Large River Monitoring Technical Report 2020-2022

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SUSQUEHANNA RIVER BASIN COMMISSION
NY ▪ PA ▪ MD ▪ USA

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INTRODUCTION

The Susquehanna River Basin Commission (Commission) has been monitoring the Susquehanna River and its major tributaries through its Large Rivers monitoring program since 2007. Previous study efforts of this program have focused on basinwide water quality and biological conditions (2007-2013), geographically underrepresented areas (2016-2018), and studies of the impounded portions of the lower river (2012 and 2014). From 2020 through 2022, the Commission focused its monitoring efforts on the lower 75 miles of the mainstem Susquehanna River from Harrisburg, PA, to Havre de Grace, MD.

The lower Susquehanna River receives various upstream inputs from its over 27,000 square mile watershed and over 4 million residents. This section of river also represents the transitional area from free-flowing riverine conditions to impounded pools created by hydroelectric dams and the river's incursion into the Northern Piedmont ecoregion from the Ridge and Valley ecoregion (Figure 1). This section of river contains four man-made impoundments: Lake Frederick created by York Haven Hydroelectric Dam, Lake Clarke created by Safe Harbor Dam, Lake Aldred created by Holtwood Dam, and the most downstream, Conowingo Pond, created by Conowingo Hydroelectric Plant. In addition to the four hydroelectric dams, this section of river also contains other power generation facilities: the coal-fired Brunner Island Steam Electric Station, Old Dominion Electric Cooperative Wildcat Point natural gas power plant, Peach Bottom Atomic Power Station, and Muddy Run Pumped Storage Facility. The reach also contains sections of free-flowing river upstream of York Haven Dam and between York Haven Dam and Columbia, PA, where the upstream extent of Lake Clarke diminishes.

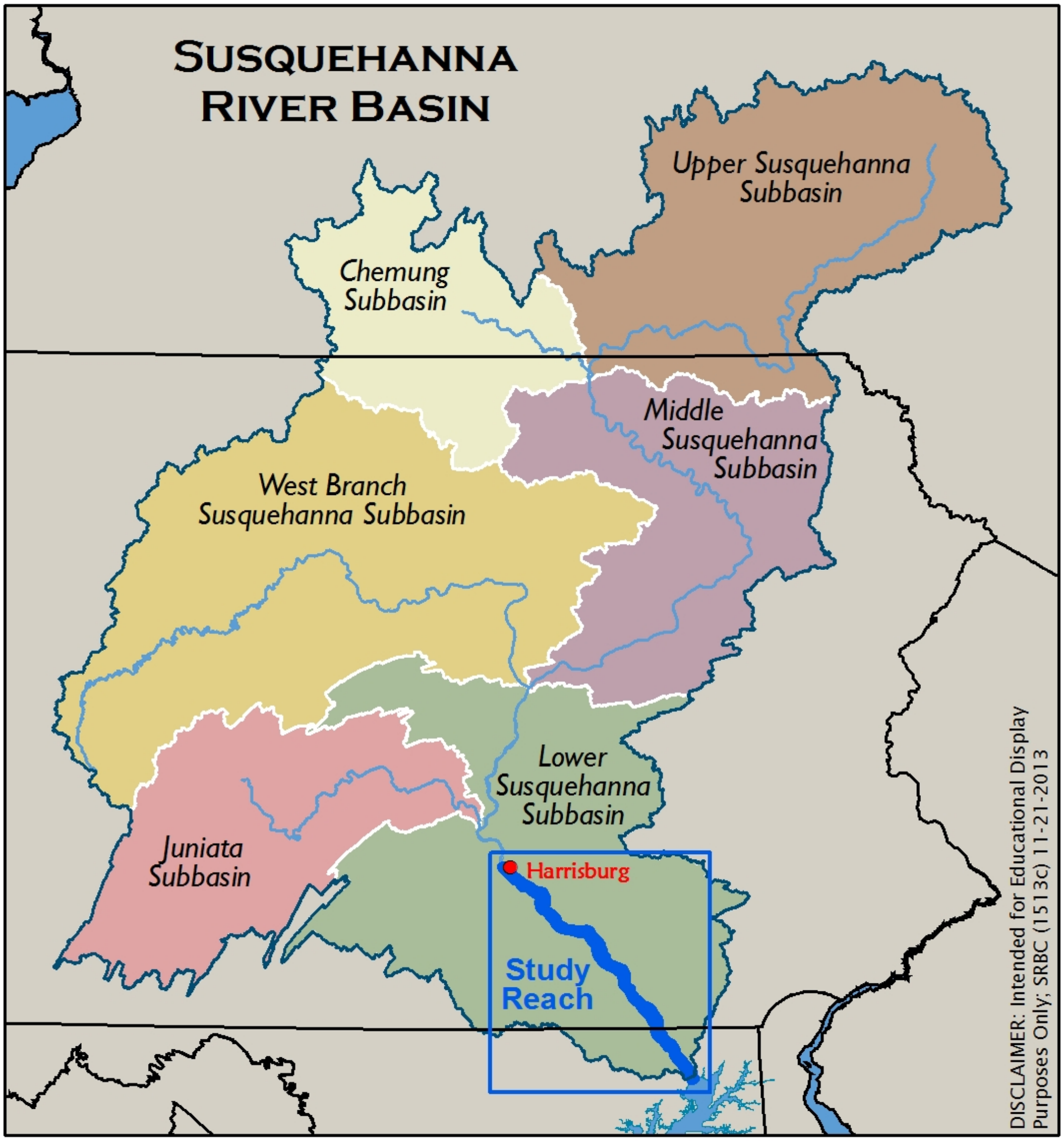

Figure 1. Location of the Study Reach Within the Susquehanna River Basin

STUDY AREA & DESIGN

A total of 16 monitoring sites were positioned throughout the reach typically occurring every 4-5 miles (Figure 2). Each site was designated a priori as either 'Free Flowing' or 'Impounded' based on streamflow characteristics and relative location to a major dam (Table 1). Sites were positioned to minimize the influence of tributary influence to the greatest extent possible. Sampling sites were positioned at least 2 km from hydroelectric dams to minimize direct impacts and ensure crew safety.

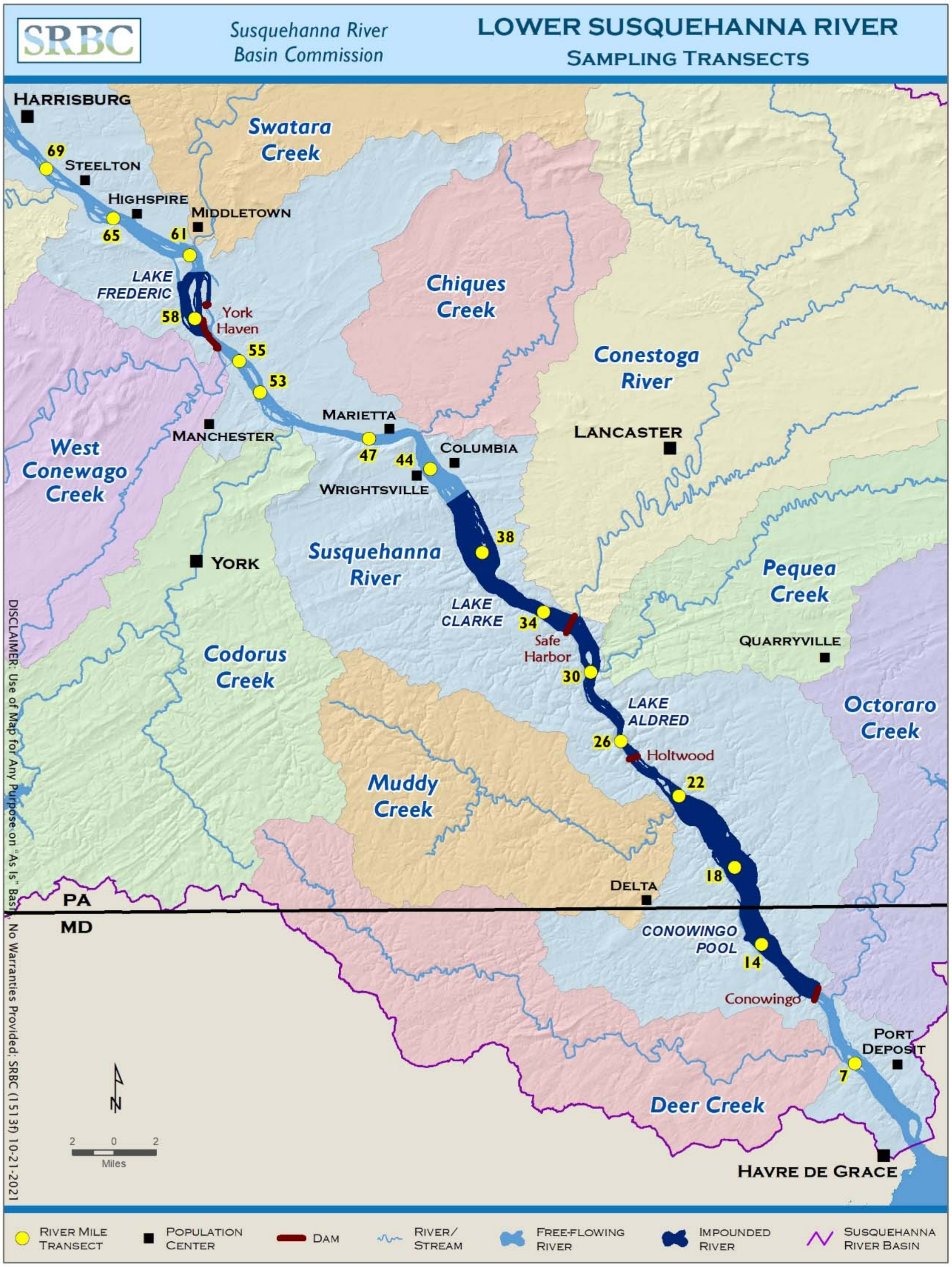

Figure 2. Detailed Map of the Study Reach

Table 1. Large River Monitoring Locations and Designated Flow Condition

Alias	River Mile	Site Description	Latitude	Longitude	State	Flow Condition
SUSQ 69	69	Redbuds Island, upstream New Cumberland, PA	40.239117°	-76.867379°	PA	Free Flowing
SUSQ 65	65	Turnpike Bridge, Highspire, PA	40.204377°	-76.806124°	PA	Free Flowing
SUSQ 61	61	Poplar Island, Royalton, PA	40.178451°	-76.736614°	PA	Free Flowing
SUSQ 58	58	South end of Shelley Island, Falmouth, PA	40.134320°	-76.732187°	PA	Impounded
SUSQ 55	55	Islands upstream of Brunner Island, York Haven, PA	40.104693°	-76.691793°	PA	Free Flowing
SUSQ 53	53	South end Haldeman Island. Bainbridge, PA	40.082839	-76.673239	PA	Free Flowing
SUSQ 47	47	North Accomac, Wrightsville, PA	40.050150°	-76.574510°	PA	Free Flowing
SUSQ 44	44	Old bridge piers, Columbia, PA	40.028887°	-76.518915°	PA	Free Flowing
SUSQ 38	38	South end island complex upstream of Turkey Hill, Washington Boro, PA	39.970419°	-76.471952°	PA	Impounded
SUSQ 34	34	South Highville, Township of Manor,York Haven, PA	39.928689°	-76.416890°	PA	Impounded
SUSQ 30	30	South end Weise Island, Pequea, PA	39.886788°	-76.374618°	PA	Impounded
SUSQ 26	26	South of the pinnacle, dam warning sign, Holtwood, PA	39.838423°	-76.347629°	PA	Impounded
SUSQ 22	22	North end Hennery Island, Drumore, PA	39.799696°	-76.295614°	PA	Impounded
SUSQ 18	18	Downstream of Peach Bottom Atomic discharge, Peach Bottom, PA	39.749617°	-76.245526°	PA	Impounded
SUSQ 14	14	Downstream mouth of Broad Creek, Darlington, MD	39.695515°	-76.221853°	MD	Impounded
SUSQ 7	7	Robert/Wood Island complex, Susquehanna State Park, Havre De Grace, MD	39.611933°	-76.138724°	MD	Free Flowing

METHODS

Water Quality Field Measurements

Field measurements of water quality were collected at each site using a YSI Pro Plus or YSI EXO multi-meter to record temperature, specific conductivity, dissolved oxygen, pH, and turbidity (if equipped). At free-flowing sites, field measurements were obtained at a depth of approximately one-half the river's depth. At impounded sites, field measurements were recorded as a vertical profile containing measurements taken at 1-meter intervals ending at least 0.5 meters from the bottom.

Water samples were collected at three locations (left bank, right bank, mid-channel) along each transect using a depth-integrated sampler, typically a VanDorn water sampler. Samples were collected at each location at 1-meter intervals and composited in a churn splitter. At locations where depths exceeded 10 meters, 10 total draws were collected and composited at intervals determined by river depth to proportionally sample the water column. Similarly, at depths less than 10 meters, repeated draws were collected to generate the composited sample for the location.

Macroinvertebrates

Macroinvertebrate assessment methods were adapted from protocols of the Ohio River Valley Water Sanitation Commission (ORSANCO, 2010) and the Pennsylvania Department of Environmental Protection (PADEP, 2017). Macroinvertebrate sampling was comprised of two separate methods of sampling. Macroinvertebrate samples were collected at each sampling transect, utilizing the method most appropriate for the flow condition (impounded or free-flowing). Transects determined to be impounded were sampled using a Hester-Dendy artificial substrate sampler, while free-flowing transects were sampled using a 500-micron D-frame net. At free-flowing transects, a sample consisted of a composite of six, one-minute kicks disturbing an area equal to one-square-meter upstream of the net per kick. Kicks were performed at riffle-run locations across the river channel transect. At impounded transects, a Hester-Dendy artificial substrate sampler was deployed in water approximately one and a half to two meters deep along each shoreline at each of the eight impounded water quality sampling transects and allowed to colonize for six to eight weeks. Two Hester-Dendy samplers were deployed per transect and composited into one sample for the transect. The D-frame sampling was done in a similar timeframe as the Hester-Dendy retrieval, and both types of samples were processed in the same way, utilizing a 200-individual subsample.

Fish Community

Fish community data were collected at each site by boat electrofishing two 500-meter reaches of shoreline or best available habitat, upstream to downstream. Two netters positioned on the bow collected all fish observed using fiberglass dipnets with ¼" mesh openings. Additionally, at impounded sites, targeted benthic fish collections were made using a Missouri-style trawl drug along the river bottom in a downstream manner for 2 minutes at a speed slightly faster than the river current (Herzog, 2005). The two trawl samples were combined with the boat-based electrofishing to generate the fish community sample for the site. All fish were identified to species in the field and returned to the river. When a field identification was not possible, the fishes were preserved in 10% formalin and later identified by a trained taxonomist in a laboratory setting. The total goal electrofishing (button) time was typically targeted to last 2400-3000 seconds.

RESULTS

Fisheries

Over the course of the three-year study, 43 independent fisheries community surveys occurred, documenting a total of 45 unique fish species (Appendix A). Each site was sampled at least once, 15 were sampled twice, and 12 sites were sampled every year. Four species (spotfin shiner, bluegill, smallmouth bass, and channel catfish) were detected at all 16 monitoring sites. Other ubiquitous species, detected at 15 sites, were common carp, flathead catfish, green sunfish, and gizzard shad. Numerically, gizzard shad typically dominated the fish sample throughout the lower river impoundments. Gizzard shad were deemed an irruptive species, disproportionally dominating the community where encountered. The site with the highest species richness was SUSQ 53, with 28 species represented, followed by SUSQ 65 (27 species). SUSQ 14 possessed the lowest species diversity with only 15 unique species present.

Officially listed a threatened species in Pennsylvania and Maryland, the Chesapeake logperch was captured at all three sites within Conowingo Pond as well as at SUSQ 7 below Conowingo Dam. Two migratory species of interest were also collected throughout this study. American eel were captured at six sites above, below, and within the greater reservoir complex. A single juvenile American shad was also collected at SUSQ 65 near Steelton, PA. These diadromous fishes are the subjects of ongoing restoration utilizing trap and truck efforts to bypass the hydroelectric dams.

Northern snakehead and blue catfish, two recently introduced non-native species, were not collected via electrofishing or trawling as part of this effort but have been previously documented in the area. Flathead catfish, another non-native species first detected in this section of river 20 years ago, was distributed throughout the study area. Flathead catfish were collected at all sites except SUSQ 38. Of the 301 Ictalurids captured throughout this study, channel catfish comprised 77% of the total sample compared with flathead catfish comprising 22% (Figure 3). Multiple age classes of flathead catfish were documented including several large adults weighing in excess of 20 kilograms (Photo 6).

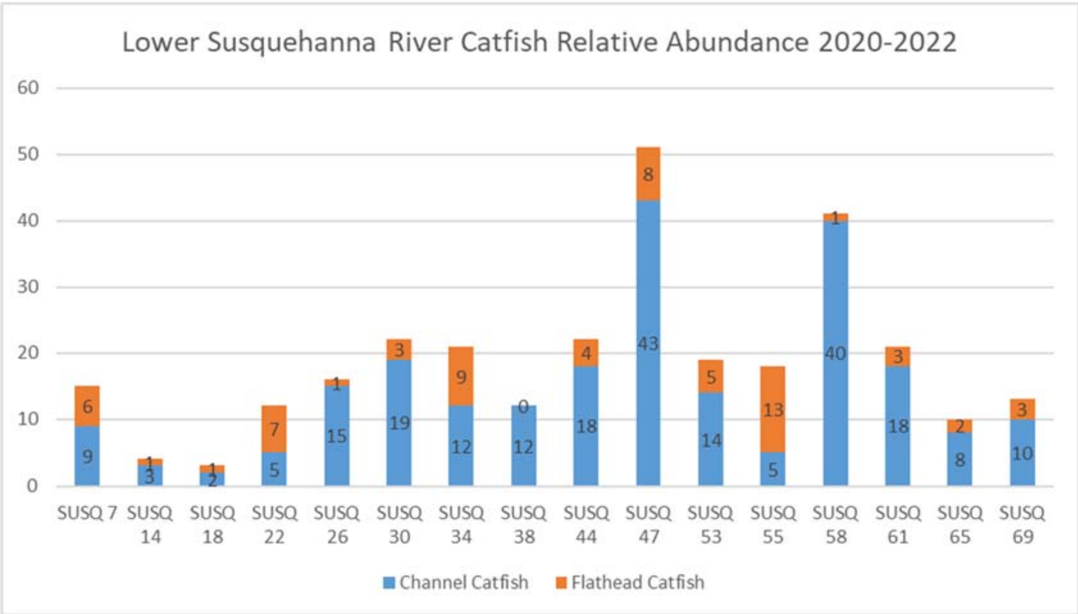

Figure 3. Relative Catfish Abundance in the Lower Susquehanna River 2020-2022

Water Quality

Water quality samples were analyzed using the Commission's Water Quality Index (Berry et al., 2020) which scores samples on a unitless 0 to 100 scale based on nine commonly collected parameters. The single sample score allows for rapid comparison of overall water quality condition among sites. Across all three years of monitoring, WQI values generally decreased with progression downstream, degrading with increased human influence (Table 2). WQI values also varied at collection locations (left bank, mid-channel, right bank) across individual sampling transects (Table 3). The magnitude of WQI score change was greater at free-flowing sites than among impounded sites. Some annual variation in WQI scores did occur but not to an appreciable degree within the course of the study.

Table 2. Average Transect Water Quality Index Values of Large River Monitoring Stations 2020-2022

Flow Condition	Site	2020 WQI	2021 WQI	2022 WQI	Mean WQI
Free Flowing	SUSQ 7	24.7	39.0	25.8	29.8
Impounded	SUSQ 14	18.9	25.9	31.6	25.5
Impounded	SUSQ 18	24.9	25.9	33.3	28.0
Impounded	SUSQ 22	13.1	30.4	27.0	23.5
Impounded	SUSQ 26	24.4	17.3	35.2	25.6
Impounded	SUSQ 30	23.4	19.7	30.5	24.5
Impounded	SUSQ 34	21.0	24.5	25.5	23.7
Impounded	SUSQ 38	23.7	29.8	25.0	26.2
Free Flowing	SUSQ 44	28.0	35.1	38.9	34.0
Free Flowing	SUSQ 47	32.8	29.3	41.6	34.5
Free Flowing	SUSQ 53	36.6	35.7	31.7	34.7
Free Flowing	SUSQ 55	30.7	34.2	26.3	30.4
Impounded	SUSQ 58	40.1	32.8	37.1	36.7
Free Flowing	SUSQ 61	49.5	36.2	45.2	43.6
Free Flowing	SUSQ 65	41.2	35.9	36.0	37.7
Free Flowing	SUSQ 69	49.9	37.0	32.7	39.9

Table 3. Change in Water Quality Index Values Across Sampling Transects at Large River Monitoring Stations 2020-2022

Flow Condition	Site	2020 Δ	2021 Δ	2022 Δ	Mean Δ
Impounded	SUSQ 14	1.5	11.2	14.4	9.0
Impounded	SUSQ 18	7.5	12.5	1.6	7.2
Impounded	SUSQ 22	4.8	3.7	2.3	3.6
Impounded	SUSQ 26	1.2	0.8	4.6	2.2
Impounded	SUSQ 30	5.4	5.8	5.7	5.6
Impounded	SUSQ 34	1.0	9.7	8.7	6.5
Impounded	SUSQ 38	8.4	16.6	7.5	10.8
Free flowing	SUSQ 44	3.6	7.1	4.7	5.1
Free flowing	SUSQ 47	9.5	11.3	8.4	9.7
Free flowing	SUSQ 53	2.8	22.2	8.2	11.1
Free flowing	SUSQ 55	-	13.6	3.5	8.6
Impounded	SUSQ 58	8.4	17.8	7.7	11.3
Free flowing	SUSQ 61	3.3	24.6	21.7	16.5
Free flowing	SUSQ 65	8.6	23.1	4.8	12.2
Free flowing	SUSQ 69	6.7	5.8	8.0	6.8

Macroinvertebrates

Macroinvertebrate samples were successfully collected at 100% of free-flowing wadeable sites utilizing the D-frame net. Over the course of the study, 58 D-frame samples were collected with 29 (50%) supporting aquatic life use (Table 4). Sites SUSQ 7, SUSQ 61A, and SUSQ 69C never received a supporting life use score. Only 75% of passive Hester-Dendy samplers were ultimately recovered. Of those able to be recovered, 28% did not possess a significant enough number of animals to generate an estimated assessment score.

Table 4. Macroinvertebrate Sample SWMMI Scores 2020-2022 (green denotes attaining life use score)

Method	Site	2020	2021	2022
Hester-Dendy	SUSQ 14	NA	21.8	0.9
Hester-Dendy	SUSQ 18	NA	27.1	NA
Hester-Dendy	SUSQ 22	0.4	NA	18.3
Hester-Dendy	SUSQ 26	0	27.7	0
Hester-Dendy	SUSQ 30	0	18	0
Hester-Dendy	SUSQ 34	0	NA	NA
Hester-Dendy	SUSQ 38	2	24.7	11.2
Hester-Dendy	SUSQ 58	7.8	18.7	24.4
D-frame	SUSQ 7	23.4	46.7	13.5
D-frame	SUSQ 44A	39.9	53.4	50.7
D-frame	SUSQ 44B		69.6	58.4
D-frame	SUSQ 44C		40.1	48.1
D-frame	SUSQ 47A	47.3	45.5	33.6
D-frame	SUSQ 47B		75.1	77.5
D-frame	SUSQ 47C		73.9	73.4
D-frame	SUSQ 53A	60.5	71.7	27.7
D-frame	SUSQ 53B		36.3	61.8
D-frame	SUSQ 53C		47.2	48.8
D-frame	SUSQ 55A	50.6	48.1	19.1
D-frame	SUSQ 55B		60.6	58.7
D-frame	SUSQ 55C		64.3	65.5
D-frame	SUSQ 61A	36.1	42.1	31.4
D-frame	SUSQ 61B	54.1	45.9	39.3
D-frame	SUSQ 61C	52.6	62.1	37.2
D-frame	SUSQ 65A	52.4	42.8	33.5
D-frame	SUSQ 65B	71.8	35.5	59.7
D-frame	SUSQ 65C	51.5	27.8	50.8
D-frame	SUSQ 69A	61.8	47.5	25.2
D-frame	SUSQ 69B	53.8	81.4	62.2
D-frame	SUSQ 69C	47.5	27.7	36.8

Habitat

Habitat conditions varied greatly throughout the study reach. The sites impounded by Conowingo, Holtwood, and Safe Harbor Dams (SUSQ 14 through SUSQ 38) possessed similar conditions with steep banks typically comprised of exposed boulders or large cobble (Photo 4). The Western shoreline throughout this reach was mostly forested with ample riparian corridors but sporadic adjacent development. The Eastern shore possesses similar substrates but with more artificial grading along the bank due to the presence of railroad tracks running adjacent to the river from Wrightsville, PA, to Conowingo, MD. Within the impounded site group, SUSQ 22 possessed unique island habitats consisting of massive boulder and bedrock outcroppings resembling river conditions pre-hydroelectric development (Photo 1). SUSQ 58, classified as impounded due to its location behind York Haven Dam, deviated from other impounded sites due to the relatively minor hydrologic alteration created by the facility. River flows in excess of 17,000 cfs are spilled over this dam along its 2.5 km long dam face. Pool depth behind the dam seldom exceeded 2.5 meters and slack water diminished 5 km upstream of the dam. Conversely, Safe Harbor Dam created a non-wadeable pool that exceeded 18 km with measured depths that routinely exceeded 7 meters.

Free-flowing sites consistently possessed better, more varied habitat conditions. Shoreline development and modification was slightly more prevalent throughout the upper reaches of the study area than the lower portion but typically occurred at riverside towns and industrial areas located closer to the population center of Harrisburg, PA. Functionally diverse substrates and instream cover were found to be more abundant upstream of SUSQ 44. Riffle habitat was generally infrequently encountered downstream of SUSQ 69 but can present under low flow conditions (Photo 2) and does routinely occur along select thrust lines caused by geologic uplift and compression from magmatism and regional faulting (Photo 3). SUSQ 7 located downstream of Conowingo Dam was impacted by peaking operations of Conowingo Dam where variable station discharges resulted in fluctuation river of flow ± 70,000 cfs and state heights ± 2m multiple times per day.

DISCUSSION

This monitoring effort was an initial attempt to assess suitability of various sampling methodologies in a unique and challenging transitional aquatic environment. Staff sought to collect representative data from functionally diverse group of riverine monitoring sites bracketed and influenced by hydroelectric dams. There was inherent difficulty in selecting a suite of methods to adequately address the variety of conditions encountered in the study area. Understanding the full suite of natural and anthropogenic influences acting upon the river was crucial for successful sample collection. Site placement and selection within the study area was informed by previous studies (Steffy, 2013; Henning, 2015).

Sampling during the summer boating season (Memorial Day – Labor Day) is necessary as dam operators are required to maintain minimum pool elevations during this period. Outside of this window, greater surface water elevation deviations are permitted which severely limit the safe navigability of the impounded sections and subsequently inhibits the ability to consistently collect representative samples. These fluctuations also have the ability to desiccate passive sampling gear such as the Hester-Dendy samplers or submerged continuous data loggers.

Hester-Dendy samplers were found to be effective devices for obtaining macroinvertebrate assemblage data from the impounded and consequently deeper sites. Careful sampler placement within the river and sampler buoy markings were critical components of successful deployments. Hester-Dendy samplers placed in protected areas, lees of islands, protected coves, etc., were usually recovered. Placing samplers in at least two meters of water and affixing 3-4 meters of buoy line minimized the risk associated with unanticipated water level fluctuations. Concealing marking buoys as nondescript floats resembling debris or trash minimized tampering throughout the deployment. Using Hester-Dendy samplers throughout the impounded portions of the Susquehanna River is appropriate where water depths preclude safe wading and the likelihood of recoverability is high.

Ponar grab samplers may also be viable for use in this environment but not tested in this study. Inclusion of Ponar samplers would likely function well in the soft-sediment, detritus-laden substrates encountered in the lower reservoirs. Additionally, they would allow for greater sample collection consistency acting as an active gear more akin to the D-frame net used at free-flowing. Regardless of the collection device selected, appropriate assessment methods for this non-wadeable reservoir system are needed.

The fisheries techniques employed in this study were generally sufficient and effective at documenting the ichthyofauna of the area. The supplemental trawling to capture benthic fishes, however, typically yielded few additional individual and seldom additional species not detected via shoreline electrofishing. The occurrence is likely a factor of the limited benthic diversity of this Atlantic slope drainage rather than inability of fishes to recruit to the gear. Shoreline electrofishing typically yielded low numbers of benthic fishes, similar to mid-channel trawling. Future studies targeting or focusing on benthic fishes would benefit from the inclusion of an electric trawl (Freedman et al., 2009) to better capture benthic structure and composition.

Each of the four hydroelectric dams contained with the study area possess some mechanism to facilitate upstream fish passage. Due to the observed passage of multiple northern snakehead over Conowingo Dam in April 2020, fish lifting operations at Conowingo and Holtwood Dams were discontinued at the request of the Susquehanna River Anadromous Fish Restoration Cooperative (SRAFRC). Seasonal volitional passage continues to occur at York Haven Dam but in an effort to minimize dispersal of invasive species no upstream passage operations have occurred at Conowingo, Holtwood, or Safe Harbor Dams since April 2020. Each dam continues to serve as formidable impediments to fish movement. Striped bass, a semi-anadromous species and sea lamprey, a fully anadromous primitive fish species, were both detected below Conowingo Dam but at no locations upstream. Currently, the practice of restricting all fish passage at the dams has served effective in limiting the upstream dispersal of northern snakehead and blue catfish.

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PHOTOS

Photo 1. Bedrock and Boulder Islands at SUSQ 22

Photo 2. Staff collecting macroinvertebrates at riffle created by water gap at SUSQ 44

Photo 3. Riffle habitat created at site of former fishing weir under low flow conditions at SUSQ 69

Photo 4. SUSQ 14C Hester-Dendy deployment buoy along steep eastern bank

Photo 5. Partially desiccated Hester-Dendy sampler compromised by water level fluctuations at SUSQ 58

Photo 6. Multiple age classes of Flathead Catfish collected at SUSQ 53

APPENDIX A

Fish species collected from 2020-2022

Genus and Species	Common name	SUSQ 7	SUSQ 14	SUSQ 18	SUSQ 22	SUSQ 26	SUSQ 30	SUSQ 34	SUSQ 38	SUSQ 44	SUSQ 47	SUSQ 53	SUSQ 55	SUSQ 58	SUSQ 61	SUSQ 65	SUSQ 69
Anguilla rostrata	American eel	X			X								x		X	X	X
Fundulus diaphanus	Eastern Banded Killifish						X	X		X		X		X		X	
Alosa sapidissima	American Shad															X	
Dorosoma cepedianum	Gizzard Shad	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Carpiodes cyprinus	Quillback				X							X		X			
Catostomus commersonii	White Sucker			X					X	X	X	X				X	
Hypentelium nigricans	Northern Hog Sucker				X			X	X	X	X	X		X	X	X	X
Moxostoma macrolepidotum	Shorthead Redhorse	X			X	X	X	X	X	X	X	X	X	X	X	X	X
Cyprinella spiloptera	Spotfin Shiner	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cyprinus carpio	Common Carp	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Exoglossum maxillingua	Cutlip Minnow									X							
Luxilus cornutus	Common Shiner					X											
Nocomis micropogon	River Chub									X		X					X
Notemigonus crysoleucas	Golden Shiner		X	X													
Notropis amoenus	Comely Shiner	X	X		X	X	X	X	X	X	X	X				X	
Notropis hudsonius	Spottail Shiner	X			X	X	X	X		X	X	X		X	X	X	X
Notropis rubellus	Rosyface Shiner				X			X		X	X		X	X	X	X	X
Notropis volucellus	Mimic Shiner				X	X	X	X	X	X	X	X	X		X	X	X
Pimephales notatus	Bluntnose Minnow		X	X	X	X	X	X			X	X		X	X	X	X
Semotilus atromaculatus	Creek Chub															X	
Semotilus corporalis	Fallfish							X		X	X	X		X	X	X	
Ambloplites rupestris	Rock Bass	X							X	X	X	X		X	X	X	X
Lepomis auritus	Redbreast Sunfish	X					X				X	X		X	X	X	
Lepomis cyanellus	Green Sunfish	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Lepomis gibbosus	Pumpkinseed	X		X	X	X		X	X	X	X	X		X		X	
Lepomis macrochirus	Bluegill	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Micropterus dolomieu	Smallmouth Bass	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Micropterus salmoides	Largemouth Bass	X	X	X	X	X	X		X		X	X	X	X			
Pomoxis annularis	White Crappie				X						X			X			
Pomoxis nigromaculatus	Black Crappie				X								X	X			
Morone americana	White Perch				X												
Morone saxatilis	Striped Bass	X															
Etheostoma blennioides	Greenside Darter		X	X	X				X	X	X	X				X	
Etheostoma olmstedi	Tessellated Darter	X		X		X	X	X	X	X	X	X	X	X		X	X
Etheostoma zonale	Banded Darter					X				X	X	X					X
Perca flavescens	Yellow Perch	X	X		X									X			
Percina bimaculata	Cheseapeake Logperch	X	X	X	X												
Percina peltata	Shield Darter	X								X						X	
Sander vitreus	Walleye				X					X	X	X					
Petromyzon marinus	Sea Lamprey	X															
Esox masquinongy	Muskellunge												X				
Esox lucius masquinongy (hybrid)	Tiger Muskellunge											X					
Ameiurus natalis	Yellow Bullhead																X
Ictalurus punctatus	Channel Catfish	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pylodictis olivaris	Flathead Catfish	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X