Pulse of the Heartland
Annual Report

presented by the SRHCES

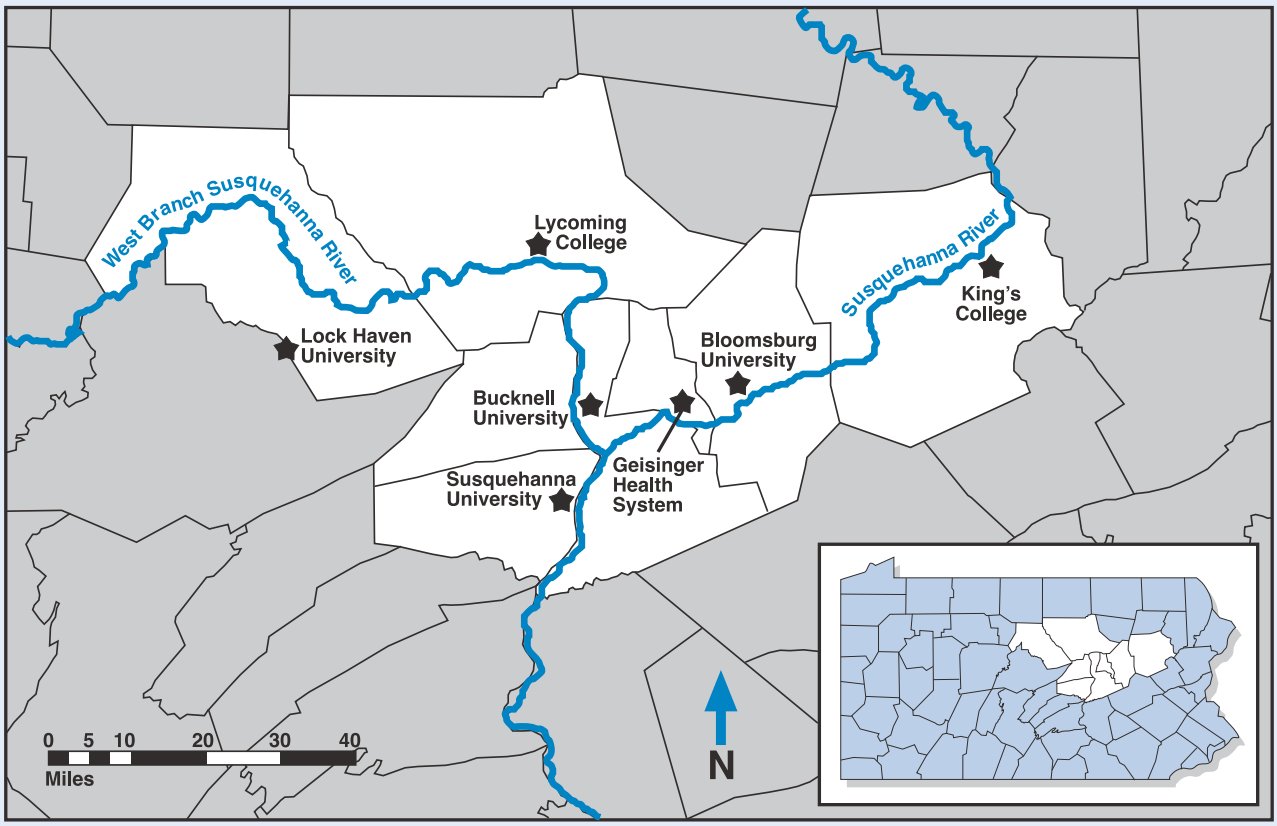
Susquehanna River Heartland Coalition for Environmental Studies

SUSQUEHANNA RIVER HEARTLAND COALITION FOR ENVIRONMENTAL STUDIES

The Susquehanna River, and the watershed it encompasses, are arguably this region's most important assets in defining the quality of life for all who live, work and play within its boundaries. Because the Susquehanna River 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 recognition of this tremendous asset, six years ago six regional colleges and universities joined other partners, including ***Geisinger Health System, Trout Unlimited, 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 and staff's impressive talents are engaged to address environmental issues within the watershed. Additional promotion and support for this effort have come from sponsors such as* ***WVIA*** *(Northeastern Pennsylvania's public broadcasting station),* ***Sunbury Broadcasting Co.,*** ***The Daily Item****, and the* ***Degenstein Foundation****.*

Included in this report, you will find summaries of the projects and activities within the various fields in which SRHCES has become involved. Additionally, you will find updates on our partner the Nature and Human Communities Initiative, the efforts of WVIA and Sunbury Broadcasting, a report on the efforts of the Coalition to monitor mercury levels in the watershed, and information regarding the Marcellus shale drilling that has become prevalent in the region within the last year.



For more information about SRHCES, please visit www.SRHCES.org.

Map provided courtesy of Jeff Brunskill, Department of Geography & Geosciences, Bloomsburg University

MONITORING THE SUSQUEHANNA

Last Summer, the Susquehanna River Heartland Coalition for Environmental Studies began a collaborative project involving faculty and students from Bloomsburg University (Dr. Steve Rier, Dr. Cynthia Venn, and Dr. Chris Hallen), Bucknell University (Dr. Matt McTammany, Dr. Ben Hayes, and Dr. Craig Kochel), King's College (Dr. Brian Mangan), Lycoming College (Dr. Mel Zimmerman), and Susquehanna University (Dr. Jack Holt, Dr. Ahmed Lachhab, and Mike Bilger). Each college and university is primarily responsible for some component of the research, but many members gather similar data. The project is to study water quality, water chemistry, and biota (algae, bentic invertebrates, fish, etc.) in the Susquehanna River in central Pennsylvania in conjunction with the Susquehanna River Basin Commission (SRBC). Primary sites include the locations of two stationary sondes (water quality–measuring devices) on the West Branch in Milton and in the main branch near Danville, as well as below the confluence near Hummels Wharf/ Selinsgrove. The Heartland Coalition scientists will be using the information to create a snapshot of water quality on a regional scale (rather than focusing on a certain stream or part of the river as a whole), hoping to identify potential threats as an early warning system. On a personal level, this research will expose students to the group as a whole and also help to establish contact and and forge a new relationship with the water companies at Milton and Danville (where two of the sondes are located).

In addition to this collaborative effort, the Susquehanna River Heartland Coalition for Environmental Studies conducts many studies on the ecology of the Susquehanna River and its surrounding environment. Currently, the group has research projects at the PPL Montour Preserve, on Shamokin Creek, in Montandon Marsh and other locations throughout the Susquehanna River drainage. The focus of the majority of the Heartland Coalition is to gather data on the different parameters to assesss the Susquehanna River. Below, you will read more about a variety of research that has been conducted over the past year by university representatives within the coalition, but the information here by no means represents all of the work being done. For further information, please visit **www.srhces.org**.

MEL ZIMMERMAN

Professor of Biology and
Director of the Clean Water Institute

The Lycoming College Clean Water Institute (CWI) has three main projects this summer. The first, funded by a Ben Franklin Technology grant, involves testing a Sequence Batch Wastewater Treatment system manufactured by Cromaglass Corporation in Williamsport and set up at the Kelly township sewage treatment plant outside Lewisburg. The system treats 500 gallons of sewage per day. Professor Zimmerman and his interns are testing a new technology that uses a biofilm to remove more nitrogen from the waste. The new machine, Cromaglass model 1200 sequence batch reactor, treats up to 1,200 gallons of wastewater and sewage per day. The biofilm works by allowing bacteria to grow on its membranes, which will reduce nitrogen from the waste by nitrification and denitrification. If tests indicate that the unit is effective, the company will send the unit for NSF Certification testing in Texas. To limit the levels of nitrogen in the waters that reach the Chesapeake Bay, restrictions have been put in place that impose a nitrogen limit of 6 ppm on wastewater treatment plants. Thus, should the biofilm technology of the Cromaglass Corporation be certified, it would especially open up new markets locally, where wastewater plants are in need of a means to effectively reduce nitrogen levels. CWI's testing of the unit is near completion, and thus far the results look good for Cromaglass Corporation to submit the unit for certification in the fall; however, final results are pending.

The second project of CWI, supported by a grant from the Degenstein Foundation, is to continue water monitoring on the lower West Branch of the Susquehanna River. As part of a long-term monitoring project undertaken by Lycoming College, Bucknell University, Susquehanna University, and Bloomsburg University, interns from CWI grab samples by collecting surface water off of the sides of the boat along transects at 12 sites between Lock Haven and Sunbury. The samples are subjected to water chemistry analysis, through which levels of nitrogen, phosphorus, pH, alkalinity, conductivity, total dissolved solids, dissolved oxygen, temperature, and coliform bacteria are monitored. In addition, Lycoming College interns collect macroinvertebrates from rock baskets and Hester-Dendy samples that are incubated in the river at Watsontown, Milton, and Shady Nook. A rock basket is a wire basket that is filled with number 3 limestone rock and placed in the river for 6 weeks, allowing aquatic insects (macroinvertebrates) to colonize them. A Hester- Dendy is another kind of artificial sampler, though with a matted surface (rather than rocks) on which the aquatic bugs grow. The presence of macroinvertebrates in the rock baskets and Hester-Dendy samples can be indicative of water quality because depending on how clean the river is, only certain bugs will colonize the rocks or sampler.

Summer interns electrofishing

The third project, supported by a Pennsylvania Fish and Boat Commission grant and the Community Foundation for the Alleghenies, involves CWI faculty and interns electrofishing at least 20 headwater streams in the Loyalsock, Lycoming, Pine, or Muncy Creek watersheds as part of the Pennsylvania Fish and Boat Commission's unassessed waters program. The fish populations in these streams either have either never been assessed or have not been looked at for over 20 years. The Pennsylvania Fish and Boat Commission wants to develop a fish-population survey for these sensitive streams. The CWI faculty and interns use electricity to temporarily stun the fish so that there is enough time to count the fish; to identify them as brook trout, brown trout, or other types of fish; to measure the fish; and to release them unharmed. The type and numbers of fish found in a given area can help to determine the water quality of the stream. These data will be used by the Pennsylvania Fish and Boat Commission to classify the steams as class A (streams with high numbers of reproducing trout of various ages); B, C, or D (streams with fewer numbers of trout); or E (streams without trout) trout streams. Information regarding the ongoing projects of the CWI can be found at **lycoming.edu/biologydept/cwi**. Professor Zimmerman can be contacted at **zimmer@lycoming.edu**.

PETER PETOKAS

Research Associate with the Clean Water Institute

For the past 5 years, Dr. Peter Petokas has been conducting research on the Eastern Hellbender salamander in several tributaries of the West Branch of the Susquehanna River. Dr. Petokas and his student interns have been recording where the salamanders live, the conditions in which they live, whether they are reproducing, their age, the speed at which they grow, and the size of their populations. By tagging the Hellbenders with microchips, Dr. Petokas and his interns have discovered that otherwise sedentary Hellbenders will sometimes migrate and have been found as far as 5 miles from their original capture location.

Other discoveries this season include an unusual yellow Hellbender among the normally colored olive-brown Hellbenders. Despite its conspicuous color, the rare Hellbender is a large adult and is likely at least 15 years old.

Yellow Hellbender

One major focus of the current Hellbender study is the occurrence of amphibian Chytrid fungus in Hellbenders, a disease that is associated with global amphibian declines. Given the high mortality among some North American amphibians, there is concern that Chytrid could lead to a decline in Hellbender populations.

A new project that Dr. Petokas has been conducting this season is the ecology of vernal pools on mountaintops in Clinton and Luzerne counties. Dr. Petokas is monitoring the chemistry of the pools over the course of their seasonal evolution: from very wet to totally dry. He is also monitoring the influence of acid deposition on the pools and on the amphibians that use them as principal breeding sites. His research has shown that some amphibians use the pools for breeding despite a pH of close to 5 and that the breeding is successful, producing many viable offspring. Where the amphibian species go in summer and why some species are present and others are not will be the focus of future study at the seasonal pools.

Another new project that Dr. Petokas is conducting is a survey of all of the plants and animals at Camp Victory, a unique summer camp for special-needs children. Camp Victory is located east of Millville in Columbia County and encompasses 220 acres of forest, fields, wetlands, streams, and ponds. Under the direction of Dr. Petokas, student interns from Lycoming College conducted a study of the wildflowers, shrubs, trees, fish, amphibians, reptiles, birds, and mammals, using simple observation and several trapping methods. The purpose of the inventory was to compile

Dr. Petokas and the Hellbender Team

information that could be used at the nature center that will be built at the camp in the future. There will be two final products of the study: 1) a series of annotated posters of each plant and animal group, which will be placed on display at Camp Victory, and 2) an annotated list of each plant and animal group in booklet form for use by students and camp counselors.

Dr. Petokas and his students provide education and outreach to elementary schools, high schools, watershed groups, sportsmen's groups, and youth groups. If you would like to report a Hellbender sighting, request more information on the Camp Victory inventory or on vernal pool ecology, or schedule a presentation for a group, Dr. Petokas can be reached at **petokas@lycoming.edu**.

CHRISTOPHER HALLEN
Professor of Chemistry

CYNTHIA VENN
Professor of Geography & Science

STEVEN T. RIER
Associate Professor of Biology & Ecology

Together, Professors Hallen, Venn, and Rier and their students this summer are collecting and analyzing water samples from the Susquehanna River for pH, conductivity, dissolved oxygen, turbidity, oxidation-reduction potential, metals (including iron, aluminum, barium, and strontium), anions (including nitrates, nitrites, phosphates, sulfates, chloride, and fluoride), alkalinity, and acidity. The group is trying to characterize the water chemistry to the maximum extent possible.

Their results will provide chemical data to the groups sampling the biology and provide baseline data for the river so that changes in water chemistry can be detected. Such baseline data could be particularly useful given the developments with Marcellus shale drilling.

To perform the water chemistry testing, the group collects surface samples using 4-liter acid-washed bottles that are rinsed three times with the river water before collection. Samples were collected twice this summer (once in higher water and once in lower water) from three river transects sampled in 2009 (Danville, Milton, and Shady Nook near Shamokin Dam) as well as from an additional transect at Watsontown, twice this summer. Thus far, a few differences have been seen in results from this summer's analyses compared with the results from last year's analyses. Data will be presented at the Susquehanna Symposium at Bucknell University in the fall.

Another sampling trip in May focused on the potential effects of Shamokin Creek and Byer's Island on the water chemistry of the river at Shady Nook. Shady Nook is a river access area just south of where Shamokin Creek enters the River. Last year, the group found high dissolved lead and copper in the water samples near the island in the middle of the river and just downstream from Shamokin Creek, but they did not have a sampling plan to test whether the island or the creek could be a source. This year, the group sampled at more stations and took sediment cores from the island, which will be analyzed for heavy metals. Shamokin Creek has been impacted by abandoned mine drainage, with high dissolved iron, low pH, and high sulfate. Currently, the group is researching baseline data with which their findings can be compared.

The group's final sampling expedition was near the Hazleton area to gauge the effectiveness of a newly installed treatment system for acid mine drainage from the Oneida #3 tunnel draining into Tomhicken Creek, a tributary of the Susquehanna River. Acid mine drainage causes low pH, high dissolved aluminum, high sulfate, and high iron, all of which can degrade water quality, kill small organisms and fish, and leave orange-colored "yellow boy" on the rocks. Pennsylvania coals and coal waste have large amounts of pyrite, which dissolve and cause low pH, high iron, and high sulfate. In addition, the clays in the mines can dissolve and add aluminum and lower pH, both of which phenomena are bad for fish. In December 2009, a treatment system became operational in an effort to raise the historically low pH and lower the levels of aluminum. The treatment system diverts water from the tunnel into a tank filled with limestone. The water in the tank reacts so that the pH rises and aluminum hydroxide converts to aluminum precipitate. The water then flows into a pond, where excess dissolved iron drops out. The water flows from this pond back into Tomhicken Creek. The group at Bloomsburg University is trying to evaluate the treatment system's effectiveness at treating the water that drains from the mine tunnel. They intend to sample the inflow, outflow, treatment tanks, and Tomhicken Creek upstream and downstream of the treatment system every few months to monitor the chemistry. Thus far, the results seem to suggest that the

Sampling drainage from Oneida #3 tunnel

treatment system is working. However, analyses are still underway, and there are no definitive findings as of yet.

Another effort of the group this summer was to organize an interlab comparison of water chemistry analyses. Scientists representing labs from Bloomsburg University, Bucknell University, Lycoming College, and Susquehanna University came together on July 30, 2010 at the Shikellamy Marina in Sunbury to simultaneously collect samples at the same locations and then run analyses the usual way. Results could then be compared, allowing an assessment of the consistency of results among labs.

In addition, Dr. Rier is collecting water samples to be analyzed for total nitrogen and total phosphorus, as he did last year. All organisms require nitrogen and phosphorus. However, too much of these nutrients can impair aquatic ecosystems by causing prolific algal growths. As excess algae decay, oxygen is consumed by bacteria, potentially leading to low oxygen. In the Susquehanna River, this may be happening along the margins, where juvenile fish such as smallmouth bass tend to be, and may be partially responsible for causing the stress that leads to some of the fish diseases that have been hearing about the press. As these nutrients move downstream into the Chesapeake Bay, they stimulate algal growths there as well, which have resulted in summer "dead zones" and a decline in the Bay's fisheries.

This year, he has added biofilm sampling to his testing. A biofilm is a community of microorganisms that includes algae, bacteria, fungi, and protozoa encased in a jelly-like substance that are attached to a surface such as a rock on the bottom of a river. To sample this community, one simply scrapes an area of rock with a toothbrush. A number of tests are then run on this material to determine, for example, the amount of algae (measured as chlorophyll a), the total amount of organic material (measured as ash free dry mass), the amount of nitrogen and phosphorus that is stored in the biofilm, and metabolic activities of actual micro-organisms (measured with enzymes). With this information, much can be learned about the river such as how nitrogen and phosphorus pollution is affecting the river ecosystem. Professors Hallen, Venn, and Rier can be contacted, respectively, at **challen@bloomu.edu, cvenn@bloomu.edu,** and **srier@bloomu.edu.**

BENJAMIN R. HAYES

Director of the Susquehanna River Initiative

Dr. Hayes and a Heartland Coalition–sponsored student intern have begun mapping the channel of the West Branch of the Susquehanna River at selected locations to characterize the physical habitat of the river and relate its shape to the geology and hydrology of the region. Much of this field work has involved snorkeling to depths up to twenty feet to photograph and measure the size and variability of sediments comprising the river bottom and note places where the river flows directly over bedrock. At several islands between Milton and Sunbury, they have documented the stratigraphy, or layering of loose sediments, exposed along the banks of the river. They are comparing this data with geologic information from nearby wells or gravel quarries to gain a better understanding of the natural history of the Susquehanna River and how its islands and adjacent flood-plain areas may have formed. During higher water conditions, they have been measuring water depths and velocities across a quarter-mile section of the river to better understand the hydraulics of flow and the extent to which velocities vary with discharge. This effort is the beginning of multi-year study of the erosion, transport, and storage of sediment in the Susquehanna River and its major tributaries. Dr. Hayes can be contacted at **brh010@bucknell.edu**.

MATT McTAMMANY

Assistant Professor of Biology & Environmental Studies

In 2009, Professor McTammany worked to obtain the grants needed for the installation of four sondes, computerized instruments that measure water-quality data in real time. Since then, Professor McTammany has continued to maintain the sondes and to monitor the data that come in from them every 15 minutes.

UPDATE ON REAL-TIME MONITORING

Be sure to read about Professor McTammany's Real Time Monitoring Update on page 11.

In addition to the project of monitoring the sondes, Professor McTammany is working on two other projects. In the Susquehanna River, he has been looking at fine-scale variability in water quality and how that is related to spatial patterns of algal production. Oxygen levels rise during the day, when photosynthesis occurs. Photosynthesis is the process by which plants take in light and release oxygen. Plant matter in the water (such as algae) add oxygen to the water upon taking in light. Thus, when the sun goes down at night, oxygen production in water ceases and only oxygen consumption (otherwise referred to as respiration) occurs. Respiration occurs during the day, as well, but so much oxygen production occurs during the day from photosynthesis that oxygen concentrations still rise during the day. As Professor McTammany phrases it, "The river breathes all day long." His study of these oxygen patterns in the river led him to notice that there are certain locations within the river that seem to be more sensitive to these biological processes. In places where the water is shallow, slow flowing, or stagnant, these biological processes can act on the water for a longer

Professor McTammany and students sampling water

period of time. Flowing water brings in new water and expels the old water; the water does not sit and bake in the sun or get exposed to a lot of respiration by bacteria. It is always replenished; it is always fresh. When water levels are high, at least during wet years or wet periods of the year, the water tends to replace itself very quickly. When that occurs, one will not see large changes in oxygen levels. By contrast, during low-water periods, water flows more slowly and is shallower and warmer. During this summer, for example, Professor McTammany observed that the water has been very warm, and at warm temperatures there is more algal production, which produces more oxygen during the day. At nighttime, oxygen consumption rates, measured as respiration, were very high; as a result, oxygen concentrations were going very low. His research looks at how different habitats or locations within the river respond differently to or have different oxygen patterns in response to biological processes. Low levels of oxygen are of particular concern for baby fish, which need more oxygen than older fish. Baby fish, however, tend to stick to more shallow areas in the river, where the oxygen levels are lower, because these areas of the water are safer for baby fish in other ways. Professor McTammany's study on the locations in the river that are more sensitive to changes in oxygen concentrations directly targets kinds of areas in the river where baby fish dwell. At the moment, he is attempting to break down data that he has observed seasonally to establish oxygen patterns in relation to wet versus dry years in more temporal detail.

In addition, Professor McTammany, Professor Rier at Bloomsburg University, and scientists from the Stroud Water Research Center are together writing up the results from a project that has just come to a close. As an ecosystem, rivers and streams either retain or store nutrients. Considering the excessive nutrient levels that are currently plaguing the Chesapeake Bay but that originate in the Susquehanna River, the group considered whether there is any relationship between mine drainage and impaired retention of nutrients in streams. If the Susquehanna River retained more of its nutrients, the nutrients would not travel into the Chesapeake Bay. Heightened levels of nitrogen and phosphorous, for example, result from acid mine drainage. The group aimed to establish whether acid mine drainage affected the River's ability to store these nutrients rather than pass them on to the Chesapeake Bay. The group is currently writing up its findings for publication. Professor McTammany can be contacted at **mmctamma@bucknell.edu**.

MOHAMED KHALEQUZZAMAN

Associate Professor of Geology & Physics

LOCK HAVEN UNIVERSITY OF PENNSYLVANIA

Dr. Khalequzzaman (known as Dr. K by many) has been conducting ongoing water-quality monitoring in the Fishing Creek (since 2002) and Beech Creek (since 2006) sub-watersheds of the West Branch to see the impact of agriculture on the water quality. Working closely with the local watershed associations and the Clinton County Conservation District, Dr. K and three students regularly sample and analyze water for nutrients, sediment, and pollutants. Coupled with these projects, he and his students continue ongoing research at the Avery Big Run facility, a $1.5-million passive treatment system constructed by the Bureau of Abandoned Mine Reclamation on the Middle Branch of Big Run in the eastern part of the Beech Creek watershed. A retired colleague, Dr. John Way, actively supports much of Dr. K's field research.

This summer, Dr. K. and his team have collected and analyzed samples from multiple stations throughout Avery Big Run acid mine treatment facility, from downslope drainage off the facility, and from the Middle Branch of Big Run, the ultimate recipient of these waters. The goals of this initiative are to continue to evaluate the long-term effectiveness of the facility itself (designed to have a 25-year lifespan) and to monitor the health and recovery of the impaired Middle Branch below this site. Materials left behind at abandoned coal mines leech acidic water, which kills the organisms in the stream. To treat that acidic water, the Pennsylvania Department of Environmental Protection established a series of ponds that are covered with limestone and mushroom compost. The acid mine–impacted water is channeled by a plumbing system to ponds, where limestone and mushroom increase pH and remove metals from impacted water because it is discharged into the stream.

Thus far, data gathered over the last 4 field seasons at 10 stations throughout the facility and at 6 off-site locations in the natural watercourse that receive drainage outfall from the treatment system indicate that although the treatment process does raise pH and facilitates reduction in metals of the water it collects, its effectiveness has declined measurably since it went on-line in 2006. Major funding for the AMD work has generously been provided by the Degenstein Foundation and the Community Foundation of the

Dr. K with SRHCES members

Alleghenies, with additional support from Lock Haven University of Pennsylvania.

In addition to this work, Dr. K and his team have recently forged an alliance with the Beech Creek Watershed Association and Pennsylvania Senior Environmental Corps to initiate new monitoring efforts and to establish a baseline dataset network for streams located in the vicinity of Marcellus shale drilling sites. Specifically, they have started collecting water samples from key points in the following streams: Little Sandy Run, Wolf Run, Council Run, Hays Run, Big Run, and the main stem of Beech Creek. To the best of their knowledge, their project to monitor the environmental impacts of gas well drillings will be the first of its kind in the region. Dr. K. can be contacted at **mkhale-qu@lhup.edu**.

CARLOS A. IUDICA
Assistant Professor of Biology

Susquehanna University

Professor Iudica continues his long-term work monitoring the food sources of small mammals that live in the watershed. He and his students are studying the stomach contents of foxes, minks, and coyotes, and he will soon be adding bobcats to the list. Tissues from minks are being sent to the new mercury-analyzing equipment now available, the Direct Mercury Analyzer, in an attempt to establish the mercury levels present in the mammals. Professor Iudica and his students have also have been setting up and checking traps in the winter and summer to gather information on the presence of these animals in the region and to assess whether the populations are changing depending on the health of the overall ecosystem.

In addition, Professor Iudica is currently wrapping up some papers on owl diets. He and his students have, for the past six years, been collecting owl pellets and other species samples in different localities and identifying the diets. Professor Iudica has already had a few papers on this topic published; the papers on which he currently works compare different species in different places with different species in the same place to see how resources are partitioned; i.e., what do the different kinds of owls eat? Another study that Professor Iudica is wrapping up, on which he hopes to write a paper during the next year, relates to two species of foxes that live in the area. Professor Iudica and his students are trying to assess the foxes' diet and compare it with that of foxes that live near big rivers in other areas of the U.S.

Most of Professor Iudica's efforts at the moment, however, are directed toward a project that involves looking back through time. He and his team are exploring the remains of a natural sinkhole where they are findings assemblages of animals from different time periods: from the present back to 1-2 million years ago, when the whole area was covered in glaciers. Since then, the water in the region has drastically changed in intervals of 10 to 100 thousand years. During these variations in climate, huge changes in vegetation and animal population occurred. Dr. Iudica and his students are trying to 1) reconstruct these faunas back in time and 2) characterize what animals lived where and when. That information will eventually provide enough raw information to generate a kind of modeling that will help scientists predict what kinds of changes will occur with regard to vegetation and animal population in the event of climate change. Four graduate students assisted Professor Iudica with this work during the school year; during the summer, one graduate student assists.

In the sinkhole, archeological techniques are used to collect the samples. The area for sampling is split up into a grid with squares that measure 1 m by 1 m, with a depth of 10 cm. All of the sediments in square no. 1, for example, within the 10 cm of depth, are bagged. The digging continues, and new tools are used to ensure that the next bag contains the sediments from only 10 cm down in the same square. The bags are eventually weighed and the sediments cleaned. Then, Professor Iudica and his students separate the rocks from the bones and begin the process of identifying the bones. Once they are finished with a particular layer of sediment, they start putting together the group of animals that lived during the time period represented by that sediment. The sinkhole trapped more and more animals as more dirt and sediment deposited in the hole over time. Therefore, the deeper the layer sediment that is bagged, the older the remains of the animals identified in that sediment. Armed with this information, Professor Iudica aims to link the groups of animals that he finds with those that today live in other parts of the world. For example, identification of a group of animals that were buried in the sinkhole thousands of years ago and that now live in the Northern part of Canada might indicate that the landscape in the watershed thousands of years ago resembled that of Northern Canada now. Currently, Professor Iudica is working on getting his

findings from this research published. Professor Iudica can be contacted at **casaiud@susqu.edu**.

BRIAN MANGAN

Associate Professor of Environmental Science & Ecology

Professor Mangan, in conjunction with the Heartland Coalition, continues his work sampling organisms in the water all along the Susquehanna River for levels of mercury, testing for patterns of distribution of mercury within the bodies of the organisms.

In addition, together with Professor Mel Zimmerman at Lycoming College, Professor Mangan just began a project to help the Pennsylvania Fish and Boat Commission assess the trout population in select watersheds in Pennsylvania to identify the locations of specific kinds of trout. Not all species of trout are native to local waters; the only native species is the brook trout, which is the Pennsylvania state fish. The other species that might be encountered include rainbow trout and brown trout. Establishing the trout population of a stream involves electrofishing. To electrofish, one wears a backpack with a couple of big batteries attached to it, as well as a control system with which one turns on the electricity and shocks the water to stun the fish temporarily.

For the last few years Dr. Mangan has worked to track the presence of three foreign species – rusty cray fish, Asian clams, and zebra mussels – in the Susquehanna River. Rusty cray fish are introduced into the Susquehanna by fishermen who bring them from area to another instead of disposing of them correctly. In 2002, Dr. Mangan first published his findings that Asian clams had moved into the Susquehanna; currently, he is trying to track their movements north. Last year, zebra mussels were first found in the Susquehanna River around the New York border. Dr. Mangan will be studying whether the zebra mussels have moved south – and if so, how far.

To survey for rusty cray fish, Professor Mangan and his team constructed a trap, which sits on the riverbed floor and keeps out other kinds of species. One hundred traps are baited with cat food and dropped at locations on the Susquehanna River between the New York border and Harrisburg.

To assess the presence of zebra mussels and Asian clams in an area, Dr. Mangan and his team wade into the river and simply look to see whether the organisms are present in the substrate down below their feet. They also turn over and pick up rocks because zebra mussels tend to attach themselves to the sides or bottoms of rocks to avoid scouring by the water. Because zebra mussels and Asian clams fasten themselves to boats or get caught up in the holding tanks of fishermen, Dr. Mangan and his team will often go to boat launches around the river to look for the species. Professor Mangan can be contacted at **brian.mangan@kings.edu**.

BRIAN S. SCHWARTZ, MD, MS

Co-Director Environmental Health Institute, Geisinger Center for Health Research; and Professor of Environmental Health Sciences, Epidemiology and Medicine, Johns Hopkins University Bloomberg School of Public Health

The environmental projects of the Geisinger Center for Health Research (GCHR), Environmental Health Institute (EHI), seek both knowledge about health and the environment and the translation of knowledge into sustainable solutions. The EHI has been up and running for over 3 year, working on a myriad of projects related to health and the environment. Currently, the EHI is involved in several ongoing projects, below are short summaries of three projects.

In the Abandoned Mine Lands and Community and Individual Health study, the EHI used electronically mapped/represented data on all abandoned mine lands in Pennsylvania to create information on the density, diversity, accessibility, and clustering of 12 features of abandoned mine lands left behind in communities. In an ecologic analysis, they found that several measures of the burden of abandoned mine lands were associated with higher levels of community socioeconomic deprivation (CSD). A large body of scientific literature documents that CSD is associated with adverse impacts on a variety of health measures, including cardiovascular disease and diabetes. In the second phase of this study, the EGI is obtaining information on approximately 20,000 patients with diabetes from the Geisinger Clinic to analyze the association of abandoned mine lands with diabetes risk and progression.

The EHI is also currently engaged in performing a Marcellus Shale Health Impact Assessment using existing and available information that will inform the public about potential health impacts of Marcellus Shale drilling. The assessment will also be used to facilitate future funding to continue studying potential health impacts. Health Impact Assessments are also generally used to assist in informed decision-making processes.

Lastly, the EHI is in a methicillin-resistant Staphylococcus aureus (MRSA) study. Currently more than 70% of all antibiotics used in the U.S. are used as additives to animal feeds for nontherapeutic purposes (i.e., not for treating infections but, for promoting growth). Many of these antibiotics are similar to those used to treat infections in humans. Simultaneously, new strains of MRSA are being identified among humans. MRSA is a skin infection that causes deep abscesses requiring surgery. Several European

studies have established that the community-associated MRSA strains may be related to antibiotic use in animal-feeding operations (AFOs). Pennsylvania is home to a large number of concentrated AFOs. In this study, the EHI will evaluate the risk of MRSA infection in a population-based study in relation to concentrated AFOs and other AFOs in Geisinger's 31-county area. The results of the study will have policy implications for antibiotic use in AFOs in the future. Dr. Schwartz can be contacted at **bschwart@jhsph.edu**.

JACK R. HOLT
Professor of Biology

AHMED LACHHAB
Assistant Professor of Earth and Environmental Sciences

Susquehanna University

Professors Holt and Lachhab continued their work from last summer, assessing the main stem of the river below the confluence. They worked with students to set out rock baskets, diatometers, dataloggers and other equipment at 4 sites referred to as Byer's Island transect, as well as at a site above the energy plant. These locations allow the scientists to study how the West Branch mixes with the north branch, and what impact Shamokin Creek (which suffers from abandoned mine drainage) has on the mainstem of the River.

The Byer's Island transect was used last summer and fall, but the site above the energy plant is new. Professor Holt added the site because he noticed the energy plant was creating a thermal plume. The plume may or may not be impacting the River, but by adding the site, it will help him understand the river above the plume and help point out any changes the plume may be causing to the river system.

The summer sampling and collection are done. Professor Holt and his students are now spending time "picking and counting madly" to pull together their data. The data consists of the types of insects and how many of each type are found. Once these numbers are tallied, analysis can begin. This can be a tedious and time consuming process. Last summer, one rock basket yielded over 4,000 animals!

When he's ready to begin his analysis, Professor Holt will compare numbers from 2009 to 2010. He'll further examine the 2010 numbers to look for impacts resulting due to less rainfall during the summer of 2010, and what impacts these drier conditions may have had on the river system.

Professor Lachhab noted that one of the sites in the Byer's transect was vandalized. Someone removed the rock baskets from their original positions in the river, and stacked them up in a pile. River users (whether paddlers, anglers, or swimmers) need to be aware that various research projects are underway, and scientists use a variety of equipment to test and monitor water quality and chemistry. Moving this equipment may not damage the equipment, but can have a huge impact on the quality and usability of the data.

Professor Holt spent the other part of his summer teaching an ecology course on the lower Volga river basin in Russia. This summer Russia faced an unusual heat wave which caused the Volga to be overcome by algae. There were also two lakes in the basin that had small fish kills. Professor Holt explains that the fish faced a "double whammy." Warmer water holds less oxygen, and some algae release toxins. The fish may have suffered from one or both stressors. Professor Holt can be reached at **holt@susqu.edu**.

Professor Lachhab continued his work studying the Susquehanna River's hydrology, as well as its physical and chemical properties. He also extended it to study probable contamination from treatment of Marcellus shale fracturing water from the Sunbury Generation, LP. Locally, Sunbury Generation, LP has been treating and releasing fracturing water into Susquehanna River. Dr. Lachhab and his students are investigating the water in the vicinity of the treatment facility to evaluate if there is any noticeable change in the water quality near the flowback water release point. This was performed by deploying two sondes upstream and downstream of the treatment plant to measure various parameters, including dissolved oxygen, conductivity, pH, temperature, and turbidity. In addition, water samples were collected to be tested in lab for salt cations and anions. Additional related issues were also studied.

Compiled data from these methods in addition to biological findings from rock basket by Professor Holt and his students together are expected to develop a firm understanding of water quality downstream from the two main confluences of the two branches. The thermal monitoring and the chemical analysis will further add to the understanding of the effects of fracturing water on Susquehanna River.

UPDATE: REAL-TIME MONITORING

In 2009, Professor McTammany at Bucknell University obtained grants to purchase 4 sondes for the Susquehanna River. Sondes have probes that can measure temperature and conductivity of the water (the ability of the water to conduct electricity), which is related to the amount of dissolved salts in it. Sondes also measure dissolved oxygen, pH, turbidity (how cloudy the water is), and water column chlorophyll concentrations.

The sondes were installed on July 1, 2009 at Milton and Danville. By now, the sondes have collected over a year's

worth of data. The sondes are programmed to collect measurements every 15 minutes. The data are logged at the site, and then the computer in Professor McTammany's research lab at Bucknell University transfers the data to his computer via a cellular modem.

Professor McTammany and his team usually go out and perform maintenance on the sondes once a month. There have not been any major problems, though on two occasions there were problems that required attention. An electrical glitch in the sonde at Milton required a censor repair, and a rock stuck in the screen at Danville on another occasion.

For more information visit:
http://www.departments.bucknell.edu/environmental_center/susquehanna_river_monitoring/index.html

http://www.wqdata.com/webdblink/srhces.php

MERCURY IN THE SUSQUEHANNA RIVER SYSTEM

This year, scientists involved with the Susquehanna River Heartland Coalition for Environmental Studies set out to study the effects of mercury in the watershed. Mercury in the environment is of special concern because of its effect on biological organisms. No biological systems need mercury. Other metals are needed: trace metals help the body metabolize correctly. But there is no known biological system that needs mercury for anything.

Mercury does, however, find its way into living systems, where the effects of high mercury levels are very harmful. Accumulation of high enough concentrations of mercury can cause significant damage to the system – especially neurological and kidney damage. Studies in Japan in the 1960s revealed that high levels of mercury caused neurological disorders that in turn caused disruption of muscle coordination, speech disorders, motor disorders, constricted visual fields, severe cognitive dysfunction, and emotional lability (a condition that involves frequent mood changes and excessive emotional reactions). In studies in the Seychelles and Faroe Islands, where fish eating is a way of life, mercury caused cognitive disturbances, especially in children. Because of these studies and others (including a severe contamination of grain in Iraq in the early 1970s), it is advised that pregnant women limit their intake of fish to avoid mercury exposure in the fetus, for whom risk is high and damage can be severe.

Some mercury occurs naturally in the environment in certain geological settings, though only in limited locations. Most mercury that living systems mow encounter is released into the air by the smokestacks of coal-fired power plants. Mercury is naturally found in all fossil fuels but is the biggest problem in coal. The scrubbers on the smoke stacks of these power plants can remove mercury, but the more effort exerted to lower the levels of mercury released into the air, the more expensive the operation. Coal-fired power plants are prevalent in the U.S., where coal provides almost fifty percent of the nation's electricity. The mercury released by smoke stacks settles out into the environment, and because it travels by air it knows no geological or political bounds. Mercury in the air will drift wherever the wind takes it.

Traveling as a gas, mercury is breathed by organisms and can precipitate with rain, thereby further affecting land and bodies of water. Much of the mercury found in the Susquehanna River watershed comes from the Ohio River Valley, where there is a concentration of coal-fired power plants.

Organisms that are higher on the food chain have a higher risk of mercury poisoning because of a process called bioaccumulation. Very small amounts of mercury get into the tissue that is part of a very small organism such as algae. When that particular tissue is ingested by a larger animal (such as an insect, the larvae of an insect, or a very small fish), the mercury that is ingested accumulates in the organism. This amount of mercury becomes concentrated in the tissue of the organism that ingests it. One of the characteristics of mercury is that animals cannot completely metabolize it, so the mercury in the tissues of an organism will never go away. As a result, mercury biomagnifies, meaning that with each step up on the food chain, the levels of mercury increase. The higher the organism on the food chain, the greater likelihood that it will both encounter in its prey and itself have much higher concentrations of mercury. Thus, the larger fish that ingests the insect or small fish will then add to its tissue all of the mercury that its prey has accumulated throughout all of its life. Higher up on the food chain, when a person eats a smallmouth bass, for example, that person eats a fish that has had perhaps 5 or 6 years' worth of mercury consumption. The effect of biomagnifications is such that this smallmouth bass has in its tissues all of the mercury that all of its prey had accumulated by eating smaller mercury-containing organisms that had in turn eaten even smaller mercury-containing organisms. Thus, during the life of this animal, this smallmouth bass may accumulate a

dosage of mercury that could be dangerous for a human to ingest. When people eat these fish, they absorb the methyl mercury, and it accumulates in the bodies of humans as well. After awhile, one can accumulate enough mercury for it to become poison inside of the body. Large, top-of-the-food chain predators have the highest levels of mercury.

In marine micro-environments, mercury is biomethylated by microorganisms. Biomethylation is the process whereby microorganisms transform mercury into a form that is more toxic (called methylmercury) and that most easily bioaccumulates in organisms. The bacteria that carry out biomethylation live in anoxic marine environments, meaning environments with low dissolved oxygen such as estuaries (bodies of water with many nutrients and bacteria because they connect fresh water bodies to salt water bodies) and the sediments at the bottoms of lakes. Thus, the mercury that humans encounter in fish is especially dangerous because mercury that reaches water bodies becomes more toxic there. Almost all Americans have measurable levels of mercury in their blood, most of which is the mercury from fish, though dental amalgam fillings also contribute to blood mercury levels. Many studies have shown that the more fish people eat, the higher the mercury levels in blood.

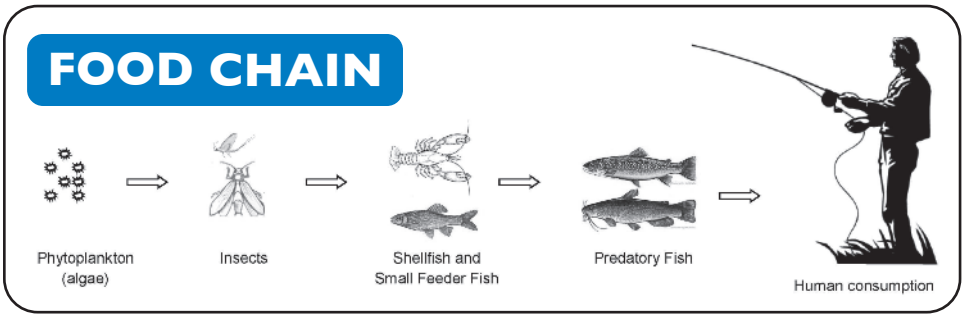
The Pennsylvania Department of Environmental Protection and the Pennsylvania Fish and Boat Commission have put the Susquehanna River along with other water bodies throughout the state on a Fish Consumption Advisory because of mercury and other contaminates. Fishermen are warned about eating too many fish too often from these water bodies. Although there is not a commercial fishing industry in the watershed, there is a thriving recreational fishery throughout Pennsylvania. According to the Annual Report of the Pennsyvlania Fish and Boat Commission, fishing permits in Pennsylvania were sold to 1,491,280 people in 2009. The Susquehanna River watershed is one of the fastest-growing fisheries in the country because of the smallmouth bass fishery. However, there has never been a census to ascertain how many of the fishermen are eating their catch.

During the last year, Professor Brian Mangan, Associate Professor of Environmental Science and Ecology at King's College, began a project in conjunction with the Heartland Coalition to characterize the distribution of mercury within

the Susquehanna River and the watershed. Because of the effects of bioaccumulation, such analysis involves testing organisms rather than the water because mercury levels in the water won't necessarily reflect the amount of mercury that organisms in the water have taken in. The build-up of mercury in tissue over time means that mercury levels in organisms will be much higher than would be found in the water. In addition, other researchers have found mercury can fluctuate through space as well as time, Professor Mangan also studies how mercury levels in organisms may vary through space and time.

Professor Mangan and his students take samples from all along the Susquehanna River. His goal for the summer is to sample locations from New York all the way down the River to Harrisburg. He also aims to sample at a few sites along the West Branch. The process involves collecting as many different kinds of organisms as possible and sampling them and their tissues for mercury to see which organisms might have the highest mercury load as well as where within their bodies the mercury is concentrated. At this point, he and his team have confirmed what other researchers have already shown: that organisms in the Susquehanna River and watershed contain mercury. Now, Professor Mangan seeks patterns in the presence and the concentration of mercury.

The Pennsylvania Fish and Boat Commission and the Pennsylvania Department of Environmental Protection have done some monitoring of fish in the Susquehanna and in many other water bodies across the state and have found mercury in certain concentrations. Professor Mangan aims to build upon these foundational data. He and his team are taking mercury research to the next step: whereas these previous studies only analyzed mercury levels in fish, Professor Mangan and his team are doing this as well but also looking at two other factors: 1) they are collecting other organisms in addition to fish so as to see how the mercury is getting into the fish and 2) they are looking at how the mercury is distributing itself inside of the organisms – where in the animal it tends to be concentrated. Although data from the Pennsylvania Fish and Boat Commission and the Pennsylvania Department of Environmental Protection can to some degree serve as



a basis of comparison of prior mercury levels versus current mercury levels, the ability to make a direct comparison is limited because the means by which the former studies were carried out were different than the methodology of Professor Mangan and his team. The earlier studies took their samples differently. Multiple fish from a site were mixed together, and then a subsample was drawn off of that composite for analysis. Professor Mangan, alternatively, is sampling individual fish and individual tissues of fish.

The purchase of a new machine, a Direct Mercury Analyzer, enables Professor Mangan and other members of the Heartland Coalition to easily test for mercury in individual fish. The traditional methodology for testing mercury samples was much more difficult: samples were placed into vats of acid, which broke down the samples and enabled researchers to study mercury levels. With the Direct Mercury Analyzer, by contrast, all a researcher has to do is cut a sample into a small size, weigh it, and place it in the machine. From there, the machine carries out the analysis.

Professor Mangan hopes to further change the methodology of analyzing mercury in organisms. Historically, and even now, much of the sampling required that fish be sacrificed, after which tissues are cut from the fish for analysis. Professor Mangan and his team are trying to establish a mathematical correlation between internal mercury loads and external mercury loads. This involves clipping fins and taking scale samples to see whether the external levels of mercury might reflect the fish's internal mercury levels. If that mathematical relationship is strong enough, in the future fish will not have to be sacrificed. Researchers will only have to snip off a fin or a piece of fin and take a few scales to get a good idea of the mercury levels in the fish.

At the moment, Professor Mangan's work in mercury is focused on the acquisition of some good measures of mercury levels and distribution in organisms in the environment. Once that information has been published, the next step will be to investigate the mercury burden in the local human population. Despite the mercury advisories that have been in place for many years, there has never been a study of the connection between the mercury levels in fish and those in the local population. Upon speaking with the chief toxicologist at the Pennsylvania Department of Health, Professor Mangan and his team discovered that there are no data on mercury burdens in Pennsylvanians. As a result, datasets and recommendations from other states, such as the Great Lake states, are used as the basis for estimates of what mercury burdens in Pennsylvanians might be. Although these data might be overestimates of mercury burdens in Pennsylvanians because people in the Great Lake states might use more fish, nobody can be sure without a study to confirm such a hypothesis. Professor Mangan hopes that the next phase of the mercury project will involve the acquisition of some human tissue samples (such as, for example, hair samples) and an analysis of the samples to ascertain the mercury burden. Although plans for this next step are speculative, some ideas involve testing representatives of the general population as well as targeting sectors of the population that might be more likely to have higher levels of mercury, such as fishermen who eat their catch. Another idea is to feed other animals fish with mercury burdens and then take blood and hair samples to study how much of that mercury gets into the animal.

Professor Carlos A. Iudica, Assistant Professor of Biology at Susquehanna University, currently studies the diets and the mercury levels of mammals that live on the land surrounding the Susquehanna River and in the watershed. Much of his research focuses on the stomachs of minks and other small- to medium-sized carnivorous mammals that live in the forest or by the water. Though minks, for example, often eat food from land, they also often eat food from the water, such as small fish.

Professor Iudica obtains the minks and other mammals (such as foxes, raccoons, and skunks) from the Pennsylvania Trapper Association, a group of people who have been trapping for over a hundred years. Most members of the association trap not as a job but as a hobby. The trappers skin the animals and then discard the rest of the carcasses. When Professor Iudica heard about this practice, he contacted members of the group and asked them to save the carcasses. At this time, Professor Iudica is in contact with a large group of trappers through e-mail. Every year, when they are setting up their traps, they contact him and ask what he needs for his research. Last year, when he was finishing up a study on foxes, for example, he was able to direct the trappers as to how many and what sex of foxes he needed; they then e-mailed him when they had the carcasses, and he went to pick them up. The animals that have already been harvested by trappers are in this way collected and used for research. Professor Iudica also preserves the bones of the animals and uses them for teaching.

Professor Iudica and student assistants have taken advantage of the machine Professor Mangan uses to study mercury levels. For example, Professor Iudica has one student who is dissecting approximately 150 male minks from different areas that live on tributaries of the Susquehanna. She is collecting the stomachs so as to decipher the winter diet of minks along the Susquehanna River, and she is also collecting tissues from different parts of the body and sending them for analysis on the Direct Mercury Analyzer. Some preliminary results have come in: all of the animals seem to have some levels of mercury in their tissues. The values thus far vary widely from animal to animal; some have ten times the mercury in their tissue as others. Very few results have come back from the machine thus far, however. Currently,

Professor Iudica is conducting research to establish, based on others' findings in the past, baseline levels of mercury for animals without exposure to mercury so as to have a basis for comparison with the animals that he is testing.

The diet of minks, for example, can vary widely based on the time of the year and the place of habitation. Whether minks use the water often depends on the time of the year. In addition, males and females use the environment in a very different way. Males like to be in the forest most of the time, and they spend a lot of time in open areas. Females, meanwhile, live close to the water and feed close to the water or in the water. Males will approach the water to interact with females. As a result, analysis of contents of minks' stomachs have revealed fish or macroinvertebrates that are available in the water in addition to birds, lizards, amphibians, and mammals that are typical of forested areas.

An analysis of the mercury levels from minks can be considered to have a relationship with the mercury levels one might expect to find in mammals higher up on the food chain, such as humans. Because humans eat fish that are one step up on the food chain from the fish that are consumed by minks, the levels of mercury in humans might be expected to be even higher than those found in minks. In effect, the minks are catching the small fish that would eventually be eaten by the fish that could eventually be ingested by humans. The results of the research of Professor Iudica will not only say something about how these mammals can live with this amount of mercury in their body but will also provide a sort of window to take a peek and see how the ecosystem is doing even before one reaches the top, where humans are consuming the fish that are feeding on the same small fish on which minks feed.

Professor Iudica did not expect to find mercury in the minks at all; he surmises that the presence of mercury in minks would mean that the system itself is recycling mercury somehow through different parts of the food chain. Humans are part of the same food chain as minks because people, too, fish and hunt. Humans ingest the fish that compete with minks for aquatic pray. Only one step farther as a competitor for the same meals that the minks are using to accumulate mercury, humans might be able to learn something about their own mercury levels from the forthcoming results of Dr. Iudica's study of mercury levels in minks.

COMMUNITIES & CULTURE

The Nature and Human Communities Initiative is a partner to the **Susquehanna River Heartland Coalition for Environmental Studies**. Researchers and practitioners in the Nature and Human Communities Initiative study the human stories and history of the Susquehanna River Valley. Together, the two partners form the Susquehanna Colloquium and work to research, document, and share the region's cultural and environmental heritage.

John Smith National Chesapeake Waterways Trail

The Susquehanna Colloquium submitted a proposal to the National Park Service to extend the John Smith National Chesapeake Waterways Trail from the Susquehanna's main source at Cooperstown, NY, down to Smith Falls, MD, just above the Chesapeake Bay. The existing trail allows kayakers to follow the path taken by John Smith during his first voyage by water through the region. Advocates for the extension argue that the designation of the Susquehanna River as an extension of the trail would focus people's attention on the river as a whole system through its history. The production of the proposal involved intensive research on the part of many scholars, including Katie Faull, David Minderhout, and Alf Siewers. If the National Park Service were to grant the extension, the river corridor would stand to receive significant funding and recognition, as well as environmental protections. Because the river is non-navigable, kayakers and fishermen would be in a good position to take advantage of its quiet waters; as a result, the river corridor could see a boost in ecotourism. The Nature & Human Communities Initative hopes to receive the decision of the National Park Service before the end of 2010.

Stories of the Susquehanna Valley

Stories of the Susquehanna Valley is a multimedia project underway to unearth and share the multi-faceted history of the Susquehanna Valley. The project includes a book series, a documentary series, and the provision of online educational materials. All of the parts of the series will be interrelated such that a book will relate to a documentary; meanwhile, information related to the subject matter of both the book and the documentary will be available in the online educational materials.

A grant has been submitted for the first studio production, entitled America's Forgotten Eden. The current idea for the documentary is to portray the features of the Susquehanna

Valley in the 17th century, including the early contact between settlers and the Native Americans and the natural landscape. The documentary would then move into the changes that occurred during the French and Indian War, the influx of Euro-American settlers, the beginning of large-scale industrialization and resource extraction such as lumbering and coal mining on a massive scale, and the removal of much of the Native American community from the Susquehanna Valley.

Plans for the book series tentatively includes five books. One volume will delve into the history of river towns, another will consider the history of mills along the river. A third volume, edited by Alf Siewers (Professor English, Bucknell University) will feature writers whose works were influenced by and reflect on the area. Professor Katie Faull's research on 18th-century diaries of the Moravian settlers in the Susquehanna Valley will comprise the fourth volume. The settlers lived in a number of communities along the river in very close proximity with the Native Americans. Because interactions between the groups was unusually peaceful, diaries contain much information on the practices, culture, and lifestyle of Native Americans at that time.

The research involved for these latter two books overlaps with another project that involves scholars across many disciplines: historical digital mapping of the environment and the cultures in the area. The products of the digital atlas efforts have been utilized in the proposal for the extension of the John Smith National Chesapeake Waterways Trail. Duane Griffin from the Geography Department at Bucknell University is involved with the digital atlas project, as is David Minderhout (Professor Emeritus of Anthropology, Bloomsburg University), who will be the editor of the fifth book in the Stories of the Susquehanna series. This book will be focus on the presence of Native Americans in the Susquehanna River Valley through the ages.

David Minderhout
Professor Emeritus of Anthropology
Bloomsburg University

Dr. Minderhout has been working with people in Pennsylvania who claim Native American hertitage since 2005. For the 2009 river symposium at Bucknell he organized a panel that focused on issues faced by contemporary tribes in Pennsylvania.

As part of an ongoing project, Dr. Minderhout continues collecting oral histories to house and display in the culture center that the Eastern Delaware Nations is in the process of building on its land near Wyalusing. He is also writing a book about Totem Rhythms, a Native American healing arts organization based in the Philadelphia area. Totem Rhythms is an internationally renowned group that has been creating native arts projects in the U.S. and abroad since 1999. Its board is made up of people of Lenape descent, and the book is being written at their request.

Susquehanna Valley Summer Writers Institute

The 2nd Annual Susquehanna Valley Summer Writers Institute was extended from 8 weeks' to 10 weeks' duration for a more extensive experience. Six students focused on the summer's topic: Marcellus Shale. The students researched the impacts of Marcellus Shale in the region and then wrote their findings into a report that will be published online in the fall. The internship provides training in environmental journalism. This year the students had Pulitzer Prize-winning environmental investigative journalist Deborah Nelson (University of Maryland) in addition to creative nonfiction Professor Chris Camuto (Bucknell University), environmental studies Professor Amanda Wooden (Bucknell University), and Native American studies Professor Donald Grendy (University of Buffalo) for guidance and advice. Interns also benefited from the workshops taught by David Minderhout on techniques for oral interviews.

The interns split into three groups. One group focused on Marcellus drilling in relation to Native Americans; the interns interviewed Native Americans regarding their views of the Marcellus drilling and also focused on Native American lands related to drilling in Pennsylvania and New York state. During one such visit to New York, intern Brendan Wills and Professor Siewers met with the President and other leaders of the Iroquois Confederacy to discuss their views of Marcellus drilling and its effect on watersheds in traditional native lands, including both the lands that the Iroquois hold in New York and also those with which they feel culturally connected in the Susquehanna watershed. The Iroquois have been a leading force in resistance against Marcellus drilling in New York state. From the standpoint of their traditions, the Iroquois expressed concerns with large-scale resource extraction as a basis for a society and an economy. Those with whom Professor Siewers and Brendan Wills spoke on this occasion expressed their opinion that resource extraction stems from a very different concept about nature and human beings than is found in Native American culture. The Iroquois leaders also have practical concerns regarding the potential contamination of water-ways, as they have in the past experienced contamination of their local waterways as a result of pollution and industrial activities. The views of a larger representation of the Native Americans in New York and Pennsylvania will be available online in the interns' reports in the fall.

Another group of interns researched the contamination of the underground watershed of Dimock, Pennsylvania, which may have been caused by Marcellus drilling. Their research involved interviews of local residents. The third group's research also revolved around interviews of local residents, though in this case the focus was on the drilling in forest-lands of Pennsylvania. One intern, David Manthos, also interviewed members of state government in Harrisburg to compare the views of local residents with those on the state government level. Emily Anderson focused her research on impact of Marcellus Shale on the community of Tioga

County. She conducted approximately ten open-ended interviews, many of which lasted a couple of hours, with a range of stakeholders including landowners who had leased their land for Marcellus drilling, industry workers, activists, and residents concerned with the development in their community. Specifically, she analyzed the different narratives that people use to understand their experiences. Questions that she considered include the following: How can people overcome a history of exploitative resource extraction? What issues about our society and culture in general does resource extraction highlight and reveal?

Watershed: A Journal of the Susquehanna

The third annual issue of ***Watershed: The Journal of the Susquehanna*** will be published in the Fall of 2010. The journal contains articles, fiction, poetry, artwork, and photography, all of which are related to the people and places of the Susquehanna River region. Contributors include regionally and nationally recognized writers and artists, as well as newer voices. The journal is edited by Professor Jerry Wemple (Department of English, Bloomsburg University). To submit a piece for publication, contact Professor Wemple at **jwemple@bloomu.edu**.

The Berwick Ethnography Project

Since 2006, a team of academics and community leaders have been conducting a sociological ethnography of Berwick, a town that once was organized around a large boxcar manufacturing plant that employed 50,000 workers. Berwick is a declining industrial town with approximately 9,000 residents, a rich ethnic history, and a keen sense of its history as a manufacturing town. It has been the commercial center for Eastern Columbia County, serving coal towns to the north and east and farming and Appalachian mountain communities to the west. The work uses a variety of methods including life histories, documentary histories, policy discussions with local institutions, and large-scale needs assessment surveys. The group is especially interested in health issues that affect residents and that are related to the social and cultural history of Berwick. They are also working with leaders to explore implications of economic growth that is beginning to affect the town and its region. Economic growth is related to Marcellus Shale gas deposits, to the planned construction of a third nuclear power plant in the town, and to the possible construction of a major freight airport in nearby Hazelton. These prospects raise the issue of how depressed industrial towns like Berwick can change to support and benefit from economic growth.

Thomas Kinnaman
Associate Professor of Economics
Bucknell University

Professor Kinnaman is in the process of completing two reports that consider economic issues related to Marcellus shale drilling in the watershed. The first study was a review of literature that has been written about the economic aspects of shale extraction. Drilling associations hire economists to generate reports containing estimates of how many jobs will be created, profits that local residents might accumulate, and tax revenues that will be earned as a result of drilling. The reports are not published; they are issued by the industry, and the intended readers are legislatures and governors who are considering various regulations in relation to the industry as well as the impact drilling might have on the economy. As a result of the attention that a recent report received, Professor Kinnaman decided to perform a critical study of the reports issued by the industry to evaluate the methodology by which the economists reached their conclusions and the accuracy of their conclusions.

All of the reports that Professor Kinnaman evaluated date from the last 6 years. A few related to shale extraction in Texas and Arkansas. The recent report that received much attention, called "Economic Impacts of the Pennsylvania Shell Gas Shale Play: An Update" but widely referred to as the Penn State report, was published in 2010 as an update to an earlier report published in 2009 (though the report's leading researcher was associated with Penn State at the time of its generation, Penn State University has disavowed any official association with the report). The Penn State report relates only to drilling in Pennsylvania, and Professor Kinnaman's study also focused on the predicted economic impacts of drilling activities in Pennsylvania. Professor Kinnaman's report will discuss three shortcomings that he found in the two Penn State reports that he indicates resulted in an overestimate of the economic benefits from drilling. However, his report has yet to be finalized; he is in the final stages of revision, and he will soon be submitting it for publication in various economics journals.

The other report that Professor Kinnaman is finishing up studies the degree to which local residents value the safety of the environment in the context of Marcellus shale extraction. Economists have long studied the economic value that consumers assign the objects that they purchase. For example, if a person does not purchase an apple because of its price, then the price of the apple does not reflect the economic value that the individual personally assigns to the apple. Professor Kinnaman is applying this same concept to consider the economic value that a person assigns to, for example, the environment's safety from a drilling accident. A total of 186 drivers were questioned at a local Department of Motor Vehicles. They were asked how much money per month they would be willing to pay to 1) fund projects that would improve access to the Susquehanna River and 2) to fund hypothetical safety measures that would ensure zero accidents from Marcellus shale drilling. At present, the findings that his report contains indicate that households each would be willing to pay an average of $12.44 per month to improve access to the river and $9.19 per month to support extra safety measures against the risk of accidents from drilling. Professor Kinnaman is in the process of finalizing his findings and revising the report for publication.

AWARENESS & EDUCATION

WKOK

Newsradio 1070 WKOK continues to focus news and public affairs programming attention on its ***Boroughs to the Bay and Beyond*** series. Environmental topics have appeared in news stories, ***On The Mark*** (a live talk show), ***Roundtable*** (panel discussions), and ***Leaders & Lawmakers*** (one-on-one interviews). Topics covered include smallmouth bass intersexing, the impact of subtle–but increasingly pervasive--contaminants in groundwater and in the Susquehanna River, and citizens' concerns regarding the purported contamination from the former landfill in Northumberland.

WKOK's award-winning coverage has lately tapped local expertise to cover the Gulf of Mexico oil spill. On this topic, we have interviewed professors from Bucknell University and Bloomsburg University, as well as other schools nationally. We have sought local reaction to this disaster as well.

On The Topic series continues with Molesevich Environmental, our interns continue to share in our earth science coverage, and we remain an open mic for environmental experts and advocates. We have also monitored and covered the **Susquehanna River Heartland Coalition for Environmental Studies** (**SRHCES**) efforts.

Sara Bartlett, our News Director, has affected our most recent coverage, focusing on the SRHCES plans to renovate and occupy the Shikellamy State Park marina building. She has also participated in several of the monthly meetings of the coalition.

Bartlett's coverage this summer has included news of the reintroduction of eels to the river. Our main Web site, www.wkok.com, continues to be an outlet for our coverage and the posting of "long form" interviews. WKOK continues to be a proud supporter of SRHCES and remains open to more suggestions for coverage.

WVIA

WVIA's ***Hearth and Harvest*** was released in September of 2009. The documentary tackles the lives and processes of Pennsylvania farmers today by following some farmers through a chronological year. The voices of the farmers tell the story of crops' journeys from seed to shelf: from the Farm Show in Harrisburg in January through the end of the harvest season. The role of farmers in Pennsylvania's history is also considered.

Greenlife Pennsylvania, a television series that premiered last year, will begin its second season this year. The series considers actions that individuals can take to create a healthier environment and home. The series was viewed in all eight markets in Pennsylvania. Because of the positive feedback that it received, the necessary funding was received for a second season.

Production has begun on a documentary about Camp Victory, a summer camp for special-needs children located east of Melville in Columbia Country. The camp encompasses 220 acres of wildlife. The documentary will focus on specific children and their families and how the children's lives at camp have impacted them. The documentary will be released by June 30, 2011.

MARCELLUS SHALE

Marcellus shale is a formation of fine-grained, black rock that contains natural gas. The formation covers the entire northern and western parts of Pennsylvania and extends into parts of New York, West Virginia, and Ohio. The result of the solidification of ordinary mud, the shale is approximately 390 million years old and was originally deposited at the bottom of an inland basin. The basin was akin to an inland ocean. The water did not have any oxygen in it, which the organic material (such as plants and tiny bugs) needed to survive. Without oxygen, the organic material died and fell through the water to the bottom of the ocean floor, where the organic material was eventually buried over millions of years. Under miles of rocks, the organic material became pressurized and cooked into natural gas. Now, the natural gas is locked down in the shale formation itself.

Gas exploration and development companies from across the country are now working in Pennsylvania to drill into this formation and extract the natural gas, which is a relatively cleaner fossil fuel than coal. The drilling is having a profound effect throughout the Appalachian plateaus of Pennsylvania. Development of the deep wells and the well sites – including construction of the entire supporting infrastructure, roads, compressing stations, pipelines, etc. – is just beginning to ramp up. During 2008–2010, at least 100 applications for permits have been granted for Marcellus wells throughout Clinton and Centre Counties and 16 in the Beech Creek watershed.

To allow the gas to escape, the companies break apart the formation using pressurized water, a technology known as hydrofraking. Chemicals are used during the drilling process, many of which are very toxic. Because each of the drill holes requires millions of gallons of water, the drilling process leaves the operator with quantities of chemical-laden wastewater to treat. The drilling and extraction process have raised concerns about water quality, air quality, habitat fragmentation, and the spread of invasive species.

Susquehanna River Basin Commission

In January 2010, the Susquehanna River Basin Commission (SRBC) began to install a multitude of sondes around the watershed to monitor for possible effects of natural gas drilling. Since then, 23 sondes have been installed, with hopes to have 50 more installed by winter.

Exploratory drilling of the Marcellus shale began in Pennsylvania in 2005. To help determine if the sondes, installed 5 years later, already are showing impacts from the drilling, some of the sondes are being placed in watersheds where drilling has not occurred and the effects are minimal. Additionally, sondes will be installed in New York prior to drilling beginning to provides SRBC will data of drill-free water.

SRBC is locating their sondes in watershed that are 60 square miles or less. This will help reduce the chance that the volume of water is diluting any possible contamination.

The sondes were purchased with money donated by East Resources, a natural gas extraction company. SRBC will provide the funds for the operation and maintenance of the sondes. Funds from the New York State Energy Research and Development Authority support the purchase of the sondes that will be installed in New York. The SRBC is currently working out a partnership with the Pennsylvania Department of Conservation and National Resources for the purchase of 10 new sondes to be placed in Pennsylvania.

The sondes measure the ability of the water to conduct electricity (conductivity), which can be a leading indicator of impacts from natural gas activities should they occur. Conductivity would rise if the water used to fracture the shale (referred to as "flowback") made its way into the water system. Flowback contains more salt than the water in the rest of the watershed. Because the conductivity of water changes based on the amount of dissolved solids contained in the water, a change in conductivity could indicate that the salty flowback water has leaked or spilled into the water system. Although the salt would be the means of detecting the intrusion of flowback water via changes in conductivity, any such leak would involve the other chemicals that the flowback water also contains. Most drilling companies contain the flowback and reuse this water at other sites, trucking it from place to place. Other companies hold the flowback water in pits, though the practice is frowned upon even within the industry. Some companies are looking to have the flowback reprocessed and reintroduced into the water system after filtration. To monitor the quality of flowback water that has been treated and reintroduced, a sonde has specifically been installed downstream of a projected water treatment site in Meshoppen Creek.

Between four and five people at the SRBC who work on maintaining the sondes also look at the data. Currently, the project is in its implementation phase, but the SRBC hopes to start assessing the data in depth in the winter. In the meantime, the SRBC set up a system so that if any parameter of water quality reaches a certain value, an alert will be activated. Thus far, alerts have gone off on only one occasion. At Bob's Creek in the Juniata River Basin, conductance levels activated an alert as a result of a situation with drilling in the area. Although the event was not publicized, the Pennsylvania Department of Environmental Protection was involved, and the gas company was aware of the situation. The SRBC states that the levels of conductance did not indicate a threat to water safety but that the difference was considerable enough to merit immediate attention.

SRBC is posting the data online at www.srbc.net. This will allow the general public and scientists to track data being collected in their area.

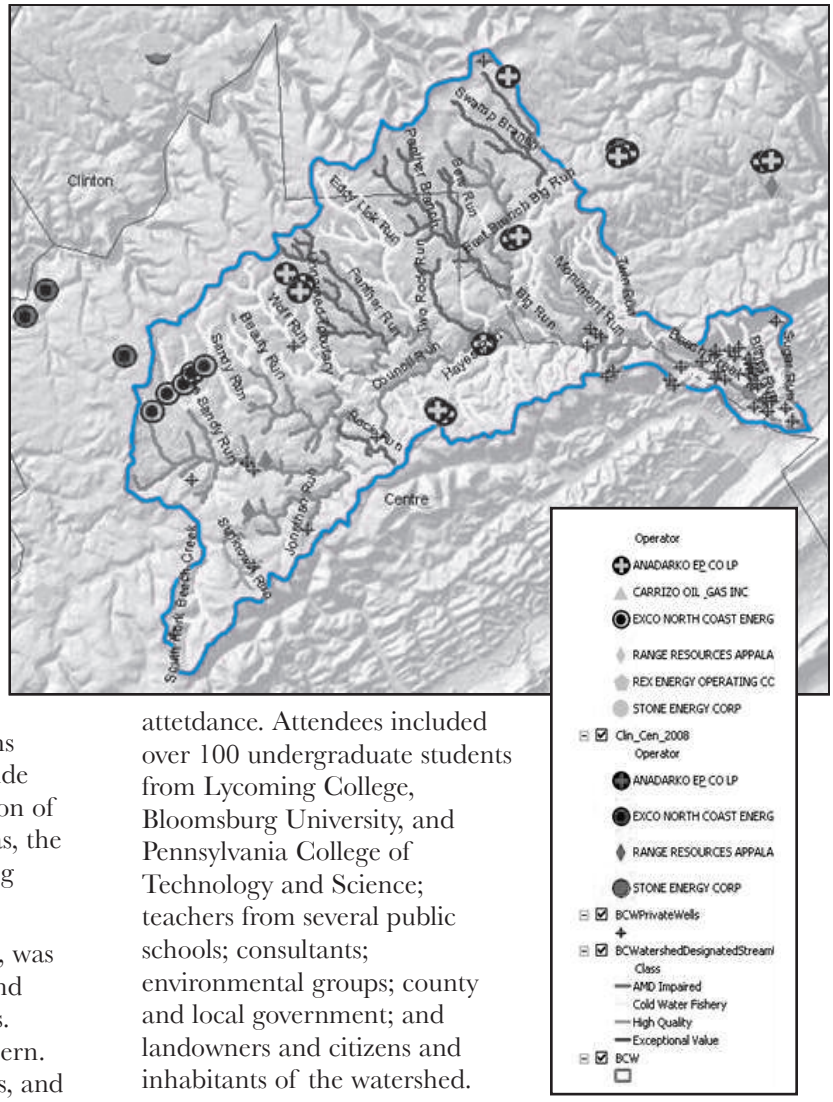
Local Partnership to Monitor the Effects of Drilling

For some time, the geology department at Lock Haven University of Pennsylvania has had a relationship with the Beech Creek Watershed Association. Recently, the Pennsylvania Senior Environmental Corps, an environmentally conscious group of citizens, joined the partnership. Under the guidance and leadership of Dr. Mohamed Khalequzzaman (Associate Professor of Geology and Physics, Lock Haven University of Pennsylvania), the geology department at Lock Haven University together with these two other groups have been monitoring the water quality in the Beech Creek watershed to assess the effects of drilling.

The groups collect water samples from the streams and rivers that are in the vicinity of Marcellus shale drilling in an attempt to establish baseline data with which the water quality can later be compared in case of any contamination from the drilling in the future. The samples are collected both upstream and downstream of the drill sites. Samples in the Beech Creek watershed have been collected in the past for other projects; now, the groups are specifically targeting locations in proximity to the drilling so as to establish how and where, in the event of an accident, contaminated water would travel. The areas upstream of the drilling sites would not be affected by drilling; therefore, by collecting samples from both upstream and downstream of the drilling site, the group can acquire data on the water quality of both unaffected and potentially affected areas.

The group is still in the process of analyzing the samples collected, but thus far no impact from drilling has been observed. If, however, water contamination from the drill site event should occur, the group will have acquired data on the water quality so as to have a thorough understanding of the effect of the event on the water. The group intends to expand their research in the future to include organisms in the water and perhaps soils as well. However, if contamination were to occur, the water would be affected first, so the group's initial attention has been focused on establishing a database of the quality of the water itself.

The map at right shows the locations of proposed and completed Marcellus drilling sites in the Beech Creek watershed (area outlined in blue).



Marcellus Shale Symposium

In mid- to late 2009, the Coalition recognized that many citizens were concerned about the potential environmental impacts of Marcellus shale drilling and were looking for information so as to be better informed. A subcommittee was formed, and soon plans were underway for a 1-day workshop that would provide attendees with information and insight on the formation of Marcellus shale, methods used for extraction of the gas, the water-withdrawal permit process, and the actions being taken to treat the waste water.

The January 2010 event, hosted by Lycoming College, was structured with an opening overview of the geology and formation of Marcellus shale, followed by three panels. Each panel focused on an area of environmental concern. Speakers included industry representatives, researchers, and representatives from regulatory agencies. The Coalition hoped to provide a range of perspectives on the issues discussed.

Nearly 500 people attended the workshop. The attendance came as a pleasant and overwhelming surprise to the organizers, who had originally set 100 people as the goal for attetdance. Attendees included over 100 undergraduate students from Lycoming College, Bloomsburg University, and Pennsylvania College of Technology and Science; teachers from several public schools; consultants; environmental groups; county and local government; and landowners and citizens and inhabitants of the watershed.

As a result of the success of the event, discussions are underway regarding the possibility of additional forums that would examine the issues of habitat fragmentation and the potential increase in the variety and distribution of invasive species. Events would be advertised in local newspapers and on local radio stations once set.

SPEAKERS AT THE MARCELLUS SHALE SYMPOSIUM

Michael Beattie
Anadarko, Senior Geological Advisor

Dr. John Way
Pennsylvania Geologic Survey, retired; Lock Haven University, retired

Dr. Carl Kirby
Bucknell University

Karen Johnson
Environmental Protection Agency

Jennifer Hoffman
Susquehanna River Basin Commission

Deb Nardone
Pennsylvania Trout Unlimited

Bryan Swistock
Pennsylvania State University, Cooperative Extension

John Hines
Pennsylvania Department of Environmental Protection

Dr. Kevin Gilmore
Bucknell University

Tim Keister
Pro Chem Tech

L. Richard Adams
Chief Oil and Gas

Alex Fried
Proctor & Gamble

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**Susquehanna River Heartland Coalition
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