American Eel Reintroduction & Monitoring in Three Southcentral Pennsylvania Streams

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American eel (*Anguilla rostrata*) elvers were experimentally stocked and monitored in three tributaries to the lower Susquehanna River. Stockings occurred over the summers of 2016 and 2017 with a total of 48,622 animals being released over the three sites (Table 1). Target stocking quantities were derived from observations of densities in streams with existing eel populations from the Upper Chesapeake Bay.

Table 1. American Eel Stocking Timing and Quantities

Watershed	2016 Stocking	2017 Stocking	Total Stocked
North Branch Muddy Creek	22,004	0	22,004
Conewago Creek	1,563	15,317	16,880
Beaver Creek	0	9,738	9,738

Follow-up monitoring in 2018 and 2019 showed American eels have successfully established themselves in two of the three stocked streams. The Muddy Creek and Conewago Creek Watersheds have experienced widespread dispersal and successful inhabitation of transplanted American eels. American eels have been found at the stocking locations on these streams as well as at novel upstream and downstream sites (Normandeau Associates, 2018). Additionally, American eels have been observed in the headwaters and mouths of these watersheds, indicating successful dispersal throughout the systems.

Reintroduction of American eels in the Beaver Creek watershed, however, has not been successful. Monitoring at the stocking location as well as at additional upstream and downstream sites has not found eels in any surveys since 2017.

SRBC staff implants a PIT tag into an American eel captured at Conewago Creek.

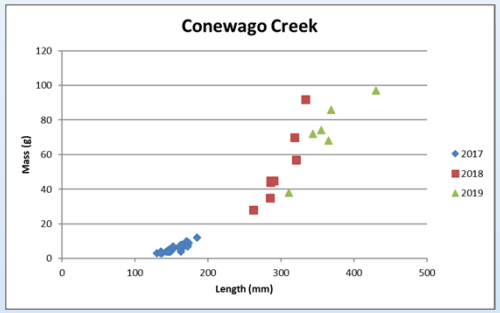

Figure 1. American Eel Length/Weight Relationship Observed in Conewago Creek

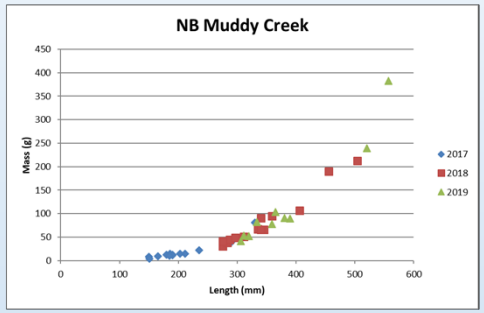

Figure 2. American Eel Length/Weight Relationship Observed in North Branch Muddy Creek

Annual growth rates were derived from recapture of passive integrated transponder (PIT)-tagged American eels during follow-up surveys at Conewago Creek and North Branch Muddy Creek (Figures 1 & 2). American eels in the lower Susquehanna watershed exhibited greater annual growth (87.4 mm/year) than eels in established populations in any other major Chesapeake Bay watershed (Table 2). The lower Susquehanna growth rate also ranks among the highest reported on the Atlantic slope, exceeding those observed in Newfoundland, New York, and South Carolina (Fenske, 2010). A separate study monitoring American eel growth in the Susquehanna reported a more modest growth rate of 47.8 mm/year (Newhard, 2019). This later study had a greater sample size and longer monitoring period which explains some differences in observations since growth slows considerably in older animals.

Prior studies have suggested density is a growth-limiting factor for eel populations restricted by dams (Stranko, 2014). The entirety of the Susquehanna's potential eel population is restricted by Conowingo Dam near the mouth of the river in Darlington, MD. The Susquehanna population exists solely from trap and transport efforts than began in earnest in 2005. While overall growth rates will presumably decline as more older animals are measured, the reintroduction effort in the Susquehanna watershed is novel in both its geographic scope and scale. The Susquehanna is one of the largest watersheds on the Atlantic slope from which American eels had been extirpated. The PIT tags implanted in captured eels by both the Susquehanna River Basin Commission and U.S. Fish & Wildlife Service will also allow biologists to monitor the migratory movements of the fish as they prepare to exit the system. An apparent turbine mortality event was observed in October 2019 indicating that some of the stocked eels have already begun their outmigration.

Table 2. Annual Growth Rates of American Eels in the Chesapeake Bay (Fenske, 2010)

Location in Chesapeake	System	Growth Rate (mm/year)
Upper Bay	Susquehanna	87.4
	Sassafras	54.4
	Chester	68.7
Lower Bay	Choptank	80.9
	Patuxent	67.4
	Potomac	72.7
	James	74.8

Table 3. Mean Length and Mass at Age of American Eel Experimentally Stocked in Lower Susquehanna Tributaries

Evaluation point	Age (years)	length (mm)	mass (g)
stocked (0 years post)	2	122	2.1
1 year post	3	240.4	31.8
2 years post	4	349.3	79.2
3 years post	5	384.1	120.9

Restoration efforts for American eel throughout the Susquehanna River Basin

- Long-term effort between SRBC, Exelon, PADEP, PAFBC, MDDNR, MDE, NYDEC, USFWS, NOAA
- Over 1.5 million American eels stocked in nine tributaries in the Basin since 2005
- Basin-wide dispersal has been documented
- Trap and truck from two lower basin elver ramps every May-September
- Capacity to transport over 25,000 elvers/day
- Monthly interagency coordination meetings to facilitate transports and address emerging issues
- PIT-tagged animals in system and monitoring for outmigration is ongoing
- Targeted stocking at existing Eastern elliptio *(Elliptio complanata)* mussel populations

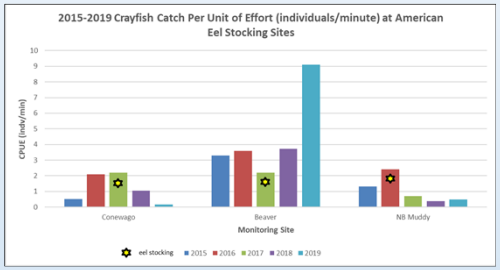

Figure 3. Total Annual Observed Crayfish CPUE (n/minute) in Eel Stocked Watersheds

Changes in crayfish populations were monitored annually at the stocking locations following eel reintroduction. A sample was collected by excavating ten 1-m^2 quadrats to determine species composition and biomass. American eels are known to consume increasing amounts of crayfish as eels grow in size and crayfish become a more viable prey item (Ogden, 1970). Initial results show declines in overall crayfish biomass and capture rates following successful American eel establishment at Conewago and North Branch Muddy sites (Figures 3 & 4). These observations confirm data from Maryland showing reduced benthic animal densities in streams with eels compared to those without eels (Stranko, 2014).

SRBC staff samples crayfish populations using a quadrat sampler.

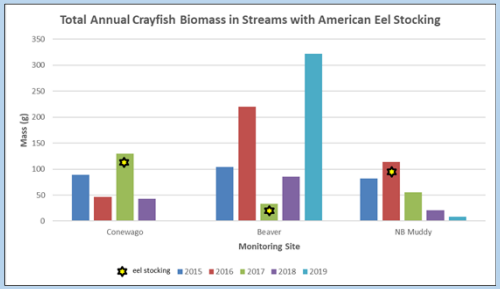

Figure 4. Total Annual Observed Crayfish Biomass (g/m^2) in Eel Stocked Watersheds

Fenske, Kari H., et al. 2010. Demographics and Parasitism of American Eels in the Chesapeake Bay, USA. Transactions of the American Fisheries Society, 139: 1699-1710.

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Normandeau Associates. 2018. Muddy Run Pumped Storage Project Periodic Evaluation of Upstream Stream Segments, 2018. FERC Project No. 2355.

Ogden, John C. 1970. Relative Abundance, Food Habits, and Age of the American Eel *Anguilla rostrata (LeSueur)* in Certain New Jersey Streams. Transactions of the American Fisheries Society, 99: 54-59.

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