

## **GROUNDWATER AS A SOURCE OF EMERGING CONTAMINANTS IN THE CHESAPEAKE BAY**

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Since 2005, high young-of-year natural mortality rates and declines in adult indices of abundance have been observed in some smallmouth bass populations in the Susquehanna River Basin. Endocrine disrupting compounds (EDCs) are hypothesized to be a contributing factor to the observed population dynamics. In order to better understand these compounds in the environment and their effects on fish populations, further research is needed to understand potential exposure pathways. In particular, there is a paucity of information on the role of groundwater as a source of EDCs for aquatic organisms. In fact, current research at river sites throughout the Chesapeake Bay Watershed, including in Pennsylvania - where surface water, stream sediment, and adult/young-of-year smallmouth bass are sampled for contaminants - led to the hypothesis that groundwater could be a potential exposure pathway for EDCs. Therefore, the objective of this research was to investigate the role of groundwater as a source of emerging contaminants in areas of known smallmouth bass spawning and rearing activity. Using thermal cameras to locate areas of groundwater upwelling, we sampled groundwater using drive-point piezometers at three locations, two located in the Susquehanna River Basin and one in West Virginia. Samples of ground and surface water were collected biweekly during smallmouth bass spawning season and monthly through September 2017. As an initial water chemistry screening tool, total estrogenicity was quantified through a bioluminescent yeast estrogen screen to use as an indicator of the presence of estrogenic EDCs. Preliminary analyses suggest that groundwater samples may be an important pathway of exposure, especially given the use of these areas for spawning by smallmouth bass.

*Keywords: groundwater, emerging contaminants*

## **BATHYMETRY OF FAYLOR LAKE USING GROUND PENETRATING RADAR AND SUB-METRIC GPS SYSTEMS**

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Sediment accumulation poses the problem of decreased water storage in man-made reservoirs. The optimal way of identifying the topography and sediment levels in a lake is to use ground penetrating radar (GPR). This study was conducted using a GSSI SIR3000 and a 100MHz antenna combined with a high resolution sub-metric GPS system. The GPR antenna was placed in an inflatable boat powered by an electric trolling motor. A total of 19 transects were performed along the entire length of the lake and a three-dimensional bathymetry and sediment accumulation models was performed. Both water and sediment deposit volume were defined using a grid volume computation. Both The bathymetry, volume of sediment, and its accumulation rate were estimated.

*Keywords: Bathymetry, GPR, Ground Penetrating Radar*

## **PRELIMINARY SURVEY FOR LYCOMING COUNTY CONSERVATIONAL DISTRICT'S WOLF RUN RESTORATION PROJECT**

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The Lycoming County Conservational District is preparing to start restoration projects at 4 sites along Wolf Run in Muncy, PA. The restoration projects are needed because of the historical use of agriculture, limited or absent riparian buffers in the agricultural areas, conservation farming practices are limited, and there is a high rate of bank erosion. In 2013, the DEP completed a TDML (Total Maximum Daily Load) for the Wolf Run Watershed. In this document, the DEP recommended putting in: stream bank stabilizations, riparian buffers, heavy use area protection, and manure storage. The project designed is going to stabilize 2,880 feet of stream bank and will prevent high amounts of nutrients and sediments from entering the Wolf Run Watershed. Clean Water Institute Interns were tasked with completing a survey prior to the start of the restoration projects. This survey included, water chemistry, coliform sampling, fisheries survey, and macroinvertebrate samples were taken. The fisheries survey was only completed at the most upstream site. With the water chemistry data, we found that pH goes in a steady decline when going downstream, Alkalinity increases going downstream, and Orthophosphate and Phosphorous both decrease going downstream. The fisheries survey showed that there were 9 species of fish present, and that the largest fish was 15cm in length. An Index of Biological Integrity showed that none of the sites are impaired biologically, however the sites are very close to being impaired. The Lycoming County Conservational District is planning to finish this project in the fall of 2018.

*Keywords: CWI, Stream Restoration*

## **BIOLOGICAL EFFECTIVENESS OF INSTREAM RESTORATION**

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Agriculture can negatively influence stream ecosystems through a variety of means including increased sedimentation, increased runoff of pesticides and nutrients, and contamination of local groundwater. Loss of water quality can decrease in-stream habitat availability resulting in a shift in fish and benthic macroinvertebrate assemblages. In recent years, many farmers have become more receptive to adopting environmentally friendly agricultural practices. A variety of best management practices have been used by farmers, including restricting livestock access to the stream, enlarging riparian buffers, and using less harmful pesticides and fertilizers in general or at more effective times. Efficacy of these management practices has not been well-studied enough to determine ecological benefits to stream species. In conjunction with the Conservation Districts in Montour, Northumberland, and Union counties, 11 local farmers and residents agreed to have 16 riparian habitat restoration projects constructed on streams that run through their property. To determine the biotic response to stream bank restoration, we conducted pre- and post-restoration sampling from 2015-2017. Stream assessments consisted of benthic macroinvertebrate sampling according to Pennsylvania Department of Environmental Protection protocol, backpack electrofishing a 100-m site to determine the amount of fish species present, and collection of standard water chemistry data for comparative analysis. We have found increase in aquatic species abundance post-restoration, likely due to decreases in sedimentation, increases in habitat availability, and less stormwater runoff. Our results suggest that simple streambank restoration projects and best management practice plans could improve the health our not only local watersheds, but also to the Susquehanna Watershed and even the Chesapeake Bay.

*Keywords: farm, stream, restoration, agriculture*

## **WHAT IS THE MOST ACCURATE WATER QUALITY INDEX FOR STREAM WATER ASSESSMENT: A CASE OF FIVE HEADWATER STREAMS IN BALD EAGLE STATE FOREST**

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Water quality index (WQI) uses many weighted, measurable parameters to give one number that reflects how good the water is. WQI is a standard approach to evaluate and compare results of different streams because of its concise form. The correct WQI expression for a specific stream can be challenging and requires a good stream water quality knowledge. In this study, five Penns Creek headwater streams in the Bald Eagle State Forest, PA were selected and assessed with five different WQI to evaluate the specific expression that can be used for these streams. A set of water quality data from each stream was collected from June 2015 to July 2017, has been used and the correct expression was identified. Using different WQI expressions, revealed a range of values from 80 to 100 making it ranked between good and excellent quality. Since the WQI is meant for drinking water, the normalization factors of some of the parameters, pH, temperature, and Biochemical Oxygen Demand (BOD5), are excessively lowered. Due to the nature of the natural headwater characteristics, some parameters do not need to be assessed. Using this experimental site that is known to have a high water quality, with little to no human impact, the WQI has been rearranged taking in consideration the following factors: 1) the range of the pH has been expanded to more acidic and basic water 2) the range of temperature lowered for colder water 3) excess parameters, like BOD5 and ion concentration removed to lower cost of assessment.

*Keywords: Water Quality Index, headwater*

## **CHANNEL SEDIMENT CHANGES DURING A STREAM RESTORATION PROJECT**

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Streams and rivers with compromised riparian zone, especially those along agricultural landscapes, are particularly susceptible to an increased buildup of stream bottom sediment. An abundance of fine sediment within a stream system can congest the water, potentially smothering fish species, aquatic insects and oxygen producing plants. The Chesapeake Conservancy developed a stream restoration prioritization tool to identify properties based on lack of riparian forests, neighboring land use, and hydrologic flow paths. This tool was used to select sites for stream restorations. We are monitoring these sites and others to build a reference profile of the grain size characteristics of streams that are pristine trout streams to agriculturally impaired stream bottoms. We will compare the grain size statistics from before restoration projects are implemented with samples collected after the restoration. We hope to also analyze the relationships between stream bottom sediment characteristics and biological monitoring to determine if there are relationships between good stream habitat and its sediment profiles.

*Keywords: stream restoration, sediments, mean grain size, habitat improvement*

## **LANDSCAPE CHARACTERISTICS THAT CONTRIBUTE TO SUCCESSFUL STREAM RESTORATION PROJECTS**

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Riparian zone management practices influence the ecological issues attributed to agricultural land use and environmental quality. Geographic Information Systems can be utilized to prioritize areas adjacent to waterways that are used for agricultural purposes and have high rates of runoff where no riparian zone is present. The Chesapeake Conservancy has developed a prioritization tool that identified sites on Elk Creek, Spring Creek, and Pine Creek in Central PA for restoration. Using this priority tool for selecting sites, we are monitoring sites as stream restoration projects are begun. We wish to compare site-specific measurements of fish populations, macro-invertebrate populations, and stream sediment characteristics with the prioritization weights to determine whether sites selected using GIS tools can be significantly improved after stream restoration projects.

*Keywords: stream restoration, landscape analysis, GIS, habitat improvement*

## **QUANTIFICATION AND COMPARISON OF PHYTOPLANKTON COMMUNITIES AND MORTALITY DYNAMICS BETWEEN TWO SMALL FRESHWATER LAKES: IMPLICATIONS FOR THE EFFECTS OF ANTHROPOGENIC INFLUENCE ON FRESHWATER PHYTOPLANKTON ECOLOGY**

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The classification of phytoplankton mortality dynamics is an expanding field of research that contributes extensively to our knowledge of primary production and energy flow in aquatic environments. Although the practice of determining growth and grazing rates of microalgae has existed since the 1980's, the majority of present literature examines the marine or estuarine environment exclusively, leaving a noticeable lack of research surveying freshwater communities. This study aimed to contribute to this gap of data by documenting and comparing the community compositions and mortality dynamics of phytoplankton in two small freshwater lakes. Our study consisted of 6 paired dilution experiments conducted on Walker and Faylor Lakes of Snyder County Pennsylvania between September and October of 2017. Using methods of digital spectrophotometric analysis, Guava flow cytometry, and FlowCAM image assessment, we quantified and compared the bulk and size-specific phytoplankton growth rates, bulk microzooplankton grazing rates, and size/fluorescence-based community compositions between the two freshwater lakes. Due to variations in the biotic and abiotic conditions driven by anthropogenic pollution and direct manipulation, the community compositions and dynamics are predicted to vary significantly between the two lakes. The determination of phytoplankton mortality and community compositions in this study will ultimately allow for broader inferences on both the overall health of the lakes and the flow of energy/carbon within them.

*Keywords: freshwater phytoplankton, dilution experiment, mortality dynamics, community composition*

## **ASSESSMENT OF BROOK TROUT PASSAGE THROUGH AMBIGUOUS CULVERT BARRIERS IN PENNSYLVANIA HEADWATER STREAMS**

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Habitat fragmentation driven by human activity is a common threat to aquatic organisms. Road culverts in particular can isolate fish populations and reduce genetic diversity by preventing access to upstream spawning habitat. The prioritization process for removing culverts and restoring connectivity includes an assessment of passibility. Culverts often receive scores that categorize them as partial barriers, known as "Reduced AOP" culverts, however detailed assessment of passibility on gray culverts is lacking. To fill this research gap, we used stationary PIT-tag readers to investigate brook trout passage through two "No AOP" culverts, one "Reduced AOP" culvert, and a reference stream lacking a culvert for 16 months in Little Bear Creek of Lycoming Co., PA. Results indicate significant differences in upstream movement rates among culvert sites. The rate of upstream passage was five times greater through the metal corrugated culvert than the reference stream. In contrast, relatively little upstream movement occurred through the two box culverts (up to 13 times less passage than the reference), indicating drastic passage differences in culverts receiving similar passibility scores. Our study implies that more nuanced culvert classifications may be needed to accurately reflect fish passage.

*Keywords: brook trout, culvert, habitat fragmentation, pit tag*

## **POLYPHOSPHOROUS STORAGE DYNAMICS IN STREAM BIOFILMS**

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How algal-dominated biofilms in streams respond to phosphorus (P) enrichment and store polyphosphate (Poly-P) has not been fully elucidated. Understanding the dynamics of how P is stored as Poly-P can have various implications for assessing nutrient status and criteria of agriculturally impacted streams. The purpose of this study was to compare the Poly-P concentration of algal dominated biofilms across a gradient of P conditions in 19 Pennsylvania streams. SRP concentrations varied from 2 mg/L to 20 mg/L. Other variables were sampled as well to investigate their influence on Poly-P storage. Preliminary Poly-P data from an artificial stream experiment suggests that algae treated with high concentration phosphorus pulses had greater polyphosphate content.

*Keywords: polyphosphorous, phosphorus, agriculture*

## **DO STREAM RESTORATION PROJECTS CHANGE CARBON AND NITROGEN DYNAMICS IN THESE STREAMS?**

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Pennsylvania is known for its river life. Property owners in the upper Susquehanna River basin in particular, take pride in any flowing water on their land. When these streams are degraded, conservancies and government agencies can provide help to landowners to install plantings, materials, devices and earth-moving to restore the stream channel. These strategies attempt to anchor sediments, re-vegetate the stream bank, remove nutrients from runoff, provide shade to the channel, and add structures that improve the stream bottom for improved fish and insect habitat. A stream prioritization tool from the Chesapeake Conservancy identified properties on Elk Creek in Central PA as a priority for restoration based on new hi-resolution land cover, flowpath analysis, and stream forests. Carbon and nitrogen in both stream water and stream sediments are being monitored during the stream restoration to determine if these concentrations change during after the stream channel is improved. By examining a range of PA streams, the carbon:nitrogen ratio of stream waters are about 44 for mountain trout streams while severely impaired streams have a ratio of about 1. In sediments, these ratios are 17 for pristine streams and <1 in severely impaired streams. We are monitoring these ratios at 4 sites along Elk Creek to determine if this ratio can be improved following a stream restoration.

*Keywords: stream restoration, carbon nitrogen ratio, water quality, habitat improvement*

## **THE EFFECTS OF ROAD SALT ON SPOTTED SALAMANDERS (*AMBYSTOMA MACULATUM*) AND WOOD FROGS (*LITHOBATES SYLVATICUS*)**

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The majority of the United States employs the use of road de-icing salts - primarily NaCl - during the winter and early spring months. As a result, much of the runoff from roads into roadside and forested vernal pools contains road de-icing salts. Many amphibian species live at least a portion of their lives in these vernal ponds, including spotted salamanders (*Ambystoma maculatum*) and wood frogs (*Lithobates sylvaticus*). Because amphibians are the most threatened group of vertebrates and are important biotic elements of both terrestrial and aquatic ecosystems, it is crucial to determine the impact of road salt on amphibians. We hypothesized that salt would delay hatching in both amphibian species. Additionally, we hypothesized that salt would negatively affect predatory insects, thus decreasing predation on both species. Lastly, we predicted that salt would increase competition between the two species by reducing the amount of invertebrates available for consumption. During the spring and the summer of 2017, we conducted an outdoor mesocosm experiment in which we created eight experimental conditions: presence/absence of NaCl (1000 mg/L Cl<sup>-</sup>), presence/absence of interspecific competition between the two species, and presence/absence of predatory dragonfly nymphs (Family *Libellulidae*). So far, our experiment has revealed that salt delayed hatching and increased deformity in spotted salamander hatchlings. Additionally, we have found that salt increases tail size in wood frog tadpoles. Overall, our data suggest that the application of road de-icing salt has many far-reaching impacts on amphibians and their ecosystem.

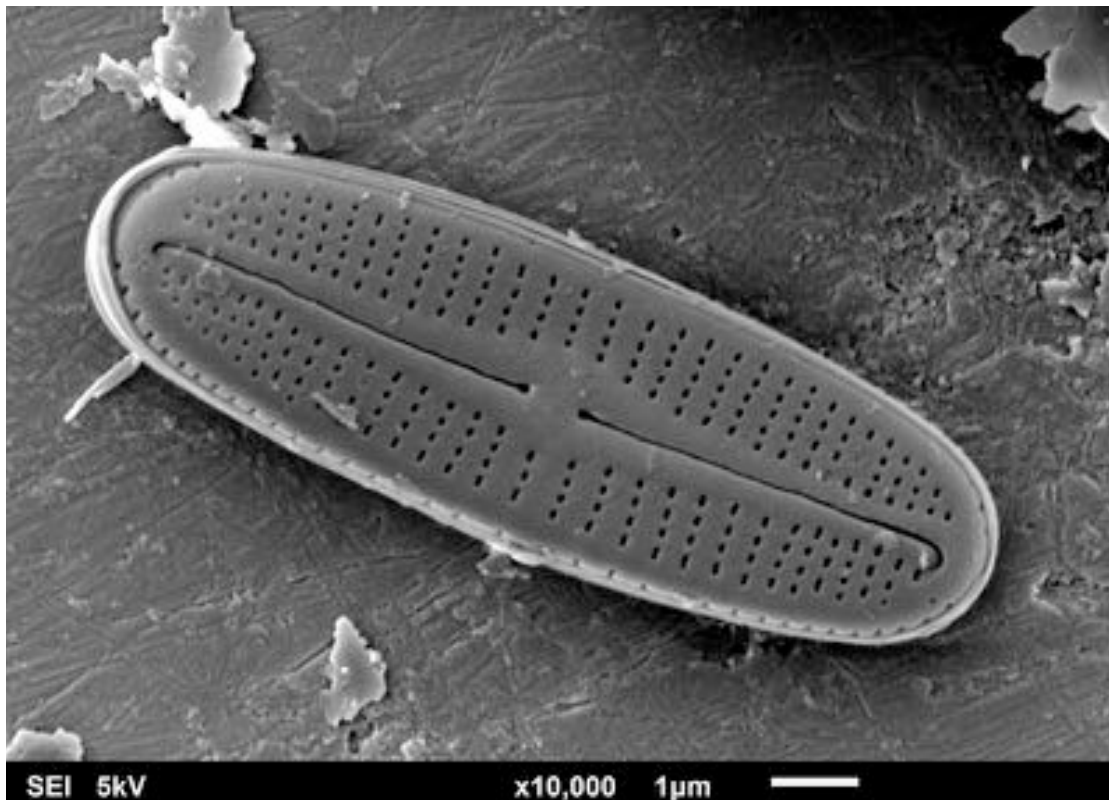
*Keywords: ecology, amphibians, road salt*

## A STUDY OF DIATOM COMMUNITIES OF THE UPPER MAIN STEM OF THE SUSQUEHANNA RIVER DURING SUMMER 2017

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The upper main stem of the Susquehanna River is formed by the confluence of the West and North Branch, both of which are chemically and physically distinctive. The upper main stem retains the signatures of the two branches due to weak lateral mixing, and we refer to them as the West Branch plume (WBP) and the North Branch plume (NBP). Thus, characterization of the diatom communities requires samples taken from sites that occur in the plumes of both branches. Since 2009, we have monitored the upper main stem at an established transect that straddles Byers Island near Shamokin Dam, PA and below the Adam T. Bower inflatable dam at Sunbury, PA. Attached diatom communities were sampled from stones which were prepared for examination by scanning electron microscopy. The Pollution Tolerance Index (PTI) and Shannon Diversity Index (SDI) values showed very little variation between all sites (2.38-3.03 and 2.35-2.93). We found the greatest species richness in the diatom communities of the NBP (Site 3- 30; Site 4- 29). Proportional Bray-Curtis Similarity analyses of samples showed low to moderate overlap between the diatom communities. Across all sites we identified 57 different species. Habitats of the NBP were dominated by *Discostella pseudostelligera* (a small centric), *Rhoicosphenia abbreviata* (a biraphid), and *Achnantheidium minutissium* (a small monoraphid). Similar habitats of the WBP were dominated by *Ach. minutissium*, *Encyonema appalachianum* (a biraphid). Despite similarities between 2014 and 2017 regarding discharge, the diatom communities were depauperate this year (57 taxa; 104,470 cfs) compared to other high discharge summers (June, July, and August) especially 2014 (93 taxa; 80,590 cfs). Difference in taxa richness could possibly be explained by lingering effects of a prior low discharge year (2016- 36,562 cfs).

*Keywords: diatoms, biofilms, Susquehanna River*





## **A STUDY OF DIATOM COMMUNITIES AT 5 SMALL HEADWATER STREAMS IN CENTRAL PENNSYLVANIA, DURING SUMMER OF 2017**

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The diatom communities at 5 headwater streams that flow through Bald Eagle State Park on Penns Creek Mountain were examined. From June to August of 2017, weekly water samples were collected at Little Weikert Run, Coral Run, Green Gap Run, Lick Run, and Henstep Run. The surrounding geology and land use of each stream are extremely similar, resulting in very low variability in the chemical and physical properties of the streams. Conductivity remained low (17-26  $\mu\text{m}/\text{cm}$ ); buffering capacity ranged from 50 to 200  $\mu\text{eq}/\text{L}$ , and pH rarely exceeded 6.00. Biofilms were collected from headwater cobbles, and diatoms were removed chemically. Cleaned diatom valves were counted and identified to species using a JEOL 6010 LV Scanning Electron Microscope (SEM). The number of species found in 300 valves ranged from 30 to 35, and the Shannon Diversity index ranged 2.2-3.1. The Pollution Tolerant Index (PTI) of the streams did not exceed 3, which falls in the relatively pollution intolerant range. Generic Diatom Index (GDI), the European equivalent to PTI, ranged from 16 to 18, which also falls in the pollution intolerant range. The Trophic Diatom Index (TDI) supports the oligotrophic nature of the sites with values that ranged 19-39. Despite the similar measurements and metrics, the diatom community similarity generated by the Proportional Bray-Curtis Similarity algorithm showed very low to low overlap (0-39%) between the majority of the stream comparisons, and moderate overlap in taxa (40-59%) between Lick Run and Green Gap Run, Lick Run and Coral Run, and Coral Run and Henstep Run. Although the players (diatom taxa) vary from stream to stream, the stories defined by diatom metrics remain the same for these small headwater streams.

*Keywords: diatom, biofilm, headwater stream*





## COMPARISON OF FIVE SIMILAR HEADWATER STREAMS IN CENTRAL PENNSYLVANIA DURING THE SUMMER OF 2017

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We compared the benthic macroinvertebrate (BMI) communities between the five headwater streams that flow down the north slope of Penn's Creek Mountain in Bald Eagle State Forest through the summers of 2015 to 2017. The five headwater streams, Little Weikert Run, Green Gap Run, Lick Run, Coral Run, and Henstep Run are similar in size and substrate (sand, cobble, and boulder) and maintained flow even through the drought conditions of 2016. Alkalinity averaged 72, 190, 178, 205 and 122  $\mu\text{eq/L}$  during the three year study for each of the headwater streams, respectively. They were also similar in conductance averaging 18, 26, 23, 25, and 22  $\mu\text{s/cm}$ , respectively. The %EPT (Ephemeroptera, Plecoptera, Trichoptera), for the five headwaters ranged from 52-75% during the summer of 2017, which given the sites is unexpectedly low. We collected the BMI during the first half of July using the 6-kick method, and processed them by the PA DEP and US EPA protocols. Another common metric is Proportional Bray-Curtis Similarity Index which shows the degree to which the BMI taxa overlap between the five headwater streams. During the summer of 2017 the two most similar streams were Little Weikert and Coral Run (62% overlap), but all stream community comparisons were moderate to high. Based on the collections from the summer of 2017 the five streams are moderate replicates of each other as far as the BMI communities are concerned.

*Keywords: benthic macroinvertebrates, headwater streams*



## SEASONAL AND DIEL SIGNATURE OF EASTERN HELLBENDER ENVIRONMENTAL DNA

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Examination of environmental DNA (eDNA) is a non-invasive conservation tool that has been used for the detection of aquatic organisms. When coupled with quantitative PCR (qPCR), eDNA sampling may be utilized to infer seasonal or diel activities of target species. In order to survey the status of eastern hellbender (*Cryptobranchus a. alleganiensis*), a fully-aquatic cryptic salamander of conservation concern, through eDNA analyses, we collected water samples monthly from 13 sites across eight tributaries of the Susquehanna River in Pennsylvania, USA, from June through October 2014. We also examined the effects of the breeding season, diel nocturnal activity, and stream environmental variables on eDNA concentration estimates. We repeatedly detected hellbender eDNA from all four tributaries with previously known records, as well as from downstream sites of two of the four tributaries without known records. In the known tributaries, we observed notable increases in eDNA concentrations during the September breeding season, suggesting possible reproductive events. However, such seasonal eDNA signature was lacking from the eDNA positive sites of the unknown tributaries. In contrast to our prediction, there was no difference in eDNA estimates between day and night samples, indicating that diel activity was inconsequential to eDNA estimates. Our findings concur with recent studies on the importance of temporal sampling in interpreting eDNA signature in relation to life histories of target species. Further studies are needed to characterize the core habitats of the newly found populations for the future management of the declining hellbender populations.

*Keywords: Cryptobranchus a. alleganiensis, diel activities, eDNA, hellbender*

## COMPARISON OF FIVE SIMILAR HEADWATER STREAMS IN CENTRAL PENNSYLVANIA DURING THE SUMMER OF 2017

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We compared the benthic macroinvertebrate (BMI) communities between the five headwater streams that flow down the north slope of Penn's Creek Mountain in Bald Eagle State Forest through the summers of 2015 to 2017. The five headwater streams, Little Weikert Run, Green Gap Run, Lick Run, Coral Run, and Henstep Run are similar in size and substrate (sand, cobble, and boulder) and maintained flow even through the drought conditions of 2016. Alkalinity averaged 72, 190, 178, 205 and 122  $\mu\text{eq/L}$  during the three year study for each of the headwater streams, respectively. They were also similar in conductance averaging 18, 26, 23, 25, and 22  $\mu\text{s/cm}$ , respectively. The %EPT (Ephemeroptera, Plecoptera, Trichoptera), for the five headwaters ranged from 52-75% during the summer of 2017, which given the sites is unexpectedly low. We collected the BMI during the first half of July using the 6-kick method, and processed them by the PA DEP and US EPA protocols. Another common metric is Proportional Bray-Curtis Similarity Index which shows the degree to which the BMI taxa overlap between the five headwater streams. During the summer of 2017 the two most similar streams were Little Weikert and Coral Run (62% overlap), but all stream community comparisons were moderate to high. Based on the collections from the summer of 2017 the five streams are moderate replicates of each other as far as the BMI communities are concerned.

*Keywords: headwaters, BMI, %EPT, Bray-Curtis*

## WHO WILL BE THE APEX PREDATOR WHEN CLIMATE CHANGE EFFECTS LOCAL STREAMS?

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Air temperatures are expected to rise approximately 4° C over the next 50 years as a result of global climate change. As temperatures rise, the range of habitats will shift along the latitudinal gradients, potentially causing local species decline. This is especially true for less mobile species that are limited in their ability to disperse and colonize new habitats, for example specific fish species. Studying the response of aquatic populations to stream temperature rise will enable more accurate predictions of abundance, which will lead to more appropriate conservation efforts. Warmer temperatures will increasingly favor species with a higher thermal tolerance, including many nonnative species. As these species colonize new habitats, they are predicted to increase in population size and distribution, which could impact native species. Brook Trout (*Salvelinus fontinalis*) populations are native to headwater streams in the Appalachians of North America. This species is of high conservation need, with threats including stream temperature rise and competition with nonnative species, particularly Brown trout (*Salmo trutta*). Because Brown Trout have a higher thermal tolerance than Brook Trout, future competition is expected to decrease Brook Trout population sizes. Using an experimental stream system and video we evaluated the effects of brown trout on brook trout behavior and habitat use in experimental streams across three temperatures at the upper, lower, and intermediate thresholds for brook trout. In addition, we also measured short-term growth rate at these three different temperature thresholds over the course of several weeks. We hypothesize that competitive advantage and preferential habitat positions will shift from brook trout to brown trout with increasing temperatures. We also hypothesize that there will be decreased brook trout growth in the presence of brown trout as temperatures increase. Brook trout are a recreationally and culturally important species, which indicate high water quality, and it is important to preserve this native trout to maintain biodiversity.

*Keywords: brook trout, brown trout, competition*

## EFFECT OF DIETARY AND PREDATORY CONDITIONS ON WOOD FROG (*LITHOBATES SYLVATICUS*) MORPHOLOGY

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Diet is a critical factor in the growth and development of organisms. Additionally, chemical cues from predators have the potential to induce phenotypic plasticity in morphology and development of the prey species. In its larval stages, the wood frog (*Lithobates sylvaticus*) is known to feed on plant matter as well as dead animal tissues and the eggs of other amphibians found within the same vernal ponds. The benefits of consuming a meat or plant based diet over one another are unclear in *L. sylvaticus*. We hypothesized that tadpoles would express anti-predatory morphological responses at a greater degree when fed both plant and meat based foods. To test the hypothesis, 60 *L. sylvaticus* tadpoles were raised under six conditions: three dietary conditions (meat, vegetation and a combination of both foods) crossed with two predatory conditions (presence or absence of chemical cues from predatory dragonfly nymphs (Family Aeshnidae)). Over a five week period, tadpoles were fed ad libitum. At the end of the feeding period, we recorded developmental staging, gut length and 12 morphological measurements of each tadpole. Furthermore, we ran a y-maze experiment at weeks two and four in order to test for preference between a meat or plant based diet. Although y-maze data was inconclusive, the results also showed significant effects of diets on the morphological measurements while effects of the predatory cues and the interaction between the two factors were not significant. This data potentially hints at possible benefits of a combination diet over solely meat or plant based feeding in regards to growth and development.

*Keywords: ecology, dietary conditions, predatory conditions, morphology*

## **INSTALLATION AND CALIBRATION OF LEVEL LOGGERS TO ASSESS STREAM BMP EFFECTIVENESS**

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Urbanization and development have degraded stream health and increased pollutant flux. Recent efforts have included stream restoration to stabilize the channel. Additionally, channel restoration qualifies for BMP pollutant reduction credits. However, the effectiveness of channel restoration in achieving flow and pollutant reductions is uncertain. To assess flow and flux impacts, we installed level loggers at three sites for which channel restoration is to be conducted within the next two years. Level is being monitored to collect baseline data prior to BMP installation. Discharge rating curves are being developed for all three sites using the salt dilution and flow-weighted methods to determine the best calibration approach for the streams selected.

*Keywords: stream restoration, discharge calibration, level loggers,*

## **LONG-TERM TRENDS IN AMD AND MARCELLUS SHALE RELATED PARAMETERS IN BEECH CREEK AND CLEARFIELD WATERSHEDS, PENNSYLVANIA**

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The Beech Creek and Clearfield area watersheds in central Pennsylvania have a long history of coal mining, which resulted in a legacy of Acid Mine Drainage (AMD) degradation of water and soil resources. Beginning in 2008, the area experienced another wave of resource extraction related to Marcellus Shale gas-well drilling. Recent gas-well drilling has raised concerns among citizens and the science community relating to potential impacts of resource extraction on the quality of water resources and ecosystems. In the wake of Marcellus Shale drilling activities, Lock Haven University's Geology program forged a partnership with several community-based organizations to monitor the quality of surface water within these watersheds over a long-term basis. On average, a total of 20 samples have been collected monthly from Beech Creek and Clearfield County watersheds beginning in 2010 for laboratory analysis. The parameters monitored include, but are not limited to, temperature, pH, TDS, total Fe, Al<sup>3+</sup>, Ba<sup>2+</sup>, Cl<sup>-</sup>, and SO<sub>4</sub><sup>2-</sup>, which were determined using HACH™ DR6000 Spectrophotometer and HACH™ multi-parameter probes. These parameters were chosen due to their association to both AMD and Marcellus Shale drilling activities.

Over the years of the study, there have been multiple streams with concentrations that warranted alarm and potential for further investigation. The Moose Creek tributary in Clearfield County is an emergent issue, featuring low pH and high aluminum concentrations relative to the rest of the study locations in Clearfield County. Stoney Run in Clearfield County continues to prove itself as a severely impaired by low pH and high TDS. The samples collected from Beech Creek at Monument and Jonathan Run in Beech Creek watershed shows deterioration in terms of TDS, total Fe, Ba<sup>2+</sup>, and SO<sub>4</sub><sup>2-</sup> values over time. In conclusion, Marcellus Shale drilling and the legacy of AMD damage in these watersheds continue to be a problem, as seen in the slow decrease in water quality.

*Keywords: water quality, Marcellus Shale, acid mine drainage, mining*

## **VARIATION IN TOTAL MERCURY CONTENT OF SPIDERS FROM COAL-IMPACTED AREAS IN CENTRAL PENNSYLVANIA**

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Mercury is a persistent environmental contaminant that primarily originates from coal-fired power plants. Methylmercury biomagnifies as it moves through food chains, reaching toxic levels in apex predators. Aquatic rather than terrestrial communities are thought to be more impacted by mercury contamination putatively because aquatic food chains are longer and therefore more susceptible to biomagnification. Recent studies however suggest that mercury transport is complex and may involve recursive loops through multiple terrestrial and aquatic food chains. Some spiders can concentrate mercury at high levels, even exceeding levels found in fish. Since spiders can occupy positions within detrital, terrestrial, and aquatic food chains, trophic pathway for mercury biomagnification are difficult to discern. This study examines mercury levels among spider taxa near various coal-impacted areas near and away from aquatic systems. During the last three years, over 3000 spiders have been collected and identified from over 26 sites in Central Pennsylvania. Collecting sites from mining-impacted areas included riparian zones and river islands adjacent to a coal-fired power plant, the perimeter of a coal ash burial site, ponds formed from abandoned surface mining, uncontrolled mine-fire sites, and remediation ponds from an AMD-impacted creek. Mercury levels from these coal-impacted areas were compared to agricultural and headwater stream reference sites away from mining and coal burning areas. Results to date indicate that spiders, especially ground spiders, are particularly good bioindicators of mercury mobilization across aquatic and terrestrial interfaces within coal-impacted areas but that aquatic sources are important, but not necessary for significant trophic transfer among terrestrial arthropod predators.

*Keywords: mercury, spider, coal mining, riparian*

## **AN INVESTIGATION OF THE FEASIBILITY OF USING LOW-COST APPLIANCE TURBIDITY SENSORS FOR WATER QUALITY MONITORING**

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Continuous and accurate monitoring of water quality is key to efficient and proactive water resource management. However, the cost and complexity of deploying such monitors limits their use. This research set out to determine if low-cost, off-the-shelf, appliance-grade turbidity sensors (~\$3 in volume) have the needed precision and accuracy to be used in water quality monitoring applications. Several different models of appliance-grade turbidity sensors were considered. Tests were run to determine the variation between different units of the same model, the effect of temperature on the measurements, and the ultimately the granularity/precision of these turbidity sensors. The primary conclusion was that these low-cost turbidity sensors, even with device-specific calibration, do not have the precision required to provide useful data for typical water resource management applications. Future work focuses on improving the precision of low-cost turbidity sensors in water resource management applications by changing the geometry of the sensor and applying signal processing techniques.

*Keywords: sensor, turbidity, monitoring, low-cost*

## **ASSESSING THE WATER QUALITY INDEX OF LICK RUN, CENTRE COUNTY, PENNSYLVANIA**

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The purpose of this study was to examine historical and current water quality data in order to determine the impact of local geology and land-use on water quality in Lick Run; a perennial stream draining into the Foster Joseph Sayers Reservoir in Howard, Pennsylvania. The watershed's carbonate bedrock and near-surface iron ore bodies are the two greatest factors influencing the water quality in Lick Run. From May to September 2017, water samples were collected each month at six locations throughout the watershed, focusing on Lick Run and a major tributary to Lick Run. At each field location, the water was tested for pH, DO, temperature, and conductivity. In the laboratory, an additional sixteen parameters were tested. Each month, stream sediment samples were collected and prepared for analysis using an Olympus Delta Professional Handheld XRF. The dominant component of streambed sediment samples is iron, which is a testament to the historic iron mining in Little Nittany Valley. Once collected, the new data were compared to baseline water quality data gathered by the USGS in the mid-1970s. The data for this study is also comparable to the data collected by the Centre County Senior Environmental Corps. A weighted matrix of various parameters was used to determine water quality index for the Lick Run watershed. It was determined that the overall water quality index for the study area is 78.37 on a scale of 0 to 100. Based on the observed spatial and temporal variations in water quality, it was concluded that the relatively low water quality index can be attributed to the relatively high concentrations of nitrates, nitrites, and COD.

*Keywords: water quality, land use, mining, agriculture*

## **BURROWING HABITS AND RESPONSES TO FLOOD EVENTS AMONG RIPARIAN AND NON-RIPARIAN WOLF SPIDERS**

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Spiders inhabiting dynamic boundaries between terrestrial and lotic systems are under constant risk of flooding and may have evolved adaptations to respond to rising water. Mechanisms for coping with periodic flooding have important implications for predicting species composition, recolonization, and resilience against flood-related disturbance for riparian arthropod communities. We examined burrowing propensities of riparian and non-riparian populations of three wolf spider species (*Tigrosa helluo*, *Hogna lenta*, and *Trochosa ruricola*) and also measured their emergence responses during simulated flood events. Spiders were housed in sleeved 35cm deep transparent containers with 25 cm of composite soil. The number of burrowing spiders, burrow dimensions, age and sex of each species were recorded. Spider containers were slowly flooded and emergence time from burrows were recorded. Both burrow depth and emergence latency from burrows of riparian *H. lenta* and *T. helluo* were half that of non-riparian populations. This pattern was not observed in *T. ruricola*. Both *H. lenta* and *T. helluo* burrow less than *T. ruricola* and their burrow positions and depth are different. Preliminary results suggest *H. lenta* and *T. helluo* have adaptively modified their behavior and burrow morphology to cope with inundation threats.

*Keywords: submergence tolerance, burrowing, wolf spider, riparian*

## **ASSESSMENT OF THE BENTHIC MACROINVERTEBRATE COMMUNITIES OF THE UPPER MAIN STEM OF THE SUSQUEHANNA RIVER DURING SUMMER 2017**

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The summer of 2017 was the ninth year in a long term study of the benthic macroinvertebrate (BMI) community in the upper main stem of the Susquehanna River. The purpose of this long-term study was to use these taxa to provide a baseline estimate of water quality. A total of five locations in the river were sampled in the transect that straddles Byers Island near the Sunbury Generation LP and below the Adam T. Bower inflatable dam at Sunbury, PA and below the confluence of the West Branch and North Branch of the Susquehanna River. Of these five locations sites 1 and 5 were located inside the west branch plume (WBP) and sites 2, 3, and 4 were inside the north branch plume (NBP). Rock basket passive samplers were deployed at all sites according to EPA guidelines for non-wadeable streams. Preliminary results between site 1 (WBP) and site 2 (NBP) low variability in generated metrics for sites 1 and 2. For example the number of taxa recovered from sites 1 and 2 was 15 and 12, respectively. The Hilsenhoff number generated by preliminary counts in sites 1 and 2 were 3.9-5.0 and 3.8-4.3, respectively. In addition the Shannon Diversity Index (SDI) and the %EPT were similar also. The SDI values were 1.7 for site one and 1.9 for site two while the %EPT was 76 and 78, respectively. During the months of May through July, the time period that had the greatest impact on the BMI community that we collected, average discharge was much higher during 2017 than 2016 (34,823 gps vs . 12,187 gps, respectively). In comparison the 78 year average is 22,300 gps. The %EPT had much more in common with 2015's (85% for site one and 87% for site 2) than 2016's (50% for site one and 65% for site 2). This leads us to believe that since 2015 was also high discharge year that this factor could have a large effect on %EPT. They had an average Bray-Curtis similarity of 52% during 2016 and 55% in 2017 according to the preliminary studies. Hester-Dendy Multiplate samplers and the other sites will be discussed in full later.

*Keywords: benthic macroinvertebrate , %EPT, Discharge*

## **A TRANSVERSAL AND LONGITUDINAL STUDY OF 4 HEADWATER STREAMS USING WQI AND HYDRO-GEOCHEMICAL ANALYSIS**

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Headwater streams are an important part of the river continuum and make up for more than 90 percent of the streams within a major rivers watershed (Leopold et al. 1964). Little is known about headwater streams and their impact on larger stream systems. The headwaters of Penn's Creek provide clean water to a large river system and increase Penns creek's volume as it makes its way to the Susquehanna River. To understand the impact of these headwaters a study was conducted, in which four streams at similar elevations and on the same geologic formations was studied transversally and longitudinally. Water samples and physical data was collected using a YSI™ multimeter while long term data collection was completed using Hydrolab™ sondes, HOBO™ pendent data loggers, and Solinst™ pressure transducers. The geochemical compositions of the streams went into Piper Diagrams, Stiff Diagrams and to identify trends in the data. Data was also used in the Water Quality Index (WQI) to create a numerical representation of the streams health. The streams are high in Bicarbonate, which is explained in the lower pH values and conductivity. Diagrams were skewed due to the lack of diversity in the Anions yet the streams are high in calcium and Magnesium, which is a characteristic of water within the geologic formations.

*Keywords: geochemistry , water quality , hydrology , spring seep*



## DIET OF YOUNG-OF-THE-YEAR SMALLMOUTH BASS IN THE UPPER JUNIATA RIVER SYSTEM

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The decline of young-of-the-year (YOY) smallmouth bass (SMB, *Micropterus dolomieu*) recruitment and adult densities in the Susquehanna River basin since 2005 raises concern for the health and well being of the fishery. Our study focused on understanding the feeding ecology of YOY SMB in the upper Juniata River watershed, a major tributary to the Susquehanna River. We studied the mainstem of the upper Juniata River, and the major tributaries forming and joining the river. We sampled the YOY smallmouth bass for a two-year period during the summer of 2016 and 2017. Our specific objectives were to 1) characterize the diet of SMB and a potential invasive competitor, the rusty crayfish (*Orconectes rusticus*), 2) document the physical condition and external health of individuals, and 3) evaluate the effectiveness of gastric lavage to extract diet contents at an early life history stage. A subset of individuals was sacrificed to check lavage efficiency and these individuals were also sent to be examined for histopathological anomalies that may result from pharmaceutical contamination (i.e., endocrine disrupting compounds) that is considered to be a likely cause of SMB decline. We also quantified habitat conditions using rapid visual techniques and ecological health of each site following the protocols for the Pennsylvania Index of Biotic Integrity for wadeable freestone streams. PA IBI scores (range 34 - 67) and habitat conditions (range 46 - 70%) were rather poor in both years. In summer (July and August) 2016, YOY SMB were numerous and were in excellent health, but were nearly absent during the same time in 2017. Few external anomalies consisted of parasites only. Most individuals were full of prey items, which on average consisted of about half aquatic prey and half terrestrial or neustonic prey. Rusty crayfish diet contents lacked any resemblance to diet contents in YOY SMB. Gastric lavage techniques were effective at removing gut contents and only a few individuals were found to have stomach contents remaining when dissected in the lab. Furthermore, nearly all YOY SMB fully recovered from field lavage experiences. Only 2 individuals died, and this was likely due to extreme river surface water temperatures (89 F) at the time of sampling. Thus, gastric lavage is a safe and effective technique to study YOY SMB feeding ecology and important links between recruitment, diet, and food quality without having to kill numerous fish.

*Keywords: Young of the year smallmouth bass, diet, Juniata River watershed, gastric lavage*

## VARIABILITY IN ENDOCRINE-DISRUPTING COMPOUNDS IN THE UPPER JUNIATA RIVER SYSTEM

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Population declines and disease incidence in smallmouth bass (*Micropterus dolomieu*) in the Susquehanna River basin have been linked to endocrine-disrupting compounds (EDCs) as a likely causative agent. Nothing is known about EDC dynamics in the upper Juniata River basin, and specifically how EDC patterns may vary with hydrologic conditions and landscape characteristics. We sampled water in the mainstem of the Juniata River and at 5 major tributaries across a range of discharges (e.g., peak storm flows, descending flows, base flows, etc.) and landscape characteristics over a 2-year time frame during the summers of 2016 and 2017. Samples were analyzed for EDCs measured as total estradiol equivalents (EEQ, ng/L). We also collected information on pH, dissolved oxygen, temperature, specific conductance, and total dissolved solids during each sampling event to identify possible connections between hydrologic conditions and variation in EDC concentrations. We found extremely high spatial and temporal variation in EDCs concentrations. Concentrations varied highly within sites at the same time, within sites at different times, among sites, and between years, but levels thus far have not surpassed the 1 ng/L threshold considered to be a concern for fish health. Thus far, we could not detect a trend in EDC concentrations along a continuum of the Juniata River downstream of the waste water treatment plant. Additionally, our current analyses cannot link variation in EDC concentrations to discharge, simple water quality measurements, or landuse/landcover at 2 spatial scales, but early indications suggest that EDCs are present in quantities that should be considered important for addressing ecological health in the broader Susquehanna River basin.

*Keywords: endocrine-disrupting compounds, Juniata River watershed, land use, storm flows*

## EVOLUTION OF DISPERSAL TRAITS OF ADULT STREAM INSECTS

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Mating and dispersal occur during a stream insect's adult life stage. An insect can disperse from one stream to another by flying along the stream or through the terrestrial habitat between streams. Insects can also fly at different heights. Most insects stay slightly above the surface of the water, but few studies have examined flight through the forest canopy. Stream insects may have evolved different body morphologies and behaviors to better help them disperse through or above the forest. We tested if the abundance of adult caddis flies, stone flies, and mayflies differed between the tree canopy and above the surface of the stream. We collected larval and adult invertebrate samples from five different sites among Mosquito Creek and Remington Run in South Williamsport, PA. Adults were collected over a period of fourteen days using canopy and malaise traps in the summer of 2017. We found a lower number of adult insects in the canopy than directly above the surface of the stream, but insects were always present in the canopy. Our results suggest that adult stream insects do disperse in tree canopies. Future work will further examine assemblage composition and species specific wing morphologies.

*Keywords: adult stream insects, dispersal, forest canopy*

## CHANNEL AND RIPARIAN RESTORATION TO IMPROVE HABITAT IN AGRICULTURAL STREAMS

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Sediment from stream bank erosion and runoff from agricultural fields can transform rocky-bottom stream channels with varying depths to silt-clogged waterways with homogeneous habitat. Physical modifications to stream banks can be used to increase water velocity and direct stream flow toward the center of the channel, which can mobilize and transport sediments and increase depth heterogeneity in streams. State agencies (PA-FBC, PA-DEP) have partnered with local organizations (NPC, county conservation districts, watershed groups) and landowners to implement stream restoration practices along a number of agricultural streams in central Pennsylvania through the North Central Stream Restoration Partnership. In May and June 2017, bank stabilization and flow control structures were installed along a 0.5-mile reach of Conley Run, a tributary of Rapid Run in Union County impaired by agriculture. We conducted surveys of water quality, in-stream habitat, algal biomass, benthic macroinvertebrates, and fish in a 350-m section of the restoration reach prior to restoration. We surveyed Conley Run in October 2017 to quantify changes in water quality, stream velocity, depth, substrate characteristics, and channel shape as a result of the structural modifications to the stream. Based on data from a nearby site in Turtle Creek, we expect Conley Run to have faster velocity, more variable depth, less silt and more coarse substrates, and decreased width compared to pre-restoration conditions. All of these changes should improve in-stream habitat conditions for biota and lead to higher diversity of invertebrates and fish. Once it becomes established, riparian vegetation along the creek should also improve shade and cover, and the new riparian buffer should help to improve water quality by reducing inputs of sediment and nutrients from nearby agricultural fields and pastures.

*Keywords: stream, restoration, habitat, agriculture*



## **7 YEARS OF SAMPLING UNASSESSED WILD TROUT WATERS AS PART OF THE PFBC UNASSESSED WATERS INITIATIVE**

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Since 2011 Susquehanna University has been a partner of the Pennsylvania Fish and Boat Commission's Unassessed Waters Initiative. This cooperative program between the PFBC and colleges and universities seeks to collect biological data on previously unsampled (unassessed) streams across Pennsylvania to determine their status as possible new Wild Trout streams. Prior to this program which began in 2010, only 8% of the 62,725 streams across Pennsylvania had been sampled for biological data by the PFBC. Since 2011, Susquehanna University faculty, staff and students have surveyed 761 previously unassessed waters as part of the program. Sample sites have been predominately across north central Pennsylvania including the following major watersheds: Loyalsock Creek, Schrader Creek, Muncy Creek, Lycoming Creek, Buffalo Creek, Penns Creek, White Deer Creek, First Fork Sinnemahoning Creek and Dubois River. We found wild trout (brook and brown trout) in 47% of the streams (358 of the 761). A portion (21%) of sampled sites were found to be seasonally dry during the sampling. Brook trout were found in 321 (42%) of the streams. While brown trout were found in 148 (19%) of the streams. The Unassessed Waters Initiative has led to the designation of almost 1000 new wild trout streams, with many more to be added in the future.

## **VARIABILITY OF WATER TEMPERATURE IN A SECTION OF THE LOWER WEST BRANCH SUSQUEHANNA RIVER AT LEWISBURG AND CHILLISQUAQUE, PENNSYLVANIA**

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A network of six buoys and river bed temperature sensors were built and deployed at two river cross section locations on the West Branch of the Susquehanna at Lewisburg and Chillisquaque, Pennsylvania. The buoys were equipped with sensors collecting 15-minute measurements of solar radiation ( $W m^{-2}$ ), relative humidity, air temperature ( $^{\circ}C$ ), and water temperature ( $^{\circ}C$ ) at the water's surface and at mid-depth. An additional temperature sensor was placed on the bed of the river. Flows in the river were relatively normal for this time of the year (July 2017), with channel widths averaging 200-220 m and depths 1-2 m. Downstream changes in temperatures were generally consistent, with  $.278^{\circ}C km^{-1}$  increase between Lewisburg and Chillisquaque. Cross-sectional variability in temperatures were much more complex. Temperatures in the middle of the channel showed only 1-2  $^{\circ}C$  warming from the water surface to the bed, with albedo and long-wave stream bed conduction effects warming waters along the bed of the river. In general, water temperatures are a subdued replica of air temperatures, with atmospheric and solar radiation effects dominating diurnal variability in water temperatures in the river. Peak diurnal water temperatures typically lag peak diurnal solar radiation by several hours each day. The buoys deployed approximately 10 m from banks of the channel indicate that shading from the riparian corridor dominate the temperature variability along the margins of the river, with the middle and west bank portions of the channel experiencing 600-800  $W m^{-2}$  more solar radiation during morning hours and temperatures as much as 3.33 $^{\circ}C$  warmer than the left (shaded) portions of the channel. Turbidity, or water clarity, dominates light penetration in the water column and during clear water conditions.

*Keywords: water temperature, solar radiation, Susquehanna River*

## **COMPARISON OF MACROINVERTEBRATE BIOINDICATORS TO ECOSYSTEM FUNCTION ACROSS A GRADIENT OF AGRICULTURAL IMPAIRMENT.**

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The ability to assess stream health efficiently and accurately is vital for predicting the overall impact of land use on aquatic systems within their watershed. This can be done in a variety of ways, including the examination of various ecosystem functions as well as the use of structural attributes such as the resident macroinvertebrate community. For this study, the effects of stressors associated with agriculture were assessed on the macroinvertebrate community as well as ecosystem functions. This was done with the goal of establishing a link between both parameters, thus allowing for more efficient and effective assessment of water quality. The study sites included 19 streams across central Pennsylvania, with varying intensities of agriculture within the catchment area. The functional parameters we studied include extracellular enzymes, ecosystem metabolism, and nitrogen and phosphorus uptake. These were compared to structural indicators examined through the benthic macroinvertebrate community. We collected macroinvertebrates through kick netting, and then quantified stream health using a calculated index of biotic integrity (IBI) to assess water quality across samples. Preliminary findings indicate that both ecosystem function and macroinvertebrates reflect similar impairment to land alterations from agriculture.

*Keywords: macroinvertebrate, ecosystem function, bioindicator*

## **EFFECTS OF ELEVATED SOIL TEMPERATURE ON THE GROWTH OF *CIRSIMUM ARVENSE* (CANADA THISTLE)**

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Canada thistle (*Cirsium arvense*) is an invasive plant species that came from Europe and reproduces using both seeds and rhizomes. This species and other invasives may opportunistically invade disturbed patches in riparian forests. In addition to increased development and riparian deforestation, global climate change may increase the potential growth and reproduction of Canada thistle. The purpose of this study is to develop a method for examining the effects of elevated soil temperatures on plant growth using Canada thistle as a model organism. Canada thistle was grown from rhizomes in one gallon pots with 8 pots on soil heating mats. A subset of pots with normal and elevated temperatures were monitored with soil temperature sensors. We recorded mortality and the height of each plant during several periods throughout the study. Preliminary results indicate that sunlight may have a stronger effect on plant growth than soil temperature. Overall, assessing the effects of soil warming on Canada thistle growth can provide some insight into how climate change may affect the health of riparian forests.

*Keywords: Canada thistle, soil warming, climate change*

## **WATER QUALITY INDEX ASSESSMENT OF THE HEADWATER SYSTEM FEEDING THE LOCK HAVEN PUBLIC DRINKING WATER SUPPLY**

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Surface water within the McElhattan Creek watershed in central Pennsylvania serves as the source of drinking water for 19,590 subscribers of the Central Clinton County Water Filtration Plant in Pennsylvania. The purpose of this study was to determine the water quality index for the source water within the system.

Grab samples of water were collected at 5 locations on a monthly basis from April to September, 2017. HACH™ field and laboratory equipment were used to collect, process, and analyze data to evaluate baseline water quality. Data collected throughout 2016 served as a background dataset for understanding seasonal trends throughout the summer months. The primary objective of this study was to determine total organic carbon concentration, due to its importance for the final outcome of the treatment process. Field parameters included temperature, pH, conductance, TDS, and DO. Additional lab analysis yielded results for COD, BOD, NH<sub>3</sub>-N, NO<sub>3</sub>-N, NO<sub>2</sub>-N, PO<sub>4</sub>-P, Cl<sup>-</sup>, and SO<sub>4</sub><sup>2-</sup>. Water Quality Index (WQI) was calculated following the methods developed by Vicente et al. (2009).

The WQI values were found to be excellent. The WQI values were relatively similar between each of the 5 study locations through the duration of the study period. Throughout the course of the study period, none of the parameters tested had values that warranted alarm when compared to the US EPA's primary drinking water standards. The highest observed NO<sub>3</sub>-N values were less than 1/10 the MCL for drinking water; other parameters showed results that were also below those suggested by the US EPA. On average, the values of nutrients, such as NH<sub>3</sub>-N and NO<sub>3</sub>-N, were below or equivalent to the natural background levels suggested by the USGS literature (U.S. Geological Survey, 1999). The toxicity levels, in terms of heavy metals, in sediment samples collected were also less than the probable effect levels published by the US EPA (Ingersoll et al., 2000).

*Keywords: Water Quality Index , drinking water, water treatment, nutrients*

## **DIET ANALYSIS AND MICROPLASTIC INSPECTION FOR SMALLMOUTH BASS INHABITING THE CENTRAL SUSQUEHANNA RIVER ECOSYSTEM**

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A diet analysis was performed amongst 84 smallmouth bass (SMB), *Micropretus dolomieu* diets inhabiting the central portion of the Susquehanna River along with a few major tributaries to exhibit the frequency of occurrence and percent composition by number of organisms present. Following the diet analysis, a wet peroxide procedure was conducted to eradicate all organic matter allowing for the inspection for miniscule, inorganic microfibers collectively known as microplastics. Microplastic pollution and its existence within the diets of aquatic organisms is an escalating concern predicated on the excessive manufacturing of the non-biodegradable material worldwide. Both the diet analysis and wet peroxide procedure were used in the same experiment to realize how microplastic pollution could potentially spread to multiple trophic levels inhabiting the Susquehanna River ecosystem. Because of the piscivorous and insectivorous habits intrinsic to SMB, their diets are not only most applicable to show how microplastic pollution can spread to a variety of trophic levels in their ecosystem, but how microplastic pollution is affecting SMB, the most populous game fish in the Susquehanna River.

*Keywords: microplastic, diet , smallmouth bass , Susquehanna River*

## MONITORING OF WATER TEMPERATURE AND DETERMINING WATER BUDGET OF KELLER RESERVOIR IN THE MCELHATTAN CREEK WATERSHED

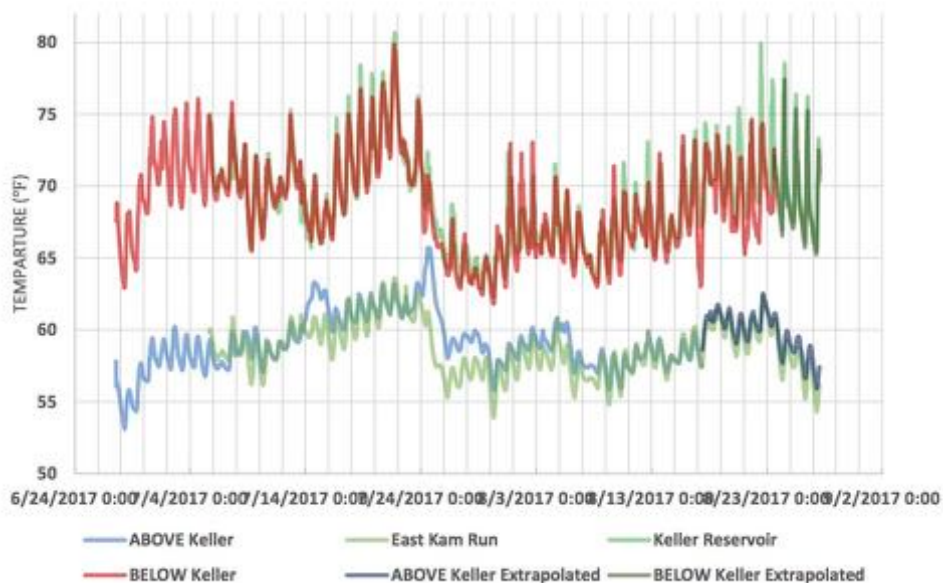
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In the summer of 2016 the Pennsylvania Fish & Boat Commission (PFBC) conducted a study on McElhattan Creek to gauge the health of the wild trout population within the watershed. The study identified a significant problem that the watershed faces in relation to the difference in water temperature upstream and downstream of Keller Reservoir (92 Million Gallons), which is situated alongside McElhattan Creek. This discrepancy in water temperature is affecting the wild trout population, with some showing Black Spot, a parasite found when fish are combating temperature stress.

Following up on the PFBC study, the focus of this project was to keep an extended record of water temperature above and below Keller Reservoir for the entire length of the summer, when the temperature discrepancies were observed to be at their highest. A series of HOBO Water Temp Pro data loggers were deployed at four locations in the watershed to obtain a broader picture of what could be influencing the previously observed temperature fluctuations. Monthly reports were then generated and compiled into a comprehensive file to examine trends in water temperature within the watershed. There was an isolated period (7/21/2017) when the temperature differential at two locations in McElhattan Creek, which are located upstream and downstream of Keller Reservoir, respectively, exhibited the highest range, which appears to be influenced by air temperature. There was a second event (7/24/2017) that displayed the smallest range in temperature differential between the same two locations following a major rain event. This event seems to be influenced by a relatively higher amount of water being discharged from Ohi Reservoir (580 Million Gallons) into the upstream segment of McElhattan Creek. Our data indicate that the surface water in Ohi Reservoir is relatively warmer than the upstream segment of McElhattan Creek.

This project also investigated water budget for Keller Reservoir to assess a full view of the hydrologic controls of the area. Flow measurements were conducted at several sites within the watershed on various dates to investigate any fluctuations in the amount of water contributed by different components of water budget. The most recent data collected revealed a slight surplus in the output of water budget, which could be attributed to groundwater flow, evaporation, or direct precipitation over Keller Reservoir.

*Keywords: Keller reservoir, water temperature, black spot, water budget*





## **LONGITUDINAL CHANGES IN STREAM MACROINVERTEBRATE COMMUNITIES ALONG A GRADIENT OF STORMWATER INPUTS**

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This study examined changes in water quality along a gradient of stormwater systems using the macro-invertebrate communities. The diversity and species of macro-invertebrates will change as stormwater inputs increase. We hypothesized that the macroinvertebrate community will change to one dominated by tolerant taxa like chironomids and oligochaete worms as more stormwater drains into the stream. To test this hypothesis, macroinvertebrates were collected from ten different sites along Millers Run (Williamsport, PA). Water chemistry and habitat data were also collected at the same ten sites. Insects were identified down to family. Calculations of macroinvertebrate community composition and diversity were used to assess the effects of stormwater inputs. A higher number of pollution sensitive taxa were found in sections with low stormwater inputs than sections with high inputs. Oligochaetes and chironomids were found towards the mouth of the stream after passing several stormwater inputs. Water chemistry also showed higher levels of phosphorus and nitrogen at the mouth of the stream indicating higher pollutants in the water. Riparian cover was lowest in the areas where the stream flowed through Williamsport. The data supported our hypothesis that stream quality decreases as it passes along a gradient of stormwater inputs. This demonstrates the importance of stormwater inputs and not just urban development as a cause of poor water quality in streams.

*Keywords: macroinvertebrates, stormwater, water chemistry*

## **ASSESSMENT OF PASSIVE AMD TREATMENT SYSTEMS IN SCHUYLKILL COUNTY, PENNSYLVANIA**

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Abandoned mine drainage (AMD) is an environmental issue of key concern in Pennsylvania. Once a rich coal mining area, Pennsylvania has been left with the consequences of abandoned or poorly regulated mines that now pollute the state's waterways. In particular, Schuylkill County, once known for its abundance of anthracite coal, now has several AMD sites causing a change in pH and an increase in metal concentration in the water. This project analyzed five specific AMD sites which have passive treatment systems installed to mitigate the effects of the acidic drainage. The sites were Tracy Airhole, Mary D Borehole, Bell Colliery, Oneida #3, and Silver Creek. Each site is located in Schuylkill County and is part of the Northern Swatara Watershed. Tracy Airhole is west of Donaldson, Pennsylvania on SR 125 and water from this site flows into Good Spring Creek. Mary D Borehole and Bell Colliery treatment systems are located in Mary D, Pennsylvania. Treated water from these systems flows into the Schuylkill River. The Silver Creek treatment system is in New Philadelphia, Pennsylvania and water from this system flows into Silver Creek. The project aimed to determine the water quality of these sites and assess whether the treatment systems were properly functioning. Each system was sampled once in the summer of 2017. In situ measurements using a YSI EXO<sup>2</sup>™ sonde include pH, turbidity, conductivity, dissolved oxygen, and temperature. Bulk samples were stored in 4-liter jugs in ice for transport back to the laboratory. Titrations to measure acidity and alkalinity were performed on triplicate filtered samples. Sub samples were stored for heavy metals (both unfiltered (total) and filtered (dissolved); both acidified to pH <2) and simple anions and cations (filtered). Comparative results will be presented.

*Keywords: AMD, Schuylkill County, Abandoned Mine Drainage*

## **MINIMAL CAPTIVE INTROGRESSION IN WILD BROOK TROUT (*SALVELINUS FONTINALIS*) POPULATIONS IN THE LOYALSOCK CREEK WATERSHED, PENNSYLVANIA**

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Due to increased anthropogenic pressures on many fish populations, stocking wild populations with hatchery individuals has become a common management practice. Stocking has been the subject of much controversy due, in large part, to the potential for captive individuals to breed with wild stocks. By modulating the abundance of locally adapted gene complexes and introducing maladaptive genotypes, genetic introgression can cause declines in wild population fitness, resiliency, and accelerate local population extirpation. However, the rate of introgression in highly stocked river systems has not been rigorously evaluated, and so the relative risk of genetic erosion from stocking is unknown. We quantified the proportion of introgressed individuals in 30 populations of wild brook trout (*Salvelinus fontinalis*) distributed throughout the Loyalsock Creek watershed in Pennsylvania. Genetic assignment tests were used to determine the origin (wild vs. captive) for 1748 wild-caught and 300 hatchery brook trout. These assignment tests generated the probability of an individual fish belonging to either a simulated wild or simulated hatchery population. Fish with intermediate probabilities of wild descent were classified as introgressed, with cutoff values determined through simulation of first-generation crosses between wild and hatchery individuals. Even though streams in Loyalsock Creek are annually stocked with high densities of adult trout, we found minimal evidence for genetic introgression in the populations studied. Over 93% of all wild-caught individuals assigned to wild origin, and only 5% of wild-caught fish showed evidence of recent introgression. There was variation in introgression across populations; however, average within-site wild probability was 97%. Our results suggest that introgression with hatchery fish can occur at low rates, even in heavily managed ecosystems. However, results from this study should be viewed cautiously. Higher rates of introgression are not uncommon in other species of salmonids, and introgression may be more common under different environmental conditions. Further, we did not evaluate potential declines in wild brook trout fitness from competition with hatchery individuals, and so negative effects of stocking could still occur despite limited introgression.

*Keywords: brook trout, introgression, genetics, hatcheries*

## **INFLUENCE OF INTERACTING STRESSORS ON NATIVE BROOK TROUT IN A WESTERN PENNSYLVANIA WATERSHED**

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Freshwater species have declined throughout their native ranges in part due to habitat fragmentation and invasive species. Information is often lacking, however, about how interactions between these stressors affect certain aspects of native populations. Brook trout (*Salvelinus fontinalis*) are a prime example of a species in decline due to human-related stressors, two of which are fragmentation from abandoned mine drainage (AMD) and competition with non-native brown trout (*Salmo trutta*). In an ongoing, multi-year study, we are assessing the abundance, behavior, and genetic structure of brook and brown trout in a western Pennsylvania watershed fragmented by AMD and scheduled for remediation in 2018. From past surveys, we predicted that AMD was acting as a chemical barrier to brown trout invasion into a tributary dominated by brook trout. This watershed represents a common situation in Pennsylvania—brook trout populations are simultaneously fragmented, yet “protected” from brown trout invasion by AMD, but remediation could permit brown trout invasion upstream. However, preliminary results show brown trout invasion has already begun prior to any remediation. We predict that as water quality improves after remediation, brown trout invasion upstream will accelerate, increasing interspecific competition with the resident brook trout. This trade-off between isolation and invasion presents a significant management challenge, and our study will highlight the need to be mindful of potentially negative outcomes stemming from AMD remediation efforts to the imperiled brook trout.

*Keywords: Brook trout, Brown trout, Mine drainage, stressors*

## **A SURVEY OF PHORMIDIUM SP. ACROSS AN AGRICULTURAL IMPACT GRADIENT IN CENTRAL PENNSYLVANIA**

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There has been a recent proliferation of the benthic, mat-forming, filamentous cyanobacterial genus *Phormidium* in streams and ponds around the world. However, even though the genus is known to produce anatoxins and has been linked to animal deaths, little is known about the specific environmental conditions that lead to its colonization and success. In a recent survey of 19 streams in central Pennsylvania, with varying levels of agricultural impact, we found *Phormidium* species in six of the streams, in different stages of growth. We took quantitative and qualitative measurements of stream environmental parameters including water nutrients, ecosystem metabolism, nitrogen and phosphorus uptake in portable mesocosms, photosynthetic capacity via pulse amplitude modulated fluorometry, algal cover types, turbidity, and canopy cover. Preliminary results show higher nutrient concentrations, especially nitrates and nitrites in streams where *Phormidium sp.* were present. Amount of storm nutrient runoff from neighboring agricultural lands may play a role in proliferation, as well as scouring from storm events impacting the ability of mats to colonize.

*Keywords: cyanobacteria, stream survey, cyanotoxins, agricultural impact*

## **PERSONALITY PREDICTS SUCCESS AT USING THERMAL REFUGIA IN BROOK TROUT (*SALVELINUS FONTINALIS*)**

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Climate change is one of the most pervasive threats to coldwater fish populations, and there remains considerable uncertainty as to how organisms will respond to changes in local environmental conditions. For brook trout (*Salvelinus fontinalis*), a species of coldwater fish with important socioeconomic and ecologic value, climate change is expected to reduce available habitat by as much as 80%. However, models predicting range shifts are conducted at large spatial scales and fail to account for local habitat features that enable population persistence. Small areas of thermal refugia created by groundwater upwelling or tributary confluences can decrease water temperature by up to 10°C, and have been shown to increase trout survival. However, individual fish survival depends on the individual's ability to locate and compete with other fish for access to thermal refugia. In this study, we investigated how fish size and behavior influence an individual's success at finding and competing for food and space in a thermally diverse environment. After assessing behavioral phenotype, 20 brook trout were randomly assigned to each of four artificial streams. We increased ambient stream temperature from 14°C to 23°C over seven days while maintaining one pool at 14°C to simulate groundwater upwelling. During trials, movement was monitored via two PIT tag antenna arrays, and agonistic interactions were documented by scoring underwater videos filmed four times a day. Overall, most fish moved less and engaged in more competitive interaction at higher temperatures. However, there was significant individual variation in movement, with some individuals moving more in warmer temperatures, presumably to access food. Competitive dominance was only weakly correlated to size. These results suggest that individual fish respond differently to stream temperature rise, and that certain behavioral phenotypes may be more successful at finding and occupying thermal refuge.

*Keywords: brook trout, climate change, fish behavior*

## **QUANTIFYING THE MOVEMENT EFFICIENCY OF TERRESTRIAL SALAMANDERS ACROSS AQUATIC BARRIERS**

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Little is known about the swimming ability of terrestrial salamanders. Studies involving displacement have shown that salamanders are capable of crossing streams during long distance travel. However, the efficiency of their movement across aquatic barriers is largely unknown. This study intends to observe the ability of terrestrial salamanders to swim or otherwise cross streams. We will locate individual salamanders under natural cover objects and subject them to trials in an aquatic arena to determine their average burst speed. Possible influences on the results include the size, sex, and species of the salamander. We expect to observe differences between the species and size of the salamander versus their swimming ability.

*Keywords: salamander, herpetology, movement efficiency, speed trials*

## **GEOCHEMICAL ASSESSMENT OF ABANDONED MINE DISCHARGES ON WICONISCO CREEK, SCHUYLKILL AND DAUPHIN COUNTIES, PENNSYLVANIA**

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I investigated the impact of the three mine drainages on water quality in Wiconisco Creek, a 43 mile tributary of the Susquehanna River. Located in lower Schuylkill and upper Dauphin Counties, Wiconisco Creek has historically been called "black creek" by locals due to excessive coal sludge in the stream. Abandoned mine drainage (AMD) also impacts water quality in the stream.

All three AMD inputs have treatment systems (two passive and one active) in place. Each system is different and specifically designed for that particular AMD. Discharge from the Porter Tunnel is low pH and alkalinity and high in metals (especially iron and aluminum) requiring treatment with both limestone and settling ponds. Discharge from Big Lick Tunnel is high in iron and low in dissolved oxygen requiring only a series of vertical drops to aerate the water and precipitate iron. Discharge from Short Mountain Mine is also high in metals and low in dissolved oxygen requiring a series of 3 settling ponds. For each of these drainages, samples were collected both above and below the treatment systems and above and below the confluences of the treated water with the Wiconisco Creek. Conductivity, pH, dissolved oxygen, and temperature were measured in situ using a Hach™ HD40 meter with probes. Large volume samples were collected, transported to the lab, and filtered. Alkalinity and acidity were immediately determined in the lab. Additional chemical analyses were later performed on preserved samples using ion chromatography (IC) for simple cations and anions and inductively coupled plasma - optical emission spectroscopy (ICP-OES) for 11 selected metals.

Porter Tunnel had the lowest pH (3.62) and lowest alkalinity (0 mg/L as CaCO<sub>3</sub>) compared to those of Big Lick (7.04 and 100 mg/L as CaCO<sub>3</sub>) and Short Mountain Mine (6.58 and 21.0 mg/L as CaCO<sub>3</sub>). Conductivity was highest in Porter Tunnel AMD (843 μS/cm) compared to that from Big Lick (283 μS/cm) or Short Mountain Mine (174.9 μS/cm). Results of ion and metal analyses indicate that it is not due to dissolved iron, aluminum and manganese as originally predicted, but due to high levels of sodium, chloride, magnesium, and calcium, indicative of road salt contamination.

*Keywords: Abandon Mine Drainage, Aqueous Geochemistry*

## **COMPARING WATER CHEMISTRY PARAMETERS AND MACROINVERTEBRATE METRIC SCORES WITHIN LYCOMING COUNTY MS4 AREA**

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From 2015-2017, Lycoming College CWI completed an assessment of over 250 stormwater drains in the Lycoming County MS4 area. There are five urban streams within this area that have outfalls and all drain into the West Branch Susquehanna River. The two largest urban streams, Millers Run and Bull Run were the focus of this project. The outfall survey showed that there are a total of 38 outfalls in Bull Run and 24 in Millers Run. In addition a PADEP study in 2017 shows impairment of Millers Run by aluminum (non-point origin). This study summarizes a pilot program to follow monthly changes in water chemistry and quarterly samples of macroinvertebrates to assess water quality of these urban streams. Samples for aluminum were also taken to understand the source and impact in the Millers Run watershed.

*Keywords: urban stream, stormwater, MS4*

## **REGIONAL DIFFERENCES IN MUNICIPALITIES' FLOOD POLICIES: UNDER-INSURANCE AND COMMUNITY RESILIENCE IN PENNSYLVANIA**

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In the US, many flood mitigation actions and decisions are made at the municipal level, though subject to Federal and State-level rules, requirements, regulations, and incentive programs. The National Flood Insurance Program (NFIP), a federal program, is designed to compensate policy-holders for damages, but also serves to encourage property-owners to either move from flood-prone areas or modify structures to be less susceptible to damage - and therefore acts powerfully at the municipal level. Municipalities must participate in NFIP for residents to be eligible, but individuals and companies must choose whether to purchase policies. Pennsylvania has some 2,500 municipal entities, which vary in their susceptibility to flood damage; in their personnel, financial resources, and institutional capacity to conduct flood mitigation; and, not least, in the extent to which they make use of NFIP. The objective of this research was to identify areas of Pennsylvania that make greater, or less, use of NFIP, and identify some factors that may help explain the variations. Two kinds of data were evaluated for 20 selected counties: number of NFIP flood-damage claims in the period 1978-2015; and number of NFIP policy-holders as of 2016. A high ratio of claims to policies (C/P) indicates "under-insured" regions compared to other areas. This impacts community resilience because fewer property-owners receive financial compensation in event of a flood; businesses may fail and residents may move away, and communities may never recover. Findings show C/P ratios ranging from 3.9 for Wyoming County to 0.26 for Philadelphia County. Factors that appear to help explain the variation include a) income, in particular the number of households with relatively high income (>\$250,000/year), which appear to purchase more insurance policies; b) density of population, which is believed to reflect increased institutional capacity of municipalities to implement advanced regulations and programs; and c) municipalities' choices about flood mitigation activities, such as public outreach about importance of insurance. Federal, state, and local agencies may target regions with high C/P ratios to increase their use of NFIP and other flood-mitigation programs.

*Keywords: flood policy, NFIP, flooding*

## **FISH ASSEMBLAGES**

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Aquatic systems in the eastern United States have been shown to have altered fish communities in areas where the flow path is directly altered by dams. Just below the confluence of the North and West branches of the Susquehanna River is the Adam T. Bower Memorial Dam, a seasonal inflatable dam near Sunbury, Pa. Ongoing studies of water temperature suggest that in the summer when the dam is inflated the River's water surface profile is affected 2.4km upstream near the confluence of Chillisquaque Creek. Compounding that effect is a coffer dam on the west side of the river to build the Route 15 bypass. We hypothesize that the hydrological variation influenced by the inflatable dam and the physical conditions correlated with flow regime, such as changing of water temperatures and velocity will negatively affect native fish assemblages. Near shore fish assemblages were sampled at randomly selected sites on the lower West Branch of the Susquehanna River.. All electro-fishing efforts were conducted after dusk and when the water's conductivity was at an optimum level. This was the first year of a multi-year sampling effort. Additional surveys will be conducted in 2018 and 2019 to assess the impacts of a seasonal inflatable dam on the fish communities of the lower West Branch Susquehanna River.

*Keywords: fish assemblages, dams, water flow*

## **A CRAYFISH SURVEY OF THE FISHING CREEK WATERSHED IN NORTHEASTERN PENNSYLVANIA**

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Introductions of invasive crayfish species have impacted freshwater ecosystems worldwide, typically resulting in displacement of native crayfish species by non-native species. Two crayfish species (*Orconectes limosus* and *Cambarus bartonii*) are thought to be native to the Susquehanna River Drainage in eastern and central Pennsylvania. However, several non-native crayfish (e.g., *O. obscurus*, *O. rusticus*, *O. virilus*) have been introduced and have become established in this river system. Few data are available on the present occurrence and distribution of crayfish species within the Fishing Creek watershed, a drainage encompassing approximately 620 km<sup>2</sup> within the North Branch Susquehanna River Drainage in eastern Pennsylvania. Records from the early 1900s report the occurrence of both *O. limosus* and *C. bartonii* in this watershed; however, recent point-surveys in the lower reaches of the watershed have reported the presence of the non-native crayfish *Orconectes obscurus*. In this work, crayfish were sampled at fifteen sites from the lower reaches of Fishing Creek to its headwater branches and major tributaries in order to elucidate the current presence and distribution of crayfish species within this watershed. A total of 484 crayfish were collected, representing the species *O. obscurus* (n = 376) and *C. bartonii* (n = 108). *O. obscurus* were found to be widespread within the drainage, but absent from the upper reaches of the Fishing Creek watershed, potentially as a result of physical or environmental barriers (e.g., dams, shifting stream characteristics). *C. bartonii* were primarily distributed in the upper portions of the Fishing Creek watershed, but also found in smaller tributary near the mouth, and sympatric (but in found in low abundance) with *O. obscurus* in the central portions of the drainage. This distribution of *C. bartonii* within the watershed is likely due to habitat preferences (e.g., cooler, smaller, and higher gradient portions of streams) of this species, but may also result from displacement by *O. obscurus*. The historically present *O. limosus* was not collected within the watershed, potentially suggesting local extirpation via competition with *O. obscurus*, as has been reported in other elsewhere in aquatic ecosystems invaded by non-native congeners.

*Keywords: crayfish, native, non-native, survey*

## **LOWER DELAWARE RIVER SPECIAL PROTECTION WATERS ASSESSMENT OF MEASURABLE CHANGES TO EXISTING WATER QUALITY, ROUND 1: BASELINE EWQ (2000-2004) VS. POST-EWQ (2009-2011)**

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The Delaware River Basin Commission (DRBC) adopted the Special Protection Waters (SPW) program in 1992 to prevent degradation in the 197-mile non-tidal reach of the Delaware River and its tributaries where existing water quality is better than water quality standards. Under SPW, DRBC defines Existing Water Quality (EWQ) and monitors sites to ensure that established EWQ is being preserved. Data collected by DRBC, and other monitoring agencies, were used to define site-specific EWQ for locations within the non-tidal Delaware River and tributaries. DRBC recently performed an assessment to determine whether changes to EWQ have occurred between the definition period (2000-2004) and the assessment period (2009-2011) at 24 EWQ sites. For most water quality parameters at most locations, there was no degradation to EWQ and evidence of improved nutrient concentrations, demonstrating the importance and effectiveness of DRBC's Special Protection Waters program. This presentation will describe the SPW program, an overview of the monitoring efforts and methods, and the overall results of this assessment in addition to some examples.

*Keywords: water quality, nutrients, watershed management*



## ROSE VALLEY LAKE SURVEY

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Rose Valley Lake is 369-acre man-made reservoir located in Lycoming County and managed by the PA Fish and Boat Commission for recreational fishing and boating. Since 2000, the Lycoming College Clean Water Institute (CWI) has been a partner with the Loyalsock Creek Watershed Association to complete the chemical and biological assessment of the lake. A major part of this assessment is the determination of the trophic state of the reservoir. This involves measurement of chemical and biological parameters following the protocols of Carlson's Trophic State Index as outlined in the Secchi Dip-In. Rose Valley lake was sampled on June 9, 2017 for this year's assessment at 2 sites. The trophic State Index is calculated based in the Secchi Disc depth, chlorophyll and total phosphorous. For the last decade, the lake has been changing from mesotrophic to eutrophic and this year may have changed to a higher level with a TSI of 71. In addition, zooplankton samples were taken and show a dominance of rotifers especially Keratella.



*Keywords: trophic state, lake*

## LYCOMING COLLEGE'S CWI CONTRIBUTION TO PAFBC UNASSESSED WATERS PROJECT 2010-2017

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This is the 8th year that Lycoming College CWI has participated with PA fish and Boat Commission in the Unassessed Waters Project. To date, the CWI team has completed a total of 473 streams in the Loyalsock, Lycoming, and Pine Creek Watersheds (about 10% of the total amount of streams sampled for this project). In the past 4 years, streams in the Genesee, Alleghany, White Deer Hole Creek, Black Hole Creek, Quenshukeny, Pine Run, and Antes Creek watersheds, as well as unnamed tributaries in Tioga County have been completed. Data for this project has been logged into the PFBC Unassessed Waters Data set for consideration of trout stream protection. The number of class A, B, C, D, and E streams from each watershed will be presented. On average, 50% of the streams sampled support wild trout and nearly 20% are considered class A or B trout streams. A breakdown of the benefit and limitations of this program will be presented. In addition, a comparison of the Alleghany Plato Region and the Ridge-Valley Plato Region will be done, in terms of supporting trout populations. In 2017, Lycoming College sampled 40 streams in the Lycoming, Pine, and Larry's Creek watersheds. Additional Creeks in the Nippenose Valley Watershed were also sampled.

*Keywords: unassessed waters, CWI*

## **BASELINE CHANNEL CHARACTERIZATION OF THE LOWER BUSHKILL CREEK IN EASTON, PA, PRIOR TO THE REMOVAL OF THREE LOW-HEAD DAMS**

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Funds have been allocated through a Consent Order and Agreement by the Pennsylvania Department of Environmental Protection (PADEP) to be administered by the Delaware River Basin Commission (DRBC) to remove the first three run-of-river dams on the Bushkill Creek. Dam 1, the lowermost dam, is owned by Lafayette College and is 1.8 m high and 21.3 m long, dam 2 is 2.4 m high and 39.6 m long, and dam 3 is 1.5 m high and 33.5 m long. The dams will be removed with the goal of restoring the lower Bushkill to a more natural, free-flowing condition and to improve ecosystem function. We are collecting baseline background data on channel morphology and channel bed sedimentology immediately downstream and upstream of each dam. These data will be used to help develop a model of channel response to dam removal and also as the baseline for continued monitoring the channel response to dam removal. We measured multiple channel cross-profiles upstream and downstream of the two upstream dams, and more thoroughly surveyed the channel upstream and downstream of dam 1 near the confluence of the Bushkill Creek and the Delaware River. We are also collecting grain size data at each cross-profile to characterize the channel bed prior to dam removal. During the summer 2017 we mapped approximately 5.7 km of the Bushkill Creek from the mouth of the creek at it's confluence with the Delaware upstream to the bridge at Edgewood Ave in Easton PA. The stream was separated based on physical characteristics into runs, riffles, pools, and dam pools formed. Other characteristics that were mapped include both natural and man-made features such as islands, rip-rap, bridges, significant storm drainage pipes, and retaining walls along the riparian corridor. The proposed dam removals afford a unique opportunity close to our campus to study channel bed dynamics and hydrologic impacts of dam removal at relatively short timescales as well over the long term.

*Keywords: dam removal, channel adjustment*



## **METHODS AND MOTIVATIONS OF WATER PRICING IN PENNSYLVANIA AND THE UNITED STATES**

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This study presents a geospatial analysis of water pricing rates and structures in Pennsylvania (PA) and the United States (US), to provide insight into (1) the value of water and (2) the mobility and variability in water pricing. The study also begins to interrogate reasons for variability in water rates amongst companies characterized as public offering “uniform” rates. Variables tested include population, population density and fixed charge, as these factors may indicate how aptly a company can capitalize on economies of scale or how much it will cost the company to pump water a given distance. A trade off between fixed and volumetric charge amongst public uniform companies is also tested for statistical significance. Rate information procured from the 2015 American Water Works Association, water company tariffs filed with Public Utility Commission, company websites, and direct communication with water company officials over the phone. The data were compiled into spreadsheets and a relational database in a Geographic Information System (ArcGIS). Different water pricing structures were identified and characterized and maps showing the variability across the country and state were generated to disparities in price structures and rates between private versus public companies in PA and between PA companies versus US companies. Increasing block pricing structures were common across the US, yet relatively rarely across Pennsylvania. Decreasing block structures were primarily found in “rust belt” areas across the US. Water prices were consistently higher in arid regions, due to limited water resources, infrastructure, and transmission costs. Both fixed and volumetric charges show variability amongst PA water companies implementing a “uniform” rate structure. Some level of variability can be explained by the aforementioned fixed charge, population, and population density variables. However, further research can be conducted to see capital costs and elevation may also play into water pricing variability. Also, it is important to note the study’s ability to spatially represent pricing variability as an indicator of companies facing different costs in the allocation of water.

*Keywords: water pricing, water economics*

## **ANALYSIS OF SPIDERS FOR HEAVY METALS AND VOLATILE COMPOUNDS**

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The accumulation of heavy metals in indicator species, such as Wolf Spiders, is being studied to determine if levels of cadmium, and other heavy metals, can be detected. Detection of metals can provide information on the potential transfer of metals in the food chain. Spiders and soil have been collected from several brownfield sites, will be dried and extracted, and will be analyzed by flame or graphite furnace atomic absorption spectroscopy for cadmium and a variety of other metals. Live spiders (*Tigrosa Huello* and *Gladicosa*) will also be analyzed for volatiles utilizing solid phase microextraction and gas chromatography/mass spectrometry to identify compounds that may be used for potential natural crop pesticides.

*Keywords: metals, volatiles, spiders*

## **FROM INDUSTRIAL RELIC TO WILDLIFE CORRIDOR: ESTABLISHING WOOD TURTLE NESTING ALONG PINE CREEK RAIL TRAIL**

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The wood turtle (*Glyptemys insculpta*), a native of the northeastern United States and eastern Canada, continues to face pressures from habitat loss and predation. According to the IUCN Red List, the wood turtle is “endangered,” meaning that the species’ cumulative decline over the past 100 years is likely to have exceeded 50%. Considering their low reproduction rates and delayed sexual maturity, continuing research on their reproductive activities and nesting success rate is warranted. This study focuses on the utilization of the Pine Creek Rail Trail by wood turtles for nesting purposes. While defunct railroads are relics from the industrial era in the nation, this particular aged infrastructure has been converted to a recreational space that contemporaneously functions as a wildlife corridor. By further investigating wood turtle activity through a nesting and hatching cycle, our goal was to uncover factors that may be beneficial in promoting stability in population. Nests were found along the entirety of the rail trail. Given that each year a female will only construct one nest, the quantity of nests observed via evidence from predation suggest that there is a significant population attempting to reproduce. Our findings will contribute to developing conservation approaches and strategies for development, management, and environmental naturalization.

*Keywords: Pine Creek*

## **ARE EASTERN HELLBENDER SALAMANDERS IN THE ALLEGHENY RIVER WATERSHED MORE ROBUST AND IN HEALTHIER CONDITION THAN THOSE IN THE SUSQUEHANNA RIVER WATERSHED?**

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Casual observations suggest that individual Eastern Hellbender salamanders from Allegheny River populations are more robust and experience fewer traumatic injuries than those from populations in the Susquehanna River. We compared body mass, total body length, snout-to-vent length, mass/length ratios, and evidence of past or recent injuries for two Eastern Hellbender populations, one from the upper Allegheny River watershed and one from the West Branch Susquehanna River watershed. Mean total body length and snout-to-vent length were significantly larger for the Susquehanna River population. Mean body mass and mass/length ratios were significantly higher for the Allegheny River population. Allegheny River individuals may have experienced fewer traumatic injuries, based on a lower number observable scars, wounds, and bite marks. We conclude that the Allegheny River individuals are smaller in length, but are more robust in body form and in a healthier condition than those from the Susquehanna River. We postulate that the Allegheny River hellbenders may occupy a less stressful environment and have fewer aggressive intraspecific encounters than Susquehanna River hellbenders.

*Keywords: Eastern hellbender, health, Allegheny River, Susquehanna River*

## READY, SET, FIT

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As widely reported in the news media, the majority of Americans are not motivated to get outside and walk to get exercise. As a result of this, sedentary lifestyles are formed which can lead to health problems later on in life. To solve this problem we hope to motivate different communities to walk and exercise around the town while also learning the history associated with the environment with the "Ready, Set, Fit" app.

The app loads several paths from the internet onto the user's device. The user can then select and load any path that they have downloaded to follow as a workout. As the user follows the path, they will reach several points of interest along the route marked by the line on the path. When a user reaches a point of interest, a pop up with information about that point, and an image or video will appear on the screen. Once a user has reached all points of interest, or manually clicked a button to finish a workout, it is saved to their device and can be reviewed at a later date.

Over this summer, student interns gathered data and historical information about towns located near Bucknell University in the Susquehanna River Valley. Some of the towns we worked with include Milton, Sunbury, Danville and Williamsport. Using the Google My Maps App, we created multiple digital paths in the Lewisburg area and the Bucknell campus including: the Arboretum, an Admissions Tour, Historical Information on the university.

In order to produce as many paths as possible, we focused much of our time on paths for Bucknell. For example, we made an archival tour of the campus, using photos from databases to capture what campus was like in the past. We also worked with admissions and created a self-guided tour of the campus which was tailored for prospective students.

As an example of university/community collaboration we focus on T.I.M.E. in Milton. Most recently, the post-industrial town of Milton has been working on updating their Milton in Motion program which motivates people to get out and walk around the town and incentivizes the activity through rewards and discounts at local shops.

For future development we hope to give the public the ability to make their own paths through the easy-to-use Google My Maps app. By crowdsourcing "Ready, Set, Fit," path creation of walking routes with historical and cultural content will be collected at a quicker rate and will be uniquely relevant to the users who created them thereby increasing motivation to get outside and walk.

*Keywords: fitness, history, culture, technology*