AMERICAN EEL SAMPLING AT CONOWINGO DAM – 2012

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BACKGROUND

Eels are a catadromous species that ascend freshwater environments as juveniles then reside in riverine habitats until reaching maturity at which time they migrate to the Sargasso Sea where they spawn once and die. Larval eels are transported by ocean currents to rivers along the eastern seaboard of the continent. Unlike anadromous shad and herring, they have no particular homing instinct. Historically, American eels were abundant in East Coast streams, comprising more than 25 percent of the total fish biomass in many locations. However, Atlantic coast commercial landings have been declining since the 1970's.

The Atlantic States Marine Fisheries Commission Fishery Management Plan for American Eel lists access to freshwater habitat as a priority for protecting the population. Although the Chesapeake Bay and tributaries support a large portion of the coastal eel population, eels have been essentially extirpated from the largest Chesapeake tributary, the Susquehanna River. The Susquehanna River basin encompasses 43% of the Chesapeake Bay watershed. Construction of Conowingo Dam in 1928 effectively closed the river to upstream migration of elvers at river mile ten (Figure 1).

Mainstem Susquehanna fish passage facilities (lifts and ladder) were designed and sized to pass adult shad and herring and are not effective (due to attraction flow velocities and operating schedules) in passing juvenile eels (elvers) upriver. Specialized passages designed to accommodate elvers are needed to allow them access to the watershed above dams.

SURVEY METHODS AND EQUIPMENT PLACEMENT

To determine the best method to reintroduce eels into the Susquehanna River above Conowingo Dam, we have collected baseline information on eel abundance, migration timing, catch efficiency, and attraction parameters at the base of the Conowingo Dam since the spring of 2005. Information from the study will assist in determining the potential for reintroducing eels into the Susquehanna watershed above Conowingo Dam.

The 2012 American eel sampling below Conowingo took place on the west side of the dam adjacent to the West Fish Lift. This sampling served as an attempt to further survey the population of juvenile eels (elvers) at the base of Conowingo Dam. In 2007, elvers were observed climbing up the rip rap where water was spilling over from pumps operated to supply water for the West fish lift operations. From 2008 through 2012 we used this excess water as attraction flow for our elver trap, constructed from industrial cable tray with landscape fabric attached to the bottom (Figure 2). Elvers that found this attraction flow would crawl up the rip rap to the trap and then climb into the trap. The top of the cable tray emptied into a covered collection tanks (Figure 3). Aerated water was supplied to the collection and holding tank using a 1/8 HP Sweetwater™ Blower. In 2009 and 2010 we made an attempt to attract elvers directly from the Susquehanna River at the base of the riprap as well. In 2011 we discontinued the experimental trap going down to the river's edge. Elvers were sedated with, Finquel Tricane Methanesulfonate (MS-222), individually counted and a subsample were measured for total length (TL). Large numbers of eels were counted volumetrically. The collection of substantial numbers of eels allowed for the experimental stocking of elvers into several tributaries to the Susquehanna River as well as the Susquehanna River mainstem (Table 1). Stockings in Buffalo Creek and Pine Creek is part of a compensatory mitigation for the Sunbury Riverfront Stabilization Project for the City of Sunbury (DA Permit Application Number: NAB 2005-02860-PO5).

All of the elvers stocked were marked with a 6 hour immersion in buffered oxytetracycline (OTC) at a concentration of 550 ppm prior to release. Subsamples of elvers were sent to the Lamar Fish Health Center (Lamar, PA) for disease testing before any stocking occurred.

In 2012, our yellow eel collection continued using a double throated rectangular trap with a 25 mm by 13 mm mesh that is consistent with local commercial gear. Yellow eels captured in eel pots were sedated with a concentrated solution of MS-222 (450g/L), measured, and had a Passive Integrated Transponder (PIT) tag inserted in the dorsal musculature and released.

In 2012, young-of-year (glass eels) were collected by Maryland Department of Natural Resources (Maryland DNR) in Turville Creek, MD. These eels were then transported to the United State Geological Survey lab in Wellsboro, Pennsylvania. The glass eels were held in the lab until May, and then released in Buffalo and Pine Creek (Table 1).

RESULTS

Eels were sampled between 16 May and 27 August 2012 and elvers were collected throughout the entire sampling period (Table 2). A total of 127,000 elvers were collected during 2012 with the majority collected in five pulses. The first pulse occurred at the end of May and then about every two weeks after. The seasonal pattern of migration in 2012 was similar to that observed in previous years with a majority of the eels collected from mid June through mid August. In 2008, 2010, 2011 and 2012 we saw multiple pulses of elvers throughout our sampling efforts; where as in 2009 there did not appear to be peaks in collections, but more of a steady level of migration through the sampling period. In 2011 we saw a large peak in elver collection at the end of August through the beginning of September during high flows associated with hurricane Irene and tropical storm Lee (Figure 4).

Juvenile eel lengths ranged from 71 to 208 mm TL (Figure 5), similar to previous years sampling. In 2012, 95% of elvers measured were between 90 and 149 mm, and from 2005-2011 90% of elvers measured were between 90 and 149 mm.

Yellow and silver eel collections in eel pots have taken place from 2007 through 2012. In 2012, we captured 187 yellow and silver eels that ranged from 352 to 578 mm TL. Of the 187 captures, 66 eels had new PIT tags inserted, 22 were recaptures from tagging done in 2012 or in previous years, the remainder were released without being tagged or were sacrificed for studies. In 2012 we had fewer captures and recaptures compared to 2011 (224 captures and 55 recaptures, Table 3). The addition of the 66 eels PIT-tagged eels this year brings the total number of PIT-tagged yellow eels in the study to 355. We are tracking annual growth rates of the 36 PIT tagged eels that have been recaptured after at least one year after tagging (Table 4).

Nine stockings from elvers captured at Conowingo Dam were completed, with an estimated total of 96,000 elvers being stocked in Susquehanna Watershed (Table 1).

To evaluate stocking success at Buffalo and Pine Creek, we conducted electrofishing surveys using 3 backpack electrofishers and a barge electrofisher in July and August 2012. We duplicated methods used by the Maryland Biological Stream Survey (2007) to quantify the catch per unit effort (CPUE) and the biomass of eels. Two sites, bracketing the eel stocking sites, in each creek were surveyed (Table 1). At each site, 75 meters of stream were blocked off using ¼" mesh block net. In order to quantify the fauna in the stream, two passes with the electrofishing units were conducted and all species of fish collected were enumerated. Captured eels were measured to assess growth and a subsample of the eels collected was brought back to confirm previous marking of otoliths by OTC. In August of 2012, 163 elvers were recaptured in Buffalo Creek. We recaptured 64 elvers at the Strawbridge Rd site and 100 were at the foot bridge on Rte. 1003. Sampling in Pine Creek in 2012 provided 235 recaptured elvers, 21 of which were recaptured at the Darling Run site, and 214 were caught at the Ansonia Bridge site. The average TL of stocked elvers from Conowingo was 125 mm, and the average TL of glass eels stocked was 76 mm, while the average TL of recaptured eels in Buffalo Creek was 196 mm. The average TL of recaptured eels in Pine Creek was 128 mm. In addition to eels, 3,348 individuals of 33 fish species were collected in Buffalo Creek and 4,717 individuals of 24 fish species were collected in Pine Creek during electrofishing surveys. (Minkkinen et al. 2012)

In addition to the electrofishing surveys at the stocking locations in Buffalo Creek, we sampled upstream and downstream within the watersheds of our stocking locations. We used two backpack shockers and sampled the creek 2.4 kilometers upstream and 2 kilometers downstream from the stocking locations and previously surveyed areas. We collected a total of 210 eels, the upstream CPUE was 38.2 eels per hour, and the downstream CPUE was 26.7 eels per hour. The recaptured eels were sedated with MS-222 and measured, total length ranged from 138 mm to 551 mm (Figure 6). We inserted PIT tags into the dorsal musculature of eels that were over 200 mm prior to being released (174).

A subsample of elvers and yellow eels were sacrificed to evaluate the presence of the swim bladder parasite *Anguillicola crassus*. A total of 144 elvers were euthanized using MS-222, then examined for the presence of *Anguillicola crassus*. The elver samples were collected in 2010, 2011 and 2012. *Anguillicola crassus* was found in 66 of the samples (46%), with the highest infection rate of 7 nematodes found in one eel. An additional 28 yellow eel samples were collected in 2012 and *Anguillicola crassus* was found in nine eels (32%), with the highest infection rate of 22 nematodes being found in one eel. There does not appear to be any relationship between the length of an eel and the infection rate (Figure 7), or an increase in infection rate from one year to the next.

DISCUSSION

The sampling above and below the stocking site in Buffalo Creek has shown that at least some of the elvers that we have stocked have the ability to grow much faster than the yellow eels that we have caught below the Conowingo dam. The yellow eels captured below the dam had an average growth rate of 44 mm per year with a standard deviation of 25. The maximum growth in one year for a yellow eel captured below Conowingo dam is 129 mm per year. We found four eels in Buffalo Creek that were over 525mm, assuming that they were elvers stocked in 2010 and were the average size of stocked eels (125 mm), they have grown an average of over 200mm a year.

Samplings conducted by other agencies have captured eels that had migrated away from the stocking locations. Biologists from the Pennsylvania Fish and Boat Commission collected two

eels in Rapid Run (a tributary to Buffalo Creek). The eel's lengths were estimated to be 280-330 mm and were found about 19 kilometers upstream from the stocking locations (personal communication). Biologists from the Susquehanna River Basin Commission have found several eels upriver and downriver from our stocking location in Pine Creek. The most upriver eel found is approximately 19 kilometers from the stocking location, and the most downriver location is about 82 kilometers downstream (personal communication). The Pine Creek recaptures ranged from 130 mm to 500 mm. Eels could be in other locations in the basin and additional sampling will likely provide more information about their dispersal throughout the watershed.

We attempted to evaluate the relationship between elver migrations in relation to environmental uces. The factors we considered were lunar fraction, river flow, barometric pressure, air temperature, daily precipitation levels, and the average daily values of dissolved oxygen, salinity, water temperature, pH, turbidity, and chlorophyll. In years past we have not been able to determine what environmental factors control the timing of the elver migration below Conowingo Dam. Typically elvers reach the dam between the first week of May through the end of June and peak captures usually occur in June and July. In 2011 using Pearson correlation it appeared that turbidity, river flow and precipitation have the largest correlation value and these three values are directly related to one another. However in 2012 we did not see a correlation between environmental factors and elver collection.

Interruptions in power supply to our pumps have impacted elver catch on several occasions. We have implemented several sampling design changes in an attempt to ensure that we would have an uninterrupted supply of water throughout the sample period. We have also increased the size of our collection and holding tanks in an effort to increase survival and decrease stress while holding the elvers for stocking. These measures have improved our ability to capture and hold larger numbers of elvers for stocking above the dam.

FUTURE PLANS

In 2013 we will release a majority of the elvers captured at Conowingo Dam into the Susquehanna River above the York Haven dam. A smaller quantity of elvers will also be released into Buffalo Creek. The Maryland Fishery Resources Office will survey Buffalo Creek for PIT tagged eels in an attempt to continue growth analysis of stocked eels.

REFERENCES

Maryland Department of Natural Resources. 2007. Maryland Biological Stream Survey: Sampling Manual Field Protocols. 65 pp.

Minkkinen S.P., Devers J.L. & Galbraith H. 2012. Experimental Stocking of American Eels in the Susquehanna River Watershed. City of Sunbury, Riverbank Stabilization Project DA Permit Application Number: NAB2005-02860-POS

FIGURES AND TABLES

Figure 1. Map of the Maryland Biological Stream Survey (MBSS) sampling sites of tributaries to the Susquehanna River in Maryland. The numbers in boxes indicates eel counts at each sampling site. Note the difference in densities of eels in tributaries below Conowingo Dam compared to above the Dam.

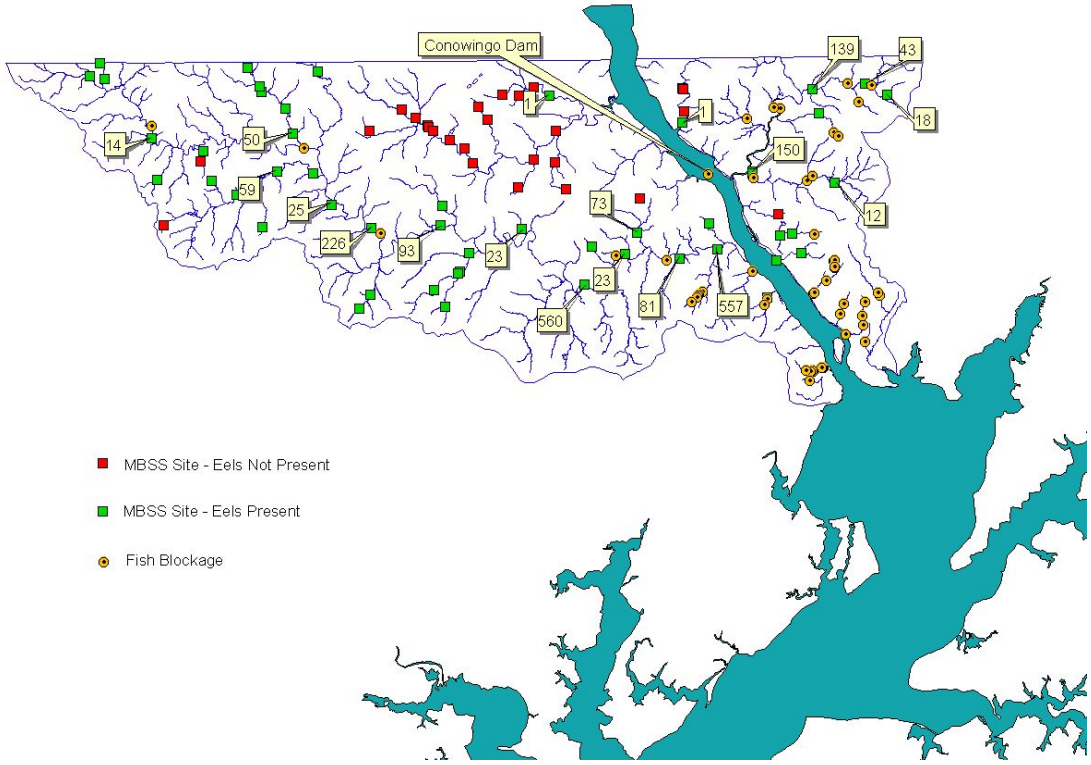

Figure 2. Eel trap constructed of industrial cable tray and landscape fabric.

Figure 3. The cable tray emptying into a collection tank.

Figure 4. Weekly elver captures at Conowingo Dam, 2008 – 2012.

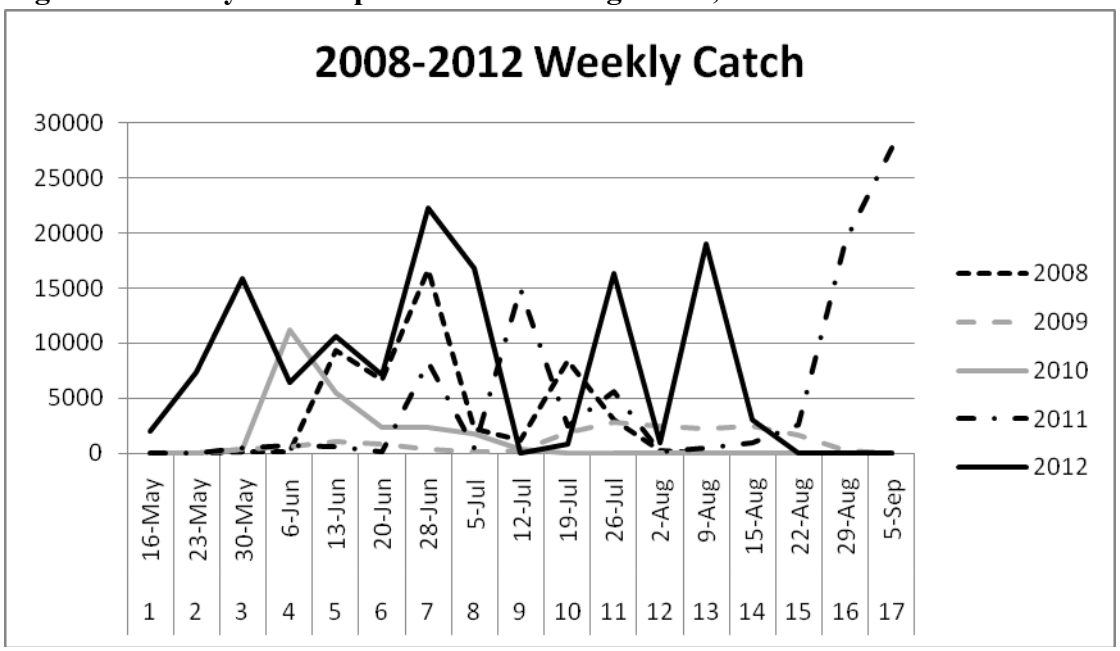

Figure 5. Length frequency of elvers captured below Conowingo Dam 2005-2012.

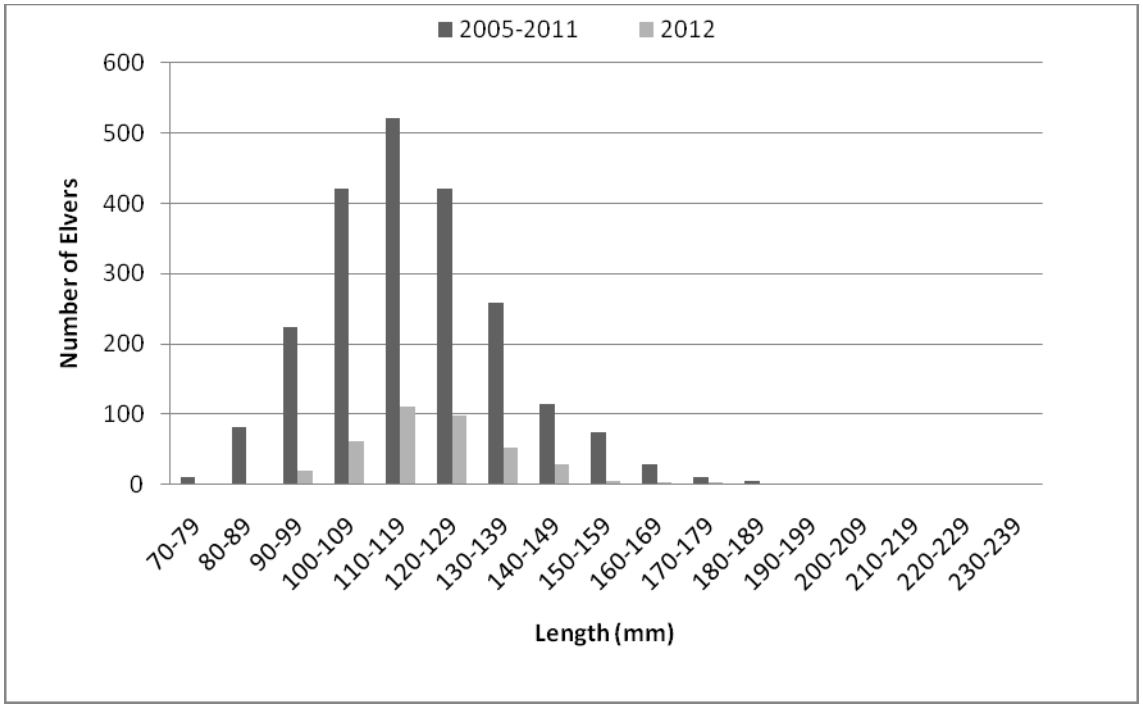

Figure 6. Length frequency of yellow eels captured in Buffalo Creek

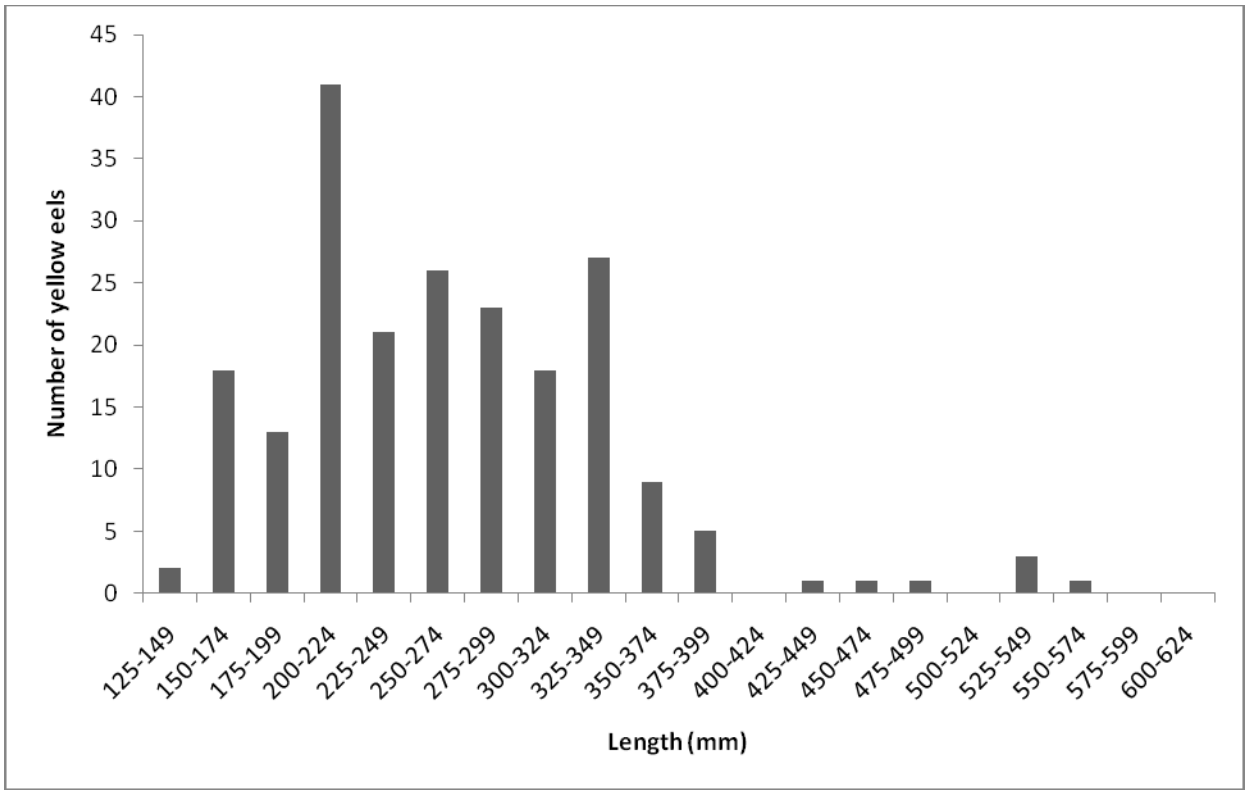

Figure 7. The number of *Anguillicola crassus* present in different lengths of elvers collected from Conowingo Dam.

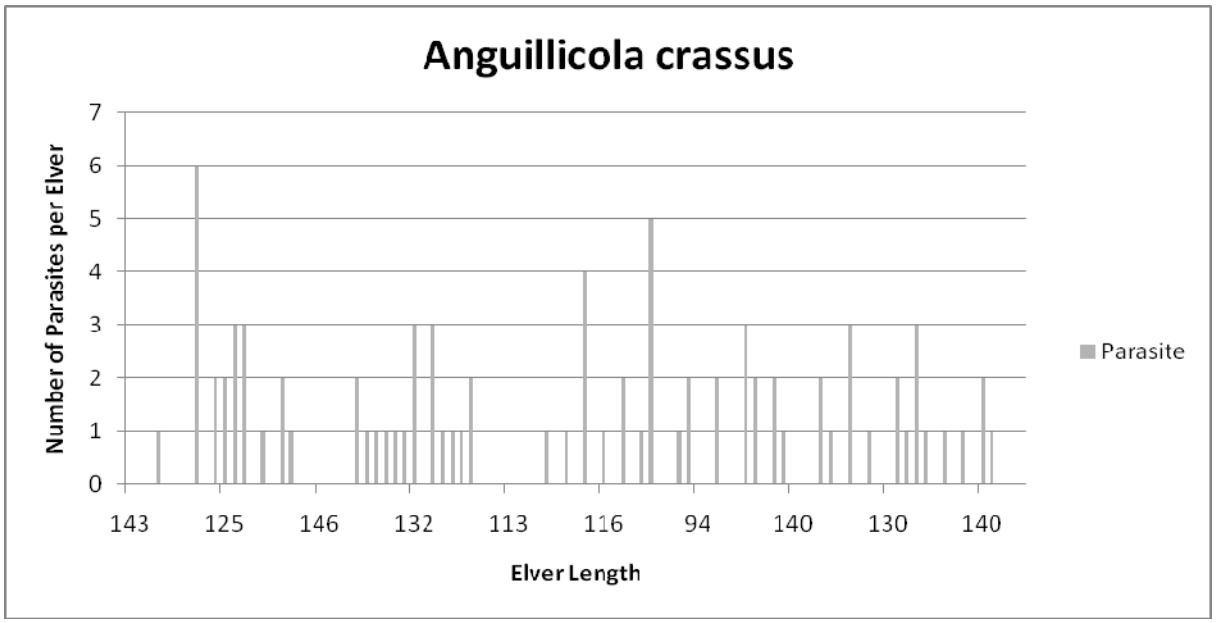

Table 1. Date, location, and number of elvers stocked in 2012

Date	# stocked	Latitude	Longitude	Site	Source
5/24/2012	15237	41 44.203' N	77 25.822' W	Darling Run Acces, Pine Creek, PA	Glass
5/24/2012	8426	40 59.139' N	76 55.930' W	Strawbridge Rd, Buffalo Creek, PA	Glass
5/31/2012	7122	40 59.139' N	76 55.930' W	Strawbridge Rd, Buffalo Creek, PA	Conowingo
6/6/2012	16241	41 44.633' N	77 26.031' W	Anasonia Bridge, Pine Creek, PA	Conowingo
6/20/2012	11592	41 44.633' N	77 26.031' W	Anasonia Bridge, Pine Creek, PA	Conowingo
6/27/2012	5000	39 36.873' N	76 12.382' W	Glenville Rd Dam, Deer Creek, MD	Conowingo
6/28/2012	8827	39 40.794' N	76 16.847' W	Robinson Mill Rd Bridge, Broad Creek, MD	Conowingo
7/5/2012	11401	39 41.702' N	76 14.460' W	Flintville Rd Boat Ramp, Broad Creek, MD	Conowingo
7/26/2012	15536	40 09.900' N	76 44. 850'W	Etters Boat Ramp, Susquehanna River PA	Conowingo
8/7/2012	1068	40 59.139' N	76 55.930' W	Strawbridge Rd, Buffalo Creek, PA	Conowingo
8/13/2012	19865	40 09.755' N	76 44. 953'W	Etters Boat Ramp, Susquehanna River PA	Conowingo

Table 2. Number of elvers caught at the base of Conowingo Dam on the West side of the dam during 2012.

Date	# of Elvers		Date (con't)	# of Elvers
5/16/2012	100		6/29/2012	1421
5/18/2012	613		7/2/2012	3520
5/21/2012	1330		7/5/2012	16822
5/23/2012	277		7/17/2012	0
5/24/2012	108		7/23/2012	829
5/29/2012	7029		7/25/2012	14513
5/30/2012	2067		7/26/2012	722
5/31/2012	2652		7/27/2012	402
6/1/2012	5354		7/30/2012	737
6/4/2012	5820		8/1/2012	110
6/6/2012	5238		8/3/2012	387
6/8/2012	487		8/6/2012	438
6/11/2012	667		8/10/2012	8002
6/13/2012	1795		8/11/2012	3316
6/15/2012	3379		8/13/2012	7697
6/18/2012	3508		8/15/2012	2080
6/20/2012	1956		8/17/2012	840
6/22/2012	849		8/20/2012	164
6/25/2012	4327		8/24/2012	0
6/27/2012	13950		8/27/2012	71
6/28/2012	3436			

Table 3. Number of Passive Integrated Transponder Tags (PIT) applied to yellow eels below Conowingo Dam by year.

Year	# of Tags Applied
2007	51
2008	32
2009	68
2010	11
2011	127
2012	66

Table 4. Growth of yellow eels caught and recaptured in pots at the base of Conowingo dam by year.

	Average Length (mm)						*Average Annual Growth Increase (mm)*
Eel ID	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	
1	594	617	*	*	*	*	23.0
2	733	770	*	*	*	*	37.0
3	463	474	*	*	*	*	11.0
4	404	510	521	*	*	*	58.5
5	426	445	*	*	*	*	19.0
6	338	390	505	*	*	*	83.5
7	551	589	*	*	*	*	38.0
8	475	511	*	*	*	*	36.0
9	405	471	510	*	*	*	55.0
10	377	405	440	*	*	*	31.5
11	466	490	*	*	*	*	24.0
12	391	520	*	557	*	*	55.3
13	386	428	*	*	*	*	21.0
14	458	*	565	*	*	*	53.5
15	484	*	624	*	*	*	70.0
16	457	*	590	*	*	*	66.5
17	386	*	478	*	*	*	46.0
18	447	*	580	*	*	*	66.5
19	*	419	433	*	*	*	14.0
20	*	364	383	395	449	*	28.3
21	*	393	516	*	*	*	123.0
22	*	479	543	*	*	*	64.0
23	*	497	575	*	*	*	78.0
24	*	454	*	550	*	*	48.0
25	*	*	612	626	*	*	14.0
26	*	*	495	578	*	*	83.0
27	*	*	432	462	470	*	19.0
28	*	335	*	*	446	*	37.0
29	*	321	*	*	377	*	18.6
30	*	*	476	*	508	*	16.0
31	*	*	368	*	465	*	48.5
32	*	*	*	*	446	482	36.0
33	*	*	*	*	390	422	32.0
34	*	*	405	*	*	465	30.0
35	*	*	*	*	418	458	40.0
36	*	*	*	*	464	513	49.0