Pulse of the Heartland 2007

AN ANNUAL REPORT

Coal Refuse Pile in Cambria County prior to clean-up efforts

Same area in Cambria County in March 2007 following clean-up efforts

Presented by the

SRHCES

Susquehanna River Heartland Coalition for Environmental Studies

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

Recognizing this tremendous asset, four years ago six regional colleges and universities joined other partners, including ***Geisinger Health System, Trout Unlimited, Western Pennsylvania Watershed Program, 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)** and engage the impressive talents of faculty and staff to address environmental issues within the watershed. Additional promotion and support for this effort has come from sponsors such as ***WVIA*** (Northeastern PA's public broadcasting stations), ***Sunbury Broadcasting Co., The Daily Item*** and the ***Degenstein Foundation***.

The coalition's goal is to mobilize the scientific and student resources of these colleges and universities in combination with community and regional interest groups to improve the watershed by encouraging and facilitating environmental research, analysis, advocacy and public service. Over the first four years, working with watershed associations and other advocacy groups, more than $800,000 in projects have been undertaken, including mitigation of acid mine drainage, riparian planting projects and water quality monitoring in the river and its tributaries. An additional outreach initiative has included providing environmental education classes for K-12 science teachers.

Furthermore, the coalition has supported humanities research such as the Heritage Area Study at SEDA-COG and the publication of the journal ***Watershed***, containing original poetry about the area. These efforts seek to re-define and celebrate cultural identity in central Pennsylvania, largely by returning to the Susquehanna as a source of revitalization.

Included in this report, you will find summaries of the projects and activities within the various fields that SRHCES has become involved in. Additionally, you will find extensive information regarding Abandoned Mine Drainage (AMD), the highlight of this year's Susquehanna River Symposium. AMD has significantly damaged the water quality of the Susquehanna River, but much is currently being done to restore the river and celebrate its stunning potential.

A special word of thanks goes to those six institutions of higher education (**Bloomsburg University, Bucknell University, Kings College, Lock Haven University, Lycoming College and Susquehanna University**) for their commitment to the region as well at to the Environmental Health Institute at Geisinger.

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

Abandoned Mine Drainage: The History, the Environmental Impact, the Solution

What is Abandoned Mine Drainage?

Abandoned Mine Drainage, or AMD, occurs when water passes through abandoned coal mine sites and reacts with the minerals found in the waste rock and leftover coal. The reaction creates highly acidic drainage that ultimately damages streams and rivers. An AMD-impacted stream can often be identified by the reddish-orange or blue color that tinges the water, although even highly polluted streams can also remain perfectly clear. AMD can create unsuitable living environments for fish and other aquatic species, in addition to contaminating drinking water and raising public health concerns. According to the Environmental Protection Agency, drainage from abandoned mines poses the largest threat to the Appalachian environment.

Coal Spoil Pile

Why should we be concerned?

The communities that developed along the river have suffered from its destruction. The time has come to start changing the way we think about the river and start bringing the Susquehanna back to life. The communities deserve a river that they can enjoy and there are many organizations dedicated to its remediation. Improving the water quality of the Susquehanna River means safer drinking water, better fishing and economic revitalization. The river has the potential to be a source for community enjoyment, and with a little time and hard work, anything is possible.

How did this happen?

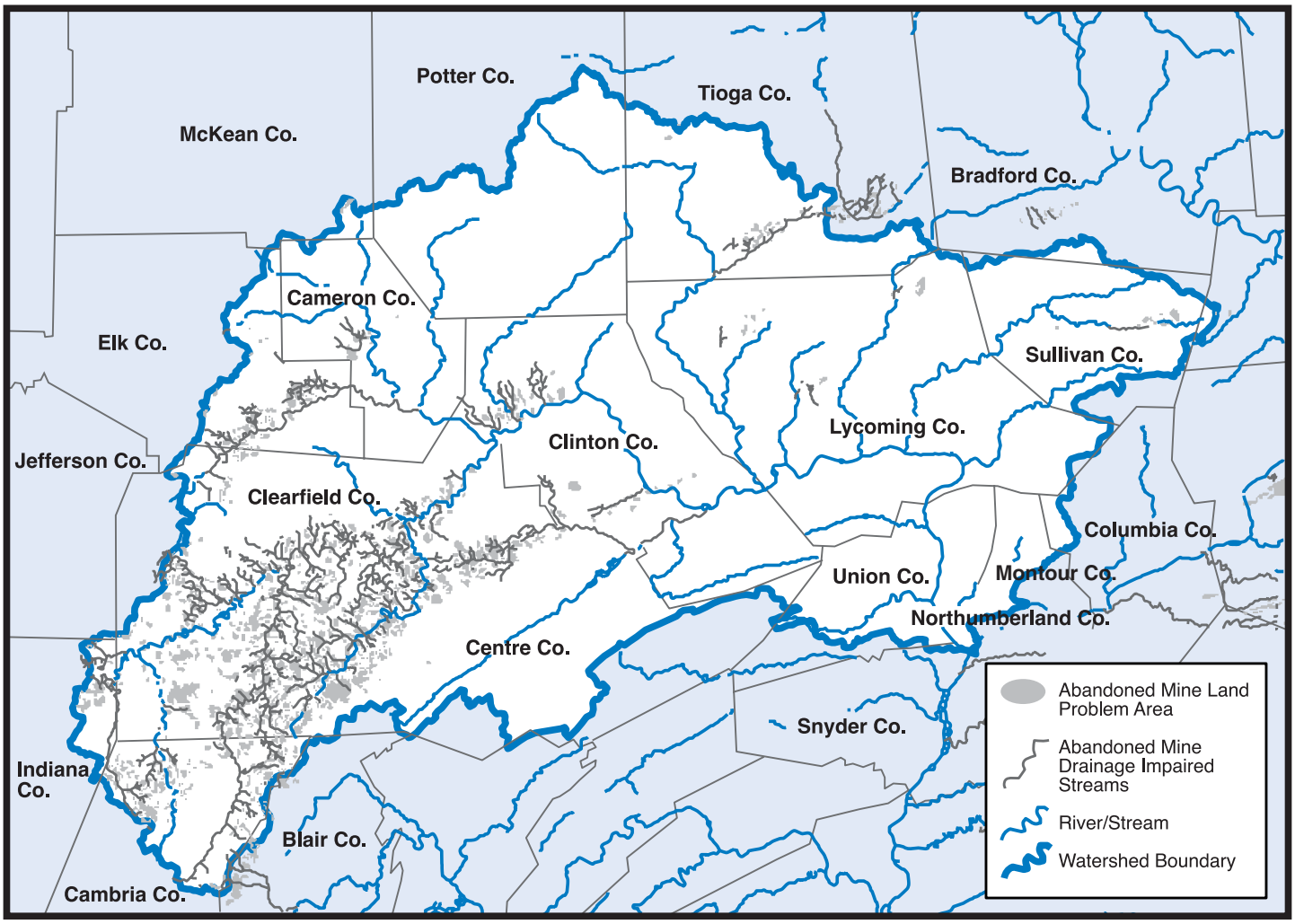
The coal mining industry largely shaped the identity of the communities throughout Appalachia. Driven by pioneer settlements, the Industrial Revolution and the World Wars, coal mining historically provided the economic backbone for the country. Unfortunately, the industry was troubled, not only by corruption, but also by relative disregard for the environmental consequences of extreme natural devastation. We still live with the consequences of their actions today.

The Surface Mining Control and Reclamation Act (SMCRA) of 1977 resulted in mining regulations so that, after nearly a century of unregulated mining, further damage to the environment could not continue. The act created the Office of Surface Mining Reclamation and Enforcement (OSM) to monitor and enforce these regulations. Additionally, the office was placed in charge of the Abandoned Mine Reclamation Fund, established under Title IV of SMCRA, which generates money to support projects to restore land and water resources impacted by AMD. The fund is sustained by a reclamation fee that is collected for every ton of coal mined in the United States.

Fortunately, in December of 2006 Congress re-authorized Title IV and under the new regulations, Pennsylvania will receive approximately $1.4 billion from the Abandoned Mine Reclamation Fund between now and 2022. The Commonwealth will be required to put this money first and foremost to priority one and two concerns (health and safety), which leaves the potential for up to 30% to be spent by the Pennsylvania Department of Environmental Protection (DEP) on water quality improvement and AMD remediation.

How does AMD damage aquatic habitats?

AMD has been documented all along the Appalachians, with the most extreme damage in Pennsylvania and West Virginia. According to the Pennsylvania DEP, AMD is responsible for polluting more than 5,400 miles of streams throughout the state. AMD can affect aquatic habitats in many



Map of Abandoned Mine Land Problem Areas and Abandoned Mine Drainage Impaired Streams in the West Branch Susquehanna River Basin provided courtesy of The Susquehanna River Basin Commission

different ways. High aluminum and iron concentrations common in AMD-impacted streams can clog the gills of fish and aquatic insects making it difficult for them to breathe. Low pH also causes respiratory difficulties and while some fish, such as Brook Trout, can tolerate pH levels as low as 5.0, low pH in conjunction with high metal concentrations often proves lethal. Additionally, high metal concentrations create slippery surfaces on stream bottoms, preventing insects and bugs from living on the rocks. This causes the fish population to decrease from limited food resources.

What does restoring the environment have to do with the economy?

The U.S. Geological Survey estimates that Pennsylvania loses approximately $70 million each year, in revenue that could be generated by sport fishing, were our streams returned to optimal health. Furthermore, 90% of the stream sites along the West Branch sampled by the Susquehanna River Basin Commission (SRBC) have excellent or supporting fish habitats, they simply need remediation. Nearly half of the West Branch watershed land is owned by the state and this region has become a primary target for Governor Rendell's PA WILDS initiative. With the ultimate goal of increasing economic growth through tourism and recreation activities, the Governor's initiative has brought some much-needed attention to the more than 1,100 stream miles affected by AMD pollution in the West Branch. By restoring the river and its tributaries, towns that have suffered the impacts of many years of intense mining may be brought back to life and economic revitalization may be envisioned through environmental restoration.

What are some restoration strategies?

AMD treatment is not simple, but it has proven to be effective. Initial assessments regarding the impact of AMD must first address where it is coming from, how and where it is traveling and finally, how it is affecting the stream. Often before any specific strategy is developed, at least one year of monitoring is recommended. The more that is known about the watershed, the more successful the remediation strategy.

Although there is no simple, consistent solution to AMD, a combination of approaches is often used with success. For example, passive treatment systems operate by capturing mine drainage in a series of ponds as the drainage flows downhill. Once in the pond, gravity encourages the toxic metals to fall to the bottom, where they are guided through crushed limestone, which aids in neutralizing their acidity. The water continues through the ponds, until finally reaching the river in a more purified state. Wetlands are also often a component of passive treatment systems. Active treatment systems add neutralizing material directly to the AMD-impacted water. Surface or land reclamation establishes vegetation where there had been none and restores the land to approximate pre-mining conditions. Land reclamation is typically done in conjunction with the appropriate re-mining of left over coal reserves. Any combination of these strategies might be implemented to successfully remediate AMD-impacted streams.

Beech Creek Watershed "Kill Zone"

The West Branch Susquehanna Restoration Initiative

Despite being home to more than 1,100 miles of AMD-polluted streams and over 36,800 acres of unreclaimed mine lands, the future of the West Branch Susquehanna River Basin is not bleak. Countless federal, state, nonprofit and local watershed groups are working to restore the land and water. In 1998, Trout Unlimited (TU), a private non-profit organization dedicated to conserving, protecting and restoring trout and salmon fisheries in North America, embraced the significance of AMD in the Kettle Creek watershed in Clinton County. Through their nationally renowned Home Rivers Initiative, TU has witnessed positive results in that watershed and hopes to duplicate their success in the West Branch Susquehanna River Basin. In 2004, TU established the West Branch Susquehanna Restoration Initiative and since then, has acted as a lead catalyst in the restoration of coldwater streams throughout the West Branch. TU is also providing organizational support to the West Branch Susquehanna Restoration Coalition, a group that represents the collective efforts of watershed groups, TU chapters, county conservation districts, businesses and others that are working to address AMD problems throughout the West Branch Susquehanna River Basin. For more information, please visit **www.tu.org**.

What can I do to help?

A huge amount of restoration is the result of volunteers from local watersheds. The best thing you can do to get involved is contact your local watershed organization and ask what you can do to help. There is a lot to be done, but fortunately there is already a great and active network out there for you to become a part of. Abandoned mine drainage is not a simple problem to fix; treatment systems are very expensive and can take some time to produce results. But with enough support, the damage from the past can be remedied and the Susquehanna can achieve its tremendous potential.

Listed on the next page is the contact information for conservation districts in the heartland region. Conservation districts can direct you to local watershed groups. This information was current as of July 13, 2007; however this information changes on a regular basis. Please visit **www.pacd.org** for updates.

Centre Conservation District
414 Holmes Avenue, Suite 4
Bellefonte, PA 16823
Phone: (814) 355-6817 Fax: (814) 355-8696
resweitz@co.centre.pa.us

Clearfield Conservation District
650 Leonard Street
Clearfield, PA 16830
Phone: (814) 765-2629 Fax: (814) 765-1336
clfdccd@atlanticbbn.net

Clinton Conservation District
45 Cooperation Lane
Mill Hall, PA 17751
Phone: (570) 726-3798 Fax: (570) 726-7977
conserve@comcast.net

Columbia Conservation District
702 Sawmill Rd., Suite 204
Bloomsburg, PA 17815
Phone: (570) 784-1310 Fax: (570) 784-3247
Maryruth.Wagner@pa.nacdnet.net

Luzerne Conservation District
485 Smith Pond Road
Shavertown, PA 18708
Phone: (570) 674-7991 Fax: (570) 674-7989
info@luzernecd.org

Lycoming Conservation District
542 County Farm Road, Suite 202
Montoursville, PA 17754
Phone: (570) 433-3003 Fax: (570) 433-3907
tom.corbett@lyco.org

Montour Conservation District
112 Woodbine Lane, Suite 2
Danville, PA 17821
Phone: (570) 271-1140 Fax: (570) 271-1327
mcdklesh@fastgateways.com

Northumberland Conservation District
RR #3, Box 238-C
Sunbury, PA 17801
Phone: (570) 286-7114 ext. 4 Fax: (570) 988-4488
Judy.Becker@pa.nacdnet.net

Snyder Conservation District
403 West Market Street
Middleburg, PA 17842-1038
Phone: (570) 837-0007 ext. 5 Fax: (570) 837-3000
snyder@pa.nacdnet.org

SIDEBAR The Babb Creek Success Story

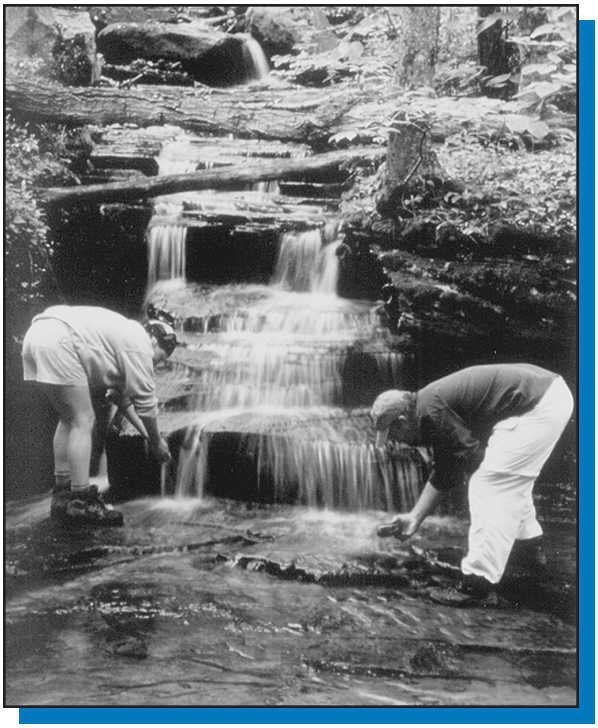
The Babb Creek Watershed Association has achieved tremendous success from its remediation efforts on Babb Creek and Pine Creek in Tioga and Lycoming counties. The restoration project essentially began in 1989 when legal action was taken against the Antrim Mining Co. for breaking into deep mines and increasing the amount of acid mine drainage into Babb Creek. The settlement from that lawsuit forced Antrim to contribute to a trust fund, which would be dedicated to the projects required to restore Babb Creek. Over the next 14 years many dedicated groups and volunteers contributed to the successful restoration of Babb Creek, so that, recently the Pennsylvania Fish and Boat Commission re-designated Babb Creek as a wild trout fishery. Additionally, Pine Creek is no longer impacted by the AMD from Babb Creek. The water quality and fishery restoration is the result of numerous remediation projects that have been completed throughout the watershed including limestone diversion wells, an active treatment system and multiple passive treatment systems. The Babb Creek restoration project is testimony to what a few dedicated citizens can accomplish.

Union Conservation District
155 North 15th Street
Lewisburg, PA 17837
Phone: (570) 524-3860 Fax: (570) 524-3873
jerb@unionco.org

An Explanation of Water Quality Variables

As constantly changing ecosystems, rivers and streams are challenging to represent on paper. A stream's water quality can often vary from day to day, and various circumstances, such as where samples are taken across the width of the river, can often affect the outcome of a water sample. Additionally, streams are affected by everything going on around them, whether it be agricultural practices, AMD or plain old rain, streams are highly sensitive to all sorts of events.

SRHCES is currently in the process of developing a grading index of water quality variables, which will be applied to the Susquehanna River in order to evaluate the health of the water. The group anticipates that this "Report Card" will evolve into an annual production that will allow the public to monitor river progress. Bringing together the research of all the institutions involved in SRHCES and building on data from other water quality monitoring organizations such as the Susquehanna River Basin Commission (SRBC), the Department of Environmental Protection (DEP) and the U.S. Geological Survey (USGS), the Report Card will represent the dynamic features of the river and how they have changed over time. In conjunction with the Environmental Center at Bucknell University, the group is currently in the process of hiring a River Coordinator to oversee the creation of this report.



Collecting water samples on a tributary

Since rivers and streams are very complex, the following summary provides some basic explanation about what is tested when evaluating water quality and what the ideal measurements might be, given correspondingly ideal circumstances in the environment. Along with the summary are some of the results of water quality sampling on the Lower West Branch conducted by the Clean Water Institute at Lycoming College. Multiple tests were conducted between May 2006 and July 2007. The single result reported represents the average outcome of these tests. Data is available in further detail at www.pawatersheds.org. Again, it is important to remember that rivers are constantly changing, and that, at this point, the data really just represents a single snap shot of the river. Following the summary, you may read about the events and circumstances that often threaten water quality. All of the listed threats currently affect the Susquehanna River in some way, shape or form.

Nitrogen

Nitrogen is found naturally in the environment and is an essential nutrient to plant life. However, high concentrations can increase algal growth and blooms that ultimately disrupt the water ecosystem. Fertilizer run-off and municipal waste are two causes of high nitrogen concentration. Nitrogen most commonly comes in three forms: nitrite, nitrate and ammonium. The Clean Water Institute tested for nitrite and nitrate in their water quality sampling. Generally, healthy nitrogen levels should be around 0.5 milligrams per liter of water (0.5 mg/L) or less. The test samples showed a nitrogen concentration of 1.2 mg/L, a level that is not optimal, but not yet extremely threatening.

Dissolved Oxygen

Dissolved oxygen is the oxygen available in the water for the aquatic organisms to breathe. The more the water moves, the higher the oxygen level will be. Typically, waterways with large amounts of organic decay have low levels of dissolved oxygen. If oxygen levels remain below one or two milligrams per liter of water for just a few hours, many fish can die. Although good oxygen levels are often challenging to pinpoint since oxygen levels fluctuate naturally between day and night, generally good oxygen levels fall around 7 mg/L or higher. The test samples showed a healthy amount of dissolved oxygen at 7.8 mg/L.

Phosphorus

Phosphorus, like nitrogen, is a nutrient naturally present in the environment. But when found in high concentrations phosphorus can disrupt the natural ecosystem by increasing the growth of algae and water plants. Some sources of high phosphorus concentrations include detergents and municipal fertilizer run-off. Healthy phosphorus levels generally fall below 0.05 mg/L. Phosphorus concentrations in the river were 0.25 mg/L in the test samples, which deviates significantly from a healthy level and indicates very high concentrations of phosphorus.

pH

The pH measures acidity in the water. It can be affected by many different sources including contaminated run-off and AMD. The pH can differ dramatically from day to day, or even at different times throughout the same day, largely as a result of photosynthesis. Ideal pH generally falls between six and eight in an aquatic environment. The pH of the test samples was 6.97, a very satisfactory level.

Alkalinity

Alkalinity is the water's ability to resist changes in pH. This is a natural phenomenon, but often with the addition of pollutants, water systems are less capable of balancing the pH and keeping waterways healthy. Since alkalinity can create a sort of buffer against various forms of pollution, the higher the alkalinity the more resistant the stream might be to external influences like acid rain. Affective alkalinity levels usually begin around 20 mg/L and higher. The alkalinity of the test samples was around 23.8 mg/L and therefore satisfactory.

Benthic Invertebrates

Conductivity

Conductivity is the water's measured ability to pass an electrical current and is affected by the quantity of total dissolved solids (TDS), often dissolved chemicals or salts, in the water. If test results show a change in conductivity that may mean there has been a change in the amount of TDS in the water. Many sources of TDS are natural; however, municipal run-off and wastewaters can increase the amount of TDS beyond healthy levels. Conductivity is measured in micromhos per centimeter (µmhos/cm) or microSiemens per centimeter (µS/cm). A healthy conductivity rate for inland streams and rivers falls around 500 µS/cm or less. The test samples showed conductivity of 216.1 µS/cm, a fairly healthy level.

Coliform Bacteria

Coliform bacteria are present in the fecal matter of all animals. Coliforms appear naturally in low amounts in low-flowing water. High concentrations, however, are often signs of municipal wastewater, dumping or septic contamination. For primary contact with the water (ie. swimming) the coliform concentration cannot exceed 200 coliforms per 100 milliliters (ml) and primary drinking water must report 0 coliforms per 100 ml. Natural contamination usually lies under the 200 coliforms per 100 ml level. The test samples showed 139.4 coliforms per 100 ml, which is not ideal, but also not extremely threatening.

Benthic Invertebrates

Benthic invertebrates are insects and other small animals that live on the bottom of different waterways. By collecting and determining the species that are living in the water, the condition of the water can be gauged. For example, various insects can show a whole range of tolerances to fluctuations in the environment; if a particularly sensitive insect (one that shows low tolerance to many changes) is discovered at a given location, this can be an indicator of good water quality. The Hillsenhoff Biotic Index produces a score between 0 (Excellent water quality) and 10 (severe pollution) by assigning each species a pollution tolerance score. Using the number of each species found in a specific location, the overall score is calculated using the Biotic Index Formula. The ideal score is 3.75 or lower and the average score for the test samples was 4.7, but results fluctuated between fair and excellent.

Threats to Water Quality

Abandoned Mine Drainage (AMD)

The result of acidic run-off from abandoned mines, AMD has caused significant damage to our rivers and streams. AMD-impacted streams often have very high acidity and are unable to sustain life. For more information about AMD, please refer to the previous section.

Combined Sewer Overflows

Outdated sewer systems often combine municipal, industrial and rain water run-off into one piping system. This material travels to a sewage treatment plant and is treated before being released into a body of water. However, during periods of heavy rainfall or spring snowmelts, these systems can exceed capacity, causing the material to bypass the treatment plant and flow directly into the body of water. These events are called combined sewer overflows (CSO). CSO can significantly pollute streams and rivers, dramatically affecting drinking water and the aquatic environment.

Mercury

Mercury contamination in the water supply is becoming an increasing health concern. In the Susquehanna River basin alone, 35 different locations are under guidelines from the Pennsylvania Fish and Boat Commission to limit the consumption of aquatic species. Four of these locations are within the heartland region.

In humans, when mercury accumulates beyond a certain level it can potentially damage the brain or inhibit brain development, especially during fetal growth and childhood. Dissolved mercury in the water is absorbed by aquatic species over time and can be passed on when the animal is consumed. Mercury cannot be removed from fish by cleaning or cooking, making it persistent regardless of preparation.

Riparian Buffer Damage

Riparian buffers filter out and often prevent contaminated run-off from reaching the streams and rivers. Riparian buffers are thick, forested areas lining the banks of streams, often additionally aiding in erosion prevention. As community and agricultural lands expand, they often come close to the edge of a river and compromise the buffer. The removal of, or damage to, the buffer can lead to increased sediment and nutrient loads in the river water.

Acid Rain

Also known as atmospheric deposition, acid rain is any precipitation (wet or dry) with a pH less than 5.6. Acid rain is caused when rain water absorbs pollutants in the upper atmosphere and brings them down to the surface as precipitation, including snow. The acid rain causes high acidity in streams in rivers. Higher acidity can damage the ecosystem by making conditions less than optimal for the flora and fauna of the area. Plant leaves can be burnt by the low pH, animal systems are upset when they consume the water, and aquatic organisms are affected from damage to their skin and gills. Acid rain also simultaneously increases polluted run-off to the waterway, as the falling precipitation travels back to the river.

Invasive Species

Invasive species can be damaging to both aquatic and terrestrial habitats. On land, they can choke off native plant species and limit the food supply for land animals. In water, they operate similarly, overwhelming other species and often disrupting food supplies. One example of an aquatic invasive species that has caused damage nationwide, as well as Pennsylvania, is the zebra mussel (*Dreissena polymorpha)*. Originally native to the Mediterranean rivers and freshwater seas, the larvae of the creature were first transported from their native area on the hulls of boats and it is thought that this is how they got to the United States. The mussel changes and stresses the environment and with no natural predators, it quickly out-competes the natural fauna. It is known to be so numerous that it can damage boating equipment and water intakes in areas of infestation.

Dams

Dams and water restrictors have been introduced all along the Susquehanna's length since the 1800s for purposes ranging from canals to hydroelectric power. Dams are impassible for migratory fish, including native shad and eels. More recently, there have been modifications to many of the dams to create ladders or elevators to assist in the movement of the fish upstream. Plans are also underway on some dams, like the Fabridam in Sunbury, to make fish passageways or fishways. The development and implementation of this fishway will open the North and West Branches to shad and eel migrations.

Monitoring the Susquehanna

SRHCES sustains many ongoing studies regarding the ecology of the Susquehanna River and its surrounding environment. Currently, the group monitors water quality at 17 different sites along the Lower West Branch of the Susquehanna River and assesses riparian buffers at the PPL Montour Preserve. They are also in discussion with the Pennsylvania Department of Conservation and Natural Resources (DCNR) with hopes of constructing an Environmental Center at the Shikellamy marina. The following highlights various research that has been conducted by universities within the partnership, although it by no means represents the whole field of work that is being done. For further information about the group, or the group's research, please visit www.srhces.org.

Mohamed Khalequzzaman

Associate Professor and Department Chair of Geology and Physics, Lock Haven University of Pennsylvania

Dr. Mohamed Khalequzzaman, or Dr. K for short, gears most of his research towards the effects that agricultural practices and acid mine drainage produce on the river. For five years now, he has been collecting monthly samples from ten different locations along Big Fishing Creek in Clinton County. He monitors the water to observe and analyze various chemical parameters, such as pH, dissolved oxygen, turbidity, phosphate and nitrate. Agricultural run-off can cause significant damage to a stream, potentially creating high levels of nitrates and phosphates that then limit the amount of oxygen available to fish and other aquatic organisms. Increases in turbidity, or murkiness (turbidity measures the clarity of the water in relation to the total amount of suspended solids within it) can also cause fish and other aquatic organisms to suffocate, in addition to killing fish eggs. Dr. K monitors the river for these various changes and notifies farmers if and when their practices are negatively affecting the river.

Dr. Way, studying in the field, works with Dr. K on many research projects.

Recently, Dr. K has received a grant from the Degenstein Foundation to study the extent of water quality impairment caused by abandoned coal mines on the East Branch of Big Run within the Beech Creek Watershed. Additionally, Dr. K is involved in monitoring the effectiveness of a passive treatment facility installed by the Bureau of Abandoned Mine Reclamation (BAMR) in the Big Run watershed. Dr. John Way, emeritus professor of Lock Haven University, and several student interns are involved in all of these studies with Dr. K.

Finally, Dr. K is conducting research on air and water quality along Wolf Run, another tributary to Beech Creek. Although the lower part of this stream is AMD impacted, it remains a high quality fishing stream in headwater areas. Dr. K is studying the quality of air and water in the Wolf Run watershed to learn more about the impacts of AMD and acid deposition on the water. Acid deposition can come in the form of acid rain or dry deposition and it can harm stream water quality. Dr. K studies the stream to potentially see if an increase in alkalinity (the result of limestone treatment) can create resistance to, or minimize the effects of acid rain and AMD on water quality in Beech Creek watershed in general and in Wolf Run specifically.

Carlos A. Iudica

Assistant Professor of Biology, Susquehanna University

Dr. Carlos A. Iudica investigates the river from something of a reverse perspective: instead of monitoring the effect of the surrounding environment upon the river, Dr. Iudica researches the effect of the river on the surrounding environment. He is currently in his third year of a ten-year project that seeks to gain a perspective of how terrestrial vertebrate (including amphibians, reptiles and mammals) populations change through seasons and over time. Dr. Iudica is attempting to gain an idea of the health of the

A Dr. Iudica's student measures a field mouse

environment by studying the various interactions that occur. The health of the river can significantly affect the health of the land animals that live in the surrounding area (for example, owls feed on animals that live in or near the water), but this is just one of the many interactions that he monitors. He currently conducts most of his research at the PPL Montour Preserve and at Shikellamy State Park.

Monitoring terrestrial animals can mean many different things. For example, Dr. Iudica might track the growth rate of an animal by capturing and marking it when it is just born, and then checking up on it again yearly and measuring it. This technique also allows him to see where animals live and how long they live. He learns what Red and Gray Foxes eat by studying the content of their stomachs. And he finds out what barn owls are eating similarly by studying their droppings. When he finds a family of owls, he will lay down a tarp to collect the droppings, which then show what they are eating, in addition to showing what they eat in different seasons and different periods of growth. Just this summer, Dr. Iudica began overseeing a student who is conducting bat research on the Isle of Que in Selinsgrove. Bats feed on the larvae that live in the river; if the river is contaminated, the larvae population might decrease, which would limit the bat's food supply and potentially decrease the bat population as well. Since bats also feed on local crop pests, a decrease in the bat population could also cause a decrease in food because there would be more pests to eat the crops, and fewer bats to eat the pests.

Dr. Iudica is still in the beginning phase of his work, which involves cataloguing all of the species in the PPL Montour Preserve and Shikellamy State Park areas. Once he knows what is there, he will ask the questions: What are they doing? Where are they going? When are they going? Throughout the next seven years he intends to expand his research on the ecology and natural history of several species of vertebrates that live and interact with the river.

Matthew McTammany

Assistant Professor of Biology and Environmental Studies, Bucknell University

Although Dr. McTammany's research interests are vast, much of his research is centered in agriculture management. This summer he has been evaluating the riparian buffer at the PPL Montour Preserve. Riparian buffers are sections of land that separate farmland from rivers. They serve to filter out sediment and nutrients from agricultural run-off, thus protecting the river from harmful chemicals. Dr. McTammany is evaluating the effectiveness of small trees (3-5 feet tall) in comparison to large trees (7-8 feet tall) within the buffer. Small trees can be less effective because they are often eaten by deer and can take a long time to grow. Large trees, however, are very expensive and difficult to plant, therefore they are not commonly used in the riparian buffer area.

Dr. McTammany is also conducting a regional water quality assessment to determine the effectiveness of CREP (Conservation Reserve Enhancement Program). CREP is a program funded by the USDA that pays farmers not to farm along streams and offers incentives to plant trees in between fields and streams. Dr. McTammany is comparing streams with and without CREP management in order to determine whether or not the program has been successful.

He is also working with a student to test local variability in water quality of the Susquehanna River. Between Winfield and Milton, he measures

Dr. McTammany's students measure various parameters of the river

temperature, light, velocity, depth, dissolved oxygen, respiration and pH across the river in 30-meter increments. This study provides a sense of how much a river can vary from its bank to the middle, demonstrating the necessity of location in research.

In the fall, Dr. McTammany plans to guide one of his classes through a study of the changes in a stream as a result of a vertical flow wetland treatment system. The class will test the wetland's effectiveness at regulating acidity as a result of acid rain. He plans on presenting the class's findings to the Buffalo Creek Watershed Alliance, as well as the Department of Conservation and Natural Resources.

Steven Rier

Assistant Professor of Biology and Ecology, Bloomsburg University of Pennsylvania

Dr. Steven Rier is interested in determining whether or not measuring the level of peroxidase in streams could be used as a reliable indicator of heavy metal stress in an aquatic environment. Peroxidase is an enzyme produced by microorganisms as a means of coping with high metal concentrations in the water (often the result of AMD). Dr. Rier is conducting most of his research on Morris Run, an AMD-impacted tributary to the Tioga River, where high levels of peroxidase have been discovered. He suspects that measuring peroxidase activity may be useful in determining if an AMD treatment system is successfully functioning. For example, a decrease in peroxidase activity would indicate that the treatment is working because the microorganisms are not producing the enzyme that otherwise would help them cope with the high metal content of the water. He has already documented this phenomenon on Lick Creek, a remediated stream in Tioga County. Furthermore, Dr. Rier suspects that one measure of peroxidase activity might detect stress from previous, short-term elevations in heavy metal concentrations, since organisms respond to their environment over time. Heavy metal concentrations can fluctuate as the result of episodic events such as acid rain, but these fluctuations can go unnoticed with traditional testing methods. Therefore, this summer Dr. Rier is testing for high peroxidase activity in a number of AMD-impacted and acid rain-impacted streams (including Morris Run) throughout the region.

Dr. Rier conducting water quality tests.

Additionally, Dr. Rier and his students are doing preliminary work on a project that will investigate how acid rain affects nitrogen and phosphorous processing in Fishing Creek, a tributary to the North Branch of the Susquehanna River. The research will investigate the way acid rain affects the ability of streams to retain and process nutrients. Dr. Rier is currently collecting background data for the study, which he will continue with his research students and Limnology class in the fall.

WORKING TOGETHER:
Dr. Steven Rier & Dr. Matthew McTammany

The Susquehanna River is responsible for nearly half of the water that flows into the Chesapeake Bay, thus the health of the river significantly impacts the health of the bay. Dr. Rier and Dr. McTammany are currently investigating the nutrient retention capabilities of three different streams in order to understand the way rivers process, or remove, nutrients. If a river does not retain nutrients, which is often the case with AMD- impacted areas, the nutrients will continue to flow, and in this case, cause nutrient overloads to spill into the Chesapeake Bay. High levels of nutrients (such as nitrogen and phosphorous) overwhelm the bay and cause excessive algal production. As the algae decomposes it consumes oxygen, which then limits the amount of oxygen available to the aquatic animals, such as fish and crabs, inhabiting the bay. Therefore, Dr. Rier and Dr. McTammany are testing the ways in which streams handle these nutrients. They conduct their research on three different types of streams – one healthy, one AMD-impacted, and one restored – in

order to evaluate the way AMD-impaired streams process nutrients in comparison with healthy streams. In addition, they observe restored streams in order to assess remediation efforts, which fortunately seem to indicate success in restoring appropriate nutrient retention.

Dr. Rier and Dr. McTammany currently have two grant proposals to further their research. The first one, through the Pennsylvania Department of Environmental Protection, would allow them to expand their AMD research statewide. The second proposal, through the US Department of Agriculture, would establish monitoring, education and outreach on the Susquehanna River. Their ultimate goal is to implement monitoring stations all along the river. Students and the public would then be able to access the status of the river daily from an internet link. Between both of these proposals, Dr. Rier and Dr. McTammany seek to create comprehensive solutions to AMD damage and direct restoration from a nutrient-oriented approach, in addition to promoting awareness and education on the Susquehanna River.

Mel Zimmerman

Professor of Biology and Director of the Clean Water Institute, Lycoming College

As a Biology professor at Lycoming College, Dr. Mel Zimmerman keeps students busy with continuous monitoring projects along the Lower West Branch of the Susquehanna River. Through the Clean Water Institute, Dr. Zimmerman organizes internships for students who perform research for local watershed projects. The Institute provides data for communities in addition to offering training programs and seminars on such environmental issues as stream restoration, habitat improvement and water quality.

Dr. Zimmerman conducts a large variety of research. In the summer of 2005, in conjunction with Dr. Matthew McTammany at Bucknell University and interns from Bucknell and Lycoming, the Lower West Branch was monitored for various features, such as pH and dissolved oxygen, in order to conduct a water quality assessment. More data is still needed to provide an unbiased understanding of the Lower West Branch, but the foundational research could eventually lead to the development of continuous monitoring stations along the river, which would be helpful in generating more comprehensive data. Since rivers are continuously changing, it is significant that the research reflect the huge number of variables in water quality.

Dr. Zimmerman with students from his Susquehanna River course offered through the Clean Water Insitute this summer

One of Dr. Zimmerman's primary research interests is waste water treatment. One aspect of this research is the effect of combined sewer overflow (CSO) on water quality. In 2005, American Rivers cited CSO as one of the main contributors to the Susquehanna's endangered status. CSOs typically occur after heavy rain, which overburdens sewage treatment plants. As a result, the storm water bypasses the plant and carries raw sewage into the river. Currently Dr. Zimmerman monitors 12 sites along the Lower West Branch monthly, but he is seeking to shift his research specifically towards post-storm events.

Dr. Zimmerman sustains a large number of research projects that cannot all be mentioned here, but the following two provide a sense of the range of his work. On Lycoming Creek, an erosion and sediment-impacted stream, Dr. Zimmerman is working with local watershed partners to create a 900 foot natural stream channel demonstration project, which would help to prevent erosion problems and allow the stream to retain its natural channel. He has also been working with Rose Valley/Lake Mill Creek Watershed Association to provide awareness and education about the relationship of the lake to the watershed and its role in proper water quality management.

Brian Mangan

Associate Professor of Environmental Science and Ecology, King's College

Dr. Brian Mangan defines himself as a River Ecologist, which means that he studies the many interactions that occur between organisms and the river (including humans). Much of Dr. Mangan's research revolves around monitoring the North Branch

Dr. Mangan's students have the opportunity to go electrofishing

of the Susquehanna River for various signs of health, since historically the North Branch suffered from high iron levels as a result of AMD. He has had the positive experience of documenting the river coming back to life. He has witnessed an increase in both the mayfly population and in the smallmouth bass population as a result of improved water quality. In fact, the river has gained fame as a tremendous smallmouth bass fishery.

While conducting his research, Dr. Mangan does a great deal of electrofishing, which uses a weak electric pulse to temporarily stun fish. Once the fish have been collected and identified they are released back into the water unharmed. Dr. Mangan is currently studying the growth rates of fish from 30 years ago with fish today. By comparing recent fish scales with those from 30 years ago, he hopes to determine if fish are now growing at a faster rate due to improved water quality.

In addition to electrofishing, Dr. Mangan can also be found scuba diving, which is a technique he has mastered in order to collect insects and other small creatures from the bottom of the river. He uses a contraption called the Dome Sampler – a rugged, homemade piece of equipment that creates an underwater vacuum – to collect various samples from the river substrate.

Dr. Mangan, in conjunction with SRHCES, is currently exploring opportunities for monitoring mercury levels in fish and other aquatic species in northcentral and northeastern Pennsylvania. Through a partnership with the Geisinger/John Hopkins Environmental Health Institute, the study could include the investigation of human health concerns related to mercury contamination.

In addition to conducting research, Dr. Mangan serves as director of the Susquehanna River Institute, an organization devoted to developing and promoting educational initiatives and scholarly research related to the Susquehanna River. And furthermore, as a professor and director of the Environmental Program at King's College, he has developed two environmental degrees and a variety of environmental courses.

Peter Petokas

Research Associate with the Clean Water Institute at Lycoming College

Dr. Peter Petokas has been studying Eastern Hellbender populations in various tributaries of the Susquehanna River. Hellbenders are among the largest salamanders in North America, growing up to 29 inches in length. Olive in color, they live completely in the water, usually under large flat rocks, and are generally only active at night when they search for food. Dr. Petokas, working under a contract with the Pennsylvania Fish and Boat Commission, has been documenting where they live, the conditions in which they live, whether or not they are reproducing, how old they are, how big they are and how many there are. Along with two or three students, he has been monitoring Hellbenders for two summers and has observed that the populations he has discovered seem to be healthy, although the salamanders are not nearly as widespread and abundant as they once were.

The Hellbender population has declined in various areas for various reasons. Historically, the logging industry and the agricultural industry negatively affected Hellbender habitats by causing sediment to fill in the areas under the rocks where they live. There was also a movement in the 1930s to exterminate

The Eastern Hellbender is among the largest salamanders in North America

Hellbenders because it was thought that they were eating trout and trout eggs. Hellbenders eat crayfish, but unfortunately the misconception was widespread and the movement damaged the Hellbender population. Additionally, AMD-impacted streams that do not support aquatic life, such as fish, crayfish, and insects, do not contain Hellbender populations. Dams can also prevent Hellbender dispersal, and with many new dam proposals for the Susquehanna River, the Hellbender population may become even more isolated.

Stream restoration and water quality improvement are just two ways of improving living conditions for Hellbenders. In addition, suitable habitats, which include large, flat rocks, moderate stream flows and forested riparian zones can be created to ensure their continued health. If you happen to find a Hellbender, do not be afraid because they are not poisonous and they do not bite. If you accidentally catch one while fishing, remove the hook and return it to its natural habitat. Under current Pennsylvania Fish and Boat Commission regulations, you may not possess or keep a Hellbender without a special permit.

River Communities

SEDA-COG

SEDA-Council of Governments (SEDA-COG), one of the members of SRHCES, was a key partner in planning the Susquehanna Greenway and in forming the Susquehanna Greenway Partnership (SGP). SGP is a private non-profit organization that advocates tying the various communities along the 500-mile corridor of the Susquehanna River together through the celebration of the river. The group seeks to bring economic development, community revitalization, enhanced recreation and healthy living opportunities to the many communities established within the corridor. As a means of generating smart community growth the group considers environmental planning, community atmosphere, health concerns and economic development. Ultimately, by tying all of the towns together with a common focus on the river, the group seeks to create a regional identity for the residents of the river community.

SEDA-COG has been contributing to the partnership by meeting with local communities to establish plans of action. Community planners and landscape architects provide technical assistance to communities to try to learn what the community would like to see happen, discuss what is feasible and generate a plan for development. The following are examples of plans that have been generated for local areas.

Williamsport Riverfront Restoration

The construction of the Susquehanna RiverWalk in Williamsport is a multi-institutional endeavor involving the county, city and other partners, and will include an amphitheater pavilion, an extensive trail along the river for bikers and pedestrians and water access areas for boats. Trails will connect downtown Williamsport to the RiverWalk area, and the RiverWalk trail itself will create a link into South Williamsport. The RiverWalk is anticipated to be only one piece of a regional trail system connecting various communities along the Susquehanna. Construction of the RiverWalk is expected to increase the movement of residents and visitors of Williamsport between the downtown, residential neighborhoods, parks and public gathering areas, in addition to promoting recreation on and near the water.

North Branch Canal Trail

The North Branch Canal Trail will travel along the historic North Branch Pennsylvania Canal and will connect Northumberland, Danville and Bloomsburg. The trail will maintain the natural character of the

Vounteers working on the North Branch Canal Trail

canal corridor and celebrate the history of the canal system, not to mention tie together the communities along the river. The trail is meant to encourage healthy recreation for local residents of all ages.

Sunbury Riverfront

The Sunbury Riverfront project is a community revitalization plan to develop a downtown hub for arts, entertainment and recreational activity. The project includes the construction of an amphitheater, scenic overlooks, a RiverWalk greenway and connections to the city's historic business district and downtown neighborhoods. The project also includes the construction of a marina for improved access to the river. Revitalization of the Sunbury riverfront will encourage economic investment in the city by celebrating and reconnecting with the Susquehanna River.

Humanities

Susquehanna River Heartland Humanities Council

The Susquehanna River Heartland Humanities Council is essentially the humanities department of SRHCES. Devoted to river research as it applies to the history and culture of the region, the Humanities Council began late in 2005 and has inspired a number of ongoing projects. Its long-term goals include developing curricular and bibliographic material about the Susquehanna Valley for local teachers and compiling a WPA-style (Works Progress Administration) guide to the Susquehanna Valley. Below you will read about the many projects that the group has been working on.

Heritage Area Study

The Pennsylvania Heritage Areas Program (PHAP) is sponsored by the state and administered through the Department of Conservation and Natural Resources (DCNR). The program encourages communities to compete for heritage area status, a designation that ultimately funds regional heritage projects such as museums and parks. The goal of the program is to celebrate Pennsylvania's rich history while simultaneously promoting economic development. Furthermore, the program seeks to preserve, enhance, interpret, and promote regional heritage themes together through greenways and other projects in addition to generating private and public community partnerships. Through the celebration of regional identity, established by the dispersal of a common theme, communities can be brought together and cultural heritage can be conserved. There are currently twelve regions designated as state heritage areas and within the next few years, portions of the heartland region might be added to the list.

Working with interns and faculty advisors from Bucknell, Bloomsburg and Susquehanna Universities, SEDA-COG has been conducting a feasibility study, which will build a case for establishing this region as a state heritage area. They are looking at nine river towns within a five-county area, including Union, Snyder, Columbia, Montour and Northumberland counties. The feasibility study must define a common theme (deriving from industrial heritage) that has significantly shaped and created the region that we know today. Research to date suggests a transportation theme and a period of significance (the period that is particularly responsible for the character of the region today) extending from 1750-1880. The regional story will be further broken down into relevant themes within the time period, including Native Americans and European Ethnicity; Trade Towns and Transport; Knowledge, Inventors and Entrepreneurs; and Religion, Rebellion and Independence. The interns have collected numerous data and interviewed many regional historians and their work has been summarized in a report that will augment the feasibility study. The feasibility study is expected to be complete by March 2008 at which point it will be submitted to DCNR for approval. If the study is approved, the next step will be developing an action plan that explains how the heritage area will be run.

Watershed: A Journal of the Susquehanna

Supported by a grant from the Degenstein Foundation, ***Watershed: A Journal of the Susquehanna***, is a collection of poetry, fiction and artwork inspired by the people and landscape of the watershed region,

including parts of upstate New York, most of Pennsylvania and Maryland. Edited by Associate Professor of English, Jerry Wemple at Bloomsburg University, the journal seeks to provide a space for narratives about the region. The journal is expected to debut this fall and will be an annual publication with periodic updates on its website.

History On-line

In the summer of 2006, two students from Bucknell University became part of a Sunbury on-line project that documented the "river history" of Sunbury, stressing its location at the confluence of the North and South branches of the Susquehanna River, where Shamokin Creek joins the main stem. These hyper-linked maps show what is now Sunbury at different times from the mid-18th century to the mid-19th century. The project, overseen by Assistant Professor of English, Alf Siewers of Bucknell University, is hoped to expand into a regional effort that will create on-line, environmentally-oriented histories for all of the river towns in the Susquehanna Valley. Currently, Professor Emeritus Donald Housley of Susquehanna University is coordinating a history project for Selinsgrove, and an on-line history of Lewisburg has already been created by Bucknell Professor Ben Marsh. The goal now is to link these individual projects into one unified, informational set.

The Moravian Diaries

Recording and describing the settlement at Shamokin (now Sunbury) between the years 1744 and 1855, the Moravian Diaries (the collection is also referred to singularly as the ***Shamokin Diary***) provide rich insight into the cultural and industrial development of the region around Sunbury. Documenting the Moravian missionary effort, the diaries reflect a series of cultural, linguistic and geographic confluences that, counter to popular belief, describe a close relationship between European Americans and Native Americans.

Written in both Germanic script and English, the translation and transcription of the diaries has become the current undertaking of German Professor Katherine Faull of Bucknell University. She has applied for a grant from the National Endowment for the Humanities (NEH) in order to gain the time and resources to complete her 350-page transcription project, which is approximately 10 percent complete. Written by at least ten different people and without standardized spelling and grammar, the project is no simple task. In addition to the diary entries, the collection includes about 50 pages of letters, documents, messages and addresses, all providing significant insight into the historic culture.

Included in the grant proposal is also an initiative to work with local middle and high school teachers of American History, Creative Writing and Cultural Geography to generate collaborative learning projects that focus on the history of the confluence. Teachers would work with professors from Bloomsburg, Susquehanna and Bucknell universities to develop local history curriculums and various learning activities.

Tourism in Centralia

Assistant Professor Edward Slavishak and one of his Susquehanna University students have conducted research on Centralia and, oddly enough, its popularity as an alternative tourist destination. The town, containing only about a dozen residents, has been burdened by a 45-year mine fire that has made it nearly uninhabitable.

The study began in the summer of 2005 and continued into the spring of 2007 allowing Professor Slavishak and his student to categorize various Centralia tourists into different groups.

Traditional tourists usually visit the town after being referred there by staff from the Pioneer Coal Mine and Tunnel in nearby Ashland. They are usually families or individuals over 40-years-old generally interested in the catastrophe. Non-traditional tourists, on the other hand, are younger (20s and 30s) and they visit the site because they have heard that it is a weird but cool, unofficial and hidden tourist attraction, one that actually warns visitors away due to safety concerns.

Centralia, PA

Other significant tourist populations come from the internet, where they are inspired by road trip journals and photo-sharing websites that duplicate the Centralia experience described by Bill Bryson in his book, ***A Walk in the Woods***. These tourists often appreciate the authenticity of a destination like Centralia, especially in the midst of many pre-packaged tourist destinations.

Many tourists are not especially interested in the history of the town, but rather they are awed by the vision of the mine fire and the gothic nature of the landscape. Many tourists come just for the spectacular photo-opportunity.

Professor Slavishak's student presented these findings at the National Conference on Undergraduate Research in 2006 and 2007. He hopes that their work will eventually find its way into a tourism studies journal, as Centralia continues to contradict popular opinion about what might attract tourists to central Pennsylvania.

Awareness & Education

Teaching communities about the river is an essential part of environmental restoration. Without education, it is difficult for a community to understand what is happening in the river and how they can help. The following summarizes some local educational initiatives that support environmental and ecological outreach.

The Susquehanna River Institute

Directed by Dr. Brian Mangan, the Susquehanna River Institute is a partnership organization that seeks to direct public attention to the resources of the Susquehanna River by promoting educational initiatives and scholarly research. Currently, through King's College the institute offers a graduate course for science teachers. The course, generally titled "The Susquehanna River," is a five-day intensive workshop that includes a lot of traveling to various sites along the Susquehanna River. The teachers visit AMD-impacted streams, tour treatment facilities, learn about riparian areas and appropriate land management strategies, meet with watershed supervisors and learn about many other factors involved in river ecology. This summer the course was offered twice. The first session, focusing on the North Branch, was taught by Dr. Brian Mangan. The second, focusing on the West Branch, was taught by Dr. Mel Zimmerman from the Clean Water Institute at Lycoming College, one of the institute's partners. For more information about the course please visit the Susquehanna River Institute website at www.susquehannariverinstitute.org, or visit the Clean Water Institute at http://www.lycoming.edu/biologydept/cwi.

Mel Zimmerman's Susquehanna River Class at Shamokin Creek

The Environmental Center, Bucknell University

The recently accepted grant proposal for the "Susquehanna River Initiative" at the Environmental Center at Bucknell University will transform the way students learn about river ecology and the Susquehanna River. The grant, worth $450,000 from the Henry Luce Foundation Public Policy and the Environment program, will support education about the ecology of the Susquehanna River, community outreach and scientific research. Over the next four years, the initiative is expected to reach approximately 100 students in various fields from the natural sciences to the humanities.

There are five main objectives in the initiative, including the development of a "Semester on the Susquehanna" course, which, similar to a study-abroad, would allow students to study the river in an out-of-the-classroom environment. The initiative also seeks to create two interdisciplinary courses:

one that would study watershed systems from multi-disciplinary perspectives including geological, hydrological and biological; and one that would focus on applied environmental studies, which would develop a remediation strategy for Miller Run, an impaired watershed located partially on Bucknell's campus. The third initiative objective plans to establish a field station in the Susquehanna watershed, which would facilitate long-term research projects. The final two objectives include partnering with various outreach groups, such as SRHCES, to provide community education and service-learning projects, in addition to developing a "State of the River" report card that would provide water quality assessment of the Susquehanna River.

WVIA

WVIA, Northeastern Pennsylvania's Public Broadcasting Stations, has documentaries about the Susquehanna River available for use in the classroom as a way of educating students about the history and environmental issues surrounding the river.

"**Looking to the River,**" explores the historical culture and development of the natural environment on the Susquehanna River. The DVD is available with a complimentary guide to classroom activities and teaching strategies. WVIA intends to distribute these teaching materials to local classrooms, but information is also available at **http://www.wvia.org/education/curricula/LookingtotheRiver.doc**.

"**Expedition Susquehanna**" follows eleven high school students who travel the whole length of the Susquehanna River in 30 days. Organized by the Chesapeake Bay Foundation, the program guides students through the various environmental concerns regarding the Susquehanna River. The students begin their trip in Cooperstown at the headwaters of the Susquehanna and travel south, making many stops along the way.

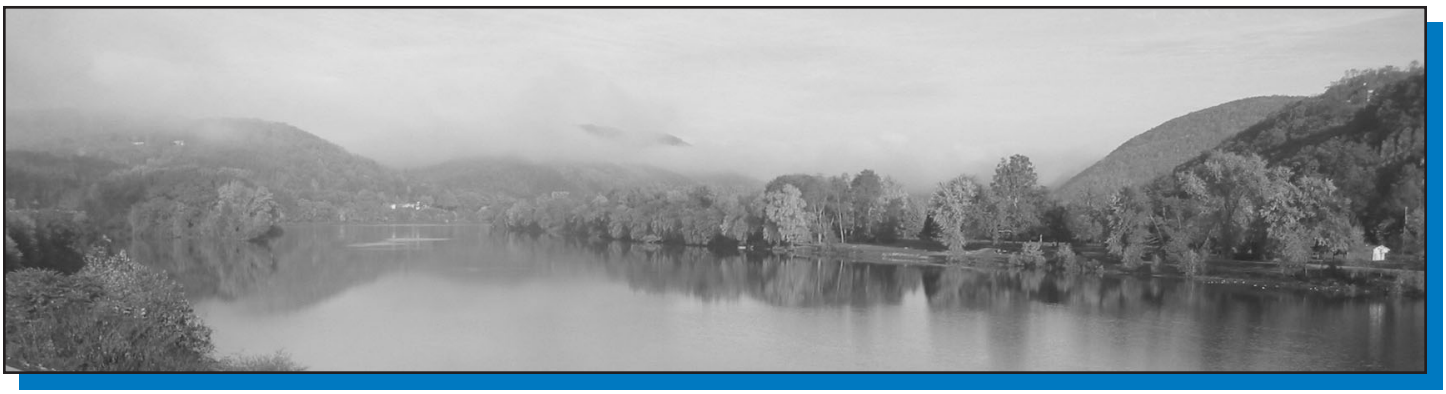
A third documentary will be available this fall. "**Hope for Polluted Waters,**" is a one-hour production about AMD and its impact on the river and river communities. The film follows the work of volunteer and environmental groups in their endeavors to transform many miles of waterways.

Trout Unlimited

Trout Unlimited has developed a program called "**Trout in the Classroom,**" where students have the opportunity to raise trout from eggs to fingerlings inside the classroom. Students are responsible for sustaining an aquatic habitat and are expected to closely monitor the environment. Local Trout Unlimited representatives have been promoting initiatives to get this program up and running in local schools. Lesson plans and web resources are available for this program at **www.troutintheclassroom.org**.

WKOK

WKOK has recently become the first annual recipient of the Hellbender award for its zealous coverage of issues pertaining to the environment and conservation. As a partner in SRHCES, WKOK has showed tremendous support by organizing and broadcasting weekly roundtable discussions and implementing its "**Boroughs to the Bay and Beyond**" series. The series provides ongoing coverage regarding critical local environment issues. Interviews and written reports discussing the Susquehanna River watershed and the Chesapeake Bay are available for download at **www.wkok.com**.



Lock Haven Riverfront Overlook

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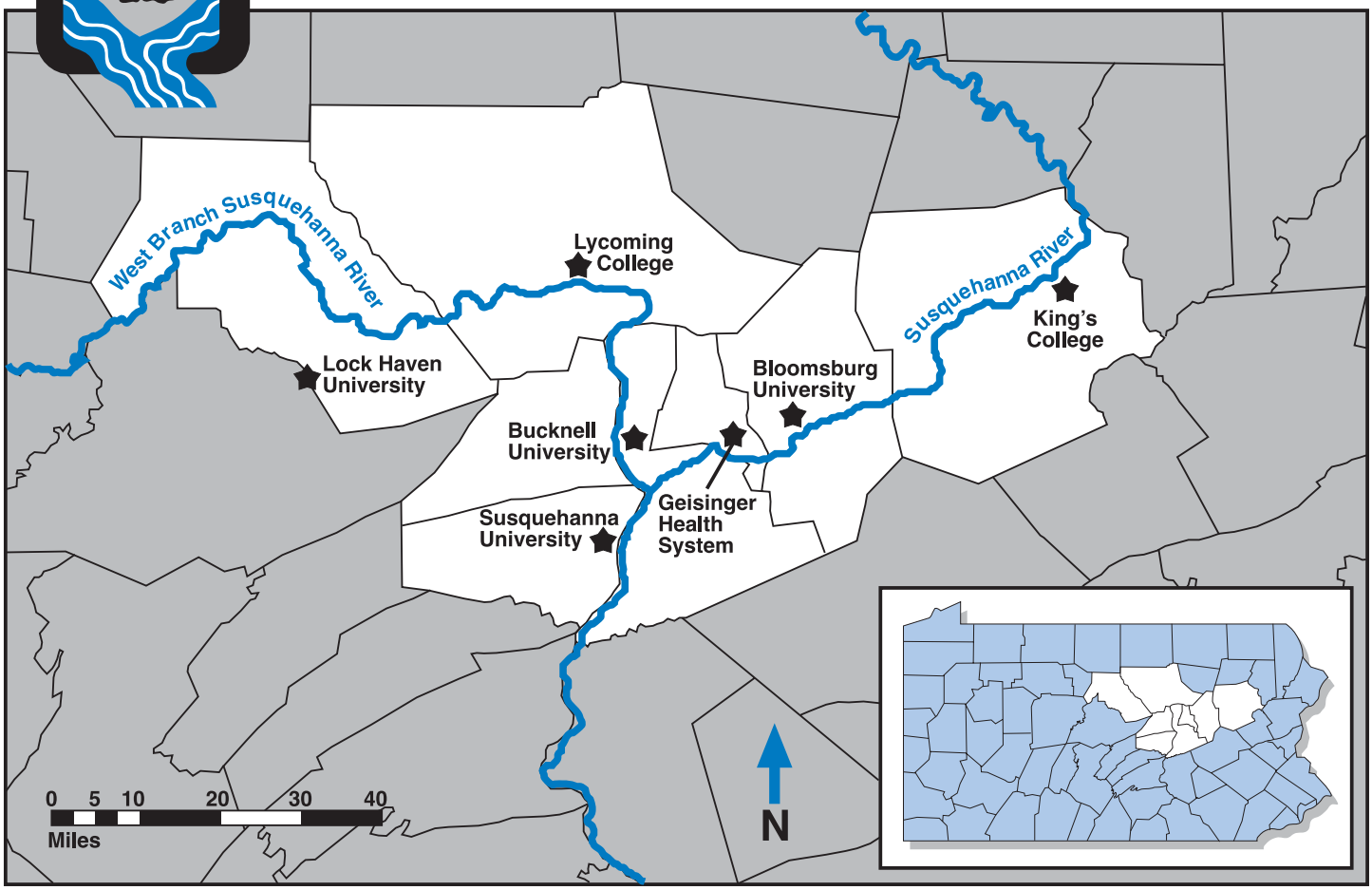
www.SRHCES.org



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