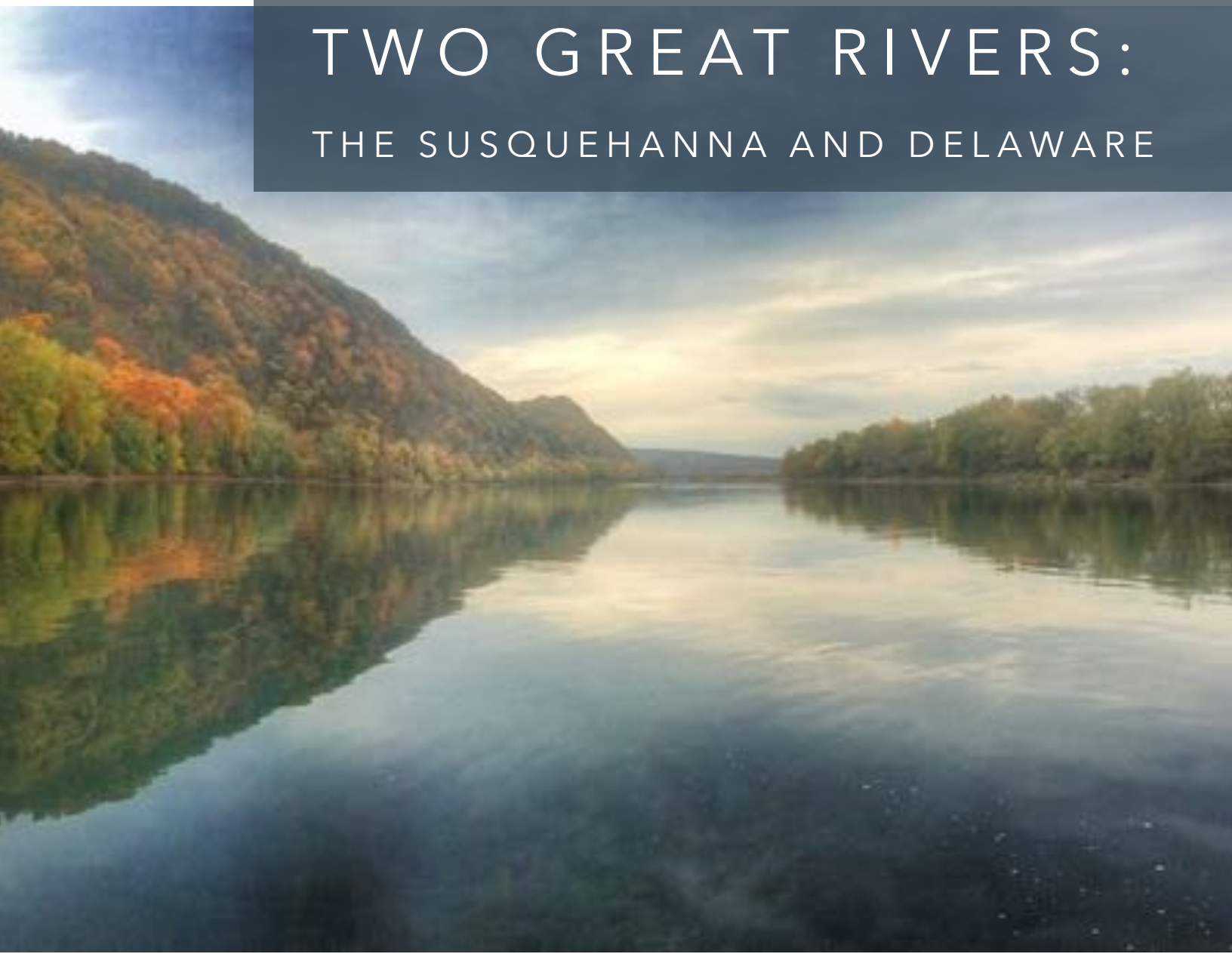
2017

12th Susquehanna River Symposium Program with Abstracts

Bucknell Center for Sustainability and the Environment

THE SPIRIT OF TWO GREAT RIVERS:

THE SUSQUEHANNA AND DELAWARE



PROGRAM WITH ABSTRACTS

2017 Susquehanna River Symposium
November 10-11, 2017
Bucknell University

www.bucknell.edu/riversymposium

Symposium Committee

Benjamin Hayes, Ph.D., P.G.
Director, Watershed Sciences and Engineering Program, Bucknell University

Sean Reese, M.S.
Aquatic Biologist, Watershed Sciences and Engineering Program, Bucknell University

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Executive Director, Susquehanna River Heartland Coalition for Environmental Studies

Karen Morin, Ph.D.
Associate Provost, Bucknell University

Barbara Altmann, Ph.D.
Provost, Bucknell University

Photos:

Front cover: West Branch Susquehanna River near Montgomery, PA in October 2016. [B. Hayes]

Next page: Nippenose Spring near Oval, PA in June 1998. [B. Hayes]

Inside rear cover: Student researchers on the North Branch Susquehanna River near Harding, PA in July 2015. [S. Reese]

Rear cover. West Branch Susquehanna at Muncy, PA, July 2015. [B. Hayes]

Welcome!

This symposium brings the public together with faculty, students, scientists, engineers, consultants, watershed groups, and state and federal agencies to share their latest research findings and discuss sustainable watershed management strategies that will ensure the long-term health of the Susquehanna and Delaware rivers and their estuaries.

It features keynote and plenary addresses, breakout discussions, oral and poster presentations, and exhibits from over 120 students, faculty, consultants, agencies, and watershed groups. All working to understand, restore, and protect the Susquehanna and Delaware Rivers.

All events are held in the Elaine Langone Center on the campus of Bucknell University and are free and open to the public. Parking is available along Moore Avenue and 7th Street. For more information, please visit:

www.bucknell.edu/riversymposium.

"No river can return to its source,
yet all rivers must have a beginning."

- Native American proverb

Contents

Welcome

"The Spirit of Two Great Rivers"
The Susquehanna and Delaware

On behalf of Bucknell University and the symposium committee, welcome to the 12th Susquehanna River Symposium. This two-day event is offered by the Watershed Sciences and Engineering Program of the Center for Sustainability and the Environment. Our goal is to bring together students, faculty, planners, consultants, regulators, watershed organizations and members of the public to explore environmental issues in the Susquehanna River and Delaware River watersheds. Both rivers share similar climate, geology, and hydrology but have distinct differences in demographics, land use and natural resources. Dams and natural gas extraction are more prevalent in the Susquehanna than the Delaware and thus require different management and conservation approaches. As we look to the future of these watersheds, it is important that the perspective and wisdom of Native Americans be part our discussions of interconnectedness, ecosystem services, and sustainability.

KEYNOTE SPEAKER. On Friday, from 7:30 to 8:00 p.m., Dr. Thomas R. Porter, also known as Sakokwenionkwas, will deliver the symposium's keynote address *"The Spirit of Two Great Rivers: The Susquehanna and Delaware."* A member of the Bear Clan of the Haudenausanee Mohawk Nation, Porter is founder and spiritual leader of the Kanatsiohareke community near Fonda, New York, and author of several books. He is a former director and instructor at the Akwesasne Freedom School and a former instructor at the Kahnawake Survival School. Porter taught Mohawk language, philosophy, and history for both institutions. In 2017, in recognition of a lifetime of work in cultural preservation and education of members of the Haudenausanee Six Nations (Iroquois) Confederacy as well as his efforts to educate non-Haudenosaunee peoples about Mohawk history and cultural traditions, Porter received honorary Doctor of Humane Letters degrees from both Syracuse University and Keene State College.

RESEARCH POSTERS. On Friday, from 8:00 to 10:00 p.m., poster presentations by over 100 students and faculty from 15 colleges and universities and 17 government agencies and environmental organizations. Their work will feature projects throughout the Susquehanna and Delaware watersheds and Chesapeake Bay and Delaware Estuary. An evening social will follow, which is a great way to mix with others and make new connections. Their research posters will remain on display through Saturday's symposium events.

PLENARY ADDRESSES. On Saturday, from 9:00 to 10:30 a.m., three plenary addresses will set the stage for the morning's discussions:

- Dr. Elizabeth W. Boyer, Associate Professor of Water Resources, Penn State Department of Ecosystem Science and Management and Director of the Pennsylvania Water Resources Research Center, will speak on *"Nutrient Pollution in the Susquehanna and Delaware Watersheds from the Headwaters to the Bays."*
- Dr. David L. Strayer, a distinguished senior scientist emeritus at the Cary Institute of Ecosystem Studies and visiting scholar at the Graham Sustainability Institute at the University of Michigan, will speak on *"What Is a River Worth?"*
- Dr. Thomas R. Porter will speak on *"The Spirit of Water."*

Information about these invited speakers is available on pages 13-15.

BREAKOUT DISCUSSIONS. Following the plenary addresses, from 11 a.m. to 12:15 p.m., breakout discussions will explore three themes:

- Watershed Pollution and Landscape-River-Bay Connections
- Aquatic Ecology and Ecosystem Services
- The Spirit of Water and Native American Perspectives

Everyone is encouraged to participate in these breakout sessions, which are engaging and provide everyone the chance to ask questions and discuss the topics in greater detail.

LUNCH. A free lunch will be served from 12:30 to 1:30 p.m. in Walls Lounge.

ORAL PRESENTATIONS. Saturday afternoon will feature 22 oral presentations organized into six topical sessions:

- agriculture, nutrients, and water quality
- aquatic and terrestrial ecology
- watershed education and sustainability
- stream restoration
- watershed mapping and modeling
- flood hydrology and policy

EXHIBITS. In the Center Room (Room 256) are 12 exhibits by environmental consultants, watershed groups, conservancies, and other organizations working to protect and restore the watersheds throughout the mid-Atlantic region. From 2:30 to 3:15 p.m., agency representatives will be at their exhibits to answer any questions and provide you more information.

ACKNOWLEDGEMENTS. This symposium would not be possible without the generous support of the Provost's Office at Bucknell University and the Degenstein Foundation. Special thanks are due to Reneé Carey and H.W. "Skip" Wieder for coordinating this symposium with the Susquehanna River Heartland Coalition for Environmental Studies and to the committee members who helped plan and carry out this event: Sean Reese, Richard Crago, Jessica Newlin, Matthew McTammany, R. Craig Kochel, Sid Jamieson, Carol High, Belinda Bergin, and Samantha Myers.

Best wishes for a great symposium!

Sincerely,

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

Symposium Chairman

Watershed Sciences and Engineering Program
Center for Sustainability and the Environment
Bucknell University

Schedule

Friday, November 10, 2017

The Forum (Room 272), Elaine Langone Center, Bucknell University

7:00 - 7:05 p.m.

Welcome

Jessica Newlin
Interim Executive Director, Center for Sustainability and the Environment

7:05 - 7:15 p.m.

Opening Remarks

John Bravman
President, Bucknell University

7:15 - 7:25 p.m.

Collaborative Partnerships for Watershed Research and Conservation

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

7:25 - 7:30 p.m.

Introduction

Benjamin Hayes
Symposium Chair

Keynote Address

7:30 - 8:00 p.m.

"The Spirit of Two Great Rivers: The Susquehanna and Delaware"

Sakokwenionkwas (Dr. Thomas Porter)

Elder, Educator, and Spiritual Leader
Bear Clan of the Haudenausanee Mohawk Nation

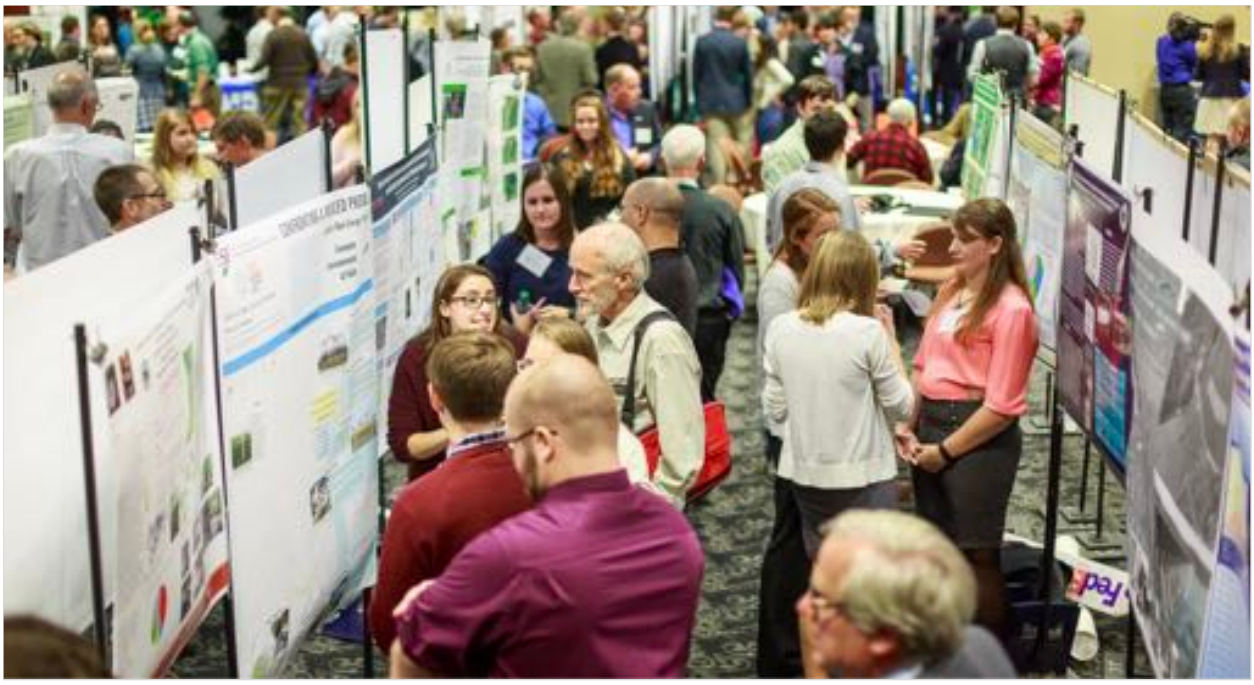
Friday, November 10, 2017

Research Posters and Evening Social

8:00 - 10:00 p.m.

The Terrace Room (Room 276)

Poster displays from over 100 students and faculty from universities and colleges throughout the Susquehanna and Delaware watersheds, as well as state and federal environmental agencies, consulting firms, watershed groups, and other organizations.



Saturday, November 11, 2017

All events held in the Elaine Langone Center, 701 Moore Avenue, Bucknell University

Light Breakfast

8:00 - 8:50 a.m.

The Terrace Room (Room 276)

Exhibitors set up in the Center Room (Room 256)

Plenary Presentations

The Forum (Room 272)

9:00 - 9:05 a.m.

Welcome and Announcements

Benjamin R. Hayes, Symposium Chairman

9:05 - 9:10 a.m.

Opening Comments

Barbara K. Altmann, Provost, Bucknell University

9:15 - 9:45 a.m.

"Nutrient Pollution in the Susquehanna and Delaware Watersheds, from the Headwaters to the Bays"

Dr. Elizabeth W. Boyer

Director, Pennsylvania Water Resources Research Center, Penn State University

9:45 - 10:15 a.m.

"What is a River Worth?"

Dr. David L. Strayer

Distinguished Senior Scientist Emeritus at the Cary Institute of Ecosystem Studies and Visiting Scholar at the Graham Sustainability Institute at the University of Michigan

10:15 - 10:45 a.m.

"The Spirit of Water"

Sakokwenionkwas (Dr. Thomas Porter)

Elder , Educator, and Spiritual Leader
Bear Clan of the Haudenausanee Mohawk Nation

Intermission

10:45 - 11:00 a.m.

Exhibits on display in the Center Room (Room 256)

Breakout Discussions

11:00 a.m. - 12:15 p.m.

1.	**Watershed Pollution and Landscape-River-Bay Connections**	Elizabeth Boyer, leader Arches Lounge (Room 304)
2.	**Aquatic Ecology and Ecosystem Services**	David Strayer, leader Terrace Room (Room 276)
3.	**The Spirit of Water and Native American Perspectives**	Thomas Porter, leader The Forum (Room 272)

Lunch

12:30 - 1:30 p.m.
Walls Lounge (RM. 231)

Exhibits on display in the Center Room (Room 256)

Oral Presentations

1:45 - 2:30 p.m.

Session 1. **Agriculture, Nutrients, and Water Quality**
The Forum (Room 272)

Session 2. **Aquatic and Terrestrial Ecology 1**
Rooms 241, A and B

Session 3. **Watershed Stewardship, Sustainability, and Education 1**
Rooms 241, C and D

Session 4. **Stream Restoration**
Gallery Theater (Room 301)

Exhibits

2:30 - 3:15 p.m.

Center Room (Room 256)

Connect with representatives from state and federal environmental agencies, environmental consultants, and conservancies and watershed groups. Light refreshments will be served.

Oral Presentations

3:15 - 4:00 p.m.

Session 5. **Watershed Mapping and Modeling**
The Forum (Room 272)

Session 6. **Aquatic and Terrestrial Ecology 2**
Rooms 241, A and B

Session 7. **Watershed Stewardship, Sustainability, and Education 2**
Rooms 241, C and D

Session 8. **Flood Hydrology and Policy**
Gallery Theater (Room 301)

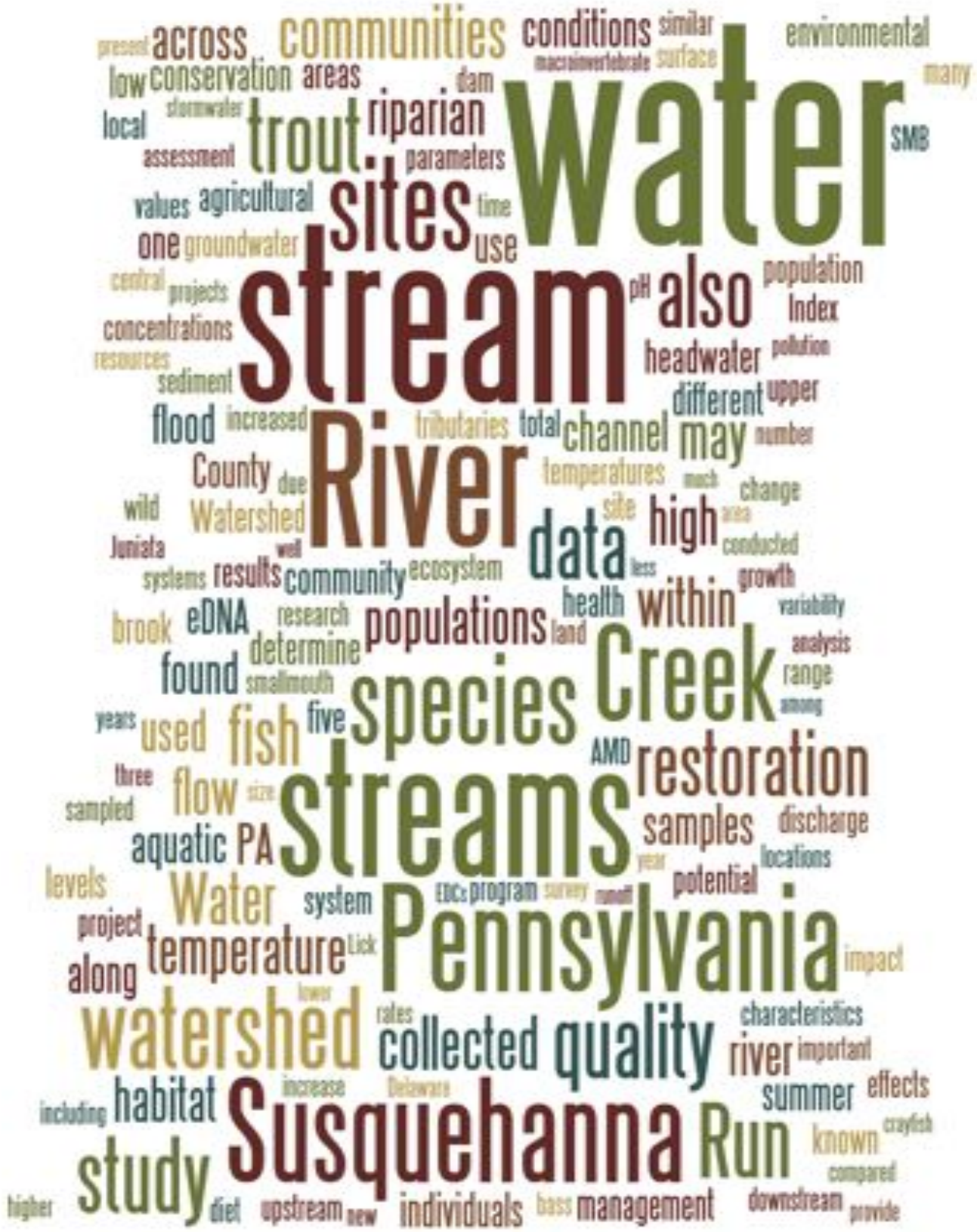
Reflection and Looking Ahead

4:00 - 4:30 p.m.

The Forum (Room 272)

Reflect upon important issues and problems that emerged from the symposium presentations, exhibits, and discussions. Share your suggestions and ideas for moving forward.

A portion of the students and faculty who presented research posters at the 2016 Susquehanna River Symposium. Keynote speaker Dr. Bernard Sweeney (Stroud Water Research Center) and retired PA Senator Franklin Kury (Honorary Symposium Chair) are in front.



A "word cloud" visualization of the 150 most frequently words (out of a total of 21,287) that appeared in the 78 oral and poster presentation abstracts contributed to this symposium (pages 17-66). Their relative size denotes greater prominence to the words that appear most frequently.

Oral Presentations

Abstracts for oral presentations are provided on pages 17 - 32.
* denotes presenting author.

Session 1

Agriculture, Nutrients, and Water Quality

The Forum (Room 272), Saturday, November 11, 2017, 1:45 - 2:30 p.m.

1:45 p.m. *"Boots on the Ground: Agricultural Technical Assistance in the Chesapeake Bay Watershed."*
Ann Swanson,* Ann Jennings, and Marel King

2:00 p.m. *"Rapid assessment of stream ecosystem function across an agricultural impact gradient in central Pennsylvania."*
Steven T. Rier,* Jennifer A. Tuomisto, Corey J. Conville, and Aaron Gordon-Weaver

2:15 p.m. *"Transport of nitrogen rich groundwater to surface waters by riparian macropore flow in an agriculturally dominated watershed."*
Brian Redder,* Anthony Buda, Casey Kennedy, Gordon Folmar, and Elizabeth Boyer

Session 2

Aquatic and Terrestrial Ecology 1

Rooms 241, A and B, Saturday, November 11, 2017, 1:45 - 2:30 p.m.

1:45 p.m. *"How social media led to the discovery of a "new" species on the Shikellamy Bluffs."*
Christopher T. Martine* and Scott Schuette

2:00 p.m. *"Comparing relative abundance and population characteristics of Flathead Catfish across a range of establishment levels at the Susquehanna River."*
Geoffrey D. Smith,* Danielle Massie, and Tyler Wagner

2:15 p.m. *"Temporal and spatial variation in endocrine disrupting compounds and young-of-the-year smallmouth bass health in the upper Juniata River system."*
George T. Merovich,* Ryan E. Heisler, Logan R. Stenger, Katie Mattas, Francesca, M. Ferguson, Grace Noll, and Ryan Braham

Session 3

Watershed Stewardship, Sustainability, and Education 1

Rooms 241, C and D, Saturday, November 11, 2017, 1:45 - 2:30 p.m.

1:45 p.m. "*Informing and Involving the Next Generation of Leaders in the River.*"
Mark Gutshall* and James Reeb

2:00 p.m. "*The View Below: Connecting People to the Susquehanna and Delaware Rivers through Snorkeling.*"
Keith J. Williams*

2:15 p.m. "*Innovative Approaches to Watershed Health Education and Community Awareness/ Engagement.*"
Jerry A. Griffith* and Michael J. Griffith

Session 4

Stream Restoration

Gallery Theater (Room 301), Saturday, November 11, 2017, 1:45 - 2:30 p.m.

1:45 p.m. "*Advantages of Stream Corridor Restoration as a BMP in the Chesapeake Bay Watershed MS4 Program.*"
Todd Moses,* Michael Lower, and Carrol Ehrhardt

2:00 p.m. "*Future History of Pennsylvania Anthracite Abandoned Mines.*"
Michael C. Korb*

2:15 p.m. "*Adaptive Stream Restoration Strategies that Add Large Woody Material to Headwater Streams to Improve Aquatic Life, Channel Complexity, Hyporheic Exchange, and Floodplain Connectivity.*"
Benjamin R. Hayes* and Nathan Reigle*

Session 5

Watershed Mapping and Modeling

The Forum (Room 272), Saturday, November 11, 2017, 3:15 - 4:00 p.m.

3:15 p.m. "*Mapping Runoff Flow Paths and Their Pollution Contribution Potential: The Impact of Crops as a Land Cover Category.*"

Chanda Singoyi,* Richard D. Crago, and Luyang Ren

3:30 p.m. "*Precision Conservation in the Susquehanna River Watershed: Tools and High-Resolution Datasets for Watershed Organizations and Community-Based Strategies for Success.*"

Adrienne R. Gemberling* and Jennifer A. Soohy

3:45 p.m. "*Updated Lidar for PA - Status and Plans.*"

Eric Jespersen*

Session 6

Aquatic and Terrestrial Ecology 2

Rooms 241A and B, Saturday, November 11, 2017, 3:15 - 4:00 p.m.

3:15 p.m. "*Conservation Threats and Opportunities for the Giant Eastern Hellbender Salamander in the Susquehanna River Watershed.*"

Peter J. Petokas*

3:30 p.m. *"Seasonal and Diel Signature of Eastern Hellbender Environmental DNA."*

Mizuki Takahashi*

3:45 p.m. "*Implementing an Ecosystem Services Approach in the Delaware River Basin: Successes, Challenges, and Future Directions.*"

Daniel E. Spooner,* Christopher Huber, Heather S. Galbraith, and Barbara St. John White

Session 7

Watershed Stewardship, Sustainability, and Education 2

Rooms 241C and D, Saturday, November 11, 2017, 3:15 - 4:00 p.m.

3:15 p.m. "*Forty-Mile Stories: Student Storytelling on the Susquehanna River.*"
Justin D. Mando* and Madeline Giardina

3:30 p.m. *"Engaging Non-Traditional Citizen Scientists in Watershed Protection."*
Carol Parenzan*

Session 8

Flood Hydrology and Policy

Gallery Theater (Room 301), Saturday, November 11, 2017, 3:15 - 4:00 p.m..

3:15 p.m. "*Flood Mitigation for Pennsylvania's Rural Communities: Community-Scale Impact of Federal Policies. Findings of the September 2017 report to the Center for Rural Pennsylvania.*"
L. Donald Duke* and Lara Fowler

3:30 p.m. "*Hydrologic analysis of a 100-year flood event in a small rural watershed in Clinton County, PA.*"
Md. Khalequzzaman*

Invited Speakers

Sakokwenionkwas (Dr. Thomas Porter)

Elder and Spiritual Leader
Bear Clan of the Mohawk Nation

Thomas R. Porter (*Sakokwenionkwas,* "The One Who Wins") has been the founder, spokesperson and spiritual leader of the Mohawk Community of Kanatsiohareke (Ga na jo ha lay gay) located in the Mohawk Valley near Fonda, New York since 1993. He is a member of the Bear Clan of the Mohawk Nation at Akwesasne. (Akwesasne, also known as the St. Regis Mohawk Reservation, straddles the New York State/Canadian border near Massena, New York.) He is married to Alice Joe Porter who is Choctaw. They have six children.

Mr. Porter; held the position of sub-chief for the Tehanakarine Chieftainship title, one of the nine chief titles of the Mohawk Nation, for 21 years (1971-1992). Chiefs are considered to be spiritual as well as political leaders. Some of the duties of that position were: officiating at marriage ceremonies, death ceremonies and numerous other traditional ceremonies held throughout the year.

He was the director of and a teacher at the Akwesasne Freedom School and taught at the Kahnawake Survival School. He taught Mohawk language, philosophy and history at both schools as well as carpentry at Kahnawake. The purpose of both schools is to teach all of the usual subject matter, but within a traditional Mohawk worldview and with emphasis on keeping the Mohawk language alive and vital. It is said that with the loss of language, there also is the loss of at least 50% of a people's culture and identity.

For over a decade, Mr. Porter worked as secretary for the Mohawk Nation Council of Chiefs and as interpreter. He organized the "White Roots of Peace", a traveling multi-media communications group designed to revitalize Native traditions and beliefs in North America. He was the main speaker and lectured for the group at various universities and colleges all over the United States and Canada.

Mr. Porter was the Native American consultant for the New York State Penitentiary System and Chaplain for all of the Native inmates in the New York State Penal System for 10 years. His office was located in Albany, New York, but he traveled all over the state to meet with Native inmates. He conferred with them, taught and helped them conduct traditional ceremonies.

Dr. Porter will deliver the keynote address entitled *"The Spirit of Two Great Rivers - The Susquehanna and Delaware"* at 7:30 to 8:30 p.m. on Friday, November 10, 20017 in the Forum, Elaine Langone Center, Bucknell University.

Dr. Porter will also deliver a plenary address entitled ***"The Spirit of Water"*** at 10:15 - 10:45 a.m. on Saturday, November 11, 20017 in the Forum, Elaine Langone Center, Bucknell University

Dr. Elizabeth W. Boyer

Associate Professor of Water Resources in the Department of Ecosystem Science and Management and Director of the Pennsylvania Water Resources Research Center, and Assistant Director of Penn State Institutes of Energy & the Environment

Dr. Elizabeth W. Boyer is an Associate Professor of Water Resources in the Department of Ecosystem Science and Management at the Pennsylvania State University. She serves as Director of the Pennsylvania Water Resources Research Center, and as Assistant Director of Penn State Institutes of Energy & the Environment. Prior to her current position, Boyer served on the faculty at the State University of New York at Syracuse and at the University of California at Berkeley.

She holds a B.S. degree in Geography from the Pennsylvania State University, and M.S. and Ph.D. degrees in Environmental Sciences from the University of Virginia. Dr. Boyer's work focuses on hydrological and biogeochemical processes that affect water resources. Her research explores the status and trends of water quality of streams, rivers, and estuaries in response to factors such as atmospheric deposition, climatic variability, land-use, and watershed management .

Dr. Boyer will deliver a plenary address entitled ***"Nutrient Pollution in the Susquehanna and Delaware Watersheds, from the Headwaters to the Bays"*** at 9:15 - 9:45 a.m. on Saturday, November 11, 20017 in the Forum, Elaine Langone Center, Bucknell University.

Dr. David L. Strayer

Distinguished Senior Scientist Emeritus at the Cary Institute of Ecosystem Studies and Visiting Scholar at the Graham Sustainability Institute at the University of Michigan

David Strayer is a Distinguished Senior Scientist Emeritus at the Cary Institute of Ecosystem Studies and a Visiting Scholar at the Graham Sustainability Institute at the University of Michigan. He has a B.S. in Zoology from Michigan State University and a Ph.D. in Ecology and Evolutionary Biology from Cornell, and has been conducting research in freshwater ecology for almost 40 years.

A world-renowned scientist, Dr. Strayer's recent research has focused on the ecology of the Hudson River, biological invasions, and conservation ecology of pearly mussels (www.caryinstitute.org/science-program/our-scientists/dr-david-l-strayer). He also writes and speaks regularly to general audiences about ecology.

Dr. Strayer will deliver a plenary address entitled ***"What is a River Worth?"*** at 9:45 - 10:15 a.m. on Saturday, November 11, 20017 in the Forum, Elaine Langone Center, Bucknell University.

Key Contributors

Schools, Colleges and Universities

Bloomsburg University
Bucknell University
Elizabethtown University
George Mason University
Indiana University of Pennsylvania
Juniata College
Kings College
Kutztown University of Pennsylvania
Lafayette College
Lock Haven University
Lycoming College
Millersville University
Pennsylvania State University
Susquehanna University
University of Georgia

Exhibitors

American Dairy Association
Chesapeake Bay Foundation
Chesapeake Conservancy
Conservation Union
Environmental Solutions & Innovations, Inc.
Middle Susquehanna River Keeper
PA Amphibian and Reptile Survey
PA Water Resources Research Center
Rummel, Klepper, & Kahl (RK&K)
Susquehanna Greenway Partnership
Susquehanna River Basin Commission
Pennsylvania Trout Unlimited

Agencies and Organizations

Berks Nature
Chesapeake Bay Commission
Chesapeake Conservancy
Coldwater Conservancy
Delaware River Basin Commission
Middle Susquehanna River Keeper
NorthBay Education Foundation
North Central Pennsylvania Conservancy
PA Department of Environmental Protection
PA Bureau of Forestry, Department of Conservation and Natural Resources
PA Fish and Boat Commission
PA Mapping and Geographic Information Consortium
RiverStewards
Skelly and Loy, Inc.
Susquehanna River Basin Commission
TetraTech, Inc.
Trout Unlimited
U.S. Department of Agriculture Agricultural Research Service
U.S. Fish and Wildlife Service
U.S. Geological Survey

Oral Presentations

BOOTS ON THE GROUND: AGRICULTURAL TECHNICAL ASSISTANCE IN THE CHESAPEAKE BAY WATERSHED

Ann M. Swanson,, Executive Director , Chesapeake Bay Commission, 60 West Street, Suite 406, Annapolis , MD, 21401, aswanson@chesbay.us; **Ann F. Jennings**, Virginia Director, Chesapeake Bay Commission, ajennings@chesbay.us; **Marel A. King**, Pennsylvania Director, Chesapeake Bay Commission, c/o Senate of Pennsylvania, Rm G-05 North Office Bldg, Harrisburg, PA 17120, mking@chesbay.us.

To meet water quality goals for Chesapeake Bay and its tributaries, widespread adoption of agricultural best management practices (BMPs) is required. While most discussion of policy to achieve these goals has focused on support of the practices themselves, implementation will not be possible without the conservation professionals who advise farmers, write farm-specific environmental plans, engineer practices and guide their implementation. This report will identify the types of technical assistance providers, their current funding sources, and recommendations to improve technical assistance delivery to farmers.

Keywords: agriculture, technical assistance, BMP, funding

RAPID ASSESSMENT OF STREAM ECOSYSTEM FUNCTION ACROSS AN AGRICULTURAL IMPACT GRADIENT IN CENTRAL PENNSYLVANIA

Steven T. Rier, Department of Biological and Allied Health Sciences, Bloomsburg University, 400 East Second Street, Bloomsburg, PA, 17815, srier@bloomu.edu; **Jennifer A. Tuomisto**, Department of Biological and Allied Health Sciences, Bloomsburg University, 400 East Second Street, Bloomsburg, PA, 17815, jat18435@huskies.bloomu.edu; **Corey J. Conville**, Department of Biological and Allied Health Sciences, Bloomsburg University, 400 East Second Street, Bloomsburg, PA, 17815, cjc37025@huskies.bloomu.edu; **Aaron M. Gordon-Weaver**, Department of Biological and Allied Health Sciences, Bloomsburg University, 400 East Second Street, Bloomsburg, PA, amg43366@huskies.bloomu.edu.

The capacity to reliably assess the functional integrity of stream ecosystems is at the heart of stream assessment and restoration. However, direct measures of ecosystem function are often cumbersome, expensive and have not been used widely enough to develop predictive models relating functional indicator responses to the myriad of potential stressors. The goal of this project was to utilize a suite of "rapid" ecosystem assessment protocols to examine the response of 19 stream ecosystems spanning a gradient of agricultural impact in central Pennsylvania. We measured ecosystem metabolism (diel oxygen data coupled with inverse modeling), nitrogen and phosphorus uptake in portable mesocosms, photosynthetic capacity (pulse amplitude modulated fluorometery) and extracellular enzymes (β-glucosidase, β-xylosidase, alkaline phosphatase, leucine-aminopeptidase, β-N-acetylglucosaminidase and phenol oxidase). Our preliminary results indicate that, although stream size and underlying geology are potentially important covariates, these "rapid" protocols for characterizing ecosystem function responded well to variations in nutrient concentrations, canopy cover and sedimentation observed across this agricultural gradient.

Keywords: ecosystem metabolism, periphyton, algae, stream assessment

TRANSPORT OF NITROGEN RICH GROUNDWATER TO SURFACE WATERS BY RIPARIAN MACROPORE FLOW IN AN AGRICULTURALLY DOMINATED WATERSHED

Brian Redder, Department of Ecosystem Science and Management , Penn State University, 234 Forest Resource Building, University Park, PA, 16802, redderbrian@gmail.com; **Anthony Buda**, Agricultural Research Service (ARS), United States Department of Agriculture, Building 3702, Curtin Road, University Park, PA, 16802, anthony.buda@ars.usda.gov; **Casey Kennedy**, Agricultural Research Service (ARS), United States Department of Agriculture, 1 State Bog Road, East Wareham, MA, 02538, casey.kennedy@ars.usda.gov; **Gordon Folmar**, Agricultural Research Service (ARS), United States Department of Agriculture, Building 3702, Curtin Road, University Park, PA 16802, gordon.folmar@ars.usda.gov; **Elizabeth Boyer**, Department of Ecosystem Science and Management, Penn State University, 304 Forest Resource Building, University Park, PA 16802, ewb100@psu.edu.

Nitrogen (N) pollution continues to be a major concern in the Chesapeake Bay watershed due to its potential contributions to climate change, negative health effects, and the decline in quality of aquatic ecosystems. Groundwater in Pennsylvania can have elevated concentrations of dissolved N that can migrate to surface waters, either by diffuse discharge through the streambed or by macropore flow in the riparian zone. These riparian seeps show significant variability in both discharge and nutrient concentrations. In this study, we use stream measurements to differentiate and quantify contributions of groundwater discharge from matrix flow in the streambed and riparian seeps. A combination of differential stream gauging, streambed measurements of hydraulic head and conductivity, and water chemistry, were used to solve for riparian groundwater flux using a reach mass balance equation. A 175m stream reach was identified in a heavily cultivated 45 hectare watershed in east-central Pennsylvania in the headwaters of the Susquehanna River.

Despite air-water manometers readings from piezometers installed in the shallow streambed (30 cm) indicating a losing reach, discharge substantially increased (36-66%) throughout the reach consistently throughout the study period. Using the mass balance approach, riparian groundwater fluxes contributed 85-206 $m^3 d^{-1}$ of water, while transporting 1.48- 3.98 kg N d^{-1} through this fractured aquifer system. Throughout the winter/spring recharge period (Jan-May), there was a constant increase in both flow and N transport from these macropore riparian seeps. Chemical data for the stream, streambed, and shallow ground waters suggest that the stream is disconnected from the underlying aquifer and that groundwater riparian seeps supply essentially all of the water and N to the system. The results from this study, and water chemistry comparison between stream, shallow groundwater, deep groundwater, and riparian seeps, provide insight into the sources of these inputs and help determine the transport and fate of N in a fractured system. This information is important for planning mitigation techniques and best management practices. Further analysis of water isotopes and hydrometric data will be used to test our hypothesis of a perched stream disengaged from the aquifer below.

Keywords: water quality, agriculture

HOW SOCIAL MEDIA LED TO THE DISCOVERY OF A "NEW" SPECIES ON THE SHIKELLAMY BLUFFS

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In the summer of 2017, a group of scientists and students conducted a survey of the cliffside flora above the bank of the West Branch Susquehanna River at Shikellamy State Park. The primary goal of the survey was to locate individuals of the golden corydalis (*Corydalis aurea*), a state-endangered species only known in Pennsylvania from this single site. During the course of the survey, numerous specimens identified as *Heuchera americana* (American alumroot) were also collected. A photo of one specimen was posted to Twitter, kicking off an electronic discussion that, in turn, led to a series of new collecting trips and establishment of the first state records for the globally-imperiled *Heuchera alba* (white alumroot). Before the Tweet, this species was previously recorded from just a few localities in Virginia and West Virginia. Through a collaboration between the Pennsylvania Natural Heritage Program and Bucknell University, we are now evaluating the biology and status of the species in the state and what its discovery here means for the conservation of the species across its now-expanded known range. Likewise, the presence of rare plants on some local cliffs suggests the need for additional surveys of bluff habitats throughout the Susquehanna Valley.

Keywords: botany, endangered species, biodiversity, science communications

COMPARING RELATIVE ABUNDANCE AND POPULATION CHARACTERISTICS OF FLATHEAD CATFISH ACROSS A RANGE OF ESTABLISHMENT LEVELS AT THE SUSQUEHANNA RIVER.

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Flathead Catfish were first documented in the Susquehanna River in 2002 downstream of Safe Harbor Dam, York and Lancaster counties, Pennsylvania. Since that time the species has increased in range and abundance throughout the Susquehanna Basin. In 2016, we initiated a study to evaluate abundance and growth characteristics of Flathead Catfish along a gradient of establishment in the Susquehanna River. We used baited, tandem hoop nets at 12 randomly selected locations within each reach to evaluate relative abundance (CPE, catch per effort) and provide individuals for age and growth analysis. Temporal replicates we also set at a portion of the sites to evaluate variability in CPE between sets. Age was determined using lapilli otolith for each fish (n=142) and von Bertalanffy growth estimates determined using R software package to evaluate differences in growth parameters among different levels of establishment. Growth rates were similar among reaches however maximum age and CPE differed among reaches. These data along with other North American populations are currently being used to evaluate factors affecting population characteristics to inform management of both native and non-native populations in Pennsylvania and elsewhere.

Keywords: invasive species, Flathead Catfish, Susquehanna, von Bertalannffy

TEMPORAL AND SPATIAL VARIATION IN ENDOCRINE DISRUPTING COMPOUNDS AND YOUNG-OF-THE-YEAR SMALLMOUTH BASS HEALTH IN THE UPPER JUNIATA RIVER SYSTEM

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Over a 2-year time frame in summer 2016 and 2017, we quantified the dynamics of endocrine disrupting compounds (EDCs) in the upper Juniata River system. EDCs have been implicated as a likely cause of declines in recruitment and thus adult smallmouth bass (SMB) populations in the lower Juniata and Susquehanna Rivers since 2005. We studied the mainstem of the upper Juniata River (near Mapleton), and 5 other major tributaries in the drainage system. Specifically, we quantified EDC levels (estradiol equivalents, EEQ in ng/L) across a range of flow types at 9 different sites and subsequently looked at how these hydrologic conditions (e.g., peak storm flows vs. ascending flow, vs. base flows, etc.) and landscape characteristics among sites may explain the variation in EDCs. In addition, we measured EDC levels along a continuum of the Juniata River downstream of a waste water treatment plant to quantify decay patterns once entering water. Finally, at each site we collected information on young-of-the-year (YOY) SMB condition and diet. We used non-lethal gastric lavage techniques to extract diet contents and sacrificed a subset of individuals to estimate efficiency. EDC concentrations varied widely within sites at the same time, within sites at different times, among sites, and between years, but levels thus far in our surveys have not surpassed 1 ng/L, a threshold considered to be a concern for fish health. Initial analyses indicate that river discharge and flow characteristics related to storm runoff cannot explain variation in EDCs, nor have we identified landscape characteristics at 2 spatial scales that can explain variation. Thus far, we could not detect a trend in EDC concentrations downstream of the waste water treatment plant. In 2016, YOY SMB were numerous and were in excellent health, but were nearly absence during the same time in 2017. Most individuals contained at least some prey items, which on average consisted of about half aquatic prey and half terrestrial or neustonic prey. Rusty crayfish diet lacked resemblance to diet in YOY SMB. After gastric lavage, only a few fish were found to have some stomach contents remaining when dissected in the lab. Furthermore, nearly all YOY SMB fully recovered from field lavage experiences. Our study has identified levels of EDCs in the upper Juniata River systems that should be considered important for addressing ecological health in the broader Susquehanna River basin. Advancing our understanding of the dynamics of these emerging contaminants and their potential effects on smallmouth bass will require tracking and measuring specific compounds. We found gastric lavage to be a safe and effective technique to study YOY SMB feeding ecology without having to kill numerous individuals of this popular gamefish.

Keywords: endocrine-disrupting compounds, young of the year smallmouth bass, Juniata River watershed, storm flows

INFORMING AND INVOLVING THE NEXT GENERATION OF LEADERS IN THE RIVER

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RiverStewards is a new non-profit consortium of educational institutions, private sector companies, non-profit organizations, communities, government agencies, and individuals working to conserve one of our most significant ecological, economic and recreational resources in central Pennsylvania, the Susquehanna River. *RiverStewards* brings together those interested in the river to make a significant, collective social impact through inter-academic applied research, eco-tourism, reports from river guides and their clientele, and other deliberate cross-sector actions. We recognize the value of the Susquehanna River's social return on investment, which considers the environmental and social values that the river gives to us all, in addition to the economic benefits. Through our continued collective efforts and communication, we raise awareness of the river's importance and how we can sustain it.

We consider *RiverStewards* as the "Economic Value Curator for the Susquehanna," seeking to inform and involve the next generation of leaders in caring for the river.

During this session we will discuss the upcoming projects of *RiverStewards* and its partners, focusing on the economics and people that stem from the Susquehanna River. These projects include academic studies done by college students and professors along the length of the river in Pennsylvania. We will explore the content of these upcoming studies, including the ways we are informing and involving Millennials and members of Generation Z in the effort. We will also discuss how your organization can get involved in one or more of the projects.

Keywords: economics, student research, ecology, youth empowerment

THE VIEW BELOW: CONNECTING PEOPLE TO THE SUSQUEHANNA AND DELAWARE RIVERS THROUGH SNORKELING

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We often perceive that there isn't much to see beneath the surface of our nation's freshwater rivers and streams, but once we look underwater, an amazing world appears. Fish of incredibly diverse colors, shapes, and behaviors live in freshwater ecosystems. The streams themselves create other worldly, breathtaking streamscapes, giving humans willing to submerge themselves the opportunity to witness incredible ecological feats such as thousand-mile fish migrations, predator-prey interactions, or the vibrant-colors of mating displays. The underwater world of our rivers and streams is unexpected, largely unnoticed, and amazing! They are thriving aquatic communities, composed of subjects intimately tied to one another, and humans, through an aquatic matrix.

Snorkeling establishes powerful connections between people and rivers, and is one of the most intimate interactions we can have with a river, experiencing the movement and organisms of a moving water body on its own terms. Snorkeling allows us to bond with subjects that are intertwined in these aquatic communities, granting us new perspectives and reasons to care about the importance of clean water. The ways in which rivers, and the creatures that live in them, are woven into our cultural and natural heritage become apparent.

The Susquehanna and Delaware rivers support underwater communities that are unexpected in a heavily farmed and developing landscape. This presentation will explore the Delaware and Susquehanna from beneath the surface, and will show the importance of connecting people to these rivers through snorkeling.

Keywords: education, outreach, connection

INNOVATIVE APPROACHES TO WATERSHED HEALTH EDUCATION AND COMMUNITY AWARENESS/ ENGAGEMENT

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Berks Nature, a non-profit conservation organization, is the leading agent for conservation of the environment in Berks County, Pennsylvania. Its mission includes land protection, water conservation, environmental education and community engagement. This presentation highlights the organization's innovative approaches to water conservation, watershed education and community engagement in support of healthy watershed ecosystems in the Delaware and Susquehanna River Basins.

Berks Nature has spent the past ten years addressing these water resources and gaining support for the restoration and protection of water resources. Our partnerships across the region in developing and implementing watershed management plans received statewide recognition, as we are a proud past-recipient of the Governor's Award for Watershed Stewardship. We enjoy partnerships with organizations that share a goal of improving and protecting the Schuylkill River Watershed – the Philadelphia Water Department, the William Penn Foundation, the Schuylkill River Heritage Area, the Schuylkill Action Network, and RiverPlace Development Corporation.

This presentation will focus on three areas in which *Berks Nature* is addressing the integrity of the Delaware and Susquehanna River Basins: 1) watershed health awareness, 2) training of community volunteers, and 3) a stream and wetland restoration project.

Specifically, *Berks Nature* hosts events such as Aquapalooza and River Days for children and the public alike. Berks Nature also hosts an annual "State of The Environment" meeting, which may be unique for similarly-sized conservation organizations in the region, and which publishes environmental indicators that describe conditions and trends in the County's water resources. Secondly, engagement includes training volunteers, including an "Ambassador" volunteer program for interested laypersons, educators, and professionals alike who help both to educate and to perform water quality sampling in streams across the county and collect data for the international citizen-science project GLOBE. Finally, we discuss the educational and outreach opportunities afforded by a stream and wetland restoration project immediately adjacent to Berks Nature's brand new headquarters and education center.

Keywords: community awareness and education, watershed planning sustainability, watershed monitoring

ADVANTAGES OF STREAM CORRIDOR RESTORATION AS A BMP IN THE CHESAPEAKE BAY WATERSHED MS4 PROGRAM

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Stream Restoration (SR) is among the structural Best Management Practices (BMPs) acceptable for pollution reduction credits under the Municipal Separate Storm Sewer System (MS4) permit program. An important advantage of SR over other, infiltration-based MS4 BMPs, such as rain gardens and permeable pavement (here termed Green Stormwater Infrastructure, or GSI), is that SR directly reduces channel erosion, the principal source of fine sediment pollution in anthropogenic streams. Even when widely deployed, GSI cannot prevent the largest, most intense rainstorms (≥2 inch per hour) from generating high peak flows in channels because runoff from such storms tends to exceed the infiltration capacity of GSI facilities, causing much of this runoff to overflow and quickly drain to receiving streams. Peak flows from such heavy rainstorms are the main cause of channel erosion and the incidence of such storms is increasing in the USA.

Acquiring MS4 credit via SR can also piggyback on essential projects addressing failing municipal infrastructure, such as sanitary sewer line exposure due to stream erosion. In such cases, MS4 program benefits are acquired as streamside property owners realize the tangible benefits of continued sewer operation and land preservation. Stream restorations are also a proven way to enhance community livability in public open spaces such as parks and downtowns. People are naturally attracted to flowing water within accessible green spaces and SR in such areas can make these key locations for urban revitalization and economic re-development.

SR can also provide an economic advantage with respect to long-term maintenance, which is required with all MS4 BMPs. While many SRs can be allowed to re-naturalize and become largely self-maintaining, upland GSI landscaping must be maintained to accommodate societal norms of tidiness and attractiveness in the built landscape. Also, these facilities must not only be maintained for appearance but for continued function (e.g. infiltration capacity). Many upland GSI BMPs such as rain gardens will therefore require renewal of the soil media and replanting after a limited number of years of receiving pollutant-laden runoff from grimy impervious surfaces. Permeable pavements likewise have known long-term maintenance costs and a limited effective lifespan.

Keywords: stream restoration, stormwater management, MS4 Program, pollution reduction

ADAPTIVE STREAM RESTORATION STRATEGIES THAT ADD LARGE WOODY MATERIAL TO HEADWATER STREAMS TO IMPROVE AQUATIC LIFE, CHANNEL COMPLEXITY, HYPORHEIC EXCHANGE, AND FLOODPLAIN CONNECTIVITY

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Sustainable and effective stream restoration strategies should focus on assisting the recovery of ecological integrity in degraded sections of a watershed by (1) reestablishing hydrologic, geomorphic, and ecological processes and (2) replacing lost, damaged, or compromised biological elements. This presentation provides examples of chop-and-drop adaptive restoration techniques used in headwater streams in Pennsylvania and Maine that can be applied to watersheds throughout the Mid-Atlantic and New England. The streams contain coarse channel sediments that are naturally sorted into a complex network of log jam/step/pool and gravel bars. In their equilibrium state, the channels have a braided or multi-threaded pattern, with numerous side channels and depressions present across their floodplains. However, during the 19th and 20th century, many of these watersheds were clearcut and the streams channelized, straightened, bermed, and "cleaned" of logs and large boulders. Their braided patterns were reduced to a single channel to facilitate seasonal log drives or route flood waters quickly downstream.

We have been experimenting with new, adaptive restoration strategies such as "chop and drop," where selected trees in a riparian corridor are strategically felled directly into the channel and the stream self-adjusts over during high water events. Larger "digger" logs promote step-pool formation and finer "sweeper" branches promote bar formation, improve grain size distribution of the channel bed sediments, and spawning habitat for fish. Channel complexity and aquatic habitat is greatly increased. The hyporheic zone is also improved, with increased groundwater-surface exchange and transfer of carbon and nutrients between the forested floodplain and stream. In selected reaches, larger trees are being dropped into the stream at the head of the braid bar to redirect a portion of high-water flow to the abandoned side channels, thereby reconnecting the stream to its floodplain. This results in sediment being filtered out, water quality improved, groundwater recharge increased, and downstream flood peaks reduced. Chop and drop restoration approaches improve carbon sequestration within the local watershed system and the branches and leaves provide a food for macroinvertebrates and shelter for fish, amphibians, and reptiles. Compared to traditional methods, project costs can be reduced by orders of magnitude, because these methods require less materials and human resources to complete.

Keywords: stream restoration, chop-and-drop, floodplain reconnectivity

FUTURE HISTORY OF PENNSYLVANIA ANTHRACITE ABANDONED MINES

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The Anthracite Coal Region is a historically important coal-mining area in the Susquehanna and Delaware watersheds, located in portions of 12 counties in Northeastern Pennsylvania.
Pennsylvania and the United States would not be what we know today without the past's 250 years of anthracite mining. The story of the Anthracite Coal Region is one of a remarkable heritage involving working-class culture, innovative technology and corporate will. Hundreds of thousands of men in NEPA created modern America by digging coal. Our industry produced over five billion tons of anthracite which drove the Industrial Revolution. Doing so, we altered rural America, provided thousands of jobs and homes for immigrants, and produced a curious legacy, both fascinating and offensive.
We went from unspoiled Appalachian landscapes to 400 square miles of abandoned mines – thousands of miles of underground openings, gaping strip pits, man-made mountains of waste piles, silt-filled creeks, dangerous highwalls, open shafts and portals, hundreds of miles of technicolor, pollutant-laden streams. Pennsylvania has been the leader in enacting mine reclamation and clean water legislation and providing funding for restoring land and water resources and the environment degraded by legacy coal mining practices, including measures for the conservation and development of soil, water, woodland, fish and wildlife, recreation resources and agricultural productivity. Federal funding from the OSMRE, EPA, ARC and EDA has been key for cleanup of legacy coal issues. Industry sources also are working to address the problem, most notably the independent power producers (IPPs) who burn waste coal to produce power.
Progress has been made, but future improvement is uncertain because much of the future support of legacy remediation is fragile – citizen coalitions are working to deal with the inevitable depletion of the Growing Greener II bond program and the 2021 expiration of the Surface Mine Control and Reclamation Act, funding of other Federal Agencies is involved in budget debates, and waste coal IPPs have competitive price issues. In this presentation, I plan to talk about the past, present and future of abandoned mines in the Anthracite Coal Region. What we've done, what we're doing, and what can be done with the resources we have and may have in the future.

Keywords: abandoned mines, mine drainage, reclamation

MAPPING RUNOFF FLOW PATHS AND THEIR POLLUTION CONTRIBUTION POTENTIAL: THE IMPACT OF CROPS AS A LAND COVER CATEGORY

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High resolution land use and land cover (LULC) and digital elevation models (DEMs) can be used to map stormwater runoff flow pathways, and to estimate, based on land use, the likelihood of the flow path to contribute pollutants to a stream. Pioneered by Jeffrey Allenby and Conor Phelan at the Chesapeake Conservancy, this is an example of Precision Conservation--the use of high-resolution remotely-sensed data to identify priority sites for conservation. For each cell in a watershed, all the upstream cells that contribute overland flow to that cell are counted in two ways. The "unweighted" count is simply the number of contributing cells, and the "weighted" count sums up a weighting factor attributed to each contributing cell, based on the cell's LULC classification. For example, forests (weight 2) have a lower potential for contributing pollution than parking lots (weight 10). The weighted and unweighted contributing areas for each cell are combined into an index called NDFI, which theoretically varies from -1 to 1, with larger values indicating greater potential to contribute pollution.

This study centers on whether NDFI values are impacted by inclusion of crops as a LULC category, because many available LULC maps lump crops and other low vegetation into a single category. A simple rule-based procedure was used at Bucknell during the summer of 2015 to develop a LULC for the Buffalo Creek watershed near Lewisburg, PA. This map includes both low vegetation (weight 5) and crops (weight 7). A second map was developed in which crops were given the same weight as low vegetation (weight 5). Differences between the two estimates of NDFI are greatest for smaller channels in agricultural regions of the watershed.

Keywords: precision conservation, runoff, GIS, flow-path mapping

PRECISION CONSERVATION IN THE SUSQUEHANNA RIVER WATERSHED: TOOLS AND HIGH-RESOLUTION DATASETS FOR WATERSHED ORGANIZATIONS AND COMMUNITY-BASED STRATEGIES FOR SUCCESS

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To pilot a new innovative approach to conservation, Chesapeake Conservancy, Susquehanna University, Bloomsburg University, the Chesapeake Bay Foundation, and the Pennsylvania Department of Conservation and Natural Resources are collaborating to harness newly available high-resolution GIS datasets and tools to conduct precision conservation in an effort to better focus restoration efforts on the ground. This project aims to demonstrate improved efficiency, effectiveness, and returns on investment through better site selection prioritization and support technology transfer to broaden adoption across multiple regions in the Susquehanna.

This talk will outline community-based tools for implementation partners and landowners created in our pilot region of Centre and Clinton counties, monitoring work associated with Precision Conservation, and high-resolution datasets available for watershed groups across the Susquehanna River Watershed. In the future, we will be scaling these tools across the Susquehanna River Watershed to guide best management practice implementation where we can achieve the greatest water quality benefits and inform landowners of restoration opportunities as well as the conservation professionals who can provide assistance with projects.

Keywords: conservation, watershed, GIS, prioritization

UPDATED LIDAR FOR PA - STATUS AND PLANS

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Pennsylvania was one of the first states to have complete topography (2-foot contours) derived from lidar data. Collected between 2006 and 2008, that data has empowered researchers, conservancies, private developers, regulators, and innovators in the understanding and management of PA's natural resources and infrastructure.

The rate of change in lidar technology and the cumulative changes wrought by man and nature over the last decade dictate that we plan and execute the collection and use of updated topography. Furthermore, advances in data analytics and data handling capacity offer heretofore impossible change detection capabilities; forest growth and fragmentation patterns over the last 10 years are clear examples of potential comparisons.

This session will describe progress in the update process including: areas already updated, parties interested in completing a statewide update, and activities of the newly formed PA Lidar Working Group.

Keywords: LiDAR, topography, change detection, remote sensing

CONSERVATION THREATS AND OPPORTUNITIES FOR THE GIANT EASTERN HELLBENDER SALAMANDER IN THE SUSQUEHANNA RIVER WATERSHED

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Catastrophic flood events, urban development, road and highway construction, industrial discharge, and forestry and agricultural practices have all impacted the ecology of streams and rivers in the Susquehanna River watershed in ways that have restricted, diminished, or eliminated quality habitat for the giant Eastern Hellbender salamander. In addition, crayfish invasions and amphibian disease epidemics have further stressed hellbender populations. The Eastern Hellbender has experienced range-wide local extinctions since the late 1990's and is currently a candidate species for federal listing as threatened or endangered. Conservation efforts to restore the giant salamander to its former range have been constrained by past land use practices and multiple stressors, but innovative methods to restore salamander populations have already yielded impressive results. Instream habitat structures have been installed to serve as salamander habitat and are already occupied by wild hellbender populations. The rearing of hellbenders from eggs to adult size by conservation organizations is nearing completion and captive-reared animals will soon be released to restore or augment declining populations.

Keywords: Eastern Hellbender, Applied Conservation, Head-starting, Habitat Restoration

SEASONAL AND DIEL SIGNATURE OF EASTERN HELLBENDER ENVIRONMENTAL DNA

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

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

IMPLEMENTING AN ECOSYSTEM SERVICES APPROACH IN THE DELAWARE RIVER BASIN: SUCCESSES, CHALLENGES, AND FUTURE DIRECTIONS

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The concept of ecosystem services (ES) to define, promote, and conserve natural resources has increased over the past decade. Loosely defined as the benefits that humans gain from the natural environment, the application of ES as a potential management tool is desirable. In theory, ES have the capacity to articulate and leverage key ecological processes, that otherwise may go unnoticed, into environmental policy and management decisions. By extension, this approach serves to justify conservation or restoration actions, and their associated benefits, that may be gained or lost given management intervention. In practice, ES are difficult to implement for three reasons: biophysical (ecosystem process) and societal (value) parameters are difficult to quantify; both vary across time, space, and proximity to human activity; and once parameterized, are difficult to translate to other systems. Here, we use biofiltration of water provisioned by freshwater mussels as a model system to highlight potential opportunities, caveats, and research needs associated with the valuation of natural capital.

FORTY-MILE STORIES: STUDENT STORYTELLING ON THE SUSQUEHANNA RIVER

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We present a narrative approach to cultivating identification with and value to the Susquehanna River through experiential, place-based learning. This stems from work completed in a course titled "Environmental Advocacy Writing" and will be divided between the instructor's perspective and a student's perspective on the project, engaging pedagogy on environmental writing, science writing, and experiential learning.

This presentation represents the pilot of a larger project, supported by River Stewards, which will divide the river into twelve 40-mile sections and engage students in the process of developing narratives that promote the spirit of the diversity along this river, the common waters that run through these communities, and efforts in addressing environmental issues. Communication efforts often treat rivers as a single body that connects all communities along its course. This approach differs by dividing the river into twelve sections treated as both distinct and interconnected units. We anticipate people will more easily identify with the river when divided into distinct localities. Just as we are all simultaneously proud Americans and proud Pennsylvanians, we wish citizens to identify as stewards of the Susquehanna River as well as stewards of the Dauphin Narrows, Lake Clarke, or the Isle of Que. This particular presentation focuses on student writing on the area around Wrightsville and Columbia. We intend to both present our initial work on this project and cultivate interest for future collaboration with universities along the course of the Susquehanna.

Keywords: environmental advocacy, science writing, narrative, experiential learning

ENGAGING NON-TRADITIONAL CITIZEN SCIENTISTS IN WATERSHED PROTECTION

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What do prisoners, paddlers, parochial school students, and an energetic puppy all have in common? They are all engaged in citizen scientist work with Middle Susquehanna Riverkeeper. In this short presentation, explore outside the traditional citizen scientist box and discover ways to engage community members in your work while learning more about Middle Susquehanna Riverkeeper's newly launched programs with Pennsylvania State Department of Correction's SCI Quehanna Bootcamp, American Canoe Association-Pennsylvania, Our Lady of Lourdes Regional School, and "Little Keeper" Susquehanna, who is being trained to sniff out sewage leaks in the watershed and will serve as a spokes-dog for a new poop-to-power initiative. Curious? Join us.

Keywords: citizen scientists, community engagement, watershed protection, innovation

FLOOD MITIGATION FOR PENNSYLVANIA'S RURAL COMMUNITIES: COMMUNITY-SCALE IMPACT OF FEDERAL POLICIES. FINDINGS OF THE SEPTEMBER 2017 REPORT TO THE CENTER FOR RURAL PENNSYLVANIA

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In the US, many flood mitigation actions and decisions are made at the municipal level, though subject to Federal and State-level rules, requirements, regulations, and incentive programs. Many communities throughout the U.S. actively seek to reduce flood safety threats and property damages to their residents, including by taking advantage of available federal and Commonwealth programs. However, different communities' needs, geography, demography, preferences, and priorities are tremendously diverse, especially in a region like Pennsylvania where local government consists of some 2,500 separate counties, cities, boroughs, and townships – each responsible for their own decisions about many of the most crucial land use, building code, and mitigation activities. Therefore Federal and Commonwealth programs, designed to reach as many locations as possible, necessarily fail to accommodate the highly diverse conditions of local communities, and while those programs are intended to promote and support local efforts, in practice many of those programs inhibit or preclude some activities that would be best suited for some localities. This research highlights some of the ways in which programs succeed for some Pennsylvania communities, and ways in which they fail for some of those same communities, at meeting their local needs. Further, the research shows many communities are not aware of available resources, have expressed a need for increased resources and institutional support from those programs, and desire additional programs. The research focuses especially on FEMA's National Flood Insurance Program, a Federal program intended to provide disaster relief for individuals and firms who experience flood damages – but with premiums that vary from highly subsidized to full "actuarial" rates, and currently facing Congressional action to decide whether to remove all subsidies (with profound economic impacts on policy holders) or continue subsidies that seem to encourage over-development in the floodplains of the nation. The research also focuses on the Community Rating System, a program intended to encourage communities, individuals, and firms to undertake more extensive mitigation beyond the bare minimum, but with such programmatic complexities that many communities fail to take full advantage.

Keywords: Flood mitigation, Rural communities, River communities, Flood insurance

HYDROLOGIC ANALYSIS OF A 100-YEAR FLOOD EVENT IN A SMALL RURAL WATERSHED IN CLINTON COUNTY, PA

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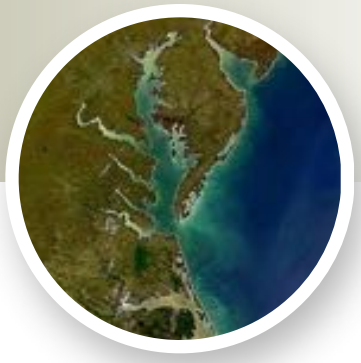
The US EPA reports precipitation from extremely heavy storms has increased 70 percent in the Northeast since 1958 (2016). NASA warns that Northeast will experience more heavy downpours and changes in patterns of precipitation will pose growing challenges to many aspects of life (2017). As per the IPCC (2007), evidence indicates that the net damage costs of climate change are likely to be significant and to increase over time.

The residents of Sugar Run sub-watershed (1.25 mi^2) within the Beech Creek watershed in Clinton County, PA experienced a total of 6.5 inches of rain in two hours on June 27, 2013. This event resulted in a flash flood that caused $17 million damage to property, one casualty, and 32 miles of road damage in the area. The amount and the intensity of rainfall corresponded to a 100-year event for the region. However, the rain event was localized in nature and did not have much impact on nearby USGS gaging stations. Field data on personal property and infrastructure damage caused by the flood were documented during and after the flood. The extent and the nature of the flood were analyzed using several hydrologic theories to determine frequency of the rain event, velocity and discharge of the Sugar Run at bankfull stage and flood stage, peak discharge during the flood, time of concentration of surface run-off following the rain event, and the duration of storm flow. The velocity of the flow (0.8 ft sec^{-1}) and discharge (<1 ft^3 sec^{-1}) in Sugar Run during normal flow conditions were determined to compare with values calculated for the flood event. The data show that the calculated flow velocity at bankfull stage (6 ft sec^{-1}) and the peak discharge during the flood (690-780 ft sec^{-1}) were an order of magnitude higher as compared to those values during normal flow conditions.

Based on hydrologic analysis of the data, it is concluded that the flood water must have been flowing at 0.6 ft sec^{-1}, which corresponded to a peak discharge rate of 690 ft^3 sec^{-1} over the floodplain (with a cross sectional area of 1180 ft^2) in Sugar Run during the flood peak discharge. The calculated values are in agreement with eyewitness accounts. The hydrologic methods applied to verify the field evidence and reported observations about the flood damage proved to be valuable tools, which can be used to predict the extent of future floods caused by similar intense precipitation events in small watersheds.

Keywords: heavy downpours, flash flood, small watershed, rural PA



GROUNDWATER AS A SOURCE OF EMERGING CONTAMINANTS IN THE CHESAPEAKE BAY

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

Keywords: groundwater, emerging contaminants

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

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

Keywords: Bathymetry, GPR, Ground Penetrating Radar

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

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

Keywords: CWI, Stream Restoration

BIOLOGICAL EFFECTIVENESS OF INSTREAM RESTORATION

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

Keywords: farm, stream, restoration, agriculture

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

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

Keywords: Water Quality Index, headwater

CHANNEL SEDIMENT CHANGES DURING A STREAM RESTORATION PROJECT

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

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

LANDSCAPE CHARACTERISTICS THAT CONTRIBUTE TO SUCCESSFUL STREAM RESTORATION PROJECTS

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

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

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

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

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

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

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

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

POLYPHOSPHOROUS STORAGE DYNAMICS IN STREAM BIOFILMS

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

Keywords: polyphosphorous, phosphorus, agriculture

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

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

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

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

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

Keywords: ecology, amphibians, road salt

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

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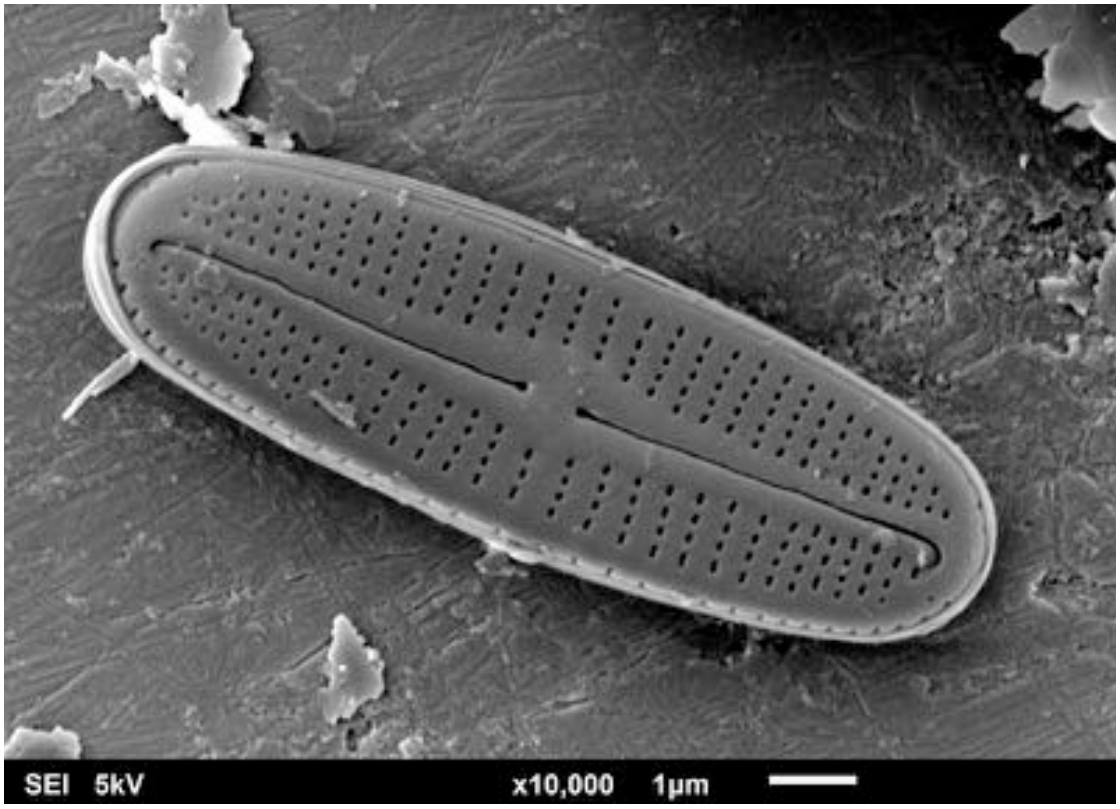
The upper main stem of the Susquehanna River is formed by the confluence of the West and North Branch, both of which are chemically and physically distinctive. The upper main stem retains the signatures of the two branches due to weak lateral mixing, and we refer to them as the West Branch plume (WBP) and the North Branch plume (NBP). Thus, characterization of the diatom communities requires samples taken from sites that occur in the plumes of both branches. Since 2009, we have monitored the upper main stem at an established transect that straddles Byers Island near Shamokin Dam, PA and below the Adam T. Bower inflatable dam at Sunbury, PA. Attached diatom communities were sampled from stones which were prepared for examination by scanning electron microscopy. The Pollution Tolerance Index (PTI) and Shannon Diversity Index (SDI) values showed very little variation between all sites (2.38-3.03 and 2.35-2.93). We found the greatest species richness in the diatom communities of the NBP (Site 3- 30; Site 4- 29). Proportional Bray-Curtis Similarity analyses of samples showed low to moderate overlap between the diatom communities. Across all sites we identified 57 different species. Habitats of the NBP were dominated by *Discostella pseudostelligera* (a small centric), *Rhoicosphenia abbreviata* (a biraphid), and *Achnanthidium minutissium* (a small monoraphid). Similar habitats of the WBP were dominated by *Ach. minutissium*, *Encyonema appalachianum* (a biraphid). Despite similarities between 2014 and 2017 regarding discharge, the diatom communities were depauperate this year (57 taxa; 104.470 cfs) compared to other high discharge summers (June, July, and August) especially 2014 (93 taxa; 80,590 cfs). Difference in taxa richness could possibly be explained by lingering effects of a prior low discharge year (2016- 36,562 cfs).

Keywords: diatoms, biofilms, Susquehanna River



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

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

Keywords: diatom, biofilm, headwater stream

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

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

Keywords: benthic macroinvertebrates, headwater streams

SEASONAL AND DIEL SIGNATURE OF EASTERN HELLBENDER ENVIRONMENTAL DNA

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

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

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

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

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

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

Keywords: brook trout, brown trout, competition

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

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

Keywords: ecology, dietary conditions, predatory conditions, morphology

INSTALLATION AND CALIBRATION OF LEVEL LOGGERS TO ASSESS STREAM BMP EFFECTIVENESS

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

Keywords: stream restoration, discharge calibration, level loggers,

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

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The Beech Creek and Clearfield area watersheds in central Pennsylvania have a long history of coal mining, which resulted in a legacy of Acid Mine Drainage (AMD) degradation of water and soil resources. Beginning in 2008, the area experienced another wave of resource extraction related to Marcellus Shale gas-well drilling. Recent gas-well drilling has raised concerns among citizens and the science community relating to potential impacts of resource extraction on the quality of water resources and ecosystems. In the wake of Marcellus Shale drilling activities, Lock Haven University's Geology program forged a partnership with several community-based organizations to monitor the quality of surface water within these watersheds over a long-term basis. On average, a total of 20 samples have been collected monthly from Beech Creek and Clearfield County watersheds beginning in 2010 for laboratory analysis. The parameters monitored include, but are not limited to, temperature, pH, TDS, total Fe, Al^{3+}, Ba^{2+}, Cl^{-}, and SO_4^{2-}, which were determined using HACH™ DR6000 Spectrophotometer and HACH™ multi-parameter probes. These parameters were chosen due to their association to both AMD and Marcellus Shale drilling activities.

Over the years of the study, there have been multiple streams with concentrations that warranted alarm and potential for further investigation. The Moose Creek tributary in Clearfield County is an emergent issue, featuring low pH and high aluminum concentrations relative to the rest of the study locations in Clearfield County. Stoney Run in Clearfield County continues to prove itself as a severely impaired by low pH and high TDS. The samples collected from Beech Creek at Monument and Jonathan Run in Beech Creek watershed shows deterioration in terms of TDS, total Fe, Ba^{2+}, and SO_4^{2-} values over time. In conclusion, Marcellus Shale drilling and the legacy of AMD damage in these watersheds continue to be a problem, as seen in the slow decrease in water quality.

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

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

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

Keywords: mercury, spider, coal mining, riparian

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

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

Keywords: sensor, turbidity, monitoring, low-cost

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

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

Keywords: water quality, land use, mining, agriculture

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

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

Keywords: submergence tolerance, burrowing, wolf spider, riparian

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

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

Keywords: benthic macroinvertebrate , %EPT, Discharge

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

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

Keywords: geochemistry , water quality , hydrology , spring seep

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

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

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

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

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

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

EVOLUTION OF DISPERSAL TRAITS OF ADULT STREAM INSECTS

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

Keywords: adult stream insects, dispersal, forest canopy

CHANNEL AND RIPARIAN RESTORATION TO IMPROVE HABITAT IN AGRICULTURAL STREAMS

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

Keywords: stream, restoration, habitat, agriculture

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

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

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

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

Keywords: water temperature, solar radiation, Susquehanna River

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

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

Keywords: macroinvertebrate , ecosystem function , bioindicator

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

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

Keywords: Canada thistle, soil warming, climate change

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

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

Grab samples of water were collected at 5 locations on a monthly basis from April to September, 2017. HACH™ field and laboratory equipment were used to collect, process, and analyze data to evaluate baseline water quality. Data collected throughout 2016 served as a background dataset for understanding seasonal trends throughout the summer months. The primary objective of this study was to determine total organic carbon concentration, due to its importance for the final outcome of the treatment process. Field parameters included temperature, pH, conductance, TDS, and DO. Additional lab analysis yielded results for COD, BOD, NH_3-N, NO_3-N, NO_2-N, PO_4-P, Cl^-, and SO_4^{-2}. Water Quality Index (WQI) was calculated following the methods developed by Vicente et al. (2009).

The WQI values were found to be excellent. The WQI values were relatively similar between each of the 5 study locations through the duration of the study period. Throughout the course of the study period, none of the parameters tested had values that warranted alarm when compared to the US EPA's primary drinking water standards. The highest observed NO_3-N values were less than 1/10 the MCL for drinking water; other parameters showed results that were also below those suggested by the US EPA. On average, the values of nutrients, such as NH_3-N and NO_3-N, were below or equivalent to the natural background levels suggested by the USGS literature (U.S. Geological Survey, 1999). The toxicity levels, in terms of heavy metals, in sediment samples collected were also less than the probable effect levels published by the US EPA (Ingersoll et al., 2000).

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

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

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

Keywords: microplastic, diet , smallmouth bass , Susquehanna River

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

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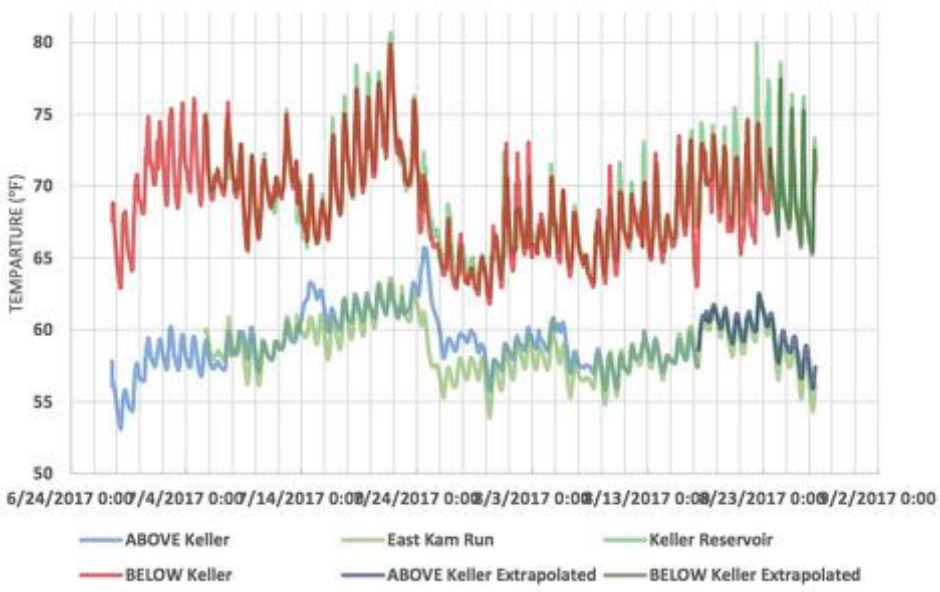
In the summer of 2016 the Pennsylvania Fish & Boat Commission (PFBC) conducted a study on McElhattan Creek to gauge the health of the wild trout population within the watershed. The study identified a significant problem that the watershed faces in relation to the difference in water temperature upstream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

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

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

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



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

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

Keywords: macroinvertebrates, stormwater, water chemistry

ASSESSMENT OF PASSIVE AMD TREATMENT SYSTEMS IN SCHUYLKILL COUNTY, PENNSYLVANIA

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

Keywords: AMD, Schuylkill County, Abandoned Mine Drainage

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

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

Keywords: brook trout, introgression, genetics, hatcheries

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

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

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

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

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

Keywords: cyanobacteria, stream survey, cyanotoxins, agricultural impact

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

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

Keywords: brook trout, climate change, fish behavior

QUANTIFYING THE MOVEMENT EFFICIENCY OF TERRESTRIAL SALAMANDERS ACROSS AQUATIC BARRIERS

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

Keywords: salamander, herpetology, movement efficiency, speed trials

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

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

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

Porter Tunnel had the lowest pH (3.62) and lowest alkalinity (0 mg/L as $CaCO_3$) compared to those of Big Lick (7.04 and 100 mg/L as $CaCO_3$) and Short Mountain Mine (6.58 and 21.0 mg/L as $CaCO_3$). Conductivity was highest in Porter Tunnel AMD (843 µS/cm) compared to that from Big Lick (283 µS/cm) or Short Mountain Mine (174.9 µS/cm). Results of ion and metal analyses indicate that it is not due to dissolved iron, aluminum and manganese as originally predicted, but due to high levels of sodium, chloride, magnesium, and calcium, indicative of road salt contamination.

Keywords: Abandon Mine Drainage, Aqueous Geochemistry

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

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

Keywords: urban stream, stormwater, MS4

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

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

Keywords: flood policy, NFIP, flooding

FISH ASSEMBLAGES

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

Keywords: fish assemblages, dams, water flow

A CRAYFISH SURVEY OF THE FISHING CREEK WATERSHED IN NORTHEASTERN PENNSYLVANIA

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Introductions of invasive crayfish species have impacted freshwater ecosystems worldwide, typically resulting in displacement of native crayfish species by non-native species. Two crayfish species (*Orconectes limosus* and *Cambarus bartonii*) are thought to be native to the Susquehanna River Drainage in eastern and central Pennsylvania. However, several non-native crayfish (e.g., *O. obscurus, O. rusticus, O. virilus*) have been introduced and have become established in this river system. Few data are available on the present occurrence and distribution of crayfish species within the Fishing Creek watershed, a drainage encompassing approximately 620 km2 within the North Branch Susquehanna River Drainage in eastern Pennsylvania. Records from the early 1900s report the occurrence of both *O. limosus* and *C. bartonii* in this watershed; however, recent point-surveys in the lower reaches of the watershed have reported the presence of the non-native crayfish *Orconectes obscurus*. In this work, crayfish were sampled at fifteen sites from the lower reaches of Fishing Creek to its headwater branches and major tributaries in order to elucidate the current presence and distribution of crayfish species within this watershed. A total of 484 crayfish were collected, representing the species *O. obscurus* (n = 376) and *C. bartonii* (n = 108). *O. obscurus* were found to be widespread within the drainage, but absent from the upper reaches of the Fishing Creek watershed, potentially as a result of physical or environmental barriers (e.g., dams, shifting stream characteristics). *C. bartonii* were primarily distributed in the upper portions of the Fishing Creek watershed, but also found in smaller tributary near the mouth, and sympatric (but in found in low abundance) with *O. obscurus* in the central portions of the drainage. This distribution of *C. bartonii* within the watershed is likely due to habitat preferences (e.g., cooler, smaller, and higher gradient portions of streams) of this species, but may also result from displacement by *O. obscurus*. The historically present *O. limosus* was not collected within the watershed, potentially suggesting local extirpation via competition with *O. obscurus*, as has been reported in other elsewhere in aquatic ecosystems invaded by non-native congeners.

Keywords: crayfish, native, non-native, survey

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

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

Keywords: water quality, nutrients, watershed management

ROSE VALLEY LAKE SURVEY

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

Keywords: trophic state, lake

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

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

Keywords: unassessed waters, CWI

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

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

Keywords: dam removal, channel adjustment

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

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

Keywords: water pricing, water economics

ANALYSIS OF SPIDERS FOR HEAVY METALS AND VOLATILE COMPOUNDS

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

Keywords: metals, volatiles, spiders

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

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

Keywords: Pine Creek

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

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

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

READY, SET, FIT

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

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

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

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

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

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

Keywords: fitness, history, culture, technology

From The Branches to The Confluence

October 18-19, 2006

Pennsylvania Abandoned Mine Drainage Remediation

September 28, 2007

The Susquehanna and Agriculture

September 12-13, 2008

Susquehanna River Symposia

Bucknell University - 2006 to 2017

Cultures At The Confluence - Native Americans

September 26, 2009

4th

River Health and The Chesapeake Bay

October 22-23, 2010

5th

River Towns in the 21st Century

October 18-19, 2011

6th

Susquehanna River Symposia

Bucknell University - 2006 to 2017

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

Susquehanna River Symposia

Bucknell University - 2006 to 2017

The River, Its Landscape and Our Lives

November 13-14, 2015

10th

A Tale of Two Rivers: The Susquehanna and Delaware

November 11-12, 2016

11th

The Spirit of Two Great Rivers

November 10-11, 2017

12th

Susquehanna River Symposia

Bucknell University - 2006 to 2017

Photo: SRHCES student researchers studying native gastropod communities in the North Branch Susquehanna River at Harding, PA

SRHCES

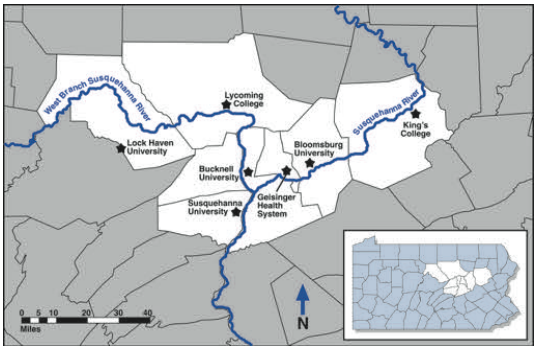
The Susquehanna River Heartland Coalition for Environmental Studies has played a major part of the River Symposium since its beginning 12 years ago. Established in 2005 by H. W. "Skip" Wieder, the SRHCES continues to grow as a unique collaboration of regional universities, environmental agencies, watershed groups, and the Geisinger Health System, all working together on interdisciplinary research projects in the "heartland" of the Susquehanna River basin.

Its members meet almost monthly to discuss ongoing research projects, opportunities for collaboration, and emerging issues in the watershed.

The Coalition creates educational opportunities that promote student interest and involvement in the natural resources of the Susquehanna watershed.

It creates a unique collaboration that connects post secondary students attending institutions in the Susquehanna heartland region with local communities and environmental organizations.

Members present their findings at the Susquehanna River Symposium and other public events throughout the year.



* Please see the SRHCES annual report "Pulse of the Heartland" (in your symposium folder) for more information.

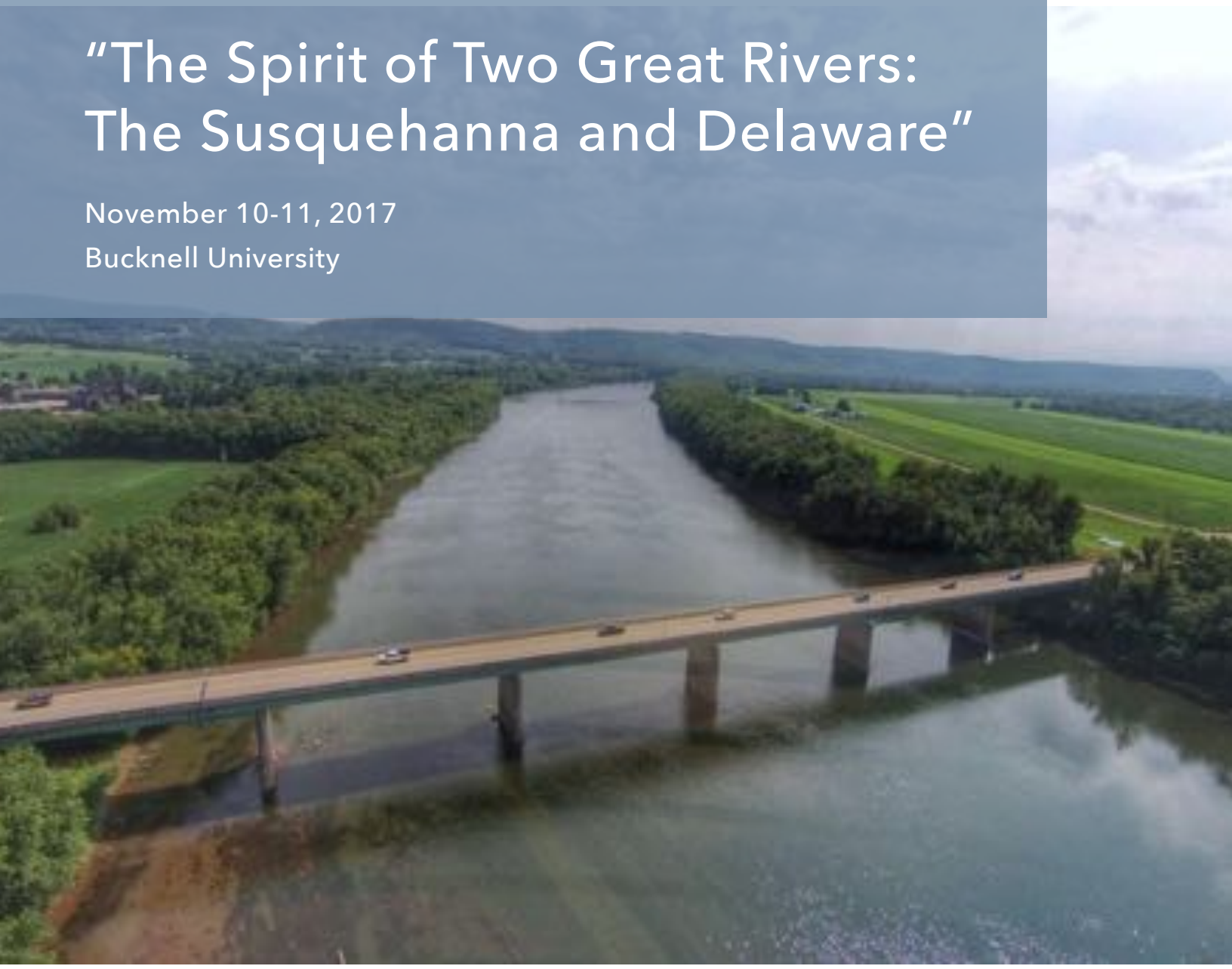
www.srhces.org

2017 Susquehanna River Symposium

"The Spirit of Two Great Rivers: The Susquehanna and Delaware"

November 10-11, 2017

Bucknell University



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Bucknell UNIVERSITY
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