

SRHCES Susquehanna River Heartland Coalition for Environmental Studies presents the

Pulse of the Heartland



2017

ANNUAL

REPORT



The Susquehanna River and its watershed define the quality of life for all who live, work, and play within its boundaries. Arguably this region's most important asset, it provides half of the fresh water that reaches the Chesapeake Bay. Its influence extends beyond Pennsylvania to the lives of many within the Chesapeake Bay area.

In this year's report Bob Garrett, President and CEO of the Greater Susquehanna Valley Chamber of Commerce, shares some thoughts on the Susquehanna River's value. There is value in the ecological functions the River performs as well as the recreation it provides.

In recognition of this tremendous asset, six regional colleges and universities joined other partners, including Geisinger Health System, Northcentral Pennsylvania Conservancy, the Forum for Pennsylvania's Heartland and SEDA-COG, to work with state agencies and Chesapeake Bay affiliates to form the Susquehanna River Heartland Coalition for Environmental Studies (SRHCES). Through the Coalition, the faculty, students, and staff's impressive talents are engaged to study and monitor environmental issues within the watershed. Additional promotion and support for this effort have come from sponsors such as Sunbury Broadcasting Co., The Daily Item, the Foundation for Pennsylvania Watersheds, and the Degenstein Foundation.

SRHCES's members meet almost monthly to discuss individual research projects, opportunities for collaboration, and the issues faced in their research. These meetings provide a forum to not only share information, but to also discuss partnerships.

SRHCES has been meeting for a number of years now. The summer work with interns from the various member colleges and universities has allowed the manpower necessary for the **SRHCES** members to take on a variety of research projects, as well as provided those students with invaluable field experience. We've reconnected with some of those students to find out where their internship has taken them (see "Past Intern Spotlight").

We hope you enjoy the updates on the scientists' work and research related to the Susquehanna River and the terrestrial habitat along its banks. We've also included updates from our partners at Geisinger Environmental Health Institute and Sunbury Broadcasting.

FRONT COVER: SRHCES professors and students gathered at Lycoming College this summer to share information about their research. The summer 2017 interns presented brief summaries of their research projects. Some of the students will be continuing their research through next year while others will be wrapping up and summarizing results this fall.

Monitoring/Research

Bloomsburg University

DR. STEVEN RIER

Professor, Department of Biology, Bloomsburg University



Dr. Rier and his three interns are beginning the initial phase of sampling for the Chesapeake Conservancy's project "Implementing Precision Conservation in the Susquehanna River Watershed." This involves testing water chemistry, photosynthesis, ecosystem respiration rates and nutrient uptake.



Rier intern Corey performs testing in the field.

He also surveyed 20 streams throughout central Pennsylvania in order to begin developing a model that predicts the degradation of stream ecosystem function (nutrient uptake and ecosystem metabolism) across an agricultural impact gradient. Each of his interns is pursuing their own research project as well. This includes work with aquatic insects, cyanobacteria (microbes that undergo photosynthesis and produce neurotoxins), and the importance of phosphorus that is delivered in storm events as a source of local stream ecosystem degradation.



A field station site set up by Rier's team.

DR. JENNIFER WHISNER Professor, Department of Environmental, Geographical, and Geological Sciences, Bloomsburg University



Dr. Whisner and her students are collecting and analyzing surface water and groundwater samples on and near deltas of tributaries to the Susquehanna River. These samples will be used to more accurately determine the impact of historic coal mining activities on water quality. They will also continue to collect and analyze data (precipitation, stream discharge, etc.) to improve our understanding of flooding patterns in the Fishing Creek watershed.

In a volunteer role, Dr. Whisner serves as the Chair of the Columbia-Montour Coalition for Source Water Protection. The Coalition is one of the partners that helps make Columbia County Conservation District's annual Water Education Day possible. The innovative environmental education event reaches over 500 Columbia County eighth graders each September. The event helps students understand where their drinking water comes from, how water can be polluted, and the connection between how land is used and the quality of water. Dr. Whisner not only helps organize the event, but spends the day at the river simulator station showing students how land and water interact. The event received statewide recognition in 2017, and earned the 2017 Governor's Award for Environmental Excellence.

Bucknell University

DR. L. DONALD DUKE Visiting Scholar, Department of Civil & Environmental Engineering, Bucknell University



All of us living in the heartland have experienced flooding. Whether it's a wet basement, washed out bank, bridge that was swept away, or something more dire, like the loss of entire neighborhoods and lives lost in swift water, the effects of flooding are widespread and numerous. What makes things interesting for public policy academic studies is that the U.S. leaves many flood mitigation decisions to local government, and since Pennsylvania has more than 2,000 municipalities, there are many ways to respond. State and federal agencies, like the Pennsylvania Emergency Management Agency and the National Flood Insurance Program, add their own incentives, regulations, and funding opportunities, all of great assistance to local governments but adding even more complexity to the situation.

Over the past four summers, Dr. Duke and his interns at Bucknell have been studying Pennsylvania's flood policies and the intensely varying ways they are implemented throughout the state. Under contract with the Center for Rural Pennsylvania, an agency of the Pennsylvania General Assembly, and in collaboration with researchers at Pennsylvania State University, he has drafted a 200 page report investigating ways in which national flood insurance, state programs, and local agencies are responding to the continuing threat of flooding in Pennsylvania. The report gives 19 conclusions and recommendations that can help reduce Pennsylvania's flood problems.

Dalton Stewart, his intern this summer, was researching the various factors that lead people to choose to purchase, or not purchase, the controversial federal flood insurance. Factors that could make it more affordable and more widely used can help Pennsylvanians to recover from any future devastating floods.

DR. BENJAMIN HAYES Director, Watershed Sciences & Engineering Program, Bucknell University



This past year, Dr. Hayes supervised three undergraduate research fellows. Alan Goecke, a senior pursuing a B.S. in Civil Engineering, explored the use of temperature as a tracer to measure exchanges between groundwater and surface water in wetlands. Josh Williard, a senior pursuing a B.S. in

Environmental Engineering, studied the temporal and spatial changes in water temperature in the lower West Branch Susquehanna River. Kyle Adams, a senior pursuing a B.A. in Economics and a B.A. in Comparative Humanities. assessed the methods and motivations



Hayes's intern Alan conducts research in a wetland.

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Hayes's interns deploy temperature monitors in the Susquehanna River.

underlying water pricing in Pennsylvania and the rest of the United States. Dr. Gregory Krohn, Professor of Economics, and Janine Glathar, GIS Specialist, also helped supervise Kyle's project (see Dr. Krohn's write-up below).

Dr. Hayes continued his own research on the legacy of historic logging on modern stream landscapes, physical habitat, and thermal dynamics of the lower West Branch of the Susquehanna River. He continues to serve as Director of Bucknell's Watershed Sciences and Engineering Program, and Chairman of the Susquehanna River Symposium.

DR. GREGORY KROHN Associate Professor, Department of Economics, Bucknell University



Dr. Krohn is studying the effectiveness of voluntary and mandatory residential water use restrictions during times of drought. He plans to assess the effectiveness of these drought status declarations on reducing residential water use in recent years, and how the effects relate to the price of water.

A student of Dr. Krohn's, Kyle Adams, is studying how residential water prices vary across the state of Pennsylvania and the United States. Some water companies levy a fixed initial charge and uniform rate applied to the quantity of water consumed. Other companies adopt a block rate structure in which the price per gallon increases or decreases as a customer uses more water. For each type of pricing, the parameters (such as price per gallon) can vary across companies. These pricing parameters are not readily available and must be obtained from each individual company. In addition to comparing the types and parameters of water pricing schedules, Kyle will observe their geographical locations and identify patterns and questions for further research. Dr. Benjamin Hayes is also advising Kyle on this project. The Pennsylvania Department of Environmental Protection reviews precipitation and groundwater levels, stream flow, soil moisture, and reservoir storage to identify drought conditions on a county basis. During a drought watch, citizens are asked to reduce water usage voluntarily by 5 to 10 percent. During a drought warning, this is raised to a 10 to 15 percent reduction. If the Governor declares a drought emergency, mandatory water use restrictions are put into place. Each public water supplier may request voluntary or mandatory water use restrictions within its service area in advance of any state announcements or declarations.

DR. MATTHEW MCTAMMANY Associate Professor, Department of Biology and Environmental Studies Program, Bucknell University



Dr. McTammany's current focus is the effects of stream restoration projects on physical habitat in streams. The restoration projects are a collaboration with Susquehanna University, Pennsylvania Department of Environmental Protection, Pennsylvania Fish and Boat Commission, and the Union County Conservation District. He is evaluating the physical improvements to the habitat, such as water depth and flow, while others are studying the restoration projects' biological effects, such as potentially increasing biodiversity. These projects have taken place in various streams in Union County. So far, Dr. McTammany has observed rapid improvements from the restoration efforts, sometimes in as little as one month. Factors such as water depth, velocity, and levels of sediment have all improved after stream restoration has taken place. He will continue evaluating these sites through the coming year.

As for data analyses, Dr. McTammany will be looking at the impact of the Susquehanna River on carbon dioxide levels, and research done with macroinvertebrates. For both the West Branch and main stem of the Susquehanna River, uptake and output of carbon dioxide through river metabolism have been measured since 2009. Dr. Benjamin Hayes and Sean Reese, also from Bucknell University, have collaborated on this project. Rates of both photosynthesis and respiration were found to increase during summer months, as expected. Photosynthesis is higher during dry periods, while respiration rates go up in times of persistent rain. Once a flood stage is reached, plants are unable to photosynthesize at all.

Despite these commonalities, the branches of the Susquehanna River also have nuanced differences. The main

stem was found to have higher rates of both photosynthesis and respiration when compared to the West Branch and to be a net producer of carbon dioxide. This means the main stem produces more carbon dioxide through its organisms' respiration than is being absorbed through their photosynthesis. However, the West Branch had a relative carbon dioxide output of zero, meaning photosynthesis equalizes its respiration output. The main stem's activity also peaks later in the year, with the most river metabolism occurring in late summer or early fall as opposed to late spring or early summer in the West Branch. Seasonal cycles in metabolism are also much more dynamic in the main stem than in the West Branch. Lastly, the main stem contains phytoplankton (microbes that undergo photosynthesis), which increase in biological activity after heavy rain as flood waters recede. The West Branch does not contain these organisms, so photosynthesis decreases after storms.

In macroinvertebrate surveys, bugs are usually collected in riffle areas, since the water is fast moving and highly oxygenated. However, many species live in slower moving pools and backwaters. While there are some species that can live in both environments, there are many excluded in riffle-only surveys. Dr. McTammany has found that stagnant backwater habitats in the river contained over 30 unique taxa not found in riffle habitats, which increased total surveyed biodiversity of the river by 36%. And while most of these taxa were not the typical mayflies, stoneflies, and caddisflies found in riffles, these worms, flies, and mollusks represent an important and often overlooked component of benthic invertebrate communities of the Susquehanna River.

SEAN REESE Project Scientist, Watershed Sciences & Engineering Program, Bucknell University



This year, through the Watershed Sciences and Engineering Program at Bucknell's Center for Sustainability and the Environment, Sean Reese and his student intern Tom Sleigh are researching if the Adam T. Bower Memorial Dam near Sunbury affects native fish populations. This dam is located just below the confluence (flowing together) of the West Branch with the main stem of the Susquehanna River, and is one of the largest inflatable dams in the world. It is inflated and deflated seasonally to create Lake Augusta. However, minimal amounts of scientific research have been conducted during its operation.

Mr. Reese is hoping to get a better understanding of if and how the organization of fish communities is related to hydrological

variations caused by the inflatable dam. He is using an active sampling technique known as night-time boat electrofishing, commonly used to capture a variety of fish taxa. By putting a small amount of electricity into the water to temporarily stun the fish, they



Reese intern Tom assists with a night-time electrofishing survey.

are then able to be collected, identified, measured and released unharmed.

DR. MIZUKI TAKAHASHI Assistant Professor, Department of Biology, Bucknell University



Dr. Takahashi has been working on two projects pertaining to the spotted salamander *(Ambystoma maculatum)* this summer. The first project aims to study the effects of road salt on wetland ecosystems. Salty runoff can hurt frogs and salamanders, as well as zooplankton that salamander larvae feed on. Higher salt levels may inhibit the animals' growth and affect their behavior. When wood frogs are in the tadpole stage, they eat the eggs of other amphibians, including spotted salamanders. Wood frog tadpoles also compete with spotted salamander larvae for zooplankton. In this way, spotted salamanders may be doubly harmed by road salt and predation. Dr. Takahashi has set up outdoor ponds where he manipulates salt levels and studies the effects.

Additionally, Dr. Takahashi's team is conducting a sort of paternity test for spotted salamanders. These amphibians undergo group mating, so it can be unclear who the father of the clutch really is. DNA fingerprinting will be used to sort out which animal (or animals) have successfully passed on their genes.

King's College

DR. BRIAN MANGAN Professor, Department of Biology, King's College



Dr. Mangan is continuing a number of his research topics during 2017. Two of his projects are related to the red-backed salamander (*Plethodon cinereus*). In previous research, Dr.

Susquehanna River Symposia - A Look Back

With input by Dr. Benjamin Hayes, Chairman of the Susquehanna River Symposium

For the past 11 years, Bucknell University has hosted the Susquehanna River Symposium, in which SRHCES partners gather to discuss their research and work. The symposium features special keynote speakers from a variety of backgrounds, such as research scientists, former senators, and speakers from Harvard, the Susquehanna River Basin Commission, the National Park Service, and the U.S. Fish and Wildlife Service. After the opening lectures, the student researchers gather for a poster session in which they present their work to fellow students, professors, scientists, engineers, and consultants. This is a wonderful networking opportunity for the students and makes for a lively evening. The following day, various presenters will speak about their research in smaller "breakout" sessions. After lunch, a group discussion ends the day.

The symposium has addressed a variety of topics affecting the heartland over the years. The 2007 symposium addressed the effects of abandoned mines, which once brought prosperity to the heartland, but left an impact on the environment. Fortunately, restoration efforts have helped to bring impaired streams back to life. The following year, the effects of agriculture on the health of the Susquehanna were discussed. In 2009, "Cultures at the Confluence" featured speakers from the Chickasaw and Iroquois nations, bringing in Native American perspectives on the river. The influence of the Susquehanna River on the Chesapeake Bay was explored in 2010's "Exploring Our Vital Resource." The next symposium returned to a local focus, discussing how the river provides a variety of assets to the towns along its banks.

After a devastating flood in 2011, flooding in the heartland became the central topic for "Wasn't That a Mighty Storm!" The effects of historic mills and canals on the Susquehanna were explored in 2013's "A Fragmented System," as well as the current effects from hydroelectric plants and dams. "Science and the River" highlighted the various scientific studies conducted in the heartland, especially in the fields of aquatic biology and hydrology. Last year, the symposium branched out to include the Delaware River in "A Tale of Two Rivers." The Delaware will also be featured in this year's symposium, entitled "The Spirit of Two Great Rivers." Thomas Porter, a spokesperson from the Mohawk nation, will be featured as this year's keynote speaker.

Mangan's lab discovered a significant difference in the mercury load of two morphs (varieties of the same species) of this salamander, which they concluded could be due to differences in diet between these morphs. Therefore, this year they plan to determine the diet of the morphs by flushing the stomachs of the adult salamanders to see if there is a difference between the two

In a second project with salamanders, Dr. Mangan and his team will explore habitat variables associated with artificial cover objects (ACOs). ACOs are commonly used in terrestrial salamander research. These objects are placed on the forest floor to provide habitat and refuge for salamanders, while simultaneously providing researchers with an opportunity A spined micrathena spider, used to sample salamander



by Mangan in his studies.

specimens. Dr. Mangan hopes to investigate the interactions between the absorption and retention of soil moisture relative to ACO size in riparian forest plots.

In another ongoing study, Dr. Mangan's team has returned to investigating a common forest spider, the spined micrathena (Micrathena gracilis). Dr. Mangan and his students have previously shown that these spiders could be used to identify a gradient in mercury contamination downwind of a coal-fired power plant. In this study, his team will be investigating the relationship between spider abundance and tree density in a riparian forest. In doing so, he is incorporating a new sampling method that potentially increases habitat opportunities for this spider. Dr. Mangan has also been collaborating with Dr. Matt Persons of Susquehanna University in his investigation of mercury contamination among wolf spiders (see page 14 for more information on Dr. Persons' work).

Lock Haven University

DR. MD. KHALEOUZZAMAN Professor, Department of Geology and Physics, Lock Haven University



OF PENNSVIVA

Recently, Dr. Khalequzzaman, who goes by Dr. K, has been working on three projects

dealing with water quality in and around Clinton County.

Marcellus shale well pads often require the construction of new gravel roads. Some have speculated that runoff from

these new roads may be a cause of increased turbidity (cloudiness caused by sediment) in local streams. To evaluate this theory, Dr. K took sediment samples from streams, streambanks, and the new gravel roads themselves to compare their compositions. He also performed soil and water assessments. TWI (Topographic Wetness Index) and ArcSWAT (Soil and Water Assessment Tool) software were used to model runoff patterns and see where possible pollutants may be coming in from. All of these factors were compared between a road leading to a 9-well pad, and a road in a mixed agricultural area. After evaluating metals such as calcium, strontium, and manganese, Dr. K did not find that the gas-related roads were the cause of increased stream turbidity. This may be because the new roads are following best management practices and are kept in good condition. In some cases the agricultural road actually created more runoff. due to being older and not as well maintained. In the summer of 2017, two new locations were added to this study.

Dr. K is also looking at the quality of Lock Haven's public drinking water, which is stored in and then drawn out of two reservoirs. The city's residents demand approximately 2 million gallons of water per day. Water drawn out of the reservoir is treated before entering the public drinking water supply, as it comes from various streams in the area. Dr. K sought to analyze the quality of these source waters, to see how much water treatment and pre-filtering is necessary. By testing

measures such as nitrates. nitrites. phosphorus. ammonia. and heavy metals, Dr. K determined that the surface waters are of good quality, and possibly some of the best in Pennsylvania.

Although the water is excellent quality by these parameters, its temperature is elevated due to standing still in the reservoir. When water from the Keller Reservoir discharges back into McElhatten Creek. it is warmer and



Dr. K, along with interns Autumn and Scott, measures the flow of McElhattan Creek.



Dr. K's team works with local officials to evaluate the effects of Keller Reservoir on McElhatten Creek.

The Nature Conservancy (TNC) Working Woodlands Program

While Dr. K from Lock Haven University is studying the water quality at the Lock Haven Water Authority's reservoirs, The Nature Conservancy (TNC) is studying the Authority's forest and working to improve the forest health and function. The Lock Haven Authority owns over 1,400 acres of land in Clinton County. The property surrounds its drinking water reservoirs. In 2014, the Authority finalized a forest management plan and entered TNC's Working Woodlands program. Working Woodlands is a model forest conservation program that brings together certified forest management and the carbon market to help conserve private forests.

Working Woodlands is part of TNC's PA Forest Conservation Program. TNC is a Forest Stewardship Council (FSC) Certified Resource Manager which allows TNC to provide FSC certification for private landowners. Foresters with TNC inventory the property using standard, FSC approved protocols and then develop a certified management plan based on current site conditions and future goals.

The Lock Haven Water Authority also entered into a working forest conservation easement with TNC to ensure the property remains a working forest and serves as open space to allow rainwater and snowmelt to be absorbed and enter the groundwater system.

One of the Authority's goals in managing the property and entering into Working Woodlands is to ensure the drinking water being drawn from this property remains high quality water. Dr. K's research will be useful to the Authority and TNC as they move forward with the overall goals to improve the property's ecological function and maintain high quality drinking water. may cause stress to fish living downstream. Working with local authorities, Dr. K and his team have deployed data loggers to monitor the changes in temperature between upstream and downstream sites. Measurements are recorded every 30 minutes, and this study continued through September 2017. Flow measurements have indicated a discrepancy between water flowing into the reservoir and the amounts being drawn out or put back into the creek, so more investigation is needed to discover where the extra water is going.

Water quality is also being monitored at Beech Creek and Lick Run. Beech Creek is an impaired stream as a result of acid mine drainage (AMD). It has been monitored since 2010 and its quality has shown to be steady or slightly improving over the years. Lick Run, on the other hand, is a Class A trout stream and is already high quality. However, it has elevated levels of magnesium and manganese, which may be leaching out of stone exposed at a nearby quarry. This issue will continue to be researched.

DR. STEVE SEILER Associate Professor, Department of Biology, Lock Haven University

Dr. Seiler spent the month of June teaching at Chincoteague Bay Field Station, located in Wallops Island, Virginia. His students studied aquatic life with seines



(large nets), long-line fishing, and electrofishing. He enjoyed the experience and was amazed at the diversity of fish in the area.

Now that he's back at Lock Haven University, Dr. Seiler, his interns, and Dr. Heather Bechtold will be surveying streams for the Unassessed Waters Initiative (see Table 1). They had previously assessed 80 streams, focused in the areas of



Dr. Seiler and his interns survey a stream for the Unassessed Waters Initiative.

Salladasburg, Renovo, and the Allegheny National Forest. This year, they intend to survey 20 streams located closer to Lock Haven.

Dr. Seiler will also be evaluating water chemistry, macroinvertebrates, and fish communities in the Allegheny National Forest. Some of these streams have not been surveyed in decades, so Dr. Seiler aims to update our knowledge of their physical conditions and the organisms living in them. His students will help with sample processing and data analysis. They will also be pursuing individualized projects, such as estimating primary (bottom of the food chain) productivity with plants' Chlorophyll A, and testing the genetics of fish fin clips to establish population estimates.

DR. PETER PETOKAS Research Associate, Lycoming College Clean Water Institute



Dr. Petokas and his team

undertook a variety of projects this summer. Foremostly, his efforts in eastern hellbender salamander conservation will continue into their twelfth year. The team dons wetsuits and searches for hellbenders in streams. This involves lifting heavy rocks and reaching underneath to hopefully find animals. Caught hellbenders are then tagged, weighed, and measured, and any unusual characteristics are noted. Some have blood samples drawn for further testing. Once all animals at a site have been evaluated, each one is released beneath the rock where it was captured.

Aside from hellbenders, Dr. Petokas is also doing work with streamside salamanders and crayfish in headwater streams. His team picks out a number of sites along a stream, then captures salamanders in seine nets, or on land beneath rocks and debris. Any salamanders or crayfish caught are identified, measured, and released.



Dr. Petokas with interns Anthony, Ruric, and Paige collecting crayfish and salamanders with a seine.



Petokas's interns Paige, Ruric, Anthony, and Jenny help with an educational outreach program in Montoursville.

Another project his team is pursuing is the use of environmental or eDNA to detect eastern hellbender presence in streams. Since hellbenders are so hard to find, this procedure is helpful because it allows for their detection through water samples instead of physically catching them. Hellbender DNA from sources such as skin can be isolated and amplified in the lab. This amplification process is known as polymerase chain reaction (PCR), and produces many copies of the DNA to make it more easily detectable. This process also gives a quantitative measure of how much DNA is in each sample. This research can be used to discover hellbenders in streams previously unknown to have them, or to confirm their absence in impaired streams.

The eDNA project is currently being expanded to allow for detection of the rusty crayfish. This is an invasive species that is driving out the native Allegheny crayfish. The rusty crayfish is larger and more aggressive than the native crayfish. It also may be impacting hellbender populations. Due to its increased size and higher levels of aggression the rusty crayfish are harder prey to catch and may leave the hellbenders hungry.

DR. ROBERT SMITH Assistant Professor, Department of Biology, Lycoming College

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LYCOMING COLLEGE

The newest member of the Lycoming College Clean Water Institute is Dr. Robert Smith. He joined Lycoming College last year after working as a postdoctoral researcher at the University of Massachusetts-Amherst and a visiting professor at the College of the Holy Cross. He researches several aspects of the natural history of aquatic insects. In addition, Dr. Smith studies how urban land development alters the health of streams and rivers. He, along with three interns, pursued a number of research projects this summer.

Unassessed Water Initiative - Number of Streams Sampled								
Bucknell University	Researchers McTammany (p.5)	2010	2011	2012	2013	2014 41	2015 41	2016
Kings College	Mangan (p.6)	23		22	10	<i></i>		
Lock Haven University	Seiler (p.8) Zimmormon (n. 11), Smith (n.9)	//3	90	20 91	19 77	24 78	32	20 76
Susquehanna University	Niles (p.13), Bilger (p.11)	40	82	64	184	165	103	40 85
Other Partners		20	259	409	486	446	346	473
Streams Sampled by all Partners Streams Sampled by PFBC		86 217	437 305	606 262	766 324	724 336	522 370	624 353
Total Streams Sampled		303	742	868	1,090	1,060	892	977
Total Steam Miles Sampled		809	1,762	2,057	2,424	1,959	1,578	1,821
% with Wild Trout		54 %	55%	52%	38%	48 %	40 %	38%

Table 1: SRHCES partners have contributed greatly to the PA Fish and Boat Commission (PFBC) Unassessed Waters project since 2010, sampling 1,326 of the 5,932 streams representing 22% of total streams sampled. For more information about the Unassessed Waters project and the various partners read the associated researchers sections in this report (page numbers provided in table above).

One project uses a survey of stream invertebrates (insects. crustaceans. worms. etc.) to evaluate the health of a stream running through an urban area in Williamsport. Streams in cities receive water that drains from impervious surfaces (e.g., roads, sidewalks, etc.) that is transported by stormwater systems to the stream channel. This research project was designed to test how communities of stream invertebrates and water chemistry change in relation to



Smith intern Cayla measures the slope of Miller's Run.

different levels of stormwater inputs. This type of research can help municipalities make decisions about how to manage stormwater to promote healthy aquatic environments.

Additionally, Dr. Smith's lab is conducting a study examining how adult stream insects move into the forest canopy. The life cycle of some stream insects includes an immature stage that lives in the water and a winged adult stage that lives in the terrestrial environment. Adults are able to move long

distances by flying along the stream or laterally into upland areas surrounding the stream. Yet, few studies have examined the movement of adult stream insects upwards into the forest canopy. This study is based on the hypothesis that stream insect species that move into the forest canopy will have longer and thinner wings (good for gliding above the forest canopy) than those that stay just above the stream.

Dr. Smith's lab is also working on research examining the effects of global warming on invasive plant species. The current project examines how Canadian Thistle responds to soil warming, one of many expected environmental changes resulting from global climate change. This invasive species is outcompeting native plants, and understanding how it grows can help develop ways to limit its spread into **10** uncolonized areas.



Smith interns Brittany, Sarah, and Cayla conduct a habitat assessment of Miller's Run.

The student running this research is currently growing plants in a green-house and subjecting them to different temperatures as part of a pilot study. Lastly, Dr. Smith is collaborating with Dr. Mel Zimmerman to conduct electrofishing surveys for the Unassessed Waters Initiative (see Table 1). This collaborative project documents the presence of naturally reproducing trout populations for the PA Fish and Boat Commission, which uses the data to manage trout populations in the state. The majority of the streams sampled for this project are in the Pine Creek and Kettle Creek drainages, including the Tioga and Tiadaghton State Forests.

DR. MELVIN ZIMMERMAN Professor Emeritus, Department of Biology, Lycoming College and Director of Clean Water Institute



The Clean Water Institute (CWI) will be evaluating streams for the Unassessed Waters Initiative (see Table 1) for the eighth year. Interns working with Dr. Zimmerman and Dr. Bob Smith will be surveying 40 streams in the Kettle Creek, Larry's Creek, and Pine Creek watersheds. He is also monitoring stream restoration projects, specifically at Wallis Run, Mill Creek, and Elk Creek. These streams' restorations were damaged by last year's flooding and were repaired in late July 2017. The restoration projects are evaluated both before and after repairs are made.

As an offshoot of last year's Municipal Separate Storm Sewer System (MS4) outfall analysis project, Dr. Zimmerman's team will be surveying urban streams in Loyalsock Township. This is a parallel study with Dr. Smith's survey of Miller Run. The



Zimmerman interns Sam, Jon, and Mikayla conduct an electrofishing survey for the Unassessed Waters Initiative.

streams of Bull Run, McClure Run, and Grafius Run were tested for aluminum levels as well as for macroinvertebrates, fish, and standard water chemistry. Interns have also completed the annual Secchi Dip-In on Rose Valley Lake for the eleventh year. Data sondes (probes) will be installed in four tributaries to the Loyalsock Creek, to monitor conductivity and water depth. This project is supported by the Loyalsock Men's Club and the Loyalsock Creek Watershed Association.

The CWI has also been involved with a number of educational outreach events. They have lead educational activities for local students at Waterdale Environmental Center, Loyalsock Creek near Montoursville, and Black Hole Creek near Montgomery. They also participated in the Sunrise Sunset Susquehanna event, hosted by the Middle Susquehanna Riverkeeper.

EMILY BOHLIN Research Assistant and Lab Manager, Department of Biology, Lycoming College



Emily Bohlin has helped the

Clean Water Institute (CWI) on a couple of projects this summer. She took Dr. Bob Smith's interns out to a potential field research site and conducted a plant survey. The site is 19 acres with both upland forest and riparian areas, with a small stream flowing along its southern side. They characterized the tree communities by point-quarter sampling and took a general inventory of the trees, shrubs, and herbaceous plants. Emily also assisted with CWI's educational program at Waterdale Environmental Center and played a key part in establishing Waterdale's arboretum and the plant guide for their nature trail.

Susquehanna University

MIKE BILGER Aquatic Research Scientist, Freshwater Research Initiative, Susquehanna University



Throughout the spring and early summer, Mike Bilger was involved in a number of stream studies, He sampled nine sites in cooperation with Chesapeake Conservancy's project "Implementing Precision Conservation in the Susquehanna River Watershed", 16 agriculturally influenced stream restoration sites in Montour, Northumberland, and Union Counties, and continued studies for the Berks and Mifflin County Conservation Districts. He collected data on water quality, stream discharge, macroinvertebrates, and fish communities. Mr. Bilger also

collaborated with Dr. Jonathan Niles of Susquehanna University for the Unassessed Waters Initiative (see Table 1), and with Dr. Brian Mangan of King's College to study the diet of crayfish in the Susquehanna River (see page 6 for more information on Dr. Mangan's work). As a parallel study with Dr. Jack Holt's diatom project, Mr. Bilger tested water quality and collected algae and



Mr. Bilger and a student work to identify and count the fish caught during an electrofishing pass on Turtle Creek.

insect samples at five headwater streams (see below for moreinformation on Dr. Holt's work).



Mr. Bilger and a student work to process the fish caught while electrofishing on Turtle Creek. Their "office" for the day was a stream crossing in a field, and their office "furniture" for the day were coolers, buckets, and a folding stool.

DR. JACK HOLT Professor, Department of Biology, Susquehanna University



For the past eight years, Dr. Holt and his team have been taking biological samples from five sites on and near Byers Island, located in the Susquehanna River

just north of Selinsgrove. More recently, the team has also been monitoring five tributary streams to Penns Creek, which is itself a

tributary to the Susquehanna River. Rock baskets are placed in the water, and rocks are taken back to the lab to isolate



Holt interns Maggie and Elise work at categorizing a diatom based on SEM imaging.

diatoms. Diatoms are types of algae which serve as a food source for other organisms, and can be indicators of water quality.

Since diatoms reside in a mucilaginous layer, which is thick and gluey, their isolation requires several washes and treatments with various acids. After more than a week of processing, the diatom samples are coated with gold and analyzed using a scanning electron microscope (SEM). This high magnification allows for accurate identification and enumeration of these small organisms.

Although the headwater streams are all located within a 10 km span (roughly six miles), only one species of diatom has been found to be dominant in all sampling locations. This means the streams are not similar enough to serve as reference points for the river or even for each other. Dr. Holt and his team will continue sampling from these sites to expand their profile of known diatoms and search for more commonalities. Dr. Holt's team is collaborating with Mike Bilger to survey macro-invertebrates, as obtained through rock baskets and kick samples (kicking into the streambed and seeing what insects come up). Water chemistry is being monitored, through collaboration with Dr. Lachhab (see below for more information on Dr. Lachhab's work). They also intend to study the effects of dappled and intermittent sunlight in these headwater streams.

DR. AHMED LACHHAB Associate Professor, Department of Earth and Environmental Sciences, Susquehanna University



Dr. Lachhab recently returned from leading two programs in Iceland,

teaching students about the country's geology, impacts from global warming, alternative energy, and culture.

He and two interns are pursuing a number of projects in



Dr. Lachhab, Dr. Holt, and their 2017 interns.

northcentral Pennsylvania this summer. First, they are continuing their hydrogeophysical study of Montandon Marsh, located in Northumberland County. They will be studying the marsh's hydrology using electrical resistivity, which creates a computer model of underground characteristics such as voids and fault lines. This project is a collaboration with Rob Jacob from Bucknell University. The team will also be studying the bathymetry of Faylor Lake, located in Snyder County. Bathymetry is a form of topography dealing with underwater areas. This will be studied using ground-penetrating radar (GPR).

His interns are also conducting a hydrogeochemical study of five headwater streams to Penns Creek, located in Bald Eagle State Forest. They are monitoring discharges from the streams and evaluating their water chemistry. Previous studies showed that the streams were similar when compared at the same elevation, but new data shows that the streams differ when observed closer to their confluences with larger streams. Along the way, Dr. Lachhab's team has been creating a new water quality index (WQI) that is more suitable for these headwater streams, based on scientific literature and pre-existing methods. Lastly, Dr. Lachhab is writing up the results from last year's study of Peck's Pond in the Delaware State Forest in Susquehanna County. This project was a collaboration with the University of Pennsylvania and Widener University, and studied the pond's bathymetry and sediment deposits.

DR. JONATHAN NILES Director of the Freshwater Research Initiative, Susquehanna University

Dr. Niles will continue his collaboration with the Pennsylvania Department of Environmental Protection, the



Northcentral Pennsylvania Conservancy, Pennsylvania Fish and Boat Commission, and county conservation districts in constructing and evaluating stream restoration projects. These efforts help to reduce the amount of sediment from the stream's banks eroding into the stream. Sediment is especially harmful to streams because its cloudiness blocks out sunlight, and prevents plants from undergoing photosynthesis. This in turn means less dissolved oxygen is being produced, so fish and other aquatic animals become stressed in these suffocating conditions. Agricultural regions are especially known for having erosion problems, since they often lack vegetation along their stream banks.

In 2015, Dr. Niles began monitoring sediment loads from six restoration sites, and added 10 more to the list in 2016. He hopes to find improvements in water quality, fish populations, and biodiversity after stream restorations take place. So far, analysis shows an increase in the fish population in five of the six original streams. Only one stream showed an increase in macroinvertebrate diversity, but it reached a high enough level to potentially not be considered impaired anymore.

Fish and macroinvertebrates are being studied at 30 sites in the Loyalsock Creek watershed. Air and water temperature are also being monitored, to measure the effects of climate change on the waterway. After the flood in October 2016, brook trout populations have had significant losses in the tributaries draining on the west side of Loyalsock Creek, and Dr. Niles continued sampling for trout this summer. Shannon White, a PhD candidate at Pennsylvania State University, will be collaborating with Dr. Niles to study the microRNA (miRNA) of brook trout when they are subjected to thermal stress. Dr. Niles and his interns will also be surveying 55 sites for the Unassessed Waters Initiative (see Table 1). These streams are located throughout Clearfield, Jefferson, Lycoming, and Sullivan Counties.

This summer, Dr. Niles began a new project with the Chesapeake Conservancy, Dr. Steve Rier of Bloomsburg University and Dr. Dan Ressler of Susquehanna University.



A site on Loyalsock Creek impacted by last year's flooding.

They will be studying the impacts of precision conservation techniques, which take into account both high-resolution mapping datasets and on-the-ground restoration efforts (see page 3 for more information on Dr. Rier's work). They will be evaluating fish and macroinvertebrate diversity, water quality, and nutrient levels both pre- and post-restoration at nine sites in Centre County.

Dr. Niles is also collaborating with Mike Bilger from Susquehanna University on monitoring macroinvertebrates at 33 sites at Fort Indiantown Gap (see page 11 for more information on Mike Bilger's work).

Lastly, Dr. Niles has been working with Dr. Chris Grant and Dr. Gina Lamendella from Juniata College to determine if fracking operations have increased mercury levels in headwater stream ecosystems. They are monitoring 45 sites with naturally reproducing brook trout populations, and are analyzing data from last year. Dr. Niles is also working with Dr. George Merovich of Juniata College to study smallmouth bass in the Susquehanna River.

DR. MATT PERSONS Professor, Department of Biology, Susquehanna University



Coal mining, burning, and coal ash burial can all introduce large amounts

of mercury into the environment. This long-lasting pollutant can reach toxic levels as it moves up food chains. Since spiders are at the top of the arthropod food chain, they are good indicators for the presence of this dangerous pollutant. Dr. Persons and his team of interns collected spiders from locations such as coal ash retention ponds, former surface mining sites, around underground coal fires, and areas downstream from coal fired power plants. These spiders are being used as indicators of mercury levels in their surroundings.

Mercury levels in wolf spiders can reach levels comparable to or higher than some fish species. This is because females can pass mercury directly to their offspring. Wolf spiders are also highly cannibalistic and will feed on smaller individuals of their own species, as well as other species of spiders. Due to their elevated levels of mercury, wolf spiders are an excellent way to monitor mercury as it moves through living things. After being collected, identified, and labeled, the spiders are sent out to Dr. Brian Mangan of King's College, who tests the spiders' mercury levels (see page 6 for more information on Dr. Mangan's work).

Research into spiders' inundation tolerance continued from last year. When spiders live too close to water, they run the



An orange Shamokin Creek, characteristic of acid mine drainage.

risk of being drowned during high water events. Luckily, they have developed adaptations to overcome this threat. Some species have been known to produce plastrons, a specialized kind of bubble to help them breathe underwater. Others can use their silk to form a "gill". If a spider does not have a method to keep breathing underwater, then it will either enter a hypoxic coma or die. Once out of the water, a comatose spider will recover after a few hours. Dr. Persons and his interns are investigating and comparing the recovery times of spiders living at the water's edge to those living further away on land, and examining why certain species die within minutes of being submerged while others can remain active while being submerged and show no ill effects at all. He hypothesizes that the number and distribution of specialized hairs on the bodies of certain species as well as the form of their respiratory structures allow them to be semi-aquatic.

Dr. Persons and his interns are also investigating spontaneous male death during mating among fishing spiders. Males appear to mate with only one female and then die immediately

afterwards. Females often drag the male body around for a period of time, and sometimes eat him. This special form of monogamy called monogyny is extremely rare among animals. One would think that dying during mating would be disadvantageous, since males forfeit the ability to seek out and mate with additional females.



Persons intern Tara collects wolf spiders at a former surface mining site.

Dr. Persons' interns will be manipulating the social conditions of mating as well as the physical environment to see if males only engage in spontaneous suicide under specific conditions.

DR. LOU ANN TOM Associate Professor, Department of Chemistry, Susquehanna University



Dr. Tom was not actively conducting any research this summer, but instead was writing up results from her

previous research for publication. Her project dealt with using ultraviolet light to break down drugs commonly disposed of by the public. Patients sometimes flush their excess medication down the toilet, which can lead to it entering the environment and potentially harming aquatic life. These commonly used drugs were detailed in a list issued by Bucknell University and Geisinger Health System. She also tested the degradation of drugs in pill form, which would be thrown out by consumers, versus in their pure chemical form. High Performance Liquid Chromatography was used to measure levels of the drugs remaining over time, and bioluminescent bacteria were used to test toxicity before and after UV treatment. A possible issue with these bacteria is that they are saltwater as opposed to freshwater bacteria. This means the toxicity results may not be as applicable to life in the Susguehanna River. She will continue testing this procedure in the fall.

Overall, her results show that water-soluble drugs take only a few hours to degrade, while insoluble drugs take several days to reach sufficiently low levels. In the future, Dr. Tom would like to investigate the levels of toxins such as metals, pesticides, and pharmaceuticals in the Susquehanna River. She also intends to continue collaborating with Dr. Matt Persons of Susquehanna University on determining mercury levels in wolf spiders, and also identifying volatile compounds in spiders as potential pesticides.

What you do with leftover prescriptions can have a lot to do with water quality. In 1999 and 2000 U.S. Geological Survey researchers found low levels of a variety of prescription drugs in 80% of the streams they sampled. This could be a problem for the fish and other aquatic life in the streams. It could also be a problem for drinking water. To find a drug take back program near you, visit the PA Department of Drug and Alcohol Programs website at http://www.ddap. pa.gov/Prevention/Pages/Drug_take_back.aspx

GEOFF SMITH Biologist, Pennsylvania Fish and Boat Commission (PFBC)

Geoff Smith and the PFBC have been continuing work on many of last year's projects. With the help of an intern from



Susquehanna University, Geoff will be looking into smallmouth bass disease, and population characteristics of invasive flathead catfish. The largest specimens of this catfish are the rarest and hardest to catch, so the PFBC only has partial information on their age and growth trends at the upper end of the species growth range. This information will later be compared to the growth rates of flathead catfish within their native range to help inform management. They will also be researching muskellunge (a large species of pike) reproduction in large Pennsylvania rivers.

As a collaboration with Michigan State University, Mr. Smith has been researching the effects of largemouth bass virus (LMBV) on smallmouth bass. Previously, the virus was only known to infect largemouth bass, but it has been found to cause substantial effects on smallmouth bass as well. Smallmouth bass with the disease also show different symptoms than largemouth bass, such as developing lesions. The virus's genome is currently being sequenced in hope of finding the genes that are causing this change in infection.

JASON FELLON Watershed Manager, Pennsylvania Department of Environmental Protection (PADEP)



This summer, the PADEP was working on stream restoration projects on sediment-impaired streams in northcentral Pennsylvania. These efforts are a collaboration with the Pennsylvania Fish and Boat Commission, Northcentral Pennsylvania Conservancy, and the county conservation districts in which they take place. There are 16 sites to be restored this year, located in Columbia, Montour,



15 For a restoration project, multi-log vanes are being installed along Conley Run.

Northumberland, Tioga, and Union Counties. The combined work will improve approximately 2.5 miles of stream. Aside from the standard implementation of multi-log vanes and mudsills, trees and shrubs will also be planted at some sites to

help with bank stabilization. Researchers from Susquehanna University, Bucknell University, and Lycoming College are working to evaluate the beneficial effects of these restoration projects.

Past Intern Spotlight

Dr. L. Donald Duke's former interns have continued their studies in the natural sciences:

- Michele Weitzel is attending Florida Gulf Coast University for graduate school, and is comparing the Community Rating Systems (CRS) of Florida and Pennsylvania. The CRS is used to evaluate an area's floodplain management activities. If the community's efforts exceed National Flood Insurance Program standards, they are eligible for a reduction in flood insurance rates.
- Seamus McLaughlin is attending the University of Wisconsin-Madison for graduate school, and plans to study geology in Alaska.

Dr. Matthew McTammany has a number of past interns doing interesting work:

- Katie Faulkner is studying bioinformatics at the University of British Columbia.
- Matt Wilson is a researcher at the Stroud Water Research Center near Philadelphia.
- Nikki King is attending the University of Toledo, and is studying invasive Asian carp species at The Lake Erie Center.
- Jordan Barton is monitoring coastal steams for the California Department of Fish and Wildlife.



Nikki King holds an invasive Chinese grass carp at The Lake Erie Center.

Dr. Jonathan Niles has former interns in a variety of fields:

- Dan Isenberg is in Alabama, and will be pursuing a master's degree in ecology from Troy University.
- Erin McKeown is working in Montana as a wildlife technician.
- Desmond Edwards is in Army Officer Candidate School.
- Sam Silknetter worked for an environmental consulting firm after graduation, and is now pursuing a master's degree in fisheries ecology at Clemson University.
- John Panas is attending dental school at Temple University.

Dr. Steve Seiler's



Sam Silknetter is studying fisheries students have found ecology at Clemson University. success in both work and further schooling:

- Keri Bechdel interned with the Department of Environmental Protection as a water guality biologist, and became a full-time employee this summer.
- Chris Rocco is working for the Pennsylvania Fish and Boat Commission as a water chemistry technician.

Updates from Our Partners

ENVISION THE SUSQUEHANNA - CHESAPEAKE CONSERVANCY **Carly Dean**

Envision the Susquehanna is an initiative sponsored by the Chesapeake Conservancy that seeks to improve the quality of the Susquehanna River and the lives of those who depend on it. They support community-based conservation efforts and projects that aim to protect and enhance the natural beauty of the River

The research partners of the SRHCES conduct research that helps to achieve several Envision the Susquehanna's goals:

American Indian Heritage and History

The fall symposium hosted by Bucknell University has featured keynote speakers from the Iroquois and Chickasaw Nations.

Wildlife Habitat

Dr. Niles, Dr. McTammany, and Dr. Zimmerman have been studying the effects of stream restoration projects on natural habitats, and have found these efforts to be quite beneficial.

• Stormwater and Flooding

Dr. Duke has been evaluating various flood policies in the state, and Dr. Smith has been surveying the effects of stormwater systems on urban aquatic life.

• Working Lands

The effects of agriculture on waterways have been studied by Dr. Khalequzzaman and Mike Bilger. Acid mine drainage, natural gas drilling, and runoff from former surface mining sites are all present in the heartland, and their effects on the environment have been evaluated by Dr. Persons, Dr. Khalequzzaman, and Dr. Whisner.

The partners of SRHCES research is helping communities move toward a cleaner, healthier, and more beautiful Susquehanna River.

WKOK Mark Lawrence



Newsradio 1070 WKOK and **WKOK.com** continued with their *Boroughs to the Bay and Beyond* stories and they are still serving as an open mic for advocates, researchers and groups working to address important environmental topics. They have aired news stories, interviews, and feature stories about issues facing the Susquehanna Valley, groups and individuals addressing those issues, and updates on progress being made. WKOK recently covered the surprising removal of the Sunbury river bank riparian buffer and the implications of the use of the chemical herbicide and potential impacts on the waterway. They also have focused on the many outdoor recreational, educational and clean-up events that happen in or along the river.

WKOK's stories have included updates on the various community river clean-up efforts in the greater Sunbury region, as well as in Lewisburg. They have provided an open mic to the Middle Susquehanna Riverkeeper, and discussed the environmental impacts of the Central Susquehanna Valley Thruway project, as well as the new Hummel's Station Power Plant in Shamokin Dam. They also aired many stories and discussions about the Sunbury Pipeline. WKOK Sunrise and WKOK On The Mark programs were an open forum for groups like the National Wildlife Federation, and they helped celebrate the Sunbury River Festival and their *Reconnectin' with the River* theme in 2017. They also have stayed current with research into Colony Collapse Disorder, White Nosed Bat Syndrome, and other environmental issues. WKOK was first to report the death of numerous commercial bee hives after black fly spraying in 2016. Everyone from Lewisburg's Elm Street Manager, the Riverkeeper, the Merrill W. Linn Land and Waterways Conservancy, the new Sunbury River Boat Society, and many, many other groups and individuals have shared their news on WKOK. They remain an ally and media partner of the Susquehanna River Heartland Coalition for Environmental Studies and hope to remain an ally in the future with the river group and all other watershed advocates.

GEISINGER ENVIRONMENTAL HEALTH INSTITUTE Dr. Brian Schwartz and Ms. Dione Mercer

The joint Geisinger-Johns Hopkins Bloomberg School of Public Health Environmental Health Institute (EHI), directed by Dr. Brian Schwartz, is continuing ongoing studies of environmental epidemiology in the region. Several investigators and staff of Geisinger's Department of Epidemiology and Health Services Research work on these studies. They continue to welcome collaborations and student involvement in all their projects. Most recently they have been working with student Rachel Herman (Gettysburg College) on some of the projects that are described below. Additional details about the EHI can be found at their website at http://www.geisinger.org/research/ centers_departments/environmental/.

The EHI continues to be involved in four main projects and has started a new project in the past year focusing on Lyme disease:

1. Animal feeding operations (AFOs) and links to health

The EHI has continued their work on AFOs with a grant from the Fisher Center Discovery Program at Johns Hopkins University to examine gastrointestinal illnesses and possible links to poultry AFOs in the Geisinger region. They have obtained updated nutrient management plans for swine, dairy/veal, and poultry operations, through a collaboration with Dr. Deborah Sills from Bucknell University which they have used in their analysis. They have completed analysis of associations between proximity to AFOs and diarrhea risk and have submitted a manuscript for publication.

2. Unconventional natural gas development (UNGD aka "fracking")

This work, funded by the National Institute of Environmental Health Sciences (NIEHS), has led to several publications on relations of UNGD with adverse pregnancy outcomes, asthma, and migraine headache, nasal and sinus, and severe fatigue symptoms. The EHI recently published a paper focused on the symptoms in relation to UNGD in *Environmental Health Perspectives*. The EHI continues to fund some projects from local River Group University members for the Marcellus Impact Pilot program grants that were awarded in 2015.

3. Childhood obesity (funded by the National Institutes of Health (NIH))

Researchers will continue their work with childhood obesity and the built environment. They have found associations between cumulative antibiotic use and weight gain across childhood and adolescence as well as early life antibiotic use and child body mass index (BMI) at age 3 years. Their findings of associations with BMI at age 3 years have recently been published in *Obesity*. Their analysis of allergies and antibiotic use was recently published in *Clinical & Experimental Allergy*. Most recently they conducted analysis on survey data collected in the home of parents and children regarding food rules and eating behaviors. This analysis revealed mixed associations between food rules, healthy behavior, and child weight. The findings have been published in the *Journal of Adolescent Health*.

4. Chronic rhinosinusitis (CRS; NIH-funded)

The EHI is approaching its fifth year of work examining CRS and its relation to community factors and environmental factors. They continue to use the survey data collected on over 7,800 patients coupled with 646 participants who computed tomography (CT) scans of the sinuses to better understand this disease. Over the past year, they have collected sinus endoscopies on a subset of participants and are starting an additional project collecting nasal washing samples from participants to understand inflammatory markers of the disease. They will evaluate symptoms and CT scan finding in relation to a number of environmental and community variables in the coming months.

5. Lyme disease

In the past year, the EHI received funding from the Steven & Alexandra Cohen Foundation to study the epidemiology of Lyme disease. They have started to examine and evaluate Lyme disease risk, as well as diagnosis and treatment patterns, in patients found in Geisinger's electronic health record. Additionally, they have been conducting patient interviews of confirmed Lyme disease cases in their patient population. These interviews have helped inform them how patients are seeking care and being treated for the disease in the healthcare system. These interviews will also assist the EHI in developing a questionnaire which will be sent to Lyme disease patients over the next year. They are evaluating Lyme disease risk, and also by stage of the disease, in relation to a number of environmental and community factors (e.g., community green- ness, forest, agricultural lands, ground cover. soil moisture).

Lyme disease is an infection deer ticks transmit. A nymphal, or immature, form of the tick is about the size of a poppy seed. At this stage in its development a tick's bite is painless, so many people won't even realize they've been bitten by a tick. The tick attaches by its bite. Once it is attached it can feed for several days if it isn't noticed and removed. The longer a tick is attached and feeding the more likely it is that Lyme and other bacteria will be transferred to the person the tick is attached to. The Centers for Disease Control and Prevention estimate 300,000 people in the United States are diagnosed with Lyme disease every year. Lyme can be difficult to diagnose since many of the symptoms are similar to other diseases and the blood test for Lyme isn't completely accurate. Some experts believe the actual number of Lyme cases is much higher.

From Environmental Intern to Business Leader: Understanding the Value of Science

Written by Bob Garrett, President and CEO, Greater Susquehanna Valley Chamber of Commerce

Back in nascent days of the modern environmental movement, it seemed that we spent an inordinate amount of time and effort trying to express the importance of our then-considered radical positions in quantitative terms. It was as if the only way that we could prove the very basic truth that there might be a better way to treat our planet was through dollars-and-cents, or worse, body counts. Just in case you weren't around in the 1960s and 70s, the radical notions that I'm writing about here are ideas such as recycling, water conservation and even the impending worldwide population explosion. As a young man in these decades, I had the good fortune to work, actually mostly volunteer, at the knee of several wellknown conservationists. Not too deep in my memory is the recollection of studying water samples at the newly-opened Stroud Water Research Center that came from streams which were located near my boyhood home in Chester County.

Honestly, I had nearly no qualifications to be working at such a world-renowned facility at such a young age. But thanks to the coincidence that a portion of the start-up funds to open this facility were given by a distant relative of mine, I had the good fortune to be involved in real, live research on local aquatic life at this fantastic facility. Also, I came cheap and I was a pretty good "counter" of things.

You might be wondering, so what was the research that Bob did? Well, I counted. Every day, I rode my bicycle to the lab (because I was too young to drive) and I counted. Some days I counted aquatic larvae. Some days I counted organic material. Once in awhile I would bump into a sample that was so polluted or contaminated that the items that I was looking for were "TNC" or too numerous to count.

On the days that I would really like to forget, but can't, I would count the number of undissolved solids in water samples from our local "pristine" creeks. All in all, it was a great summer of learning and the best possible way to teach an impressionable young person, such as me, how to sort science from spin. When I was asked to write an article for this scholarly publication and given the topic of "What is the economic impact of the Susquehanna River?" I jumped at the opportunity. At the same time, I immediately slipped back into my old, comfortable quantitative value mode. Yes, I started counting. Unfortunately, in today's world, scientific facts and spin are nearly impossible to distinguish from one another.

As I began my research on the Susquehanna River, what I was able to nail down, was that the Mississippi River has been assigned a monetary value of \$197 trillion U.S. dollars in 2015. Given the modest inflation that we've experienced over the past two years, I reasoned that we could round this figure off to an even \$200 trillion. My source was Fortune Magazine and the writers for this respected journal had derived their "facts" from the many government-required Environmental Impact Statements conducted on the "Big Muddy" in preparation for dredging operations. This dredging is being done for economic reasons, and it's been widely suggested that the livelihood of river basin communities is directly tied to the width and depth of the river for the direct benefit of commercial shipping.

Of course, with a massive gross river product potential of \$200 trillion or more, the huge cost of dredging, be it monetary, environmental or even causing the potential collapse of

municipal drinking water supplies and to recreation could be understandably justified. Never mind that \$200* trillion is more money than the entire world, let alone a single, albeit huge, river has ever produced in just one year.

Not being able to help myself, I began my analysis by plugging some numbers into a computer. For example, the 700-mile long Mississippi is half again longer than the Susquehanna. But our beloved river is "non-navigable" and frequently dammed; whereas the Mississippi is free flowing and for the most part, navigable. You can see where my thinking was leading. That was until I spent a moment to really think about it and concluded that I had bought into—hook, line and sinker—spin over science.

So, here's the absolute truth, just as when appraising a piece of fine art or in pricing the worth of a very fine bottle of wine, the Susquehanna River is worth to you whatever you think it's worth. In other words, it's each of us who, in the end, determine its worth.

Sorry for the letdown, but the river simply isn't a high bid situation. Certainly, determining the river's value is not the work of some mathematical genius hustling to plug exorbitant numbers into an impact statement for some client who wants to use the river's resources for his or her personal economic gain.

At the Greater Susquehanna Valley Chamber of Commerce, we express the value of the Susquehanna this way: "Our beloved Susquehanna River, the foundation of our very name, is one of our region's largest and most-precious resources. Many communities in our valley pull their drinking water from the river and its recreational, sport and esthetic value is inestimable. The Susquehanna River is a true destination source for many people to enjoy the river and nature. The Chamber supports science-based efforts that will preserve and improve the river and maintain its value for the residents of our valley for generations to come."

Some readers of this article may detect "code words" in this statement and others might be slightly confused by a business advocacy organization taking a pro-environment stand. As is generally true of this type of policy expression, there's something in here for everyone.

For me and for many of the members of the organization that I lead, The Greater Susquehanna Valley Chamber of Commerce, the value of our wonderful river has this in common with some of those organisms that I used to count in water samples: Too Numerous to Count.

* Note: According to the CIA's World Fact Book, the 2017 Gross World Product was US\$107.4 trillion. This report was developed with input and support from the members of the Susquehanna River Heartland Coalition for Environmental Studies,H. W. "Skip" Wieder, Bridget Kane, Jennifer Twardowski, and Reneé Carey.

Special thanks to the Degenstein Foundation for their continued support of the Susquehanna River Heartland Coalition for Environmental Studies.



Susquehanna River Heartland Coalition for Environmental Studies

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