only three eels measured greater than 175 mm ([Table 4.2-2](#)). Over 82% of the 484 measured eels ranged between 105-140 mm.

The average weight of juvenile eels was 2.2 grams (g), with a median weight of 2.0 g ([Table 4.2-1](#)). The weight of juvenile eels ranged from 0.6 – 8.1 g ([Table 4.2-3](#)). Over 92% of the 484 juvenile eels weighed between 1.0 – 3.5 g.

Eels from 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](#). External injuries were noted on 1.0%, (5 of 484 individuals) of the examined eels. Two condition factors observed on June 10, 2021 were coded as a minor hemorrhage to the caudal tail and enlarged belly, respectively ([Figures 4.2-1](#) and [4.2-2](#)).

### 4.3 Juvenile Eel Collection by Week

The majority of the juvenile eels were collected during Week 18 (August 9-15) when the facility collected 38.4% (17,350 individuals) of the season total ([Table 4.3-1](#) and [Figure 4.3-1](#)). Week 12 collected the second greatest number of eels at 33.0% (14,925 eels) of the season total. During



Weeks 12 and 18, the Octoraro Creek Eel Facility collected 71.4% (32,275 of the 45,230 juvenile eels) of the season catch.

Weeks 1-6, 9-11, 13, and 15-16 each collected less than or equal to 1.0% (less than 450 eels) of the season total ([Table 4.3-1](#) and [Figure 4.3-1](#)). The only other week greater than 10.0% was Week 14 when the Octoraro Creek Eel Facility collected 4,836 eels (10.69%) of the season total. Weekly catch data are also provided in [Appendix A](#).

#### **4.4 Peak Periods of Eel Collections**

During the season, two peak periods produced seasonally high numbers of juvenile eels. The peak periods (July 14-16 and August 27-28, 5 days) yielded 25,358 of the 45,230 juvenile eels or 56.1% of the total season catch ([Table 4.0-1](#) and [Figure 4.1-1](#)).

#### **4.5 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 did not appear to be completely related during the 2021 season. Daily average creek flow was taken from the United States Geological Survey (USGS) 01578475 Octoraro Creek at Richardsmere, MD gage, located approximately 21 kilometers (km) downstream of CWA's Pine Grove Low-Head Dam ([Table 4.5-1](#)). The highest daily average creek flow value per the USGS gage station when the facility was in operation occurred on July 26, 2021 (1,070 cubic feet per second, cfs, [Table 4.5-1](#)). After the facility was removed from service on September 1 and 2, the daily average creek flow value per the USGS gage station was 2,590 and 7,700 cfs, respectively.

During Week 18, the highest weekly average creek flow coincided with the highest weekly catch but the greatest number of eels collected during the season occurred on a sharp decrease in creek flow on August 27, 2021 ([Table 4.0-1](#) and [4.5-1](#) and [Figure 4.5-1](#)). The sharp decrease in creek flow was artificially created as the CWA was gradually lowering the water level of the reservoir to conduct some survey work. During the drawdown of the reservoir, creek flows were approximately 300 to 350 cfs. However, due to unforeseen circumstances, the survey was postponed, so the CWA closed the Tainter gate(s) discharging water from the reservoir and the creek flow quickly dropped to 92 cfs. Week 12 had a small increase in flow which produced the second largest week of collection at the Octoraro Creek Eel Facility ([Figure 4.5-1](#) and [Appendix B](#)). An increase of creek flow typically corresponds to increases in juvenile eel collection for this time period, but higher catch numbers during periods without an increase of flow may be a function of other variables (e.g., migration timing). Overall, the large creek flow events during the second half of the season related to increased number of eel being captured daily, but the smaller increases in creek flows did not match up with increases in daily catch.

##### *Lunar Fraction*

Juvenile eel catch did not appear to be correlated to lunar fraction (cycle) during the 2021 season. The largest peak in eel capture (14,014 eels collected from July 14-16, Week 12) occurred the week after the new moon in July ([Table 4.5-2](#), [Figure 4.5-2](#) and [Appendix B, Time and Date Website, 2021](#)). Full moon is equal to 1.0 lunar fraction.

Weeks 7, 3, and 11 were ranked first, second, and third darkest weeks with a total of 1,578 eels (3.5%) of the 45,230 eels collected during these three weeks ([Appendix B](#)). Weeks 5, 9, and 13 were ranked first, second, and third brightest weeks, with a total of 204 (0.5%) of the 45,230 eels collected during these three weeks ([Appendix B](#)). Typically, the lower illuminance during lower lunar fraction periods, (new moon) has been 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. Water temperatures ranged from 14.4° Celsius (C) when the facility began on May 1 and 8 (Weeks 1 and 2) to 26.8° C on August 13, 2021 (Week 16, [Table 4.5-3](#) and [Figure 4.5-3](#)). The highest average weekly water temperature (25.89° C) occurred during Week 12, which corresponded with the highest weekly eel capture week ([Appendix B](#)). The eel facility recorded daily water temperatures above 20.0° C on June 4 and continuing until the end of the season.

### *Dissolved Oxygen*

Eel collection numbers and DO did not appear to be related this season. DO is recorded as milligrams/Liter (mg/L). The data indicated that the water above the dam did stratify and the readings were typically lower than those observed in the collection tanks for most of the season ([Table 4.5-4](#) and [Figure 4.5-4](#)). The aeration system was added to the collection tank on June 16, 2021 and operated the remainder of the season; daily DO readings are presented in [Table 4.5-4](#) and displayed in [Figure 4.5-4](#). DO levels in the collection tank were lower than the head pond when large numbers of eels (Weeks 12 and 18) occurred in the collection tank ([Figure 4.5-5](#) and [Appendix B](#)). Measurements of DO were usually taken in the morning when the lowest DO level is likely to be observed.

### *Rainfall*

Juvenile eel collection and rainfall did not appear to be related during the 2021 season. Rainfall was recorded typically in tenth of inch (in) by a rain gauge affixed to the scaffolding platform. The three largest amount of rain fall were recorded on July 26, July 13, and August 23, 2021 with 2.9, 2.7, and 2.6 inches, respectively ([Table 4.5-5](#) and [Figure 4.5-6](#)). However, on September 2, 2021, Tropical Storm Ida traveled across southern Pennsylvania dropping large amounts of rain over the Octoraro Creek watershed. The facility was removed from service prior to this event. Rainfall was not recorded but it was noted that the rain gauge was full at 5 inches on September 2, 2021 when the site was checked for damage. Recorded rainfall amounts over 1.0 inch were observed on twelve days during the 2021 season: twice in May, four times in June, three times in July, and twice in August. During 66.9% of the season (83 of the 124 days), the rain gauge recorded values of 0.0 inches.

## **4.6 Juvenile Eel Transport and Mortality**

See [Table 4.6-1](#) for detailed information of transport and mortality data.

### *Transport*

A total of 42,319 of the 45,230 eels (93.6%) collected at the facility were transported within 24 hours of capture to the CWFECF at Conowingo Dam where they were held before transport or the

main stem Susquehanna River ([Table 4.6-1](#)). Transport time from the Octoraro Creek Eel Facility to the CWECF at Conowingo Dam was about 30 minutes, and 90 minutes to the main stem Susquehanna River near Harrisburg, PA. No juvenile eel mortalities were observed when transferring eels from the transport vehicle into the Conowingo holding facility.

### *Mortality*

A total of 2,911 juvenile eels (6.4%) of the 45,230 eels died in the collection tank at the Octoraro Creek Eel Facility in 2021 ([Table 4.6-1](#)). A single dead eel (0.2% of the day's collection) was removed from the collection tank on July 17, 2021 when 599 eels were collected. On August 27, 2021, a total of 2,910 juvenile eels were removed from the collection tank dead; the remaining live eels (5,866 individuals) were transported to the main stem Susquehanna River. Only five of the 5,866 eels (0.9%) died during the August 27, 2021 transports directly from the Octoraro Creek Eel Facility to the main stem Susquehanna River. All juvenile eels captured at the Octoraro Creek Eel Facility were observed to be free of fungus.

## **4.7 Quality Control Activities**

Cleaning and calibration activities were conducted weekly during the season. Scrubbing of the barrel housing the pump, along with the spray bars, was performed prior to performing any calibrations. Attraction flow lines, pump, barrel, and the manifold were cleaned as needed during the season.

Calibration of the ramp flow was executed each week after cleaning, using a 4-gallon 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 the 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 4.7-1](#).

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, the barrel, manifold, and all the attraction flow lines were scrubbed or snaked clean nine times during the 2021 season ([Table 4.7-1](#)). The same submersible pump was used all season. The water line was rerouted to the top of the hill next to the scaffolding on August 13, 2021 to help increase the attraction flows to the eel facility ([Figure 4.7-1](#)).

Volumetric eel estimates were performed seven days during the season. A quality check comparison on counts occurred once on July 27, 2021. The volumetric estimate was lower than the actual count by 50 eels. Due to the small difference in counts, no changes to the volumetric method were required.

## **4.8 Other Species Caught**

Three other aquatic species were caught in addition to American Eel. Six River Crayfish (Cambaridae family) were netted from the collection tank on six occasions during the season. A juvenile Eastern Rat Snake (*Pantherophis alleghaniensis*) was also removed from the collection tank on May 18, 2021. A common Snapping Turtle (*Chelydra serpentina*) was removed from the bottom ten feet of the Enkamat substrate ramp on June 1, 2021.

## 5 Discussion

The CWECF 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 from (May 1 to September 1). The CWECF continued to operate after the Octoraro Creek Eel Facility season was complete. Through September 1, 2021, the CWECF captured 556,176 eels compared to the Octoraro Creek Eel Facility which captured 45,230 juvenile eels during the 2021 season. When both ramps were operating simultaneously, the Octoraro Creek Eel Facility captured approximately 8.1% of the number of eels collected by the CWECF at Conowingo Dam. During this time, the size range of the juvenile eels caught at the CWECF was 66-184 mm with an average length of 116.4 mm ([Normandeau Associates, Inc. 2021](#)). The average size and range of the juvenile eels caught in the ramp at the Octoraro Creek Eel Facility were of a slightly larger size range of 90-190 mm and an average length of 123.5 mm. Overall, the eel ramp locations collected the larger size range, but the CWECF at Conowingo Dam collected much smaller eels.

The attraction flow to the ramp during the 2021 season, like the 2020 season, was decreased from the 2019 season due to the increase in head from the old scaffolding to the uphill scaffolding. The buried waterline exited the hillside at the old scaffolding prior to August 13, 2021, when the waterline was uncovered and repositioned to exit uphill scaffolding ([Figure 4.7-1](#)). The collection tank was cleaned, hoses inspected, and spray bars checked and cleaned during each sample to ensure flow. Due to the algae build up inside the hoses, a routine (weekly) and as needed clean-out of the hoses and manifolds used was performed to maintain consistent attraction flow. Decrease of attraction flows may also be due from the build-up of biological growth in the system. The hardiness of American Eel and its ability to adjust to parameters were evidenced by the numbers captured here.

The scaffolding, collection tanks, and hoses were not shaded during the 2021 season.

Water temperature and DO readings were taken daily in the head pond at the pump level and in the collection tank. The data indicated that the water above the dam did stratify and the readings were lower than those observed in the collection tank for most of the season ([Table 4.5-4](#) and [Figure 4.5-4](#)). The aeration system was placed into the collection tank on June 16, 2021 when DO level approached 5.0 mg/L and was operated until the end of the season.

The average creek flow value per the USGS gage station during the 2021 season was similar to the previous years of operation (2015-2020). The average creek flow value during the operational period of May 1 through September 15, 2015-2020 was 219.2 cfs compared to the (May 1 through September 1) average creek flow value of 203 cfs in 2021 ([Table 5.0-1](#) and [Normandeau Associates and Gomez and Sullivan 2015, 2016, and 2018a](#) and [Normandeau Associates 2018, 2019, and 2020](#)). In 2021, daily average creek flow exceeded 1,000 cfs on only one day. The daily average creek flow was below 100 cfs for two days compared to 24, 65, 46, 4, 13, and 18 days in 2015, 2016, 2017, 2018, 2019, 2020, respectively. CWA operated its hydro facility on three of the 124 days (2.4%) this year, but we observed no relationship between eel catch and hydro operation ([Table 4.0-1](#)). The cobble/gravel outcrop that was formed just downstream of the entrance to the eel ramps in 2018, and was still present through September 1, 2021 when the Octoraro Creek Eel Facility was removed ([Figure 5.0-1](#)). The outcrop did not change the location of the ramp's entrance, which remained underwater throughout the entire 2021 season, just as in previous years.

Since 2015, typically when the creek flow has increased, the catch of juvenile eels has also increased within a few days of the flow increase. This was evident during the higher creek flows in July and August 2021. [Figure 5.0-2](#) shows a comparison of 2015 through 2021 weekly catch and average creek flow data.

In 2016, 2017, and 2018, the high flow events co-occurred with a new moon phase, unlike the 2019 season high flow events, which occurred during a full moon phase. The high flow event and the full moon phase again occurred at the same time during the 2020 season, but the peak eel collection occurred the following week. Two of the three flow events in 2021 occurred during nearly full moon phase and an increase of flow, whereas the other flow event in mid-July occurred right after a new moon but a slight increase in creek flow also occurred. See [Appendix B](#) for additional weekly data comparing 2015 through 2021.

The number of eels collected (45,230 individuals) in 2021 was the highest total since the start of this facility, despite the season ending earlier than other years on September 1, 2021 ([Table 5.0-1](#)). The prior season (2020) was the shortest season length and operated on a shifted schedule (June to October) and collected the least amount of eels (3,597 individuals). The highest average collection of eels per day, prior to this season, was 152.9 eels in 2018 when 21,094 eels were collected over a 138 day season compared to the 364.8 eel per day in 2021 when 45,230 eels were collected during the 124 day season. The Octoraro Creek Eel Facility collected more than the daily average (364.8 eels per day) on 20 of the 124 days (16.1% of the season, [Tables 4.0-1](#) and [5.0-1](#)). The average size of eels, 123.5 mm, captured in 2021 was smaller than any other year ([Table 5.0-1](#)). From 2015 to 2018, juvenile eels were measured during every sample day (up to 25 eels if available), but biweekly subsamples of lengths were collected in 2019-2021. The Octoraro Creek Eel Facility has caught juvenile eels less than or equal to 100 mm every year. The size range (maximum minus minimum) of eels collected and measured in 2021 was smaller than all other years when both substrate ramps were used to collect eels.

The collection tank is 660 mm wide with a length of 1,575 mm. The depth of the water in the collection tank is about 299 mm, with a volume of approximately 310.4 Liters. The capacity of American Eel in the current collection tank is 3,104 eels under the USFWS guidelines. The capacity of the collection was exceeded on four days (3.2%) of the 124 days during the 2021 season with the collection on August 27, 2021 having the only mortality event. The mortality event of American Eel on August 27, 2021 was caused by a low DO condition in the collection tank. The collection tank contained 8,776 juvenile American Eel, with 2,910 American Eel being removed dead. See [Appendix C](#) for more detailed write up that was presented in the September 2021 EPAG meeting summary.

Suggested improvements to the Octoraro Creek Eel Facility to help minimize future mortality events are being considered. One option is the addition of a small oxygen bottle, regulator, and fine pore diffuser would help increase the oxygen levels in the collection tank. Oxygen levels should be kept close to the carrying capacity of the ambient water and not held at extreme levels. If an oxygen bottle system was added to the facility it would not be a change to the footprint of the facility. Oxygen will be controlled and maintained manually and can be increased daily when increase in creek flows are forecasted or when larger collections are being recorded in the collection tank. Typically increases of American Eel occur when river flows increase or shortly after these events. Large changes in creek flows manipulated by CWA could also increase eel catch like the event that occurred on August 27, 2021.

Another option would be to install a larger collection tank, but this would increase the footprint of the scaffolding or the angle of the ramp. Changing these aspects of the facility would need agreement from EPAG and an update and approval to FERC on the changes.

Multiple checks on any given day could be performed if collection of American Eel are high during a daily check.

After starting the 2021 season on May 1, 2021, the Octoraro Creek Eel Facility ended fourteen days early due to the aftermath of Tropical Storm Ida that dropped heavy rainfall in the watershed and caused extensive shoreline erosion in the vicinity of the Octoraro Eel Facility. The rain gauge measured five inches of rain (completely full) on September 2, 2021, when the area was checked. The equipment and ramp were not damaged due to the forethought of Exelon personnel to remove the equipment and ramp on September 1, 2021. Damage from the high flow event caused by Tropical Storm Ida to the shoreline and drastic changes to the tailrace are displayed on [Figures 5.0-3](#) and [5.0-4](#)). The mid-hill scaffolding toppled down the stream bank during the high flow event and came to rest in the tailrace near the stone masonry dam ([Figures 5.0-3](#) and [5.0-4](#)). The shoreline below the uphill scaffolding was evaluated by a professional engineer and deemed unsafe for reinstallation of equipment and ramp until a survey and engineering assessment could be completed to address the new erosion concerns.

Two loss of power events occurred on June 15 and 29, 2021. Normandeau arrived at the facility in the morning to find the power/water supply was off in the vicinity of the plant. The power and water supply automatically returned to the facility prior to the next daily check on the following day. No mortality was observed due to the above events in 2021.

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## 7 Tables and Figures

Table 4.0-1: Number of Juvenile Eel Caught Daily, Octoraro Creek Eel Facility, 2021

Date	Number of Eels	Date	Number of Eels	Date	Number of Eels
5/1/2021	0	6/16/2021	12	8/1/2021	89
5/2/2021	0	6/17/2021	8	8/2/2021	92
5/3/2021	0	6/18/2021	13	8/3/2021	119
5/4/2021	1	6/19/2021	1	8/4/2021	82
5/5/2021	0	6/20/2021	3	8/5/2021	51
5/6/2021*	1	6/21/2021	1	8/6/2021	13
5/7/2021*	2	6/22/2021	4	8/7/2021	6
5/8/2021*	1	6/23/2021	5	8/8/2021	6
5/9/2021	1	6/24/2021	2	8/9/2021	3
5/10/2021	0	6/25/2021	3	8/10/2021	8
5/11/2021	2	6/26/2021	3	8/11/2021	52
5/12/2021	1	6/27/2021	14	8/12/2021	25
5/13/2021	1	6/28/2021	9	8/13/2021	7
5/14/2021	2	6/29/2021	14	8/14/2021	11
5/15/2021	2	6/30/2021	23	8/15/2021	4
5/16/2021	4	7/1/2021	23	8/16/2021	4
5/17/2021	1	7/2/2021	35	8/17/2021	1
5/18/2021	1	7/3/2021	120	8/18/2021	4
5/19/2021	0	7/4/2021	302	8/19/2021	370
5/20/2021	2	7/5/2021	85	8/20/2021	1223
5/21/2021	4	7/6/2021	30	8/21/2021	1314
5/22/2021	1	7/7/2021	38	8/22/2021	853
5/23/2021	1	7/8/2021	29	8/23/2021	1123
5/24/2021	2	7/9/2021	15	8/24/2021	1633
5/25/2021	3	7/10/2021	20	8/25/2021	1504
5/26/2021	2	7/11/2021	14	8/26/2021	893
5/27/2021	7	7/12/2021	14	8/27/2021	<b>8776</b>
5/28/2021	8	7/13/2021	284	8/28/2021	<b>2568</b>
5/29/2021	6	7/14/2021	4738	8/29/2021	767
5/30/2021	6	7/15/2021	<b>6168</b>	8/30/2021	342
5/31/2021	13	7/16/2021	<b>3108</b>	8/31/2021	141
6/1/2021	8	7/17/2021	599	9/1/2021	69
6/2/2021	10	7/18/2021	65	9/2/2021	DNO
6/3/2021	5	7/19/2021	37	9/3/2021	DNO
6/4/2021	9	7/20/2021	15	9/4/2021	DNO
6/5/2021	26	7/21/2021	4	9/5/2021	DNO
6/6/2021	87	7/22/2021	13	9/6/2021	DNO
6/7/2021	58	7/23/2021	9	9/7/2021	DNO
6/8/2021	22	7/24/2021	11	9/8/2021	DNO
6/9/2021	110	7/25/2021	6	9/9/2021	DNO
6/10/2021	234	7/26/2021	358	9/10/2021	DNO
6/11/2021	333	7/27/2021	<u>1515</u>	9/11/2021	DNO
6/12/2021	206	7/28/2021	1282	9/12/2021	DNO
6/13/2021	786	7/29/2021	743	9/13/2021	DNO
6/14/2021	238	7/30/2021	683	9/14/2021	DNO
6/15/2021	143	7/31/2021	249	9/15/2021	DNO

\*Days the hydroelectric facility was operating (3 days)

Volumetric estimates are in italics (7)

Bolded numbers are peak days

The peak periods are shown in boxes

Quality check is underlined (1)

**Table 4.2-1: Number of Juvenile Eel Captured with Length and Weight Measurements, Octoraro Creek Eel Facility, 2021**

	<b>Total</b>
Number eels collected	45,230
Number measured	484
Data Collection Days	32
Range on lengths (mm)	90-190
Average length (mm)	123.5
Median length (mm)	121.0
Range on weights (g)	0.6-8.1
Average weight (g)	2.2
Median weight (g)	2.0

Table 4.2-2: Juvenile Eel Length Frequency, Octoraro Creek Eel Facility, 2021

TL (mm)	Number
90-94	3
95-99	3
100-104	19
105-109	30
110-114	83
115-119	83
120-124	68
125-129	55
130-134	48
135-139	32
140-144	22
145-149	16
150-154	6
155-159	7
160-164	3
165-169	2
170-174	1
175-179	0
180-184	1
185-190	2
<b>Total</b>	<b>484</b>

Table 4.2-3: Juvenile Eel Weight Frequency, Octoraro Creek Eel Facility, 2021

<b>Weight (g)</b>	<b>Number</b>
0.5-0.9	3
1.0-1.4	68
1.5-1.9	157
2.0-2.4	125
2.5-2.9	60
3.0-3.4	37
3.5-3.9	10
4.0-4.4	9
4.5-4.9	5
5.0-5.4	2
5.5-5.9	3
6.0-6.4	0
6.5-6.9	1
7.0-7.4	1
7.5-7.9	2
8.0-8.4	1
<b>Total</b>	<b>484</b>

Table 4.2-4: Observed Injuries of Juvenile American Eels, Octoraro Creek Eel Facility, 2021

Date	Length (mm)	Weight (grams)	Condition Factor
6/10/2021	156	4.4	Slight Hemorrhage Caudal Tail
6/10/2021	114	1.5	Enlarged belly
8/2/2021	156	5.6	Abrasions (bird marks)
8/5/2021	122	1.7	Lesions on belly
8/30/2021	136	2.2	Lesions

5 of 484 eels (1.0%) that were processed had injury

Table 4.3-1: Juvenile Eel Collection by Week and Ranks, Octoraro Creek Eel Facility, 2021

	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5	Wk 6	Wk 7	Wk 8	Wk 9	Wk 10	Wk 11
Total	0	5	9	13	29	77	1050	1201	21	238	519
Rank	19	18	17	16	14	13	7	6	15	10	8
Percent Catch (%)	0.00	0.01	0.02	0.03	0.06	0.17	2.32	2.66	0.05	0.53	1.15
	Wk 12	Wk 13	Wk 14	Wk 15	Wk 16	Wk 17	Wk 18	Wk 19	Wk 20	Wk 21	
Total	14925	154	4836	452	112	2920	17350	1319	DNO	DNO	
Rank	2	11	3	9	12	4	1	5			
Percent Catch (%)	33.00	0.34	10.69	1.00	0.25	6.46	38.36	2.92	-	-	

Top 2 ranked weeks are shown in boxes.

Collection was discontinued after high flows on September 1, 2021 (Week 19)

Wk 1: May 1

Wk 2: May 2 – May 8

Wk 3: May 9 - May 15

Wk 4: May 16 - May 22

Wk 5: May 23 – May 29

Wk 6: May 30 - June 5

Wk 7: June 6 - June 12

Wk 8: June 13 - June 19

Wk 9: June 20 - June 26

Wk 10: June 27 - July 3

Wk 11: July 4 – July 10

Wk 12: July 11 – July 17

Wk 13: July 18 - July 24

Wk 14: July 25 – July 31

Wk 15: August 1 – August 7

Wk 16: August 8 – August 14

Wk 17: August 15 - August 21

Wk 18: August 22 - August 28

Wk 19: August 29 – September 4

Wk 20: September 5 – September 11

Wk 21: September 12 - September 15

Table 4.5-1: USGS 01578475 - Octoraro Creek at Richardsmere, MD Gage Flows Daily Average Creek Flows (cfs), 2021

Day	May	June	July	August	September
1	230	208	122	124	2590*
2	208	182	199	174	7700*
3	204	176	179	146	195*
4	252	465	197	132	315*
5	283	318	160	122	339*
6	284	223	136	116	331*
7	240	180	125	113	301*
8	213	331	115	112	281*
9	173	227	133	110	455*
10	193	320	154	113	359*
11	194	329	118	158	296*
12	187	435	174	210	269*
13	179	259	452	166	259*
14	173	193	206	121	250*
15	170	178	144	103	243*
16	168	152	126	102	
17	163	149	115	98.6	
18	162	142	116	106	
19	153	137	120	430	
20	150	140	111	299	
21	144	149	113	194	
22	142	210	121	978	
23	139	190	112	535	
24	135	156	107	661	
25	145	140	441	363	
26	142	133	<b>1070</b>	272	
27	165	129	238	93.3	
28	164	126	164	109	
29	360	122	140	123	
30	351	115	133	137	
31	256		124	141	

Bolded value represent the average creek flows over 1,000 cfs

\*Ramp was removed on morning of 9/1/2021



Table 4.5-2: Fraction of Moon Illumination, 2021 EST (1.0 Equals Full Moon)

Day	May	June	July	August	September
1	0.759	0.590	0.544	0.414	0.296
2	0.652	0.484	0.443	0.320	0.208
3	0.540	0.382	0.346	0.232	0.131
4	0.431	0.287	0.257	0.154	0.068
5	0.328	0.202	0.177	0.089	0.024
6	0.235	0.129	0.108	0.040	0.003
7	0.155	0.071	0.055	0.010	0.008
8	0.090	0.029	0.019	0.002	0.040
9	0.042	0.005	0.002	0.018	0.098
10	0.012	0.001	0.006	0.058	0.180
11	0.000	0.016	0.032	0.121	0.280
12	0.008	0.051	0.079	0.206	0.393
13	0.035	0.106	0.147	0.307	0.512
14	0.080	0.179	0.233	0.420	0.629
15	0.142	0.267	0.335	0.538	0.738
16	0.220	0.369	0.447	0.655	
17	0.311	0.479	0.564	0.764	
18	0.412	0.593	0.679	0.857	
19	0.520	0.706	0.787	0.929	
20	0.631	0.810	0.878	0.953	
21	0.739	0.897	0.946	0.976	
22	0.837	0.961	0.967	0.997	
23	0.918	0.978	0.987	0.992	
24	0.973	0.995	0.999	0.962	
25	0.986	0.997	0.981	0.912	
26	0.999	0.967	0.938	0.846	
27	0.991	0.911	0.874	0.767	
28	0.951	0.835	0.795	0.678	
29	0.884	0.744	0.705	0.584	
30	0.796	0.646	0.610	0.487	
31	0.696		0.511	0.390	

Table 4.5-3: Water Temperature (°C) from the Collection Tank, Octoraro Creek Eel Facility, 2021

Day	May	June	July	August	September
1	14.4	17.6	22.7	24.4	24.9
2	14.8	18.2	24.8	23.7	
3	16.2	18.0	24.0	23.8	
4	16.9	20.1	24.5	23.4	
5	17.2	20.0	23.4	23.2	
6	16.0	20.6	23.1	23.8	
7	15.4	20.8	24.3	23.9	
8	14.4	21.3	23.7	23.8	
9	14.6	22.9	23.5	24.5	
10	15.5	23.8	23.8	24.6	
11	15.1	22.9	23.7	25.3	
12	15.0	22.4	23.8	26.4	
13	14.5	22.2	26.1	26.8	
14	15.3	21.0	26.5	26.7	
15	15.3	<b>20.9</b>	26.4	25.6	
16	15.8	21.0	26.0	25.5	
17	15.6	20.8	26.2	24.9	
18	15.4	20.5	25.7	26.1	
19	16.8	21.1	25.1	26.2	
20	17.7	21.7	24.9	26.4	
21	16.9	22.0	25.3	24.0	
22	17.0	22.8	24.8	25.2	
23	18.1	21.6	24.6	24.5	
24	18.7	21.4	24.4	24.5	
25	17.7	20.8	24.6	24.2	
26	18.3	21.5	25.0	23.9	
27	19.0	21.8	25.7	24.0	
28	19.6	22.5	25.6	23.9	
29	18.6	<b>22.6</b>	25.8	24.6	
30	18.6	22.9	24.9	24.8	
31	17.8		24.4	24.9	

Bolded value represents no flow to the facility, CWA plant was on generator backup

Table 4.5-4: Water Quality Parameters at Associated Locations at Octoraro Creek Eel Facility, 2021

Day	Time	Collection		Head Pond	
		Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)
5/1/2021	805	14.4	9.9	14.8	10.3
5/2/2021	816	14.8	9.2	14.9	8.91
5/3/2021	929	16.2	10.4	16.0	10.2
5/4/2021	809	16.9	8.18	16.8	8.47
5/5/2021	900	17.2	8.81	17.1	8.46
5/6/2021	839	16.0	8.9	16.3	8.3
5/7/2021	815	15.4	9.7	15.5	9.64
5/8/2021	800	14.4	9.1	14.5	8.7
5/9/2021	803	14.6	9.12	14.7	8.4
5/10/2021	912	15.5	8.8	15.6	8.4
5/11/2021	849	15.1	9.18	15.1	8.73
5/12/2021	900	15.0	9.9	15.0	9.3
5/13/2021	830	14.5	8.47	14.9	8.44
5/14/2021	915	15.3	9.9	15.1	11.4
5/15/2021	752	15.3	10.4	15.5	10.2
5/16/2021	800	15.8	10.31	15.5	9.87
5/17/2021	802	15.6	10.14	15.7	9.94
5/18/2021	740	15.4	9.1	15.8	8.9
5/19/2021	905	16.8	9.6	16.6	9.5
5/20/2021	915	17.7	10.1	17.5	10.0
5/21/2021	910	16.9	9.07	16.7	8.65
5/22/2021	725	17.0	9.06	17.2	9.39
5/23/2021	725	18.1	8.4	18.1	8.67
5/24/2021	814	18.7	9.3	18.6	9.4
5/25/2021	925	17.7	9.05	17.6	8.6
5/26/2021	905	18.3	8.1	18.2	8.1
5/27/2021	745	19.0	8.44	19.1	8.08
5/28/2021	815	19.6	8.15	19.7	8.15
5/29/2021	700	18.6	8.4	18.4	8.0
5/30/2021	810	18.6	7.56	19.3	7.32
5/31/2021	735	17.8	7.32	18.1	6.93
6/1/2021	735	17.6	7.1	17.9	6.7
6/2/2021	915	18.2	7.35	17.4	6.5
6/3/2021	740	18.0	7.02	17.9	6.25
6/4/2021	847	20.1	7.6	19.9	7.4
6/5/2021	735	20.0	7.0	20.0	6.69
6/6/2021	735	20.6	7.74	20.5	7.27
6/7/2021	740	20.8	6.9	20.7	6.2
6/8/2021	905	21.3	8.0	21.0	7.0
6/9/2021	735	22.9	7.15	23.0	7.00
6/10/2021	740	23.8	6.91	24.2	7.65
6/11/2021	711	22.9	5.8	23.2	6.5
6/12/2021	740	22.4	7.3	22.7	7.63

(continued)

Table 4.5-4. (Continued)

Day	Time	Collection		Head Pond	
		Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)
6/13/2021	800	22.2	7.5	22.4	7.42
6/14/2021	730	21.0	7.5	20.9	7.2
6/15/2021	740	20.9	6.3	21.1	5.95
6/16/2021	825	21.0	7.95	21.2	6.54
6/17/2021	730	20.8	6.95	20.9	5.7
6/18/2021	811	20.5	6.72	20.4	5.5
6/19/2021	730	21.1	6.8	21.9	5.67
6/20/2021	742	21.7	6.5	21.6	5.25
6/21/2021	745	22.0	7.45	21.7	6.15
6/22/2021	700	22.8	6.46	22.7	5.56
6/23/2021	745	21.6	6.64	21.6	5.55
6/24/2021	735	21.4	6.6	21.5	5.5
6/25/2021	734	20.8	7.0	21.0	5.6
6/26/2021	800	21.5	7.05	21.4	5.35
6/27/2021	703	21.8	6.8	21.7	5.0
6/28/2021	848	22.5	6.49	22.3	5.15
6/29/2021	725	22.6	6.83	22.5	4.9
6/30/2021	930	22.9	6.12	22.7	4.6
7/1/2021	755	22.7	6.3	22.7	4.38
7/2/2021	803	24.8	6.66	25.0	5.65
7/3/2021	735	24.0	6.43	24.1	5.31
7/4/2021	950	24.5	6.83	24.1	6.04
7/5/2021	800	23.4	7.1	23.6	6.9
7/6/2021	700	23.1	6.9	23.2	5.2
7/7/2021	955	24.3	5.95	23.9	4.44
7/8/2021	755	23.7	6.3	23.6	4.0
7/9/2021	743	23.5	5.66	23.7	4.38
7/10/2021	730	23.8	5.68	23.6	4.23
7/11/2021	750	23.7	5.6	23.7	3.92
7/12/2021	710	23.8	6.1	23.8	4.3
7/13/2021	725	26.1	7.0	26.0	7.2
7/14/2021	740	26.5	2.2	26.5	6.2
7/15/2021	700	26.4	1.8	26.5	5.9
7/16/2021	730	26.0	3.04	26.1	5.16
7/17/2021	730	26.2	5.65	26.1	4.96
7/18/2021	745	25.7	5.91	25.7	4.86
7/19/2021	810	25.1	6.31	25.3	5.14
7/20/2021	655	24.9	5.60	25.1	5.01
7/21/2021	700	25.3	5.5	25.3	4.3
7/22/2021	720	24.8	6.3	24.9	5.4
7/23/2021	700	24.6	6.63	24.8	5.42
7/24/2021	740	24.4	5.97	24.6	5.11
7/25/2021	750	24.6	6.5	24.5	4.8

(continued)

Table 4.5-4. (Continued)

Day	Time	Collection		Head Pond	
		Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)
7/26/2021	800	25.0	5.3	25.3	5.3
7/27/2021	720	25.7	4.5	25.8	5.8
7/28/2021	810	25.6	4.44	25.8	5.43
7/29/2021	700	25.8	5.16	25.8	5.02
7/30/2021	733	24.9	5.66	25.0	5.2
7/31/2021	735	24.4	6.08	24.6	5.35
8/1/2021	725	24.4	6.1	24.5	5.05
8/2/2021	702	23.7	6.88	23.9	6.0
8/3/2021	654	23.8	6.8	24.1	5.72
8/4/2021	635	23.4	6.63	23.7	5.57
8/5/2021	655	23.2	6.5	23.4	5.78
8/6/2021	700	23.8	5.07	24.0	4.6
8/7/2021	640	23.9	6.1	24.0	5.0
8/8/2021	653	23.8	5.8	23.9	6.6
8/9/2021	635	24.5	5.8	24.5	7.0
8/10/2021	630	24.6	6.4	24.7	7.3
8/11/2021	700	25.3	6.2	25.5	5.7
8/12/2021	635	26.1	7.0	25.6	7.2
8/13/2021	635	26.8	7.2	26.8	6.4
8/14/2021	623	26.7	7.1	26.7	5.18
8/15/2021	625	25.6	6.1	25.8	5.1
8/16/2021	800	25.5	7.24	25.5	5.70
8/17/2021	704	24.9	7.4	24.9	5.6
8/18/2021	1140	26.1	8.28	25.4	6.28
8/19/2021	730	26.2	6.53	26.3	7.2
8/20/2021	810	26.4	4.6	26.4	6.4
8/21/2021	705	24.0	5.06	24.0	6.45
8/22/2021	630	25.2	5.56	25.4	6.9
8/23/2021	800	24.5	3.8	24.6	7.03
8/24/2021	800	24.5	4.7	24.6	7.6
8/25/2021	640	24.2	4.08	24.3	7.33
8/26/2021	815	23.9	6.02	23.9	7.21
8/27/2021	652	24.0	1.3	23.9	4.9
8/28/2021	630	23.9	4.3	23.8	4.9
8/29/2021	730	24.6	6.06	24.7	5.8
8/30/2021	700	24.8	6.1	24.8	5.4
8/31/2021	639	24.9	5.8	25.0	5.0
9/1/2021	815	24.9	6.17	25.0	5.7

Table 4.5-5: Rainfall (inches) Reading Taken at the Collection Facility, Octoraro Creek Eel Facility, 2021

Day	May	June	July	August	September
1	0	0	0	0	0.7
2	0	0	1.0	1.0	
3	0	0	0	0	
4	1.75	1.25	1.2	0	
5	0.25	0	0	0	
6	0.5	0	0	0	
7	0	0	0	0	
8	0	0	0	0	
9	0.2	0.3	0.2	0	
10	0	0.1	0.8	0	
11	0	0.1	0.1	0.9	
12	0	1.1	0	0.25	
13	0	0	2.7	0	
14	0	0	0	0.1	
15	0	0.1	0	0	
16	0	0	0	0	
17	0	0	0	0.25	
18	0	0	0.3	0.6	
19	0	0	0	0.7	
20	0	0	0	0.25	
21	0	0	0	0.1	
22	0	2.0	0.9	0.5	
23	0	1.2	0	2.6	
24	0	0	0	0.9	
25	0.3	0	0	0	
26	0	0	2.9	0	
27	0.6	0	0	0	
28	0	0	0	0.9	
29	1.3	0	0	0	
30	0.4	0	0	0	
31	0.1		0	0.4	

Bolded values represent rainfall amounts over 1.0 inches

Table 4.6-1: Eel Transport/Stocking Data, 2021

Location of stocking	Number of Eels	Died (Mortality)			Removed for Analysis	Number Stocked
		Collection Tank	Holding Tank	Transported		
Octoraro Creek Collection Tanks	45,230	2911 (6.44%)				
Transported to Conowingo West Eel Collection Facility	39,119			0 (0.00%)		39119
Transported to West Fairview (Site 5)	3,200			5 (0.16%)		3195
Conowingo Collection Tank	556,176	80 (0.01%)	<b>689 (0.12%)</b>		100	555,996
Total Transported from Octoraro Creek and Conowingo West Eel Collection Facility	598,315			146 (0.02%)		598,169

Number displayed are from May 1 – September 1

Bolded value is assumed as worst case scenario: these could be eels from Octoraro or Conowingo

**Table 4.7-1: Calibration of Flows (Gallons per Minute) in the Octoraro Creek Eel Facility, 2021**

	DATE								
	4/30	5/4	5/12*	5/19*	5/29	6/2*	6/10*	6/16*	6/23*
<b>Enkamat Ramp</b>									
Spray bar	8.25	8.55	7.2	9.05	7.65	7.8	7.65	7.8	7.5
Collection tank drain	1.05	0.75	1.5	0.9	0.75	0.95	0.65	2.4	2.25
Top Attraction flow	7.2	7.8	5.7	8.15	6.9	6.85	7.0	5.4	5.25
Bottom Attraction flow	24.5	27.5	29.0	25.0	22.5	24.3	25.0	26.0	25.5
Total Attraction Flow	32.75	36.05	36.2	34.05	30.15	32.1	32.65	33.8	33.0
<b>Milieu Ramp</b>									
Spray bar	7.5	7.5	7.2	7.8	5.25	7.8	6.6	7.5	7.6
Collection tank drain	1.5	0.85	1.5	1.2	1.25	0.9	0.75	2.0	2.3
Top Attraction flow	6.0	6.65	5.7	6.6	4.0	6.9	5.85	5.5	5.3
Bottom Attraction flow	25.0	25.0	26.0	23.5	25.0	25.3	26.5	30.0	30.0
Total Attraction Flow	32.5	32.5	33.2	31.3	30.25	33.1	33.1	37.5	37.6
Overall Attraction Flows	65.25	68.55	69.4	65.35	60.4	65.2	65.75	71.3	70.9

\* Cleaned pump, manifold, and hoses to increase flow

	DATE								
	6/30	7/7	7/14*	7/21	7/28	8/4*	8/13*	8/18#	8/28
<b>Enkamat Ramp</b>									
Spray bar	6.6	4.5	9.0	6.6	4.8	6.9	6.9	7.65	7.8
Collection tank drain	1.25	1.2	1.9	1.0	1.35	1.2	1.75	0.65	1.9
Top Attraction flow	5.35	3.3	7.1	5.6	3.45	5.7	5.15	7.0	5.9
Bottom Attraction flow	23.5	24.5	19.5	18.0	14.5	22.5	20.4	23.5	17.4
Total Attraction Flow	30.1	29.0	28.5	24.6	19.3	29.4	27.3	31.15	25.2
<b>Milieu Ramp</b>									
Spray bar	6.75	4.95	8.4	6.0	4.5	6.6	6.9	6.75	7.8
Collection tank drain	1.5	1.25	1.85	1.0	1.5	1.2	1.75	0.7	2.1
Top Attraction flow	5.25	3.75	6.55	5.0	3.0	5.4	5.15	6.05	5.7
Bottom Attraction flow	25.0	24.0	18.9	16.8	18.0	22.0	27.0	22.0	21.0
Total Attraction Flow	31.75	28.95	27.3	22.8	22.5	28.6	33.9	28.75	28.8
Overall Attraction Flows	61.85	56.75	55.8	47.4	41.8	58.0	61.2	59.9	54.0

\* Cleaned pump, manifold, and hoses to increase flow

# Water line was rerouted to the top of the hill on 8/13/2021



Table 5.0-1: Comparison of Octoraro Creek Eel Facility, 2015-2021

Watershed area 540 km<sup>2</sup>  
 Approximate Distance from Ocean to ramp 341 km

	2015	2016	2017	2018	2021	2020	2021	Average
Eels Collected	7,197	21,094	11,347	4,203	14,170	3,597	45,230	15,262.6
Average Size (mm)	129.4	130.9	135.4	141.6	129.9	125.8	123.5	130.9
Range of Sizes (mm)	95-232	99-202	99-245	100-259	93-252	91-170	90-190	
Days of Operation	89	138	138	135	138	95	124	122.2
Average eels per day	80.9	152.9	82.2	31.1	102.7	37.9	364.8	81.3
Average creek flow (cfs)	180.9	121.3	138.0	411.0	240.0	224.0	203.0	216.9
Range of flows (cfs)	60-1,490	43-512	51-557	88-2,370	63-1,610	64-3,920	93-1,070	

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



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



Figure 3.1-1: Scaffolding and Collection Tank on top of the hill, Octoraro Creek Eel Facility, 2021



Figure 3.1-2: Rainfall gauge, Octoraro Creek Eel Facility, 2021



Figure 3.1-3: Braces and scaffolding supporting longer ramp, Octoraro Creek Eel Facility, 2021



Figure 3.1-4: Additional length of hose for attraction flow, Octoraro Creek Eel Facility, 2021



Figure 3.2-1: Measuring Juvenile Eels to Nearest Millimeter While Sedated, Octoraro Creek Eel Facility, 2021





Figure 3.2-2: Weighing Juvenile Eels in Grams While Sedated, Octoraro Creek Eel Facility, 2021



Figure 3.3-1: Small Eel Transport Tank, Octoraro Creek Eel Facility, 2021



Figure 4.1-1: Daily Eel Catch, Octoraro Creek Eel Facility, 2021

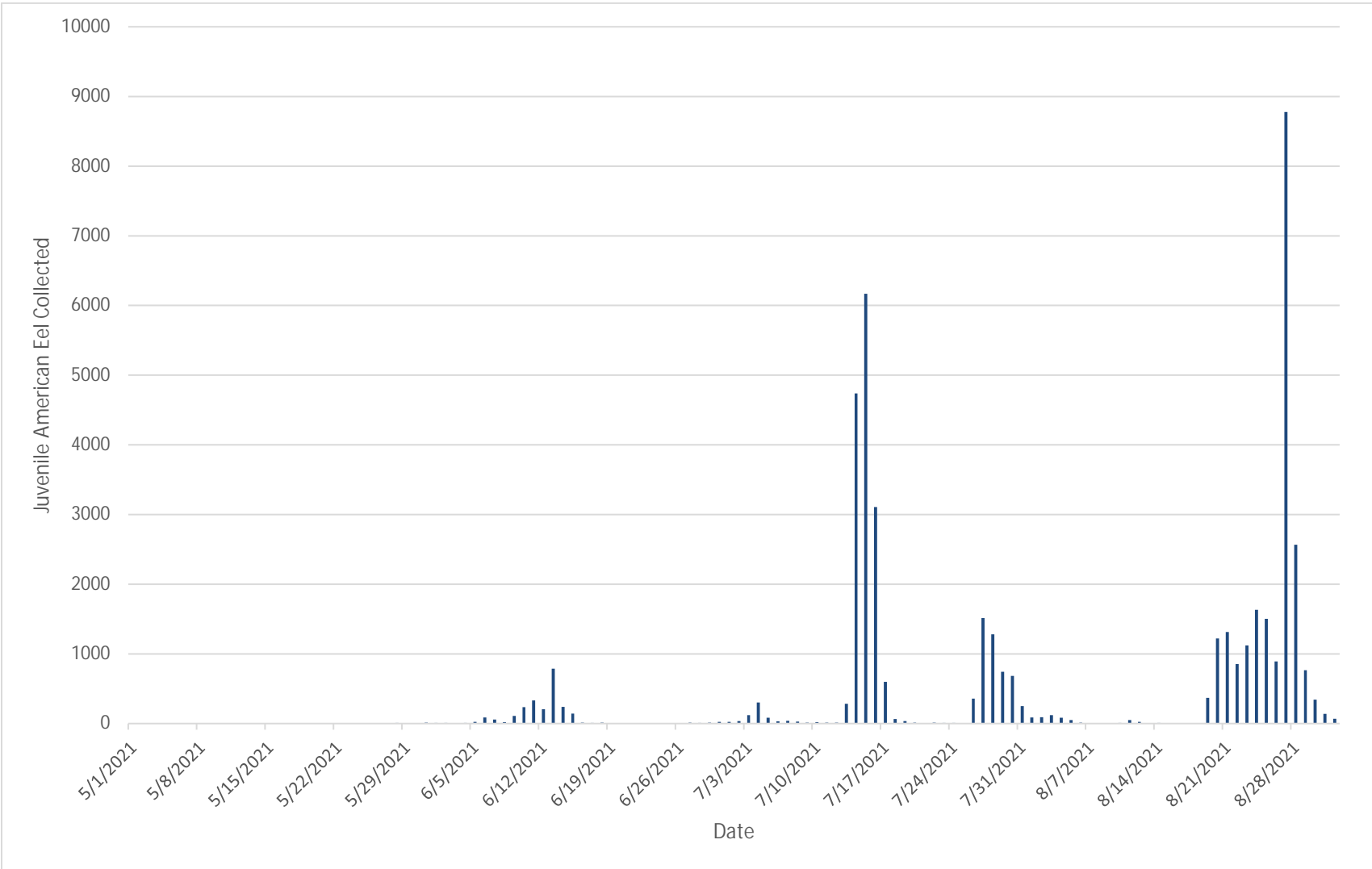


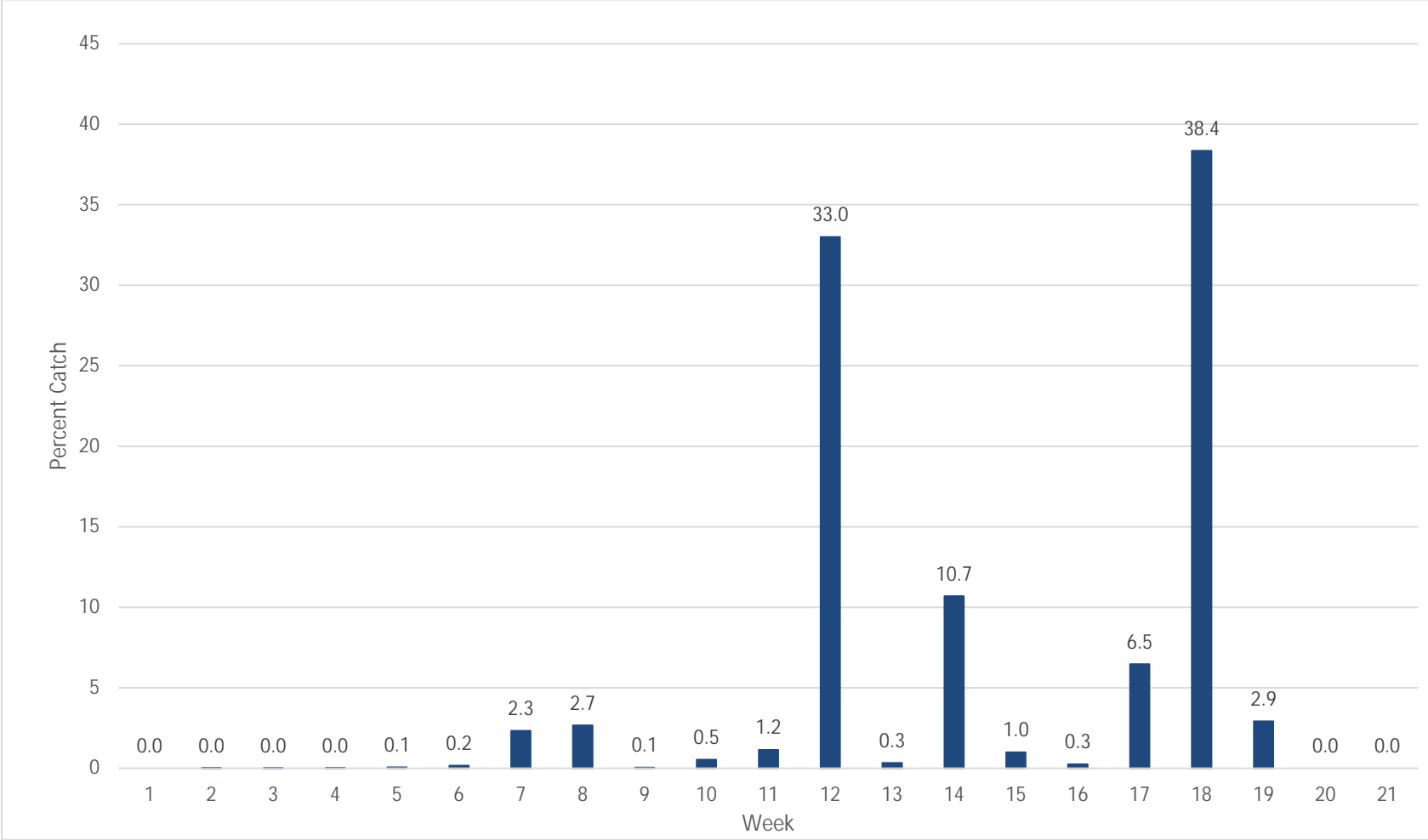
Figure 4.2-1: Image of Minor Hemorrhage Caudal Tail, Octoraro Creek Eel Facility, 2021



Figure 4.2-2: Image of Enlarged Belly, Octoraro Creek Eel Facility, 2021



Figure 4.3-1: Percentage Eel Catch per Week, Octoraro Creek Eel Facility, 2021



**Figure 4.5-1: Daily Eel Catch and Daily Average Creek Flow (cfs, top graph) and Weekly Eel Catch and Weekly Average Creek Flow (cfs, bottom graph), Octoraro Creek Eel Facility, 2021**

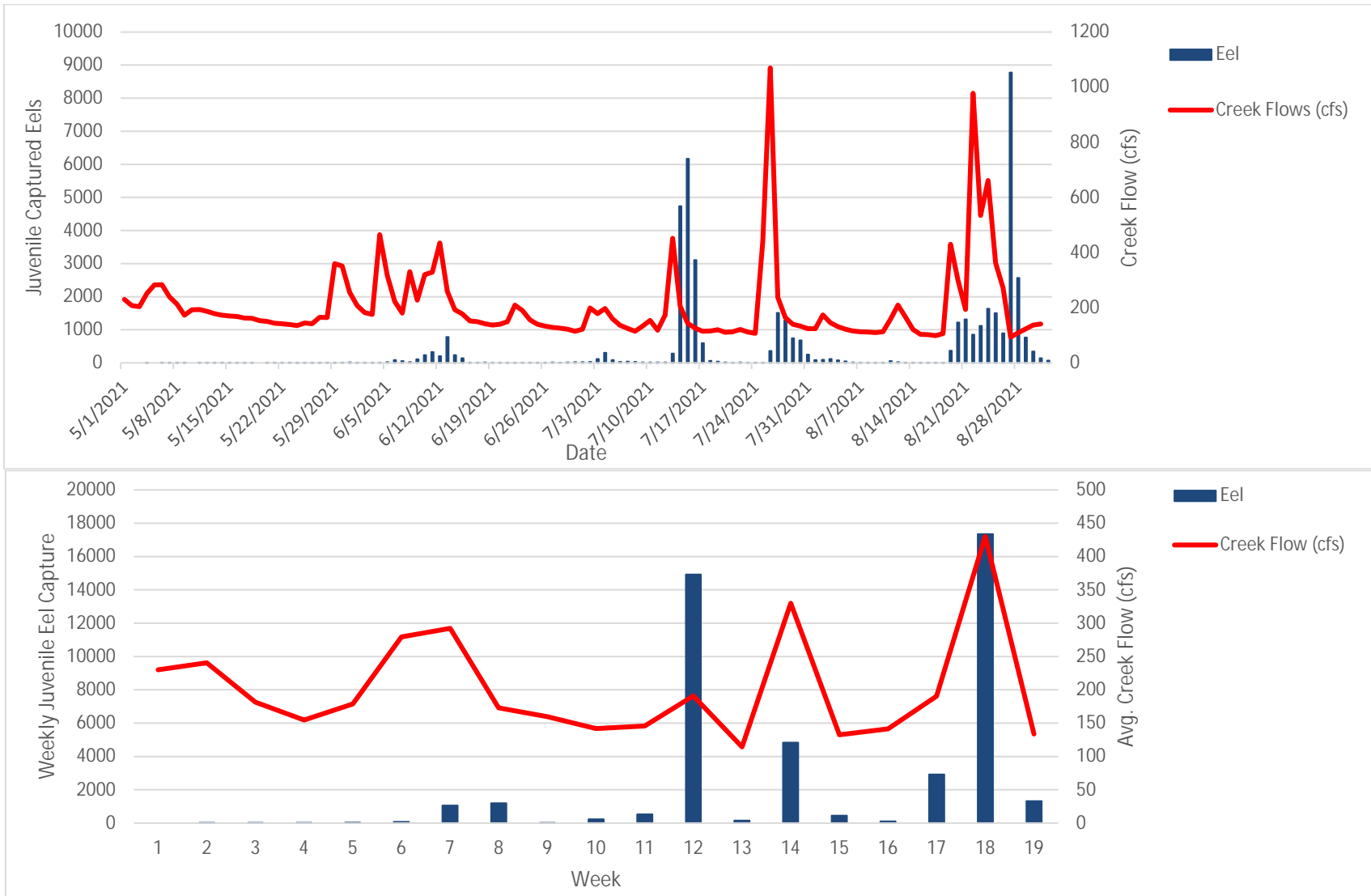


Figure 4.5-2: Eel Catch to Lunar Fraction (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2021 (1.0 Equals Full Moon)

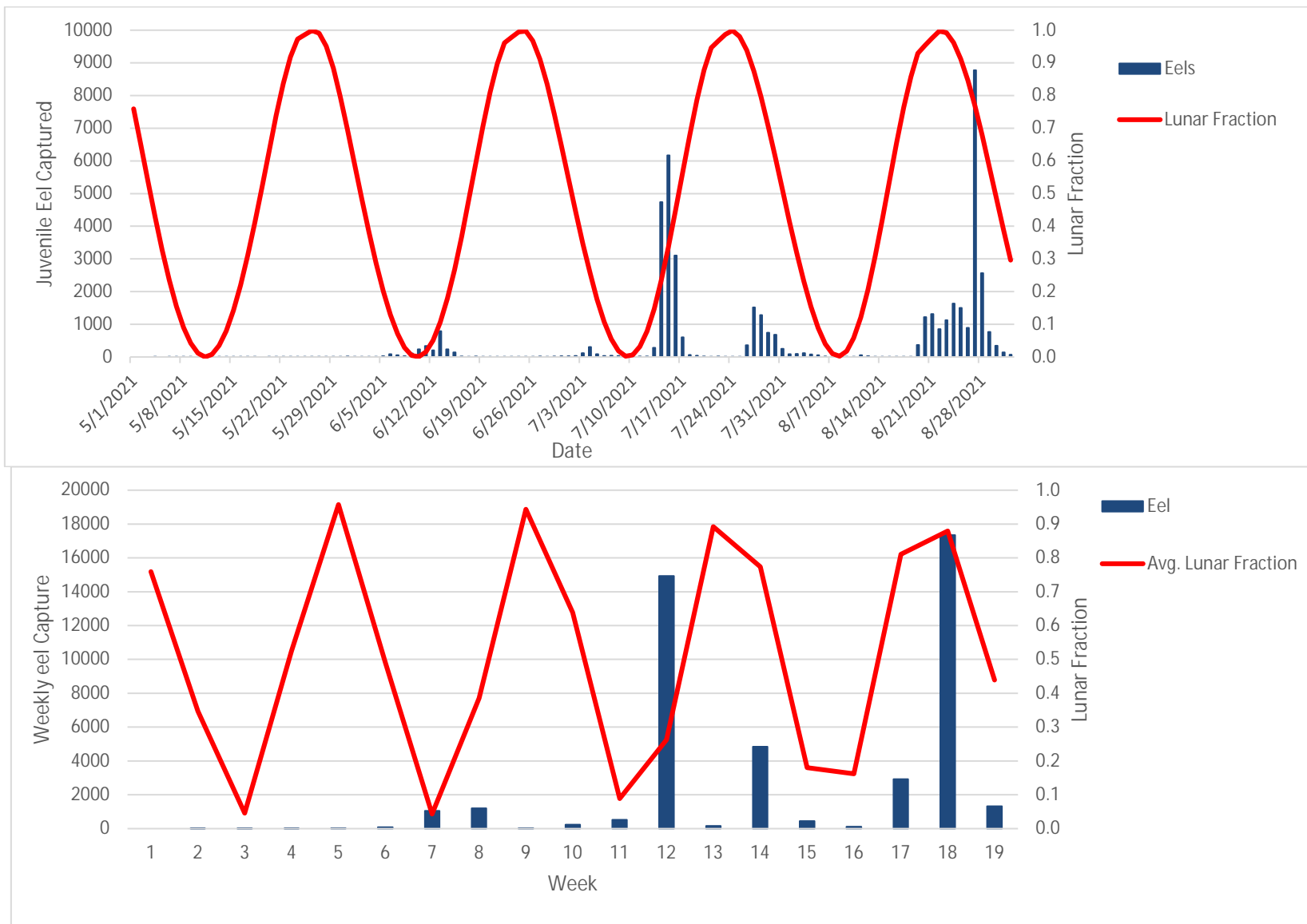




Figure 4.5-3: Eel Catch to Water Temperature (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2021

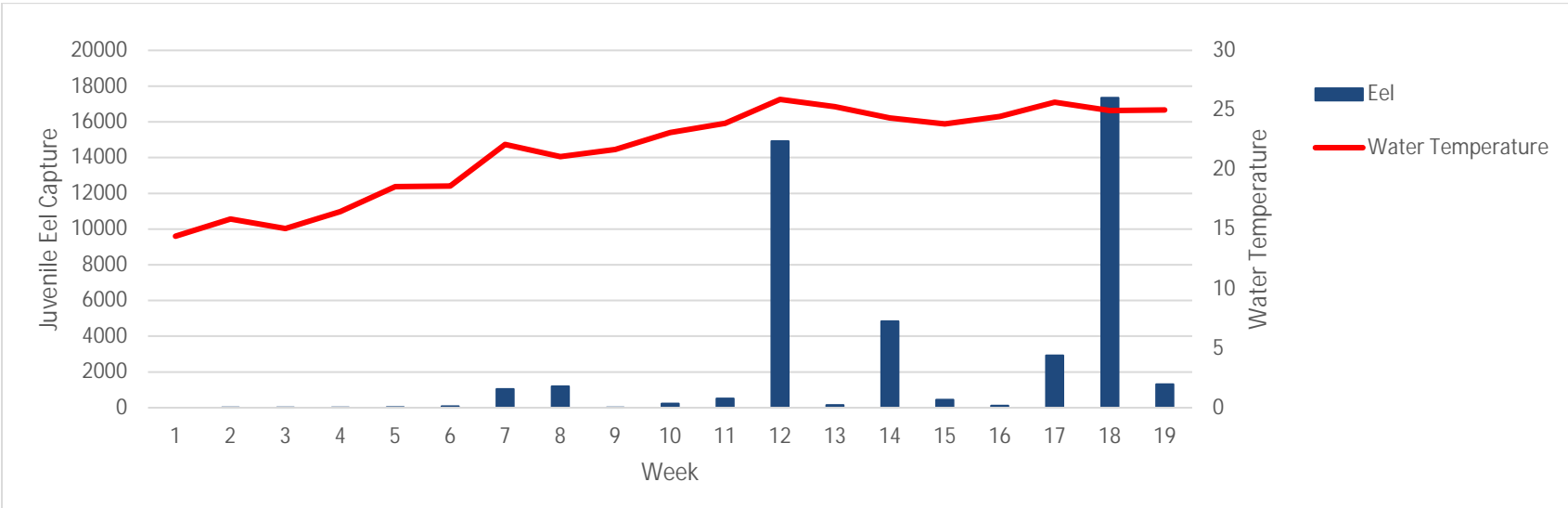
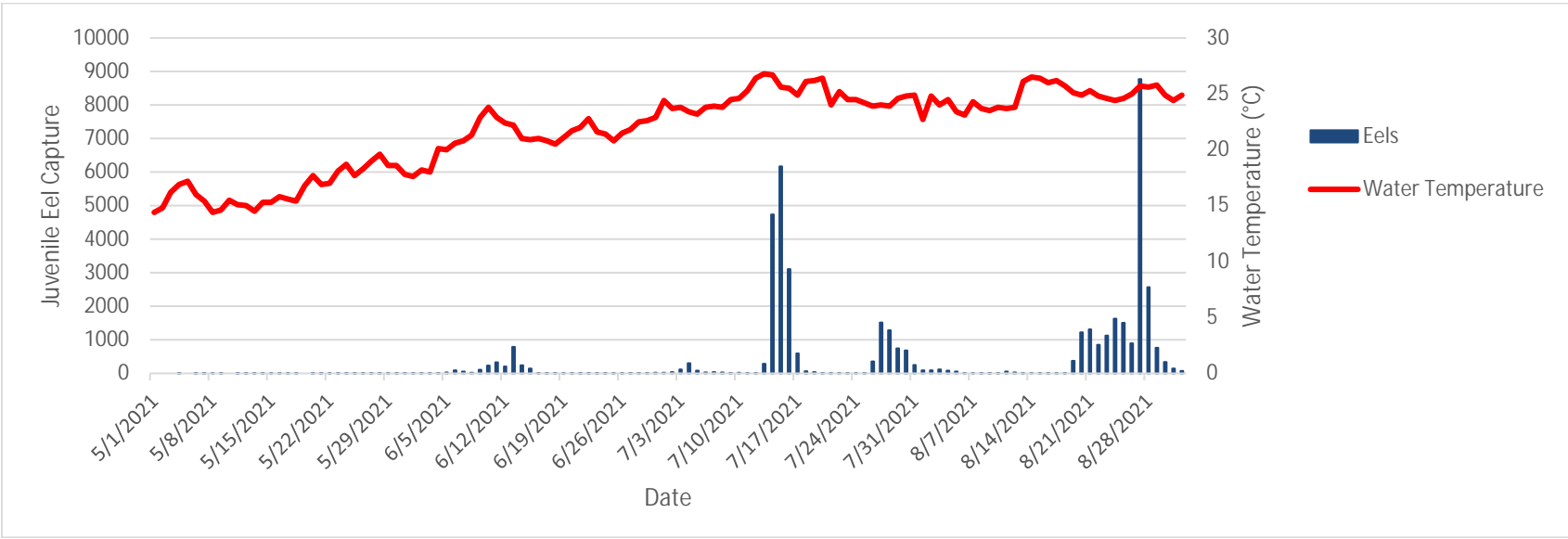


Figure 4.5-4: Comparison of Dissolved Oxygen Readings in Collection Tanks and Head Pond, Octoraro Creek Eel Facility, 2021

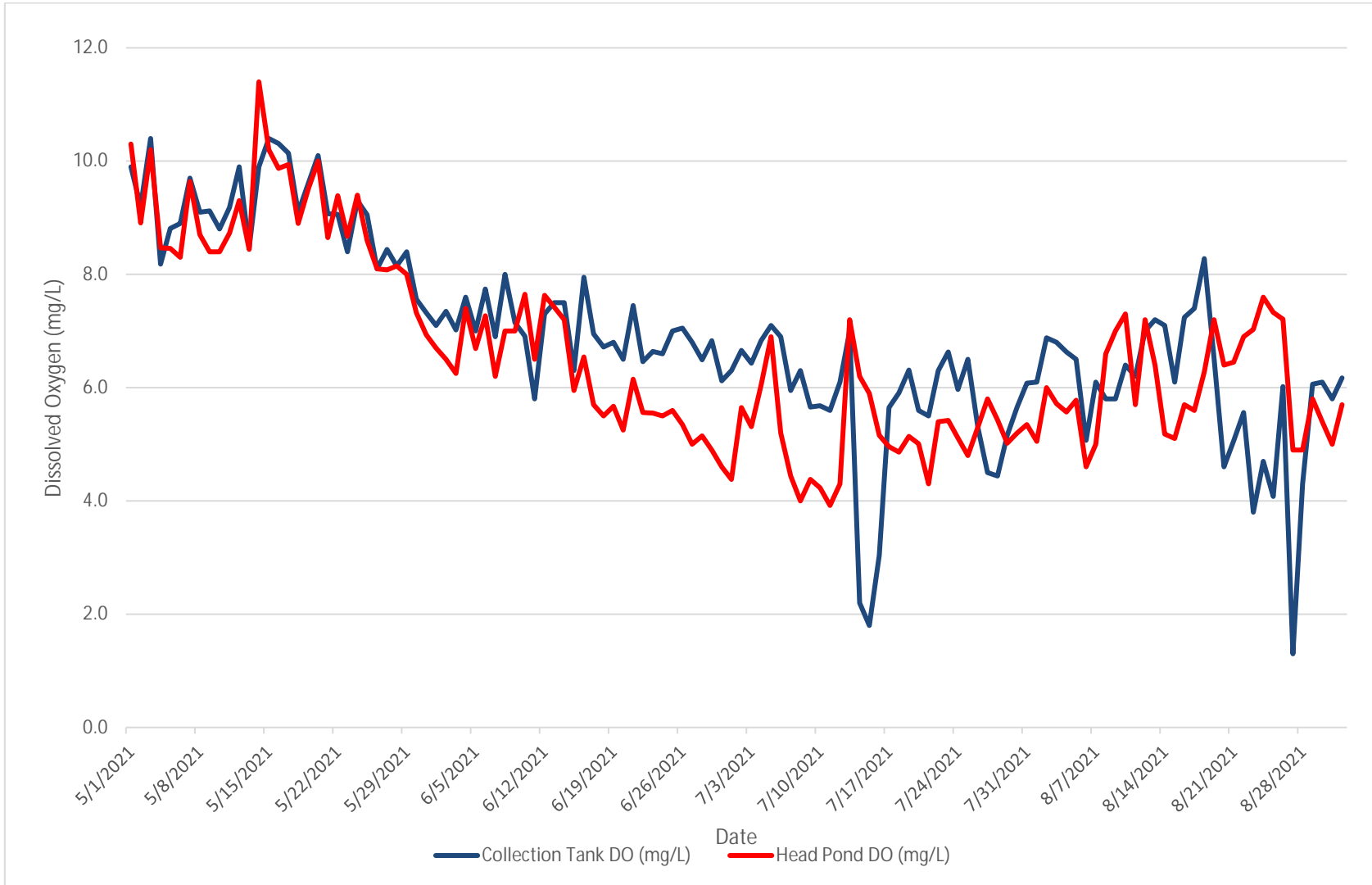


Figure 4.5-5: Eel Catch to Dissolved Oxygen (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2021

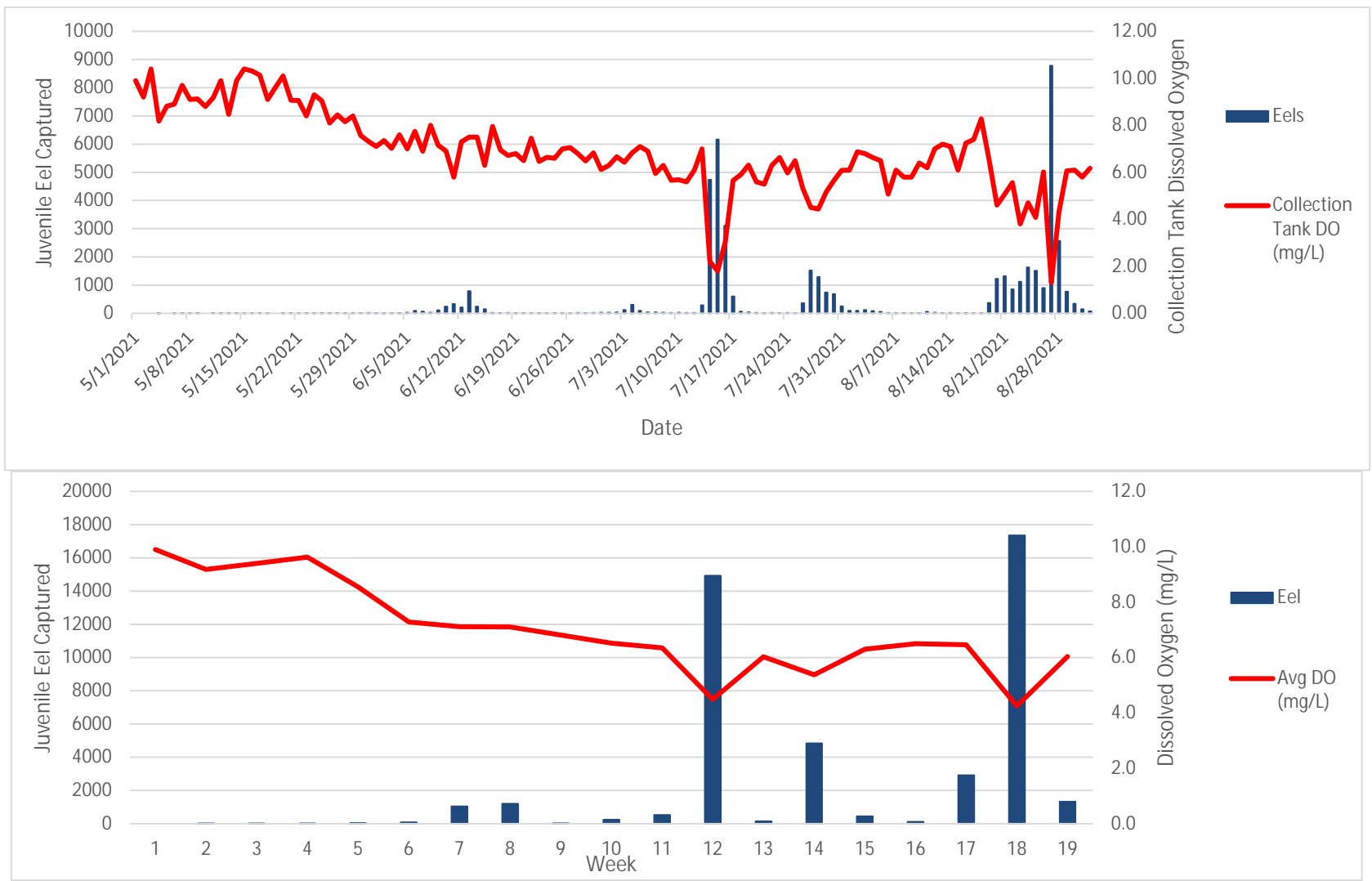


Figure 4.5-6: Eel Catch to Rainfall (Daily above, Weekly Average below), Octoraro Creek Eel Facility, 2021

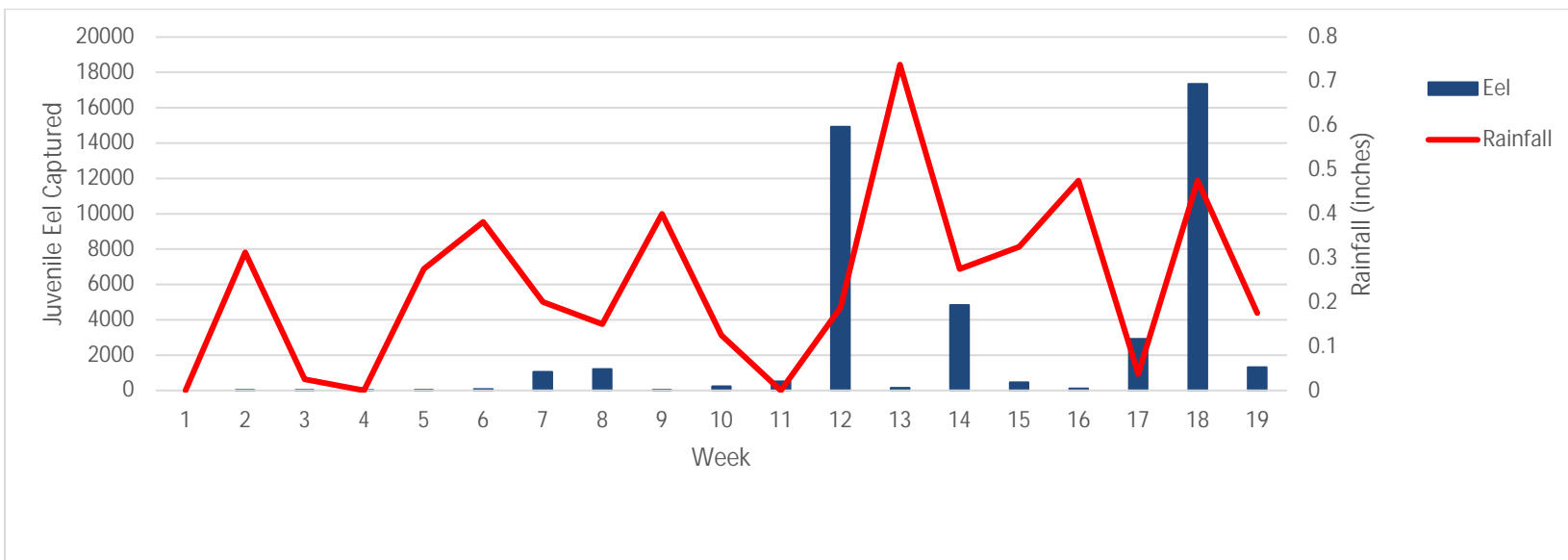
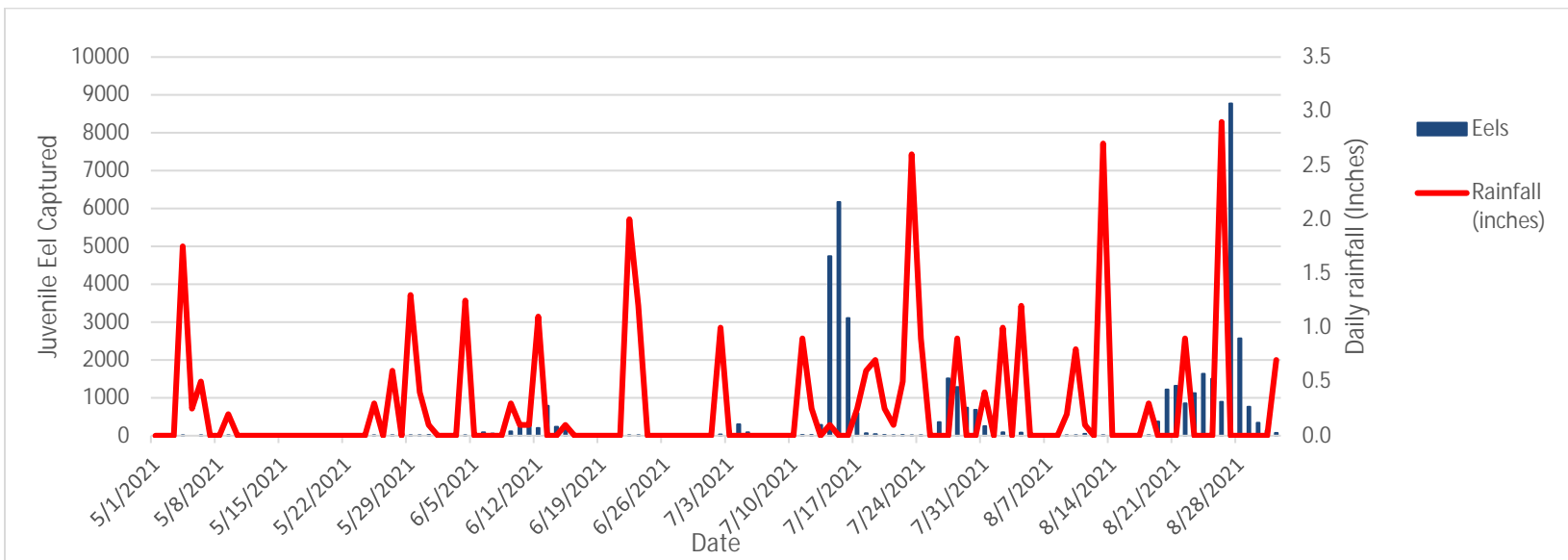


Figure 5.0-1: Cobble/gravel Outcrop Downstream of the Eel Ramp Entrance, Octoraro Creek Eel Facility, 2021



Figure 5.0-2: Weekly Catch and Average Creek Flow, Octoraro Creek Eel Facility, 2015-2021

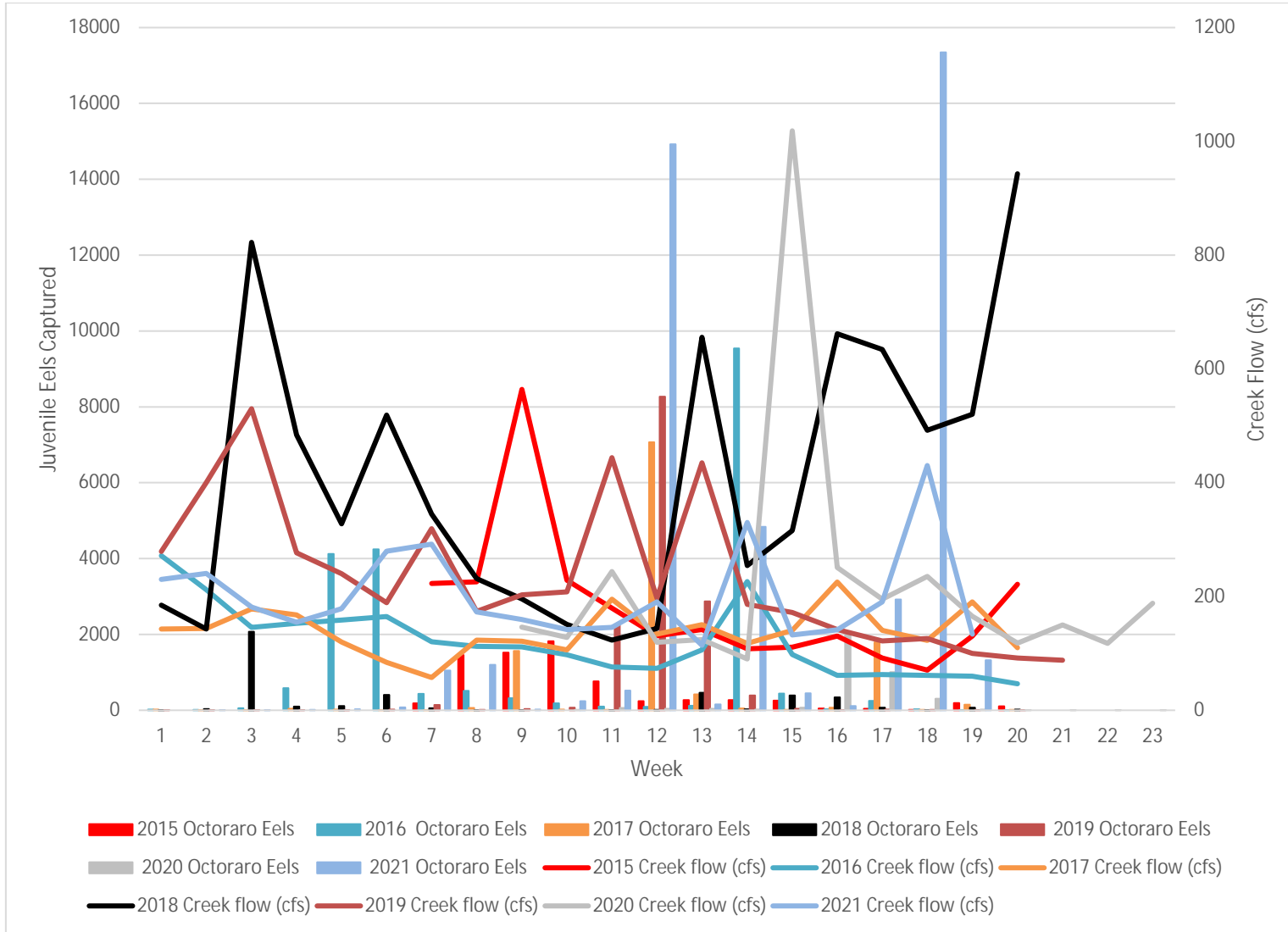


Figure 5.0-3 Damaged from High Creek Flows, Octoraro Creek Eel Facility, 2021



Figure 5.0-4 Changes in Tailrace After High Creek Flows, Octoraro Creek Eel Facility, 2021





**Appendix A:  
Weekly Biological Data and Environmental Conditions  
for Octoraro Creek, 2021**

### Weekly Eel Catch Data, 2021

2021 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2021 Octoraro Eels	0	5	9	13	29	77	1050	1201	21	238	519	14925	154	4836	452	112	2920	17350	1319
2021 Creek flow (Weekly avg. cfs)	230	240.6	181.3	154.6	178.6	279.4	292.1	172.9	159.7	141.7	145.7	190.7	114.3	330.0	132.4	141.4	190.4	430.2	133.7
2021 Lunar Fraction (Weekly avg.)	0.76	0.35	0.05	0.52	0.96	0.49	0.04	0.39	0.94	0.64	0.09	0.26	0.89	0.77	0.18	0.16	0.81	0.88	0.44
2021 Water temp (Weekly Avg. °C)	14.4	15.84	15.04	16.46	18.57	18.61	22.10	21.07	21.69	23.10	23.89	25.89	25.27	24.33	23.83	24.44	25.66	24.96	25.00
Dissolved Oxygen (Weekly Avg. mg/L)	9.90	9.18	9.40	9.63	8.55	7.28	7.11	7.10	6.81	6.52	6.35	4.48	6.03	5.38	6.30	6.50	6.46	4.25	6.03
Rainfall (Weekly avg.)	0.0	0.31	0.03	0.0	0.28	0.38	0.2	0.15	0.4	0.13	0.0	0.19	0.74	0.28	0.33	0.48	0.04	0.48	0.18
Percent of Catch	0.00	0.31	0.03	0.00	0.28	0.38	0.20	0.15	0.40	0.13	0.00	0.19	0.74	0.28	0.33	0.48	0.04	0.48	2.92
Conowingo Eels	5	46640	15851	17528	42848	29424	23335	18176	2711	5659	75609	63442	59128	50982	26007	12628	3747	19265	58774

No collection occurred at Octoraro Creek eel facility after Week 19

- |  |  |
|--|--|
| <p>Wk 1: May 1</p> <p>Wk 2: May 2 – May 8</p> <p>Wk 3: May 9 - May 15</p> <p>Wk 4: May 16 - May 22</p> <p>Wk 5: May 23 – May 29</p> <p>Wk 6: May 30 - June 5</p> <p>Wk 7: June 6 - June 12</p> <p>Wk 8: June 13 - June 19</p> <p>Wk 9: June 20 - June 26</p> <p>Wk 10: June 27 - July 3</p> <p>Wk 11: July 4 – July 10</p> <p>Wk 12: July 11 – July 17</p> | <p>Wk 13: July 18 - July 24</p> <p>Wk 14: July 25 – July 31</p> <p>Wk 15: August 1 – August 7</p> <p>Wk 16: August 8 – August 14</p> <p>Wk 17: August 15 - August 21</p> <p>Wk 18: August 22 - August 28</p> <p>Wk 19: August 29 – September 1</p> |
|--|--|

**Appendix B:  
Weekly Data for 2015-2021**

**Weekly Eel Catch Data (2015-2021)**

2015 Week							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	
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 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	4387	151	1224	5384	2196	1761	5199	23318	8090	799	1503	1432	15435	32524	13130	2654	2931	88	51	43
2018 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2018 Octoraro Eels	5	31	2072	101	115	407	55	3	4	0	1	11	464	29	393	343	73	5	69	22
2018 Creek flow (cfs)	185	143	822.6	484.1	327.9	519	345.1	231.3	195.7	150.9	123.3	143.9	655.6	254.3	315.7	661.9	634	492.1	520.4	943
2018 Lunar Fraction	0.89	0.4	0.06	0.6	0.96	0.55	0.06	0.47	0.95	0.69	0.1	0.34	0.91	0.8	0.18	0.22	0.82	0.89	0.29	0.12
2018 Water temp (°C)	15.3	15.9	18.4	19.4	21.4	20.5	20.8	22.6	22.5	25.6	25.5	25.3	24.6	24.9	25.9	25.2	23.2	25.3	24.6	18.2
Dissolved Oxygen (mg/L)	8.8	7.7	7.5	9.4	7.9	8.1	7.4	6.8	7	6.6	6.5	7.1	7.5	6.5	6.2	6.5	5.8	6.4	6.1	10.2
Percent of Catch	0.1	0.7	49.3	2.7	2.7	9.7	1.3	0.7	0.1	0.0	0.0	0.3	11.0	0.7	9.4	8.2	1.7	0.1	1.6	0.5
Conowingo Eels	7	6443	6879	197	398	1316	462	657	1077	6020	3175	1029	7986	20965	5262	3948	1870	165	73	20

(continued)

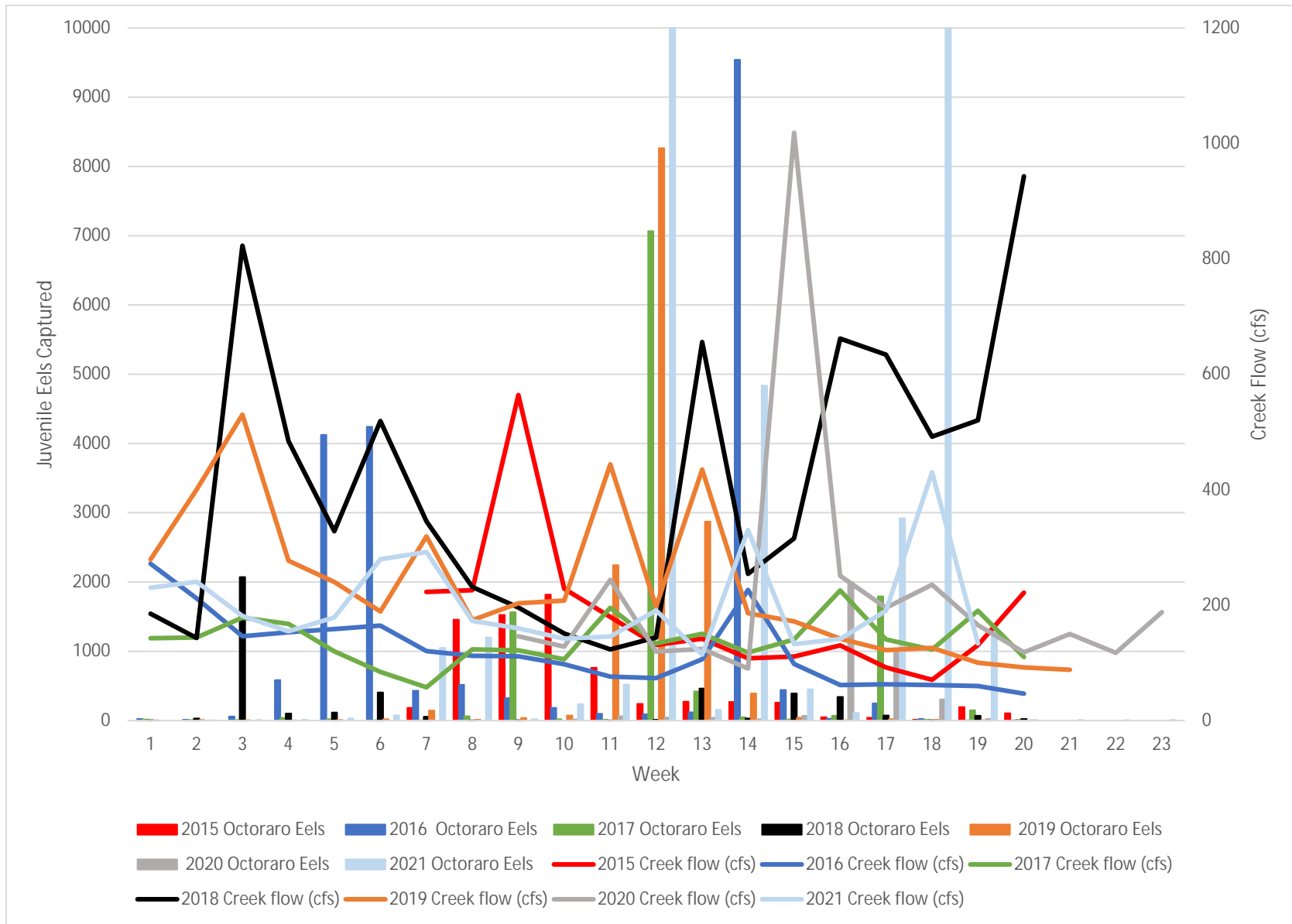
(Continued)

2019 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
2019 Octoraro Eels	1	9	5	3	9	20	144	12	36	73	2244	8266	2874	391	42	5	19	12	4	1	0
2019 Creek flow (cfs)	279	400	530	277	240	189	319	174	203	208	444	197	435	186	172	142	122	126	100	92	88
2019 Lunar Fraction	0.07	0.16	0.80	0.85	0.29	0.09	0.69	0.93	0.43	0.06	0.57	0.96	0.58	0.07	0.44	0.95	0.71	0.12	0.31	0.89	0.99
2019 Water temp (°C)	15.50	16.10	14.60	15.70	17.90	19.90	20.00	20.50	21.60	23.00	23.10	23.40	23.70	23.70	23.90	23.90	24.00	23.10	22.90	22.40	22.50
Dissolved Oxygen (mg/L)	9.73	9.36	10.18	10.05	9.26	8.75	8.29	8.52	7.14	6.32	6.13	5.72	6.17	6.29	5.89	5.41	5.87	4.69	5.13	4.93	4.63
Percent of Catch	0.01	0.06	0.04	0.02	0.06	0.14	1.02	0.08	0.25	0.52	15.84	58.33	20.28	2.76	0.30	0.04	0.13	0.08	0.03	0.01	0.00
Conowingo Eels	6	4616	2237	1774	9359	2097	1706	2187	2056	39685	3076	3141	5210	3213	1158	38115	3160	3135	192	40	18

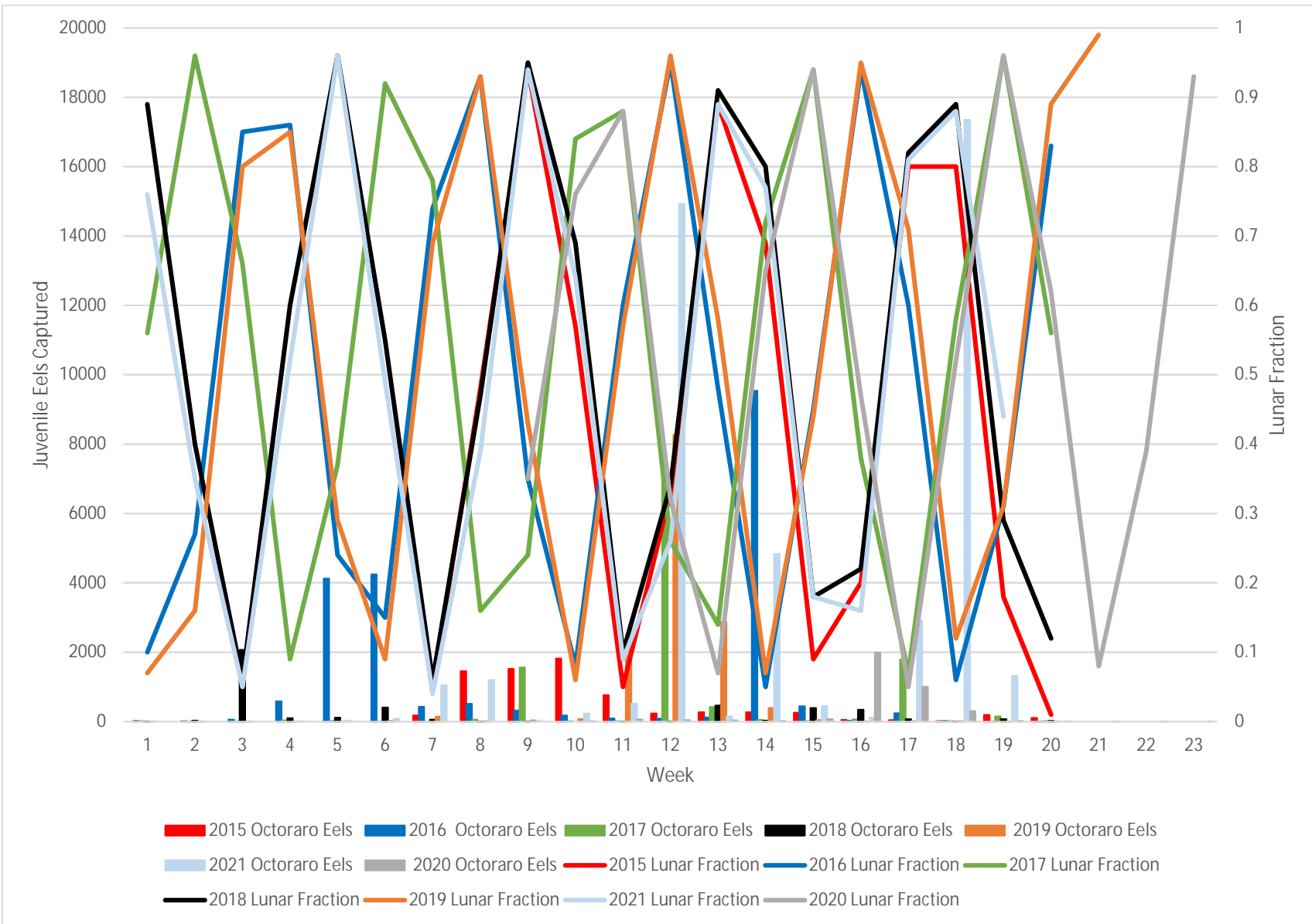
2020 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2020 Octoraro Eels									0	15	64	44	40	20	71	1992	1005	306	22	5	5	2	6
2020 Creek flow (cfs)									146	128.1	244.1	119.3	124.2	90.2	1018.5	250.9	195.5	235.4	165.4	118	150	117.4	187.9
2020 Lunar Fraction									0.35	0.76	0.88	0.32	0.07	0.65	0.94	0.47	0.05	0.52	0.96	0.62	0.08	0.39	0.93
2020 Water temp (°C)									20.7	21.4	22.7	23.8	24.8	25.5	22.5	22.8	23.6	23.5	23.4	21.7	18.6	18.6	18.8
Dissolved Oxygen (mg/L)									7.23	6.04	6.00	5.45	5.90	5.27	6.04	6.87	6.52	7.16	7.60	6.99	6.96	9.02	7.58
Rainfall (inch)									0.01	0.01	0.49	0.00	0.13	0.04	0.62	0.00	0.11	0.25	0.11	0.07	0.00	0.09	0.30
Percent of Catch									0.00	0.42	1.78	1.22	1.11	0.56	1.97	55.38	27.94	8.51	0.61	0.14	0.14	0.06	0.17
Conowingo Eels				2290	20801	36993	10842	3773	1895	4008	15127	7509	36742	17693	29622	31905	24947	6993	2570	223	608	9	101

2021 Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
2021 Octoraro Eels	0	5	9	13	29	77	1050	1201	21	238	519	14925	154	4836	452	112	2920	17350	1319
2021 Creek flow (cfs)	230	240.6	181.3	154.6	178.6	279.4	292.1	172.9	159.7	141.7	145.7	190.7	114.3	330.0	132.4	141.4	190.4	430.2	133.7
2021 Lunar Fraction	0.76	0.35	0.05	0.52	0.96	0.49	0.04	0.39	0.94	0.64	0.09	0.26	0.89	0.77	0.18	0.16	0.81	0.88	0.44
2021 Water temp (°C)	14.4	15.84	15.04	16.46	18.57	18.61	22.10	21.07	21.69	23.10	23.89	25.89	25.27	24.33	23.83	24.44	25.66	24.96	25.00
Dissolved Oxygen (mg/L)	9.90	9.18	9.40	9.63	8.55	7.28	7.11	7.10	6.81	6.52	6.35	4.48	6.03	5.38	6.30	6.50	6.46	4.25	6.02
Percent of Catch	0.00	0.31	0.03	0.00	0.28	0.38	0.20	0.15	0.40	0.13	0.00	0.19	0.74	0.28	0.33	0.48	0.04	0.48	0.18
Conowingo Eels	5	46640	15851	17528	42848	29424	23335	18176	2711	5659	75609	63442	59128	50982	26007	12628	3747	19265	58774

Eel Catch (Collection) to Creek Flow (2015-2021)



Eel Catch (Collection) to Lunar Fraction (2015-2021)



Eel Catch (Collection) to Water Temperature (2015-2021)

