

Conewago Creek Initiative



The Conewago Creek Revisited ***Fish Survey Report***

A compilation of historic fish survey data from 1972, 1973, 2007, 2012, 2015, 2018, & 2021 for three locations along the Conewago Creek

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*This is an update to earlier reports prepared by Kristen Koch, Hillary Yarger, and Ryan Hill, Penn State Agriculture and Environment Center in 2012, 2015, and 2018.

I. Background

This report highlights and compares fish survey data gathered from historic fish surveys of the Conewago Creek that were completed in 1972, 1973, June of 2007, June and October of 2012, June 2015, June 2018, and June 2021. The data collected in the 1970's was completed by York College of Pennsylvania. The 2007 survey was performed by the Tri-County Conewago Creek Association. The 2012, 2015, 2018, and 2021 surveys were coordinated by the Conewago Creek Initiative with expertise provided by the Lancaster County Conservation District, the Susquehanna River Basin Commission, and Larry Coble.

The Conewago Creek flows through Dauphin, Lebanon, and Lancaster Counties of Pennsylvania before joining with the Susquehanna River. The Hershey Meadows sampling site is located between Route 283 and Route 743 and has been sampled all six years. Beginning in 2012, a sampling location was selected close to the headwaters. This site is located within State Game Lands 145 across from Fieldcrest Drive. In the 1970's surveys, a sample site was located near the mouth of the Conewago on the section of stream that parallels Hillsdale Rd. In 2007, this sample site was moved further downstream to where Covered Bridge Rd crosses the Conewago. In summary, the current sample locations are at Hershey Meadows, State Game Lands 145, and Covered Bridge Rd.

Routine fish sampling is an essential component of ongoing monitoring to gauge effectiveness of restoration projects and overall water quality in the Conewago Creek Watershed. The results compare the number of species present in each of the six survey years at the locations that were surveyed, the number of species per fish family, the tolerability of the species identified, and the trophic level of each fish species. Electrofishing was used during all sample years and seine netting was used in addition during the 1972 and 1973 surveys. Two additional sites were sampled prior to 2012, however with the formation of the Conewago Creek Initiative in 2009 a monitoring plan was developed that eliminated those locations (near Koser Road and near Hertzler Road) and added the headwater site to create a more comprehensive monitoring plan for the entire watershed. The data from these additional sample sites will not be included in this report. Additional sampling has also occurred at Old Hershey Road and near Route 230 to track improvements related to specific restoration efforts and those results are also not included in this report.

The tolerability and trophic levels used in this report were compiled by RETTEW Associates prior to the 2007 survey using the EPA Rapid Bioassessment Protocol for use in Wadable Streams (EPA 841-B-99-002) Appendix C: Tolerance and Trophic Guilds of Selected Fish Species. Tolerability designations that identify the level to which a species can adjust to physical and chemical changes in the environment were determined by the EPA using 7 selected literature sources. These same sources were also used by the EPA to establish the trophic designations of the recorded fish species.

As part of the Muddy Run Pumped Storage Project, Exelon Generation Company, LLC stocked Conewago Creek with 16,502 juvenile eels under the direction of the SRBC on June 16, 2017. The effort is a condition by the Federal Energy Regulatory Commission which states that Exelon will trap and transport eels from the Conowingo Dam to selected sites in the Susquehanna River watershed. The American eel, *Anguilla rostrata*, population has decreased due to the lack of migration possibilities. The species spawns in salt water and spends its mature life in freshwater. Freshwater mussels, primarily the Eastern elliptio, *Elliptio complanate*, rely on the American eel to reproduce. Eel reintroduction, due to its connection with freshwater mussels, could help improve local water quality. During the 2018 and 2021 surveys, eel information was collected to track the progress of reintroduction.

II. Data

Headwaters

The survey, conducted on October 21, 2012, found 16 species of fish out of the 187 fish collected. There were 7 Minnow species, 2 Sucker species, 2 Catfish species, 1 Trout species, 2 Sunfish species, and 1 Perch species. There were 3 intolerant species, 8 intermediate species and 5 tolerant species recorded.

The survey conducted on June 30, 2015, found 13 species of fish, out of the 102 fish collected. There were 7 Minnow species, 1 Sucker species, 2 Catfish species, 1 Sunfish species, and 2 Perch species. There were 2 intolerant species, 6 intermediate species and 5 tolerant species recorded.

The survey, conducted on June 25, 2018, found 19 species of fish, out of the 48 fish collected. There was 1 Eel species, 9 Carp/Minnow species, 2 Sucker species, 1 Catfish species, 1 Trout species, 4 Sunfish species, and 1 Perch species. There were 2 intolerant species, 11 intermediate species and 6 tolerant species recorded.

The survey conducted on June 23, 2021, found 18 species of fish, out of the 243 fish collected. There was 1 Eel species, 8 Carp/Minnow species, 2 Sucker species, 1 Catfish species, 4 Sunfish Species, and 2 Perch species. There were 2 intolerant species, 13 intermediate species, and 4 tolerant species recorded.

Chart 1: Results of Fish Surveys in State Game lands 145										
Species	2012		2015		2018		2021		Tolerance	Trophic
Anguillida (Freshwater eels)										
Anguilla rostrata (American eel)					2	4%	1	0%	Intermediate	Piscivore
Cyprinidae (Carp and Minnows)										
Camptostoma anomalum (Central stoneroller)	3	2%							Intermediate	Herbivore
Cyprinella spiloptera (Spotfin shiner)							23	9%	Intermediate	Insectivore
Cyprinus carpio (Common carp)					1	2%			Tolerant	Omnivore
Exoglossum maxillingua (Cutlips minnow)	6	3%	9	9%	3	6%	18	7%	Intolerant	Insectivore
Luxilus cornutus (Common Shiner)			1	1%			1	0%	Intermediate	Insectivore
Nocomis micropogon (River chub)					2	4%			Intermediate	Insectivore
Notemigonus crysoleucas (Golden shiner)					1	2%			Tolerant	Omnivore
Notropis hudsonius (Spottail shiner)							1	0%	Intermediate	Insectivore
Notropis procne (Swallowtail shiner)	3	2%			1	2%	26	11%	Intermediate	Insectivore
Pimephales promelas (Fathead minnow)							13	5%	Tolerant	Generalist
Pimephales notatus (Bluntnose minnow)			1	1%					Tolerant	Generalist
Rhinichthys atratulus (Blacknose dace)	20	11%	19	19%	9	19%	50	21%	Tolerant	Generalist
Rhinichthys cataractae (Longnose dace)	1	1%	40	40%	8	17%	24	10%	Intermediate	Insectivore
Semotilus atromaculus (Creek chub)	3	2%	2	2%	1	2%			Tolerant	Generalist
Semotilus corporalis (Fallfish)	14	7%	3	3%	2	4%			Intermediate	Generalist
Catostomidae (Suckers)										
Catostomus commersoni (White sucker)	12	6%			3	6%	13	5%	Tolerant	Generalist
Hypentelium nigricans (Northern hog sucker)	4	2%	17	17%	3	6%	11	5%	Intermediate	Generalist
Ictaluridae (Bullhead catfishes)										
Ameiurus nebulosus (Brown bullhead)	1	1%	1	1%					Tolerant	Generalist
Ameiurus natalis (Yellow bullhead)			1	1%					Tolerant	Generalist
Noturus insignis (Margined madtom)	1	1%			2	4%	1	0%	Intermediate	Insectivore
Salmonidae (Trouts)										
Oncorhynchus mykiss (Rainbow trout)					1	2%			Intolerant	Piscivore
Salmo Trutta (Brown trout)	1	1%							Intolerant	Piscivore
Centachidae (Sunfishes)										
Lepomis auritus (Redbreast sunfish)					3	6%	33	14%	Intermediate	Generalist
Lepomis gibbosus (Pumpkinseed)	104	56%	3	3%	1	2%	2	1%	Intermediate	Generalist
Lepomis macrochirus (Bluegill)	3	2%			2	4%	2	1%	Tolerant	Generalist
Micropterus salmoides (Largemouth bass)							1	0%	Intermediate	Piscivore
Micropterus dolomieu (Smallmouth bass)					1	2%			Intermediate	Piscivore
Percidae (Perches)										
Etheostoma olmstedi (Tessellated darter)			3	3%	2	4%	17	7%	Intermediate	Insectivore
Etheostoma blennioides (Greenside darter)							6	2%	Intolerant	Insectivore
Etheostoma zonale (Banded darter)	3	2%	1	1%					Intolerant	Insectivore
Other										
Hybrid Sunfish Lepomis gibbosus X L. Macrochiru	8	4%							Intermediate	Generalist

Chart 1: The number of fish per species identified and the percentage of that count compared to the total number of fish identified is shown for the 2012, 2015, 2018 and 2021 surveys at State Game Lands 145. The tolerance and trophic designations of each fish species are also shown.

*The Hybrid Sunfish species was given a tolerability level of intermediate to not skew the tolerability average.

*Percentages are presented as rounded numbers and will not equal 100%.

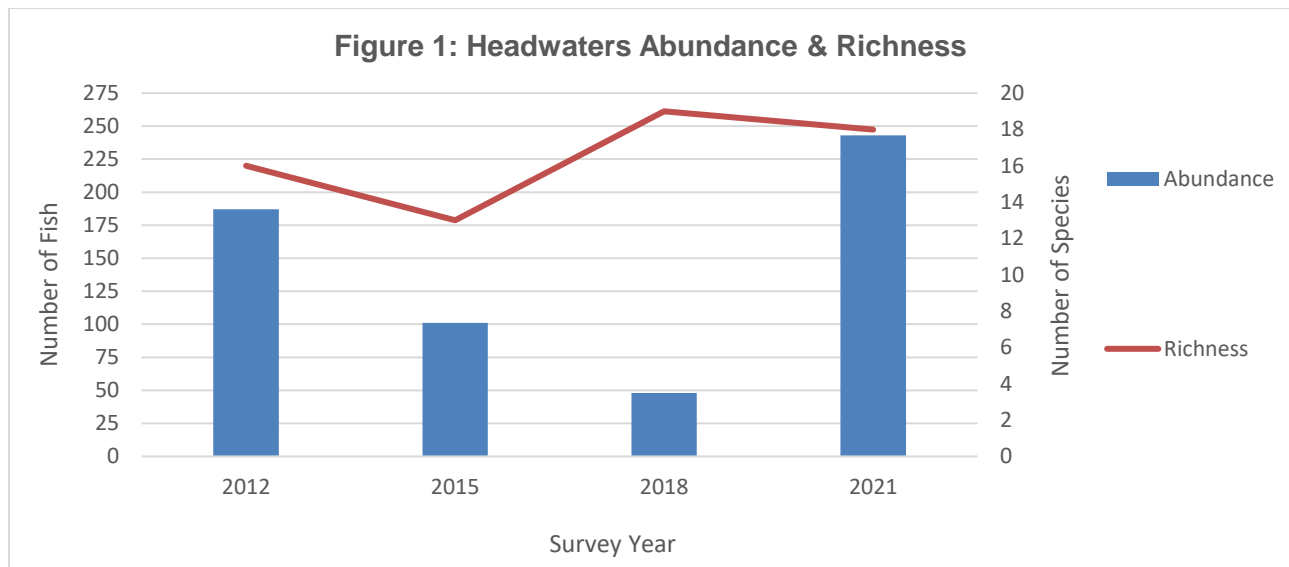


Figure 1: This graph shows the change of species richness and abundance for the headwaters for the 2012, 2015, 2018, and 2021 surveys.

Hershey Meadows

The 1972 survey found 18 species of fish, out of the 164 fish collected. There was 1 Darter species, 5 Sunfish species, 7 Minnow species, 1 Catfish species, 2 Sucker species, 1 Pike species and 1 Killifish species. There were 1 intolerant species, 10 intermediate species and 7 tolerant species recorded.

The 1973 survey found 18 species of fish, out of the 299 fish collected. There was 1 Darter species, 5 Sunfish species, 8 Minnow species, 1 Catfish species, 1 Sucker species, 1 Pike species and 1 Killifish species. There were 1 intolerant species, 11 intermediate species, and 6 tolerant species recorded.

The 2007 survey found 12 species of fish, out of the 123 fish collected. There was 1 Darter species, 3 Sunfish species, 4 Minnow species, 1 Catfish species, 2 Sucker species, and 1 Killifish Species. There were no intolerant species, 7 intermediate species and 5 tolerant species recorded.

The June 28, 2012 survey found 24 species of fish, out of the 882 fish collected. There were 2 Darter species, 11 Minnow species, 6 Sunfish species, 2 Catfish species, 2 Sucker Species and 1 Killifish Species. There were 3 intolerant species, 15 intermediate species and 6 tolerant species recorded.

The June 30, 2015 survey found 18 species out of the 181 fish collected. There were 6 Minnow species, 6 Sunfish species, 1 Catfish species, 2 Sucker species, 1 Killifish species, and 2 Perch species. There were 3 intolerant species, 9 intermediate species, and 5 Tolerant species recorded.

The June 25, 2018 survey found 28 species out of the 315 fish collected. There were 1 Eel species, 13 Minnow species, 3 Sucker species, 1 Catfish species, 1 Killifish species, 6 Sunfish species, and 3 Perch species. There were 4 intolerant species, 18 Intermediate species, and 6 tolerant species recorded.

The June 23, 2021 survey found 23 species out of the 671 fish collected. There was 1 Eel species, 11 Carp/Minnow species, 2 Sucker species, 1 Catfish species, 1 Killifish species, 5 Sunfish species, and 2 Perch species. There were 2 intolerant species, 15 intermediate species, and 6 tolerant species recorded.

Chart 2: Results of Fish Surveys in Hershey Meadows

Species	1972	1973	2007	2012	2015	2018	2021	Tolerance	Trophic									
Anguillida (Freshwater eels)																		
Anguilla rostrata (American eel)											4	1%	3	0.4%	Intermediate	Piscivore		
Cyprinidae (Carp and Minnows)																		
Camptostoma anomalum (Central stoneroller)						9	1%				2	1%	5	0.7%	Intermediate	Herbivore		
Cyprinella anolostana (Satinfin shiner)	4	2%	1	0%											Intolerant	Insectivore		
Cyprinella spiloptera (Spotfin shiner)	44	27%	16	5%							35	11%	54	8.0%	Intermediate	Insectivore		
Exoglossum maxillingua (Cutlips minnow)						9	1%	3	2%		3	1%			Intolerant	Insectivore		
Luxilus cornutus (Common Shiner)				C		18	2%				8	3%	18	2.7%	Intermediate	Insectivore		
Nocomis micropogon (River chub)						8	1%				1	0%			Intermediate	Insectivore		
Notemigonus crysoleucas (Golden shiner)	1	1%	1	0%									3	0.4%	Tolerant	Omnivore		
Notropis amoenus (Comely shiner)	5	3%	1	0%											Tolerant	Insectivore		
Notropis hudsonius (Spottail shiner)	5	3%	14	5%	C										Intermediate	Insectivore		
Notropis rubellus (Rosyface shiner)						26	3%	2	1%		8	3%	54	8.0%	Intermediate	Insectivore		
Notropis rubellus (Rosyface shiner)						135	15%	2	1%		4	1%	7	1.0%	Intolerant	Insectivore		
Notropis procne (Swallowtail shiner)	25	15%	157	53%		104	12%	4	2%		17	5%	183	27.3%	Intermediate	Insectivore		
Notropis volucellus (Mimic shiner)											6	2%	14	2.1%	Intermediate	Generalist		
Pimephales notatus (Bluntnose minnow)						3	0%				18	6%	2	0.3%	Tolerant	Generalist		
Pimephales promelas (Fathead minnow)					P										Tolerant	Generalist		
Rhinichthys atratulus (Blacknose dace)			8	3%	A										Tolerant	Generalist		
Rhinichthys cataractae (Longnose dace)			5	2%							1	0%			Intermediate	Insectivore		
Semotilus atromaculus (Creek chub)	2	1%				16	2%	3	2%		1	0%			Tolerant	Generalist		
Semotilus corporalis (Fallfish)						6	1%	4	2%		29	9%	28	4.2%	Intermediate	Generalist		
Cyprinus carpio (Common carp)													3	0.4	Intermediate	Generalist		
Catostomidae (Suckers)																		
Catostomus commersoni (White sucker)	11	7%	8	3%	A		188	21%	37	20%	46	15%	78	11.6%	Tolerant	Generalist		
Hypentelium nigricans (Northern hog sucker)	1	1%			P		8	1%	1	1%	7	2%	6	0.9%	Intermediate	Generalist		
Erimyzon oblongus (Creek chubsucker)											2	1%			Intermediate	Generalist		
Ictaluridae (Bullhead catfishes)																		
Ameiurus natalis (Yellow bullhead)	2	1%			P		1	0%	1	1%			2	0.3%	Tolerant	Generalist		
Noturus insignis (Margined madtom)			1	0%			1	0%			1	0%			Intermediate	Insectivore		
Esocidae (Pikes)																		
Esox niger (Chain pickerel)	2	1%	2	1%											Intermediate	Piscivore		
Cyprinodontidae (Killifishes)																		
Fundulus diaphanus (Banded killifish)	4	2%	16	5%	C		12	1%	19	10%	13	4%	4	0.6%	Tolerant	Insectivore		
Centachidae (Sunfishes)																		
Ambloplites rupestris (Rock bass)	4	2%	3	1%	P		70	8%	32	18%	32	10%	18	2.7%	Intermediate	Piscivore		
Lepomis auitus (Redbreast sunfish)	29	18%	40	13%	C		35	4%	38	21%	55	17%	148	22.1%	Intermediate	Generalist		
Lepomis gibbosus (Pumpkinseed)			12	4%			142	16%	15	8%	1	0%	1	0.1%	Intermediate	Generalist		
Lepomis macrochirus (Bluegill)	3	2%	8	3%			23	3%	2	1%	2	1%			Tolerant	Generalist		
Lepomis cyanellus (Green sunfish)											1	0%	1	0.1%	Tolerant	Generalist		
Micropterus dolomieu (Smallmouth bass)	5	3%	1	0%	P		17	2%	4	2%	5	2%	31	4.6%	Intermediate	Piscivore		
Micropterus salmoides (Largemouth bass)							2	0%							Intermediate	Piscivore		
Percidae (Perches)																		
Etheostoma blennioides (Greenside darter)									5	3%	3	1%	1	0.1%	Intolerant	Insectivore		
Etheostoma olmstedi (Tessellated darter)	15	9%	5	2%	P		8	1%	5	3%	8	3%	7	1.0%	Intermediate	Insectivore		
Etheostoma zonale (Banded darter)							2	0%			2	1%			Intolerant	Insectivore		
Other																		
crappie sp	2	1%													Intermediate	Generalist		

Chart 2: The number of fish per species identified and the percentage of that count compared to the total number of fish identified is shown for all 7 survey years at Hershey Meadows. The tolerance and trophic designations of each fish species are also shown. Note: The 2007 fish data for Hershey Meadows was recorded as a range, rather than specific count. The data was recorded as: Present: (1-4) Common: (5-24) Abundant: (25+).

*The unknown crappie species was given a tolerability level of intermediate and trophic level of generalist to not skew the averages.
*Percentages are presented as rounded numbers and will not equal 100%.

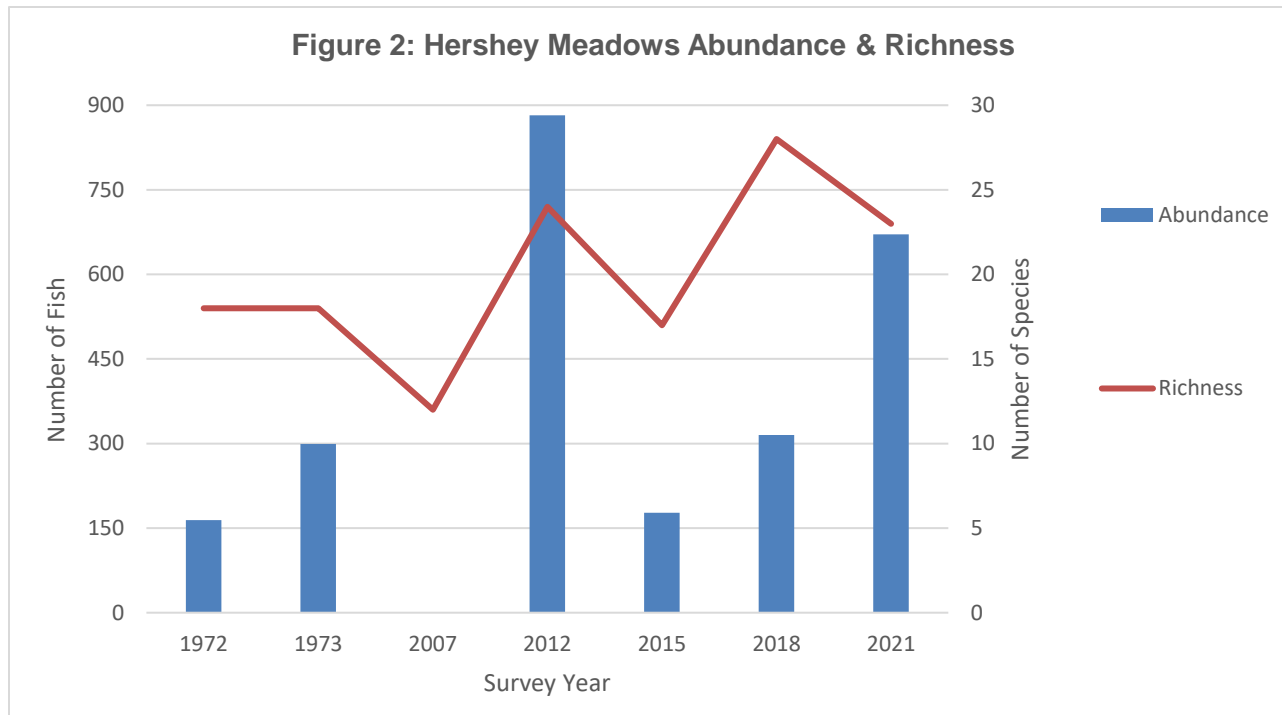


Figure 2: This graph shows the change of species richness and abundance for the 7 years that sampling occurred at Hershey Meadows.

Near the Mouth

The 1972 survey found 12 species of fish, out of the 50 fish collected. There were 2 Darter species, 2 Sunfish species, 7 Minnow species, and 1 Sucker species. There were 3 intolerant species, 7 intermediate species and 2 tolerant species recorded.

The 1973 survey found 18 species of fish, out of the 640 fish collected. There were 2 Darter species, 1 Sunfish species, 12 Minnow species, 2 Catfish species, and 1 Sucker species. There were 3 intolerant species, 12 intermediate species, and 3 tolerant species recorded.

The 2007 survey found 20 species of fish, out of the 402+ fish collected. There were 4 Darter species, 4 Sunfish species, 10 Minnow species, and 2 Sucker species. There were 3 intolerant species, 14 intermediate species and 2 tolerant species recorded.

The October 21, 2012 survey found 22 species of fish, out of the 287 fish collected. There were 4 Darter species, 9 Minnow species, 6 Sunfish species, 1 Catfish species, 1 Sucker Species and 1 Killifish Species. There were 4 intolerant species, 11 intermediate species and 7 tolerant species recorded.

The June 30, 2015 survey found 18 species of fish out of the 149 fish collected. There were 8 Minnow species, 4 Sunfish species, 2 Catfish species, 1 Sucker species, and 3 Perch species. There were 4 intolerant species, 8 intermediate species, and 6 tolerant species recorded.

The June 25, 2018 survey found 20 species of fish, out of the 120 fish collected. There were 1 Eel species, 8 Minnow species, 1 Sucker species, 1 Catfish species, 1 Killifish species, 5 Sunfish species, and 3 Perch species. There were 3 intolerant species, 11 intermediate species, and 6 tolerant species recorded.

The June 23, 2021 survey found 18 species of fish, out of the 92 fish collected. There were 7 Carp/Minnow species, 3 Sucker species, 2 Catfish species, 3 Sunfish species, and 3 Perch species. There were 3 intolerant species, 10 intermediate species, and 5 tolerant species.

Chart 3: Results of Fish Surveys Near the Mouth

Species	1972	1973	2007	2012	2015	2018	2021	Tolerance	Trophic									
Anguillida (Freshwater eels)																		
Anguilla rostrata (American eel)							1	1%						Intermediate	Piscivore			
Cyprinidae (Carp and Minnows)																		
Campostoma anomalum (Central stoneroller)		1	0%		2	1%	1	1%	1	1%	2	2%	Intermediate	Herbivore				
Cyprinella analostana (Satinfin shiner)	1	2%											Intolerant	Insectivore				
Cyprinella spiloptera (Spotfin shiner)	29	58%	562	88%	18	4%	98	34%			6	5%	3	3%	Intermediate	Insectivore		
Exoglossum maxillingua (Cutlips minnow)		1	0%						5	3%	1	1%			Intermediate	Insectivore		
Luxilus cornutus (Common Shiner)				5	1%				2	1%	1	1%			Intermediate	Insectivore		
Nocomis micropogon (River chub)	6	12%	18	3%	12	3%	4	1%							Intermediate	Insectivore		
Notropis amoenus (Comely shiner)		1	0%												Tolerant	Insectivore		
Notemigonus crysoleucas (Golden shiner)												2	2%		Tolerant	Generalist		
Notropis hudsonius (Spottail shiner)	3	6%	1	0%	8	2%									Intermediate	Insectivore		
Notropis rubellus (Rosyface shiner)	2	4%	5	1%	13	3%	5	2%	5	3%			6	7%	Intolerant	Insectivore		
Notropis procne (Swallowtail shiner)		2	0%	25	6%										Intermediate	Insectivore		
Notropis volucellus (Mimic shiner)							83	29%	38	26%	22	18%	29	32%	Intermediate	Generalist		
Pimephales notatus (Bluntnose minnow)		10	2%		19	7%	1	1%	1	1%	8	7%	2	2%	Tolerant	Generalist		
Rhinichthys atratulus (Blacknose dace)	1	2%	1	0%	1	0%									Tolerant	Generalist		
Rhinichthys cataractae (Longnose dace)			9	1%	15	4%	7	2%	25	17%	15	13%	5	5%	Intermediate	Insectivore		
Semotilus atromaculus (Creek chub)							4	1%	6	4%					Tolerant	Generalist		
Semotilus corporalis (Fallfish)	1	2%	2	0%	18	4%	6	2%			1	1%			Intermediate	Generalist		
Catostomidae (Suckers)																		
Catostomus commersoni (White sucker)	2	4%			6	1%	5	2%	4	3%	5	4%	5	5%	Tolerant	Generalist		
Hypentelium nigricans (Northern hog sucker)			2	0%	10	2%							3	3%	Intermediate	Generalist		
Moxostoma macrolepidotum (Shorthead redhorse)													1	1%	Intermediate	Insectivore		
Ictaluridae (Bullhead catfishes)																		
Ameiurus natalis (Yellow bullhead)							7	2%	7	5%	2	2%	1	1%	Tolerant	Generalist		
Ameiurus nebulosus (Brown bullhead)									1	1%					Tolerant	Generalist		
Ictalurus punctatus (Channel catfish)			1	0%									1	1%	Intermediate	Piscivore		
Noturus insignis (Margined madtom)		4	1%												Intermediate	Insectivore		
Cyprinodontidae (Killifishes)																		
Fundulus diaphanus (Banded killifish)							1	0%			2	2%			Tolerant	Insectivore		
Centarchidae (Sunfishes)																		
Ambloplites rupestris (Rock bass)				12	3%	9	3%	8	5%	6	5%	9	10%		Intermediate	Piscivore		
Lepomis auritus (Redbreast sunfish)	1	2%	7	1%	3	1%	7	2%	2	1%	7	6%			Intermediate	Generalist		
Lepomis cyanellus (Green sunfish)							14	5%			13	11%	9	10%	Tolerant	Generalist		
Lepomis gibbosus (Pumpkinseed)					14	3%	5	2%							Intermediate	Generalist		
Lepomis macrochirus (Bluegill)							1	0%	1	1%	1	1%			Tolerant	Generalist		
Micropterus dolomieu (Smallmouth bass)	1	2%		7	2%	3	1%	7	5%	5	4%	2	2%		Intermediate	Piscivore		
Percidae (Perches)																		
Etheostoma blennioides (Greenside darter)							1	0%	17	11%	7	6%	7	8%	Intolerant	Insectivore		
Etheostoma olmstedti (Tessellated darter)	2	4%	11	2%	25	6%	2	1%	17	11%	10	8%	1	1%	Intermediate	Insectivore		
Etheostoma zonale (Banded darter)				6	1%	2	1%	2	1%	6	5%	4	4%		Intolerant	Insectivore		
Stizostedion vitreum (Walleye)				2	0%										Intermediate	Piscivore		
Other																		
shield darter	1	2%	2	0%	2	0%	2	1%							Intolerant	Insectivore		
Cyprinella species				200	50%										Intermediate	Insectivore		

Chart 3: The number of fish per species identified and the percentage of that count compared to the total number of fish identified is shown for all 7 survey years near the mouth of the Conewago Creek. The tolerance and trophic designations of each fish species are also shown.

*The unknown *Cyprinella* species was given a tolerability level of intermediate to not skew the tolerability average.

*Percentages are presented as rounded numbers and will not equal 100%.

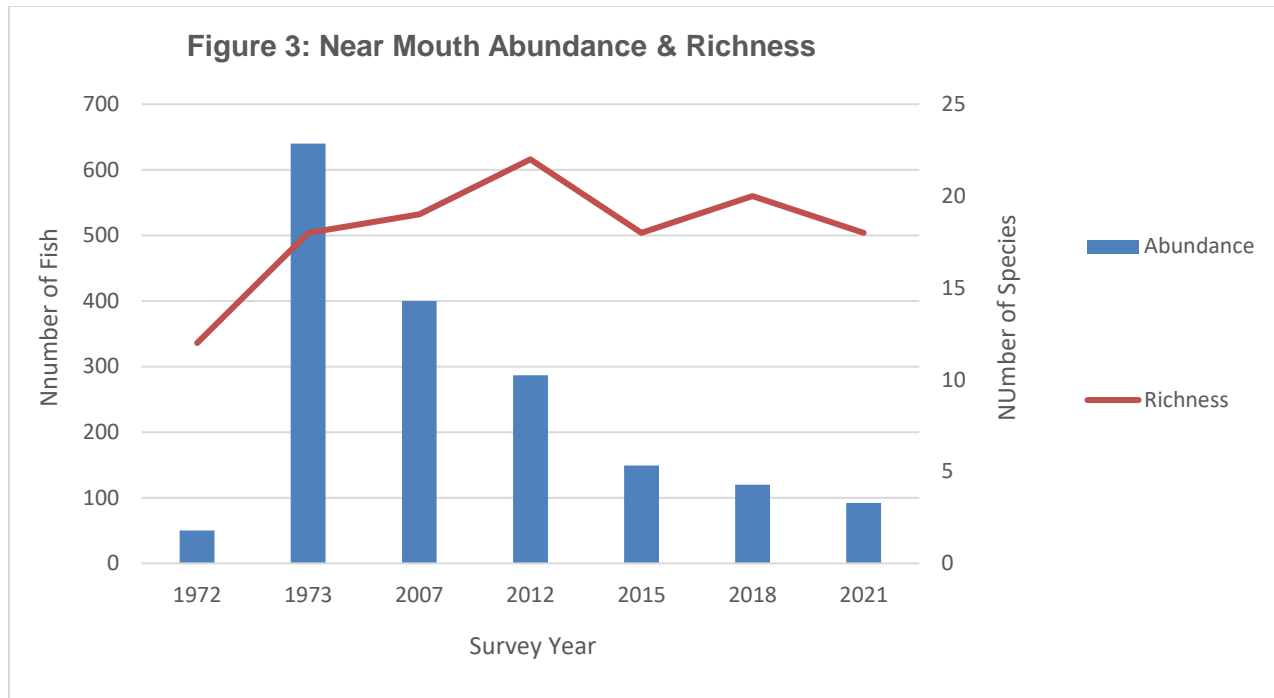


Figure 3: This graph shows the change of species richness and abundance for the 7 years that sampling occurred near the mouth.

III. Discussion

Fish survey results are compared to all available historical fish sample data to show changes in species diversity and tolerance. Since 2012 was the first-year sampling was conducted close to the headwaters, older historical data is not available for comparison at that site.

The 2015 survey was conducted after significant rainfall. The month of June recorded 6.84 inches of rain with 1.54 inches of that during the week of June 21, 2015-June 27, 2015. The survey was completed June 30, 2015. Regardless of the consistent rain fall during the season, researchers felt that the survey needed to be done at this time, despite the conditions, if it was to be completed during the spring of 2015. At the Hershey Meadows and Mouth locations, the water was muddy and it was difficult to see the fish. This could be an explanation for the downward trend in species numbers, especially the minnows which are small and difficult to see in muddy water.

The 2018 survey was also conducted during turbid conditions. The survey was held on Monday, June 25, 2018, following about an inch of rain falling over the weekend. The survey had already been postponed once due to rain and it was decided that the survey should be held to stay consistent with a spring survey. The Hershey Meadows site and the Mouth locations had particularly muddy waters making it challenging to capture bottom sinking fish.

The 2021 survey followed bridge construction at Cover Bridge Road which increased water depth at the Near Mouth sample site. As a result, sampling at this location was more difficult due to the increased water depth and a small section immediately beneath the bridge had to be skipped as the water was too deep to wade.

Headwaters

The following charts display various data from 2012, 2015, 2018, and 2021. Figure 4 compares the number of fish species per family identified at the Headwaters site for the 2012-2021 surveys. The population composition has stayed consistent with more minnows compared to the other families, although there has been an increase in sunfish species from 2015 to 2018.

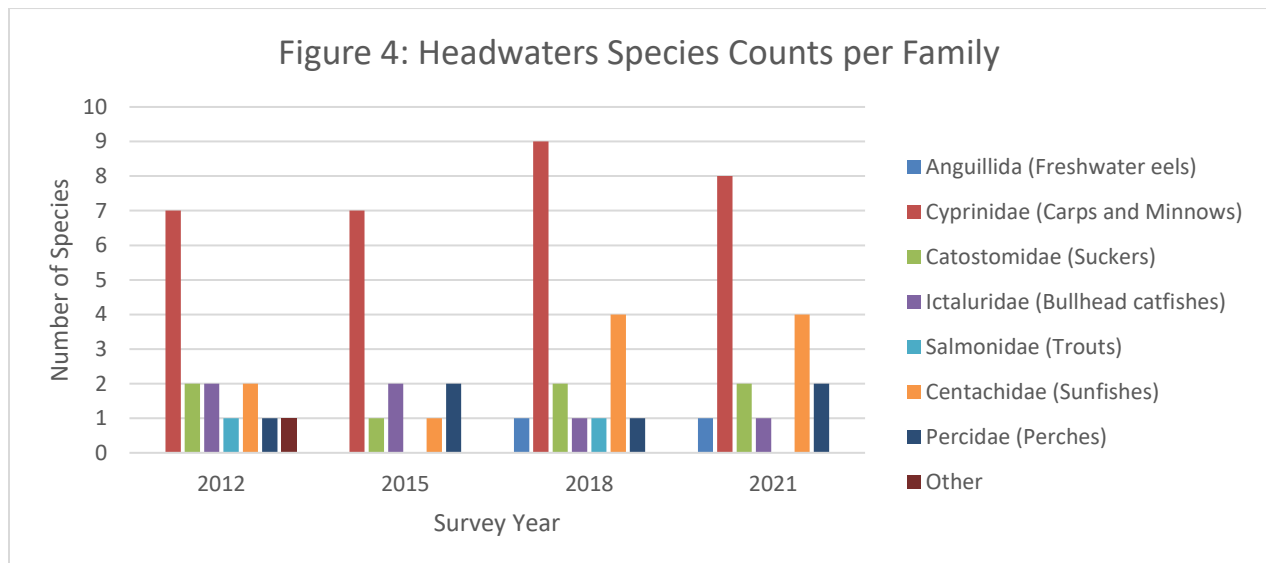


Figure 4: This graph compares the number of species within each family found at the headwaters site from the 2012, 2015, and 2018 surveys.

Figure 5 shows the number of fish per tolerance level found in the Headwaters from 2012, 2015, 2018 and 2021. Species composition has changed slightly over the survey years; however, the trend remains constant: most of the fish species identified are of intermediate tolerability and intolerant species are few. Intolerant species are indicators of good stream health and while they are not thriving in the headwaters, there has remained several species present.

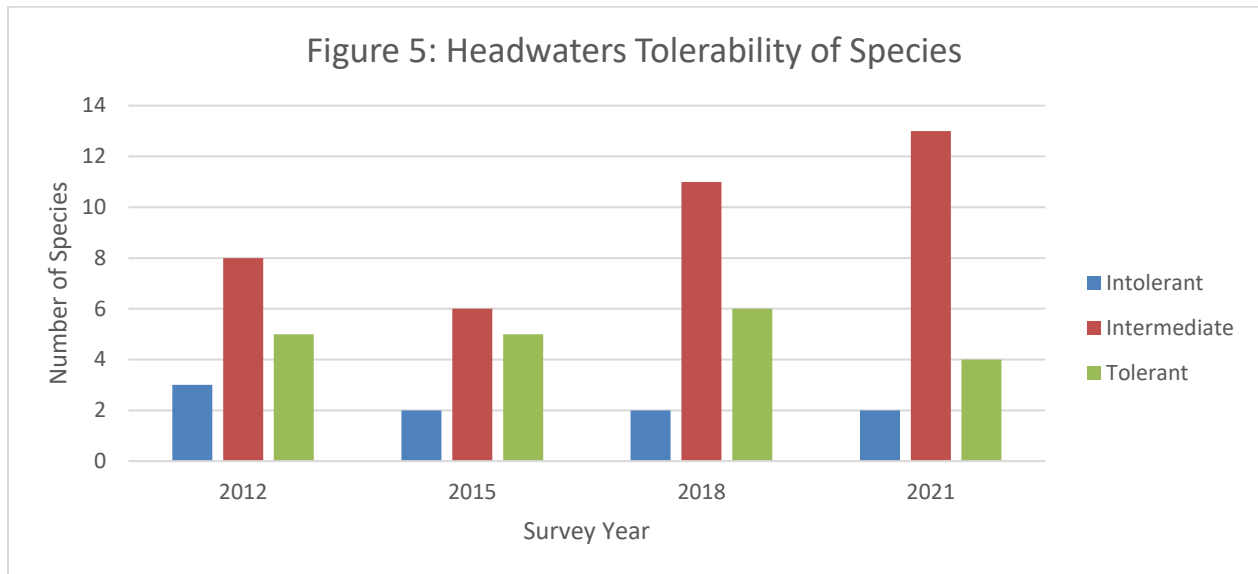


Figure 5: This graph compares the number of species per tolerance levels at the headwaters site from the 2012, 2015, 2018 and 2021 surveys.

Fish can also act as indicators of stream health based on the diets of the species present. Omnivores and generalist feeders can survive on many different food sources while insectivores need to have specific types and amounts of aquatic bugs to eat. Macroinvertebrates are good indicators of stream health, and their presence is determined by the water quality and habitat provided by the stream. It suggests then, that if a greater abundance and variety of insect eating fish are present in the stream, that there is a healthier macroinvertebrate population and a higher quality stream environment. Figure 6 compares the number of fish species in each trophic level at the Headwaters in 2012, 2015, 2018 and 2021. During the 2015 survey, no piscivores or herbivores were identified. Since fewer fish and fish species were identified this year, and numbers of fish in these trophic levels were small in 2012, it is hard to say whether habitat changed or whether sampling missed certain trophic levels during 2015. In 2012 the two fish species that accounted for these trophic levels were Central Stonerollers and stocked Brown Trout. In 2018, there was an overall increase in the diversity of trophic levels. In 2021 there was an increase in the number of insectivore species. This may indicate an increase in stream health.

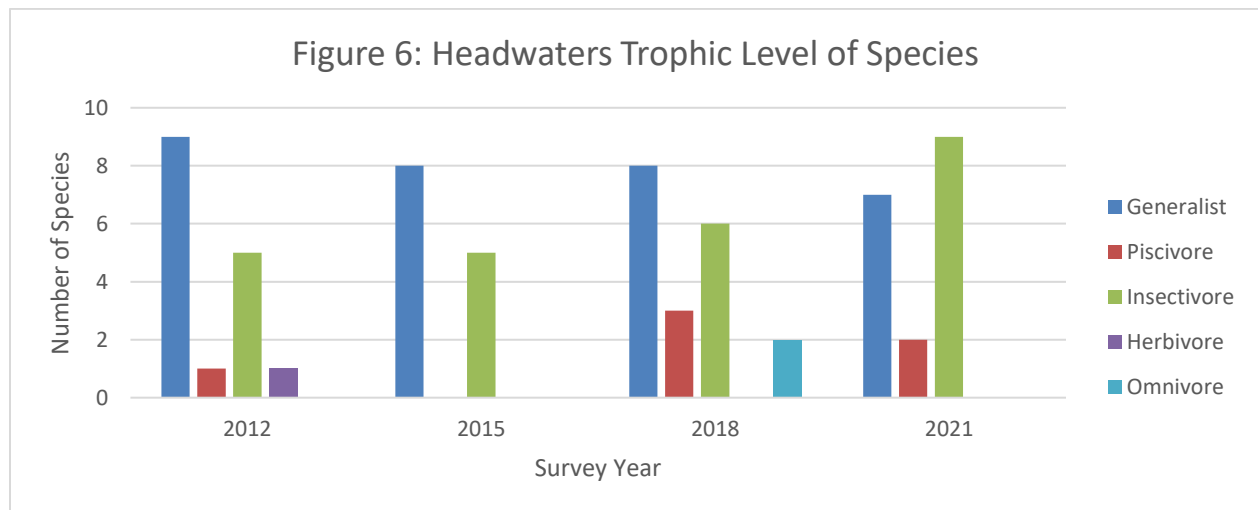


Figure 6: This graph compares the number of fish in each trophic level at the headwaters site from 2012, 2015, 2018, and 2021 surveys.

Hershey Meadows

The section of the Conewago Creek referred to as Hershey Meadows underwent a stream restoration project that began in 2009 on Hershey Trust Property. This project was designed to repair nearly a mile of eroded

stream banks and 15 acres of wetlands. The restoration was led by the U.S. Fish and Wildlife Service and the Tri-County Conewago Creek Association. On this site, steep banks were leveled out and log and rock structures were installed to increase fish habitat and stabilize the banks. Wetlands were restored in the floodplain to increase the site's infiltration capacity and reduce pollutants entering the stream. Twenty acres of native trees and shrubs were planted alongside the stream to create a forest buffer. The 2012 fish survey was the first survey to be conducted at this site following the completed restoration.

It appears from these results that the restoration project has been effective at increasing the diversity and intolerance of fish in this section of stream. The total number of species caught at this site doubled from 2007 (12 species) to 2012 (24 species) and further increased in 2018 to 28 species, although it dipped back down to 23 in 2021 (Figure 2). However, this suggests an increase in diversity of fish species overall. Figure 7 demonstrates how diversity is distributed between the different families. A decrease in minnow species was observed during the 2015 survey, likely attributable to the muddy water.

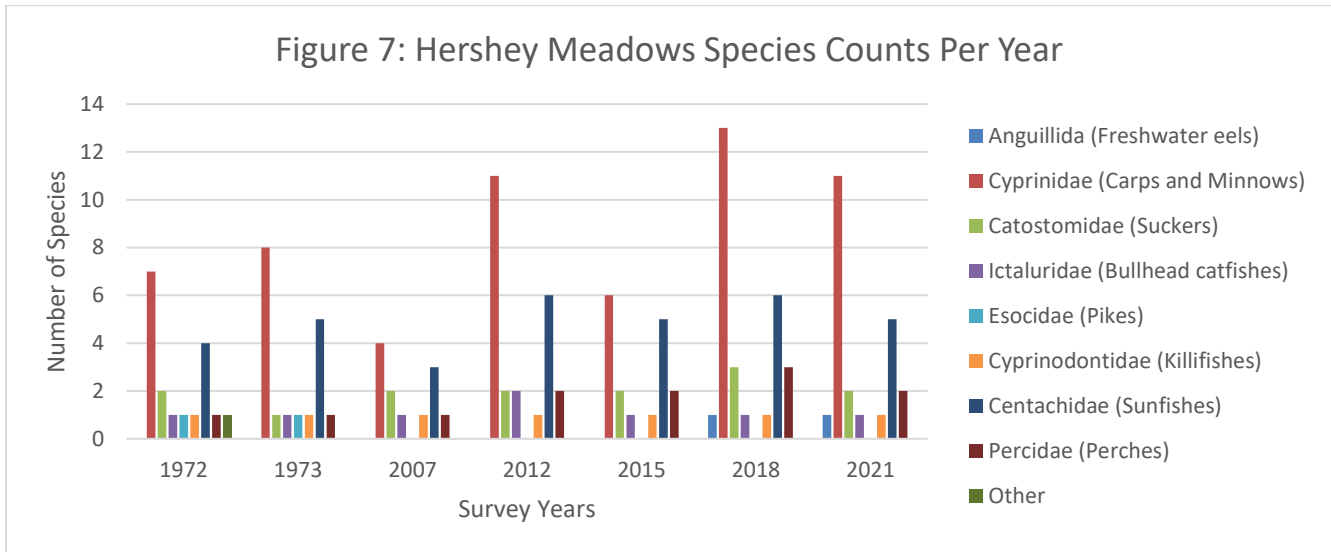


Figure 7: This graph compares the number of species within each family for the 7 years that sampling occurred at Hershey Meadows.

The number of intolerant species has increased and remained relatively constant following the restoration project as can be seen in Figure 8. This could be tied to an improvement in stream health due to the restoration project.

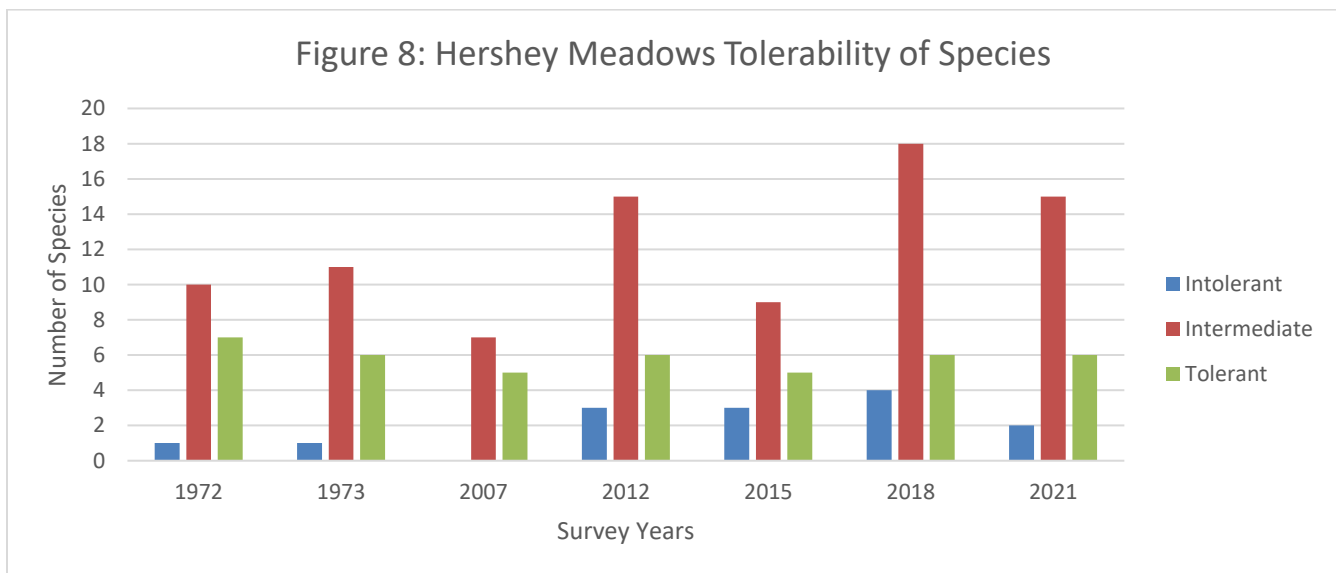


Figure 8: This graph shows the number of fish from Hershey Meadows identified as either tolerant, intermediate, or intolerant during the 7 sample years.

Figure 9 shows that there was a shift from a population dominated by generalists in 2007 to a population dominated by insectivores in 2012. This switch in dominant trophic level could demonstrate an improvement in macroinvertebrate habitat and water quality. In 2015 the insectivore population dropped but remained above 2007 levels. In 2018 the insectivore population is the dominant trophic level, and an increase in fish species diversity suggests that macroinvertebrate habitat has remained healthier since the restoration project was installed. In 2021, the insectivore population dropped below the generalist population as the dominant trophic level but remained above 2007 levels.

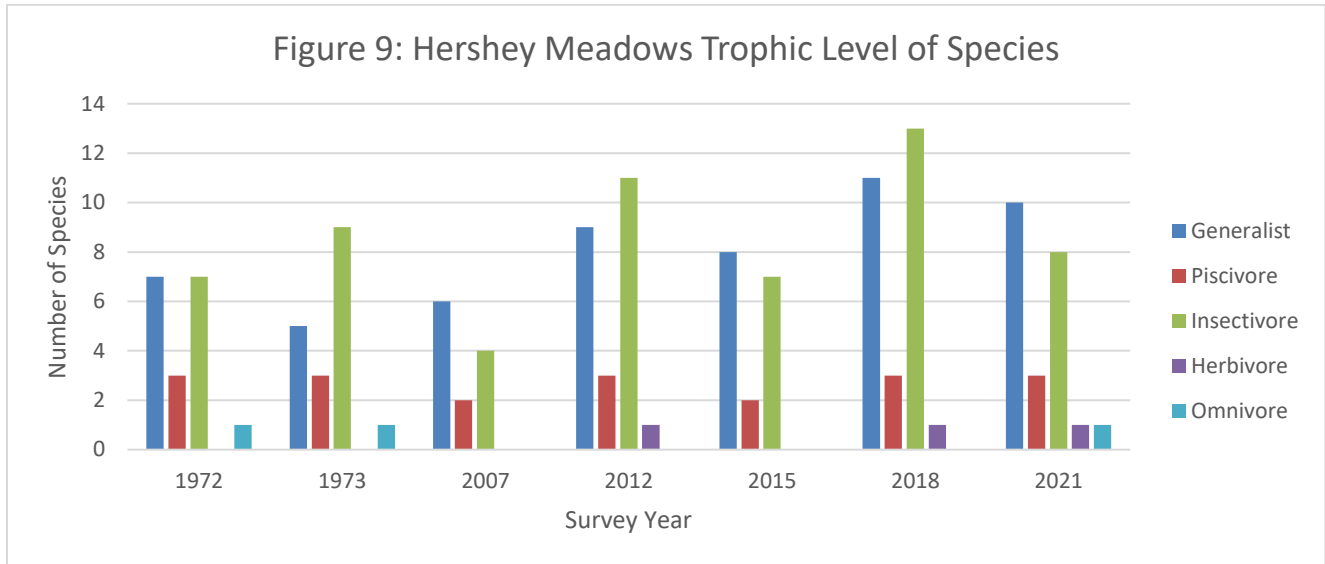


Figure 9: This graph shows the number of fish species identified at Hershey Meadows during the 7 sample years within each trophic level

Near the Mouth

Diversity of species at the mouth is higher today than it was in 1972 (18 versus 12 species). Although the number of species in the Minnow family has decreased since the 1973 survey, across the board there are more species per family today than there were in 1972 (Figure 10). 2012 had the highest level of diversity at 22 species.

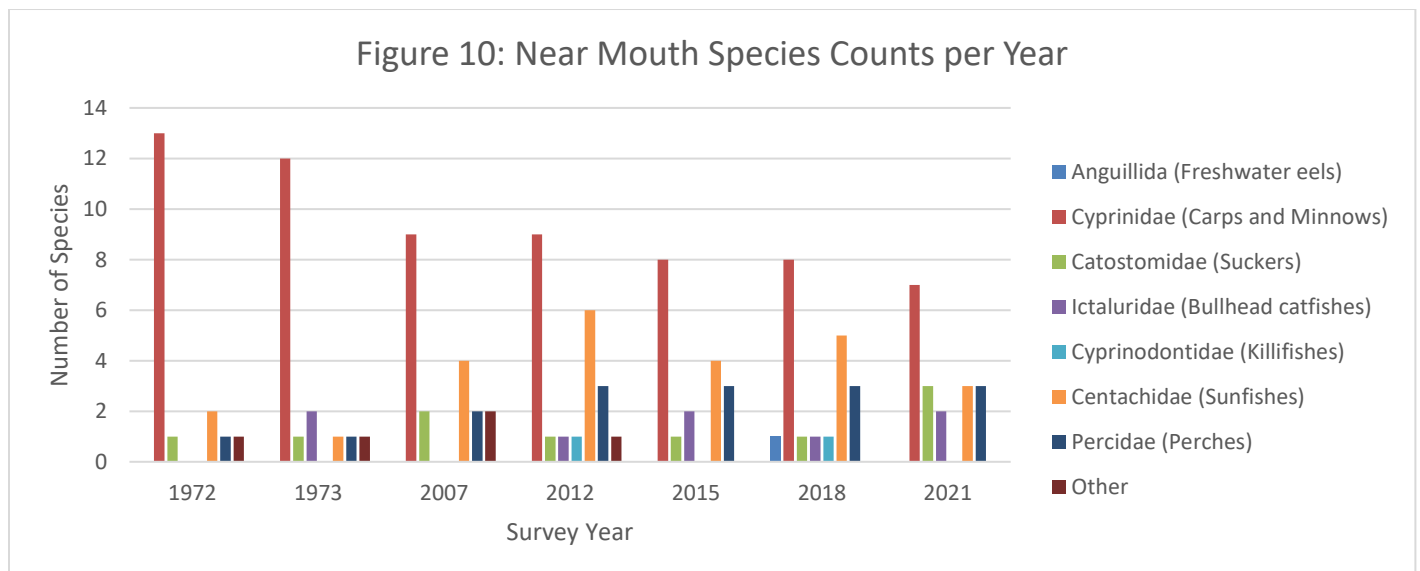


Figure 10: This graph compares the number of species within each family for the 7 years that sampling occurred near the mouth of the Conewago Creek.

Figure 11 shows the number of fish species per tolerance level near the mouth. Tolerant species continue to be higher than 2007 levels while intolerant species have managed to stay at similar levels.

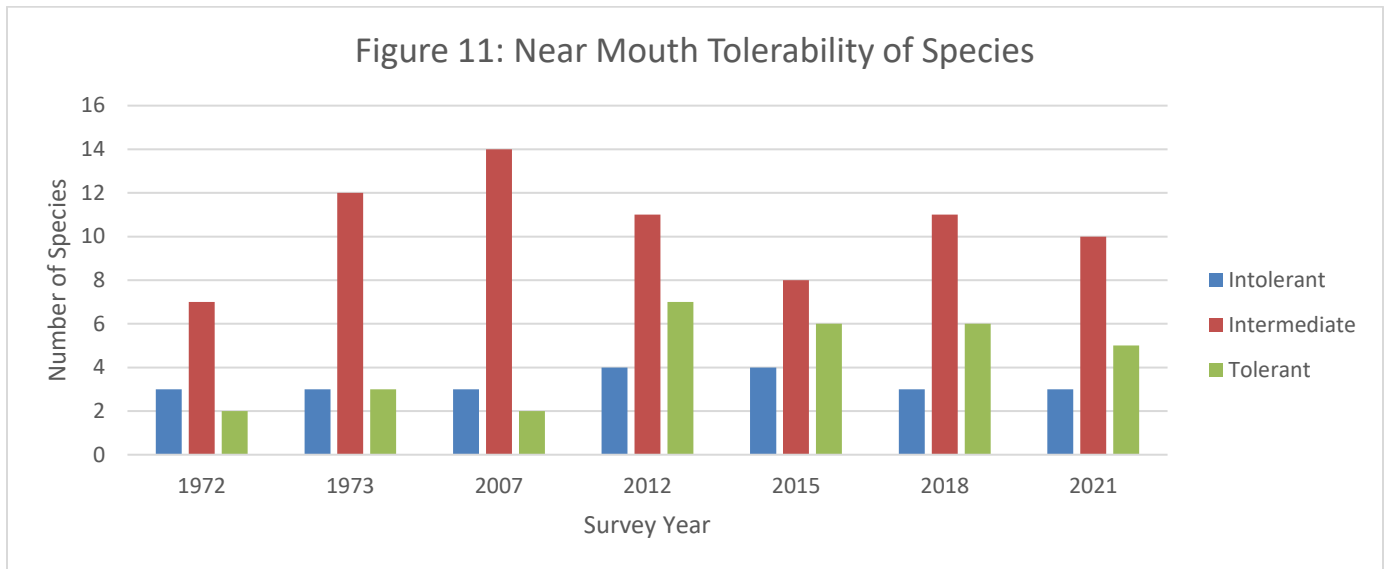


Figure 11: This graph shows the number of fish species from the sites near the mouth of the Conewago Creek identified as tolerant, intermediate, or intolerant during the 7 sample years.

During and prior to 2007, the fish population was dominated by insectivores. In more recent years the population has been dually dominated by insectivores and generalists. Piscivores have increased since 1972.

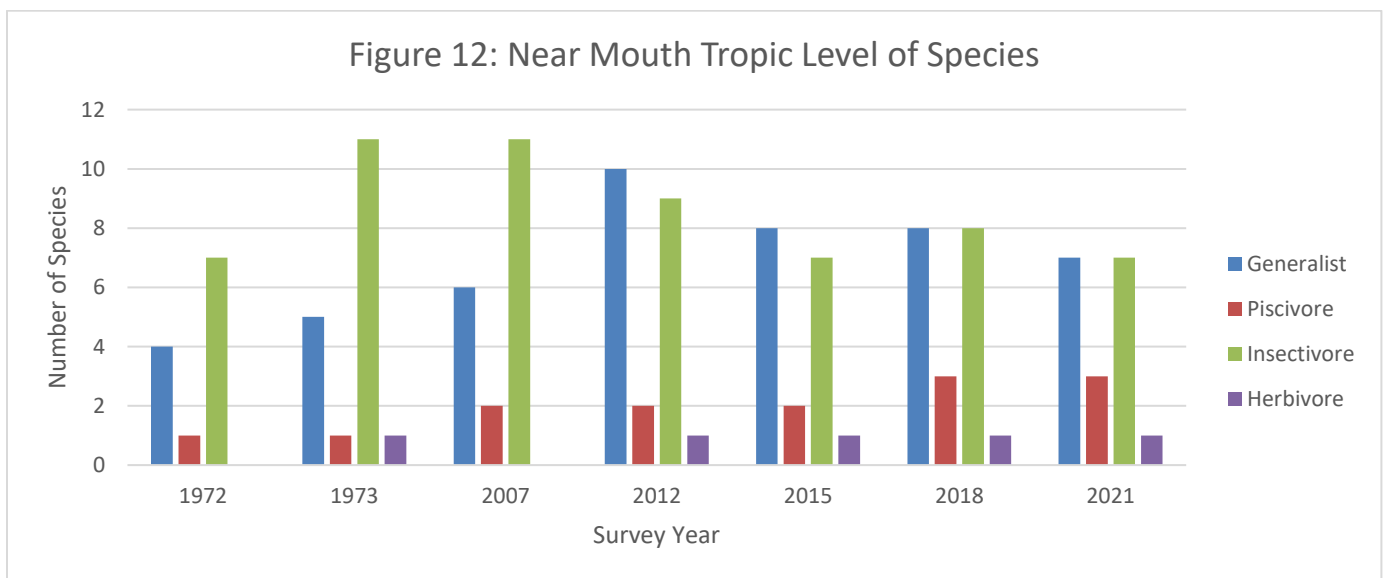


Figure 12: This graph shows the number of fish species identified at sites near the mouth of the Conewago Creek during the 7 sample years within each trophic level.

The fish population appears to have remained fairly stable since 2012. Trophic levels and tolerance levels have remained equivalent although there was an increase in the amount of piscivore species sampled in 2018 and 2021.

Sampling conditions have made sampling this site challenging which makes drawing conclusions on diversity and species composition impossible. Over the 7 sample years, the number of fish sampled has varied from 50 fish identified in 1972 to 640 fish in 1973. Additionally, high water in 2012 prevented the team from sampling both sides of the stream, and the muddy waters in 2015 and 2018 prevented thorough sampling. Prior to the 2021 survey, the bridge underwent construction, which deepened the stream channel, making it impossible to sample directly under the bridge. Length of stream sampled in the oldest surveys is unknown. The shift in sample locations from Hillsdale Rd to Covered Bridge Rd could also affect any noticeable trends. Future sampling will help solidify any conclusions that were made.

It is also worth noting that there were a considerable number of nonnative, rusty crayfish observed during the 2021 sampling that had not been observed before.

Comparison of 3 Surveys Completed in 2021

All three sites are showing similar fish population diversity and tolerability. Diversity is consistent at all three sites, with the Minnow family representing many of the species found at each site followed by sunfishes (Figure 13). Intermediate species are by far the most common tolerance level at all three sites followed by tolerant and then intolerant species (Figure 14). Generalists and insectivores are the most common trophic levels identified (Figure 15). The following graphs compare the three locations for the 2021 survey.

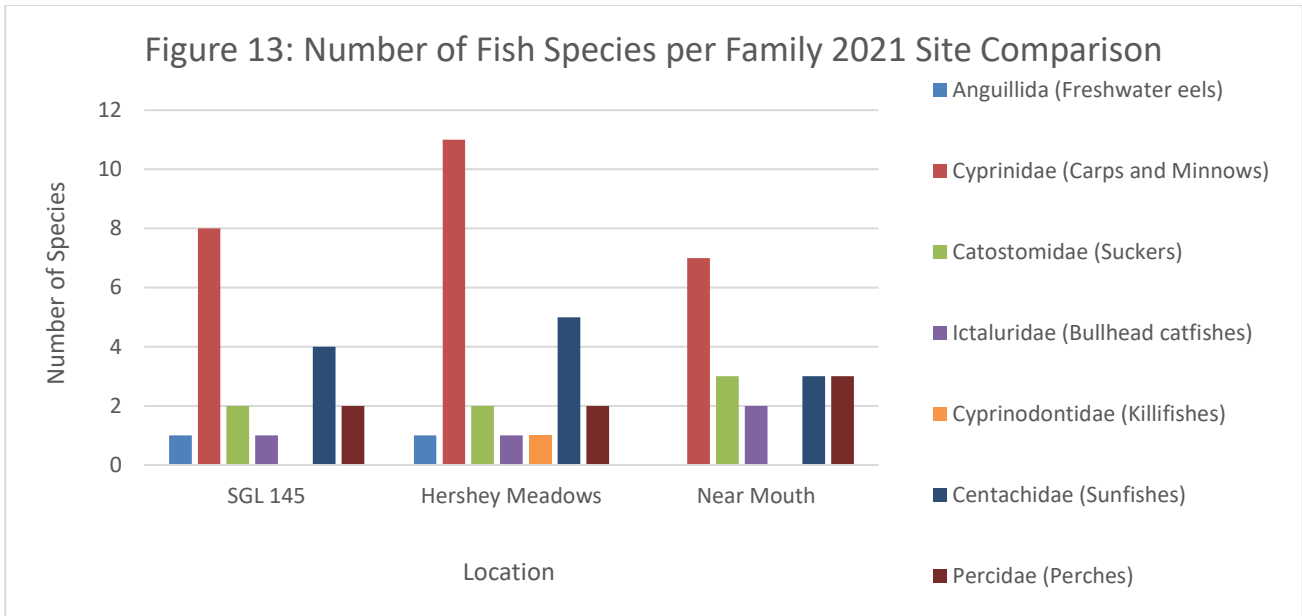


Figure 13: This graph compares the number of species within each family for the 3 sites that were surveyed in 2021.

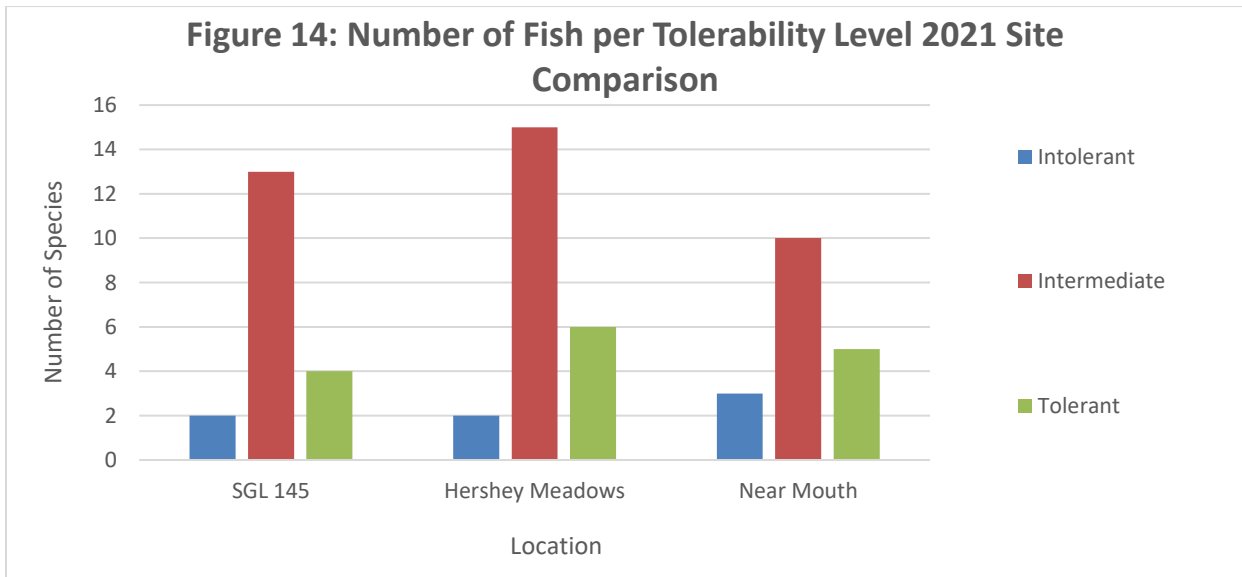


Figure 14: This graph shows the number of fish species broken down into tolerant, intermediate, and intolerant levels for the 3 sites surveyed in 2021.

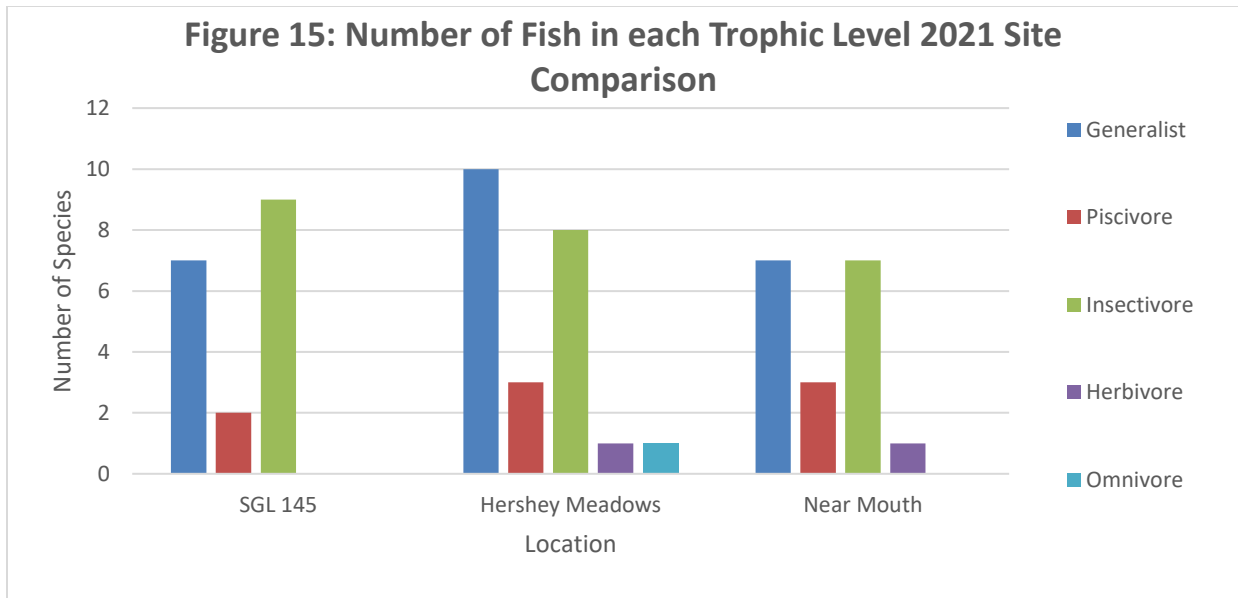


Figure 15: This graph compares the number of fish in each trophic level by each of the 3 sites for the 2021 survey.

Figure 16 shows the total number of fish species identified each year a survey has been conducted. As seen on the graph, there has been an average increase in total number of species since 1972 which could indicate an improvement in stream health. In 2021, 33 species of fish were identified.

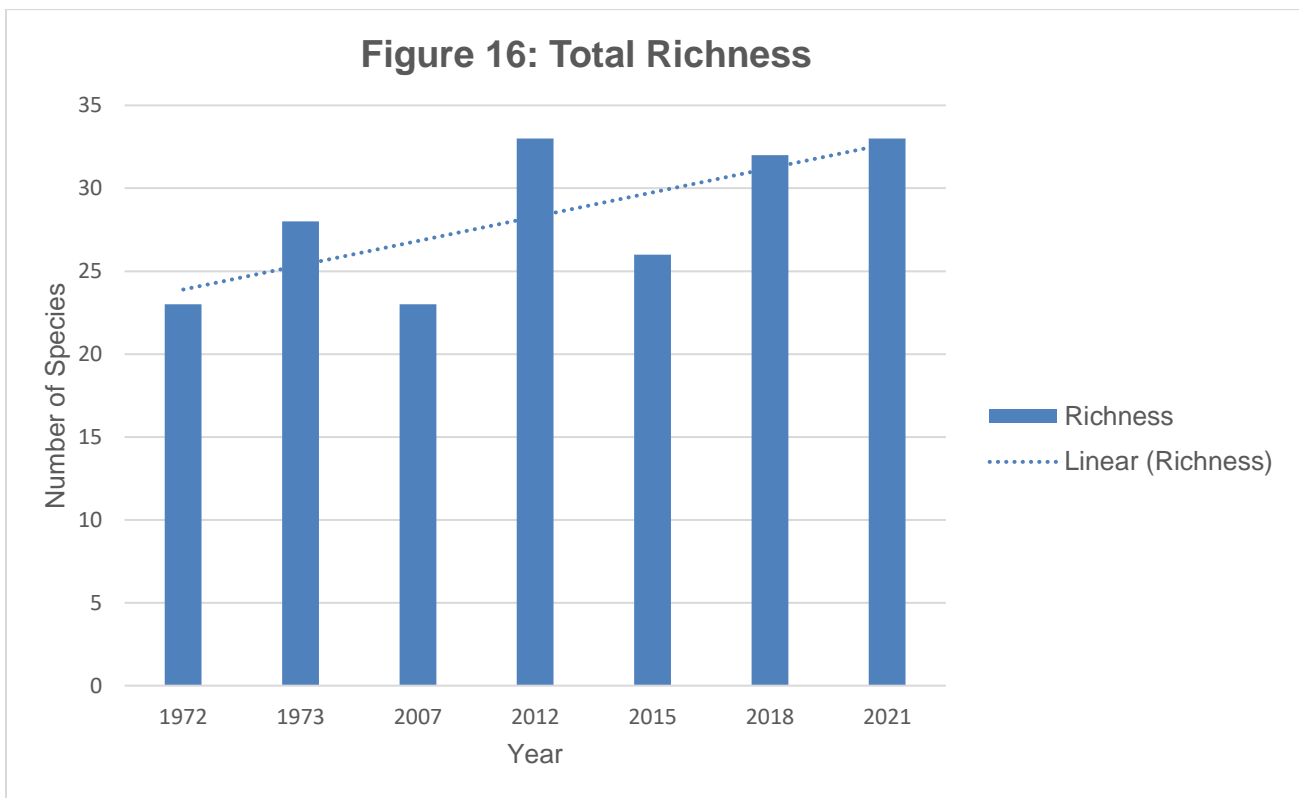


Figure 16: This graph shows the total number of species collected during the years that the survey took place.

During the 2018 and 2021 surveys, captured eels were weighed and measured to track progress following their release in 2016. The eel information collected during the 2018 and 2021 surveys is provided in Chart 4. When the eels were stocked in 2017, the average length was 122.3 mm and the average weight was 2.1 grams. All eels captured have shown growth since their release. Photo 1 is of the largest eel, captured in SGL 145 during the 2018 survey. Additionally, eels captured during the 2021 survey were given ID tags.

Chart 4: Eels Captured Since Release					
2018 Eels			2021 Eels		
Site	Length (mm)	Weight (grams)	Site	Length (mm)	Weight (grams)
SGL 145	254	14	SGL 145	*	*
SGL 145	660	454	Hershey Meadows	*	*
Hershey Meadows	254	28	Hershey Meadows	440	382
Hershey Meadows	317	113	Hershey Meadows	360	95
Hershey Meadows	285	38			
Hershey Meadows	290	40			
Covered Bridge	229	21			

Chart 4: This chart provides the recorded eel information gathered in the 2018 and 2021 surveys. (* indicate eel observed, but not captured)



Photo 1: largest eel captured during the 2018 survey.

During the 2021 survey, Swallowtail shiner (*Notropis procne*) and Redbreast sunfish (*Lepomis auratus*) were surveyed at the highest percentages at 21% and 18% respectively as can be seen in Chart 5. This is in comparison to White sucker (*Catostomus commersoni*) and Redbreast sunfish (*Lepomis auratus*) in the 2018 survey comprising 13% and 11% respectively.

Chart 5: Comparison of 2021 Fish Survey Results							
	Mouth	Hershey Meadows	Headwaters	Tolerability	Trophic Level	Total Number	Total Percent
Anguillida (Freshwater eels)							
Anguilla rostrata (American eel)		3	1	Intermediate	Piscivore	4	0%
Cyprinidae (Carp and Minnows)							
Campostoma anomalum (Central stoneroller)	2	5		Intermediate	Herbivore	7	1%
Cyprinus carpio (Common carp)		3		Tolerant	Omnivore	3	0%
Cyprinella analostana (Satinfin shiner)				Intolerant	Insectivore	0	0%
Cyprinella spiloptera (Spotfin shiner)	3	54	23	Intermediate	Insectivore	80	8%
Exoglossum maxillingua (Cutlips minnow)			18	Intolerant	Insectivore	18	2%
Luxilus cornutus (Common Shiner)		18	1	Intermediate	Insectivore	19	2%
Nocomis micropogon (River chub)				Intermediate	Insectivore	0	0%
Notemigonus crysoleucas (Golden shiner)	2	3		Tolerant	Omnivore	5	0%
Notropis hudsonius (Spottail shiner)		54	1	Intermediate	Insectivore	55	5%
Notropis rubellus (Rosyface shiner)	6	7		Intermediate	Insectivore	13	1%
Notropis procne (Swallowtail shiner)		183	26	Intolerant	Insectivore	209	21%
Notropis volucellus (Mimic shiner)	29	14		Intermediate	Generalist	43	4%
Pimephales notatus (Bluntnose minnow)	2	2		Tolerant	Generalist	4	0%
Pimephales promelas (Fathead minnow)			13	Tolerant	Generalist	13	1%
Rhinichthys atratulus (Blacknose dace)			50	Tolerant	Generalist	50	5%
Rhinichthys cataractae (Longnose dace)	5		24	Intermediate	Insectivore	29	3%
Semotilus atromaculus (Creek chub)				Tolerant	Generalist	0	0%
Semotilus corporalis (Fallfish)		28		Intermediate	Generalist	28	3%
Catostomidae (Suckers)							
Catostomus commersoni (White sucker)	5	78	13	Tolerant	Generalist	96	10%
Hypentelium nigricans (Northern hog sucker)	3	6	11	Intermediate	Generalist	20	2%
Moxostoma macrolepidotum (Shorthead)	1			Intermediate	Insectivore	1	0%
Ictaluridae (Bullhead catfishes)							
Ameiurus natalis (Yellow bullhead)	1	2		Tolerant	Generalist	3	0%
Ictalurus punctatus (Channel catfish)	1			Intermediate	Piscivore	1	0%
Noturus insignis (Margined madtom)			1	Tolerant	Generalist	1	0%
Salmonidae (Trouts)							
Oncorhynchus mykiss (Rainbow trout)				Intolerant	Piscivore	0	0%
Cyprinodontidae (Killifishes)							
Fundulus diaphanus (Banded killifish)		4		Tolerant	Insectivore	4	0%
Centarchidae (Sunfishes)							
Ambloplites rupestris (Rock bass)	9	18		Intermediate	Piscivore	27	3%
Lepomis auritus (Redbreast sunfish)		148	33	Intermediate	Generalist	181	18%
Lepomis gibbosus (Pumpkinseed)		1	2	Intermediate	Generalist	3	0%
Lepomis macrochirus (Bluegill)			2	Tolerant	Generalist	2	0%
Lepomis cyanellus (Green sunfish)	9	1		Tolerant	Generalist	10	1%
Micropterus dolomieu (Smallmouth bass)	2	31		Intermediate	Piscivore	33	3%
Micropterus salmoides (Largemouth bass)			1	Intermediate	Piscivore	1	0%
Percidae (Perches)							
Etheostoma blennioides (Greenside darter)	7	1	6	Intolerant	Insectivore	14	1%
Etheostoma olmstedii (Tessellated darter)	1	7	17	Intermediate	Insectivore	25	2%
Etheostoma zonale (Banded darter)	4			Intolerant	Insectivore	4	0%
Totals	92	671	243			1006	

Chart 5: This chart compresses Charts 1-3 to include only the 2021 data. Like charts 1-3, number of fish per species identified and the percentage of that count compared to the total number of fish identified at that site is shown. The tolerance and trophic designations of each fish species are also shown. The total count and percentage are shown in the right-hand columns.
*Percentages are presented as rounded numbers and will not equal 100% as presented in this chart.

Chart 6: Native Designations		
	Previous	2021
Anguillida (Freshwater eels)		
Anguilla rostrata (American eel)	Native	*
Cyprinidae (Carps and Minnows)		
Campostoma anomalum (Central stoneroller)	Native	*
Cyprinus carpio (Common carp)	Non	*
Cyprinella analostana (Satinfin shiner)	Native	
Cyprinella spiloptera (Spotfin shiner)	Native	*
Exoglossum maxillingua (Cutlips minnow)	Native	*
Luxilus cornutus (Common Shiner)	Native	*
Nocomis micropogen (River chub)	Native	
Notemigonus crysoleucas (Golden shiner)	Native	*
Notropis amoenus (Comely shiner)	Native	
Notropis hudsonius (Spottail shiner)	Native	*
Notropis rubellus (Rosyface shiner)	Native	*
Notropis procne (Swallowtail shiner)	Native	*
Notropis volucellus (Mimic shiner)	Non	*
Pimephales notatus (Bluntnose minnow)	Native	*
Pimephales promelas (Fathead minnow)	Non	*
Rhinichthys atratulus (Blacknose dace)	Native	*
Rhinichthys cataractae (Longnose dace)	Native	*
Semotilus atromaculus (Creek chub)	Native	
Semotilus corporalis (Fallfish)	Native	*
Catostomidae (Suckers)		
Catostomus commersoni (White sucker)	Native	*
Hypentelium nigricans (Northern hog sucker)	Native	*
Moxostoma macrolepidotum (Shorthead redhorns)	Native	*
Ictaluridae (Bullhead catfishes)		
Ameiurus natalis (Yellow bullhead)	Native	*
Ameiurus nebulosus (Brown bullhead)	Native	
Ictalurus punctatus (Channel catfish)	Native	*
Noturus insignis (Margined madtom)	Native	*
Esocidae (Pikes)		
Esox niger (Chain pickerel)	Native	
Cyprinodontidae (Killifishes)		
Fundulus diaphanus (Banded killifish)	Native	*
Salmonidae (Trouts)		
Oncorhynchus mykiss (Rainbow trout)	Non	
Salmo Trutta (Brown trout)	Non	
Centachidae (Sunfishes)		
Ambloplites rupestris (Rock bass)	Non	*
Lepomis auritus (Redbreast sunfish)	Native	*
Lepomis cyanellus (Green sunfish)	Non	*
Lepomis gibbosus (Pumpkinseed)	Native	*
Lepomis macrochirus (Bluegill)	Non	*
Micropterus dolomieu (Smallmouth bass)	Non	*
Micropterus salmoides (Largemouth bass)	Non	*
Percidae (Perches)		
Etheostoma blennioides (Greenside darter)	Native	*
Etheostoma olmstedti (Tessellated darter)	Native	*
Etheostoma zonale (Banded darter)	Non	*
Stizostedion vitreum (Walleye)	Native	

Chart 6: This chart includes all the species that have been identified in the sampling years (while excluding species placed in the “other” category) and indicated their designation as native or non-native to the Susquehanna River basin. It also indicated which of these species were found in the 2021 survey.

There have been 41 combined species identified in the years since the study has begun, excluding those in the “other” category. Of those, 31 are native to the Susquehanna River Basin and 9 are non-native. During the 2021 survey, 33 species were identified, with 24 being native and 9 being non-native as seen in chart 6.

Conclusion

Overall, all three sites are demonstrating similar fish population diversity and tolerability. Total richness continues to increase across the watershed which is a good sign. Due to the significant amount of rain received before the 2015 and 2018 samplings, species counts were likely lower than if there had been ideal sampling conditions. Additionally, the deepening on the stream channel near the mouth in 2021, due to bridge construction at the sampling site, may have resulted in lower species counts, as the added depth made sampling difficult. These results are continuing to build a trend that is needed to judge improvement as restoration projects continue.