Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC)

American Eel Restoration Plan for the Susquehanna River Basin

Addendum to the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC) 2010 Migratory Fish Management and Restoration Plan for the Susquehanna River Basin

Approved by the Policy Committee
December 5, 2013

Cooperators
U.S. Fish and Wildlife Service
National Marine Fisheries Service
Susquehanna River Basin Commission
Pennsylvania Fish and Boat Commission
Maryland Department of Natural Resources
New York State Department of Environmental Conservation

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INTRODUCTION

American Eels (*Anguilla rostrata*) range on the Atlantic Coast from Greenland to northern South America. American Eel is a catadromous and panmictic species. The entire population spawns in the Sargasso Sea and the young are transported by ocean currents to the Atlantic coast where they move into estuaries and freshwater rivers to grow and mature. Historically, American Eels could be found in nearly all estuaries, rivers, and streams in the eastern half of the U.S. However, American Eel populations have declined over the past century and are considered a Depleted Stock by the Atlantic States Marine Fisheries Commission (2012) and are currently being considered for listing under the Endangered Species Act (USFWS 2011).

American Eels were once very abundant in mid-Atlantic States, comprising up to 50% of the fish biomass in some streams (Ogden 1970). Historically, American Eels likely occupied the majority of the Susquehanna Basin, and supported commercial fisheries in both New York and Pennsylvania (Pennsylvania State Commissioners of Fisheries 1883, Dittman et al. 2010). Since the construction of the large mainstem dams in the early to mid-1900's, American Eels have been absent from the majority of the Susquehanna Basin (Dittman et al. 2010, SRAFRC 2010).

Since the mainstem dam construction, efforts have been made to transplant American Eels into the watershed. From 1936 to 1980, the Pennsylvania Fish and Boat Commission collected elvers in Maryland and stocked them throughout the watershed (SRAFRC 2010, Table 1). American Eels have also been trucked upstream from the Conowingo West Fish Lift or passed into Conowingo Pool via the fish lift since 1974 (Table 2), but in recent years, very few eels have been passed. More recently, the U.S. Fish and Wildlife Service has been evaluating methods to collect American Eels at the west side of Conowingo Dam and some of those eels have been stocked in the watershed since 2008 (Tables 3 and 4).

Based on collections from the Maryland Biological Stream Survey (1995-2011, provided by Maryland Department of Natural Resources), American Eel densities in the tributaries to the lower Susquehanna River (below Conowingo Dam) are higher than other Chesapeake Bay tributaries (Table 5, MDDNR MBSS Survey 1995-2011, unpublished). These high densities may be attributed to the attraction of young American Eels to the discharge of the Susquehanna River, but as they are unable to migrate up the mainstem, they divert into the tributaries nearest the dam. Although American Eel can successfully complete their life cycle downstream in the Chesapeake Bay and tributaries below Conowingo Dam, moving eels into upstream habitats will generate benefits to the ecosystem of the Susquehanna watershed and can increase eel survival and fecundity and thus potentially enhance spawning stock escaping from the Susquehanna River (Sweka et al. *draft*).

The loss of American Eels, one of the most abundant fish in the watershed, had additional effects on the Susquehanna River ecosystem. The freshwater mussel, *Elliptio complanata* is the most abundant mussel species in the mid-Atlantic, but its abundance in the Susquehanna River is lower than other regional watersheds (i.e. Delaware River), and there appears to be a lack of successful recruitment in many areas within the basin (H. Galbraith, USGS, personal communication). Freshwater mussels require a host, usually a fish, to complete their reproductive cycle. Lellis et al. (2013) has identified American Eels as an important host species for *E. complanata* in the mid-Atlantic region. The near extirpation of American Eels from the watershed likely played a significant role in the limited abundance, size, age, and recruitment of *E. complanata* populations. Freshwater mussels have the ability to filter large quantities of water (0.01-0.3 $m^3 \cdot m^{-2} \cdot d^{-1}$) and have the potential to improve water quality in the Susquehanna River (Strayer et al. 1999). Restoring American Eels to the watershed may also accrue indirect benefits to the ecosystem by supporting functioning, reproducing mussel populations (Spooner and Vaughn 2006, Vaughn and Spooner 2006).

Moving American Eels above blockages can change the dynamics and life history characteristics of eel populations. Upstream areas produce a higher proportion of female American Eels and the

females are typically large and more fecund (Facey and Van Den Avyle 1987). American Eels that migrate long distances upstream tend to be older and have a slower growth rate compared to those found in estuarine areas (Goodwin and Angermeier 2003, Morrison and Secor 2003). Freshwater areas may also increase survival by providing a refuge from large piscivorous predators, such as Striped Bass, that are found in lower reaches of the Susquehanna River and Chesapeake Bay. Providing access to the Susquehanna River may reduce intraspecific competition and cannibalism that occurs when American Eels are found in high densities such as below Conowingo Dam. In addition, moving American Eels above significant blockages will reestablish the natural predator-prey relationships in the Susquehanna River Basin that were lost when American Eel migration was interrupted in the early 1900s.

THREATS

1. *Access to Upstream Habitat*

   American Eels have had limited access to the Susquehanna River watershed since 1904 when the York Haven Hydroelectric project was placed into service. Construction of Conowingo Dam in 1928 restricted American Eel populations to the lower 10 miles of river. In addition to Conowingo Dam, there are several other mainstem dams and hundreds of tributary dams that partially or totally block upstream eel migration. Areas of poor water quality may also act as barriers to upstream migration. As previously mentioned precluding American Eels from historical habitat may alter sex ratio and fecundity of eels as well as have impacts on the successful mussel reproduction in the watershed.

2. *Access to Spawning Habitat*

   Impediments, such as dams, may also delay or even eliminate downstream migration to the Sargasso Sea. Multiple dams and reservoirs may have significant impacts on the timing and duration of outmigration.

3. *Impingement / Entrainment*

   The presence of water intake structures and hydroelectric facilities may impact American Eel populations. Intake structures for municipal water supply, electrical power production (nuclear, coal, or natural gas) and other commercial uses may impinge and/or entrain resident and migrating eels. Turbine mortality at hydroelectric facilities may also cause substantial mortality for American Eels migrating downstream.

4. *Contaminants*

   American Eels are long-lived benthic species that have the ability to bioaccumulate toxins from their environment. High levels of contamination may lead to reduced survival for all life stages of American Eels and may impact reproductive potential for mature eels (Geeraerts and Belpaire 2010). Endocrine disruptors, present in sewage treatment outfall, may also impact the reproductive potential of the eels (Jobling and Tyler 2003).

5. *Swimbladder Parasite*

   The non-native swimbladder nematode *Anguillicoloides crassus* has been documented in American Eels in most Atlantic coast and tributaries. The swimbladder parasite has been found with varying levels of infestation in American Eels that have been captured in recent years at the base of Conowingo Dam. American Eels carrying the parasite have also been transported into the upper watershed through recent trap and transport efforts (SRAFRC 2013). High levels of parasite infestation may impact the American Eel's ability to reach the spawning grounds in the Sargasso Sea. Although the swimbladder parasite may have negative impacts on American Eel populations, is not known to cause any adverse impacts to other aquatic organisms. There is no known treatment to remove parasites from American Eels at this time.

6. *Predation*

American Eels are likely preyed upon during their upstream migration and as indicated by diets of predatory fish and birds as well as other eels below dams (Jellyman 1977, Jessop 2000).

7. *Fishing Mortality*

Recreational and/or commercial exploitation could impact recovering American Eel populations in the Susquehanna River basin if permitted. Current state American Eel regulations are listed below:

State	Location/Fishery	Season	Daily Limit	Size
Maryland	Non-tidal	Closed	N/A	N/A
Pennsylvania	Commercial	Closed	N/A	N/A
	Recreational	Year-round	50/day	>8"
New York	Commercial	Set at the discretion of the NYSDEC		
	Recreational	Year-round	50/day	>6"

8. *Other Threats*

There are additional threats that cannot be quantified that impact Susquehanna River American Eel populations, including climate change (Friedland et al. 2007), degradation of upstream habitat, sedimentation and dredging, etc.

GOALS FOR RESTORATION

The goal of this plan is to ensure that every American Eel that approaches Conowingo Dam is passed upstream into the Susquehanna River Basin in order to restore American Eels to the watershed, to provide a net increase of out-migrating American Eel, and restore the ecosystem functions provided by healthy American Eel populations, including their role as predator and prey as well as acting as hosts for the glochidia of *E. complanata.*

OBJECTIVES

1. Ensure upstream passage of American Eel throughout the Susquehanna River Basin.
2. Increase survival and escapement of American Eels passing barriers and hydroelectric facilities during their downstream spawning migration.
3. Evaluate efforts to reintroduce American Eels throughout the Susquehanna River Basin and document the influences on American Eel on freshwater mussel populations.
4. Increase public awareness, appreciation, and knowledge of American Eels.

TASKS

Objective 1 – Ensure upstream American Eel passage throughout the Susquehanna River Basin.

Task 1a: Implement trap and transport of American Eels from the lower Susquehanna River to upstream sites in Pennsylvania. American Eels will be stocked at locations that are annually agreed upon by the SRAFRC Technical Committee.

Lead: USFWS until duties assumed by Exelon post licensing
Funding: USFWS supported by SRAFRC until assumed by Exelon
Time for Completion: Ongoing

- Install upstream collection devices both at the west side and in the vicinity of the East Fish Lift at Conowingo Dam (or another appropriate downstream location on the east side of the river) to maximize upstream collection effectiveness and provide American Eels for trap and transport operations.
- Stock American Eels throughout the Susquehanna River and/or its tributaries at locations to be determined by a SRAFRC American Eel subcommittee, but should be inclusive of all suitable waters above Conowingo Dam. Initial stockings may be dispersed throughout Pennsylvania in specific areas to promote freshwater mussel reproduction and/or reestablishment. Long-term stocking of American Eel may be conducted above other priority passage barriers (see Task1b) until alternative upstream passage measures are implemented (see Appendix A).
- A portion of American Eels collected at Conowingo Dam may be used for research purposes with the approval of the SRAFRC Technical Committee and appropriate state entity.

Task 1b: Develop and implement upstream passage plans at priority barriers to ensure adequate passage of American Eels. Incorporate upstream passage plans and evaluation requirements in Federal Energy Regulatory Commission (FERC) licenses, if applicable.

Lead: MDDNR, MDE, PFBC, PADEP, NYSDEC, SRBC, USFWS, FERC, and dam owners
Funding: State Agency Base Funding and dam owners
Time for Completion: Upon relicensing at FERC projects, ongoing at remaining locations

- Develop a list of dams and other barriers that preclude access to upstream habitat for American Eels.
- Priority passage barriers include (but are not limited to):
    - Conowingo Dam - MD
    - Muddy Run Pumped Storage Facility - PA
    - Holtwood Dam - PA
    - Safe Harbor Dam - PA
    - York Haven Dam - PA
    - Fabridam (Sunbury) - PA
    - Hepburn Street Dam – PA
    - Oakland Dam - PA
    - Warriors Ridge Dam (Juniata) - PA
    - Rock Bottom Dam - NY
    - Goudy Station Dam – NY
    - Chase Hibbard Dam - NY
- Monitor relative abundance of American Eels at priority barriers to determine appropriate siting for eel passage.
- Provide adequate upstream passage (safe, timely, effective and efficient) for American Eels at all dams where upriver habitat is suitable.

Objective 2 – Increase survival and escapement of American Eels encountering barriers and hydroelectric facilities during their downstream spawning migration.

Task 2a: Develop performance measures and implement downstream passage plans for American Eels at FERC-licensed dams and other significant water withdrawal projects (i.e. municipal water supply, nuclear, coal, or natural gas) along the Susquehanna River and its tributaries. Ensure at least 85 percent survival at York Haven, Safe Harbor, Holtwood, and Conowingo Dams and Muddy Run Pumped Storage Project. Where needed, require installation of fish passage facilities and associated protective measures (including, but not limited to, fish guidance systems, operational modifications, or trap and transport) to maximize survival.

Lead: MDDNR, MDE, PFBC, PADEP, NYSDEC, SRBC, USFWS, FERC, and dam owners
Funding: State Agency Base Funding and dam owners
Time for Completion: Upon relicensing at FERC projects, ongoing at remaining locations

Task 2b: Minimize downstream migration delays at projects so that American Eels are able to escape the Susquehanna River in a timely manner during their spawning migration.

Lead: MDDNR, MDE, PFBC, PADEP, NYSDEC, SRBC, USFWS, FERC, and dam owners
Funding: State Agency Base Funding and dam owners
Time for Completion: Upon relicensing at FERC projects, ongoing at remaining locations

Objective 3 – Evaluate efforts to reintroduce American Eel throughout the Susquehanna River Basin and document the influence on American Eel and freshwater mussel populations.

Task 3a: Develop and maintain a basin-wide database to facilitate monitoring, assessment, research, and other American Eel restoration activities.

Lead: SRBC, with support from State Resource Agencies
Funding: SRBC Base Funding
Time for Completion: Ongoing

- Document and report to SRAFRC annually, any collections of American Eels in the Susquehanna River Basin which occur during routine or targeted fishery or mussel survey activities.
- Specific agencies requested to submit American Eel collection data include:
    - Pennsylvania Fish and Boat Commission
    - Pennsylvania Department of Environmental Protection
    - Maryland Department of Natural Resources
    - New York Department of Environmental Conservation
    - Susquehanna River Basin Commission
    - U.S. Fish and Wildlife Service
    - Power Generation Companies

Task 3b: Monitor American Eel densities at set locations to evaluate restoration efforts.

Lead: SRBC, with support from State Resource Agencies
Funding: SRBC Base Funding
Time for Completion: Ongoing

Task 3c: Establish, implement, and evaluate methodologies to measure successes of American Eel restoration.

Lead: SRAFRC TC
Funding: Respective Agency Base Funding
Time for Completion: Ongoing

- Determine target densities of American Eels for stocking strategy.
- Determine target densities of American Eels for mussel restoration.

Task 3d: Ensure that all FERC licensed facilities adhere to their respective license conditions set forth to protect American Eels during upstream and downstream migrations which may include monitoring and survival studies. Monitoring and study parameters may include seasonality, daily timing, counts, survival and efficiency of upstream and downstream passage measures.

Lead: Fish Passage Technical Committees and State Agency Representatives
Funding: Respective Agency Base Funding
Time for Completion: Ongoing

Task 3e: As funding and resources allow, cooperating agencies will coordinate the implementation of research priorities listed in the "RESEARCH PRIORITIES" section of this document.

Lead: MDDNR, PFBC, NYSDEC, SRBC, and USFWS
Funding: Respective Agency Base Funding
Time for Completion: Ongoing

Objective 4 – Increase public awareness, appreciation, and knowledge of American Eels.

Task 4a: Develop outreach materials for distribution by SRAFRC cooperating agencies referencing American Eel restoration efforts within the Susquehanna River Basin, general eel life history information, the link to freshwater mussel populations, and general aquatic ecosystem health.

Lead: SRAFRC TC
Funding: Respective Agency Base Funding
Time for Completion: Ongoing

Task 4b: Involve the public, local watershed associations, sportsman groups, and other interested parties in American Eel stockings and monitoring for upstream passage at small dams and migration barriers.

Lead: USFWS and PFBC
Funding: Respective Agency Base Funding
Time for Completion: Ongoing

Task 4c: Initiate and support the development of American Eel education outreach programs for school children linking eel restoration activities, catadromous fish life history, and ecological functions to current biology curriculums (i.e. Eels in the Classroom).

Lead: MDDNR and PFBC
Funding: Respective Agency Base Funding
Time for Completion: Ongoing

RESEARCH PRIORITIES

Research priorities listed in this section are items that, if completed, would benefit American Eel restoration and management in the Susquehanna River Basin. The completion of any of these research priorities is not necessarily the responsibility of any SRAFRC cooperating agency.

1. Migration
    a. Upstream
        i. Develop a stocking strategy that distributes American Eels throughout the watershed and optimizes American Eel production, growth, and escapement, as well as mussel recruitment.
    b. Downstream
        i. Determine the time of day, seasonal timing, and environmental cues associated with downstream American Eel migration.
        ii. Evaluate methodology and effectiveness for trap and transport for American Eels to reduce turbine related mortality.
2. Life History Characteristics
    a. Establish Biological Reference Points
        i. Develop and or modify population models and life history information to estimate thresholds for various sources of mortality and include all life stages to properly evaluate benefits of the relocation project and where adaptive management is most beneficial.
    b. Sex Ratio
        i. Determine if stocking densities impact sex ratios for trap and transported American Eels.
        ii. Determine the age when sex is determined in juvenile American Eels.
    c. Growth/Maturity
        i. Determine how long it takes American Eels to mature in the Susquehanna watershed and does that time to reach maturity change as American Eels saturate the watershed.
        ii. Estimate mature American Eel biomass or appropriate metric in repatriated streams.
    d. Mortality/Survival
        i. Determine if specific stocking densities influence mortality/survival.
        ii. Evaluate sources of in-river mortality (natural and anthropogenic) and determine how to decrease mortality through adaptive management strategies.

3. Ecological Impacts
    a. Freshwater Mussels
        i. Determine if mussel populations show increases in successful recruitment in areas where American Eel populations have been re-established.
    b. Fish and Macroinvertebrate Communities
        i. Determine how stream community structure and function change with the re-introduction of American Eels.
        ii. Determine the extent that American Eels directly compete for resources with other fish species.
    c. Habitat
        i. Identify, evaluate and quantify changes in water quality as a result of eel and mussel reintroductions.

SUMMARY AND CONCLUSIONS

The priority strategy for Susquehanna River American Eel restoration is annually relocating American Eels into historic habitat of the Susquehanna River to restore ecological balance and integrity of the watershed. Research should be conducted to measure the densities and ecological benefits that accrue from these reintroduction efforts. Success of the program will be dependent upon mature American Eels out-migrating safely in sufficient numbers from the Susquehanna River.

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TABLES:

Table 1. American Eels (thousands) transported into Pennsylvania waters of the Susquehanna River from Maryland, 1936-1980.

County	Waterbody	1936	1941	1942	1946	1957	1958	1959	1960	1961	1962	1963	1964	1965	1968	1978	1979	1980	*Total*
Bedford	Dunning Ck.												500						*500*
Bedford	Juniata R., Raystown Br.												167	100	100				*367*
Centre	Black Moshannon Lake	15	12	2															*29*
Centre	Bald Eagle Ck.	15	12		8							90	69	83					*277*
Clinton	Kettle Ck.											90							*90*
Clinton	Bald Eagle Ck.										375	90	554	83					*1,102*
Columbia	Fishing Ck.								500										*500*
Cumberland	Susquehanna R.																300		*300*
Cumberland	Conodoguinet Ck.								175	25	156	50	83	100					*589*
Cumberland	Yellow Breeches Ck.								5										*5*
Huntingdon	Aughwick Ck.						35	97	524	50	156	50	83	100					*1,095*
Huntingdon	Juniata R., Raystown Br.						48	110	353	50		50	167	100					*878*
Huntingdon	Juniata R.									75	156								*231*
Juniata	Cocolamus Ck.									75	156	50							*281*
Juniata	Tuscarora Ck.					3	39	97	496	50	156	50	83	100					*1,074*
Lancaster	Susquehanna R.															1,000			*1,000*
Lycoming	Pine Ck.										375								*375*
McKean	Allegheny R.											90							*90*
McKean	Marvin Ck.											90							*90*
McKean	Potato Ck.											90							*90*
Mifflin	Kishacoquillis Ck.													100					*100*
Mifflin	Jacks Ck.									75		50		100					*225*
Montour	Chillisquaque Ck.							72	196		375	90	69	83					*885*
Montour	Mahoning Ck.						30	70	228	200	375	90	69	83					*1,145*
Montour	Susquehanna R., N. Br.					6		35		300									*341*
Montour	Susquehanna R.						70	35											*105*
Northumberland	Susquehanna R., N. Br.						40	42		300					50				*432*
Perry	Susquehanna R.															20	183	108	*311*
Perry	Juniata R.															15	300	108	*423*
Perry	Buffalo Ck.						39	97	335	50	156	50							*727*
Perry	Shermans Ck.					2	39	97	367	50	156	50	83	100	100				*1,044*
Snyder	Middle Ck. Lake													83					*83*
Snyder	Middle Ck.						50	49	413	200		90							*802*
Snyder	Mussers Dam						40	98		300									*438*
Snyder	Penns Ck.						90	135	413	400		90		83					*1,211*
	Total	*30*	*24*	*2*	*8*	*11*	*520*	*1,034*	*4,005*	*2,200*	*2,592*	*1,300*	*1,927*	*1,298*	*250*	*1,035*	*783*	*216*	*17,235*

Table 2. American Eels trucked or passed upstream via the Conowingo Dam East or West Fish Lift, Susquehanna River, 1976 to 2012.

Year	West Fish Lift Trucking	East Fish Lift Passage
1976	2,384	0
1983	2,500	0
1991*	0	1
1997*	0	13
1998	0	5
1999	0	3
2000	0	0
2001	0	3
2002	0	0
2003	0	0
2004	0	0
2005	0	5
2006	0	11
2007	0	0
2008	0	0
2009	0	0
2010	0	4
2011	0	0
2012	0	4
Total	***4,884***	***49***

**Most American shad and river herring were trucked during these years, but a small number of fish were allowed to pass into Conowingo Reservoir, including some American eels.*

Table 3. U.S. Fish and Wildlife Service American Eel elver collection at the west side of the Conowingo Dam, 2005-2013.

Year	Number of Elvers Captured
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
Total	***592,364***

Table 4. U.S. Fish and Wildlife Service American Eel elver stocking efforts in the Susquehanna River Basin, 2008-2012. The source indicated where the American Eels were collected. Conowingo Dam eels (elvers) were collected by USFWS on the west side of the dam and MD Coastal Bay eels (glass eels) were collected by MDDNR in Turville Creek near Ocean City, MD.

Release Location	County	Collection Source	2008	2009	2010	2011	2012	2013	*Total*
Broad Creek, MD	Harford	Conowingo Dam					20,228		***20,228***
Buffalo Creek	Union	Conowingo Dam			15,874	14,319	8,190	30,614	***68,997***
Buffalo Creek	Union	MD Coastal Bay			9,000	32,219	8,426		***49,645***
Chemung River	Bradford	Conowingo Dam						9,763	***9,763***
Conestoga Creek	Lancaster	Conowingo Dam	17,504						***17,504***
Conodoguinet Creek	Cumberland	Conowingo Dam						41,997	***41,997***
Conowingo Creek	Lancaster	Conowingo Dam		15,316	1,651	9,641		15,500	***42,208***
Conowingo Pond	Lancaster	Conowingo Dam						14,416	***14,416***
Deer Creek, MD	Harford	Conowingo Dam					5,000		***5,000***
Pine Creek	Tioga	Conowingo Dam				37,979	27,833		***65,812***
Pine Creek	Tioga	MD Coastal Bay			9,000	31,198	15,237		***56,235***
Susquehanna R. (Etters)	Dauphin	Conowingo Dam					35,401	149,236	***184,637***
Susquehanna R. (Sayre)	Bradford	Conowingo Dam						9,763	***9,763***
Susquehanna R. (Terrytown)	Bradford	Conowingo Dam						4,090	***4,090***
		Total	***17,504***	***15,316***	***35,525***	***126,156***	***120,315***	***275,479***	***590,295***

Table 5. American Eel densities (eels/m^2) recorded at Maryland Biological Stream Survey sites from 1995 to 2011.

River	Number of Collections	Average Density	Minimum Density	Maximum Density
Lower Susquehanna River	7	0.1035	0.0333	0.2193
Susquehanna River	75	0.0918	0.0006	0.3474
Chester River	187	0.0883	0.0018	0.7925
West Chesapeake Bay	47	0.0881	0.0024	0.3556
Elk River	75	0.0763	0.0018	0.4148
Nanticoke River	62	0.0751	0.0009	0.3224
Bush River	53	0.0723	0.0013	0.2187
Pocomoke River	60	0.0659	0.0011	0.2650
Gunpowder River	57	0.0643	0.0015	0.3432
Washington Metropolitan	4	0.0578	0.0100	0.1199
Choptank River	74	0.0574	0.0027	0.2296
Lower Potomac River	215	0.0544	0.0011	0.9748
Patapsco River	92	0.0476	0.0011	0.2204
Washington Metro Potomac River	85	0.0365	0.0013	0.2056
Patuxent River	129	0.0300	0.0027	0.1978
Upper Potomac River	4	0.0037	0.0010	0.0066
Middle Potomac River	13	0.0019	0.0008	0.0040
North Branch Potomac River	3	0.0014	0.0009	0.0022

APPENDIX A: Susquehanna River Basin American Eel Trapping and Stocking Protocol

Trapping

Exelon will design, install and operate an eel trapping facilities along the western shore of the Conowingo Dam and on a location in Octoraro Creek or on the eastern shore below Conowingo Dam. The trapping facilities will be operated continuously during the eel migration period from May 1 to September 15. Exelon will monitor and record days fished, hours fished and the weather. Daily counts of eels will be recorded; counts will be estimated volumetrically when the number of eels captured is large. Temperature data will be obtained from Monitoring Station 643 (located approximately 0.6 miles below Conowingo Dam near the western shoreline) to examine river temperature in relation to catch rates of juvenile eels. Biweekly subsamples of collected eels will be examined for various life history parameters (*e.g.*, length, weight, and condition factor). Additionally, at least 60 eels will be sacrificed and evaluated for the presence of priority fish diseases and examined for the presence of *Anguillicoloides crassus* annually. *Anguillicoloides crassus* infection rates (proportion of eels infected), the number of parasites per eel, along with associated age, length, and weight data will be reported. Otoliths will also be removed from sacrificed eels and retained for age analysis.

Release

Exelon will release eels at locations in amounts consistent with the recommendation of the SRAFRC Technical Committee. Where feasible, eels will be released at public access locations at least one hour after sunset to promote eel dispersal and minimize predation and into at least three feet of water at multiple locations within designated release areas in order to avoid concentrations of eels that could become potential targets for increased predation. Alternate release locations may be selected, as necessary to avoid mortality. The estimated number of eels released at each location will be documented in writing and on a GPS device capable of being mapped in a database. After release, any dead eels remaining in the transport vehicle or observed at the stocking locations will be removed, enumerated, and reported.

Stocking Locations

Site Number	Location	Waterbody	Pennsylvania County
1	Conowingo Pool	Susquehanna River	Lancaster
2	Between Safe Harbor and York Haven Dam	Susquehanna River	Lancaster
3	Upstream of York Haven Dam	Susquehanna River	Dauphin
4	West Fairview Access (Route 11/15)	Susquehanna River	Cumberland
5	Fort Hunter Access	Susquehanna River	Perry
6	Shikellamy State Park	Susquehanna River	Northumberland
7	Route 487 Bloomsburg	North Branch Susquehanna River	Columbia
8	Route 29 Bridge (Wilkes Barre)	North Branch Susquehanna River	Luzerne
9	Upstream of Hepburn Street Dam (Williamsport)	West Branch Susquehanna River	Lycoming
10	Upstream of Grant Street Dam	West Branch Susquehanna River	Clinton