American Eel sampling at Conowingo Dam 2007

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Background

The Atlantic States Marine Fisheries Commission (ASMFC) is considering changes to its Interstate Fishery Management Plan for American Eel (*Anguilla rostrata*) (FMP). The American Eel Management Board (state directors) recently reviewed advice from the American Eel Technical Committee with respect to potential management changes needed to address modern population declines. The Board tasked the American Eel Plan Development Team with developing a Public Information Document (PID) to explore issues related to American eel management and potential changes to the FMP. Specifically addressed in the PID are efforts to modify fishing regulations and to provide safe upstream (elvers) and downstream (silver eels) passage at hydroelectric dams. Such improved passage for eels will increase habitat availability and improve escapement of adult eels

American eel occupy a significant and unique niche in the estuarine and freshwater habitats of the Atlantic coast. Eels are a catadromous species that ascend freshwater environments as juveniles. These fish 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 very abundant in East Coast streams, comprising more than 25 percent of the total fish biomass in many locations. This abundance has declined from historic levels but remained relatively stable until the 1970s. More recently, fishermen, resource managers, and scientists have noticed a further decline in abundance from harvest and assessment data.

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 comprises 43% of the Chesapeake Bay watershed. Construction of Conowingo Dam in 1928 effectively closed the river to upstream migration of elvers at river mile 10. Before mainstem dams were constructed, the annual harvest of silver eels in the Susquehanna River was nearly one million pounds. There is currently no commercial harvest (closed fishery in Pennsylvania) and very few fish (resulting from Pennsylvania Fish & Boat Commission stockings in the early 1980s) are taken by anglers above the dam. The Maryland Biological Stream Survey (MBSS) collects data in freshwater drainages of Maryland. Eel captures in this survey were collected for the Susquehanna River and tributaries in the vicinity of Conowingo Dam (Figure 1). This data reflects the fact that the dam blocks the upstream migration of eels. By extrapolating densities of eels captured in Maryland the MBSS survey estimated that there would be over 11 million eels in the Susquehanna watershed if their migration was not blocked by dams.

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 upriver. Specialized passages designed to accommodate eels are needed to allow them access to the watershed above dams.

Research conducted by the USGS, Northern Appalachian Research Laboratory indicates that American eel may be the primary fish host for the freshwater mussel, eastern elliptio (*Elliptio complanata*) (Lellis et al. 2001). The larval stage (glochidia) of freshwater mussels must parasitize a host fish to complete metamorphosis to the juvenile life stage. Some mussel species are generalists and can use multiple fish species as hosts while others are specialists that rely heavily on one or two host fish species to complete this life stage. Glochidia collected from eastern elliptio in Pine Creek (a tributary to the Susquehanna River) appear to have much higher metamorphosis success rates on American eels than on other fish species found in the river (Lellis et al. 2001).

Eastern elliptio is abundant throughout most of its range which spans the entire east coast. However, in comparison with other rivers such as the Delaware River where the eastern elliptio population is estimated to be in the millions (Lellis 2001), biologists have noticed a distinct absence of eastern elliptio abundance and recent recruitment to the Susquehanna River (personal communication, William Lellis, USGS, Wellsboro, PA). Low recruitment of eastern elliptio could be linked to the lack of eel passage over 4 dams in the Susquehanna River.

If eels are essential to the reproduction of eastern elliptio or other freshwater mussel species, the implications of providing eel passage to freshwater mussel populations and in turn, ecosystem function could be significant. Similar to oysters in the Chesapeake Bay, freshwater mussels provide the service of natural filtration to the rivers and streams where they live. A healthy reproducing population of eastern elliptio could remove algae, sediment, and micronutrients from billions of gallons of Susquehanna River water each day. Restoring the upstream distribution of American eels and eastern elliptio could potentially improve water quality of not only the Susquehanna River but also the Chesapeake Bay. A research project to further evaluate the relationship between eastern elliptio and American eel has been funded under the USFWS, Region 5, Science Support Program during 2008.

Survey methods and Equipment Placement

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

Sampling for eels took place from May 30 through August 8, 2006. Once again our sampling was limited to the west side of the dam; however this year we attempted to improve our sampling efforts. As in previous years a modified Irish elver ramp was used to sample for elvers (Figure 2) and eel pots with a 6 mm square mesh, were set around the base of the West Fish Lift to catch larger eels. This year an experimental eel passage was created on the shore of the west bank in an attempt to further determine the population of juvenile eels at the base of Conowingo Dam.

(Figure 3). River flows were collected from a USGS gauging station (USGS 01578310). Lunar fraction (percent moon illumination) was collected from the U.S. Naval Observatory (http://aa.usno.navy.mil/). The elver ramp was initially operated outside of the West Fish Lift raceway, but due to large fluctuations in the water levels caused by power generation, and a lack of rain, the ramp would become inoperable during periods of low water level. The ramp was moved to the shore adjacent to the West Fish Lift when juvenile eels were observed in the rip rap where water was spilling over from our pump collection site. (Figure 4 and 5)

Results

Eels were captured throughout the period sampled, May 30th - August 8th (Table 1). Juvenile eel length frequencies ranged from 76 to 169 mm TL (Figure 6), and the length frequency of yellow and silver eels varied from 256 to 734 mm TL (Figure 7). Yellow and silver eels captured were sedated, measured, fin clipped, and had a Passive Integrated Transponder tag (PIT tag) inserted in the dorsal musculature and released (Figure 8). A total of 51 silver or yellow eels were captured and tagged, 28 of which were recaptured at a later date. Juvenile eels were sedated, measured, counted, and in the occurrence of large numbers, eels were volumetrically counted. Juvenile eels were then transported to Deer Creek and released above Wilson Mill dam. Several methods of collecting juvenile eels were attempted and altered as the sampling season progressed. As mentioned before, the modified elver ramp was moved to shore, where juvenile eels were observed. Once moved to shore, the Irish elver ramp was the most prevalent method of capturing juvenile eels (Figure 9). It captured significantly more elvers than the eel passage that was created, however it is believed that this occurred as a result of location of the two. The over flow from the pump collection area was spilling into a slow moving eddy where the trickling effect of the spill was noticeable. However the eel passage was situated down river and we were attempting to collect elvers from a flowing section of river and that our attraction flow was unnoticable.

We believe that abundance estimates have shown that silver and yellow eels become trap happy, or that they set up distinctive home ranges from which they do not emigrate or immigrate. Historically it was thought that eel migration was determined by water temperature and stream flow; we also compared landings to lunar phase. However looking at historical eel landings at Conowingo Dam, we believe that the elver migration up the Susquehanna is not readily influenced be environmental cues. However it does appear that historically juvenile eels can be expected from the first week of May through the end of June.

In 2006 juvenile eels were taken to Manning Hatchery and marked with oxytetracycline (OTC) for an age validation study. The elvers were collected in the West Fish Lift at Conowingo Dam and immersed in an OTC bath at a concentration of 550 ppm for 7 hours. After which the juvenile eels were placed in a small pond on hatchery grounds and collected again a year later. A total of 31 juvenile eels were harvested and sacrificed. Otoliths were removed and viewed under an ultraviolet light to view the OTC markings (Figure 10)

Citations:

Lellis, W. A. 2001. Freshwater mussel survey of the Delaware Water Gap National Recreation

Area: qualitative survey. Report to the National Park Service. 13pp.

Figure 1. Map of the Maryland Biological Stream Survey (MBSS) sampling sites of tributaries to the Susquehanna River in Maryland. Note the difference in densities of eels in tributaries below Conowingo Dam compared to above the Dam.

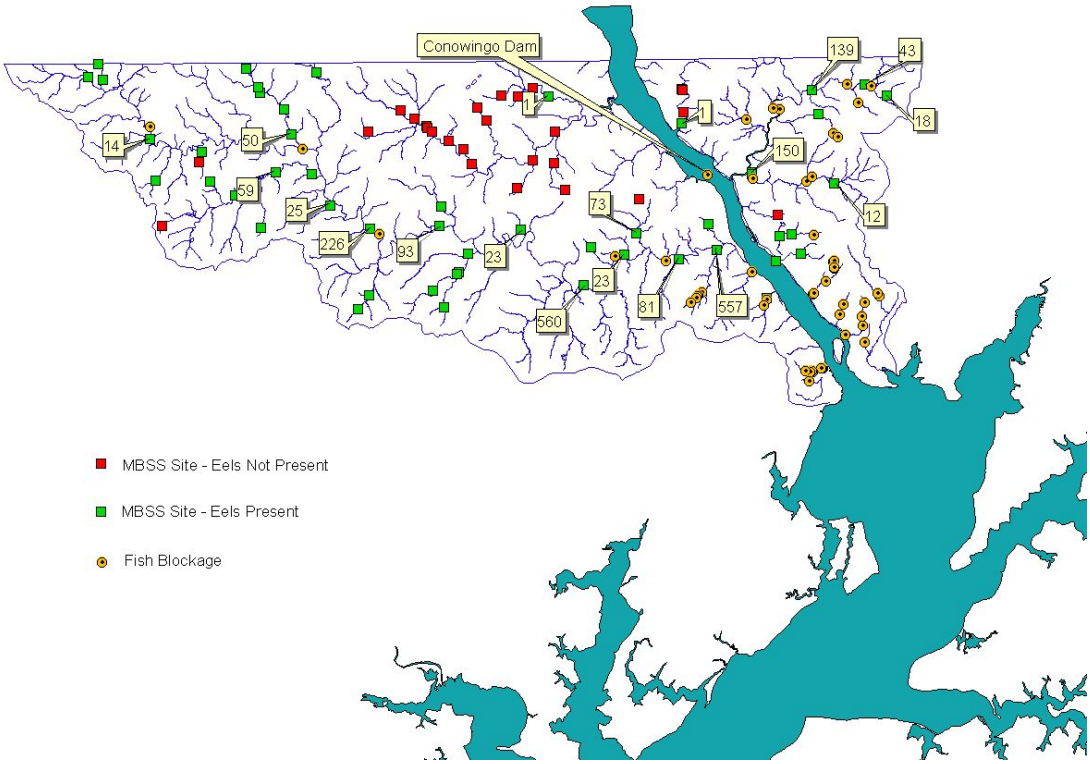

Figure 2. Photo of an Irish Elver Ramp used to sample elvers (young American eels) at the base of Conowingo Dam during 2005.

Figure 3. Experimental Eel passage below Conowingo Dam, 2006.

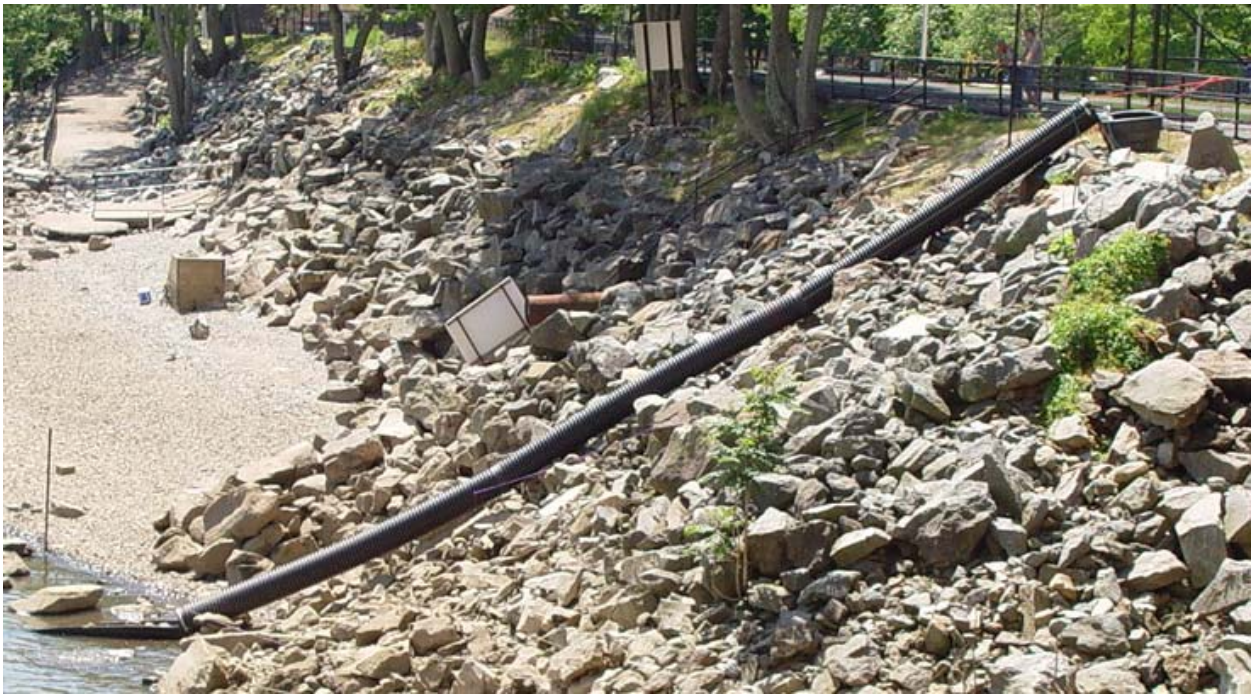

Figure 4.

Figure 5.

Figure 6. Length frequencies of elvers captured at the base of Conowingo Dam during 2007.

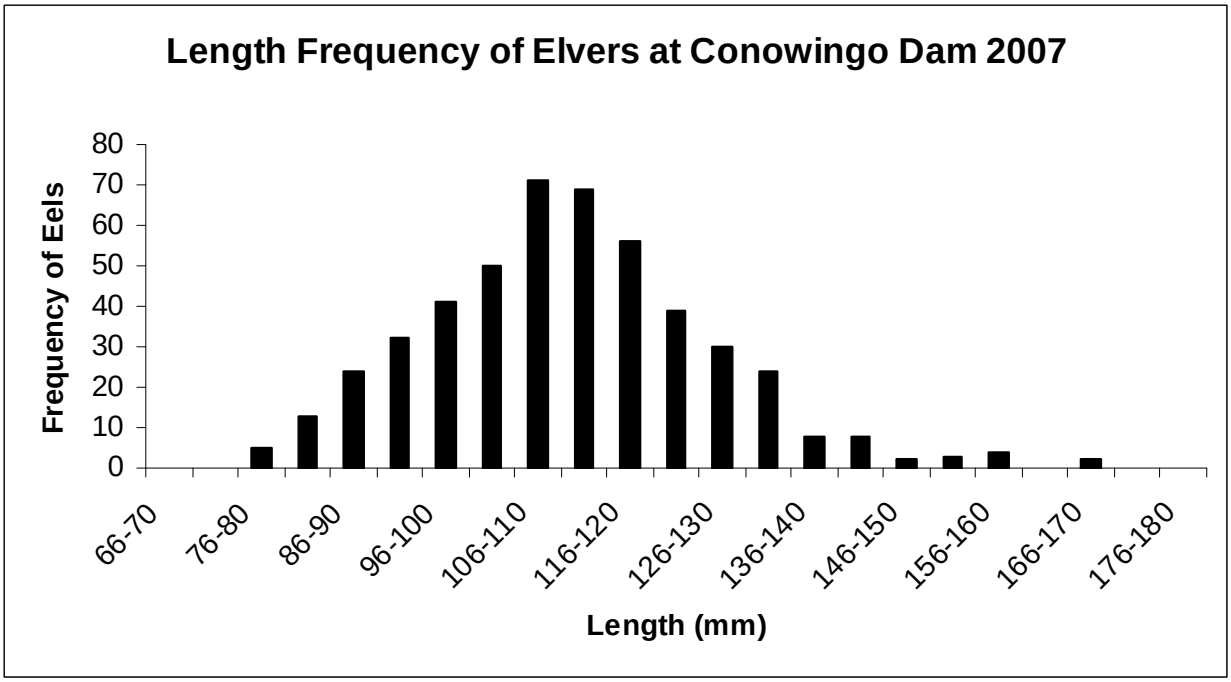

Figure 7.

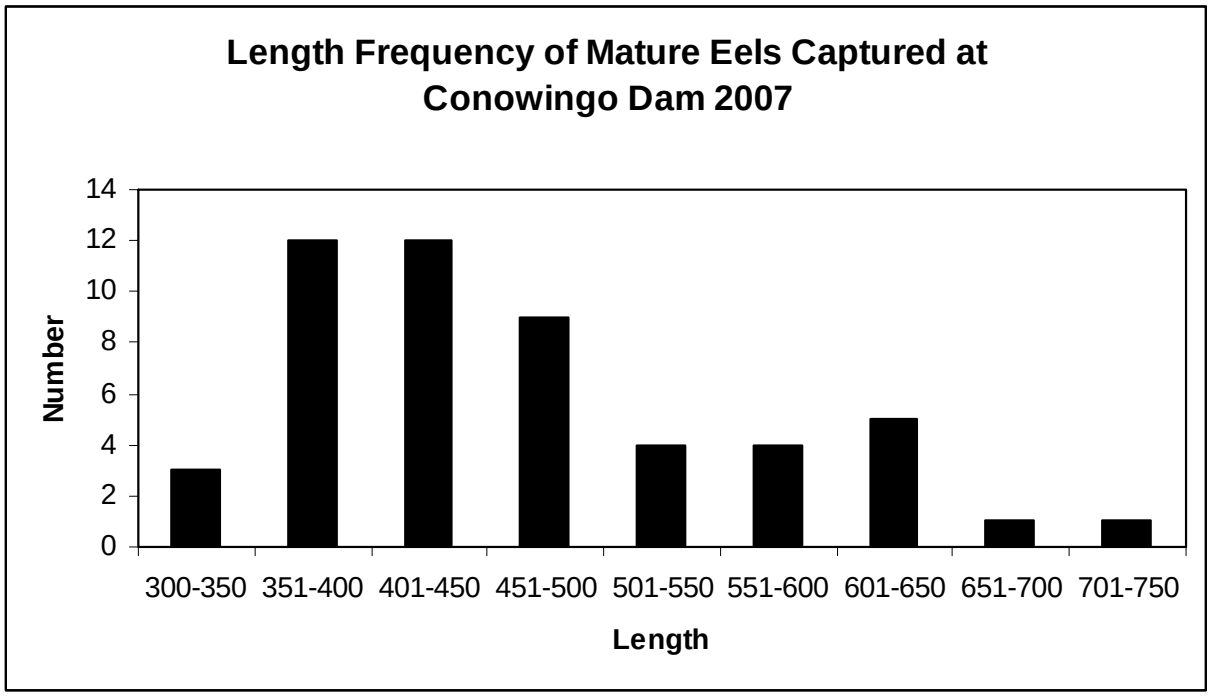

Figure 8.

Figure 9.

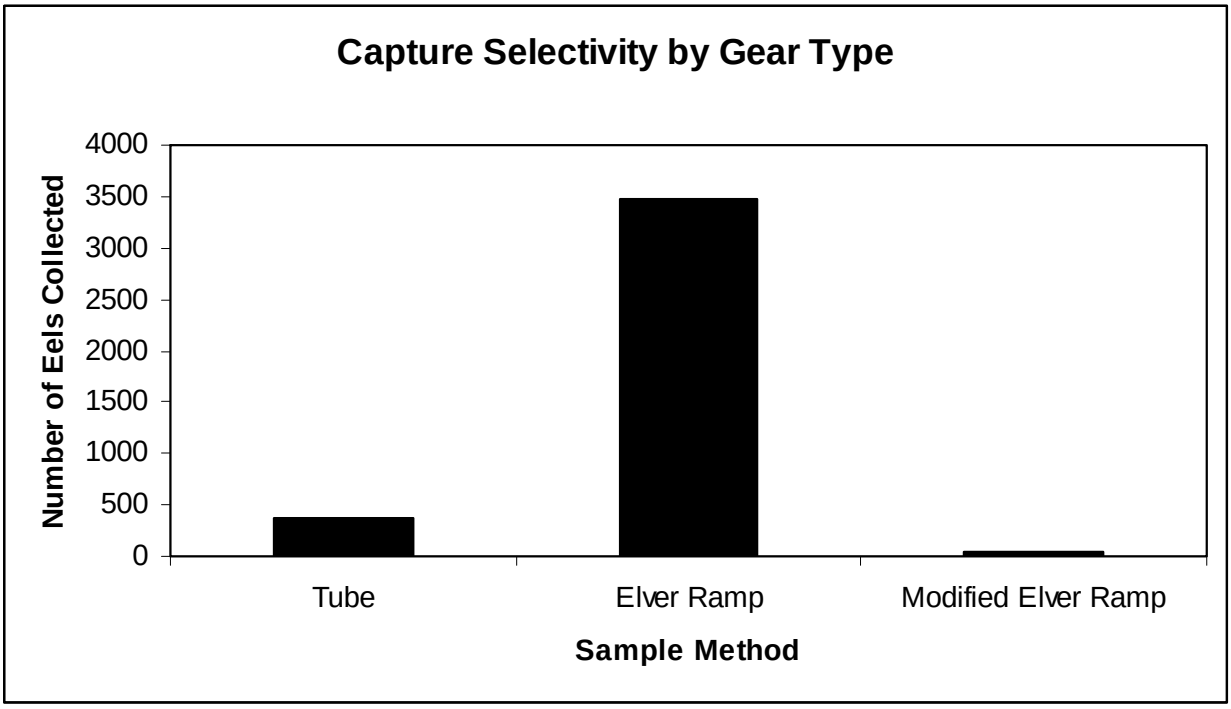
Capture Selectivity by Gear Type
Number of Eels Collected
4000
3500
3000
2500
2000
1500
1000
500
0
Tube
Elver Ramp
Modified Elver Ramp
Sample Method

Figure 12. Lunar cycle for 2007 and predicted migration patterns at Conowingo Dam 2007

Table 1. Number of eels caught at the base of Conowingo Dam on the Susquehanna River by a Modifield Irish Elver Ramp, Irish Elver Ramp, Eel Pots, and an Experimental Eel (data are combined for four pots per collection date).

Collection Date	Lunar Fraction	Eels Collected in Eel Passage	Eels Collected in Elver Ramp	Eels Collected in Modified Elver Ramp	Total Eels Captured
30-May	0.97	0	0	0	0
1-Jun	1	0	0	2	2
4-Jun	0.9	0	0	8	8
6-Jun	0.74	0	0	7	7
8-Jun	0.53	0	0	21	21
11-Jun	0.21	5	0	0	5
13-Jun	0.05	8	0	1	9
15-Jun	0	5	0	0	5
18-Jun	0.12	20	0	2	22
20-Jun	0.28	15	0	0	15
22-Jun	0.47	10	0	0	10
25-Jun	0.74	17	1320	0	1337
27-Jun	0.89	11	525	0	536
29-Jun	0.98	9	391	0	400

2-Jul	0.97	5	216	0	221
5-Jul	0.77	7	62	0	69
9-Jul	0.33	8	100	0	108
11-Jul	0.14	5	53	0	58
18-Jul	0.15	47	74	0	121
20-Jul	0.31	6	96	0	102
23-Jul	0.59	111	408	0	519
26-Jul	0.85	33	125	0	158
30-Jul	1	9	46	0	55
3-Aug	0.79	11	34	0	45
6-Aug	0.46	14	8	0	22
8-Aug	0.25	14	9	0	23