American Eel: Collection and Relocation Conowingo Dam, Susquehanna River, Maryland 2015

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BACKGROUND

The American Eel (*Anguilla rostrata*) is the only species of freshwater eel in North America. They are catadromous, meaning they are hatched in the ocean, mature in freshwater, and then return to the sea to spawn. Throughout their life cycle, the American Eel occupies a variety of habitats and goes through multiple physical changes, known as metamorphoses. The American Eel begins its life in the Sargasso Sea, which is about two million square miles of warm water located in the North Atlantic Ocean (USFWS 2011). The larval eels, known as leptocephalus larvae, are transported to the eastern seaboard of North America via ocean currents, which takes about a year. Their coastal range extends as far north as Greenland and as far south as Brazil. By the time the larvae reach the coast, they have developed fins and have taken on the shape of an adult eel (Hedgepeth 1983). There are two stages of juvenile eels. In the first stage, the juveniles are called glass eels as they are transparent, and they are typically 5-8 cm long. Juveniles begin an active migration into estuarine and riverine habitats (Deedler 1958) where they begin to develop a green-brown to gray pigmentation and grow beyond 10 cm in length (Haro and Krueger 1988); this is the second stage of juvenile development and the eels are called elvers. The elvers remain in these estuarine and riverine habitats until they reach a sexually immature stage, where they are known as yellow eels. Yellow eels have a yellow-green to olive-brown pigmentation and they may remain in this stage anywhere from 3 to 40 years before reaching sexual maturity. There are a variety of factors contributing to the sexual determination of the American Eel, including growth rate, water salinity, and population density (Krueger and Oliviera 1999). Starting to become sexually mature when they are about 25 cm in length, the eels take on a darker coloring with silver undersides and become known as silver eels. Silver eels complete their sexual maturation as they return to their natal waters to spawn, with females reaching up to 150 cm and males reaching up to 40 cm in length.

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

In the United States, both the yellow eel and elver fisheries have had a long history of being commercially and recreationally significant (Crawford 1996). However, commercial and recreational landings have been in decline since the 1970s (ASMFC 2012). Exploitation of multiple life stages of the American Eel may adversely affect the population due to the eels' slow maturation time, its seasonal migration, and cumulative stresses on a given age-class (ASMFC 2000).

Habitat degradation may also be a contributing factor in the population decline of American Eels. This includes residential and industrial pollutants, eutrophication, increases in

sedimentation, run-off and water temperature, as well as general habitat loss due to development (Busch and Lary 1996; Richkus and Whalen 1999).

A potentially larger factor in the decline of American Eel populations is obstruction of their migration. American Eels no longer have access to much of their historic habitat due to dams and other obstructions, contributing to a fragmented habitat and migration corridor (ASMFC 2012). Population declines can also be attributed to mortality in hydroelectric plant turbines (Hadderingh 1990).

The Atlantic States Marine Fisheries Commission Fishery Management Plan for American Eel lists protecting access to freshwater habitat as a priority for sustaining American Eel populations. Although the Chesapeake Bay and its tributaries (Figure 1) support a large portion of the current coastal eel population, eels have essentially been extirpated from the largest Chesapeake tributary, the Susquehanna River (AMSFC 2000). The Susquehanna River basin comprises 43% of the Chesapeake Bay watershed (Figure 2; Minkkinen and Park 2008). Four major dams constructed in the early 1900s on the mainstem Susquehanna River have effectively blocked all upstream eel migration (Figure 3). These dams on the lower Susquehanna River are: York Haven Dam at river mile 65, Safe Harbor Dam at river mile 33, Holtwood Dam (originally named McCall's Ferry Dam) at river mile 25, and Conowingo Dam at river mile 10.

Prior to mainstem impoundment of the Susquehanna River, annual harvest of eels throughout the watershed was notably higher (ASMFC 2000). The eel fishery is currently closed in Pennsylvania and there is limited entry for commercial licenses in Maryland (ASMFC 2000). The Maryland Biological Stream Survey (MBSS), through the Maryland Department of Natural Resources, surveys and collects data in the freshwater drainages of Maryland. Eel captures discussed in this report were from the Susquehanna River and its tributaries in the vicinity of Conowingo Dam (Figure 4), the first major obstruction to upstream migration of American Eels. By extrapolating densities of eels captured in Maryland, the MBSS estimated that had their upstream migration not been blocked by Conowingo Dam, there would be over 11 million eels in the Susquehanna watershed (Minkkinen and Park 2007).

Fish passage facilities on the mainstem Susquehanna River, including both lifts and ladders, were engineered in order to pass migratory fish species (Normandeau 2011), including American Shad (*Alosa sapidissima*), Hickory Shad (*Alosa mediocris*), Blueback Herring (*Alosa aestivalis*), Alewife (*Alosa pseudoharengus*), Striped Bass (*Morone saxatilis*), and White Perch (*Morone americana*). Although these structures are effective at passing these species, they have not proven effective at passing juvenile American Eels upriver; specialized passage facilities are required to accommodate elvers (Sheldon 1974).

Providing upstream passage to American Eel may benefit another species, Eastern Elliptio (*Elliptio complanata*), a native freshwater mussel. The larval stage of freshwater mussels, known as glochidia, must parasitize a host fish in order to complete metamorphosis to the juvenile life stage. Some mussel species can use multiple fish species as hosts, while others rely on only one or two host fish species. American Eel may be the primary fish host for this mussel species (Lellis 2013). Eastern Elliptio has been found to be abundant throughout most of its range which spans the entire east coast. However, biologists and researchers have noticed reduced abundance

and recruitment of Eastern Elliptio, in the Susquehanna River basin (Minkkinen and Park 2007). Low recruitment of Eastern Elliptio could be linked to the lack of eel passage past the four dams on the mainstem, lower Susquehanna River. Therefore, increasing eel passage within the Susquehanna River watershed could increase recruitment of Eastern Elliptio.

Freshwater mussels are filter feeders and remove algae, sediment, and micronutrients, thus improving water quality (Vaughn et al. 2008). If the Eastern Elliptio is dependent on American Eel to maintain their population, then sufficient passage of the eels into upstream habitat is essential for ecosystem function. The United States Fish and Wildlife Service (US FWS), and the United States Geological Survey (USGS), have ongoing research projects to further evaluate the parasitic relationship between American Eels and Eastern Elliptio, and are monitoring the distribution and abundance of both species.

This report describes the work completed by the US FWS in 2015 to pass American Eel elvers past Conowingo Dam. Work was completed in conjunction with Exelon Corporation and Normandeau Associates, Inc..

METHODS: Surveys, Sampling, and Equipment

American Eel abundance, migration timing, and attraction parameter data have been collected at the base of Conowingo Dam since spring of 2005 in order to determine the best method of collection and relocation of eels. The purpose of this work is to reintroduce eels into the Susquehanna River basin above the dam. The resulting information gathered in this ongoing study assists Susquehanna watershed restoration efforts. Reports from each year may be obtained through the US FWS.

In 2015, American Eel collection took place below Conowingo Dam on the west side adjacent to the West Fish Lift (Figure 5). This location was selected based on exploratory studies that occurred from 2005 through 2007. During which time elvers were observed climbing short distances up the rip rap at the base of the dam, where water used for the operation of the West Fish Lift was overflowing. Beginning in 2008, this overflow water was used as an attractant flow for operation of an elver ladder. The elver ladder consists of an eighteen foot long industrial cable tray lined with landscaping fabric and is positioned on the rip rap leading up the side wall of the dam to the lower platform (Figure 6). The cable tray is covered with sheet metal to provide sun and bird protection for the elvers. The attractant water flow sprays from the top of the cable tray and flows down the length of the tray, over the rip rap, and continues into the river below. Elvers sense this “upstream” flow and follow it over the rip rap, up the cable tray, and then proceed to drop into the collection tank located on the lower platform, at the top of the ladder (Figure 7). Using an air blower, air stones oxygenate the water in the collection and holding tanks.

Visits were made to the dam collection site an average of three times per week, referred to as collection days. Elvers were removed from the collection tank, enumerated, and then kept in large, circular holding tanks equipped with air stones and fresh water circulation. If there was less than 200 mL of elvers in the collection tank, all elvers were sedated and counted; however, if there was more than 200 mL of elvers in the collection tank, then 200 mL were sedated and

individually counted, while the remaining elvers were enumerated volumetrically in liters. To obtain a volumetric count, the actual number of elvers counted in the 200 mL subsample was extrapolated to the number of liters of elvers collected. From the 200 mL subsample of sedated elvers, 25 individuals were randomly selected and measured for total length unless there were less than 25 elvers in the collection tank on that day, in which case all elvers were measured. Approximately once per week, all elvers were removed from the holding tanks, transported in a stocking truck, and relocated to pre-determined stocking locations above Conowingo Dam (Figure 3). The frequency of stocking trips was based on the number of eels being held, the length of time they were held for, and environmental factors including water temperature and dissolved oxygen content in the collection and holding tanks (Appendix A and B).

This year, elvers were sedated using a new, investigational aquatic drug, Aqui-S20E, which is effective at low concentrations, has a wide margin of safety, and shows a quick recovery time (Aquatactics 2015). This drug was obtained by applying for inclusion in the US Fish and Wildlife Service's Investigational New Animal Drug (INAD) Program which is designed to collect the scientific data necessary to establish the safety and effectiveness of this sedative. In field use, fish treated with Aqui-S 20E may be returned immediately to the water with no hold-over time or withdrawal period (Bowker et al. 2014).

Elver collection data were compared to environmental variables believed to be related to migration. These variables were lunar fraction, and river water temperature and dissolved oxygen. Temperature and dissolved oxygen data were obtained from a USGS data logger located approximately six km downstream of the dam on the Susquehanna River, and water data from past years was obtained through National Oceanic and Atmospheric Administration's (NOAA) Chesapeake Bay Interpretive Buoy System (CBIBS).

In addition to the collection of elvers at the ladder, two double-throated rectangular traps were set to sample yellow eels. These two traps were set off the floating dock of the West Fish Lift at the base of the dam. These traps had a frame size of 91 cm × 30 cm and a mesh size of 25 mm × 9 mm, and were baited using frozen pieces of horseshoe crab (Figure 8). Traps were checked, emptied, and re-baited on each collection day. Yellow eels caught in the traps were sedated using Aqui-S 20E, scanned for passive integrated transponder (PIT) tags, and measured for total length (Figure 9). Unlike previous years, no adult eels were PIT tagged at Conowingo Dam this year.

In addition to the work described above, Normandeau Associates, Inc. (Normandeau) operated a small eel ladder at the base of the low head dam immediately downstream of the Octoraro Lake Dam (Figure 10) on Octoraro Creek, Pennsylvania. This eel ladder is located 33.7 km up Octoraro Creek, which is a tributary that feeds into the Susquehanna River 1.6 km below Conowingo Dam. Normandeau recorded the number of elvers caught, water temperature, dissolved oxygen, and using MS-222 as a sedative, measured a subsample of elvers for total length. Normandeau transported their elvers to the holding facility at Conowingo Dam, where they were held until the next stocking trip. The data presented in this report represents only the juveniles caught at Conowingo Dam unless otherwise noted. For specific data regarding the juveniles caught at the Octoraro Creek site operated by Normandeau, please contact Normandeau Associates, Inc..

RESULTS

The eel ladder located at the base of Conowingo Dam was installed on May 18 and 19, 2015. Attractant flow began on May 20, 2015 and the ladder was considered operational. Over 1,600 elvers were collected the first night the ladder was operational. Based on volumetric extrapolation, 58,444 elvers were collected prior to shutting the ladder down on September 9, 2015. The ladder was operated continuously throughout the season with the collecting tank being checked and emptied variably throughout the week (Table 1). Historically, collection data was analyzed based on the number of elvers collected since the last visit (Figure 11); however, we also examined the 2015 collection data as the number of elvers, per day, since the last visit for more representative data for analyzing data. (Figure 12). It appears that there is a peak in elver migration associated with the approximate mid-point of the lunar fraction, on both the ascending and descending limb, or every fourteen days. It also appears that there were already a large number of elvers staged below the dam prior to the installation of the ladder, with 19% of the elvers collected in 2015 climbing the ladder in the first six days of operation. After the initial pulse of elvers, large numbers of elvers were collected during the mid-point of the lunar cycle for two full cycles (i.e., two months), with much lower numbers during non-peak run times. However, after two months, 97% of the elvers collected in 2015 had already passed the ladder and catch rates declined to less than 100 individuals per day (with the exception of August 27 when 147 elvers passed the ladder).

Water temperatures remained fairly consistent until a decrease in late-June and then steadily rose until mid-August, after which temperatures did not vary significantly (Figure 13). River temperatures were higher this year in late-May and early-June, lower in the first half of July and then remained higher from the end of July through mid-September than in the previous few years. Dissolved oxygen in the river downstream of the dam never decreased to levels detrimental to fish (Figure 14). However, dissolved oxygen levels did start to decline after July 23, likely due to increasing water temperatures, and this was after the vast majority of elvers had already traversed the eel ladder.

To facilitate comparison with historic data, the number of elvers collected per week in 2015 was compared to the weekly average from the past seven years (Figure 15). More elvers were collected early in the season (i.e., through the end of May) than in previous years. Also, as discussed above, elver migration decreased in mid-summer, a time period when, historically, elver migration is ramping up to peak numbers at Conowingo Dam.

In total, 1,152 elvers (~2% of total catch) were measured (Figure 16) from the sub-sample that was taken on each collection day. Juvenile eel lengths ranged from 80 to 185 mm total length, with an average length of 117 mm. Similar to previous years, over 95% of the measured elvers were between 80 and 150 mm, and over 63% were between 105 and 130 mm.

A hatchery stocking truck was used to stock 52,952 elvers from the Conowingo collection site during fourteen stocking events (Table 2). Elvers were stocked at two locations this year: Etters Boat Launch in Goldsboro, Pennsylvania, which is upstream of all four mainstem dams on the Susquehanna River, and at Conowingo Creek Landing in Oakwood, Maryland, which is upstream of Conowingo Dam (Figure 3). The number of elvers stocked is less than the number

of elvers collected due to mortality that occurred either during holding or transport. Mortality due to holding and/or transporting is estimated at 9%. The eel ladder operated by Normandeau Associates, Inc. on Octoraro Creek, Pennsylvania, collected an additional 5,739 elvers (Table 3). Of those, 5,449 were stocked with the Conowingo fish and 290 were collected after the last stocking trip on September 9, 2015 and were stocked by Normandeau at a site immediately upstream of the Octoraro Lake Dam.

Yellow eel collection at the base of Conowingo Dam began on July 1, 2015 and continued through the season until September 9, 2015. A total of 21 adult eels were caught and measured (Table 4). However, after being scanned for PIT tags, it was determined that one of the eels was actually caught twice; therefore, only 20 individual adult eels were caught and it is possible that there were more recaptures. Of the 20 eels caught, only one had a positive reading for a PIT tag (Tag #: 3DD.003B9C5E66). This individual was initially tagged on June 10, 2013 at a length of 471 mm and was later recaptured that same year at a length of 480 mm. This individual had a length of 505 mm at both re-capture events in 2015. The length of eels captured in 2015 varied from 342 mm to 505 mm total length.

DISCUSSION

During the initial installation of the eel ladder on May 18, 2015 there were a considerable number of elvers observed climbing up the side wall of the lower platform of Conowingo Dam from the rip rap below at the river's edge. There was a small flow of water originating from a holding tank being used in the collection and sampling of American Shad that was running across the platform and down the wall into the river. This small stream of outflow water was acting as an attractant for the elvers and it appeared that they were trying to use it in their migration. Historically, this behavior has been observed each year during setup; however, this is the first year that elvers were collected immediately after ladder operation began (Figure 12). Additionally, the greatest number of elvers per day, was collected on the second day of operation (Figure 12). As such, it is worth considering starting the ladder earlier to allow passage and prevent increased stress on staging elvers.

One factor that has long been thought to be a driver for eel migration is the lunar cycle. In examining the data as number of elvers per day, it appears that elvers attempt to pass the dam around the mid-point of the lunar cycle.

In comparing the number of elvers collected with the temperature and dissolved oxygen data from the USGS data loggers downstream of the dam, there was no strong correlation with water temperature or dissolved oxygen. . Additionally, 2015 seemed to be an unusual year in regard to water temperature, highlighting the importance of conducting these types of analyses with long-term data sets, so that individual years do not skew underlying trends. Future analyses should also include flow and turbidity as possible explanatory variables in a multimetric analysis.

The total number of elvers collected at Conowingo Dam has been variable since the elver ladder project began in 2005 (Table 5). The collected number of elvers increased from 2009 through 2013; however, the past two years have seen a decline in the number collected. The 58,444 elvers collected in 2015 was below the 11 year average of 76,040. This could be related to the

unusual weather conditions in 2015, as discussed above, or this long-term trend could be related to natural variability in eel numbers.

It should be noted that although Normandeau Associates, Inc. transported elvers from the eel ladder on Octoraro Creek, these elvers were held separately from the Conowingo Dam eels. This was necessary as a new sedative (Aqui-S 20E) was being evaluated on the Conowingo fish and mortality rates were being monitored for reporting in the INAD with US FWS. All mortality within 30 minutes of the recovery period was considered to be drug-related. All mortalities that occurred after this time were considered environmental in nature whether due to water quality in the collection (Appendix A) or holding tanks (Appendix B), or during transport to stocking locations. There were only two drug-related mortalities out of the 4,272 elvers included in the drug study, and those two mortalities occurred on the first day of drug testing.

FUTURE PLANS

Next year, US FWS will continue to operate the eel ladder at Conowingo Dam, and truck and transport of the eels above the main stem dams will continue. Continued improvements should be considered and implemented if determined beneficial. These include improvements to the eel ladder, collection site, holding facility, and transportation. For now, immediate future plans involve continuing to collect the eels and transport them above the dams.

In addition to the continued operation of the eel ladder, US FWS will continue with American Eel related projects throughout the Susquehanna Watershed. We are currently scheduled to continue sampling for the presence of eels in Buffalo and Pine creeks until 2019. We will also continue to monitor the growth rate of PIT tagged eels in Buffalo Creek until 2019. We have plans to continue monitoring and sampling for freshwater mussels in Buffalo Creek, Pine Creek, and Penns Creek until 2020.

Acknowledgments

We thank the many personnel who assisted on this project whether it was in the installation and/or break-down of the project, the continued monitoring and sampling throughout the season, or ensuring that operations ran smoothly. Their time and effort has been greatly appreciated. We also thank the staff of the US FWS-Maryland Fishery Resources Office, the staff of Normandeau Associates, Inc., and the employees of Exelon Corporation stationed at Conowingo Dam. Without the continued co-operation of these agencies and companies, the collection and relocation of American Eels on the Susquehanna River would not have been a success.

We also appreciate the peer revision of this report by the following professionals:

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Figure 1. Chesapeake Bay Watershed, north-eastern United States. Figure credit to USDA-Natural Resources Conservation Service.

Figure 2. Susquehanna River basin and sub-basins, north-eastern United States. Figure credit to Susquehanna River Basin Commission.

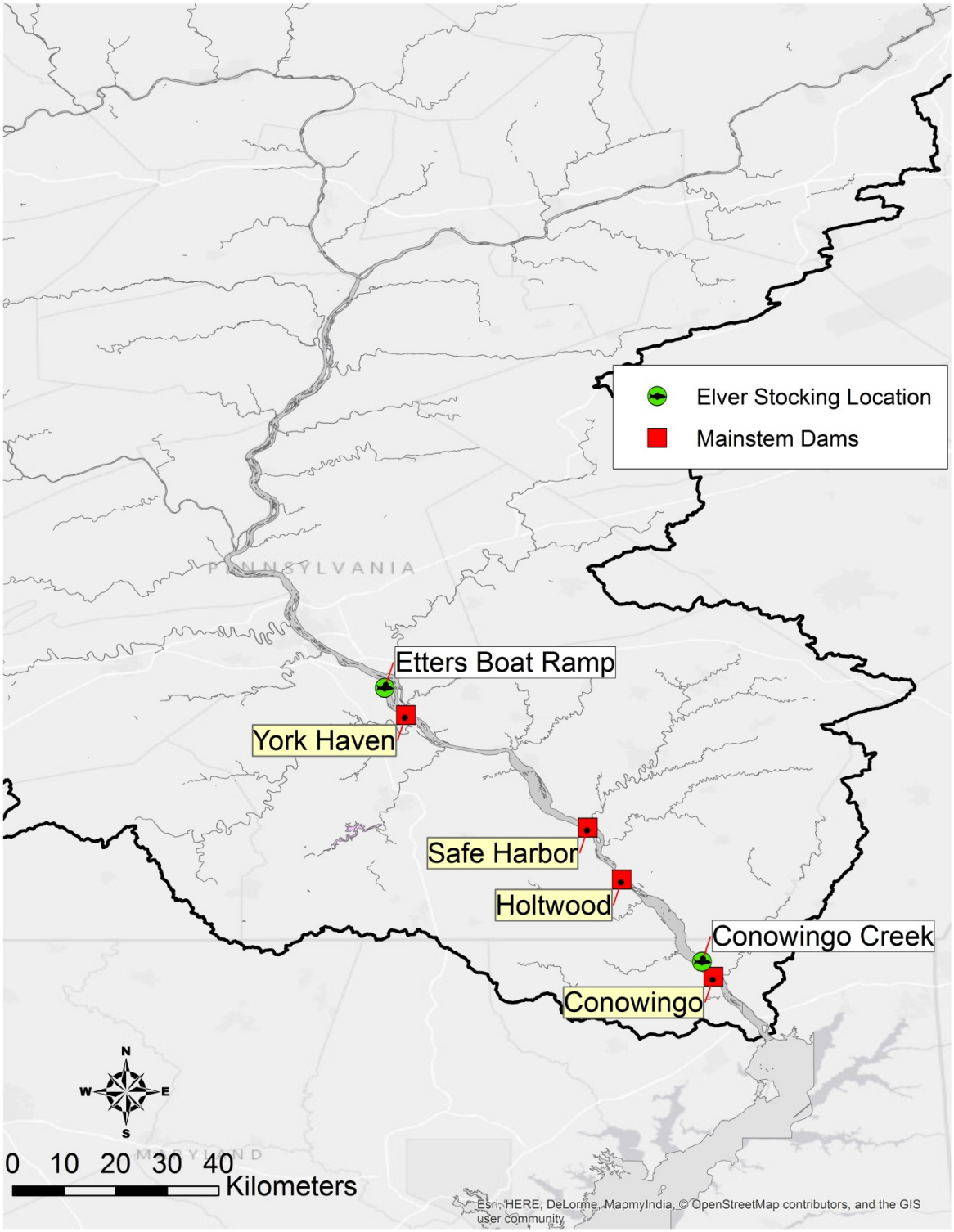

Figure 3. Locations of the four mainstem dams on the Lower Susquehanna River, including Conowingo Dam at river mile 10, Holtwood Dam at river mile 25, Safe Harbor Dam at river mile 33, and York Haven Dam at river mile 65. Also shown are the two locations at which elvers were stocked in 2015. Figure credit to USFWS/MFRO/JNewhard.

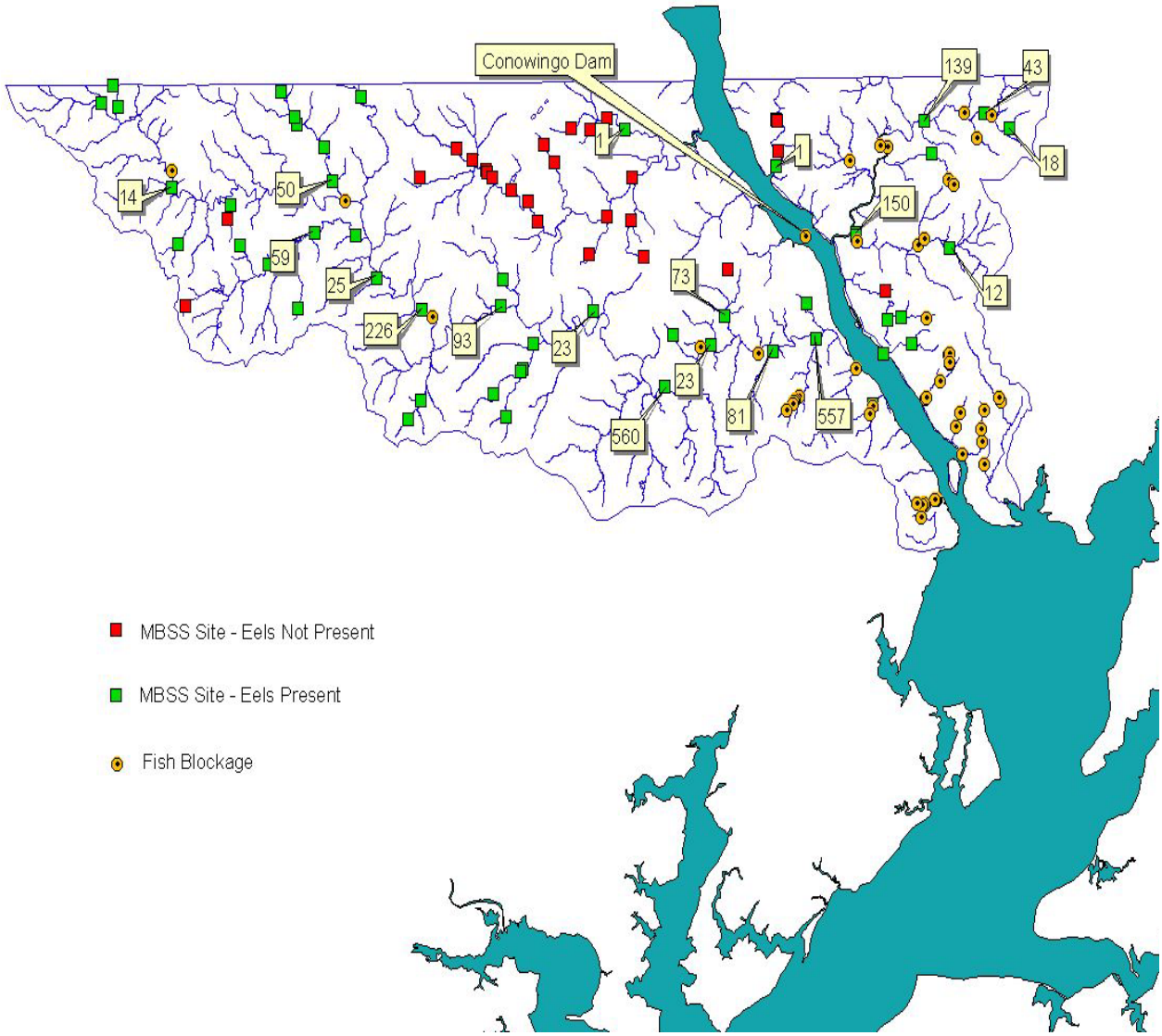

Figure 4. Map of Maryland Biological Stream Survey (MBSS) sampling sites on tributaries of the Susquehanna River. The numbers of eels sampled at each site are indicated in boxes on the map. Note the difference in densities of eels found in tributaries below Conowingo Dam versus above the Dam. Figure credit to Maryland Department of Natural Resources-Maryland Biological Stream Survey.

Figure 5. Collection location for American Eels at the base of Conowingo Dam, Darlington, Maryland. Photo credit to USFWS/MFRO/JMalavasi.

Figure 6. Elver ladder at base of Conowingo Dam, Maryland. Photo credit to USFWS/MFRO/JMalavasi.

Figure 7. Collection tank and holding tanks located on the lower platform, at the top of the elver ladder, Conowingo Dam, Maryland. Photo credit to USFWS/MFRO/JMalavasi.

Figure 8. Yellow eel trap used at Conowingo Dam, Maryland, during the 2015 sampling season. Photo credit to USFWS/MFRO/MMangold.

Figure 9. Yellow eel being scanned for a passive integrated transponder (PIT) tag. Photo credit to USFWS/MFRO/JMalavasi.

Figure 10. American Eel collection site on Octoraro Creek, Oxford, Pennsylvania; operated by Normandeau Associates, Inc.. Also shown is the stocking location for Octoraro eels collected between September 10 and September 15, 2015. Figure credit to USFWS/MFRO/JNewhard.

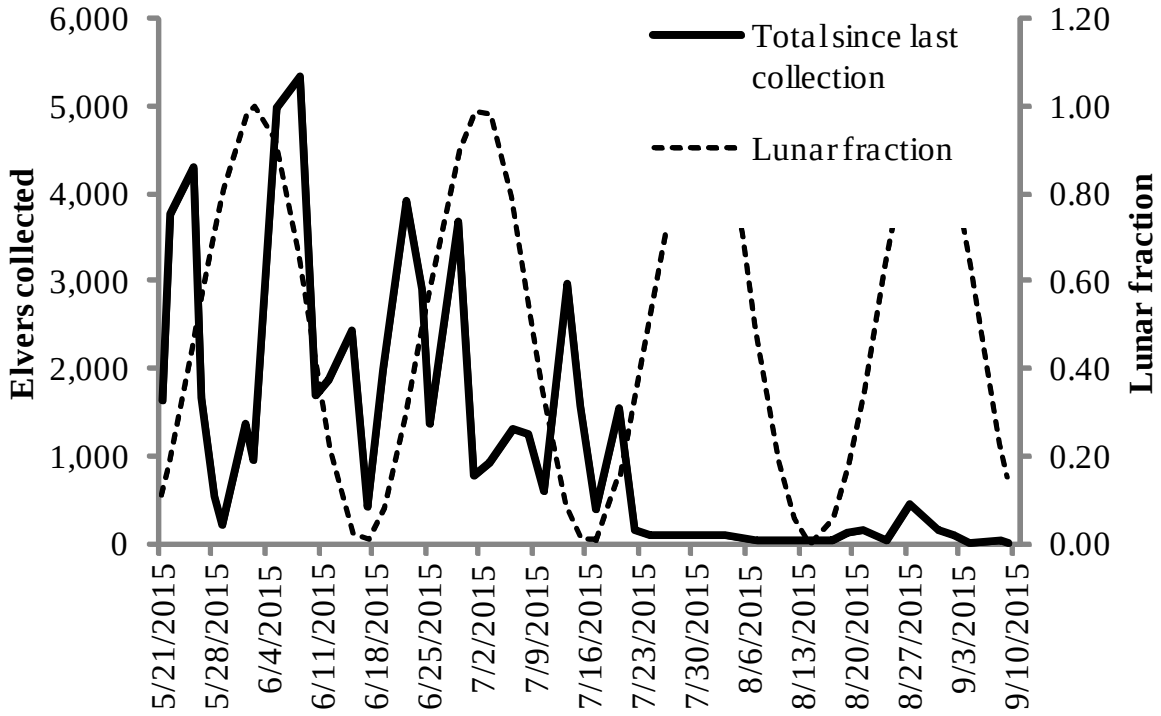

Figure 11. Number of elvers collected by date at Conowingo Dam, Maryland, during the 2015 sampling season. Also shown is the lunar fraction on the secondary y-axis.

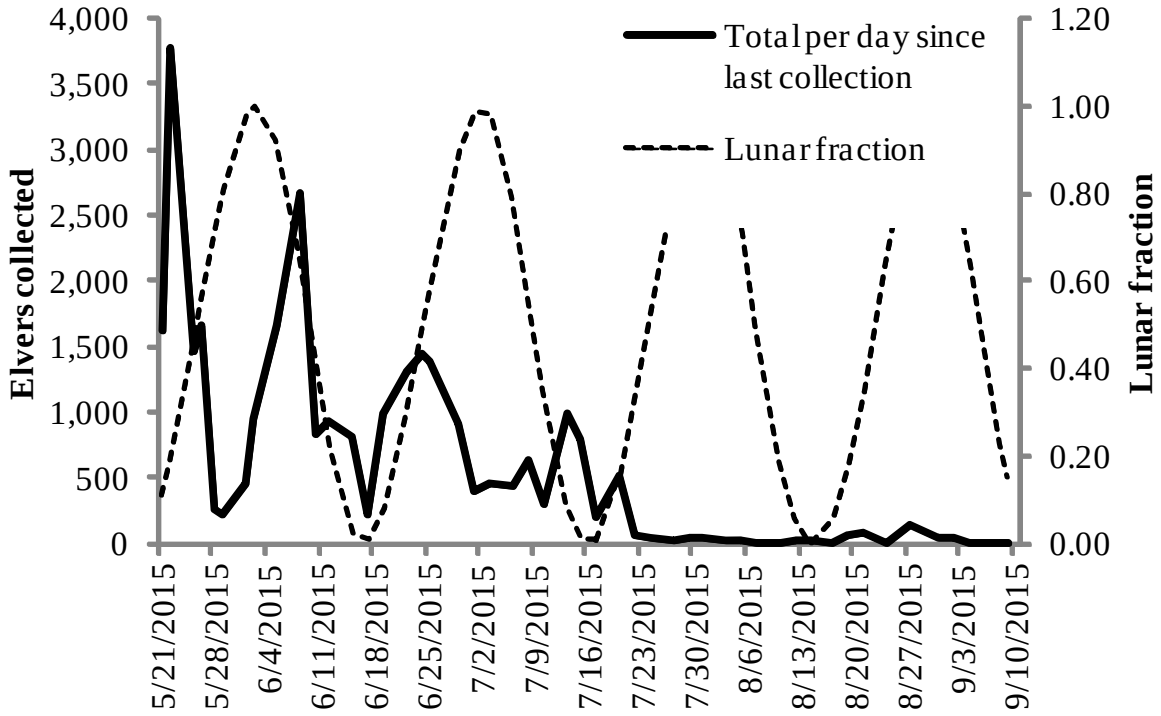

Figure 12. Daily average eel captures since the last collection at Conowingo Dam, Maryland, during the 2015 sampling season. Also shown is the lunar fraction on the secondary y-axis.

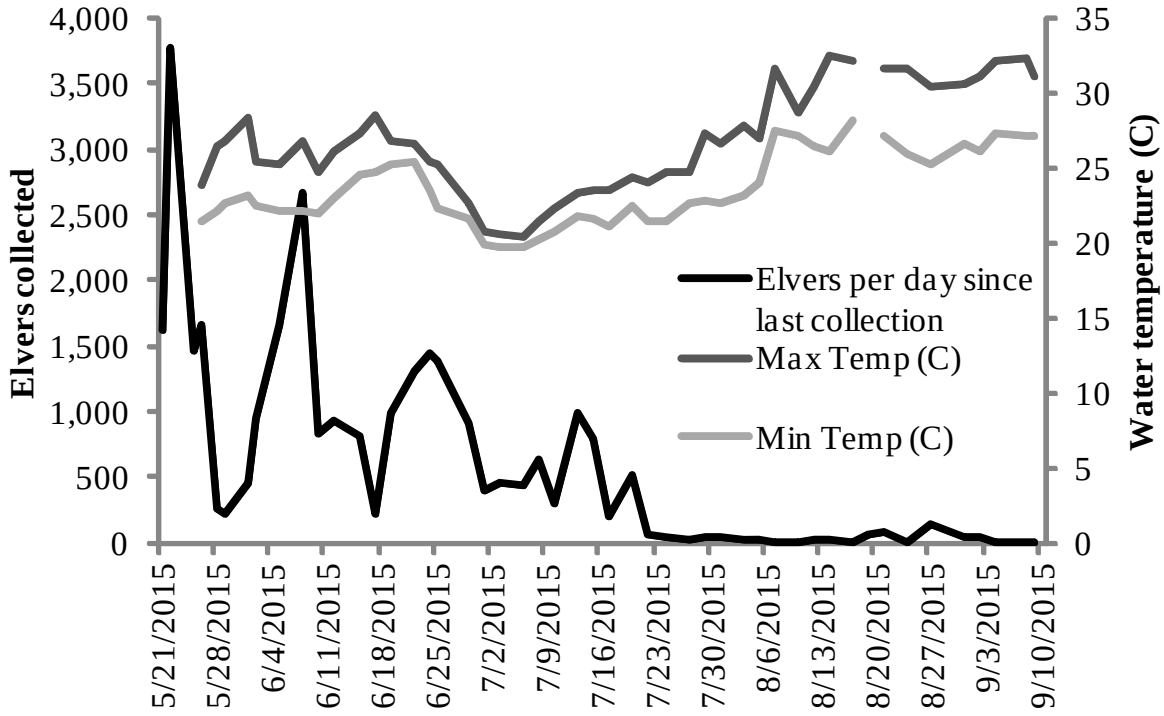

Figure 13. Number of elvers, per day, since the last collection at Conowingo Dam, Maryland, during the 2015 sampling season. Also shown is minimum and maximum daily water temperature of the Susquehanna River, approximately 6 km downstream of the dam on the secondary y-axis.

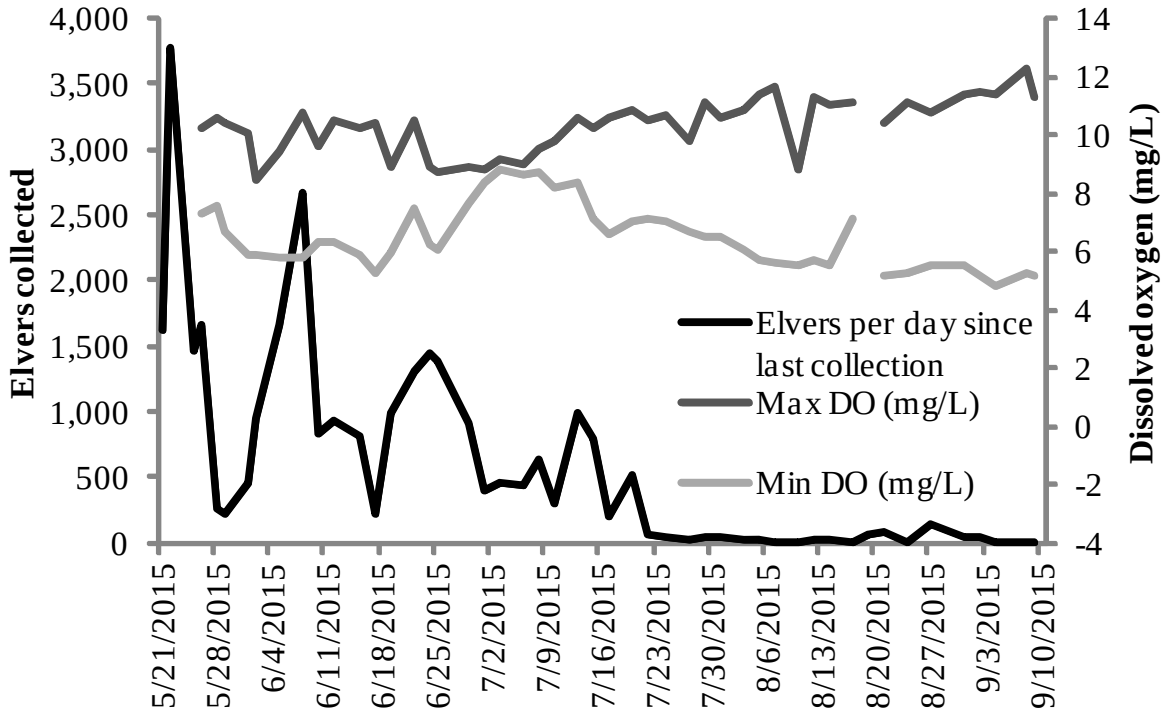

Figure 14. Number of elvers, per day, since the last collection at Conowingo Dam, Maryland, during the 2015 sampling season. Also shown is minimum and maximum daily dissolved oxygen measurements of the Susquehanna River, approximately 6 km downstream of the dam on the secondary y-axis.

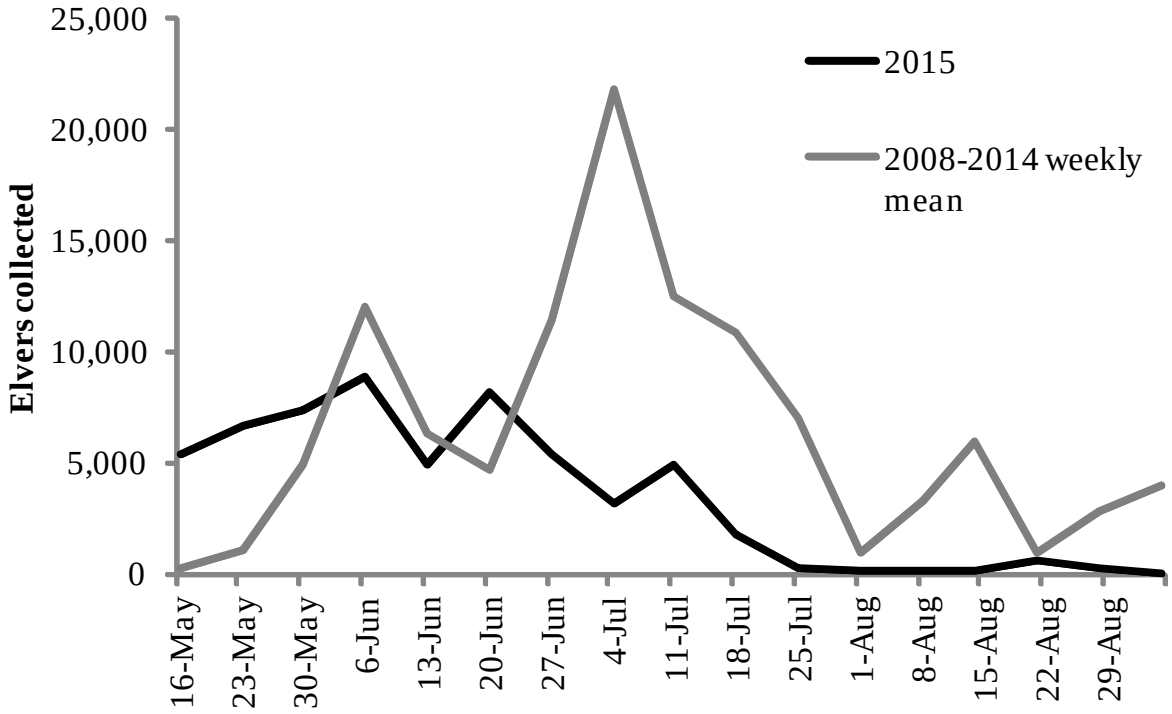

Figure 15. Weekly elver catch at Conowingo Dam, Maryland during the 2015 sampling season compared to the mean weekly elver catch from 2008 through 2014.

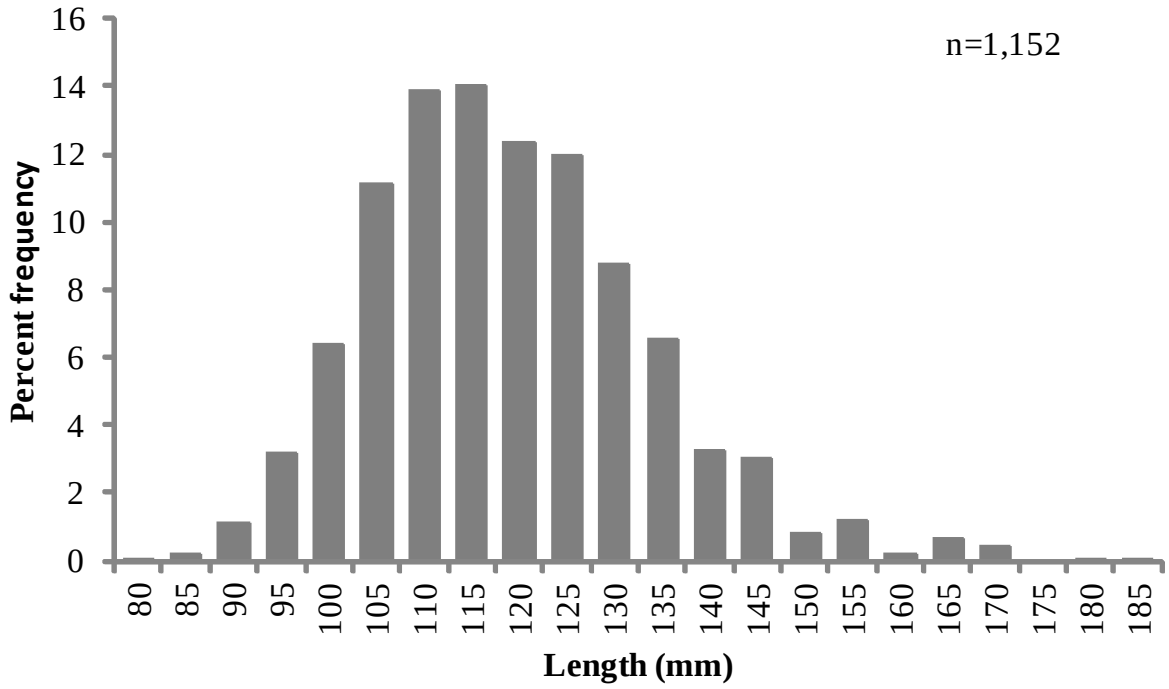

Figure 16. Length-frequency histogram of all elvers measured at Conowingo Dam, Maryland, during the 2015 sampling season using 5-mm bins.

Table 1. Number of elvers collected by date at Conowingo Dam, Maryland, during the 2015 sampling season. The elver ladder was operational from May 20 through September 9, 2015. Asterisks represent dates on which elvers were stocked.

Date	Total since last collection
5/21/2015	1,625
5/22/2015	3,780
5/25/2015	4,290
5/26/2015*	1,665
5/28/2015	535
5/29/2015	215
6/1/2015	1,380
6/2/2015	960
6/5/2015	4,988
6/8/2015*	5,333
6/10/2015	1,684
6/12/2015	1,887
6/15/2015	2,449
6/17/2015*	437
6/19/2015	2,002
6/22/2015	3,910
6/24/2015	2,910
6/25/2015*	1,380
6/29/2015	3,690
7/1/2015	788
7/3/2015	922
7/6/2015	1,312
7/8/2015*	1,259
7/10/2015	595
7/13/2015	2,960
7/15/2015	1,575
7/17/2015	395
7/20/2015*	1,540
7/22/2015	147
7/24/2015	107
7/27/2015*	100
7/29/2015	93
7/31/2015	91
8/3/2015	97
8/5/2015*	68
8/7/2015	25
8/10/2015	48
8/12/2015	45
8/14/2015*	35
8/17/2015	43
8/19/2015	115
8/21/2015	169
8/24/2015	28
8/27/2015	441
8/31/2015	171
9/2/2015*	94
9/4/2015*	2
9/8/2015*	51
9/9/2015*	8

Table 2. Dates and stocking locations for elvers collected from Conowingo Dam, Maryland, during the 2015 sampling season.

Date	No. Stocked	Latitude	Longitude	Site
5/26/2015	10,999	40°09'45.9"N	76°44'57.4"W	Etters Boat Ramp, Susquehanna River
6/8/2015	11,435	40°09'45.9"N	76°44'57.4"W	Etters Boat Ramp, Susquehanna River
6/17/2015	6,304	40°09'45.9"N	76°44'57.4"W	Etters Boat Ramp, Susquehanna River
6/22/2015	5,157	40°09'45.9"N	76°44'57.4"W	Etters Boat Ramp, Susquehanna River
6/25/2015	2,956	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
7/8/2015	7,103	40°09'45.9"N	76°44'57.4"W	Etters Boat Ramp, Susquehanna River
7/20/2015	7,049	40°09'45.9"N	76°44'57.4"W	Etters Boat Ramp, Susquehanna River
7/27/2015	347	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
8/5/2015	337	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
8/14/2015	152	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
9/2/2015	1,053	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
9/4/2015	2	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
9/8/2015	51	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
9/9/2015	8	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
Total stocked	52,953			

Table 3. Dates and stocking locations for elvers collected from Octoraro Lake Dam, Pennsylvania, during the 2015 sampling season.

Date	No. Stocked	Latitude	Longitude	Site
6/22/2015	261	40°09'45.9"N	76°44'57.4"W	Etters Boat Ramp, Susquehanna River
6/25/2015	588	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
7/8/2015	1,902	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
7/20/2015	1,614	40°09'45.9"N	76°44'57.4"W	Etters Boat Ramp, Susquehanna River
7/27/2015	212	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
8/5/2015	451	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
8/14/2015	264	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
9/2/2015	143	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
9/4/2015	3	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
9/6/2015	9	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
9/8/2015	2	39°40'59.8"N	76°11'43.1"W	Conowingo Creek Landing, Conowingo Pool
9/10/2015	14	39°47'38.0"N	76°02'37.8"W	Octoraro Creek, above Octoraro Lake dam
9/12/2015	169	39°47'38.0"N	76°02'37.8"W	Octoraro Creek, above Octoraro Lake dam
9/14/2015	14	39°47'38.0"N	76°02'37.8"W	Octoraro Creek, above Octoraro Lake dam
9/15/2015	93	39°47'38.0"N	76°02'37.8"W	Octoraro Creek, above Octoraro Lake dam
Total stocked	5,739			

Table 4. Adult eel capture date, length, and recapture information from trapping conducted just downstream of Conowingo Dam, Maryland, during the 2015 sampling season.

Date	Total length (mm)	Recaptured (Y/N)
7/3/2015	360	N
7/3/2015	363	N
7/3/2015	401	N
7/3/2015	342	N
7/3/2015	431	N
7/3/2015	459	N
7/3/2015	393	N
7/6/2015	372	N
7/8/2015	425	N
7/10/2015	461	N
7/10/2015	360	N
7/17/2015	365	N
7/22/2015	505	Y*
7/22/2015	457	N
7/24/2015	505	Y*
7/24/2015	361	N
7/31/2015	396	N
7/31/2015	445	N
7/31/2015	349	N
8/3/2015	427	N
8/19/2015	470	N

*Indicates the same eel, captured twice this year. This was also the only eel found to have a PIT tag.

Table 5. Total number of elvers collected, by year, at Conowingo Dam, Maryland.

Year	Total elvers collected
2005	42
2006	19
2007	3,837
2008	42,058
2009	17,437
2010	23,856
2011	84,961
2012	127,013
2013	293,141
2014	185,628
2015	58,444

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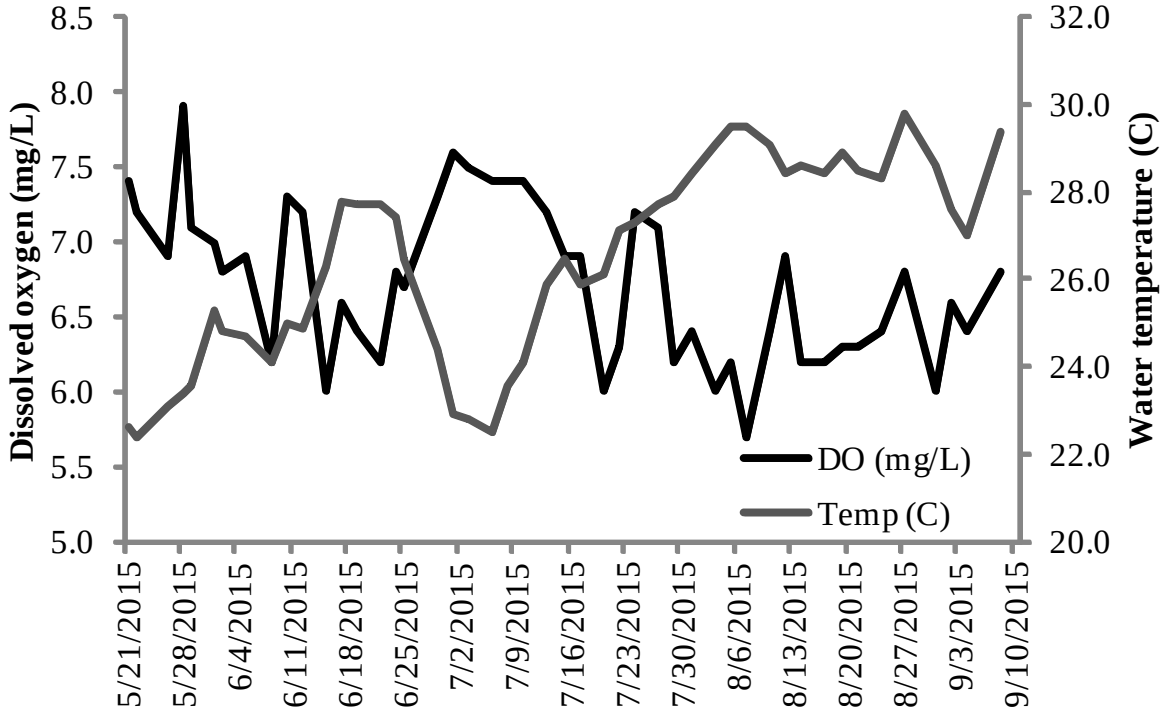
Appendix A. Water quality parameters in the elver collection tank, Conowingo Dam, Maryland, during the 2015 sampling season.



Appendix B. Water quality parameters in the elver holding tanks, Conowingo Dam, Maryland, during the 2015 sampling season. Small holding tank in the upper panel, large holding tank in the lower panel. Gaps in the data series represent time periods when the tanks were being emptied, cleaned, and refilled.