Program with Abstracts

10th Annual Susquehanna River Symposium

"The River, Its Landscapes, and Our Lives"

November 13-14, 2015

www.bucknell.edu/riversymposium

10th Annual

SUSQUEHANNA RIVER SYMPOSIUM

November 13-14, 2015

Elaine Langone Center
Bucknell University

This symposium brings the public together with scientists, engineers, consultants, watershed groups, and state and federal agencies to share some of the findings of our research within the watershed and discuss the long-term health and sustainability of the Susquehanna River and Chesapeake Bay.

KEY CONTRIBUTORS

- Bucknell University Watershed Sciences and Engineering Program
- Susquehanna River Heartland Coalition for Environmental Studies
- Susquehanna River Basin Commission
- Harvard Forest Program on Conservation Innovation
- U.S. Geological Survey
- Chesapeake Bay Commission
- Chesapeake Conservancy
- American Rivers

COVER: View down Buffalo Creek and the West Branch Susquehanna River at Lewisburg, Pennsylvania, June 2015.

Welcome!

The Watershed Sciences and Engineering Program of the Bucknell Center for Sustainability and the Environment welcomes you to the 10th Annual Susquehanna River Symposium. Additional funding for this event is also provided by the Provost's Office of Bucknell University and the Degenstein Foundation.

All events will be held in the Elaine Langone Center on the campus of Bucknell University and are free and open to the public. Parking is available on Moore Avenue and 7th Street. Maps and lodging information can be found online at:

www.bucknell.edu/riversymposium.

RESEARCH POSTERS AND PROFESSIONAL EXHIBITS

Research posters by scientists, planners, and engineers from 20 universities and 12 agencies are featured, as well as professional exhibits by 12 companies, conservancies, and organizations — all working to monitor, restore and protect the Susquehanna watershed and the Chesapeake Bay.

SYMPOSIUM PLANNING AND COORDINATION

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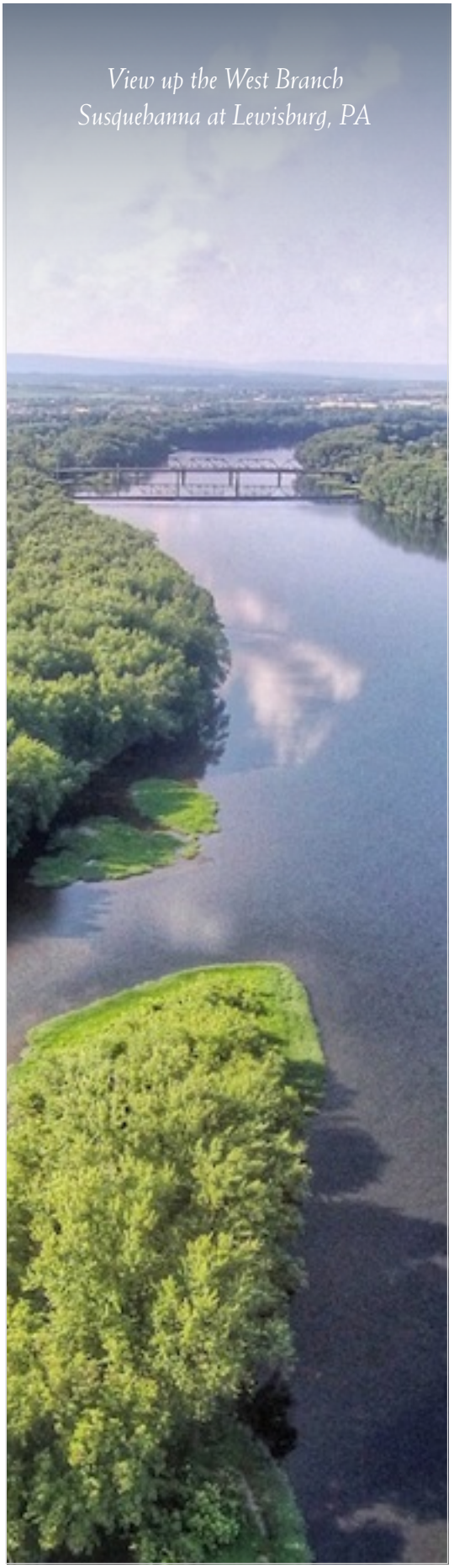
Contents

"The Susquehanna is many rivers in one. A ten-day voyage will take the canoeist through coal country, a wild canyon, small towns, fertile farmland, the state capital, hydroelectric dams and finally the coastal plain and Chesapeake Bay."

— Tim Palmer, author of "Rivers of Pennsylvania "



View up the West Branch Susquehanna at Lewisburg, PA

Notes

10TH ANNUAL SUSQUEHANNA RIVER SYMPOSIUM
Bucknell University - November 13-14, 2015

"The River, Its Landscapes, and Our Lives"

"And when I asked the name of the river from the brakeman, and heard that it was called the Susquehanna, the beauty of the name seemed to part and parcel of the beauty of the land ... That was the name, as no other could be, for that shining river and desirable valley."

— RobertLouis Stevenson

Greetings!

On behalf of all the members of the organizing committee, I would like to welcome you to the 10th Susquehanna River Symposium. The overarching theme of this year's event is "the river and its landscapes" and how our lives are connected to them. Our goal is to gather scientists, engineers, planners, managers, policy-makers, conservationists, and the public to discuss issues facing the Susquehanna River and the Chesapeake Bay.

The response to our "call for abstracts" has been terrific — there are over 80 presentations by students and faculty from 20 colleges and universities and 12 government agencies and environmental organizations. There are 12 professional exhibits by environmental consultants, watershed groups, conservancies, and other organizations working to protect and restore the Susquehanna watershed and the Chesapeake Bay.

Included in these proceedings are several special sections, beginning with a review of our previous symposia and then a special "*The River and Its Landscapes*" photo essay that highlights 10 important components of the Susquehanna - Chesapeake ecosystem. Brief facts and comments are intended to stimulate our thinking and foster discussion about what our research

and conservation priorities should be. After a *Schedule of Events* is a listing of the seals and logos of the colleges and universities, agencies, organizations, and companies who are contributing to this symposium. It a privilege to host such a wonderful and prestigious group and we encourage everyone to network and build lasting relationships.

Next are the abstracts of the oral and poster presentations, many including photos the authors felt were relevant to their work. From their abstracts, a "word cloud" was generated to depict the words most frequently used in their writings. An index of authors is also included and at the very end are the names and logos of over 145 organizations that Bucknell and the Susquehanna River Heartland Coalition for Environmental Studies has enjoyed working with over the past decade. It's been an honor to collaborate with these entities and we look forward to deepening our relationships with them in the years ahead.

I want to extend my sincere thanks to Dr. James Levitt from Harvard Forest Program on Conservation Innovation and Dr. Laura Craig from American Rivers, our keynote speakers for Friday and Saturday. Their presentations on landscape and river conservation and restoration will serve as "bookends" for this symposium. I also want to express deep appreciation for our plenary speakers: Andrew DeHoff, Executive Director of the Susquehanna River Basin Commission; Marel King, Pennsylvania Director of the Chesapeake Bay Commission; Heather Galbraith, Research Biologist with the U.S. Geological Survey's Northern Appalachian Research Laboratory; and Joel Dunn, Executive Director of the Chesapeake Conservancy.

Their plenary presentations will provide a framework for subsequent 1-½ hour long breakout discussions along four important "sub-themes:"

1. Sustainable water resources management
2. Riparian corridor conservation and restoration
3. Stresses on aquatic ecosystems
4. River-bay connections

I also want to thank the Provost's Office at Bucknell University and the Degenstein Foundation for providing additional financial support for this symposium, and the Susquehanna River Heartland Coalition for Environmental Studies for their scholarly collaborations and contributions. Special thanks are also due the symposium committee members who helped plan and organize this event: Peter Wilshusen, Sean Reese, Carol High, Marian Marchiori, Jessica Newlin, Matthew McTammany and R. Craig Kochel.

The Susquehanna watershed is one of our nation's most precious resources and provides us a wonderful place to live, work, and make our being. Our grandparents and parents have enjoyed its riches. And we want our children and our grandchildren to enjoy them too. And so it is good and appropriate for us to gather together to discuss the most issues facing this region and think about possible directions we might pursue in the near future.

I hope you enjoy the symposium!

Sincerely yours,

Benjamin R. Hayes, Ph.D., P.G.
Symposium Chairman

Celebrating 10 Years of River Symposia

10TH ANNUAL SUSQUEHANNA RIVER SYMPOSIUM

Bucknell University - November 13-14, 2015

Notes

From The Branches to The Confluence

October 18-19, 2006

1st

Pennsylvania Abandoned Mine Drainage Remediation

September 28, 2007

2nd

The Susquehanna and Agriculture

September 12-13, 2008

3rd

Previous Susquehanna River Symposiums

Bucknell University - 2006 to 2014

Cultures At The Confluence - Native Americans

September 26, 2009

Exploring Our Vital Resource - River Health & The Chesapeake

October 22-23, 2010

River Towns in the 21st Century

October 18-19, 2011

Previous Susquehanna River Symposiums

Bucknell University - 2006 to 2014

Wasn't That A Mighty Storm! Flooding In The Susquehanna

October 12-13, 2012

7th

A Fragmented Systems - Dams On The Susquehanna

October 18-19, 2013

8th

Science and the River

November 21-22, 2014

9th

Previous Susquehanna River Symposiums

Bucknell University - 2006 to 2014

Notes

The River and Its Landscapes

10TH ANNUAL SUSQUEHANNA RIVER SYMPOSIUM

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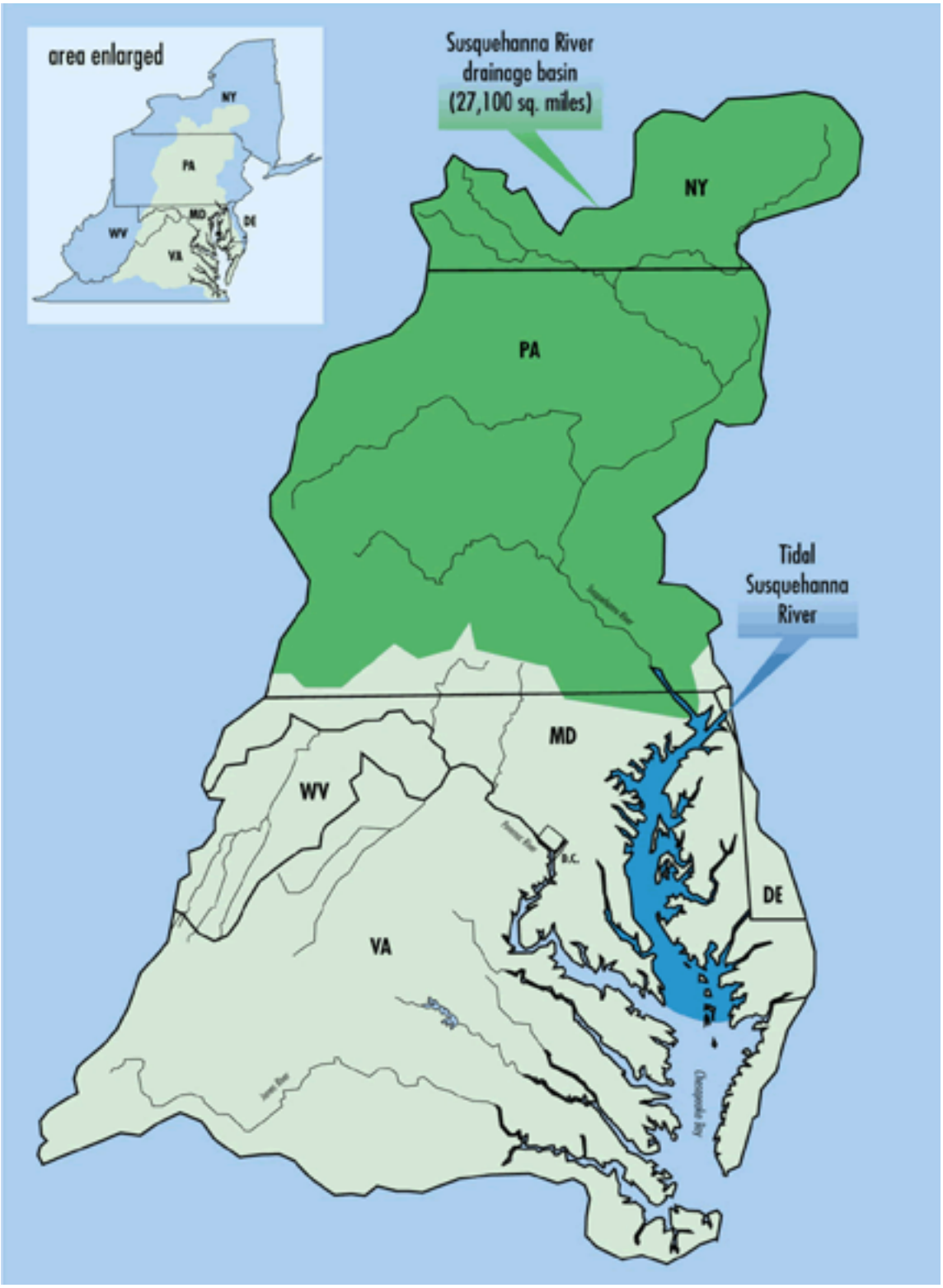


Map of the Chesapeake Bay region. On the west side of the Bay, the James, York, Rapahannock rivers drain areas of Virginia and the Potomac and Patuxent rain drain areas of Maryland. The Susquehanna drains an area of 27,100 square miles in New York, Pennsylvania, and Maryland (highlighted in green). The Choptank and Nanticoke are major tributaries on the east side of the Bay. Map courtesy of the Chesapeake Bay Foundation (used with permission).

View up the West Branch Susquehanna River from the overlook at Heiner State Park

31 major tributaries with drainage basins greater than 100 square miles contribute water to the Susquehanna.

More than just a beautiful name …

The Susquehanna begins it 444-mile journey at Otsego Lake near Cooperstown, New York and meanders southward through Pennsylvania until it joins the tidal waters of the Chesapeake Bay at Havre De Grace, Maryland. It is a river rich in history, natural resources, and beauty.

The origin of the Susquehanna's name and its precise meaning is uncertain[1]. The suffix, *hanna*, is Algonquin for "stream or river". During his 1608 exploration of the river, Captain John Smith was accompanied by interpreters who spoke Algonquin, which probably accounts for the suffix usage in the river's name. Smith refered to the natives who he met on the river as *Sasquesahannocks* and *Sasquesahanougs*. The tribe eventually came to be known as *Susquehannocks*.

One eighteenth-century authority on Indians and place names claimed that the Susquehanna was a corruption of the word *Queischachgekhanne*, which means "the long reach river", a name used to refer to the river's west branch. Still others speculate that the name means "*long crooked river.*" To the contrary, others favor "the place of the straight river," based on a translation of the Delaware word *saskwihanang*.

Watershed Facts:

- The Susquehanna drains 27, 510 square miles, making it the 2nd largest major watershed east of the Mississippi.
- The watershed receives on average 40 inches of precipitation.
- Approximately 60% of the annual streamflow occurs from February through May.

[1] *Runkle, S., 2003. "Native American Waterbody and Place Names Within The Susquehanna River Basin and Surrounding Basins," Publication No. 229, Susquehanna River Basin Commission, Harrisburg, PA.*

A blue crab takes refuge in widgeon grass beds on the Susquehanna Flats .
Photo courtesy of Susquehanna River Basin Commission (used with permission)

The Susquehanna delivers 18 million gallons of freshwater to the Chesapeake Bay every minute, supplying it with over half of its freshwater.

The Susquehanna is the lifeline of the Chesapeake Bay ...

The Chesapeake Bay is a *ria* of the Susquehanna, a drowned section of the river that was submerged after the Pleistocene ice sheets melted and sea level rose 100 meters. Today, where the river meets the bay is a vast, grass-covered shoal that's several miles wide and only 2 to 3 ft. deep — *"The Flats"* as it's called. The Susquehannocks navigated it, Captain John Smith made camp on its islands, and George Washington crossed its waters.

The Flats are the nursery for fish, crabs, and many other forms of tidal life. They're also a symbol to scientists of the Bay's resilience, and of its ability to rebound, if given a chance, from decades of pollution and periodic battering by storms that can bury them in sediment. The bay remains threatened by excess sediment and nutrients from agriculture, urban and suburban runoff, vehicle emissions and many other sources. Pennsylvania and New York are the sources. The nutrients cause algae blooms in the Bay, which block sunlight and stunt the growth of bay grasses or deplete oxygen in the tidal waters when the algal mats decompose.

River-Bay Facts:

- The West Branch provides 28% of the flow to the Chesapeake Bay, the North Branch 40%.
- The Juniata River drains an area of 3,400 miles and contributes 11% of freshwater flow to Chesapeake Bay.

Bedrock riffles on the Susquehanna, as viewed from Chickes Rock in Lancaster County, Pennsylvania
Photo by John Beatty, Pennsylvania Director of the Mason-Dixon Trail (used with permission)

*The Susquehanna flows **444** miles from Otsego Lake near Cooperstown, NY to Havre de Grace, MD*

Its landscapes are ancient, beautiful, and enchanting …

The Susquehanna flows across three physiographic provinces, beginning in the Appalachian Plateau, then curving its way through the Valley and Ridge and the Piedmont Province on its way to the Atlantic Ocean.

Tectonic forces compressed and folded the sedimentary rock layers into anticlines and synclines, which gradually weathered to form elongated ridges and valleys in the middle of the watershed.

For the past 38 million years, the Susquehanna has downcut through the folded strata to form a succession of water gaps such as visible in the photo above. The ridges in the watershed are underlain by resistant sandstone bedrock; less-resistant siltstones and limestones typically underlie the hillslopes and valleys.

More recently, continental ice sheets moved into the watershed from Canada, sculpting the landscape in the northern half of the watershed and leaving behind massive quantities of glacial till and outwash sediments on the land surface. Their glacial fingerprint is visible on the landscape, plants, and river today.

River Facts:

- The river is almost a mile wide at Harrisburg.
- From the 1840s to the early 1900s, steamboat ferries operated at a number of locations up and down the river.
- The Susquehanna is so wide and shallow that water from the West and North branches, as well as the Juniata river, do not mix for tens of miles downstream.

Fall Brook in Salt Springs State Park in Susquehanna County, Pennsylvania

The Susquehanna watershed has 31,194 streams, each with a unique geology, hydrology, and aquatic life worth protecting.

Its headwaters are cold, clear, and home to wild brook trout …

There are over 49,000 miles of streams in the Susquehanna watershed, most of which drain the forested headwater regions. Hydrologically and ecologically, they are connected to the Susquehanna and the Bay. They provide us access points where we can fish, boat and swim.

Toxic discharges from hundreds of abandoned coal mines have destroyed life in many of these headwater streams, but local cleanups and remediation efforts are helping restore their health. So vast is this problem, that costly AMD cleanup efforts will likely need to continue for another 20 to 30 years, and possibly more. Gravel dredging, dams, culverts, and pollution threaten other headwater streams as well.

Brook trout are believed to be the only stream-dwelling salmonid native to Susquehanna waters. Some of these headwaters have been designated by the PA Fish and Boat Commission as "Class A Wild Trout Waters," meaning they can support a population of naturally-produced trout of sufficient size and abundance. But thousands of miles of streams have yet to be assessed and designated, and therefore remain unprotected.

Stream Facts:

- Over 92 species of fish are found in the headwater streams.
- Commercial eel and shad fisheries were common until their migrations were blocked by dam construction on the lower Susquehanna.
- Freshwater mussels remain the most endangered aquatic animal taxon in the Susquehanna watershed.

Evening sunset bathes the second-growth forest floor in the Quehanna Wilderness Area, a tributary to the West Branch Susquehanna River. This watershed had more logging splash dams per mile of stream than perhaps any in the entire Susquehanna watershed and was completely clearcut by 1920.

Photo by Nicholas A. Tonelli (used with permission)

A recovering "Penns Woods" — Roughly 60% of the Susquehanna watershed is now covered by mixed hardwood and conifer forests.

5. Forested Uplands

Its forests are recovering and vital to the health of the watershed...

Forests are absolutely critical to the supply and quality of the Susquehanna's water resources. The tree canopies and the rich organic matter found on their forest floors store, clean and slowly release the majority of water that replenishes groundwater and maintains streamflow. The watershed's forested lands contain large reserves of clean groundwater and are often good locations for municipalities to drill high-yield water wells.

An oak and hickory forests retains an average of 90% of atmospheric nitrogen deposition, and the spruce and fir forests retains 78%. They sequester, or remove, carbon from the air helping to reduce the impact of carbon dioxide on global warming.

Today, roads and pipelines being built for the natural gas industry are severely fragmenting these high quality forests, severely impacting their wildlife populations and opening up corridors to invasive species. Erosion of sediment from these areas is degrading adjacent terrestrial and aquatic habitats as well.

Forest Facts:

- Susquehanna watershed is one of the largest producer of hardwoods in the country, accounting for10% of the total hardwood output in US
- About 70% of its forests are privately owned (5% held by forest products companies).
- About 30% of its forests are owned by state governments.

Eastern tiger swallowtail on hoary mountain mint in an transitional meadow in the Susquehanna watershed.
Photo by Tom Potterfield (used with permission)

Native Americans and early Europeans noted vast expanses of grasslands covering the Susquehanna river valley. Some places were given names like "Capoose Meadows" near Scranton.

Its meadows are part of a healthy, ecologically diverse watershed …

At one time, the broad valleys of the Susquehanna contained native meadows, sunny areas that attract and support flora and fauna that can't thrive in other conditions. Most have been lost to agriculture and river towns. Today some land owners are letting their fields, pastures, or other cleared land transition back to meadows. Once an area is no longer cut or grazed, it starts to display luxuriant growth, extending to the flowering and self-seeding of its grass and wild flower species. Natural wetland and coastal meadows are still found around the perimeter of palustrine wetlands and in the coastal areas near the Susquehanna Flats.

Meadows provide shelter for animals that are unable to seek refuge in trees, such as rabbits and land-dwelling birds. Besides offering shelter, wildlife gravitate to meadow areas for courtship and breeding under cover from vigilant predator eyes. Insects dominate this landscape and have a bountiful quantity of food and help pollinate the wildflowers that grow amongst the grasses. The successes and failures of these meadows not only affect this habitat and the wildlife inside, but ripple out and affect the entire ecosystem surrounding it.

Traditional Amish farm, Lancaster County, PA

There are over 17,000 farms in the Susquehanna watershed, with most in the Piedmont (Lancaster and York) and Valley and Ridge (Union, Snyder and Northumberland Counties)

Its streams need buffers to trap and filter polluted runoff …

Fencing stream banks and limiting livestock access with crossings promotes the establishment of a healthy vegetative cover. Forested vegetation along streams, called riparian forest buffers, helps stabilize stream banks in reducing erosion and collapse. These buffers can also help trap soils and pollutants that may otherwise run off of adjacent fields into the waterways. Riparian buffers provide food, cover and nesting sites for birds and small animals. By providing shade from the sun and a food supply (leaves, etc.) to the stream, buffers can enhance the aquatic habitat. Trees, shrubs and other plants that grow next to streams and rivers are critical to the health of the Susquehanna River and the Chesapeake Bay.

Properly managed woodlands can remove 90 percent of the nitrates in stormwater runoff given the right soil conditions. Forest buffers also stabilize stream banks, provide food and habitat to wildlife and keep streams cool during hot weather. Efforts by volunteers working through Trout Unlimited and the Chesapeake Bay Program are helping restore 900 miles of forest buffers every year, with the goal of having 70 percent of all stream banks and shorelines in the watershed buffered in the next 5 to 10 years.

Agricultural Facts:

- Sediment load delivery to streams is as high as 8.5 tons per acre in the southeastern part of the watershed.
- Nutrients from manure are a particular problem because animal densities are 5 to 10 times greater than in 1950.
- Pesticides, herbicides, fungicides, and hormones from farms are serious chemicals of emerging concern (CECs).

Lake Perez, a man-made lake at the Stone Valley Recreation Area, now owned and managed by Penn State as part of their Shaver's Creek Environmental Center program.

There are over 400 lakes and ponds in the New York State portion of the Basin and over 960 in the Pennsylvania portion of the basin.

Its lakes and reservoirs need management and protection

The Susquehanna watershed contains hundreds of lake and reservoirs that provide drinking water, flood control and recreational use for millions of citizens. Shallow ponds and lakes are found throughout the glaciated highlands region of the Susquehanna watershed. Elsewhere, over two hundred impounded streams or man-made reservoir, to serve as water supplies for local municipalities. During droughts, they can be severely depleted.

The health of all of these lakes depends on the amount of nutrients and sediments delivered to it by streams and areas around the shoreline. Excessive nutrients (phosphorus and nitrogen) lead to a eutrophication, which results in overabundant plant growth, unsightly lakes and streams, and destruction of the plant and fish habitat. Nutrient-loading comes from agricultural runoff, development (both residential and commercial), and inadequate septic disposal. Other threats to the health of the lake ecosystems include invasive plant and animal species. Effective lake management plans that address land and water management issues are needed.

Lake Facts:

- Raystown Lake (Huntingdon County) is the largest lake in the Pennsylvania portion of the Susquehanna watershed, with an area of 3,800 acres, average depth of 80 feet, and maximum depth of 200 ft.
- Harvey's Lake (Luzerne County) is the largest natural lake (by volume), having be scoured out by glaciers. It is surface area of 621 acres, average depth of 36 feet, and maximum depth of 102 ft).

Natural emergent wetlands at the Bear Meadows Natural Area

Photo courtesy of Rothrock State Forest (used with permission)

Woody and emergent wetlands cover less than 1% of the watershed (by area), but their hydrologic and ecologic importance is immeasurable.

Its marshes and wetlands are essential to its health …

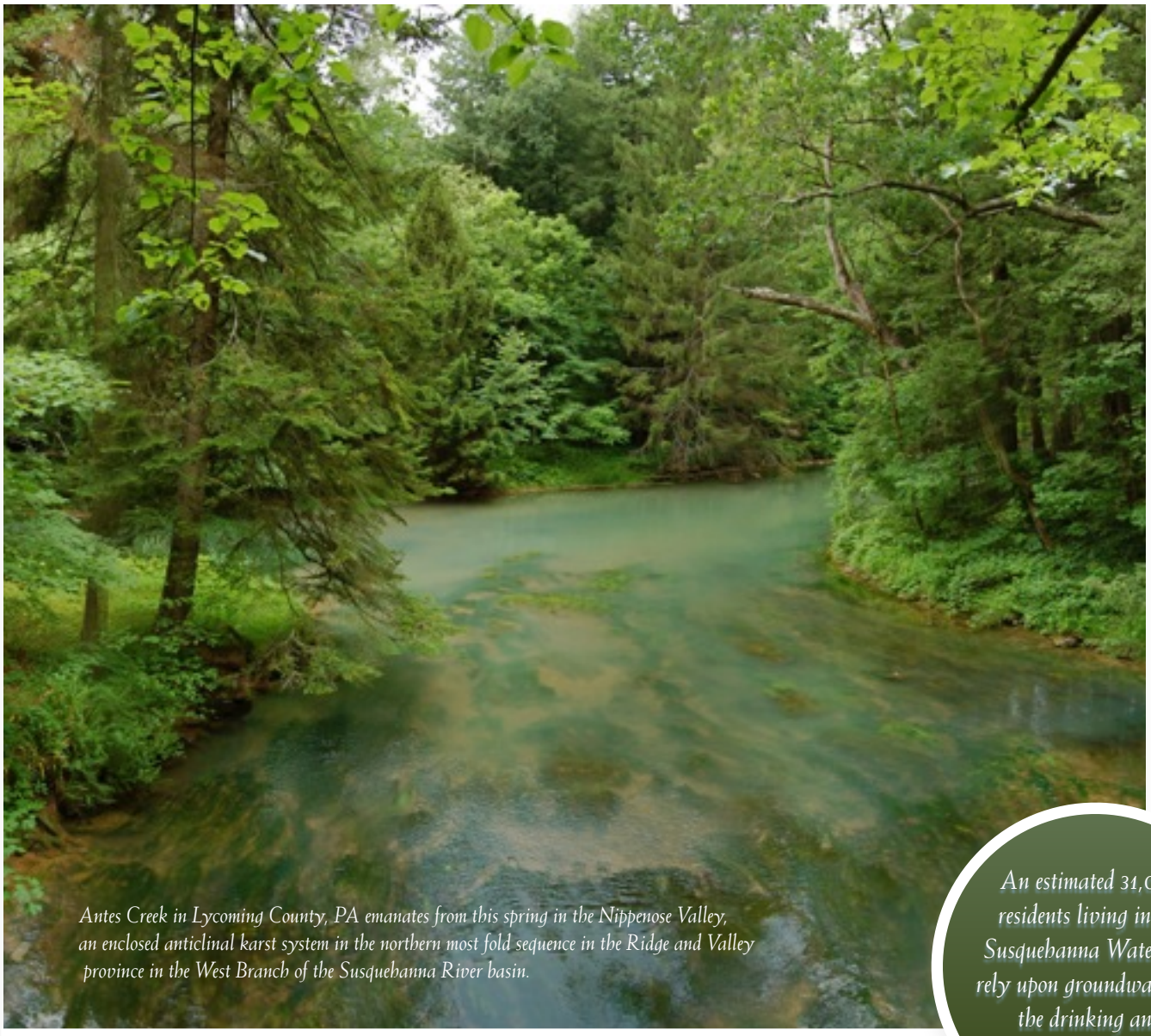
Wetlands are the hydrologic link between the Susquehanna's land and water resources, either surface water, groundwater or both, and they vary according to their topography, climate, hydrology, water chemistry and vegetation. In many ways, they are the "crown jewels" of the watershed, providing habitat to hundreds of species of fish, birds, mammals and invertebrates.

They act like sponges, soaking up storm surges and trapping polluted runoff, the roots of the wetlands plants then absorbing the nitrates and phosphorus from the sediment, eliminating it from the water and reducing its negative impacts to the Susquehanna and the Chesapeake Bay.

Sadly, it is estimated that 80% to 90% of the natural wetlands in the Susquehanna watershed were destroyed by European settlement, when vast areas of low-lying land were drained for farming and floodplains were mined for sand and gravel. Today urban development, invasive species and climate change threaten the few remaining ones. Protecting and restoring wetlands is a key way to promote clean water, healthy habitats and a restored river-bay ecosystem.

Wetland Facts:

- Wetlands are some of the most productive ecosystems in the world and provide habitat for wide variety of plants and animals.
- Wetlands filter, clean, and store flood waters, much more efficiently than any man-made levee, catch basin, or flood-control structure can.
- Wetlands absorb wind forces an provide places of beauty and outdoor recreation.



Antes Creek in Lycoming County, PA emanates from this spring in the Nippenose Valley, an enclosed anticlinal karst system in the northern most fold sequence in the Ridge and Valley province in the West Branch of the Susquehanna River basin.

An estimated 31,000 residents living in the Susquehanna Watershed rely upon groundwater for the drinking and household needs.

Its groundwater aquifers and and springs are a hidden treasure.

Springs and seeps form in areas where the groundwater table intersects the land surface, where water discharges from aquifer storage and becomes surface water. Groundwater discharge to streams is also known as base flow, which sustains the stream between periods of rain. Dry stream beds or springs that no longer supply water are a result of the water table being lower than the land surface.

Portions of the middle and lower portions of the Susquehanna watershed are underlain by limestone and dolomite, which form networks of dissolution cavities and caves. Large springs, sinkholes, and disappearing streams are common in these karst areas, making them especially vulnerable to pollution from agricultural and urban runoff. Caves are special subterranean ecosystems that need special protection.

Its estimated that 38% of residents in the Susquehanna watershed depend upon groundwater wells for their drinking water. Golf courses, farms, towns, and boroughs also rely on groundwater wells for their domestic, agricultural and manufacturing needs.

Groundwater Fact:

- Radon, a naturally-occurring radioactive decay product of uranium, is found at dangerously high levels (greater than 300 pCi/L) in many places of the Susquehanna watershed, especially the metamorphic rocks in the Piedmont and certain shales in the Valley and Ridge provinces. Many homeowner need to install sub-slab depressurization systems to reduce levels of this odorless gas in their basements.

Agriculture. Close to one-quarter of land in the Susquehanna watershed is devoted to agricultural production. Over 17,000 farms are located in the watershed, with most in Piedmont (Lancaster & York) and Valley and Ridge provinces (Union, Snyder, and Northumberland counties) These farms provide food and fiber, open areas, and many cultural and even aesthetic benefits. But agriculture is also the single largest source of nutrient and sediment pollution entering the streams, lakes, and rivers in the watershed, and ultimately the Bay. While conventional tillage, fertilizers and pesticides can be beneficial to crops, their excessive use is polluting the rivers and streams. The DEP assessments show that agriculture is the cause of degradation of 15% of the Susquehanna streams that did not attain designated water quality standards. We need to find new approaches to creating riparian buffers and keeping livestock out of streams.

Much of sediment pollution in our streams comes from eroding and unprotected stream banks on farms, especially those who have not fenced off their drainage ways to keep livestock out of the stream. Animal crossings also help.

Air Pollution. Air pollution doesn't just dirty the air we breathe, it harms our land and water. Pollution released into the air — by the millions of cars, trucks, gas-powered lawn tools, power plants and other sources in our region — eventually returns to the land's surface, where it ends up in the stream and river. Trees can help remove a tremendous amount of nitrogen and chemical contaminants, but our urban and suburban areas are lack forests of any size, but that's exactly where they're needed the most!. Maintaining our existing forests, greening our towns and cities, and continuing to enact regulations to reduce emissions from our vehicles and power plants are three ways each of us can help reduce air pollution across the Susquehanna watershed. We need to plant more trees, create new urban forests, and conserve the existing forests for generations to come. Trees provide shade to streams and ponds, they improve the air quality of our towns and cities, and we experience those healthy benefits in many ways.

Center photo: Sedum growing in urban rain garden built in Lancaster City, Pennsylvania. Courtesy of Chesapeake Bay Foundation (used with permission).

Climate Change and Weather. A changing climate will affect the Susquehanna watershed. Some effects — like rising sea levels, warming water temperatures, and prolonged periods of extreme weather — are already being observed. The islands and salt marshes of the Chesapeake are slowly disappearing due to a rise in coastal flooding, which is also increasing shoreline erosion and impacting in wildlife abundance and bird migration patterns. While all plants and animals can adapt to periodic changes in environmental conditions, scientists cannot predict with certainty how the Susquehanna and Chesapeake regions will respond to the prolonged periods of extreme weather that are linked to climate change. Much more work is needed to increase the climate resilience of the ecosystems and the communities (human and non-human) across the region. If these communities are not healthy, their ability to adapt to stresses imposed by climate change is greatly reduced.

Stormwater Runoff. The Susquehanna watershed receives on average 40 inches of precipitation a year, with roughly 45% contributed by storms between May and September. Stormwater runoff and flooding are natural events that have helped shape our watersheds and rivers. But our human activities on the landscape have greatly altered the natural drainage patterns. Urban development brings with it impervious surfaces, which increase localized flooding, stream bank erosion and loss of groundwater recharge. In addition to its physical impact on the environment, stormwater may carry a variety of pollutants.

The snow and rain may land on a field or forest and soak into the soil; or it may land on a rooftop, driveway or road and travel down the street into a storm drain or stream. Storm runoff from urban or suburban areas is typically untreated and carries high pollutant loads to the streams and rivers. More than 1,000 stream miles are classified as polluted from developed storm runoff, which includes contaminants washed from the land surface, stream bank erosion and sedimentation, overflow of raw sewage from were systems, increased water temperature, and increased flooding. Increased development across the watershed has made stormwater runoff (also called polluted runoff) the fastest growing source of pollution to the Susquehanna River and the Chesapeake Bay.

Chemical Contaminants. Almost three-quarters of aquatic life in the Susquehanna River and Chesapeake Bay's tidal waters are considered impaired by chemical contaminants. These contaminants include pesticides, pharmaceuticals, metals and more, and can harm the health of both humans and wildlife. From the insecticides that are put on farm fields to the cleaners we use to disinfect our homes, contaminants can enter the Bay and its tributaries in several different ways. While production bans have lowered the presence of some contaminants in the watershed, others are still widely used today. And conventional sewage treatment plants simply are not designed or equipped to remove hormones, pharmaceuticals, and other emerging contaminants either.

Development and Urban Growth. Approximately 10% of the lower Susquehanna watershed is developed for residential, commercial and industrial use. As the economy and population of the mid-Atlantic region grows and more people move into the Susquehanna watershed, more land is cleared to build roads, homes and businesses. Residents have expanded out of traditional urban centers and into bigger houses on larger lots, turning forests, farms and other valuable landscapes into subdivisions, shopping centers and parking lots. A new generation of sustainability-minded business leaders, architects, and planners are needed — people committed to incorporating "green technologies" that can be used to retrofit our existing infrastructure and find more "eco-friendly" methods of building homes and businesses.

Dams, Levees, and other Ecological Barriers. Beginning in the 1940s, the U.S. Army Corps of Engineers built fourteen dams on the tributaries of the Susquehanna to control about 14 percent of the flow in the main stem of the river. There are eight hydropower reservoirs too, including Shawville, Goodyear Lake, Johnson City, and Oakland dams on the North Branch and the York Haven, Safe Harbor, Holtwood, and Conowingo dams on the lower Susquehanna. The Oakland dam was breached in 1990.

Four hydroelectric dams have been built across the Lower Susquehanna River, including the Conowingo Dam which is located in Maryland but is still used by Pennsylvania. Holtwood Dam, the oldest of three major dams in Lancaster County, produces up to 109 megawatts of power. Safe Harbor Dam, which is located north of the confluence of the Conestoga River and Susquehanna River, provides power for the area interconnected between Pennsylvania, New Jersey and Maryland. In one day, at maximum output, approximately 10 million kilowatt-hours of electricity are generated. An average house uses about one-hundredth of that amount in a year.

There are hundreds of low-head recreational dams have been built over the last century for the canals and to create pools for recreational boating, fishing, and swimming. Add to this list are several thousand low-head grist mill and logging dams built in the 17th, 18th, and 19th century. Managing the sediment trapped behind these dams is a major environmental concern, but an even greater concern is the barrier to migration of fish, including species such as eel, shad, and herring. Levees have disconnected the river from its floodplain too, creating barriers for wildlife such as amphibians and reptiles and isolating local residents from the river. By not allow flood waters to spread out onto the valley floor, flood velocities and discharges are increased downstream too. Forecasters warn that the frequency and magnitude of flooding may increase with climate change as well. So we need to find new approaches to flood mitigation and recovery — ones that are culturally, economically and environmentally sustainable — for the many river towns along the Susquehanna and its tributaries. The solutions and trade-offs are not easy.

Invasive Species. Invasive species are plants and animals that have been introduced, whether accidentally or on purpose, into their current habitat. They can cause harm when they establish themselves at the expense of native plants and animals, encroaching on their food or habitat. Blue catfish, rusty crayfish, and zebra mussels are three invasive aquatic species and purple loosestrife and Japanese knotweed are two invasive plant species found in and along the Susquehanna River. Efforts to eradicate these species have limited success and much more research is needed to assess the impact these invasive species are having on native aquatic and terrestrial communities.

Wastewater Treatment. 3.8 million people liven with the Susquehanna watershed and depend upon it for drinking, bathing, washing, agriculture, food and textile manufacturing, and irrigation. Hundreds of wastewater treatment facilities throughout the watershed are being upgraded with advanced technology to reduce the amount of nutrients that are discharged into the river. Wastewater treatment plant upgrades account for a large portion of overall estimated nutrient reductions to date, and Chesapeake Bay jurisdictions are relying on additional reductions from wastewater to achieve about 15 percent of total overall nutrient reduction goals. But conventional treatment facilities require a lot of electricity as well, so more research is needed to design and implement passive treatment facilities or "wetlands" that can remove nutrients and chemicals from concentrated agricultural and industrial operations, before they reach the river.

Schedule of Events

10TH ANNUAL SUSQUEHANNA RIVER SYMPOSIUM

Bucknell University - November 13-14, 2015

Notes

Friday, November 13th

THE FORUM, ELAINE LANGONE CENTER

7:00 - 7:05 PM

Welcome

Peter Wilshusen, Executive Director
Bucknell Center for Sustainability and the Environment

7:05 - 7:20 PM

Opening Remarks and Recognitions

John Bravman, President
Bucknell University

7:20 - 7:30 PM

The Value of Collaborative Partnerships for Watershed Research

H.W. "Skip" Wieder, Executive Director
Susquehanna River Heartland Coalition
for Environmental Studies

7:30 - 8:00 PM

Keynote Address

James N. Levitt, Director
Harvard Forest Program on Conservation Innovation

TERRACE ROOM, ELAINE LANGONE CENTER

8:00 - 10:00 PM

Research Posters, Agency Exhibits, and Evening Social

Displays from watershed groups, conservancies, consulting firms, and other organizations.

Terrestrial Ecosystems

Sedges emerge from the damp leaves on the forest floor on the floodplain of Kettle Creek in the West Branch Susquehanna River.

Saturday, November 14th

TERRACE ROOM, ELAINE LANGONE CENTER

8:00 - 8:50 AM

Research Posters, Agency Exhibits, and Light Breakfast and Coffee

THE FORUM, ELAINE LANGONE CENTER

9:00 - 9:10 AM

Welcome and Announcements

Benjamin Hayes, Symposium Chairman

9:10 - 9:30 AM

Sustainable Water Resources Management

Andrew DeHoff, Executive Director

Susquehanna River Basin Commission

9:30 - 9:50 AM

Stream Corridor Conservation and Restoration

Marel A. King, Pennsylvania Director

Chesapeake Bay Commission

9:50 - 10:10 AM

Stresses on Aquatic Ecosystems

Heather Galbraith, Research Biologist

U.S. Geological Survey

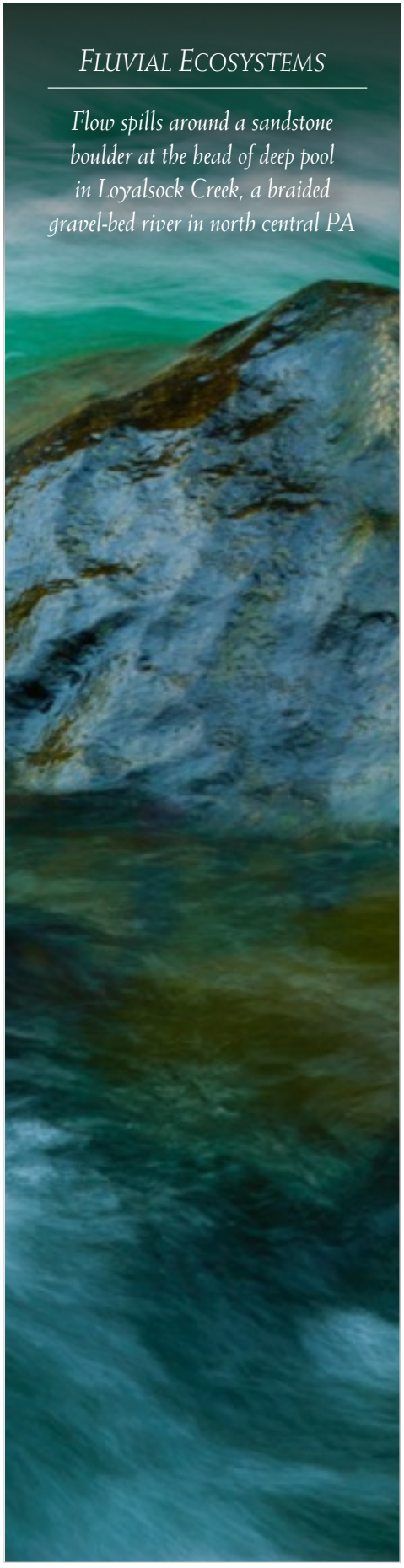
Northern Appalachian Research Laboratory

10:10 - 10:30 AM

Susquehanna River - Chesapeake Bay Connections

Joel Dunn, Executive Director

Chesapeake Conservancy



Fluvial Ecosystems

Flow spills around a sandstone boulder at the head of deep pool in Loyalsock Creek, a braided gravel-bed river in north central PA

Saturday, November 14th

10:30 - 10-45 AM

Intermission

2nd FLOOR ELAINE LANGONE CENTER (ELC)

10:45 AM - 12:00 PM

Breakout Discussions

Group 1	Terrace Room
Group 2	ELC 241, Rooms A and B
Group 3	ELC 241, Rooms C and D
Group 4	ELC Center Room

WALLS LOUNGE, ELAINE LANGONE CENTER

12:00 - 1:00 PM

Lunch *(buffet is served in adjacent room)*

1:00 - 1:30 PM

Keynote Address

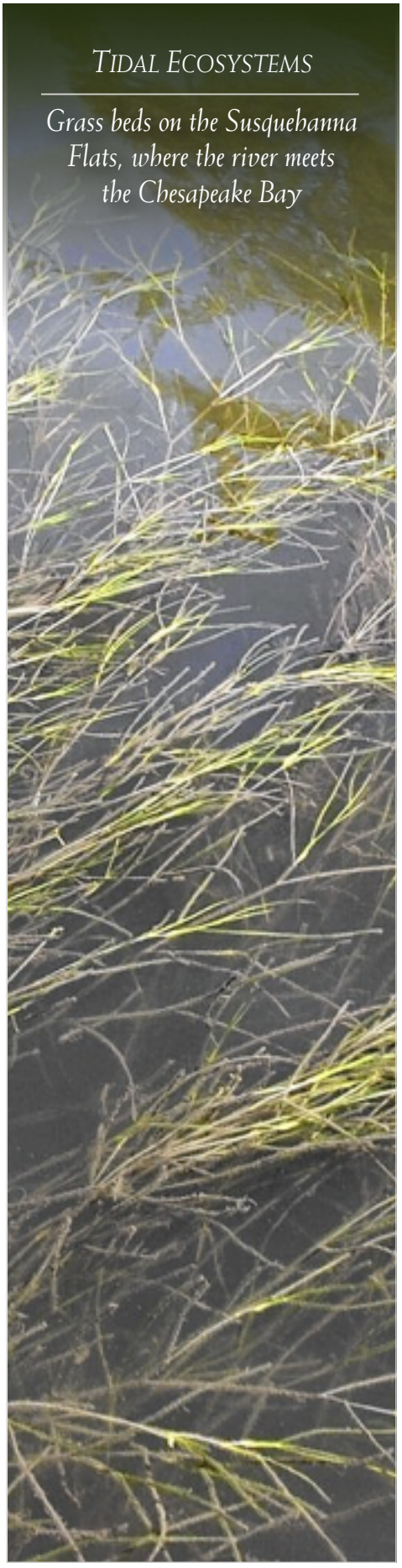
"Rivers at risk: A review of existing and emerging threats to running waters"

Laura Craig, Director of Science and Economics and Rivers Restoration Programs
American Rivers

1:30 - 3:00 PM

Wrap-Up Discussion

Analysis of the morning round-table discussions, analysis of the responses, identifying future directions.



Notes

Colleges & Universities

presenting at this symposium

10TH ANNUAL SUSQUEHANNA RIVER SYMPOSIUM
Bucknell University - November 13-14, 2015

Binghamton University
State Univ. of New York

Harvard University

Lock Haven University

The Pennsylvania State University

Bloomsburg University

Johns Hopkins University

Lycoming College

Saint Francis University

Bucknell University

Juniata College

Mansfield University

College of Environmental Sciences and Forestry
State Univ. of New York

University of California at Berkley

Kings College

University of Maryland

Susquehanna University

Cornell University

Indiana University of Pennsylvania

Millersville University

Syracuse University

Agencies, Commissions, Companies & Conservancies

presenting at this symposium

10TH ANNUAL SUSQUEHANNA RIVER SYMPOSIUM
Bucknell University - November 13-14, 2015

Alliance for the Chesapeake Bay

Lancaster County Conservancy

Susquehanna River Basin Commission

American Rivers

Pennsylvania Department of Environmental Protection

Trout Unlimited

Chesapeake Bay Commission

U.S. Fish and Wildlife Service

Chesapeake Conservancy

Pennsylvania Fish and Boat Commission

Geisinger Center for Health Research

U.S. Geological Survey

Agencies, Commissions, Companies, and Conservancies

Presenting at the 10th Susquehanna River Symposium

Alliances, Associations, Conservancies, Commissions, Companies, Organizations & Partnerships

exhibiting at this year's symposium

10TH ANNUAL SUSQUEHANNA RIVER SYMPOSIUM
Bucknell University - November 13-14, 2015

American Rivers

HydroSense Wireless Monitoring Instruments

Susquehanna Greenway Partnership

North Central Pennsylvania Conservancy

Buffalo Creek Watershed Alliance

Merrill W. Linn Land & Waterways Conservancy

Susquehanna River Basin Commission

Pennsylvania Fish & Boat Commission

Chesapeake Conservancy

Mid-Atlantic Dairy Association

pennsylvania Department of Environmental Protection

EA Engineering, Science, and Technology, Inc.

Stories of the Susquehanna Valley

Raymond B. Winter Chapter of PA Trout Unlimited

Pennsylvania Conservation Districts

North Central Stream Restoration Partnership

North Central Pennsylvania Conservancy

PA Department of Environmental Protection

PA Fish and Boat Commission

PA Conservation Districts

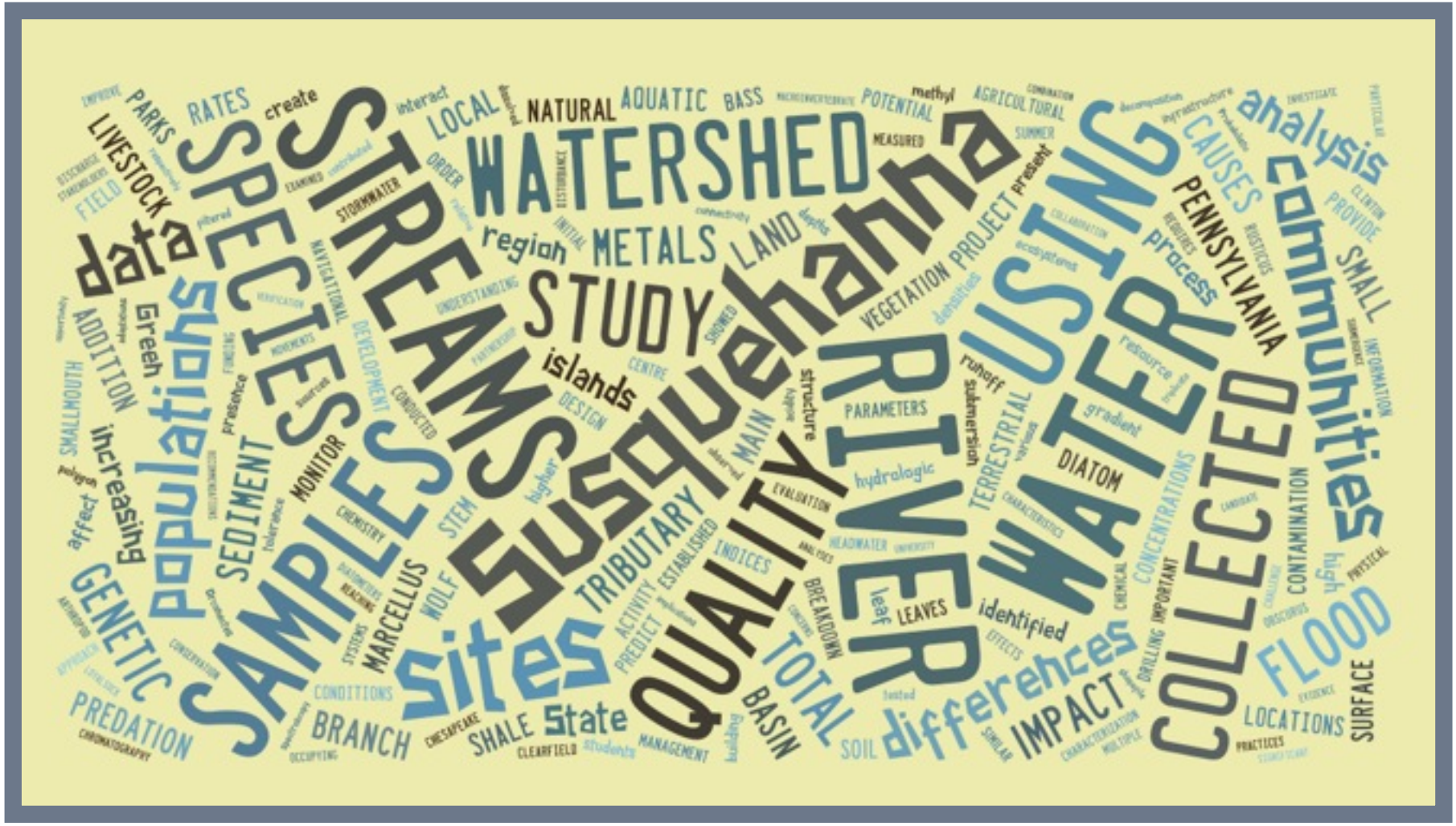
Alliances, Associations, Conservancies, Commissions, Companies, Organizations and Partnerships

Exhibiting at the 10th Susquehanna River Symposium

Research Word "Cloud"

A graphical depiction of key words used in the research abstracts

10TH ANNUAL SUSQUEHANNA RIVER SYMPOSIUM
Bucknell University - November 13-14, 2015



This "word cloud" is based on the abstracts submitted to this symposium, which are presented on the following pages. The more frequently a word appeared, the larger and bolder it is displayed in the cloud. It gives you a picture of what words the authors used most frequently, although that does not necessarily imply they are the most important. Take a few moments to see what words stick out the most to you and what words you think are notably absent.

Abstracts

10TH Annual Susquehanna River Symposium
Bucknell University - November 13-14, 2015

A STUDY OF THE DIATOM COMMUNITIES IN THE UPPER MAIN STEM OF THE SUSQUEHANNA RIVER DURING AN UNUSUALLY WET SUMMER

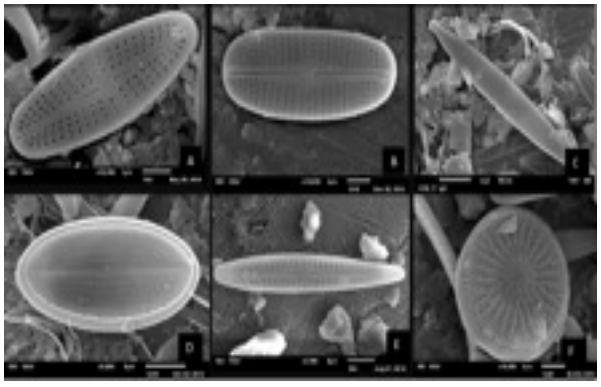
ALWALI, Amir Younous, Department of Chemistry, alwali@susqu.edu; **HOLT**, Jack R, Department of Biology, Susquehanna University, 514 University Avenue, Selinsgrove, PA, 17870.

The upper main stem of the Susquehanna River is formed by the confluence of the West and North Branches, each of which is chemically and physically distinctive. The upper main stem retains the signatures of the two branches due to weak lateral mixing, and we refer to them as the North Branch plume (NBP) and West Branch plume (WBP). Thus, characterization of the diatom communities required samples taken from sites that occur in the plumes of both branches.

Since 2009 when our river monitoring program began on the upper main stem, the summer of 2015 was an unusually wet year. Furthermore, monthly average discharge levels of the river during July exceeded those of any year during the 77 years of USGS records for the upper main stem. Indeed, the high water required that we reduce the scope of active sampling to one set of collections at each site together with artificial substrates.

Our samples were taken from an established transect that straddles Byers Island near Shamokin Dam, PA and below the Adam T. Bower inflatable dam at Sunbury, PA. Diatom samples from diatometers, stones and other substrates were prepared for examination by electron microscopy. Within the plumes of the two branches, we focused on two particular habitats inhabited by diatom communities: stone, and diatometer. Overall, we identified approximately 93 different species in this study. Taxa richness in WBP (sites 1 and 5) was relatively low 16-24 and 19 species in the stone (16-24) and diatometer (19) communities, respectively. Similar communities from NBP (sites 2, 3 and 4) were richer and more diverse (e.g. 29-48 taxa on stones and 22-34 taxa on diatometers.

Habitats of the NBP were dominated by a small centric and biraphid species (e.g. *Discostella pseudostelligera* and *Rhoicosphenia abbreviata*) and similar habitats of the WBP were dominated by monoraphid species (e.g. *Achnanthidium deflexum*, *Achananthidium minutissium*, and *Cocconeis placentula*). Our preliminary results suggest that the high levels of discharge through the summer until we made our collections on July 27 contributed to differences in diatom communities between substrates.



HYDROGEOCHEMICAL PROCESSES AND WATER QUALITY ASSESSMENT OF FIVE PENNS CREEK HEADWATER STREAMS

BARAKAT, Michelle, barakat@susqu.edu; **LACHHAB**, Ahmed, Earth and Environmental Sciences, Susquehanna University, 514 University Ave, Selinsgrove, PA, 17870.

A detailed study of water analysis was performed on five headwaters streams of Penn's Creek, a tributary of the Susquehanna River. The five streams are Henstep, Coral Run, Lick Run, Green Gap, and Little Weikert and are located in Bald Eagle State Forest of the Valley and Ridge Province. The focus of this study includes an assessment of water quality of each individual stream and their similarities and differences. Questions such as: 1) how do the geomorphology and the vegetation impact these streams? 2) How can similarities and differences be identified? 3) How can the geochemistry of the stream bed sediments be linked to the water quality? To answer these questions, physical and chemical as well sediment and hydrology were measured and analyzed. The collection of this data was done using a flow meter, YSI multi-parameter, a spectrophotometer, and an ion chromatography system (ICS). In addition, a sonde was deployed at each headwater simultaneously. Along with this data, soil samples were analyzed to further explain how the water chemistry and biology interact. The study is ongoing and monitoring is still taking place in all these streams.

MARCELLUS SHALE IMPACT ON LEAF DECOMPOSITION VIA SEDIMENTATION ACROSS A GRADIENT OF LAND USE

BARTON, Jordan A, jab101@bucknell.edu; **MCTAMMANY**, Matthew; **REILLY**, Meghan, Department of Biology, Bucknell University, 701 Moore Avenue, Lewisburg, PA, 17837.

The rapid development of hydrofracking has greatly outpaced ecological research trying to assess potential impacts of natural gas drilling on the environment, specifically aquatic ecosystems. Increased sedimentation and contamination of streams from natural gas drilling could affect stream biota, resulting in altered rates of ecosystem processes, like leaf breakdown.

Microbial and macroinvertebrate communities play the biggest roles in leaf decomposition, thus understanding how these communities respond to disturbance from natural gas drilling, such as sedimentation and contamination, should enable us to predict how leaf breakdown might be affected.

To determine impact of Marcellus Shale activity on leaf decomposition and on biological components involved, we deployed leaf packs in seven sites representing a range of Marcellus

Shale activity along a gradient of different land uses including forest, agriculture, and human development. Breakdown rates were determined for maple and oak leaves deployed in bags with coarse mesh and fine mesh to assess the relative influences of microbial decomposition and macroinvertebrate feeding.

In addition, physical and chemical variables were measured. Overall, we found the breakdown rates for all sites, mesh sizes, and leaf species to be higher in the presence of natural gas drilling. As expected, maple leaves broke down faster than oak leaves, and leaves incubated in fine mesh bags decomposed more slowly than leaves in coarse mesh bags. Across the land use gradient without Marcellus Shale influence, agricultural sites had higher breakdown rates than forested and developed areas.

Higher breakdown rates in Marcellus Shale sites suggest that more disturbed land modifies hydrology of the stream systems, promoting more runoff into the stream as well as more sediment release. This increased sediment in combination with higher runoff may not bury the leaves as predicted but may increase the mechanical breakdown of leaf material due to high water velocity.

DETERMINING RIVER WATER QUALITY USING ATOMIC ABSORPTION AND GAS CHROMATOGRAPHY/MASS SPECTROMETRY

EALE, Oliver M, bealeo@susqu.edu; **TOM**, Lou-Ann, Department of Chemistry, Susquehanna University, 514 University Ave., Selinsgrove, PA, 17870.

The presence of metals and volatile organic compounds were determined at four sites across the Susquehanna River. Dissolved and total metal concentrations of twelve metals were determined using flame atomic absorption spectroscopy of filter and digested river water samples, respectively. Metal concentrations were found to range from below the detection limit to almost 10 ppm. Metal content for many metals was found to be similar to results from previous samples. The presence of volatile organic compounds was determined using solid phase microextraction (SPME) coupled with gas chromatography/mass spectroscopy (GC/MS). GC/MS studies indicated the possible presence of butylated hydroxytoluene and di-tert-butylphenol. Work is ongoing and will focus on continued collection of GC/MS data, and metal content using more sensitive furnace atomic absorption techniques.

SUSQUEHANNA RIVER ISLAND VEGETATION

BLUMLER, Mark A, mablum@binghamton.edu; **LAMPHERE**, Danielle, Department of Geography, SUNY-Binghamton, 4400 Vesta lParkway East, Binghamton, NY, 13902-6000.

Flood control policies tend to straighten streams and simplify floodplains, reducing habitat diversity and therefore causing loss of biodiversity. Relatively unaffected are islands, many of which are small wildernesses visited occasionally by kayakers and fishermen but otherwise suffering little direct human impact. However, there are almost no published studies of river island vegetation in the Northeast. Here we report on the vegetation of islands on the Susquehanna River and tributaries, in the vicinity of Binghamton, NY. We were particularly interested in the importance of invasive species, the presence or absence of species known to be disappearing in the region, and how urban island vegetation compares with other urban green spaces.

Islands tend to lack specialized floodplain habitats such as oxbows, and the native species present tend to be widespread and common. This may not be completely true, however. Compared to other urban green spaces, the proportion of natives is high, unless the island has been occupied by Japanese knotweed. Nonetheless, alien species are always present, despite the lack of human impact. The types of plants present differ somewhat from what is present in "mainland" wetlands. For instance, grasses are less abundant on islands.

WATERSHED ASSESSMENT OF WHITE DEER CREEK

BOYD, Zach, zwb001@bucknell.edu; **NEWLIN**, Jessica T, Department of Civil and Environmental Engineering, Bucknell University, One Dent Drive, Lewisburg, PA, 17837; **HAYES**, Benjamin R; **REESE**, Sean, Watershed Sciences and Engineering Program, Center for Sustainability and the Environment, Bucknell University, One Dent Drive, Lewisburg, PA, 17837.

For conservation organizations looking to improve the quality of local watersheds, watershed assessments are a necessary first step in order to determine how to allocate their efforts. A watershed assessment consists of both quantitative and qualitative spatial data compiled to produce an overall characterization of the entire watershed. From this information, spatial analysis of the data using GIS systems can be completed to reveal the portions of the watershed that are in most need of restoration. Ideally, a watershed assessment will provide a holistic view of all of the current resource conditions that exist within a watershed. Comparing this to the desired conditions, watershed assessments serve as a quick and efficient information database that can be used when making and prioritizing conservation decisions.

The White Deer Creek watershed examined in this study covers approximately 122 square kilometers of land and spans portions of Pennsylvania's Centre, Clinton, Union, and Lycoming Counties. The basin contains 118 km of mapped streams, of which the largest is White Deer Creek. Most notably, White Deer Creek is a tributary of the West Branch of the Susquehanna River, meeting the larger river in Watsontown, PA.

This study was conducted by selecting and examining nine sites of varying characteristics along the entirety of White Deer Creek, as well as one site on the largest tributary to the creek, Sand Spring Run. Field data collection was comprised of aquatic biodiversity surveys, habitat assessments, velocity gradient readings, and water quality. This information was then combined with a LiDAR digital elevation model, historical land use data, soil characterization, bedrock maps, and climate data. Together, a watershed characterization was completed for White Deer Creek.

A STORMWATER PARTNERSHIP: COMBINING LEARNING WITH THE COMMUNITY

BUSHEY, Joseph, Masters of Science in Integrated Science Applications Program, Millersville University, PO 1002, Millersville, Pennsylvania, 17551, joseph.bushey@millersville.edu; **FRITZ**, Schroeder; **BURCIN**, Michael, Lancaster County Conservancy, 117 S West End Avenue, PO Box 716, Lancaster, PA, 17608.

Stormwater runoff, and its associated pollutants, is a major environmental problem in urban watersheds where the runoff is either channeled into surface water bodies or directed through wastewater treatment plants prior to discharge. However, implementation of stormwater management practices requires technical expertise for evaluation and design, a factor that challenges the budgets available. To address this funding challenge and to promote learning, the Millersville Master of Science in Integrated Science Applications (MSISA) Program and the Lancaster County Conservancy (LCC) developed a partnership. Site stormwater evaluations and designs were performed for three sites as part of the Lancaster City Urban Greening Initiative. Student groups in the MSISA Spring 2015 Stormwater Management course conducted site visits, met with stakeholders, and performed hydrologic evaluation for multiple BMP design options.

The projects simultaneously provided real-world learning opportunities for students while benefiting the community and regional water quality. Students were able to interact with stakeholders in addition to acquiring design experience. Meanwhile, the LCC and property owner receive technical assistance for sites that may otherwise be cost prohibitive.

The presentation will focus on management options at a Lancaster City residential property. A raingarden and an underground infiltration basin based on recommendations and designs from the students' report were installed during summer 2015 and have been operating successfully. Additionally, funding is being sought to install a second student design involving a constructed wetland to treat roof runoff from the education center at the LCC Climbers Run Nature Preserve. Additional projects are planned for spring 2016 to build on these initial successes.

POTENTIAL IMPACTS OF THE INVASIVE RUSTY CRAYFISH (ORCONECTES RUSTICUS) ON THE NATIVE GASTROPOD COMMUNITIES OF THE SUSQUEHANNA RIVER

CARRINGTON, Edward Charles, ecc016@bucknell.edu; **DUBOIS**, Sean, Department of Biology, Bucknell University, 701 Moore Avenue , Lewisburg, PA, 17837; **REESE**, Sean P, Watershed Sciences and Engineering Program, Center for Sustainability and the Environment, Bucknell University, 1 Dent Drive, Lewisburg, PA, 17837 .

The rusty crayfish (*Orconectes rusticus*) is a well-studied and highly invasive species of the Susquehanna drainage in Pennsylvania. It can survive in lakes, rivers, and streams and is capable of outcompeting native species such as *Orconectes obscurus* for food and habitat. *O. rusticus* is discernibly larger and more aggressive than *O. obscurus*, and can survive in a wide variety of habitats and extreme conditions, more so than other species of *Orconectes*. We sought to investigate predation rates on different gastropod species native to the Susquehanna River system, by both *O. obscurus* and *O. rusticus*. In addition, gastropod densities and communities were assessed at 7 longitudinal sites along roughly 200 miles of river. Through laboratory mesocosm experiments, we assessed predation rates on *Physella acuta*, *Leptoxis carinata*, and *Pleurocera virginica*, three snail species common to the Susquehanna drainage. We placed a mixed size-class of adults and/or juveniles into a mesocosm with one crayfish (*O. rusticus* or *O. obscurus*) for a 48 hour period. *O. rusticus* was found to have a mean predation rate of >90% on *P. acuta*, >35% on *L. carinata*, and 0% on *P. virginica*. *O. obscurus* was found to have a mean predation rate of >65% on *P. acuta*, >10% on *L. carinata*, and <1% on *P. virginica*. Consequently, *O. rusticus* exhibited higher mean predation rates on smaller, softer-shelled gastropods than *O. obscurus*. Our preliminary findings show *P. virginica* exhibiting the highest densities throughout our sites, and *P. acuta* exhibiting the lowest densities. Our findings suggest that an invasion of not only has the potential to outcompete and extirpate native crayfish species, but also to decrease species diversity among native gastropods to the Susquehanna watershed.

BASELINE GROUNDWATER QUALITY FROM DOMESTIC-SUPPLY WELLS IN LYCOMING AND OTHER NORTHERN PENNSYLVANIA COUNTIES

CHAPLIN, Jeffrey J., U.S. Geological Survey, Pennsylvania Water Science Center, 215 Limekiln Road, New Cumberland, PA, 17070, jchaplin@usgs.gov.

Most rural residents in Pennsylvania use groundwater from domestic wells for drinking, cleaning, and other purposes. Despite this reliance on groundwater, Pennsylvania has no well-construction standards and often little is known about the chemical quality of groundwater used for domestic supply.

Current water-quality conditions in shallow aquifers used for domestic supply need to be characterized to provide a baseline against which future water-quality changes can be evaluated, especially in areas vulnerable to contamination. Public interest in the chemical quality of groundwater in shallow aquifers is especially intense in rural areas experiencing large-scale development of natural gas from the Marcellus Shale Formation.

In the summer of 2014, the U.S. Geological Survey partnered with Lycoming County, the West Branch Regional Authority, and local health systems to collect groundwater samples from 75 domestic-supply wells representing major rock types in Lycoming County. Wells meeting prescribed construction criteria were randomly selected so that the findings are not biased toward wells with known problems.

Samples were analyzed for a combination of 145 constituents and properties including bacteria, nutrients, major ions, dissolved and suspended solids, metals and trace elements, radioactivity, volatile organic compounds, radiochemicals, and dissolved gases, including methane and radon-222.

These data will be used for characterizing groundwater chemistry in different rock types, determining spatial variability of groundwater chemistry, and establishing a baseline against which future changes can be evaluated. Expansion of this sampling into Bradford County is planned in 2016 and efforts to include other northern-tier counties in the Susquehanna River Basin are underway.

*Invited Oral Plenary Presentation**

MANAGING FOR SUSTAINABILITY IN THE SUSQUEHANNA RIVER BASIN

DEHOFF, Andrew D., Susquehanna River Basin Commission, 4423 N. Front Street, Harrisburg, PA 17110-, ADehoff@srbc.net.

Demands on the water resources of the Susquehanna basin are nothing new, but challenges continue to mount with increasing government mandates and societal pressures to implement more protective measures over the quantity and quality of water flowing in our streams and from our taps. Agencies and communities are responding with the development of new tools and stronger policies, but are doing so amid a tough economic climate. The overarching management question becomes: *How do we achieve the protections we need while still enabling the wise economic development we want?* The presentation will highlight some of the challenges facing water managers in the Susquehanna River basin and the partnership opportunities that exist to address them, and invite a discussion of the data gaps and research needs facing water resource managers.

THE CHRISTMAS TREE THAT KEEPS ON GIVING: THE INVASIVE POTENTIAL OF CULTIVATED VARIETIES OF AMERICAN HOLLY

DIAZ, Nicolas, **nad008@bucknell.edu**; **PETRUSO**, Gabrielle; **MARTINE**, Christopher; Department of Biology, Bucknell University, 701 Moore Avenue C1170, Lewisburg, PA, 17837.

The genetic, ecological, and demographic effects of invasive plant species have already been widely documented and studied. The effect of escaped cultivars of native species introduced outside of their natural range, however, has been given little to no attention. This preliminary study sought to locate and identify wild and escaped populations of American Holly (*Ilex opaca*), record sex ratios, and collect sample specimens for future genetic analysis. Site locations were provided by the Pennsylvania Natural Heritage Program. A voucher was collected for each observed population and small tissue samples were collected from individuals within a given population.

After the first field season, the study revealed a few noteworthy trends: (1) at locations where Holly was believed to have escaped, high levels of recruitment were observed in shaded understories, (2) a number of populations were observed in riparian zones with noticeably saturated soil, perhaps indicating a selection for a broadened soil tolerance, and (3) Holly thrived in disturbed forests and edge habitats where other common invasive species occurred. Determining whether an individual was sexually mature proved difficult when drupes were not present. However, a slight male bias in some populations was observed. Upcoming comparisons of populations using genetic tools will determine future directions of the study.

*Invited Oral Plenary Presentation**

ENVISION THE SUSQUEHANNA: A COLLECTIVE IMPACT MODEL

DUNN, Joel, jdunn@chesapeakeconservancy.org, Chesapeake Conservancy, 716 Giddings Avenue Suite 42 Annapolis, MD 21401.

Although the Susquehanna River and the Chesapeake Bay do not share a name, they do share an ancient past. The Bay is actually an extension of the lower Susquehanna, a river valley that has been flooded by the Atlantic Ocean for the last 15,000 years. Moreover, the Susquehanna is critical to the health of the Chesapeake. The Susquehanna River provides about half of the freshwater entering the Chesapeake Bay and its watershed provides crucial habitat for countless species of wildlife. The health of the Susquehanna itself, and the Bay downstream, relies on the actions we take within the Susquehanna's watershed today.

That is why the Chesapeake Conservancy is working to unite the efforts of groups working throughout the Susquehanna watershed through a Collective Impact Model we call Envision the Susquehanna. The Conservancy is working to coordinate and amplify individual organizational efforts by creating GIS-based prioritization tools created through our award-winning Conservation Innovation Center. We are also partnering with students, professors, and researchers at institutions like Bucknell University, Lycoming College, Susquehanna University, and other members of the Susquehanna River Heartland Coalition for Environmental Studies to generate real-world water quality and habitat data that can inform conservation work across the Susquehanna watershed.

Through the Envision the Susquehanna initiative, the Conservancy is working to create a framework for implementing collaborative, community-supported, evidenced-based solutions to the Susquehanna's environmental challenges and connecting people and their actions to both the river and the Bay downstream. By focusing on collective impact the conservation community can achieve results that are far greater than any one organization could achieve alone.

CATALOGUING OF STORMWATER OUTFALLS WITHIN AN URBANIZED AREA TO EVALUATE THE IMPACT ON TRIBUTARIES OF THE SUSQUEHANNA RIVER

DULOVICH, Hannah, dulhann@lycoming.edu; **ZIMMERMAN**, Melvin; Department of Biology, Lycoming College, 700 College Place, Williamsport, PA, 17701.

In June 2015, monitoring of stormwater outfalls, following PA-DEP protocols, within Lycoming County MS4 region (includes 8 municipalities/boroughs) was contracted between Lycoming County and the Lycoming College Clean Water Institute (CWI). A preliminary study in 2010 located 260 outfalls. This project was started by Lycoming County to locate (GPS database) and monitor stormwater entry points to the West Branch Susquehanna River as part Pennsylvania's commitment to the Chesapeake Bay clean-up. Partners cooperating in the project include eight Lycoming County municipalities, the Clean Water Institute, the Lycoming County Planning Commission, and the Department of Environmental Protection.

Clean Water Institute interns were tasked with cataloguing 260 stormwater outfalls within an urbanized area surrounding the city of Williamsport as designated by the 2010 census. Using the DEP protocol, each outfall was catalogued based on its GPS location, pipe diameter, pipe material, and pipe shape. Outfalls were then split into two categories based on whether or not flow was present.

Outfalls with flow present were further analyzed based on the presence of odors, floatables, turbidity and color. Samples were taken at flowing outfalls so that pH, alkalinity, conductivity and TDS could be preliminarily measured. All outfalls were assessed for exterior damage, deposits or stains, abnormal vegetation, poor pool quality and pipe benthic growth. Based on these parameters each outfall was rated on the potential of it being a site for illegal disposal of contaminants.

DIEL STREAM PHOSPHORUS AND PERIPHYTON POLYPHOSPHATE DYNAMICS

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Phosphorus (P), a key nutrient added to agricultural fertilizer to support plant growth, also supports the growth of algae in streams. Stream algae grow on aquatic substrata within communities of other microorganisms collectively referred to as periphyton mats. Recent evidence suggests that streams experience large 24-hour swings in P concentration (i.e. soluble reactive phosphorous, SRP) driven by shifting oxidation-reduction conditions, which can be stored by periphyton in the form of polyphosphates (polyP). The purpose of this study was to monitor (1) how stream SRP concentration varies over a 24-hour period, and (2) how stream periphyton respond to this variation with respect to polyP storage. We collected periphyton rock scrapings and water samples every four hours over a 24-hour period from Fishing Creek in Columbia County, PA. We also deployed an automatic sampler that took one water sample per hour. Our periphyton samples were analyzed for polyP, chlorophyll a, ash free dry mass, mat P, and extracellular enzymes. SRP concentration displayed no discernible cyclic diel pattern, though the concentrations did generally increase. Our hypothesis that SRP concentration would peak mid-day was partly supported, as on day 1 the highest concentration occurred at 2 PM. Further support on day 2 was lacking. Our hypothesis that periphyton polyP storage would peak in response to the lowest diel stream SRP concentration was not supported, as polyP peaked mid-day on day 2 when SRP was neither relatively high nor low. No cyclic diel pattern was observed in polyP storage, but a general pattern of increase occurred.

CONFRONTING A WICKED PROBLEM -SMARTER DAM ENERGY CHOICES FOR ECONOMIC, ENVIRONMENTAL AND PUBLIC HEALTH

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The Conowingo Dam nears a century of use as a hydropower facility. Yet, concerns mount regarding deficient fish passageways, looming species extirpation, sediment releases into Chesapeake Bay, insubstantial flood control capacity and potentially dangerous storm surge response. Conowingo produces enough power for approximately 155,000 homes and $5,000,000 in local tax revenue, but the station rarely operates at its peak capacity (572 MW). Monthly generation varied widely over the past 15 years, fluctuating two orders of magnitude (3,700 to 340,000 MWh). The dam also produces less energy in late summer months, dropping generation to ~100 MW, half the average rate. We review seven alternatives for offsetting the energy deficit that would be created by decommissioning Conowingo: anaerobic digestion, geothermal, waste-to-energy, nuclear upgrades, wind, solar and relocated hydropower options.

Additionally, although Conowingo is located fairly close to a high-voltage transmission line junction (≥ 345 kV) that crosses the Susquehanna at Three-Mile Island nuclear facility, the dam is about 80 km from Baltimore and more than 130 km from Philadelphia, the main energy markets in the region. Efficiency incentives and locally generated power could offset the loss of the dam's energy production with lower-than-peak replacement generation, providing reliable power with less transmission and distribution losses. An "all-of-the-above" strategy offers hope for implementation of multiple smaller (2 to 50 MW) projects in locations that are closer to consumer energy markets, especially if coupled with energy efficiency incentives programs. Committing to these options would create the opportunity for green jobs and more than compensate for lost tax revenue in the region.

While stakeholders' attempts at conservation are evident in Conowingo's fish ladders, hatchery programs and years of studying the effects of sediment on the Chesapeake Bay, a once burgeoning ecosystem now stands as withered evidence that successful rehabilitation is not compatible with the dam. Considering the hazards this dam presents to the health of the Susquehanna River watershed and public safety, when is the right time to re-evaluate the costs and benefits of maintaining the status quo?

EFFECTS OF JAPANESE KNOTWEED (FALLOPIA JAPONICA) DETRITUS ON BENTHIC MACROINVERTEBRATE COMMUNITIES OF THE SUSQUEHANNA RIVER MAIN STEM

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Japanese knotweed (*Fallopia japonica*) is an invasive species rapidly spreading throughout the understory of riparian forests in Central Pennsylvania. There are concerns that this species may impact aquatic ecosystems. Allocthonous material, originating from outside the system, is the basis for aquatic food webs and can impact benthic communities. This study assesses the affects of Japanese knotweed leaf litter on the benthic macroinvertebrate communities of the Susquehanna River. Three chemically and physically distinct sites within the Susquehanna were chosen to compare benthic macroinvertebrate communities within Japanese knotweed and American sycamore (*Platanus occidentalis*) leaf packs. In addition, we are quantifying the accumulation of Japanese knotweed and American sycamore biomass naturally occurring leaf packs in the Susquehanna River. We predict that macroinvertebrate communities within low-quality knotweed litter will have relatively low diversity compared to high-quality native sycamore litter. This study will begin to evaluate how the riparian invader, Japanese knotweed, influences the benthic communities of the Susquehanna River.

ANALYSES OF WATER, SOIL, AND SEDIMENT SAMPLES IN LITTLE TROUT RUN WATERSHED, CLEARFIELD COUNTY, PA TO EVALUATE THE IMPACT OF MARCELLUS SHALE GAS-WELL DRILLING ON THE ENVIRONMENT

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In response to rapid growth in Marcellus Shale gas-well drilling activities in central Pennsylvania starting in 2008, Lock Haven University Water and Environmental Lab forged a partnership in 2012 with several community-based organizations in Clearfield County to provide baseline water testing as a service to the community, and to monitor surface water quality in proximity to drilling locations. Based on several years of research we have Identified several small watersheds with high levels of signature parameters related to Marcellus Shale drilling activities, including barium, chloride, and bromine. As a follow-up we have carried out a more focused investigation of the water, soil, and sediment samples in several small watersheds throughout Clearfield County, Little Trout Run being one of the main areas of interest.

The main objective of the study was to determine the sources of barium observed in surface water samples. Soil, sediment, and water samples collected throughout Little Trout Run watershed were analyzed for elemental composition using X-Ray Fluorescence spectroscopy and Digital Spectrophotometer.
Several conclusions have been reached regarding the chemical make-up of the soils and sediments as they relate to water quality. Samples collected throughout the Little Trout Run watershed have typically exhibited barium levels exceeding the EPA's MCL for

residential soils. Through active collaboration with community-based organizations, participating students have the opportunity to garner research experience, while providing a valuable service to the community.

MODELING OF HYDROLOGICAL DRAINAGE AND SEDIMENT YIELD PATTERNS IN MARCELLUS SHALE DRILLING REGION IN CENTRAL PENNSYLVANIA USING SWAT AND TOPOGRAPHIC WETNESS INDEX

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With the ongoing Marcellus Shale gas-well drilling activities in central Pennsylvania, Lock Haven University's Water and Soil Resources Lab has partnered with the Susquehanna River Basin Commission (SRBC) to determine if earth disturbances due to Unconventional Natural Gas Development (UNGD) alter the hydrological drainage pattern of surface runoff and sediment yield to the receiving streams. There is an increased concern that sediment yield increases due to development of Marcellus Shale infrastructures and modifications of existing dirt and gravel roads. Two watersheds, namely the Marsh Creek and Baker Run, in Centre and Clinton Counties, PA were selected to assess impacts of Marcellus Shale infrastructures on surface run-off and sediment yield.

The Soil and Water Assessment Tool (SWAT) and Topographic Assessment using DEM (TauDEM) software were used to model topographic wetness index (TWI), flow accumulation and modification patterns, hydrologic response units (HRU), and sediment yield patterns. High resolution LiDAR data, land-use raster, and soil data were used to create TWI and HRU for the selected watersheds. The TWI was blended with the digitized earth disturbance features related to Marcellus activities to determine modification in drainage patterns.

Numerous conclusions have been reached regarding the earth disturbances due to UNGD. The preliminary observations of the TWI indicate modification of the hydrologic drainage patterns due to construction of Marcellus infrastructures. The density of unpaved roads is greater (2.19 km/km2) in sub-basins that contain Marcellus activities, as compared to the ones without Marcellus activities (0.81 km/km2 in Baker Run and 0.42 km/km2 in Marsh Creek). The SWAT model indicates that three out of six sub-basins in Baker Run watershed that contain Marcellus Shale infrastructures are located in areas of high surface discharge, indicating the potential to create high sediment yield to receiving streams. The TWI and SWAT models validate that Marcellus infrastructures pass through topographically wet areas and multiple land-use patterns, some of which are environmentally sensitive.

FOREST ROADS AND STREAMS AS POTENTIAL BARRIERS IN MOVEMENT OF RED-BACKED SALAMANDERS (PLETHODON CINEREUS)

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Terrestrial salamanders are generally thought of as incapable of long-distance movement. However, there are records of individuals traveling up to 90 meters to return to their territory. Studies show that roads can be obstacles in salamander movement. The objective of our study is to examine forest roads and streams as potential barriers in the return of red-backed salamanders (RBS) to their territories. Such obstacles can inhibit movement in species with poor dispersal capability and greater sensitivity to habitat alteration.

We hypothesize that the streams and roads will negatively affect the return rate of salamanders as compared to displacement of individuals into the forest. RBS, though abundant and widely distributed, are behaviorally and physiologically similar to other terrestrial species that may be susceptible to unfavorable effects from forest barriers. We began an experimental study at Camp Karoondinha in Millmont, PA in June 2015 to quantify recapture rates of RBS after displacement across roads and streams.

All RBS collected within six cover board arrays were assigned to either the control, return to the cover board it was found under, or a treatment, displacement 25 or 50 meters through either the forest or across a road or stream. After data collection is complete (predicted fall 2016), we will compare return rates of RBS across treatments to better understand the effects of roads and streams on terrestrial salamander movement. We will also compare juvenile and adult movement patterns, hypothesizing that juveniles will return to their site of origin less often than adults due to dispersal in this life stage.

TOPOGRAPHICAL WETNESS INDEX OF PLEASANT STREAM WATERSHED IN LYCOMING AND SULLIVAN COUNTIES, PA

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To study the impact of new dirt and gravel roads, and new land development related to the unconventional natural gas development on watershed drainage and instream turbidity in the Pleasant Stream watershed LAS LiDAR data was used to create a high resolution DEM image using the IDW spatial analyst tool. The TauDEM Tool and Raster Calculator were used on the DEM raster to create Topographic Wetness Index (TWI) of the study area. Since this TWI model only took elevation into consideration during this calculation, ArcSWAT was used to delineate the Pleasant Stream watershed taking into consideration soil type (USSURGO database), land use, and elevation. Even though there is relatively little to no new natural gas development in this watershed, it was greatly impacted by the logging industry in the early 1900s. The old system of logging roads and railroad grades still clearly showed up on the TWI and they have an impact on how runoff drains from the watershed. The output from ArcSWAT allows us to identify regions of the watershed that are prominent sources of turbidity and nutrient discharge during and immediately after precipitation event. To ground truth the TWI, soil samples were collected after a rainstorm and soil moisture content was analyzed. These sample locations were then plotted onto the TWI map and the measured moisture content values correlated really well with the TWI model. The TWI and ArcSWAT output maps will prove to be very useful in having baseline data to compare to watersheds where extensive natural gas development has already occurred and as well if the Pleasant Stream watershed is ever further developed.

FLOODPLAIN FRAGMENTATION DUE TO TRANSPORTATION INFRASTRUCTURE: APPLICATION OF GIS-BASED METHODOLOGY TO THE UPPER SUSQUEHANNA RIVER

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In a 2014 article by Blanton and Marcus, the impacts of transportation infrastructure on floodplain fragmentation were measured in three small cities along the Chehalis and Yakima Rivers in Washington using GIS technology. The purpose of this article was to test the viability of strategies for mapping the floodplain, as well as to produce a replicable methodology to measure fragmentation in other places. They found that around half of the functional floodplain was disconnected by transportation infrastructure in each reach. This methodology will be replicated along the Upper Susquehanna River from Oneonta to Sidney, New York with the goals of measuring floodplain fragmentation and exploring the applicability of Blanton and Marcus' methodology to this study area. A comparison of soil and geological data will be performed and issues concerning differences between the study areas will be addressed. With two recent historic floods in 2006 and 2011, this methodology has the potential to reveal areas of fragmentation that could be the focus of future flood mitigation projects.

GEOMORPHIC INVESTIGATION OF THE LOWER WEST BRANCH OF THE SUSQUEHANNA RIVER, NORTH-CENTRAL PENNSYLVANIA

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The channel morphology, island and floodplain features, and aquatic habitat along a 54-km stretch of the lower West Branch of the Susquehanna River were mapped to characterize the fluvial landforms and assess its geomorphic history. Channel features on the horizontal scale of three meters or greater were delineated using a high-resolution depth finder and side-scan sonar imager which provided over 300,000 depth/location readings.

The data were processed and combined with terrestrial LiDAR coverages to produce sonar image maps (SIMs) and digital bathymetry maps (DBMs) of the channel and adjacent floodplain features. These maps reveal two scales of river bedforms: (1) large, elongate pools, riffles, and side channels interpreted to have been formed by catastrophic Pleistocene flood erosion and sedimentation; and (2) superimposed, smaller-scale and finer-grained gravel bars formed by historic-floods. The older bedforms are typically coarser and more armored, weathered and rounded than the modern flood sediments. Underwater digital photographs and grain size measurements are being combined with side-scan sonar images to characterize textural variations in the river bed sediments.

Islands in the present-day channel are relic bars from braided Pleistocene outwash channels, deposited upstream of bedrock outcrops or where the valley suddenly expands. A 0.5-km long x 5-m deep bedrock knickpoint was discovered upstream of the Great Bend near Muncy, PA. The river valley suddenly widens downstream and depth to bedrock increases to over 40 m. The bedrock-alluvium interface over this 30 km^2 area is being mapped using numerous well logs and micro-gravity measurements collected along transects spanning the river valley. These features reflect underlying structural and lithologic factors, enhanced by Pleistocene glaciation and subsequent erosion/sedimentation by meltwaters and catastrophic dam-break floods from the 100-m-deep by 100-km-long glacial Lake Lesley located upstream. The data are being used to develop a HEC-RAS hydraulic model and assess the ability of historic flood discharges to transport existing channel bed sediments and hypothesize on the magnitude of the paleofloods that may have shaped the channel and floodplain features of the lower reaches of the West Branch of the Susquehanna River.

INVESTIGATING ANTHROPOGENIC SEDIMENT IN THE HEADWATERS OF THE SUSQUEHANNA

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This poster details the results of exploratory field investigations conducted during summer 2015 in four Pennsylvania State Parks in the Northern Tier, in an effort to identify and record anthropogenic sediment (mill pond deposits and overbank sedimentation) in headwater streams of the Susquehanna watershed. Human impact on stream form and function has been demonstrated to be significant in in both the Ridge and Valley and Piedmont regions of Pennsylvania. However, less is known regarding the impact of historic land-use changes on fluvial geomorphological processes in the Appalachian Plateau. Field investigations included walking the length of all stream sections located within Pisgah State Park (Glaciated Low Plateau Section), World's End State Park (Glaciated High Plateau Section), Hyner Run State Park (Deep Valleys Section), and Lyman Run State Park (Deep Valley Section and Glaciated High Plateau Section boundary), all located in the Appalachian Plateau physiographic province. Historical maps were consulted to identify recorded locations of water-powered mills, races, and mill-ponds. Samples of overbank sediment and suspected millpond sediment were returned to Mansfield University where particle size analysis and carbon content analysis were conducted to identify changes in the sedimentation record. Although still in the exploratory phase, the results of this research indicate that 1) mill pond sediment remains stored in low-order streams of the region, 2) buried A-horizons are not always present beneath anthropogenic sediment in the active stream channel, and 3) that the historical maps of Tioga County, and adjoining counties, seem to be relatively accurate in terms of recording the location/existence of nineteenth-century water powered mills. This research was supported by a Pennsylvania DCNR grant.

STORIES OF THE SUSQUEHANNA DOCUMENTARY: UTOPIAN DREAMS

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The Stories of the Susquehanna Documentary Series is a public history project within the Bucknell University Stories of the Susquehanna Valley Project in which students discover and unfold the stories of Susquehanna River Valley communities in a 26-minute documentary film. The first documentary in the series, "Utopian Dreams," will be broadcast by public television station WVIA. The students involved in this project work in all aspects of the production process, including researching local history, pre-planning, and making final edits on Final Cut Pro X.

"Utopian Dreams" focuses on the aspirations of two separate communities to create their ideal societies. Joseph Priestley founded a society in the Northumberland County region that emphasized scientific and technological progress. The other community was founded by French aristocrats who were fleeing the French Revolution. Their perfect society was based in egalitarian thoughts and the idea that human kind should re-engage with nature. This documentary is beneficial not only for the students who created it but also for the community; they have both worked together in order to showcase the narratives that surrounded the Susquehanna River.

A HIGH WATER SUMMER: PRELIMINARY REPORT ON BENTHIC MACROINVERTEBRATE COMMUNITIES IN THE UPPER MAIN STEM OF THE SUSQUEHANNA RIVER DURING THE SUMMER OF 2015

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The upper main stem of the Susquehanna River at Byers Island has been sampled during June and July since 2009, and this past summer was the wettest summer during that period. Furthermore, the monthly average discharge levels of the river during July exceeded those of any year during the 77 years of USGS records for the upper main stem. The upper main stem is formed from the confluence of the North and West branches, each of which forms a distinctive plume regarding its water chemistry and aquatic communities. We deployed passive samplers (rock baskets and Hester-Dendy multiplate samplers) at two West Branch sites and three North Branch sites in the Byers Island transect. Our study analyzed the communities at the family-level during the summer of 2015 in keeping with samples from previous years. Passive samplers were left in the river for seven weeks during the period of unusually high discharge and collected on July 27. Through a preliminary examination of the taxa recovered from these samplers, the mayfly families *Isonychiidae* and *Heptageniidae* appeared to be the most common taxa collected from all sites, along with the caddisfly family *Hydropsychidae*. Other families of *Ephemeroptera*, such as *Ephemerellidae* and *Caenidae* were present at each site, but much rarer in frequency. Of all the taxa collected, *Ephemeroptera* appeared to have the most diverse taxa. *Plecoptera, Odonata* and *Diptera* appeared to be uncommon across all sites. Comparisons with previous year's collections will be made to establish the presence of any discernible trends. Hester-Dendy multiplate samplers are continuing to be processed, and further identifications will be made to create a more panoramic view of the health of the Susquehanna River, as well as the diversity of its macroinvertebrate communities.

TRACKING BROWN TROUT (SALMO TRUTTA) IN THE LITTLE JUNIATA RIVER: THE UNDERGRADUATE EXPERIENCE

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The objective of our study is to identify factors that influence the movement of brown trout (*Salmo trutta*) in the Little Juniata River. Brown trout are a non-native species popular in Pennsylvania for recreational sport fishing. The Little Juniata River is a tributary of the Juniata River in the Susquehanna River watershed and is 51.7 km-long. The optimal water temperature range for brown trout is between 12°-19°C; temperatures of 27°C and higher are lethal. Stretches of the Little Juniata regularly exceed 27°C each summer. To track their movement, we surgically implanted Lotek MST930MT transmitters into fish starting in March 2015. We selected fish that were 13 inches or greater (about 340g) because the transmitter had to weigh less than 2% of the body weight of the fish.

The initial goal of the study was to investigate where brown trout moved during these lethal periods. The battery life of the transmitter is approximately 400 days, so we have expanded the study to determine other factors that could influence the movement of these fish including storm events, low flow, spawning season, low temperature. Depending on ease of access and flow conditions, we drove, kayaked, or walked a 32 km stretch of the river to locate the tagged fish. Our preliminary results show that under optimal water temperatures and high flow, fish movement was primarily driven by storm events. Storm events were also associated with high turbidity and higher fecal coliform counts. Dissolved Oxygen, pH, and conductivity did not change significantly.

In August, high temperatures and low flows were associated with movement of fish. We will continue data collection until the batteries of the transmitters fail. Our sample size is relatively small (24 fish) so we plan to increase our sample size next spring to improve the robustness of our results. Another finding that we would like to explore is the cause of detached transmitters. While we did not have mortality associated with surgery, we did find transmitters that had somehow been detached from the fish. We think it likely that these transmitters have been expelled by the fish through the body wall. We plan to test this theory by implanting mock transmitters on hatchery fish

SHARING A RIVER TO SAVE IT – AN EXPERIMENTAL COURSE IN "WICKED PROBLEM-SOLVING"

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What happens when a large dam is breached? Historically, eastern rivers were seasonally inundated with millions of fish, migrating upstream to spawn in an amazing display of fecundity. Dams provide power but block these fish migrations. Last year only 8 American shad made it past the dams on the lower Susquehanna to the spawning grounds upriver (the target was 1,000,000). As we seek "clean" sources of power, viable drinking water supplies, surface water for industry, recreational amenities, sustainable food supplies and healthy ecological systems, how might we obtain a better balance among competing and sometimes conflicting needs and desires?

This poster describes a "thought experiment course," taught simultaneously at two universities. We are trying to re-imagine humans' use of rivers that could involve "thinking the unthinkable," and ask whether it would be possible to remove the Conowingo Dam, the lowermost dam on the Susquehanna, for ecological restoration. However, we realize that foregone hydropower will need at least partial replacement. We have begun to discuss the concept of "shared rivers," whereby if dams are removed, alternative energy installations as well as habitat restorations can be designed in place of the dams. One advantage of putting in alternative energy at these sites is that the transmission infrastructure is already in place. However, serious issues have to be considered beyond power, among them the fact that Conowingo Reservoir is nearly at sediment capacity.

Together with students ranging from engineering, to biology, to landscape architecture, to regional planning, we are studying this problem by gathering data, getting expert input, and creating designs for possible scenarios involving slow dam removal, sediment dewatering and stabilization, and alternative energy. The ultimate goal of such a removal would be to restore connectivity of the Susquehanna River watershed with the Chesapeake Bay and ultimately the Atlantic Ocean.

INVESTIGATION OF CRAYFISH POPULATIONS IN THE MIDDLE CREEK WATERSHED AND THE POTENTIAL IMPACT OF INVASIVE ORCONECTES RUSTICUS ON NATIVE ECOSYSTEMS

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Orconectes rusticus is an invasive species whose presence has spread and grown in many areas of the United States and Canada, and has impacted waters in southeastern Pennsylvania. The rusty crayfish

(*Orconectes rusticus*) has had a significant negative impact on native crayfish populations and has had great success outside of the species' native Ohio River Basin habitat, thus native ecosystems and food webs have been effected. *Orconectes rusticus* has been documented in the Middle Creek watershed, though to what extent they have invaded the watershed and whether or not they have completely decimated native populations remains generally unexamined.

This study comprehensively assessed the current crayfish population composition, distribution, and density across the Middle Creek watershed. A sum of 20 tributary and main branch sites were chosen to analyze the entire spread within the watershed. A 1.0 x 1.0 m2 quadrat sampler, consisting of a metal frame, mesh netting, and a mesh bag, was utilized to collect crayfish from each site. The placing of the frame was chosen based upon representative habitat, and the crayfish were collected by first hand-netting within the frame and then raking the substrate to a depth of 20 cm. *Orconectes rusticus* were found throughout the watershed, and populations of the native *Cambarus bartonii bartonii* were found in some areas, as well. Population health of *Orconectes rusticus* and *Cambarus bartonii bartonii* was assessed quantitatively through population densities, length, weights, and sex ratios. To determine the potential impact of *Orconectes rusticus* on native aquatic food webs through foraging and predation, diet assessments will be conducted through dissection and identification of stomach contents.

A BIOLOGICAL ANALYSIS OF A SEQUENCE BATCH REACTOR, INVESTIGATING THE USE OF FIXED-FILM MEDIA TO INCREASE TREATMENT EFFICIENCY

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The CromaFlow® Corporation, an international company based in Montoursville, PA, manufactures Sequence Batch Reactor (SBR) systems for domestic wastewater treatment. A CromaFlow® SBR unit was installed at Kelly Township's Sewage Treatment Plant in Lewisburg, PA in June of 2015. The SBR was subjected to a study conducted by the Lycoming College Clean Water Institute, in conjunction with CromaFlow®. This study is being conducted in order to examine the effects of the insertion of fixed-film media into the mixed liquor chamber of the SBR. Fixed-film media provides a large surface area to promote growth of bacteria and protozoans that aid in the treatment process.

Our hypothesis is the media will lead to increased treatment efficiency through the cultivation of these biological treatment organisms. This study is in the preliminary phase and will proceed over the next year. The preliminary phase consists of monitoring the treatment process before adding the fixed-film media. This phase will run for three months. Phase two will include the addition of the fixed-film media. It is hypothesized that de-nitrification will occur and will remove a significant amount of the nitrogen.

EFFECTS OF PRECIPITATION EVENTS ON THE MOVEMENT OF THE LATERAL MIXING ZONE OF THE NORTH AND WEST BRANCHES OF THE SUSQUEHANNA RIVER AT THE SHADY NOOK SITE

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The North and West branches of the Susquehanna River converge at Sunbury, PA to create a Lateral Mixing Zone (LMZ) that extends all the way downstream to Selinsgrove, after which islands help to facilitate mixing. In this study, the movement of the LMZ was observed in accordance with multiple precipitation events over a four month span from June to September of 2015 in addition to other data acquired from prior years. The goal of this study is to identify if the water from the two branches is present at all times between site 1 and 2 to eventually place two permanent monitoring stations in the same area. YSI 556 Multimeter and a boat were used to continuously take data samples across the river between sites 1, 2, 3, and 4. Site 1 is located on the West Branch of the Susquehanna River while Sites 2 and 3 are located on opposite sides of Byer Island, while Site 4 is on the East bank (Figure 1). A GPS was used to track movement and help identify the location of the LMZ along with the data associated with each data point along all transect. Data was collected before and after various periods of precipitation and discharge rates. Four Hydrolab sondes were also deployed twice at each site in June and again in September, to support the identification of the water of the two branches. Among all the measured parameters including water chemistry, physical properties, from both the YSI multimeter and the sondes have demonstrated that specific conductivity produced the clearest trends of LMZ between the two branches. During the study period, the values of specific conductivity has increases, but the trend identifying the type of water sources was still noticeable. The analyses of all data determined that as the discharge increases, the LMZ moves away from the West branch and towards the North branch up until a threshold point and then slightly shifts back to the West branch.

INVESTIGATION OF THE ECOLOGICAL IMPACT OF JAPANESE KNOTWEED (POLYGONUM CUSPIDATIUM) ON THE RIPARIAN PLANT COMMUNITY AND ITS POTENTIAL USE AS A FOOD SOURCE FOR MACRO-INVERTEBRATES

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This study focused on two sites along the lower West Branch of the Susquehanna: the Riverfront Park in Loyalsock Township and the park surrounding Montoursville Airport in Montoursville Borough. Data were collected throughout the summer and fall of 2015. At each site, plant density data was collected using a transect method and tree density data was collected using the Point-Quarter method. Tests on the soil at each location included percent organic content, particle size, nematode count, and arthropod identification. The above-ground biomass of Japanese knotweed and the percent organic content of those samples were found at the Riverfront Park site. The allelopathic mechanism of Japanese

knotweed will be tested in a lab experiment, conducted in the late fall. To determine whether Japanese knotweed is a good food source for aquatic macro-invertebrates, a project was conducted to collect data on both leaf decomposition rates and macro-invertebrate populations. Leaf packs, comprised of pin oak, silver maple, or Japanese knotweed leaves and a brick placed in a mesh bag, were incubated for varying periods of time in Mill Creek, located in Loyalsock Township. Leaf surface area was measured and recorded before and after incubation to quantify the decomposition rates of the different species. Macro-invertebrates were collected off the leaf packs and identified to analyze the different populations colonizing each species. Ergosterol can be used to quantify the amount of fungal biomass on a leaf which indicates the palatability of the leaf for macro-invertebrates so an analysis of ergosterol content was also conducted using High Pressure Liquid Chromatography (HPLC).

SALAMANDER AND CRAYFISH COMMUNITIES ASSOCIATED WITH HEADWATER STREAMS OF THE LOYALSOCK CREEK WATERSHED

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In a cooperative research project with the Freshwater Research Initiative (FRI) at Susquehanna University, we surveyed for larval salamanders and crayfish in headwater streams of the Loyalsock Creek Watershed. Surveys were conducted from June through August 2015, at 13 sampling sites also under study by other FRI participants. Our aquatic sampling method was electrofishing and streambed raking (with a potato rake) to discharge aquatic salamanders and crayfish into a 10' x 3' x3/8"mesh seine placed immediately downstream of a defined and measured sample area. Our terrestrial sampling method was the random placement of a 1-meter-square grid on coarse terrestrial substrates within two meters of the shoreline. Each grid was quantitatively assessed for cover type, followed by the removal of all cover objects to locate resident salamanders.

All salamanders captured were identified (where possible) and measured for snout-to-vent length (SVL) and total body length (TBL). All crayfish captured were identified and a sub-sample was measured for total body length and mass. Water samples were assessed for pH, specific conductance, TDS, turbidity, alkalinity, and temperature. Salamander community diversity was found to consist primarily of two species, the Alleghany mountain dusky salamander (*Desmognathus ochrophaeus*) and the northern spring salamander (*Gyrinophilus porphyriticus*). Dusky salamanders were found primarily during terrestrial searches, while spring salamanders were found primarily during aquatic sampling. Only one crayfish species was found, the Appalachian brook crayfish (*Cambarus bartonii*.). Analyses of relationships between salamander density and diversity, crayfish density, brook trout density, and water chemistry are presented.

5 YEARS (2011-2015) OF SAMPLING WILD TROUT STREAMS WITH THE PFBC UNASSESSED WATERS INITIATIVE

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Since 2011 Susquehanna University has been a partner of the Pennsylvania Fish and Boat Commission's Unassessed Waters Initiative. This cooperative program between the PFBC and colleges and universities seeks to collect biological data on previously unsampled (unassessed) streams across Pennsylvania to determine their status as possible new Wild Trout streams. Prior to this program which began in 2010, only 8% of the 62,725 streams across Pennsylvania had been sampled for biological data by the PFBC. Since 2011, Susquehanna University faculty, staff and students have surveyed 617 previously unassessed waters as part of the program. Sample sites have been predominately across north central Pennsylvania including the following major watersheds: Loyalsock Creek, Schrader Creek, Lycoming Creek, Buffalo Creek, Penns Creek, White Deer Creek, First Fork Sinnemahoning Creek. We found wild trout (brook and brown trout) in 52% of the streams (320 of the 617). A portion (17%) of sampled sites were found to be seasonally dry during the sampling. Brook trout were found in 293 (47%) of the streams. While brown trout were found in 128 (21%) of the streams. The Unassessed Waters Initiative has led to the designation of over 500 new wild trout streams, with many more to be added in the future.

CONTRIBUTION OF LYCOMING COLLEGE CWI TO THE PFBC UNASSESSED WATERS PROJECT (2010-2015)

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This is the 6th year that Lycoming College CWI has participated with PA fish and Boat Commission in the Unassessed Waters Project. To date, the CWI team has completed a total of 399 streams in the Loyalsock, Lycoming, and Pine Creek Watersheds (about 16% of the total amount of streams sampled all together). In the past 3 years, streams in the Genesee, Alleghany, White Deer Hole Creek, Black Hole Creek, Quenshukeny, Pine Run, and Antes Creek watersheds, as well as unnamed tributaries in Tioga County have been completed. Data for this project has been logged into the PFBC Unassessed Waters Data set for consideration of trout stream protection. The number of class A, B, C, D, and E streams from each watershed will be presented. On average, 50% of the streams sampled support wild trout and nearly 20% are considered class A or B trout streams. A breakdown of the benefit and limitations of this program will be presented. In addition, a comparison of the Alleghany Plateau Region and the Ridge-Valley Plateau Region will be done, in terms of supporting trout populations. In 2015, Lycoming College sampled 38 streams in total, 17 were dry and 12 had wild trout. The Oswayo, White Deer Hole Creek, and Mill Creek Watersheds were sampled. Oswayo had 27 total streams surveyed, 15 dry and 8 had wild trout. White Deer Hole Creek had a total of 6 surveyed, 2 dry with no wild trout. Finally, Mill Creek had 5 surveyed streams with 0 dry and 4 with wild trout.

REVIEW OF THE FIRST TEN YEARS OF THE SUSQUEHANNA RIVER HEARTLAND COALITION FOR ENVIRONMENTAL STUDIES (SRCHES)

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The summer of 2015 marks the 10th year that the Susquehanna River Heartland Coalition for Environmental Studies (SRCHES) has supported student research interns. SRCHES unites partners from state and local agencies and researchers from Lycoming College, Bucknell University, Lock Haven University, King's College, Susquehanna University, and Bloomsburg University to encourage collaborative ecological study and education surrounding the Susquehanna River Watershed. The coalition has helped to support research and conservation projects throughout the region, including individual research projects, river monitoring, and PA Fish and Boat's Unassessed Waters Initiative and Stream Restoration projects. All of these efforts promote the sustainability of the Susquehanna River Watershed and the Chesapeake Bay.

A STUDY OF DIATOM PERIPHYTON COMMUNITIES ON THE MOSS GENUS FONTINALIS IN THREE HEADWATER STREAMS IN CENTRAL PENNSYLVANIA

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During June and July 2015 we sampled three headwater streams (Henstep, Little Weikert and Coral Run) that flow down the north slope of Penns Creek Mountain (Bald Eagle State Forest, western Union/Snyder counties), each in a separate cut along the ridgetop. The streams drain a perched water table underlain by impervious sandstone and are approximately two meters wide and wadeable.

Throughout the reaches studied the streams are shaded by a mixed forest of hemlock and birch with a substrate of small boulders, cobble, and sand. Because of the uniform geology and land use, the chemical and physical properties of the streams are very similar. Conductivity (19.4-31.9 μs/cm) and buffering capacity are very low (63-313 μeq/L), and pH rarely exceeds 6. The prominent producers in each stream are mosses, the most abundant of which are species of *Fontinalis*. Mosses submerged in the streams, partially submerged, or on the stream bank were collected at each sample site. Biofilms were removed chemically without scraping. Diatoms were cleaned by a standard method using HCl and H2O2, identified to species, and counted using a JEOL 6010 SEM. We investigated the diatom communities associated with *Fontinalis* in each of the streams to determine the similarity of those communities on the same substrate in different streams.

Our preliminary results suggest that there is not a moss periphyton diatom community. The metrics differed from stream to stream. The communities had 26-39 species in a count of 300 valves. The Pollution Tolerance Index values ranged from 2.261 to 2.745, Shannon Diversity was 2.218 to 3.116 and Evenness ranged from 0.68 to 0.85. The most surprising results had to do with the dominant taxa in the moss periphyton community of each stream. *Eolimna minima* was the dominant taxon on Henstep mosses while *Fragilariaforma virescens* dominated in moss periphyton of Little Weikert. Both of these streams had similar features including levels of discharge. Coral Run, a smaller stream had *Eunotia minor* as the dominant species in moss periphyton. Thus, the moss diatom communities are made up of different dominant taxa that appear to be undetermined and stochastic in occurrence.

THE CORRELATION BETWEEN MERCURY, IONS, AND WEATHER CONDITIONS AT PA-47

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Research conducted in the 1970s found that the emissions of SO2 and NOx proved to be a widespread problem through the formation of acid rain. In 2002, PA-47 was established to close an NTN/MDN measurement gap in south-central Pennsylvania, and sample collection conducted by Millersville University (MU) meteorology students has continued uninterrupted ever since. PA-47 is located approximately three kilometers from the MU Weather Information Center where a full suite of meteorological variables are recorded and archived. This research uses ion/Hg analyses and meteorological data from 2004 through 2013 to understand the correlation between the variability observed in the NADP record and the weather conditions that could have contributed to the variability. This period corresponds to the availability of trajectory analyses using the HYSPILT – Hybrid Single Particle Lagrangian Integrated Trajectory Mode, which will be employed in this study.

Anomalies were found as deviations from the mean concentrations of mercury, sulfate, potassium, calcium, magnesium, sodium, ammonium, and chlorine. This resulted in the isolation of those weeks that exhibited anomalies that were one and two standard deviations outside the mean. The meteorological conditions were found for the anomalies and categorized according to wind direction and time of year, and HYSPLIT was used to obtain back trajectories to determine source regions for this air. Results suggest that weather conditions are well correlated with variability in the weekly ion and mercury data. Our preliminary data show that highest concentrations are found when the wind direction is from the southwest in the summer seasons and in moderate precipitation events that occur after an extended period of dry conditions.

CONSTRUCTION AND INSTALLATION OF "BENDER HUTS" TO FACILITATE EGG COLLECTION FOR AN EASTERN HELLBENDER HEAD-STARTING PROGRAM

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Population declines have been taking place throughout the entire geographic range of the eastern hellbender (Cryptobranchus alleganiensis) in North America. The declines and local extinctions have led to multiple head-starting programs to augment or restore hellbender populations. In order to establish a head-starting program for the Susquehanna River basin, we constructed 24 concrete "bender huts" to facilitate the collection of fertilized eggs. The boxes were installed from June through July 2015, across five stream reaches occupied by hellbenders within the West Branch watershed. We constructed the huts by hand-packing fiberglass-reinforced concrete around a wooden form that was later knocked-out once the concrete had set, leaving a shallow internal chamber similar to natural chambers found beneath large cover rocks. Each bender hut weighed ~27 kg and contained a 3" black ABS plastic coupling into which a 3" diameter black ABS pipe was fitted to serve as an entrance. A 4" ABS plastic coupling with screw cap was installed into the top of each hut to allow us to open and examine the hut for occupancy by hellbenders and/or the presence of hellbender eggs or larvae. The huts were installed over a clean bed of gravel and covered with large boulders for concealment and to mimic the natural cover rock conditions found in high-quality hellbender habitat. Bender hut specifications, construction materials and methods, and installation procedures are presented.

ESTIMATING WATER TEMPERATURES IN HEAD-WATER STREAMS WITHIN BROOK TROUT HABITAT

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Brook trout are a native and keystone species in Pennsylvania and often used as an indicator of environmental quality due to their sensitivity to water temperature. In order to analyze the potential habitat quality for brook trout, water temperature data is required. Land use and terrain variables have been used to predict brook trout presence, but it is clear that the anthropogenic impact of climate change, as well as mining, drilling, and development will affect our ability to predict fish populations.

We are using trout population data collected in a total of 615 first- and second-order tributaries within north-central and central Pennsylvania. The USGS collects stream water temperature data on larger order streams, but not on the first- and second-order streams we are looking at. Beginning with the two assumptions that A) first order streams are fed primarily by springs and B) annual average air temperature influences spring water temperature, we have designed a model to predict water temperatures within first order streams based on the site elevation as well as its local, long term weather measurements. A random group of 60% of sites with water temperature measurements were used to calibrate the regression equations between elevation, site location, and water temperature. The remaining 40% of sites were used as a comparison group to determine the predictive ability of the model.

We aim to determine the relationship between estimated water temperature and brook trout populations. Streams containing brook trout are given a higher level of environmental protection than streams without the species in Pennsylvania and of the 62,725 streams in PA, only 8,224 of them have been sampled by the Pennsylvania Fish and Boat Commission. Over 53,000 streams remain to be sampled. Our goal is to accurately predict water temperature which will be helpful to the PFBC and allow for targeted selection of sampling sites for biological monitoring.

PRECISION CONSERVATION MAPPING OF BUFFALO CREEK, UNION COUNTY, PA

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Precision Conservation is the application of high resolution geographical data within a Geographic Information System (GIS) to identify key sites to conserve or restore. It can be used to identify locations within a watershed that are likely to contribute unusually large sediment or other pollutant loads into local streams and eventually into the Chesapeake Bay. J. Allenby and C. Phelan from the Chesapeake Conservancy have pioneered a technique to do this.

In this project, researchers at Bucknell University worked closely with the Chesapeake Conservancy to apply the technique to Buffalo Creek, a 124 square-mile tributary to the West Branch of the Susquehanna River. Its watershed is mostly forested and agricultural. High resolution (approximately 1 m) remotely-sensed elevation and Land Use / Land Cover (LULC) datasets are used. Using GIS, each cell in the watershed was analyzed to determine the contributing runoff area for the cell. LULC is incorporated by assigning different weights to different land use classes, based on the likelihood that the land use will contribute high pollutant loads. Thus forests have a low weight (2), and crops (7) and parking lots (10) have high weights. A "weighted" contributing area for each cell is found by adding up the weights (rather than just the number) of cells contributing flow to a given cell. The original (un-weighted) and weighted contributing areas are combined into a single metric, the Normalized Difference Flow Index (NDFI).

NDFI ranges from -1 to 1. Smaller values correspond to cells with low potential for contributing pollutants and larger values to high potential. NDFI can be visualized on maps by displaying it only for cells having an un-weighted contributing area exceeding a certain value. These cells indicate concentrated flow paths. The value of NDFI along flow paths is indicated (see map) by the color of the flow path, from green (smallest NDFI) to red (largest NDFI). Red flow paths likely carry high pollutant loads. Sites with red flow paths and contributing areas on the order of 10 ^ 5 m are targeted for field investigation. At these scales water quality can likely be improved through practices like buffer/filter strips and grass swales.

HYDROSENSE: A LOW-COST, OPEN-SOURCE, HYDROCLIMATIC MONITORING SYSTEM

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In the world of water resource management, professional monitoring systems are often large, expensive, and disconnected. Major obstacles are the reliance on legacy industrial data loggers and the lack of an affordable data collection network. This project aims to overcome these obstacles that inhibit the proliferation of watershed monitoring systems.

The HydroSense system is comprised of four open-source pieces of hardware: 1) HydroSense Wireless Link, 2) HydroSense Datalogger, 3) HyrdoSense OpenSonde, and 4) HydroSense Weather Module. The hardware couples with open-source software libraries for Arduino microcontroller and Raspberry Pi computer to simplify use of the hardware. This allows users to easily customize or extend the sensing application to meet their unique needs, using modern open-source tools. The goal is to enable the creation of a grassroots wide-area wireless network for collecting and reporting low sample rate hydroclimatic data.

Each long range 915 MHz HydroSense Wireless Link is managed by a gateway node running on a Raspberry Pi located near a high-speed internet access point (DSL, cable modem, or cellular). Sensor nodes can be placed anywhere within the coverage cell. The Wireless Link is on an Arduino shield and is designed specifically to connect to the HydroSense Datalogger.

HydroSense Datalogger is an Arduino Leonardo with an SD card, solar battery charger, SDI-12 network interface, and general

purpose IO ports for connecting various instruments. It is fully compatible with the Arduino Integrated Development Environment (IDE) and complies with the Arduino standard shield interface.

HydroSense OpenSonde is a low-cost water quality monitoring sonde. The OpenSonde integrates an Arduino Leonardo and specialized hardware for sensing: pH, DO, EC, ORP, pressure, and temperature. The sensor probes are installed in a novel low cost housing with a waterproof compartment for the OpenSonde.

HydroSense Weather Module touts compatibility with most Davis Standard sensors or custom sensors using exposed header pins. Supported sensing parameters are: humidity, rainfall, wind, pressure, solar radiation, and temperature. These parameters are communicated over industry standard SDI-12 to the HydroSense Datalogger.

COMPARISON OF SIMULIUM JENNINGSI (DIPTERA: SIMULIIDAE) LARVAL GUT CONTENTS ACROSS INSTARS

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Black fly larvae (*Diptera: Simuliidae*) are a widely distributed and oftentimes dominant consumer in lotic ecosystems. However, detailed information on the composition of their diet across instars is lacking. Knowledge of their diet is important in order to understand their ecological significance as well as advance sustainable management efforts. For instance, differential instar susceptibility to *Bacillus thuringiensis* var. *israelensis (Bti*), the primary larvicide used to suppress pestiferous adult populations, has been identified. Further, current science suggests that larval diet, particularly diatoms, may contribute to impaired *Bti* effectiveness. Therefore, we examined gut diatom density, species composition, diversity, morphology, and ecological guilds across larval instars of *Simulium jenningsi*, the target species of management programs. Larval collections were made in conjunction with the Pennsylvania Department of Environmental Protection Black Fly Suppression Program from lotic systems primarily within the Susquehanna River basin (n= 14).

We measured collected larvae and assigned them to size (instar) categories. Intact larvae were then subjected to a chemical digestion procedure yielding "cleaned" diatoms. A minimum of 300 diatom valves were identified to species and enumerated. Diatom community metrics were compared among instars and between geographic regions using ANOVA. A total of 134 diatom sp. were recovered from *Simulium* gut analyses. Preliminary results for community metrics will be discussed. Our work here provides a practical technique for detailed examination of *Simulium* larval gut contents across instars, ecological and spatial information on diatom consumption, and insight into a potentially important variable affecting *Bti* efficacy and population management of black flies in the commonwealth.

THE POWER OF PARTNERSHIPS: USING COLLABORATIONS WITH GRASS ROOTS ORGANIZATIONS AS AN ACADEMIC TOOL

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In this case study, Juniata College partnered with the Little Juniata River Association (LJRA) to develop a host of educational opportunities for undergraduates. The partnership was initiated because of an interest in understanding the impact of increased water temperatures on the movement of brown trout (*Salmo trutta*) in the Little Juniata River. As part of their capstone experience, seniors from the Environmental Science and Studies department met with members of LJRA to design the monitoring protocol using surgically implanted radio transmitters. Students learned how to submit an Institutional Animal Care and Use application, which required them to be certified in the surgical procedure. The training involved practicing first on dead fish and then on live hatchery fish. Members of LJRA caught all of the fish used in the study. We hired undergraduate interns for the summer; they kayaked, walked and drove along the river to track fish movement. They also collected water chemistry data. LJRA members also help with tracking fish.

We then collaborated with the Biology department to identify microbial communities along the river. Students were trained in the DNA extraction process. The PCR work was completed by students from the Biology department. The results of the sequencing will allow us to identify the source of different

biological contaminants in the stream. To complement the fish study, another team of students have been trained in the Rapid Bioassessment Protocols for Use in Streams and Wadeable Waters. They are assessed a 32 km stretch of this river. Based on our experience so far, we have initiated two more collaborations – working with the Biology department to use genetic material to identify the sex and genetic history of tagged fish; and working with the State hatcheries to design and run an experiment to understand the process and proportion of fish that expel transmitters.

Over the last nine months, over 35 undergraduates have worked on various aspects of the project, meeting with grassroots organizations and presenting their findings. This partnership has allowed us to cost effectively reach multiple educational outcomes for dozens of students, training students on stream assessment protocols and ecology, and helping them understanding the role of NGOs in habitat conservation.

ASTHMA EXACERBATIONS AND UNCONVENTIONAL NATURAL GAS DEVELOPMENT IN THE MARCELLUS SHALE

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Asthma is a common, chronic disease that can be exacerbated by air pollution and stress. Unconventional natural gas development (UNGD) has documented impacts on air quality and social disruption, and has expanded rapidly. In Pennsylvania, UNGD began in the mid-2000s and by 2012, 6,253 wells were drilled. There are no prior studies of UNGD and objective respiratory outcomes. In this nested case-control study, we evaluated associations between UNGD and asthma exacerbations. We used data from the Geisinger Health System (GHS), which provides primary care services to over 400,000 patients in central and northeastern Pennsylvania. Asthma patients ages 5-90 years (n = 35,508) were identified in GHS electronic health records, and patients with exacerbations were frequency-matched on age, sex, and year of event to patients without exacerbations using incidence density matching.

On the day before each patient's index date, we estimated a UNGD activity metric for four UNGD phases (pad preparation, drilling, stimulation ["fracking"], and production) using distance from the patient's home to the well, well characteristics, and the dates and durations of the phases. We identified 20,749 mild, 1,870 moderate, and 4,782 severe asthma exacerbations (new oral corticosteroid medication order, emergency department encounter, and hospitalization, respectively). In three-level adjusted models, there was an association between the highest group of the activity metric for each UNGD phase for 11 out of 12 exposure-outcome pairs (odds ratios [95% CI] ranged from 1.5 [1.2-1.7] for the association of the pad metric with severe exacerbations to 4.4 [3.8-5.2] for the association of the production metric with mild exacerbations). Several of the evaluated exposure-effect relations evidence linear trends. Our findings were robust to increasing levels of covariate control and in sensitivity analyses that included evaluation of unmeasured confounding.

ASSESSMENT OF ROAD CULVERTS AS PASSAGE BARRIERS TO BROOK TROUT (SALVELINUS FONTINALIS) AND BROWN TROUT (SALMO TRUTTA) IN PENNSYLVANIA HEADWATERS

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Road culverts can pose as barriers to migratory fish and other aquatic organisms, which can lead to small isolated populations. To categorize the degree to which culverts prevent fish movement, watershed managers use physical measurements to classify culverts as "green" if they are passable, "red" if they are impassable, or "gray" if passability cannot be determined. The Little Bear Creek watershed, a small subwatershed within Loyalsock Creek, contains several road culverts that fell within the "gray" category. It is unknown to us whether or not the culverts falling within this category are indeed barriers to migratory fish, especially trout. To measure how passable these culverts are, we tagged 486 brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta*) with passive integrated transponder (PIT) tags throughout the Little Bear watershed, particularly upstream and downstream of the three "gray" culverts. Antenna arrays were constructed on the upstream side and downstream side of each culvert, as well as a control site lacking anthropogenic barriers to trout movement. In addition to tracking whether or not the culverts are passable, the arrays will reveal the exact time of movements through culverts. This will allow us to test for correlations with stream flow, water temperature, and other stream conditions that may influence trout movements. By "ground-truthing" culvert assessment methods, we anticipate our study will ultimately help watershed managers better prioritize culverts for removal or replacement.

A STUDY OF DIATOM COMMUNITIES IN FIVE HEADWATER STREAMS IN CENTRAL PENNSYLVANIA

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During June and July 2015 we have sampled five headwater streams that flow down the north slope of Penns Creek Mountain (Bald Eagle State Forest, western Union/Snyder counties), each in a separate cut along the ridgetop. The streams drain a perched water table underlain by impervious sandstone and are approximately two meters wide and wadeable. Throughout the reaches studied the streams are shaded by a mixed forest of hemlock and birch with a substrate of small boulders, cobble and sand. Because of the uniform geology, hydrology, and land use, the chemical and physical properties of the streams are very similar. Conductivity (19.4-31.9 μs/cm) and buffering capacity are very low (63-313 μeq/L), and pH rarely exceeds 6. Stones with intact biofilms are were collected at each sample site, and biofilms were removed chemically, utilizing a standard method of HCL and H_2O_2. Diatoms were identified to species and counted using a JEOL 6010 SEM. Because of the size of the streams, we anticipated the communities to be relatively depauperate and primarily inhabited by one or two dominant taxa. Furthermore, we expected the streams that were similar in physical/chemical parameters to have similar diatom communities on similar substrates. Contrary to expectations, the diatom communities were quite speciose (35-52 taxa in a count of 600 valves). Although the communities were similar in measures of diversity [e.g. Shannon Diversity (2.6-3.2) and SDI evenness (0.75-0.85)], the Bray-Curtis similarity index described quite dissimilar communities; with a 42.5% average similarity (15.0-66.8). In general, the dominant morphological classifications were eunotids and monoraphids, most of which are pollution intolerant. Although co-occurrence of taxa among the streams is high, universal dominant taxa (>10%) were not present. Our results indicate that there is no particular headwater stream epilithic diatom community and that the occurrences of particular taxa are driven by stochastic processes.

LYCOSID DENSITY AND SPECIES COMPOSITION ALONG A RIPARIAN COBBLE GRADIENT ON THE SUSQUEHANNA RIVER

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Wolf spiders are ecologically important predators, reaching high densities in most temperate ecosystems and occupying the nexus of detrital, terrestrial, and aquatic food chains. Because these spiders can engage in multiple forms of cannibalism and intraguild predation, they have a strong potential to biomagnify mercury and other heavy metals disproportionate to their size. We measured stratification of wolf spiders by mass and species along a cobble gradient at a single site along the Susquehanna River (Isle of Que in Selinsgrove, PA). One m2 quadrats were exhaustively sampled for wolf spiders between zero and nineteen meters from the river over a ten week period (N = 23). Total number of spiders and species were identified at each distance. Preliminary analysis showed total wolf spider densities peak at 5 meters from the river edge (20 wolf spiders/m2) with more modest densities of 10 spiders/m2 closer or further from the river. We found a negative relationship between relative abundance of small and large lycosids, suggesting predator avoidance. Stable isotopes will be used to estimate trophic position and the intensity of cannibalism and intraguild predation among these spiders. We will also quantify total and methyl mercury for four of the most abundant species and compare mercury levels to that of terrestrial arthropod herbivores (tetrigid grasshoppers) and aquatic invertebrates (caddisflies and mayflies). Our data should contribute to our understanding of methyl mercury transport along the aquatic-terrestrial interface of the Susquehanna River.

LOCAL AND REGIONAL EVALUATION OF SMALLMOUTH BASS POPULATION GENETIC STRUCTURE IN THE SUSQUEHANNA RIVER BASIN.

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Smallmouth bass (*Micropterus dolomieu*) in the Susquehanna River basin have been displaying characteristics of disease and endocrine disruption (ED) for several years, including gross lesions and the presence of intersex. Since the initial observations of disease and

ED, a wide range of potential environmental stressors have been identified including pathogens, water quality, and contaminants. Because of the life history characteristics of smallmouth bass in this system, which often spawn in smaller tributaries to the Susquehanna River and overwinter in the main-stem, it is challenging to link processes and ecological conditions in the river and the surrounding landscape that may be contributing to the observed disease and ED. To do so requires gaining an understanding of how smallmouth bass move throughout the river system and to define how they may function collectively as a population(s). Although a radio-telemetry study on two tributaries and a section of the Susquehanna River demonstrated movements relating to spawning and overwintering, resulting in intermixing of tributary and river-tagged fish, the population-level implications of these movements are unclear.

One approach to address this question is through the use of highly variable genetic markers to quantify genetic variation within smallmouth bass from numerous sites within the Susquehanna River basin. This study aims to use population genetic tools to evaluate the structure and connectivity of smallmouth bass populations at both a local and regional scale across the Susquehanna River basin. Genetic samples were collected from 24 sites, including main-stem river sites that were paired with tributary locations to assess local gene flow between main-stem and tributary systems. A total of 1,034 fin clips were collected for genetic analysis during prespawn conditions and are being analyzed with microsatellite markers to investigate differences within and among populations. Laboratory analysis is currently underway, and results aim to provide information on the connectivity and genetic structure of populations as they may correlate to observed disease and other health characteristics and therefore aid in management.

ONLINE INTERACTIVE NAVIGATIONAL MAP OF THE WEST BRANCH SUSQUEHANNA RIVER FROM RENOVO TO LOVE RUN USING INVERSE DISTANCE WEIGHTED INTERPOLATION METHOD

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The West Branch Susquehanna River is a valuable resource to the towns it flows through. With funding from Susquehanna Greenway Partnership, Clinton County Commissioner's Office, and Anadarko Petroleum Corporation, Lock Haven University's Water and Soil Resources Lab created an interactive online navigational map that spans from Renovo to Love Creek, PA. The project began in September 2014 as a senior research initiative and has expanded to a community effort following the designation of Lock Haven as a River Town by the Susquehanna Greenway Partnership in 2015 to create a navigational map of the river for boaters and outdoor enthusiasts.

The map covered 48 river-miles illustrating water depths, public access points, parks, and landmarks along the river. The water depths, geographic coordinates, and images of land and river features were collected and analyzed using IDW method in ArcGIS software to prepare a navigational map, which was then uploaded onto an online server to make the map available to the public as an interactive online navigational map.

Water depths for over 2,000 points were collected using the Speedtech Depthmate Portable Sounder and the coordinates were recorded with the Garmin etrex 30 GPS. The data points were entered into Excel, and were exported to ArcMap as a shapefile. Using the Spatial Analyst Extension, interpolation of the water depth data was done using the Inverse Distance Weighted (IDW) method as a raster file, which was converted into a polygon shapefile to be uploaded onto ArcGIS Online. This process was done using the From Raster to Point tool in the Conversion Toolbox to create a point shapefile, which was then converted into a polygon shapefile by creating Thiessan Polygons using the Proximity Tool found in the Analysis Toolbox. The polygons were then grouped based on the water depths assigned to them and were dissolved to create continuous polygons showing variations in water depths along the entire stretch of the navigational map.

SUBMERSION TOLERANCE AMONG RIPARIAN AND NON-RIPARIAN SPIDERS

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Terrestrial arthropods that inhabit dynamic boundaries between terrestrial and lotic systems are under constant risk of flooding. Many spiders may have evolved behavioral, physiological, or morphological adaptations to cope with flooding either through avoidance or submersion tolerance. Mechanisms for coping with periodic flooding have important implications for predicting species composition, recolonization, and resilience against flood-related disturbance for riparian arthropod communities. We examined submersion tolerance of spiders by taxon, size, and microhabitat. We compared web-building and cursorial, riparian and non-riparian, and ground-dwelling versus more arboreal species. We submerged individual spiders for three hours in distilled water and recorded survival, activity level immediately after removal, and activity level eight hours after removal (N = 1,113). During trials we noted spiders that were in hypoxic comas versus those that formed plastrons (breathing bubbles) during submersion. We found large differences in submergence tolerance by taxon and habitat. Web-building spiders showed poor survival post submersion, even those that live on overhanging vegetation along rivers and streams. Most wolf spiders and fishing spider species showed no negative effects of submersion and most were active the entire time of submergence. We also found significant differences in submersion tolerance between populations of the same species within the riparian zone compared to populations from other habitats, indicating population-level local adaptation to flooding for multiple species. Spiders with dense or spatulate setae (i.e. "hairy spiders") appeared particularly well adapted to form plastrons during inundation and suggest one function for dense setae on some species. This morphological feature alone may account for the ability of lycosids and pisaurids to exploit the stochastic interface of the river and adjacent terrestrial habitats.

CAUSAL ANALYSIS OF THE SMALLMOUTH BASS DECLINE IN THE SUSQUEHANNA AND JUNIATA RIVERS

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In 2014, the DEP requested assistance from the United States Environmental Protection Agency (EPA) in identifying the causes of the smallmouth bass (SMB) declines on the Susquehanna River. EPA's stressor identification process, as described on the Causal Analysis/Diagnosis Decision Information System website (CADDIS www.epa.gov/caddis) identifies the cause(s) of an environmental problem by determining which of a set of alternative candidate causes is best supported by the body of evidence. The CADDIS process was chosen because it provides transparency and reduces bias without restricting the types of evidence used. In cooperation with the PFBC, PADEP and EPA scheduled three workshops that included representatives from various State, Interstate, Federal, and academic organizations including, the Susquehanna River Basin Commission (SRBC), United States Geological Survey (USGS), United States Fish and Wildlife Service (USFWS), and Susquehanna River Heartland Coalition for Environmental Studies (SRHCES). Over 50 worksheets consisting of almost 400 pages describing data collections and analyses were reviewed by experts. A total of 14 potential candidate causes were initially identified for the decline in SMB recruitment during the first CADDIS workshop. The CADDIS process narrowed the scope of concerns that may be affecting SMB populations in the Susquehanna and Juniata Rivers. Based on all available evidence, eight candidate causes were not supported by the data analysis and were considered Unlikely for directly causing the decline of YOY SMB recruitment. The evidence for eight additional candidate causes was judged to be Uncertain.

IMPROVING FLOOD FORECASTING IN THE SUSQUEHANNA RIVER BASIN USING A PROBABILISTIC APPROACH

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Accurate and reliable flood forecasts are important for flood prevention, minimizing flood damages, decision making and sustainable watershed management. Uncertainty in flood forecasting may arise from meteorological variables (i.e. precipitation and temperature) as well as different hydrologic sources, such as, hydrologic model structure, parameters, initial and boundary conditions. Probabilistic flood forecasting using ensembles can reduce the uncertainty in flood forecasting and improve accuracy. In this study, we use meteorological forecast ensembles (precipitation and land surface temperature) from the National Centers for Environmental Prediction (NCEP) 11-member Global Ensemble Forecast System Reforecast version 2 (GEFSRv2) to force a distributed hydrologic model and produce streamflow forecasts. The quality of streamflow forecasts are verified in a small headwater basin and a large basin in the north branch of Susquehanna River. The verification is done based on the streamflow amount, forecast lead time, season, and aggregation period for various forecasting scenarios. Ultimately, the verification results provide valuable and useful guidance regarding the potential application and accuracy of probabilistic flood forecasting in the Susquehanna River basin.

BUILDING GREEN INFRASTRUCTURE IN BLAIR COUNTY, PENNSYLVANIA

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This poster will highlight the ongoing efforts of the Alliance for the Chesapeake Bay, UMD Environmental Finance Center, American Rivers, and other partners in Blair County, Pennsylvania. The "Building Green Infrastructure" project is a prime example of taking a collaborative regional approach to building Local Leadership and securing Healthy Watersheds in a "typical" Pennsylvania MS4 atmosphere--several small municipalities strapped for resources, with a unique opportunity to work together towards the goal of improving water quality.

Green infrastructure is a sustainable approach to meeting Chesapeake Bay and local water quality regulations and goals. Green infrastructure has been shown to create community amenities, save money long-term, and is a fitting solution for under-resourced local governments.

This poster will highlight five main project components: collaboration, establishing a stormwater financing plan, creating accessible sets of skilled practitioners, public outreach, and the process of putting local BMP demonstration projects in the ground. The project partners are confident that the project will leave a lasting impact on the Blair County region and serve as a model for Pennsylvania MS4 communities, and at a larger level, all Bay communities that might benefit from a regional approach to green infrastructure. Funding for this project has been generously provided by NFWF.

SURFACE WATER AND SEDIMENT QUALITY IN CENTRE, CLEARFIELD, AND CLINTON COUNTIES, PA IN THE CONTEXT OF AMD IMPAIRMENT AND MARCELLUS SHALE GAS-WELL DRILLING

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Starting in 2010, Lock Haven University (LHU) Water and Environmental Lab began its ongoing relationships with several community-based organizations to monitor the quality of surface water in AMD impacted streams and streams in proximity of various Marcellus Shale drilling locations in several watersheds in Centre, Clearfield, and Clinton Counties, PA. Participating organizations include the Clearfield and Centre County chapters of the Pennsylvania Senior Environmental Corps, Beech Creek Watershed Association, and the Centre County Conservation District. Monitoring of water quality was carried out in Beech

Creek watershed in Clinton and Centre Counties, and in various small watersheds in Clearfield Count. The study was intended to monitor potential areas for contamination due to natural gas extraction and surface run-off from acid mine land (AML). Measured field parameters included temperature, pH, DO, TDS, conductance, ORP, and surface discharge in the monitored streams. Additional lab analyses yielded net acidity and alkalinity, along with several cations and anions, such as total iron, aluminum, manganese, copper, calcium, magnesium, barium, sulfate, and chloride concentrations. Other test parameters include TSS, bromine, total hardness, total Mg, and total Ca. Soil and sediment samples collected from Beech Creek watershed were analyzed for various metal concentrations. A set of water samples collected from Beech Creek watershed was analyzed at Earth & Environmental Sciences department of Susquehanna University in order to cross check the results determined at LHU. Additionally, Beech Creek watershed samples were analyzed for methane concentration by the Earth and Environmental Systems department of the Pennsylvania State University.

Multiple conclusions have been reached regarding the water quality of the monitored watersheds. Samples collected from the Beech Creek watershed and Clearfield sub-watersheds typically exhibit values below the established MCLs of drinking water standards for various chemical parameters, which are related to natural gas extraction. However, multiple study locations exhibit pervasive AMD impairment, which is a direct result of legacy coal mining. Through active collaboration with community-based organizations, students have the opportunity to garner research experience, while providing a valuable service to the greater community. This study has far-reaching implications for policy-making in regards to the development of Marcellus Shale as a resource while protecting the environment and preserving human health.

*Invited Oral Plenary Presentation**

HEALTHY LIVESTOCK, HEALTHY STREAMS: POLICY ACTIONS TO PROMOTE LIVESTOCK STREAM EXCLUSION

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Agriculture is a defining feature across the entire Chesapeake Bay region. The landscape of much of Maryland's, Pennsylvania's and Virginia's watershed is defined by the contours, crop rows and patchwork of farm fields.

For our Bay's farmers, keeping livestock out of the streams has been a long-term challenge. It is important for cattle and other livestock to have ready access to water. In practice this means that livestock often loiter in and drink from both large and small tributary waters. When livestock are allowed access, they trample and erode stream bottoms, stream banks and streamside vegetation as they seek water to cool themselves and drink. This increases sediment erosion and nutrient runoff, while increasing water temperature. The direct deposit of feces and urine also contributes to high nutrient pollution and bacteria counts in the waterways.

The states of Maryland, Pennsylvania and Virginia have each made commitments to help farmers implement livestock exclusion practices and establish riparian vegetative buffers to help improve water quality and meet Bay water quality goals. But practices are mostly voluntary, widely varied, and achieve mixed results. While some livestock producers have installed fencing to keep their stock from getting near or in the streams, many have not.

This report investigates why so many streams are still accessible to and impacted by livestock.

1. Financial Burden
2. Absentee Landlords and
3. Aversion to Government Funding
4. Tradition
5. Not Enough Help
6. Confusing Options
7. Not Enough Flexibility
8. Over-Engineering
9. All or Nothing
10. Distrust of Government

It further recommends policy actions to advance efforts to keep livestock from our streams. These recommendations fall into five categories:

1. Address farmer concerns and win their trust
2. Understand gaps in our programs
3. Better verification and accounting
4. Provide BMP options
5. Increased engagement of stakeholders

DETERMINATION OF WATER QUALITY OF NATURAL WATER SOURCES IN STATE PARKS AROUND THE SUSQUEHANNA RIVER VALLEY

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Water of state parks around the Susquehanna River Valley was tested in order to collect baseline quality data. Monitoring the quality of the water in state parks is important in order to ensure the water is safe for both the park's ecosystem as well as the people who depend on it for outdoor recreation. In order to assess the quality of the water in the different lakes and streams within these parks, samples were collected from the shore or by boat and analyzed in a lab. With the Susquehanna Valley lying within the Marcellus shale region of Pennsylvania, the proposed development of hydraulic fracturing pads within the region have raised environmental concerns for the continued safety and cleanliness of the natural water sources in the area. In order to determine the water quality of these sources, water was tested for turbidity, conductivity, pH, and dissolved oxygen in the field before collecting samples for lab analyses. Heavy metals were tested by inductively coupled plasma atomic emission spectroscopy and anions and simple cations were analyzed by ion chromatography. Filtered portions of each sample were titrated with either sodium hydroxide or hydrochloric acid to test for acidity or alkalinity, respectively. All of these data were collected in order to create an environmental "snapshot" for each park to be compared to later studies to assess the environmental impact of future events on these state parks. The water in the park was shown to have little fluctuation in measurements but had varying levels of iron concentration.

ANTHROPOGENIC EFFECTS ON SOIL AND STREAM CHEMISTRY IN THE MIDDLE SCHUYLKILL RIVER WATERSHED, MONTGOMERY COUNTY, PA.

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On July 10th, 2015, surface water samples were taken as part of a comparison of the Perkiomen Creek's and the Schuylkill River's water quality and soil chemistry to show the effects of different types of land use. We collected surface water samples and in situ data near the confluence of the two streams just East of Phoenixville, PA. We collected six samples total, three cross sectional samples, one on each bank and the middle from both streams. At each sample site in situ data included pH, temperature, dissolved oxygen, and conductivity. Conductivity of both streams fell between 262 to 444 μS/cm. The pH of both streams were near neutral (between 7-8). Temperatures of the streams were between 24°C to 26° C on the sampling day. After being put on ice, samples were filtered and analyzed in the field in triplicate for alkalinity and acidity. Turbidity was analyzed on each unfiltered sample in the field then triplicate unfiltered subsamples collected for later analysis of selected metals (Al, As, Ba, Cd, Cr, Cu, Fe, Pb, Mn, Ni, and Zn). Samples were filtered in the field and triplicate subsamples collected for later metal analyses and additional triplicate samples collected and frozen for analysis of major cations and anions. Nitrite, nitrate, chloride and sulfate were detected in those subsamples. Na and Mg were the major cations present above detectable limits. On July 23rd, 2015, sediment samples were taken from two locations on two islands upstream of the surface water sampling sites in each stream. They were preserved and brought back to the lab to be analyzed. Samples were dried at 75°C in an oven for more than 24 hours. Later they were powdered and analyzed using an X-ray Fluorescence Spectrometer. Samples for bulk density were taken using a 98.125 cm3 cylinder. The bulk densities ranged from 1 to 2 g/cm3.The pH of the soils in the Perkiomen ranged from 5.09 to 5.23 and the Schuylkill River had values ranging from 5.52 to 6.38. The comparison of these two streams shows significant differences in soil chemistry that may impact water chemistry of the streams in the future.

ASSESSMENT OF MIDDLE CREEK STREAM USING WATER QUALITY INDEX (WQI) AND DIATOM METRICS

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It is believed that small streams and waterways of the Susquehanna River cause the problems in the Chesapeake Bay. This study helps develop a better understanding of how these small streams are affecting the Susquehanna River and eventually the Chesapeake Bay. Water Quality Index (WQI), Shannon Diversity Index, Pollution Tolerance Index, and Cocconeis percentage were uses to assess the water quality of Middle Creek; a small stream located in Snyder County, PA. In addition, this study establishes possible trends among these indices. In the biological components, Diatoms were used to generate indices while eleven parameters including physical and chemical properties were used in the WQI. Data analysis showed visible interaction between the water quality and the diversity in aquatic species. A cause and effect dynamic was observed between WQI and diversity. As the WQI changes, the diversity was affected further downstream. The WQI seems to have a direct affect on % Cocconeis and in turn it affects the diversity. This study establishes that looking at one biological index does not indicate water quality because of the inter-dependence of the organisms on each other. Generally, the water quality of MC remains good yet the runoff from the agricultural land and the two lakes do affect the water and the diversity downstream to a certain degree.

USE OF CONSTRUCTED "BENDER HUTS" AS COVER AND BREEDING SITES BY THE EASTERN HELLBENDER

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Once widespread throughout the Susquehanna River basin, the eastern hellbender (Cryptobranchus alleganiensis) is now restricted to just a few large tributary streams in north-central Pennsylvania. Population declines have been taking place throughout the entire geographic range, once extending from southern New York through the central Appalachian Mountains to northern Georgia. The declines and local extinctions have led to multiple head-starting programs to augment or restore hellbender populations. In order to establish a head-starting program for the Susquehanna River basin, we constructed and installed 24 concrete "bender huts" during June and July, 2015, in the hope that adult hellbenders will take up residence inside the huts and produce fertilized eggs.

By the end of August 2015, 25% of the huts had resident adult hellbenders, and by the end of the second week of September 2015, two of the huts contained egg clutches and a guarding male or "denmaster". Before eggs could be removed from the older of the two nests, the larvae had already exited the eggs and were clustered in one corner of the bender hut. A sample of eggs was removed from the younger of the two nests during the last week of October 2015, and a small sample of eggs was removed from a nearby natural nest during the third week of October 2015. The collected eggs are now in the head-starting program and will be transferred to one or more cooperators for rearing until they attain an age when they can be safely tagged and released, and large enough to avoid predation.

POPULATION GENETIC STRUCTURE OF BROOK TROUT IN THE LOYALSOCK CREEK WATERSHED

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The rarity and magnitude of large disturbance events produce unpredictable changes to aquatic ecosystems. In particular, high stream flows can result in an immediate loss of fish populations and reduce genetic diversity through bottleneck effects. Conversely, high stream flows may increase population viability by facilitating movement of individuals among populations and by increasing habitat heterogeneity. In 2011, a 500-year flood event occurred in Loyalsock Creek causing catastrophic loss of many fish populations. Populations have since recovered, with some exceeding pre-flood size. However, the genetic structure of recovered populations is uncertain. As such, it is unknown whether the flood increased genetic connectivity by temporarily increasing population connectivity, or has induced loss of genetic diversity through founder effects. In summer 2015, we sampled 27 tributaries of the Loyalsock Creek to determine the genetic structure of adult brook trout (*Salvelinus fontinalis*) populations. Results will help inform management of brook trout populations in Loyalsock Creek and future studies concerning the behavior and movement of brook trout related to climate change and spawning habitat use.

TOTAL MERCURY CONCENTRATION IN PARDOSA WOLF SPIDERS ALONG SUSQUEHANNA RIVER SITES.

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Mercury is a persistent and common environmental contaminant that primarily originates from coal-fired power plants. Methyl mercury biomagnifies as it moves through food chains until it reaches toxic levels in apex predators. Wolf spiders are known to concentrate methyl mercury at levels far higher than what would be predicted for a terrestrial arthropod predator, sometimes exceeding levels found in fish or even piscivorous birds. Since these spiders occupy positions within detrital, terrestrial, and aquatic food chains, the pathway for mercury biomagnification remains unknown. We sampled wolf spider and other ground spider taxa at sites along the Susquehanna River near a coal-fired power plant and compared it to sites away from water that could have mercury contamination, but limited aquatic sources for mercury methylation (Centralia, PA) as well as sites less likely to have mercury contamination above background levels (agricultural fields). We sought to identify two pandemic species that could serve as an indicator for mercury contamination across these diverse habitats. Two species, *Pardosa milvina* and *Pardosa saxatilis* were found at 6 of the 20 collecting localities occupying both riparian and non-riparian locations. We analyzed variation within and between sites of total mercury levels for these two species near the river and compared them to other locations. We predict total mercury levels to be higher in riparian compared to non-riparian sites and predict mercury levels to be higher at sites closer to a previously coal-fired powerplant. If significant mercury methylation can occur through detrital or terrestrial food chains, we expect specimens collected in Centralia to also have elevated mercury levels compared to agricultural sites.

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10TH ANNUAL SUSQUEHANNA RIVER SYMPOSIUM
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Alliances and Partnerships

10TH ANNUAL SUSQUEHANNA RIVER SYMPOSIUM

Bucknell University - November 13-14, 2015

Alliances and Partnerships

Over the past decade, faculty, staff, and students with the Bucknell University Center for Sustainability and the Environment and The Susquehanna River Heartland Coalition for Environmental Studies have been pleased to share their work with the following state and federal agencies, watershed groups and conservancies, centers and organizations, companies, private foundations, and professional societies.

Academy of Natural Sciences

American Forests

American Society of Landscape Architects

Aquatic Informatics

Alliance for Aquatic Resource Monitoring (ALLARM)

American Geophysical Union

American water Resources Association (AWRA)

Association of Environmental and Engineering Geologists

Alliance for the Chesapeake Bay

American Meteorological Society

Appalachian Trail Conservancy

Association for the Sciences of Limnology and Oceanography

American Fisheries Society (AFS)

American Rivers

AECOM Technology Corporation

Association of Fish & Wildlife Agencies

American Farmland Trust

American Society of Civil Engineers

Aquatic Ecosystem Restoration Foundation

Audubon Society

Beech Creek Watershed Association

Biohabitats

Buffalo Creek Watershed Alliance

The Campbell Foundation

Center for Native Peoples and the Environment (SUNY-ESF)

Center for Watershed Protection Association

Chesapeake Bay Commission

Chesapeake Bay Foundation

Chesapeake Bay Program

Chesapeake Bay Trust

Chesapeake Conservancy

Clearwater Conservancy

Coldwater Heritage Partnership

Conservation Fund

CUAHSI

NSF's Consortium of Universities for the Advancement of Hydrologic Science, INC.

Cora L. Brooks Foundation

Degenstein Foundation

Downstream Strategies

Ducks Unlimited

EPCAMR

Eastern Pennsylvania Coalition for Abandoned Mine Reclamation

Earth Conservancy

Endless Mountains Heritage Region

Entomological Society of America

Excelon Generation

FEMA

Federal Emergency Management Agency

Field Geology Services

Fishing Creek Watershed Association

Food Routes Network

Foundation for Pennsylvania Watersheds

Freshwater Mollusk Conservation Society

Geisinger Center for Health Research

Geological Society of America (GSA)

Greater Nippenose Valley Watershed Association

Harvard Forest

Haudenosaunee Environmental Task Force (Mohawk-Oneida-Onondaga-Cayuga-Seneca-Tuscarora Nations)

Hawk Mountain Sanctuary

Hedin Environmental

International Association of Hydrological Sciences

International Society for River Science (ISRS)

Keep Pennsylvania Beautiful - PA CleanWays

Kettle Creek Watershed Association

Keystone Trails Association

Lancaster County Conservancy

Land Studies

Land Trust Alliance

Laurel Highlands of Pennsylvania Association

Little Conestoga Watershed Alliance

Little Juniata River Association

Living Landscape Observer

Mid-Atlantic Dairy Association

National Geographic Society

Natural Lands Trust

Lower Penns Creek Watershed Association

Mid-Atlantic Invasive Plant Council

The Nature Conservancy

Loyalsock Creek Watershed Association

Middle Susquehanna Riverkeeper

National Science Foundation (NSF)

Ned Smith Center For Nature and Art

Lycoming Creek Watershed Association

Muncy Creek Watershed Association

National Weather Service

New York State Federation of Lake Associations

Merrill W. Linn Land & Waterways Conservancy

National Fish and Wildlife Foundation

National Parks Conservation Association

North American Lake Management Society

National Wildlife Federation

The North-Central Pennsylvania Conservancy

North East Aquatic Plant Management Society

Pennsylvania Association for Sustainable Agriculture (PASA)

Pennsylvania Department of Conservation and Natural Resources (PA DCNR)

Pennsylvania Environmental Resources Consortium (PERC)

Otsego Lake Association

Pennsylvania Buy Fresh-Buy Local Program

Pennsylvania Department of Environmental Protection (PA DEP)

Pennsylvania Environmental Resources Council (PRC)

Otsego Land Trust

Pennsylvania Chapter of the American Fisheries Society

Pennsylvania Department of Transportation (PennDOT)

Pennsylvania Fish and Boat Commission (PAFBC)

Penn Future

Penn State Center for Watershed Stewardship

Pennsylvania Conservation Districts

Pennsylvania Emergency Management Agency (PEMA)

Pennsylvania Forestry Association

Pennsylvania Association of Environmental Professionals

Pennsylvania Department of Agriculture

Pennsylvania Environmental Council

Pennsylvania Institute for Conservation Education

Pennsylvania Lake Management Society

Pennsylvania Wildlife Action Plan

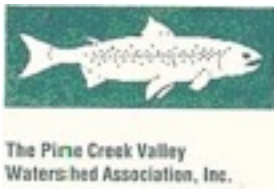
River Town Program

Society for Freshwater Science

Pine Creek Preservation Association

Pennsylvania Land Choices (PA DCNR)

Sea Grant Pennsylvania



Pine Creek Valley Watershed Association

Society of Wetland Scientists

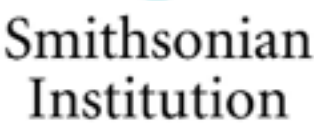
Pennsylvania Native Plants Society

Sierra Club

Ridge and Valley Streamkeepers

Soil and Water Conservation Society

Pennsylvania Organization for Watersheds and Rivers



Smithsonian Institution - Chesapeake Environmental Research Center

Soil Science Society Of America

Pennsylvania Parks and Forests Foundation

River Keeper Network

Society for Conservation Biology

Stewards of the Lower Susquehanna River

Susquehanna Gateway Heritage Area

Susquehanna River Wetlands Trust

URS Corporation

U.S. Fish and Wildlife Service

Susquehanna Greenway Partnership

Trout Unlimited

U.S. Army Corps of Engineers

U.S. Geological Survey

Susquehanna River Basin Commission

Trust for Public Land

U.S. Department of Agriculture

U.S. National Park Service

U.S. Natural Resources Conservation Service

Susquehanna River Heartland Coalition for Environmental Studies

U.S. Environmental Protection Agency (EPA)

Upper Susquehanna Coalition

National Oceanic an Atmospheric Administration

Susquehanna River Trail

U.S. Forest Service

Upper Susquehanna Conservation Alliance

Water Environment Federation

Waterkeepers Chesapeake

Wilderness Society

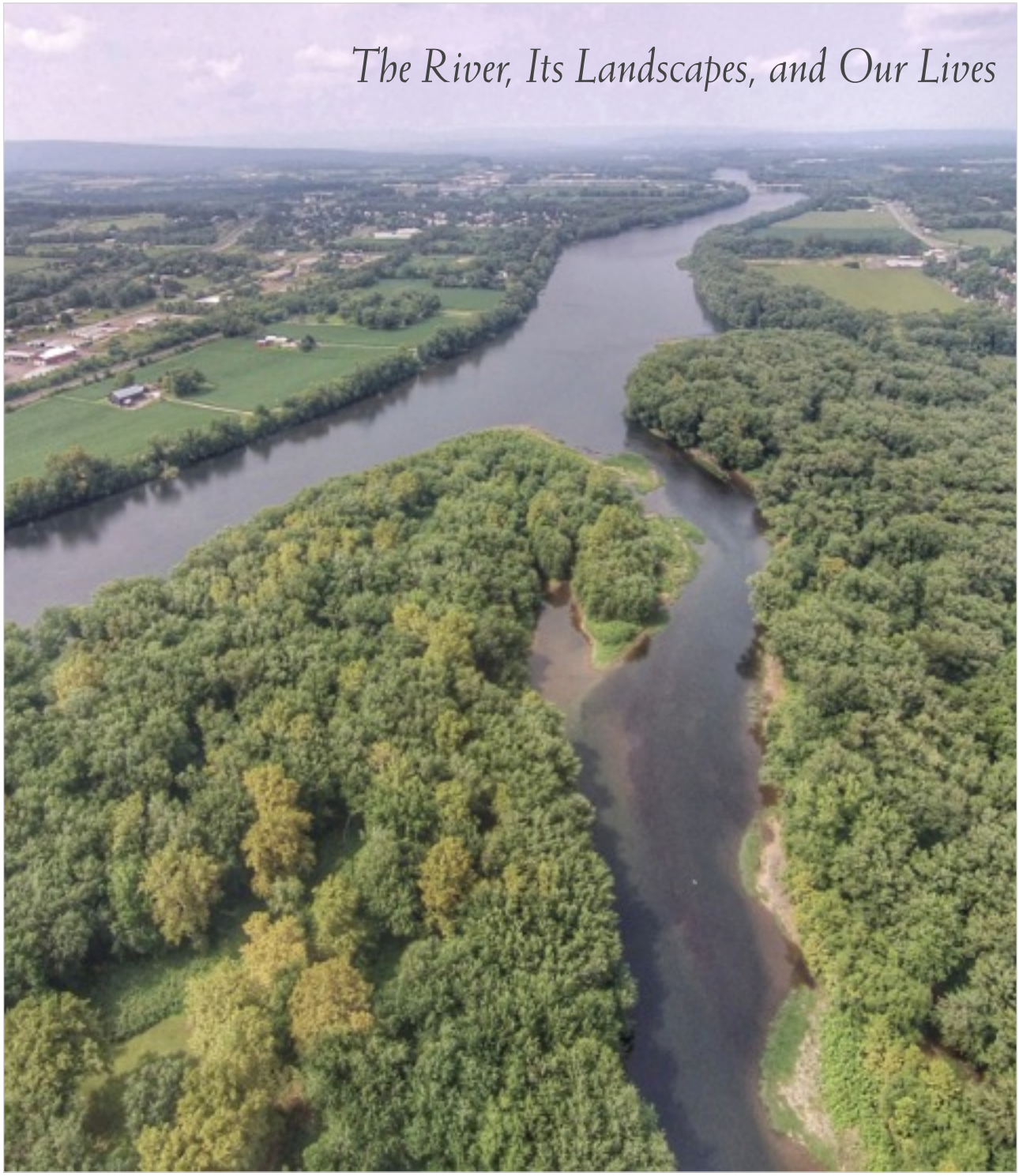
Yellow Breeches Watershed Association

Watershed Alliance of York (Pennsylvania)

Weed Science Society of American

Western Pennsylvania Conservancy

Wildlife Management Institute



A view up the West Branch of the Susquehanna River at Milton, PA, showing a very narrow fringe of riparian forest that remains along the margins of the channel, with most of the valley floor cleared for farming, industry, highways, and homes. A large alluvial island, the prominent feature in the foreground, now forms Milton State Park. During the 19th-century, huge log rafts drifted by here, carrying men and timber down river to the saw mills in Marietta, PA (Lancaster County) and some as far south as the Chesapeake. For decades, a large saw mill and log sorting facility was located here on this island.

During the Pleistocene, this island was once a mid-channel gravel bar when the Susquehanna was a massive braided river, choked with sediment washed down river from the continental ice sheets located a short distance to the north. This valley of the Susquehanna has been sculpted by numerous glaciofluvial erosional and depositional pulses over the past several million years. You can see a large riffle at the head of the island where the current split (flow is towards you). Numerous transverse side channels provide spawning habitat for amphibians, fish, and waterfowl. They also serve as aquatic refuges during floods.

In the lower left corner of the photo you can see a mowed patch of lawn where the tree canopy has been cleared to create a recreational area. In this clearing, as well as any other clearing in the forest and along the river banks, Japanese Knotweed has aggressively invaded the open spaces, completely altering the avian and mammal habitat along the riparian corridor. This photo was taken on a hot and humid summer afternoon, shortly after 4 pm on August 7, 2014.

10TH ANNUAL SUSQUEHANNA RIVER SYMPOSIUM

"THE RIVER, ITS LANDSCAPES, AND OUR LIVES"

WATERSHED SCIENCES AND ENGINEERING PROGRAM
BUCKNELL CENTER FOR SUSTAINABILITY AND THE ENVIRONMENT

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