2018 SUSQUEHANNA RIVER SYMPOSIUM

SCIENCE, CONSERVATION & HERITAGE

PROGRAM WITH ABSTRACTS

October 26-27, 2018
Bucknell University

www.bucknell.edu/riversymposium

Symposium Committee

Benjamin Hayes
Director, Watershed Sciences and Engineering Program, Bucknell University

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

Peter Jansson
Faculty Director, Bucknell Center for Sustainability and the Environment

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Executive Director, Susquehanna River Heartland Coalition for Environmental Studies

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Professor, Department of Civil and Environmental Engineering

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Mizuki Takahashi
Assistant Professor, Department of Biology/Animal Behavior

Karen Morin
Associate Provost, Bucknell University

Photos:

Front cover: Fall along the West Branch Susquehanna River near Chillisquaque, PA, October 2016. [B. Hayes]
Next page: Summer at Nippenose Spring, headwaters of Antes Creek near Oval, PA, June 1998. [B. Hayes]
Inside rear cover: Student researchers on the North Branch Susquehanna River near Harding, PA, July 2015. [S. Reese]
Rear cover. Winter along the West Branch Susquehanna at Lewisburg, PA, February 5, 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 Mid-Atlantic rivers and estuaries.

It features keynote and plenary addresses, breakout discussions, oral and poster presentations, and exhibits from over 150 students, faculty, consultants, agencies, and watershed groups. Our goal is to cultivate knowledge, discovery, and stewardship for the benefit of the Susquehanna River and Chesapeake Bay and its human and natural communities.

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.

"The care of rivers is not a question of rivers but of the human heart."

- Shozo Tanaka (Japan's conservationist pioneer)

Contents

Welcome

"Science, Conservation, & Heritage"

2018 Susquehanna River Symposium

On behalf of Bucknell University and the symposium committee, welcome to the 13th Susquehanna River Symposium. This two-day event is offered by the Bucknell 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 the mid-Atlantic region. The watersheds may share a similar climate, geology, and hydrology but have distinct differences in geology, hydrology, demographics, land use and natural resources. For example, dams and natural gas extraction is more prevalent in the Susquehanna watershed than in the Delaware and thus require different management and conservation approaches. Also, it is important we consider the heritage of this region and include the perspective and wisdom of Native Americans as part our discussions of interconnectedness, conservation, and sustainability.

KEYNOTE SPEAKER. On Friday, from 7:30 to 8:00 p.m., Christopher Williams will deliver the symposium's keynote address *"The Importance of Rivers: Water Security in an Insecure World."* As Senior Vice President of American Rivers, Chris has initiated and led river conservation and restoration projects in watersheds around the world.

RESEARCH POSTERS. On Friday, from 8:00 to 10:00 p.m., over 100 students and faculty from 18 colleges and universities and 28 government agencies and environmental organizations will present their posters. They feature projects from throughout the Susquehanna and Delaware watersheds and Chesapeake Bay and Delaware Estuary. An evening social will follow, which is a great way for everyone to intermingle and make new connections. Research posters will remain on display in the Terrace Room through Saturday's symposium events.

PLENARY ADDRESSES. On Saturday, from 9:00 a.m. to 10:30 a.m., three plenary addresses will kick off the day's events:

- **John Arway**, Executive Director of the Pennsylvania Fish and Boat Commission will speak on the theme of large river science and management with an address entitled ***"40 Years a Biologist."***
- **Christopher Williams**, Senior Vice President of American Rivers, will speak on the theme of river conservation with an address entitled ***"River Conservation in the U.S.: The State of the Art."***
- **Sid Jamieson**, Cayuga Nation Iroquois and Faithkeeper, Greenwood's Land Conservancy will speak on the theme of heritage with an address entitled ***"Iroquois Nations … Land Conservancy and Heritage."***

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

BREAKOUT DISCUSSIONS. Following the plenary addresses, from 11:00 a.m. to 12:00 p.m., breakout discussions will explore three themes:

- Watershed Science: Managing and Protecting Large River Ecosystems
- Watershed Conservation: State of the Art Practices and Solutions
- Watershed Heritage: Native American Approaches and 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. Lunch will be served from 12:15 to 1:15 p.m. in Walls Lounge.

ORAL PRESENTATIONS. Saturday afternoon features 24 oral presentations organized into eight topical sessions:

- Status, Trends, and Monitoring I
- Aquatic Ecosystems
- Watershed Hydrology
- Climate, Conservation, and Restoration
- Aquatic Ecosystems - Stress and Response
- Status, Trends, and Monitoring II
- Watershed Mapping and Assessment
- Status, Trends, and Monitoring III

A schedule is available on pages 9-12 and abstracts on pages 17-36.

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 3:30 p.m., 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, Samantha Myers, Peter Jansson, Richard Crago, Matthew McTammany, Mizuki Takahashi, and Lina Hinh.

Best wishes for a great symposium!

Sincerely,

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

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

Schedule

Friday, October 26, 2018

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

7:00 - 7:05 p.m.

Welcome

Benjamin Hayes
Symposium Chairman

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

Jack Holt
Professor of Biology, Susquehanna University
Member, Susquehanna River Heartland Coalition for Environmental Studies

Keynote Address

7:30 - 8:00 p.m.

"The Importance of Rivers: Water Security in an Insecure World"

Christopher E. Williams

Senior Vice President for Conservation
American Rivers

**Tentative*

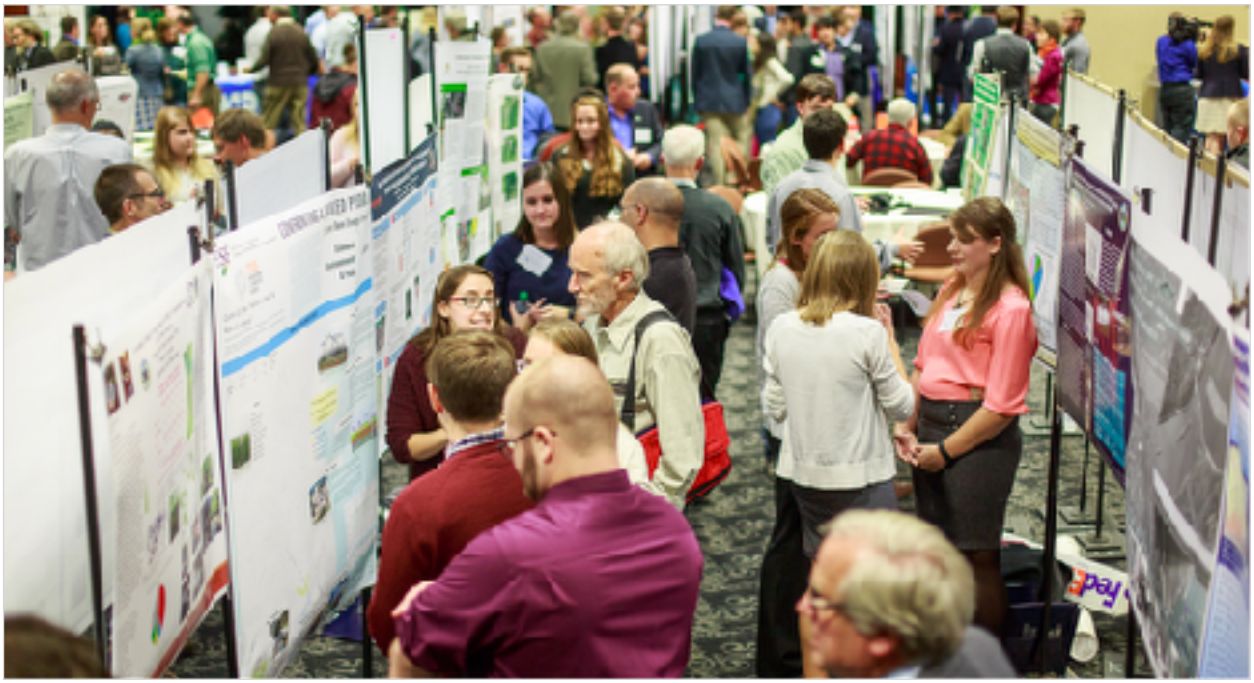
Friday, October 26, 2018

Research Posters and Evening Social

8:00 - 10:00 p.m.

Room 276 (The Terrace Room) and 241 ABCD

Poster displays from over 100 students and faculty from 18 universities and colleges throughout the mid-Atlantic region, as well as 28 state and federal environmental agencies, consulting firms, watershed groups, and other organizations.



Saturday, October 27, 2018

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 can begin setting 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

Peter Jansson, Faculty Director, Bucknell Center for Sustainability and the Environment

Watershed Science, Conservation, and Heritage

9:15 - 9:45 a.m.

"40 Years a Biologist"

John Arway

Executive Director,
Pennsylvania Fish and Boat Commission

9:45 - 10:15 a.m.

"River Conservation in the U.S.: The State of the Art"

Christopher Williams

Senior Vice President for Conservation
American Rivers

10:15 - 10:45 a.m.

"Iroquois Nations … Land Conservancy and Heritage"

Sid Jamieson

Cayuga Nation Iroquois and Faithkeeper, Greenwood's Land Conservancy
Advisory Board, Chesapeake Conservancy

Intermission

10:45 - 11:00 a.m.

Exhibits on display in the Center Room (Room 256)

Breakout Discussions

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

1. **Watershed Science**
   Managing and Protecting Large River Ecosystems
   John Arway, leader
   Arches Lounge (Room 304)

2. **Watershed Conservation**
   State of the Art Conservation Practices and Solutions
   Chris Williams, leader
   Terrace Room (Room 276)

3. **Watershed Heritage**
   Native American Perspectives and Approaches
   Sid Jamieson, leader
   The Forum (Room 272)

Lunch

12:15 - 1:15 p.m.
Walls Lounge (Room 213)

Exhibits on display in the Center Room (Room 256)

Oral Presentations

1:30 - 2:30 p.m.

Session 1. **Status, Trends and Monitoring I**
The Forum (Room 272)

Session 2. **Aquatic Ecosystems**
Rooms 241, A and B

Session 3. **Watershed Hydrology**
Rooms 241, C and D

Session 4. **Climate, Conservation, and Restoration**
Gallery Theater (Room 301)

Exhibits

2:30 - 3:30 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

3:30 - 4:30 p.m.

Session 5. **Aquatic Ecosystems - Stress and Response**
The Forum (Room 272)

Session 6. **Status, Trends and Monitoring II**
Rooms 241, A and B

Session 7. **Watershed Mapping and Assessment**
Rooms 241, C and D

Session 8. **Status, Trends and Monitoring III**
Gallery Theater (Room 301)

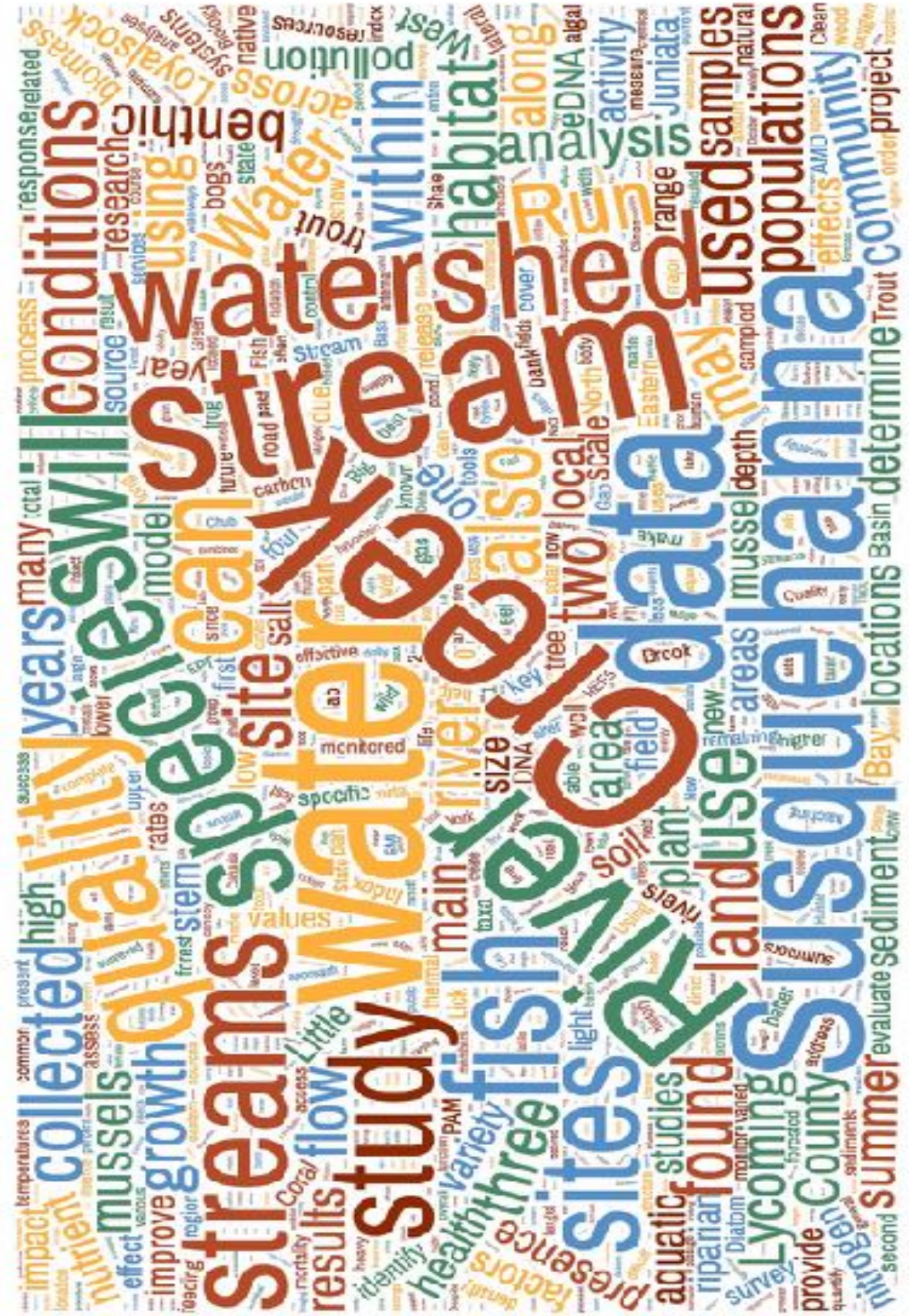
Looking Ahead

4:30 - 4:45 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 most frequently words 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 - 36.

* denotes presenting author.

Session 1

Status, Trends and Monitoring I

The Forum (Room 272), Saturday, October 27, 2018, 1:30 - 2:30 p.m.

1:30 p.m. *"Determining the scope of impact: Evaluating the indirect effects of American eel stocking on eastern elliptio populations throughout the Susquehanna River Basin."*
Carrie J.Blakeslee,* Heather S. Galbraith, Julie L. Devers, Jeffrey C. Cole, Steve Minkkinen.

1:50 p.m. *"Science-based protection of source water quality and ecosystem integrity in the Delaware River Basin."*
Marie J. Kurz,* Scott Haag, Stefanie A. Kroll, Carol Collier, Roland Wall

2:10 p.m. *"Spatial and temporal thermal patterns in the Spring Creek watershed."*
Alexandra S. Orr,* Elizabeth Boyer, Dave Yoxtheimer

Session 2

Aquatic Ecosystems

Rooms 241, A and B, Saturday, October 27, 2018, 1:30 - 2:30 p.m.

1:30 p.m. *"The re-introduction of the American Eel to the Upper Susquehanna Watershed"*
Sarah E. Coney* and Paul H. Lord

1:50 p.m. *"Assessing macroinvertebrate community response to restoration of Big Spring Run: Expanded analysis of BACI sampling designs"*
Robert F. Smith,* Emily Neidiegh, Alexis Rittle, John R. Wallace

2:10 p.m. *"Fish enzyme activity in the Susquehanna River Basin: linkages to ecology, evolution and watershed stressors."*
Kristin L. Boggs,* Daniel E. Spooner, Dale C. Honeyfield, and Dustin Shull

Session 3

Watershed Hydrology

Rooms 241, C and D, Saturday, October 27, 2018, 1:30 - 2:30 p.m.

1:30 p.m. *"Overview of summer 2018 flooding in the Susquehanna Valley."*
Robert Shedd*

1:50 p.m. *"Comparison of regression relations of bankfull discharge and channel geometry for the glaciated and nonglaciated settings of Pennsylvania and Southern New York and StreamStats regional Curves Tool for Pennsylvania."*
John Clune,* Jeffrey Chaplin, and Kirk White

2:10 p.m. *"Impact of hyporheic exchange on stream temperature in restored systems."*
Ethan A. Bauer*

Session 4

Climate, Conservation, and Restoration

Gallery Theater (Room 301), Saturday, October 27, 2018, 1:30 - 2:30 p.m.

1:30 p.m. *"Will the Lewisburg bubble protect us from climate change? "*
Sandy Field,* Susquehanna Valley PA Chapter, Climate Reality Project.

1:50 p.m. *"Exploring tree plantings in Pennsylvania through Precision Conservation and the Keystone 10 Million Tree Initiative."*
Adrienne R. Gemberling* and Molly Cheatum

2:10 p.m. *"Saving the anthracite industry in the 1950s - The Conowingo Tunnel and anthracite mine flood-control projects."*
Michael C. Korb*

Session 5

Aquatic Ecosystems - Stress and Response

The Forum (Room 272), Saturday, October 27, 2018, 3:30 - 4:30 p.m.

3:30 p.m. "*An eDNA-based assessment of the impact of 55,000-gallon gas spill on the local hellbender populations.*"

Mizuki Takahashi*

3:50 p.m. "*Happy as a clam…or not? Challenges of quantifying stress response in freshwater mussels.*"

Heather S. Galbraith,* Carrie J. Blakeslee, Kathy A. Patnode, Lora Latanzi, and Robert A. Anderson

4:10 p.m. "*Nature-like Fishway Modeling and Design.*"

Xiaofeng Liu,* Yi-xuan Zeng, Hassan Ismail, Michael Hross, Chris Goodell, Jose Zaya, and Neal Simmons.

Session 6

Status, Trends and Monitoring II

Rooms 241A and B, Saturday, October 27, 2018, 3:30 - 4:30 p.m.

3:30 p.m. "*Understanding the implication of changes in climate and river flow conditions on freshwater mussels.*"

Jeffrey C. Cole,* Heather S. Galbraith, and Barry J. Wicklow

3:50 p.m. "*Snapshot Volunteer Monitoring: A Community Science Success Story.*"

Helen C. Schlimm*

4:10 p.m. "*Development of an Instream Tag Monitoring System for the Eastern Hellbender Salamander.*"

Peter J. Petokas* and Michelle R. Herman

Session 7

Watershed Mapping and Assessment

Rooms 241C and D, Saturday, October 27, 2018, 3:30 - 4:30 p.m.

3:30 p.m.	"*High-Resolution Data Supports Precision Conservation in the Susquehanna.*" Emily Mills*
3:50 p.m.	*"PA Lidar Working Group - Status and Plans."* Eric Jespersen*
4:10 p.m.	"*The Bogs of Loyalsock Forest."* Harvey Katz*

Session 8

Status, Trends and Monitoring III

Gallery Theater (Room 301), Saturday, October 27, 2018, 3:30 - 4:30 p.m.

3:30 p.m.	"*A survey of algal productivity and nutrient concentrations across a land-use gradient using pulse-amplitude modulated (PAM) fluorometry as a rapid assessment and measure of ecosystem function on a spatial and temporal scale.*" Jennifer A. Soohy,* Aaron M. Gordon-Weaver, Emily L. Ashberry, Corey, J. Conville, Steven, T. Rier,
3:50- p.m.	"*Use of Integrated Water Resources Management to Address Our Susquehanna River Basin - New Realities"* Jerry S. Walls,* James Weaver, and Shannon Rossman
4:10 p.m.	*"Spatial and temporal variations in temperature of the West Branch Susquehanna River."* Benjamin R. Hayes*

Invited Speakers

Christopher E. Williams

Senior Vice President for Conservation
American Rivers

Chris leads a team of 50 professionals dedicated to conserving the nation's rivers and the clean water, economic benefits, recreational, cultural, esthetic and fish and wildlife resources that they provide.

Prior to joining American Rivers in 2012, Chris was Director of Freshwater Conservation at World Wildlife Fund, where he managed river conservation programs world-wide.

He holds a juris doctorate and masters in environmental policy from the Vermont Law School and a bachelor's degree from the University of Washington.

Mr. Williams will deliver the keynote address entitled *"The Importance of Rivers: Water Security in an Insecure World"* at 7:30 to 8:00 p.m. on Friday, October 26, 2018 in the Forum, Elaine Langone Center, Bucknell University.

Mr. Williams will also deliver a plenary address entitled *"River Conservation in the U.S.: The State of the Art"* at 9:45 - 10:15 a.m. on Saturday, October 27, 2018 in the Forum, Elaine Langone Center, Bucknell University

John Arway

Executive Director
Pennsylvania Fish and Boat Commission

John Arway began his career in 1980 with the PA Fish Commission as a semi-skilled laborer working on stream habitat improvement projects. He was strongly influenced by Ralph Abele and his Resource First philosophy. He has worked tirelessly his entire career to protect, conserve and enhance the water quality, habitat and aquatic resources of Penn's waters. He spent his first 30 years as a fisheries biologist who advocated science in the development of laws, regulations and public policies. He has testified over 100 times as an expert witness in state, federal and administrative courts to punish polluters and seek compensation for damages to the Commonwealth's aquatic natural resources. Since taking the helm of the PA Fish and Boat Commission in 2010, he has worked vigorously to raise public awareness of the plight of the Susquehanna River and seek remedies to fix it, assess wild trout streams so they can be protected from harm, create innovative ideas to fund agency programs into the future and lead national discussions to get more people fishing.

John has a B.S. in biology from the University of Pittsburgh and a M.S. in aquatic biology from Tennessee Tech University and is a member of many national boards and committees involved in conservation and recreational sportfishing..

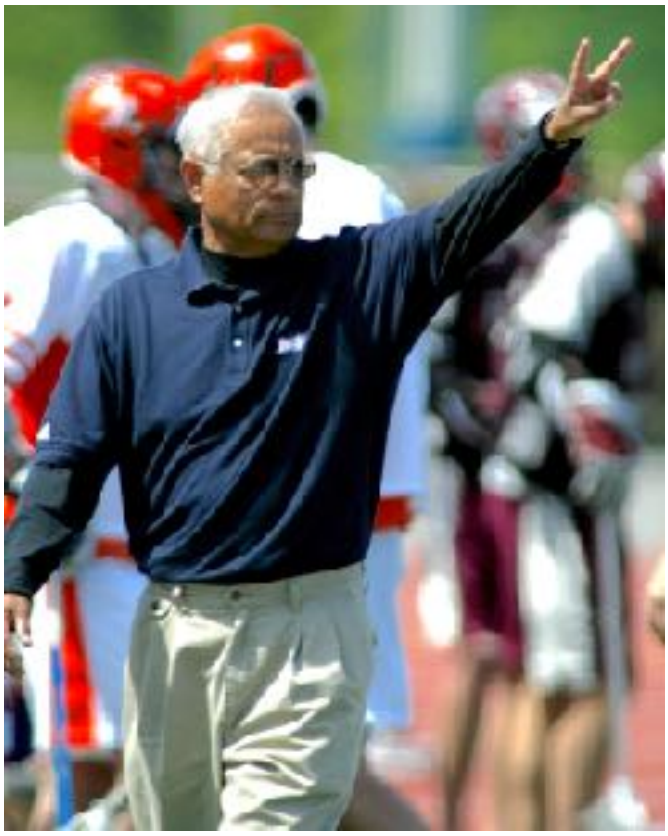
Mr. Arway will deliver a plenary address entitled ***"40 Years a Biologist"*** at 9:15 - 9:45 a.m. on Saturday, October 27, 2018 in the Forum (Room272), Elaine Langone Center, Bucknell University.

Sid Jamieson

Cayuga Nation Iroquois and Bucknell University Lacrosse Coach (retired)
Board member and Faithkeeper, Greenwood's Land Conservancy (Cooperstown , NY)
Advisory Board, Chesapeake Conservancy

Sid Jamieson is the only Native American head coach in the history of NCAA Division I lacrosse and head coach of Bucknell University's men's college lacrosse team for 38 seasons (1968-2005). He ranks 15th among all Division I collegiate lacrosse coaches in victories and led the Bison to seven championships in three different conferences, including four straight Patriot League titles from 2000 to 2003 despite being a non-scholarship program. Jamieson coached 19 All Americans and 13 players who were invited to play in the North-South lacrosse game. 111 of his players earned All Conference distinction. Sid also served for 25 years as an Assistant Coach to the football team.

A native of Youngstown, New York, Jamieson graduated from Cortland State University. He is a member of the Cayuga Nation and his parents were both raised on the Six Nations Indian Reservation in Brantford, Ontario. He adapted his coaching style from his Native American heritage. In 1983 Jamieson also became the co-founder and first head coach of what was to become the Iroquois National Team, a team composed of Native American players. He later served as Executive Director of Iroquois National Lacrosse and is an Emeritus member of that organization's Board of Directors. As coach, he took the team to the World Lacrosse Games in the United States, England and Australia.



Seven organizations have inducted Jamieson into their Halls of Fame, including the Pennsylvania Lacrosse Hall of Fame, the National Native American Hall of Fame and the Intercollegiate Men's Lacrosse Coaching Association Hall of Fame.

He remains active in conservancy and was instrumental in obtaining recognition from the National Park Service of the Susquehanna River as a National Historic Water Trail. He serves on the Advisory Board to the Chesapeake Conservancy and as FaithKeeper and member of the Board of Directors of the Greenwoods Land Conservancy in Cooperstown, NY, the headwaters of the Susquehanna River.

Mr. Jamieson will deliver a plenary address entitled ***" Iroquois Nations … Land Conservancy and Heritage"*** at 10:15 - 10:45 a.m. on Saturday, October 27, 2018 in the Forum (Room 272), Elaine Langone Center, Bucknell University.

Key Contributors

Schools, Colleges and Universities

Bloomsburg University
Bucknell University
Dickinson College
Drexel University
East Carolina University
Florida Gulf Coast University
John Hopkins University
Juniata College
Kings College
Lock Haven University
Lycoming College
Millersville University
Pennsylvania State University
Saint Anselm College
Susquehanna University
State University of New York College at Oneonta
SUNY College of Environmental Science and Forestry
University of Maryland

Exhibitors

American Dairy Association North East
Bloomsburg University Graduate School
Chesapeake Bay Foundation
Chesapeake Conservancy
Climate Reality Project
EA Engineering, Science, and Technology
Environmental Solutions & Innovations, Inc.
Master Watershed Steward Program, PSU
Merrill W. Linn Conservancy
Middle Susquehanna River Keeper
PA Amphibian and Reptile Survey
Susquehanna Greenway Partnership
Susquehanna River Basin Commission

Agencies, Firms, and Organizations

American Rivers
Chesapeake Bay Commission
Chesapeake Bay Foundation
Chesapeake Conservancy
Climate Reality Project
Cube Hydro Partners, LLC
Delaware River Basin Commission
EA Engineering, Science, and Technology, Inc.
Geisinger Department of Epidemiology and Health Services Research
Kleinschmidt Associates
Land Studies, Inc.
Loyalsock Creek Watershed Association
Lycoming County Planning Commission
Maryland-National Park and Planning Commission
Maryland State Highway Administration
National Oceanic and Atmospheric Administration
National Weather Service
Nurture Nature Center
New York State Department of Environmental Conservation
North Central Pennsylvania Conservancy
PA Department of Environmental Protection
PA Fish and Boat Commission
PA Mapping and Geographic Information Consortium
TetraTech, Inc.
U.S. Fish and Wildlife Service
U.S. Geological Survey
Western Pennsylvania Conservancy
York County Conservation District

DETERMINING THE SCOPE OF IMPACT: EVALUATING THE INDIRECT EFFECTS OF AMERICAN EEL STOCKING ON EASTERN ELLIPTIO POPULATIONS THROUGHOUT THE SUSQUEHANNA RIVER BASIN

Carrie J. Blakeslee, Northern Appalachian Research Laboratory, U.S. Geological Survey, 176 Straight Run Road, Wellsboro, PA, 16901, cblakeslee@usgs.gov; **Heather S. Galbraith**, Northern Appalachian Research Laboratory, U.S. Geological Survey, 176 Straight Run Road, Wellsboro, PA, 16901, hgalbraith@usgs.gov; **Julie L. Devers**,, Maryland Fish and Wildlife Conservation Office , U.S. Fish and Wildlife Service, 177 Admiral Cochrane Dr., Annapolis, MD, 21401, julie_devers@fws.gov; **Jeffrey C. Cole**, Northern Appalachian Research Laboratory, U.S. Geological Survey, 176 Straight Run Road, Wellsboro, PA 16901, jccole@usgs.gov; **Steve Minkkinen**, Maryland Fish and Wildlife Conservation Office, U.S. Fish and Wildlife Service, 177 Admiral Cochrane Dr., Annapolis, MD, 21401, steve_minkkinen@fws.gov.

Co-extinction among parasitic and symbiotic species is thought to be a leading cause of biodiversity loss. Freshwater mussels are one of the most globally imperiled faunas due to a variety of factors, including loss of their host fish which are needed for developing larval mussels to metamorphosis to free-living juveniles and adults. The U.S. Geological Survey Northern Appalachian Research Laboratory (NARL) and Maryland Fish and Wildlife Conservation Office (MDFWCO) have been examining the relationship between the common eastern elliptio mussel (*Elliptio complanata)* and its migratory host fish, the American eel (*Anguilla rostrata*), for over 10 years. American eel distribution has been severely reduced along the entire Atlantic coast in part by dams blocking their migration, which has resulted in cascading effects through the ecosystem. Research completed by NARL and MFRO has found that eastern elliptio populations have declined in abundance over the last 20 years and are experiencing limited recruitment (i.e. reproduction). In 2009 NARL and MDFWCO began an experimental stocking study to re-introduce the American eel to 2 sites in the Susquehanna River basin and assess the potential impacts on mussel recruitment. Five years after stocking we found that restoration of host fish improved recruitment, but results were not equivalent between stocking sites. While initial results show that mussel recruitment has improved at some American eel stocking sites, it was unknown if and how far these benefits extend outside of the direct stocking locations.

Reports of stocked eels were observed to have traveled up to 80 km from initial stocking locations. Follow-up freshwater eel and mussel surveys throughout the basin were conducted in the summer of 2018 to determine how eastern elliptio populations have changed at previously surveyed sites over a period of 10 years and if populations outside of direct stocking locations experienced increased juvenile recruitment related to eel stocking in the watershed.

Keywords: eastern elliptio mussel, American eel, demographics

SCIENCE-BASED PROTECTION OF SOURCE WATER QUALITY AND ECOSYSTEM INTEGRITY IN THE DELAWARE RIVER BASIN

Marie J. Kurz, Patrick Center for Environmental Research, Academy of Natural Sciences of Drexel University, 1900 Benjamin Franklin Parkway, Philadelphia, PA, 19103, marie.kurz@drexel.edu; **Scott Haag**, **Stefanie A. Kroll**, **Carol Collier**, and **Roland Wall**, Patrick Center for Environmental Research, Academy of Natural Sciences of Drexel University.

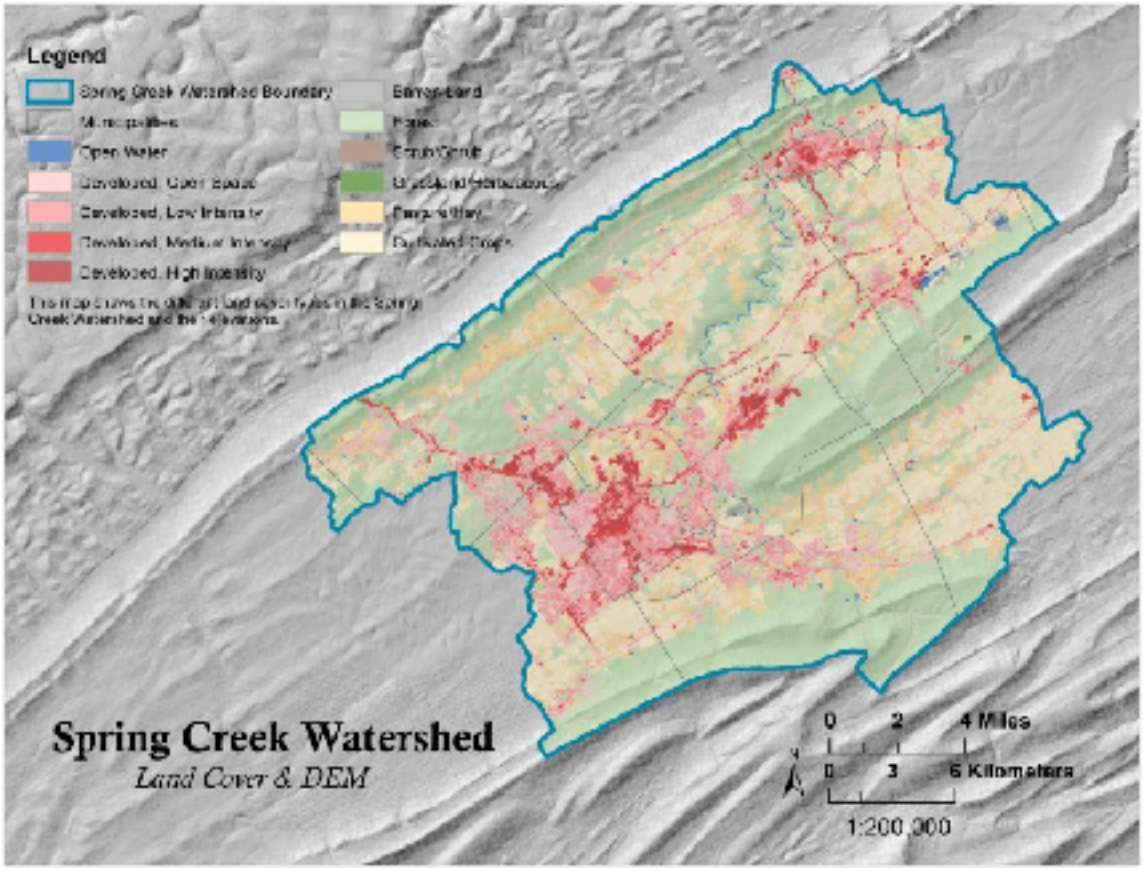
Protecting high quality headwater watersheds and restoring first and second order streams has been shown to be the most cost effective and environmentally effective approach to water resources management. Following this principle, the Delaware River Watershed Initiative (DRWI) unites more than 50 nonprofits in a collaborative program of coordinated, large-scale land protection and restoration projects with the aim of protecting and restoring stream water quality and ecological integrity in the Basin. DRWI focuses on small tributary watersheds within eight "clusters" of ecological significance covering roughly one-quarter of the Delaware Basin. These clusters encompass the continuum of catchment landscapes, from pristine headwaters to urban centers, and impacts from a range of key stressors including loss of forested headwaters and agricultural run-off. In order to accelerate science-driven conservation and improve the effectiveness of the DRWI activities we are conducting monitoring to establish baselines for local water quality and ecosystem integrity and evaluate change resulting from conservation projects. We are also developing tools to assess the potential for measurable change, refine the strategic selection of "focus" sub-watersheds for protection and/or restoration, and guide prioritization of sites for capital investment. This presentation will focus on the scientific lessons learned in the first 4 years of the DRWI and on the new tools and approaches developed to support adaptive planning of the next 3 years of DRWI activities.

SPATIAL AND TEMPORAL THERMAL PATTERNS IN THE SPRING CREEK WATERSHED

Alexandra S. Orr, Department of Ecosystem Science and Management, The Pennsylvania State University, 117 Forest Resources Building, University Park, PA, 16802, aso124@psu.edu; **Elizabeth Boyer**, Department of Ecosystem Science and Management, The Pennsylvania State University; **Dave Yoxtheimer**, Earth and Environmental Systems Institute, The Pennsylvania State University .

Water temperature is a critical physical property of stream ecosystems that influences nearly all in-stream biochemical processes. Atmospheric, physical and hydrologic conditions all influence a stream's thermal regime, and anthropogenic effects on any of these factors, such as changes in land-use or natural flow patterns, can greatly impact stream temperature and ecosystem processes. The Spring Creek Watershed in Centre County, Pennsylvania is a small, headwaters watershed that exhibits wide variation in stream size, land-use, groundwater contribution, and industrial inputs and withdrawals. The Water Resources Monitoring Project has been observing stream temperature and discharge at locations throughout the catchment regularly since 1999. Both flow and thermal regimes vary substantially between monitoring locations with temperature ranging approximately 10-12°C during the winter and summer months and discharge rates ranging annually from 0-5.7 cms. This study aims to identify the most thermally influential environmental and/or anthropogenic factors for stream reaches within the Spring Creek watershed by analyzing spatial and temporal patterns of temperature data in the context of discharge rates, groundwater contribution from springs, locally contributing land cover, riparian cover, industrial inputs and withdrawals, and air temperature and precipitation patterns. Preliminary results indicate that groundwater contribution and discharge rates may be the most critical factors in maintaining stable thermal regimes in varying atmospheric, land-use and industrial conditions. Identifying areas that may be more susceptible to these conditions can help prioritize planning for streambank restoration, stormwater management and other innovative strategies to maintaining and/or restoring natural stream temperature regimes.

Keywords: stream temperature, Spring Creek, thermal patterns,



THE RE-INTRODUCTION OF THE AMERICAN EEL TO THE UPPER SUSQUEHANNA WATERSHED

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Dams across the Susquehanna River in Pennsylvania and New York currently prevent American eels from returning to this watershed, where they were once a significant part of river, stream, and lake fauna (Dittman et al., 2009: 2010). With the loss of American eels, other impacts to our local ecosystems are apparent. These include the loss of the sole effective host of our historically most numerous riverine pearly mussel – The Eastern Elliptio (Minkkinen et al., 2010; Lellis et al., 2013) – and the irruption of the invasive crayfish: the rusty crayfish (*Orconectes rusticus*) (Kuhlman & Hazelton, 2007; Kuhlmann, 2016). Rusty Crayfish densities have apparent negative consequences to at least one pearly mussel species of greatest conservation need (SGCN), the yellow lampmussel (*Lampsilis cariosa*) (Lord, personal observation). We propose to initiate a full evaluation of American eel and ecosystem impacts following their reintroduction.

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ASSESSING MACROINVERTEBRATE COMMUNITY RESPONSE TO RESTORATION OF BIG SPRING RUN: EXPANDED ANALYSIS OF BACI SAMPLING DESIGNS

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Benthic macroinvertebrates are commonly used to determine the success of stream restoration projects. The Big Spring Run (BSR) restoration project achieved its hydrogeomorphic (abiotic) goals, but macroinvertebrate community was not a primary goal of the project. We examined the effect this novel restoration project had on the macroinvertebrate community, which included an assessment of potential aerial migrants. We also examined potential pitfalls for using a BACI approach. Benthic macroinvertebrates were collected each year for two years prior to and three years after restoration. Adult stream insects were collected in the final year of monitoring. Subsets of the macroinvertebrate data were analyzed to supplement conclusions made from the full dataset and to characterize potential pitfalls for common sample designs. Results using the overall dataset suggested that restoration had no effect on the macroinvertebrate community. The "wet meadow" created for this restoration successfully increased sediment retention, which may have maintained poor benthic habitat condition. Few adult mayflies, stoneflies, or caddisflies were observed at the restored reach, which suggested that dispersal barriers or a lack of local source populations may have limited insect colonization.

FISH ENZYME ACTIVITY IN THE SUSQUEHANNA RIVER BASIN: LINKAGES TO ECOLOGY, EVOLUTION AND WATERSHED STRESSORS

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Thiaminase, an enzyme known to degrade vitamin B1 (thiamine), has been attributed to reproductive issues and physiological abnormalities in fish in the Great Lakes and Finger Lakes; however, the mechanisms driving thiaminase activity are not well understood. We measured thiaminase activity in 29 species of freshwater fish, predominantly from the Susquehanna River Basin. Each species was classified according to phylogeny, trophic mode, native or non-native status, and location of capture to evaluate potential factors corresponding to thiaminase activity. Thiaminase activity varied widely across phylogenies (species, families, broad phylogenetic groups), trophic factors, and capture locations. Thiaminase activity was lower in phylogenetically-primitive teleosts compared to those more derived, and higher among herbivorous fishes than carnivores and omnivores. Average site-specific thiaminase activity of one species, the spotfin shiner (*Cyprinella spiloptera*), corresponded to land use within the watershed, such that thiaminase activity positively correlated to the percentage of forest within the watershed, and inversely correlated with the percentages of high- and medium-intensity development and hay fields. These findings suggest that foraging traits, phylogeny, and watershed land use could be important drivers of the thiaminase status in freshwater fish. More studies are needed to explain interacting factors that influence variation in thiaminase activity, as well as their effects on the health of freshwater ecosystems.

OVERVIEW OF SUMMER 2018 FLOODING IN THE SUSQUEHANNA VALLEY

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The summer of 2018 has seen record setting rainfall amounts in many parts of the Susquehanna Valley. Along with that there has been a series of flood events throughout the region with many locations being impacted on multiple occasions. This presentation will provide an overview of the rainfall and the flooding, along with the challenges for the National Weather Service in forecasting these events.

Flooding in Seven Valleys watershed, York County, PA
(July 26, 2018)

COMPARISON OF REGRESSION RELATIONS OF BANKFULL DISCHARGE AND CHANNEL GEOMETRY FOR THE GLACIATED AND NONGLACIATED SETTINGS OF PENNSYLVANIA AND SOUTHERN NEW YORK AND STREAMSTATS REGIONAL CURVES TOOL FOR PENNSYLVANIA

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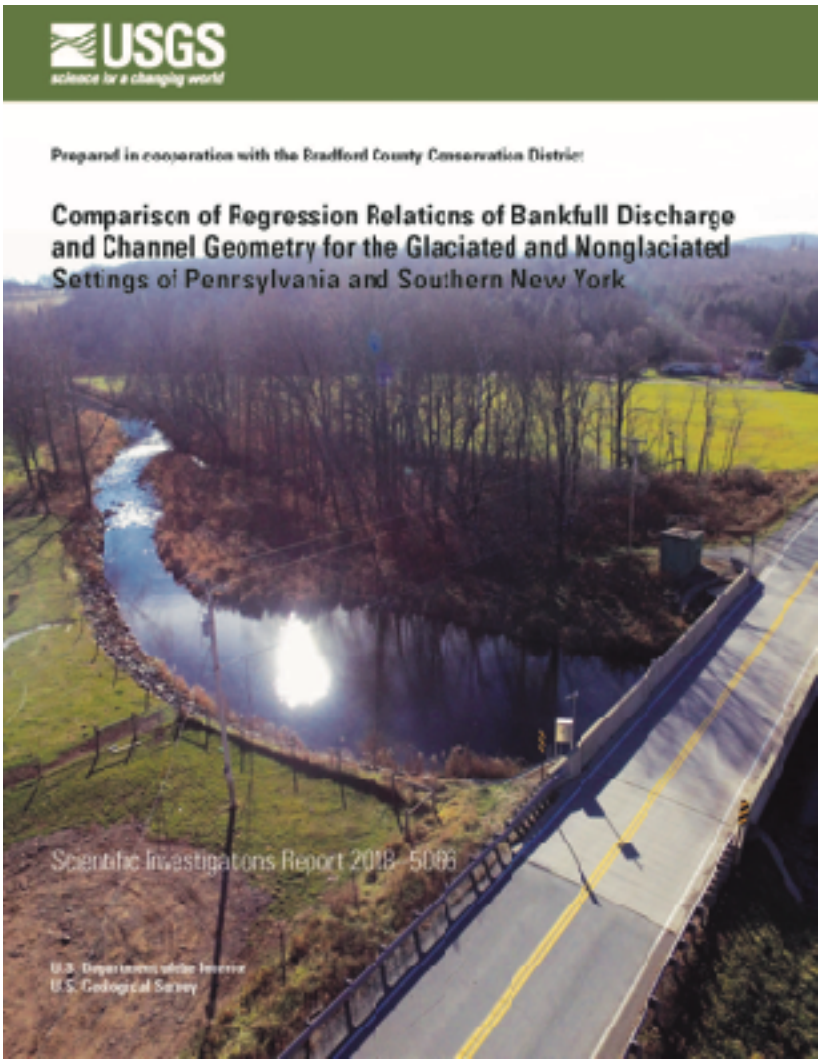
Streambank erosion in areas of past glacial deposition has been shown to be a dominant source of sediment to streams. Water resource managers are faced with the challenge of developing long and short term (emergency) stream restoration efforts that rely on the most suitable channel geometry for project design. A geomorphic dataset of new (2016, n=5) and previous (1999–2006, n=96) estimates of bankfull discharge and channel dimensions at U.S. Geological Survey streamgages was compiled to present and contrast the glaciated and unglaciated noncarbonate settings of southern New York and Pennsylvania.

Empirical models were developed by using simple linear regressions that relate bankfull discharge and channel geometry to drainage area (regional curves). Data stratification by glaciation did not improve regional curves relations developed previously for the noncarbonate (glaciated and unglaciated) and carbonate settings of Pennsylvania and Maryland.

The new data collected for bankfull discharge and channel dimensions at streamgages and updated drainage areas were incorporated into previously developed regional curves for the noncarbonate and carbonate settings of Pennsylvania and Maryland. These updated regional curves have recently been made available in Pennsylvania StreamStats, which is a web application that can now provide bankfull discharge and channel dimensions at user-selected sites.



IMPACT OF HYPORHEIC EXCHANGE ON STREAM TEMPERATURE IN RESTORED SYSTEMS

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One of the leading topics of discussion over the years in regard to stream health and water quality is stream temperature. The common school of thought within the industry is that the best and most effective way to regulate stream temperature is by blocking incident solar radiation via shading by riparian vegetation. There is much evidence to support this practice; it is known that solar radiation is the primary contributor for thermal loading within a stream (Johnson 2004). However, the practice of establishing a riparian community capable of providing significant vegetative shading is expensive and difficult to accomplish in the short term. A possible alternative lies in the practice of enhancing hyporheic connection in restored systems. It has been acknowledged that hyporheic exchange does alter the mechanics of stream temperature regulation (Forney, Soulard, & Chickadel, 2013), though its influence is rarely included in temperature analyses.

To better understand the impact of hyporheic exchange, pre and post-restoration stream temperatures were compared for Kurtz Run and its tributary in Lancaster County, Pennsylvania. The floodplain restoration was completed by LandStudies, Inc. in 2012 and resulted in significant improvement of hyporheic connection within the system. Temperature data for 2011 and 2014 (representing pre and postrestoration conditions) was taken from five on site pressure transducers with integrated temperature probes, and solar radiation data was retrieved from a public NASA database. The daily maximum temperature was then plotted against total daily solar radiation to determine a relationship. After the completion of both a graphical and statistical analysis of the relationship between the datasets, it was determined that the influence of solar radiation on daily maximum stream temperature was reduced by an average 53% in the restored system. Better understanding of the potential impact of hyporheic exchange on stream temperature could significantly impact dominant restoration practices for both designers and regulators.

WILL THE LEWISBURG BUBBLE PROTECT US FROM CLIMATE CHANGE?

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There is abundant evidence that climate change is happening globally. Hurricanes are getting bigger, droughts are lasting longer, summer temperatures are breaking records, extreme floods are happening more frequently, and fires are scorching the planet. Here in the Susquehanna Valley, it is easy to feel insulated from these extreme weather changes and to believe they are only happening in other places. But is that true? If global warming pollutant emissions continue at current rates, temperatures in Pennsylvania are expected to rise by 5.4°F by 2050. How is climate change already affecting us here in the valley and what can we do about it? Must we change our way of life? Pennsylvania is the 3rd largest emitter of carbon dioxide in the United States, so changes we make here can make a big difference. The good news is that we already have sources of renewable energy poised to replace the fossil fuels that are causing global warming. Solar and wind energy technologies are now less expensive, cleaner, and just as reliable as fossil fuels. We will discuss how we are trying to change the conversation from “is it real?” to “how can we work together to solve this crisis?”.

EXPLORING TREE PLANTINGS IN PENNSYLVANIA THROUGH PRECISION CONSERVATION AND THE KEYSTONE 10 MILLION TREE INITIATIVE

Adrienne R. Gemberling, Susquehanna Technical Coordinator, Chesapeake Conservancy, Susquehanna University, Selinsgrove , PA, 17870, agemberling@chesapeakeconservancy.org; **Molly Cheatum**, Restoration Manager, Chesapeake Bay Foundation , 1426 N 3rd St #220, Harrisburg, PA, 17102, mcheatum@cbf.org.

Streamside native trees, or riparian forest buffers are an important best management practice for Pennsylvania to improve water quality in local waterways, the Susquehanna River, and the Chesapeake Bay. Planning, installing, and maintaining riparian forest buffers is a process that often takes years to complete from first engaging a landowner to developing plans and designing a buffer to long-term care and establishment of the tree planting.

Chesapeake Conservancy and Chesapeake Bay Foundation have been examining methods to enhance these steps and streamline the process from start to finish. Chesapeake Conservancy will highlight their Precision Conservation in the Susquehanna River Watershed project, with an emphasis on identifying the right locations for tree plantings to improve water quality. Chesapeake Bay Foundation will highlight their Keystone 10 Million Tree Partnership that aims to assist conservation organizations and landowners with funding for tree plantings, increasing demand, and ensuring supply. While these programs aim to address certain steps needed for successful adoption of tree plantings, there are still several opportunities for organizations to partner on innovative ways to address remaining gaps. We will describe the step-by-step process and highlight opportunities to fill the remaining gaps.

SAVING THE ANTHRACITE INDUSTRY IN THE 1950'S -

THE CONOWINGO TUNNEL AND ANTHRACITE MINE FLOOD-CONTROL PROJECTS

Michael C. Korb, Tetra Tech, Inc, 626 Birch Rd, Wapwallopen, Pennsylvania, 18660, mikekorbllc@gmail.com .

A Historical Perspective on a "Solution" to the Anthracite Mine-water Problem.

In the 1940s, mine-water pumping was recognized as a major factor in the economic condition of the Pennsylvania Anthracite industry. USBM engineers conducted an extensive study of the problem, leading to the recommendation of a fantastic plan to drive a 137-mile tunnel to drain most of the anthracite mines to the Susquehanna Estuary. The (1954) $400-million scheme was not executed, but rather a $17-million Federal-State "interim solution" was initiated.

This review of the engineering study, discussion of some of the mine-water conditions we now observe, and examination of the interim project may suggest some potential solutions to alleviate today's anthracite region mine-water problems.

AN eDNA-BASED ASSESSMENT OF THE IMPACT OF 55,000-GALLON GAS SPILL ON THE LOCAL HELLBENDER POPULATIONS

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Environmental DNA (eDNA) analysis has become widely available as a conservation tool to survey and monitor wildlife populations. Despite its versatile applicability and effectiveness, eDNA analysis has rarely been used to assess the impact of natural or anthropogenic disturbance in aquatic environments. Eastern hellbenders (*Cryptobranchus allegheniensis allegheniensis*) are fully aquatic giant salamanders inhabiting fast-flowing mountain streams in the Eastern US including the tributaries of the West Branch Susquehanna River. The hellbender populations have declined throughout its distribution range and it is listed as a species of special concern in Pennsylvania.

One of the threats to hellbenders is pollution. In addition to chronic pollution from agricultural practices and other human activities, sporadic gas and oil spills from gas stations and fracking sites likely cause serious damages to stream ecosystems. By analyzing hellbender eDNA concentrations in water samples, we conducted a comparative assessment of the population status of hellbenders in Loyalsock Creek before and after the gas pipeline rupture which caused 55,000 gallons of gas spills into the creek in October 2016 at a site approximately 16 km upstream from the mouth. Given hellbender's sensitivity to water quality, we predicted a significant decline in eDNA concentration in 2017 compared with the data collected before the 2016 gas spill. Contrary to the prediction, the comparison in eDNA concentration revealed no significant change before and after the gas spill. We will discuss possible reasons for the result.

Eastern hellbender
(*Cryptobranchus allegheniensis allegheniensis*)

HAPPY AS A CLAM…OR NOT? CHALLENGES OF QUANTIFYING STRESS RESPONSE IN FRESHWATER MUSSELS

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Freshwater mussels are one of the most critically imperiled groups of organisms worldwide, and state and federal resource agencies are placing increased emphasis on mussel conservation and restoration. A thorough understanding of environmental conditions suitable for restoration is needed for nearly all species of conservation concern. Unfortunately, quantifying suitable, optimal, and even tolerable conditions for mussels can be challenging for a variety of reasons. Freshwater mussels can burrow beneath the sediment or temporarily close their shells for up to days at a time to avoid stressors. Because of this and other life history characteristics, traditional metrics of stress used for marine mussels or other aquatic organisms can be highly variable among individuals and often uninformative. Further challenges lie in the fact that mussels can exhibit delayed response to stressors: toxicology studies greater than 60 days can be necessary to observe effects of certain contaminants. Quantifying stress in rare or endangered species can be especially problematic when these issues are combined with low numbers of individuals for field studies or experimental statistical power. Here, we present a synthesis of these difficulties inherent in studying stress response in freshwater mussels from laboratory research conducted on a variety of common and rare species. We evaluate a range of traditional stress response metrics, their application to mussels in general, and discuss the use of emerging technology in overcoming these challenges.

NATURE-LIKE FISHWAY MODELING AND DESIGN

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Worldwide, millions of dams can have adverse impact on the connectivity of rivers and streams, hindering fish migration and proliferation. Efforts to re-establish connectivity traditionally involve providing a fish passage structure near a dam. Traditional fish passage structures, such as fish ladders, have historically performed sub-optimally. Additionally, certain fish species may have difficulty finding the entrance to the structures or may be unable to navigate through the structures. Efforts to increase passage rates have shifted to design passages which mimic natural settings by considering fish behavior and natural habitat in the design process. These "nature-like fishways" (NLF) require site-specific modeling for a given dam and target species.

This study uses one hydroelectric dams on the lower Susquehanna River as an example to show how state-of-the-art science and technology can be used to better design NLF. Here, we will test the preliminary engineering design with detailed computer modeling and laboratory experiments. Both two-dimensional and three-dimensional computer models will be used to examine the river flow at the site and the hydraulics within the fish passage. Additionally, we will build and run a laboratory model of the proposed NLF. The laboratory measurements will provide validation of the simulation results and help designers engage key stake holders in the design process. The flow field (velocity, depth, and turbulence) obtained from the computer and physical models will be further used in a Lagrangian-based fish behavior model to simulate the passing process of target fish species. Success, remaining technical issues, and future research directions will be discussed.

Conowingo Dam
(*Susquehanna River, Maryland*)

UNDERSTANDING THE IMPLICATION OF CHANGES IN CLIMATE AND RIVER FLOW CONDITIONS ON FRESHWATER MUSSELS

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Alterations to flow regimes are predicted to increase with water management and changing climatic conditions and are thus likely to affect aquatic species. Freshwater mussels are a key group of benthic organisms that could be highly impacted by streamflow alterations, primarily due to their sedentary nature and often long-life spans. Some mussel species are known to live up to 150 years as determined from annually-deposited shell growth rings (annuli). While counting shell annuli can provide useful information on basic population demographics, it is possible that additional information could be gleaned from measurements of the width of annual growth bands. We test this possibility using shell thin-sections from the federally endangered dwarf wedgemussel (*Alasmidonta heterodon*). We collected shells from 185 individuals from 5 locations in northern Atlantic Slope rivers and, combined with quantitative survey data, developed estimates of mussel age distribution for these populations. Incremental growth measurements were then made on a subset of shells from two locations. Using estimates of mussel "time of death", annual growth measurements were aligned with instream-flow and regional climatic variables. Multivariate analyses were used to identify suites of environmental variables that best predicted patterns in annual shell growth. These results could be beneficial for predicting the effects of changing flow regimes on freshwater mussel growth; identifying optimal flow conditions for maximizing mussel growth and presumably condition; and for informing water management decisions for maintaining healthy populations of this rare and endangered species.

dwarf wedgemussel
(*Alasmidonta heterodon*)

SNAPSHOT VOLUNTEER MONITORING: A COMMUNITY SCIENCE SUCCESS STORY

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In the spring of 2017, community interest in reviving a "snapshot" model of volunteer monitoring in the Conodoguinet Creek watershed in south-central Pennsylvania initiated an exciting new opportunity for collaboration among diverse partners. The Alliance for Aquatic Resource Monitoring (ALLARM) and the Cumberland County Conservation District partnered with local watershed groups to create the Conodoguinet Watershed Snapshot, a program that collects data on stream health once per season over a year. The Conodoguinet Creek is a 520 mi2 watershed, which drains into the Susquehanna River. There have been several volunteer monitoring initiatives from 1996 to 2006 but no water quality data had been collected for eleven years when community members developed an interest in the current health of the watershed.

Within this snapshot model, volunteers test several water quality indicators both in the field and in ALLARM's laboratory at Dickinson College. Connecting college resources to community science amplified the effectiveness of the program. More than forty community members of all ages were actively engaged in snapshot monitoring in 2017-2018, which included up to 29 sites throughout the watershed. Community follow-up included a series of data interpretation meetings with local watershed groups and the publication of a final report.

Positive volunteer feedback from the snapshot fueled a second year and led to the creation of a monthly monitoring program with the Conodoguinet Creek Watershed Association. This presentation will focus on key ingredients of the collaboration and community engagement that make the Conodoguinet Watershed Snapshot successful. Attendees will be able to take home lessons learned about this model of volunteer monitoring to apply in their own work.

DEVELOPMENT OF AN INSTREAM TAG MONITORING SYSTEM FOR THE EASTERN HELLBENDER SALAMANDER

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We designed, installed, and are currently operating two instream passive integrated transponder (PIT) monitoring systems for the Eastern Hellbender salamander. The systems were intended to monitor the activity of 100 three and one-half year old juvenile hellbenders that were tagged and released in August 2018 to restore a historic, and largely extirpated, hellbender population in the Upper Susquehanna River watershed. Each monitoring system consists of a loop antenna that spans a 20-meter wide stream channel and is anchored to the stream pavement with rebar and zip-ties. A tag reader is securely mounted on a streamside post and is connected to the antenna and to a control box located 30 meters landward. Each monitoring system receives 24 volts of power from a bank of four solar storage batteries charged by a solar panel installed 30 meters distant in an open field. The control box contains a removeable flash drive that holds recorded tag data and an interface used to tune the system and to change system parameters. Since hellbenders are bottom crawlers, their tags are read when they walk across an antenna. The two monitoring systems have provided data on movements of the juveniles into and out of the release sites, and on diel activity patterns. Most movements have occurred late at night and, as such, would have been otherwise undetected.

HIGH-RESOLUTION DATA SUPPORTS PRECISION CONSERVATION IN THE SUSQUEHANNA

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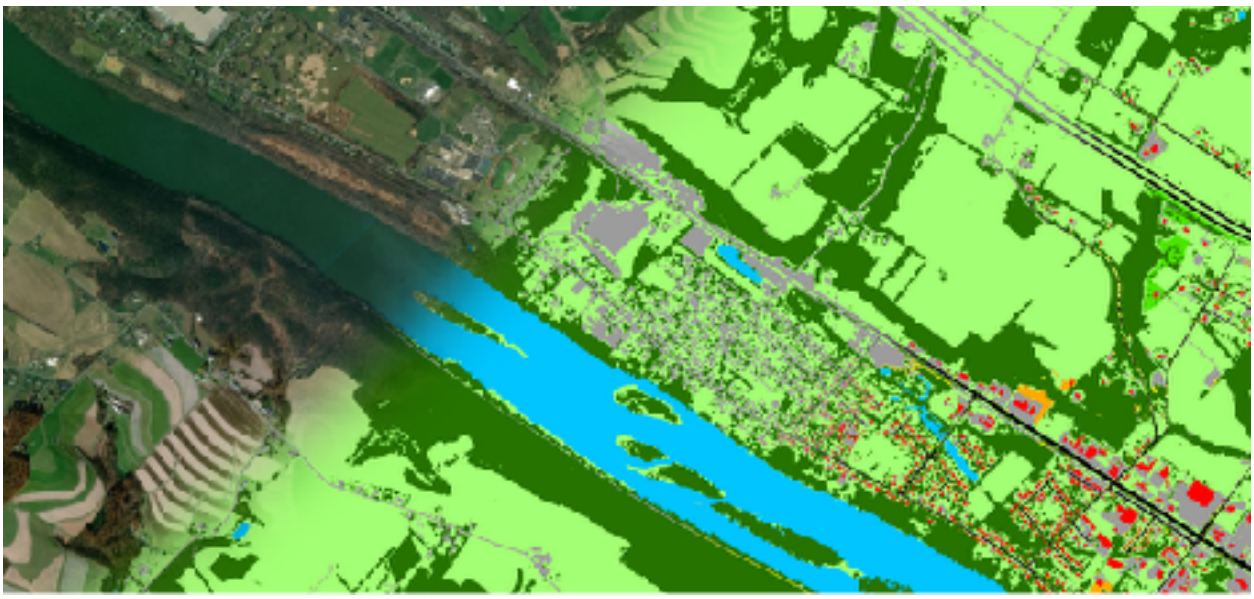
The Chesapeake Conservancy with support from the Chesapeake Bay Program is pioneering development of high-resolution land cover and flow path mapping for the Chesapeake Bay watershed. A 1-m resolution land cover dataset is available using 2013 imagery and high-resolution flow path data is available for the entire Susquehanna Watershed. Flow paths are mapped using Lidar-derived digital elevation models. High-resolution data enables project planning on a finer scale than ever before, critical for precision conservation--implementing the right restoration practices in the right places. Leveraging our high-resolution data, the Chesapeake Conservancy is working with partners in four counties in the Susquehanna watershed to prioritize restoration opportunities and maximize subsequent water quality improvements. By identifying parcels with the greatest potential for mitigating impacts of agricultural runoff in a cost-effective manner, the prioritization analysis increases the efficiency and reach of partner organizations, accelerating their positive impacts on water quality. This presentation will outline methods used to create the high-resolution datasets and examples of potential applications for restoration planning and implementation of practices for the Pennsylvania Watershed Implementation Plan.



PA LIDAR WORKING GROUP - STATUS AND PLANS

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Lidar data is now the accepted technology for regional topographic mapping and analysis. Costs are falling and data density increasing, so that data handling tools, applications, and analytic opportunities keep growing. PA was one of the first states to acquire statewide lidar (2006-2008) and is poised to acquire a second statewide round which would provide not only a current view of topographic conditions but also enable automated change detection over large areas. Come learn about the activities and plans of the Lidar Working Group.

THE BOGS OF LOYALSOCK FOREST

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Along the Wisconsin Glacier's terminal moraine are thousands of bogs. About 125 of these are in Loyalsock State Forest and adjacent private lands between Ralston, on Route 14 and Hillsgrove, on Route 87 in Pennsylvania. This 45,000 acre (18,000 hectare) forest includes a variety of bog types. The area drains both Lycoming Creek watershed and Loyalsock Creek watershed. Bogs have low pH and nutrients and are considered low productivity systems. Data were collected for the five years, 2013-2017.

Bogs take many shapes. As a general rule bogs follow the traditional early, mid and late successional character. Bog hydrology is distinctive and many bogs have waterways flowing through them, regardless of successional stage. Other bogs have no waterway visible and several are stand-alone bogs with no apparent connection to a run or stream. Size ranges from 1/4 acre (0.1 hectare) or less to 30 acres (12 hectares). Of the 115 wetlands examined, fifteen have Pennsylvania threatened and endangered plant species, thirteen in the Lycoming watershed and two in the Loyalsock watershed. The remaining 100 wetlands lack these plants. At least two bogs are seasonal, and like vernal ponds, they hold water only after snow melt or heavy rain, drying up during the summer season. Eight of the wetlands are vernal ponds.

The bogs tend to be remote and can be difficult to find. Only one bog is near a wood road. The remaining 114 are deep in the woods. Use of satellite imagery is necessary to locate these bogs. Basic data were collected to describe location, size, shape, hydrology, dominant plant type, insect/arachnid, fish, amphibian, reptile, bird and mammals. Water quality includes pH, total dissolved solids and temperature (both air and water). This presentation describes bog types and includes some historical influence to explain bog varieties. These range from human activities such as splash dams and earthen berms, usually from the 1870 through 1930 lumbering period, to the natural activities of beavers. Satellite imagery and color photos of bogs are used to give the reader a sense of what these bogs look like. The presentation ends with a brief effort to understand how the bogs fit into our current concept of ecological services.

Small bog at the headwaters of Doe Run, Loyalsock State Forest, Lycoming County.

A SURVEY OF ALGAL PRODUCTIVITY AND NUTRIENT CONCENTRATIONS ACROSS A LAND-USE GRADIENT USING PULSE-AMPLITUDE MODULATED (PAM) FLUOROMETRY AS A RAPID ASSESSMENT AND MEASURE OF ECOSYSTEM FUNCTION ON A SPATIAL AND TEMPORAL SCALE

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Using pulse amplitude modulated (PAM) fluorometry to measure algal biomass and productivity is becoming more common and has the potential to become a valuable tool in our arsenal for rapidly monitoring the response of potentially bloom-producing algae to nutrient pollution. However, more studies are needed to demonstrate the efficacy of using PAM fluorometry to monitor the response of algae to nutrient pollution in the context environmental variability, especially in stream periphyton.

The purpose of this study was to use PAM fluorometry to monitor stream periphyton over a wide range spatial and temporal scales to allow for a large variety of nutrient concentrations and other environmental factors to be included in the sample. We also compared PAM to other methods of assessing nutrient impacts to periphyton and overall ecosystem function. We sampled a site in Fishing Creek, Pennsylvania, over the course of three years, and nineteen other streams over a nutrient gradient in Pennsylvania during the summer of 2017. We used pulse-amplitude modulated (PAM) fluorometry and saturating pulses to measure algal photosynthetic capacity and efficiency. We compared these data to water column and mat nutrient concentrations, as well as visual assessment of growth and enzymatic activity. We also compared the relative rate of electron transport (ETR) with ecosystem metabolism to assess how PAM might be used as a measure of ecosystem function. By using both a spatial and temporal scale to compare PAM data with nutrient measurements, we will be able to get a more complete picture of the ability of PAM fluorometry to act as a rapid nutrient and growth assessment and ascertain its role in the overall measure of ecosystem function.

USE OF INTEGRATED WATER RESOURCES MANAGEMENT TO ADDRESS OUR SUSQUEHANNA RIVER BASIN NEW REALITIES

Jerry S. Walls, Executive Director/CEO, Lycoming County Planning Commission (retired); County Planning Directors Association Task Force on Integrated Water Resources Management, and Board Chairman, Susquehanna Greenway Partnership; **James Weaver**, Aquatic Biologist, Tioga County Planning Director (retired), Board Member, County Planning Directors Association Task Force on Integrated Water Resources Management, Tioga County Conservation District, and President, PA Wilds Planning Team; **Shannon Rossman**, Executive Director, Berks County Planning Commission, County Planning Directors Association Task Force on Integrated Water Resources Management.

This presentation conveys the philosophies and essential concepts/tools which professional planners, environmental professionals, professional engineers and designers of land developments, watershed associations, county and municipal officials should employ. These tools apply to proposed new land development proposals within our SR Basin and may help to address the new realities of large paved impervious parking lots now at risk of inattention due to shopping center abandonments and other large commercial building vacancies. The Susquehanna River communities are especially vulnerable due to the on-line commercial trends - in part because of our mainly rural region with relatively low populations.

The IWRM tools will include the key policies and planners checklist which will enable both the local government officials and concerned citizens to utilize for careful review and proactive initiatives to also address our 70 Susquehanna Rivertowns. The IWRM tools and policies are especially important given that the SR Basin consists of a wide variety of Exceptional Value and High Quality streams and that our basin supplies drinking water to 50 million residents in PA and MD.

The IWRM policies have even greater importance as a foundation that should be incorporated into the forthcoming update of the PA State Water Plan. The SR Symposium offers an opportunity to foster broad-based understanding that can enable stronger support for enlightened State Agencies to more effectively manage these issues and fulfill their PA Constitutional responsibilities as Trustees and Fiduciary Duties of our water resources.

SPATIAL AND TEMPORAL VARIATIONS IN TEMPERATURE IN THE LOWER WEST BRANCH SUSQUEHANNA RIVER

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A network of buoys and river bed temperature sensors were built and deployed on the West Branch of the Susquehanna between Muncy 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 during summer and fall were relatively normal, 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.

UNDERSTANDING THE ENVIRONMENTAL CONTEXT OF ALGAL PRIMING OF COARSE PARTICULATE ORGANIC MATTER DECOMPOSITION IN STREAMS

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Streams can obtain energy from two main sources: autochthonous organic matter or allochthonous inputs of organic matter. Interactions between organisms involved in these two types of energy acquisition can exist within biofilms. Biofilms are microcommunities of algae, fungi, bacteria, and protozoa that form on inert and organic substrata. Previous experiments have observed interactions between photosynthetic and heterotrophic organisms within biofilms in a process called algal priming. The release of a labile carbon source by algae may stimulate the decomposition of coarse particulate organic matter by heterotrophic organisms. To better understand algal priming, we evaluated the environmental factors that may influence the process within biofilms. Presence of light, nutrients, and a labile carbon source were manipulated using shading and chemical diffusing substrata. Unbleached cotton strips were attached to clay saucers containing the chemical diffusing substrata that was manipulated into four treatments: a control, the addition of nutrients, the addition of a labile carbon source, and the addition of both nutrients and a labile carbon source. The clay saucers were attached to a tile and placed in a stream under a transparent or darkened shade. After one week, cotton strips were collected and tested for respiration and tensile strength which is a measure of decomposition. Flooding prevented further sample collection beyond one week. A future study will involve placing cotton strips within transparent or darkened tubes into 25 streams of varying stream order and nutrient content. After one month, the cotton strips will be collected and evaluated for decomposition, algal biomass, bacterial biomass, fungal biomass, extracellular enzyme activity, and respiration. In examining environmental context, we aim to provide information to better understand the role priming may play in the cycling of carbon within streams.

Keywords: stream ecology, algal priming

Biofilms covering cobbles in stream bed
(Photo by Sheila Saia, Penn State University)

RELATIONSHIP BETWEEN DISCHARGE AND %EPT IN THE UPPER MAIN STEM OF THE SUSQUEHANNA RIVER DURING THE SUMMER MONTHS OF 2016 THROUGH 2018

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In this study, we are continuing the tenth year in a long-term study of benthic macroinvertebrate communities (BMI) in the upper main stem of the Susquehanna River from mid-summer collections. The benthic communities provide an assessment of both water quality and habitat variation between different temporal and spatial zones of the same river. As evaluation tools, BMI are useful in studying long-term trends because their life histories can span months to years. The study sites are on a transect that straddles Byers Island near the Sunbury Generation LP and below the Adam T. Bower inflatable dam at Sunbury, PA. The four sample locations are within the plume from the West Branch (site 1) and plume of the North Branch (sites 2-4). We follow the EPA guidelines for passive sampling in non-wadeable streams with the use of rock baskets, which emphasize drifting and colonizing animals. Riverine discharge is variable, but can reflect stochastic seasonal trends. The general weather patterns for the summers of 2016-2018 ranged from almost drought conditions in 2016 to the very wet summer of 2018. Discharge averaged from May through July relative to the 80-year average for those months was 48% (2016), 98% (2017), and 174% (2018). The %EPT (Ephemeroptera, Plecoptera, Trichoptera) values from the rock basket samples rose from 59.25% (2016), to 75.75% (2017) to 82.5% (2018). Indeed, discounting site 4, which is somewhat problematic as a site, the average for 2018 would rise to 93%. The association of EPT taxa with discharge seems to be related in the upper main stem. Ignoring site 4, the relationship between discharge and %EPT for the three years has an R2 of 0.67.

Keywords: Benthic macroinvertebrate, discharge, river ecology

INITIAL ANALYSIS OF METAL ACCUMULATION IN WOLF SPIDERS USING GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROSCOPY

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High concentrations of metal contaminants can have detrimental effects on biological systems. Detection of these contaminants within animals can provide information about the pattern, source, and pathways of metals as they move through and between food chains. Wolf spiders may represent a model indicator species for heavy metals since they intersect detrital, terrestrial, and aquatic food chains. They also frequently cannibalize and engage in intraguild predation. These feeding behaviors and the trophic position of spiders as apex arthropod predators, make them more likely to concentrate metals. Spiders and soil samples have been collected from several coal-impacted sites such as waste piles from surface mining, mine fire sites, coal ash burial sites, and a residential area to serve as a non-contaminated reference location. Cadmium, copper, lead, and iron will be measured. Differences in heavy metal concentrations will be measured by spider species and location and then compared to metal concentrations in the soil for each site. The spiders and soil samples are dried, digested in acid, extracted and then are analyzed by graphite furnace atomic absorption spectroscopy for a variety of metals. Soil results so far indicate (in µg/g) copper 55-116, cadmium ND – 0.01, lead 0.2-0.5, and in spiders (in µg/spider) copper 5-184, cadmium ND (none detected) – 0.005, lead ND – 0.001. Additional samples are being prepared and analyzed for these and additional metals. With these results, there can then be more insight with heavy metal accumulation in the environment.

Keywords: metals, Wolf spiders, soil, atomic absorption spectroscopy

COMPARISON OF 3 SIMILAR HEADWATER STREAMS IN CENTRAL PENNSYLVANIA DURING THE SUMMERS OF 2015-2018

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The benthic macroinvertebrate (BMI) communities of the three headwater streams, Green Gap Run, Lick Run, and Coral Run, which flow down the north slope of Penns Creek Mountain in Bald Eagle State Forest were compared through the summers of 2015 to 2018. Based on the collections from the summers of 2015-2018, Green Gap Run, Lick Run, Coral Run, were moderate replicates of each other, Lick and Coral Run being more similar, as far as the BMI communities were concerned. These streams are also similar in size and substrate composition (sand, cobble, and boulder) and maintained flow even through the drought conditions of 2016. Alkalinity averaged 195.24 (50.66- 258.10), 189.29(133.00- 230:00) and 188.95 (182.99-197.85) μeq/L during the four-year study for each of the headwater streams, respectively. They were also similar in conductance averaging 23 (17-27), 20 (19-22), and 22 (19-25) μs/cm, respectively. BMI communities were collected during the first half of July in 2015-2017 and late June of 2018 using the 6-kick method and processed by the PA DEP and US EPA protocols. The %EPT (Ephemeroptera, Plecoptera, Trichoptera) for the three headwaters ranged from 23-67% throughout the entire period. Coral run in 2016 had the lowest %EPT which may have been caused by the drought that year while Green Gap Run in 2017 had the highest at 67%. The BMI communities when compared by the Proportional Bray-Curtis Similarity method showed overlap between the three head water streams ranging from 50-59%. The range in similarity from 2015-2018 year was 33-76% overlap, which is low to high overlap. In 2018 there was the highest overlap of 76% between Coral and Lick run and the lowest overlap of 33% between Green Gap and Coral run. During this study we identified 59 families, 13 of them being added in 2018. The average Hilsenhoff metric for all three streams for the past four years was 4.29. The most dominant taxa across the three headwater steams were Crambidae and Empididae making up 22.86% of the total count combined. Our findings support that the three head water streams are very similar despite changes in weather condition from summer to summer.

Keywords: Benthic macroinvertebrates, headwater streams, stream assessment

VERTICAL MIGRATION OF ADULT STREAM INSECTS ABOVE FORESTED HEADWATER STREAM ENVIRONMENTS

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Aquatic insects have a life cycle that includes a larval aquatic stage and an adult terrestrial stage. Stream insects generally stay above the stream channel as adults, but dispersal through upland areas does connect populations in neighboring streams. Wings with high aspect ratio (i.e., long and thin wings) may be an adaptation for gliding that allows long distance dispersal. Similarly, little information exists about species- and sex-specific preferences for utilizing forest canopy habitats. We performed a study that examined the abundance of adult plecopteran that move into the forest canopy compared to individuals found close to the stream. During the summer (2017 and 2018) and autumn 2018, we set up malaise and canopy traps at four streams in the Mosquito Creek Watershed (Lycoming County, PA). We deployed traps for 2-week periods in Jun/Jul and Sep/Oct and identified all Trichoptera and Plectopera to family and Ephemeroptera to order. We also identified the sex of the plecopteran individuals. We found overall lower abundances in the canopy, and some differences in taxon composition between canopy and above-stream habitats.

Keywords: Adult Stage, Stream Insect, Plecoptera, Headwater Stream

HIDDEN HISTORIES: FINDING WATER IN THE LANDSCAPE

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We often think of rivers - especially rivers in the course of human history - on the grandest of scales, as "great tracks carefully provided by Providence," as Alexis de Tocqueville wrote. But the students in "North American Environmental History: Rivers" (a history/environmental studies class) have been studying how the largest themes in environmental history - themes like settlement, harvest, urbanization, and restoration - may be found both along storied rivers like the St. Lawrence and the small, numerous tributaries that vein across Pennsylvania and gather in the Susquehanna watershed.

As part of this course, students were asked to follow one of these tributaries on foot, beginning at the Susquehanna and moving through the town of Lewisburg. They first consulted archival aerial photographs and insurance maps to identify points of interest in the historical record, and then - feeling a bit like Indiana Joneses - they were to "groundtruth" those records. (Indeed, for most students, this was their first serious consideration of any of these water courses, despite having crossed them innumerable times.) They were asked to document, through notes and photographs, the relationship they saw between people and water: was it one of accommodation or avoidance? An asset or an obstacle? A component of scenery, or invisible? The key was to identify evidence of that relationship in the past - and to find evidence of human intervention in or adaptation to the landscape in ways, in artifacts, that might now go unremarked. How does something so fundamental to continental and to local history - freshwater rivers - fade into the background of our daily lives?

This poster is a collage, of sorts. Photographs of these hidden histories submitted by students have been assembled onto a section of the 1884 bird's eye map of Lewisburg. The result is a revealing statement, we think, of the value of historical study and local curiosity in understanding the place of rivers today.

Keywords: Environmental History, River towns, Mapping, Humanities fieldwork

SUSQUEHANNA UNIVERSITY TREE INVENTORY

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Trees play an important role in cleaning our air, soil and water, on top of providing economical and aesthetic benefits. On Susquehanna University's campus, the Ginkgo trees act as important part of campus lore, and many more act as memorials to past students and events. We have been using GIS technology to catalog trees by location, species, dimensions, important maintenance needs, and other noteworthy characteristics. So far, We have surveyed the whole of the academic campus for a tally of over 600 trees, and we are currently expanding to survey the dormitories. This tree data will be used to spot vulnerability to invasive species, determine the need for tree removal and replacements, and help to develop a forest management plan.

Keywords: Tree Catalog, Maintenance, Trees

ECOSYSTEM SERVICES – VALUING OUR NATURAL CAPITAL IN THE WEST BRANCH SUSQUEHANNA WATERSHED

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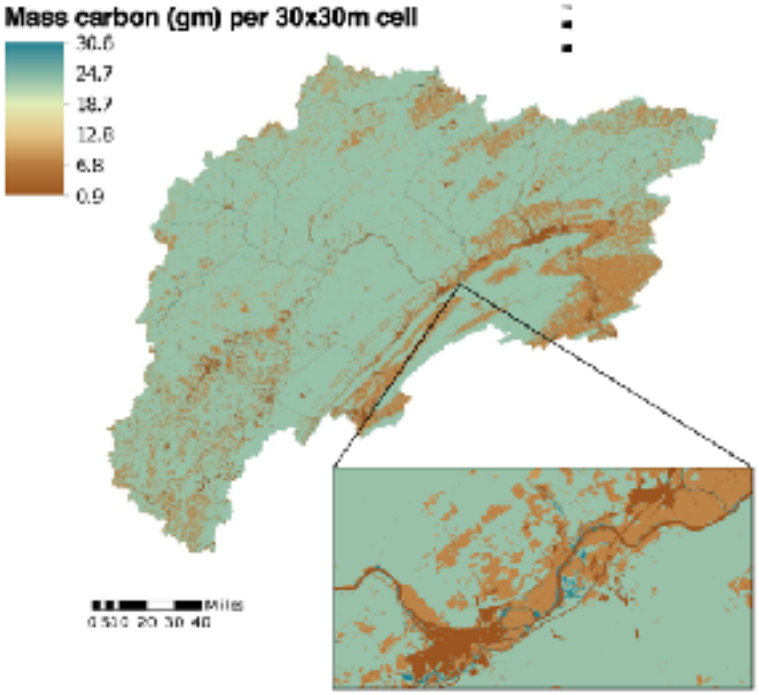
Ecological services (ES) have been a focus of research worldwide, in an effort to estimate the value to humans of natural ecosystems, including services such as habitat for commercial species; erosion control; nutrient cycling; and carbon sequestration. Their benefits to society are widely accepted, but procedures are needed to quantitatively link those services to societal values (Costanza et al., 1995). Quantifying ecosystem services can guide public agency decisions about protecting environmental systems and direct investments into aspects with the greatest value to society. Federal, state, regional, and local agencies use a wide range of methodologies to evaluate ecosystem services, many of which emphasize specific topic areas depending on the agency's goals.

This research critically reviewed several ES valuation methods and assembled a comprehensive methodology encompassing multiple topic areas. One specific objective was to test methodology by applying it to a specific target area: the region drained by the West Branch Susquehanna River in Pennsylvania. The second specific objective was to assess data and valuation methods to identify those where available data or previously-tested methods are not adequate to reliably compute ecosystem service values, either in general or for the specific target region.

Findings include: a) Well-defined topic areas developed by Kauffman et al. (2016) for the Delaware River basin include recreational values; extractive resources; water supply resources; agricultural production; and related jobs and wages. b) Flood mitigation services are included in project decisions by FEMA (2016). c) Although geospatial data sets such as land use/ land cover are widely available at very fine resolutions, procedures for translating land uses to financial values are less precise, derived from personal-value studies such as contingent valuation; willingness to pay; and value-transfer. This research provides an initial analysis and conceptual foundation for anticipated future ES studies in the Susquehanna watershed. It provides a guideline for targeted academic research to create linkage analyses where needed that will extend the method to further topic areas, refine the methods and acquire additional data for the target region, and assess applicability for other regions.

Keywords: Ecosystem Services, Economic Value, geospatial analysis, watershed functions



LULC Type	Proportion of Basin	Carbon per acre	Carbon Sequestration (kg/ year)	Economic value* (US$)
Forest	.791	57.1	315,000	102,000,000
Urban	.018	5.99	7,240	2,350,000
Wetland	.004	75.5	1,490	484,000
Other	.187	12.4	74,600	24,200,000

MONITORING THE EFFECTIVENESS AND PRIORITIZATION OF CONSERVATION PRACTICES

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The loss of soil and nutrients from agricultural land can have adverse effects on the soil productivity of arable fields. The sediment and nutrients that are lost from fields can also contribute to impairments to downstream waterbodies. Limited program resources and deadlines are requiring resource managers to better identify where and what to focus conservation efforts on and track the effectiveness of BMPs to meet water quality standards and TMDLs. A variety of new and innovative tools and techniques will be presented through an overview of USGS studies that have helped to aid resource managers in monitoring the effectiveness and prioritization of conservation practices. Topics will include 1.) tracking temporal trends through direct observations or surrogate models using continuous monitoring of flow, water quality (i.e. nitrate sensor) and sampling, 2) developing spatial frameworks such as watershed-scale synoptic sampling for nutrients or estimating soil erosion rates from landuse, 3.) identifying sediment and nutrient sources through techniques such as fingerprinting and isotopic composition, 4.) field scale studies that better understand processes and evaluate restoration and BMPs (i.e. irrigation nutrient uptake) through groundwater flowpath studies and 5.) advances in data visualization and modeling to provide resource managers planning methods that access big data to drill down to solutions. Incorporating these new and innovative tools will help resource managers to prioritize conservation practices and adaptively manage and balance agricultural production and water-quality protection. Examples of each topic will be provided from cooperative USGS studies.

Keywords: conservation, water quality, BMP, monitoring

EIGHT YEARS OF SAMPLING WILD TROUT STREAMS IN NORTH CENTRAL PENNSYLVANIA FOR THE PFBC'S UNASSESSED WATERS PROGRAM

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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 849 previously unassessed waters as part of the program. Sample sites across north central Pennsylvania have mostly been in the following major watersheds: Loyalsock Creek, Schrader Creek, Muncy Creek, Lycoming Creek, Buffalo Creek, Penns Creek, Swatara Creek, White Deer Creek, First Fork Sinnemahoning Creek, Redbank Creek and Dubois River. Over the course of 8 years we have found wild trout (brook and brown trout) in 47% of the streams (401 of the 849). In 2018, the majority of the sampling occurred in the following sub-basins: Redbank Creek, Little Sandy Creek, Sandy Lick Creek, First Fork Sinnemahoning Creek, and East Licking Creek. In 2018, we sampled 88 sites and found that 43 of the sites had wild trout in them. We found a total of 15 sites that were dry at the time of the surveys this summer. The Unassessed Waters Initiative has led to the designation of over 1700 new wild trout streams, with many more to be added in the future.

Keywords: Brook Trout, Unassessed Waters, Brown Trout

DISCHARGE AND DIATOM BIOFILM COMMUNITIES IN THE SUSQUEHANNA RIVER DURING THE SUMMERS OF 2016 - 2018

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The Susquehanna River is the fourth oldest river in the world and second in the United States. Two branches, the North and West branch converge to form the upper main stem of the Susquehanna River, and the two branches are distinct from each other both chemically and physically. The properties of the West branch and North branch remain distinct in the upper main stem, and we refer to them as the North branch plume (NBP) and the West branch plume (WBP). Since 2009, we have monitored the upper main stem at an established 4 site transect that straddles Byers Island near Shamokin Dam, PA and below the Adam T. Bower inflatable dam at Sunbury, PA. Diatom communities were sampled from cobbles 0.5m below the permanently wetted shore. Diatom frustules were removed from the stones and cleaned for identification by a JEOL 6010 LV scanning electron microscope. Taxa richness ranged from 18 to 36 species per site in 2018. In the previous years (2016 and 2017), taxa richness averaged 35 and 26, respectively. Dominant taxa included Achnanthidum deflexum, Ach. minutissimun, Cocconeis placentula, Discostella stelligera, D. pseudostelligera, Stephanodiscus parvus, and Gomphoneis clevei. Shannon Diversity (SDI) is based on the taxa richness and how evenly they are distributed. Average SDI values ranged from 2.79 (2016) to 2.60 (2017) to 2.15 (2018). Riverine discharge is variable, but can reflect stochastic seasonal trends. The Pollution Tolerance Index (PTI) is a metric related to organic pollution (0 = no organic pollution and 4 – high organic pollution), and specific diatom species have been assigned PTI values. The summer samples from 2016 to 2018, the average PTI metric rose from 2.57 (2016) to 2.70 (2017) to 2.97 (2018). The trends of the past three summers appear to be associated with discharge. The general weather patterns for the summers of 2016-2018 ranged from almost drought conditions in 2016 to the very wet summer of 2018. Discharge averaged from May through July relative to the 80-year average for those months was 48% (2016), 98% (2017), and 174% (2018). Note that during highest taxa richness (35) and SDI (2.79) were during the drought year of 2016. The PTI metric, however, showed a reverse trend. We will explain these results in light of discharge.

Keywords: diatom, discharge, river ecology

LOYALSOCK CREEK AND ITS TRIBUTARIES

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Loyalsock Creek is a 64-mile long (495 square mile basin size) tributary to the West Branch Susquehanna River. Although its headwaters are in Wyoming County, the creek mainly flows in Lycoming and Sullivan counties. The Loyalsock Creek was named by DCNR as PA River of the Year in 2018. There are 15 tributaries into Loyalsock Creek. In this pilot project on stream flow, data loggers were placed in five tributaries and one site on the main stem of the creek. Monitoring of the Loyalsock Creek tributaries allows comparison of water quality of streams feeding into Loyalsock Creek as well as comparison to the main branch. Through the use of level, temperature, and conductivity dataloggers, as well as water chemistry tests (nitrogen and phosphorus series, alkalinity, pH, turbidity, conductivity, and dissolved oxygen) and stream flow data, a sizable amount of data is collected. Tributaries running north to south that were examined were Ogdonia Creek, Plunketts Creek, Big Bear Creek, Little Bear Creek and Mill Creek (west). A site on the main stem below the confluence of Little Loyalsock at Forksville was also monitored. These data are also compared to USGS flow and depth data for Loyalsock Creek taken by a gauge in Loyalsockville. The loggers were deployed from August of 2017 to June of 2018. Level data is corrected after adjusting for barometric pressure also recorded by a logger at the Mill Creek site. Heavy rain this summer resulted in loss of several loggers after re-deployment.

Keywords: Loyalsock Creek, flow

ASSESSING THE WATER QUALITY IN BIG FISHING CREEK WATERSHED IN RELATION TO THE TMDL FOR THE CHESAPEAKE BAY

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Agricultural non-point source pollution is the leading source of water-quality impairment to many of the nation's rivers, lakes, and estuaries, including the Chesapeake Bay. A TMDL plan was developed by the US EPA in 2010 to reduce nutrient and sediment loads for the Bay. The agricultural sector in Pennsylvania portion of the Bay watershed did not meet the interim target set in the TMDL in 2017.

Detailed data, addressing the spatial and temporal variations in nutrients and suspended sediment, are essential in order to characterize small, rural watersheds and thus generate effective BMPs and TMDLs for higher-order streams. A base-line data collection was carried out during 2002-06 focusing on nutrient and sediment flux within the Big Fishing Creek watershed in Clinton County, PA, which is a major tributary to Bald Eagle Creek, which, in turn, flows into the West Branch Susquehanna River, and ultimately to the Chesapeake Bay. A follow up data collection was done during June-September in 2018. The results of this two-phase water quality analysis was used to evaluate relative contribution of nutrients and sediments loads by Big Fishing Creek watershed to the Chesapeake Bay watershed. Eleven water quality parameters were tested on ten locations along Big Fishing Creek and in several tributaries. These parameters included pH, Conductivity, Temperature, DO, BOD, TSS, NO3-N, NO2-N, NH3-N, Total Phosphorus, and COD. These parameters were used to calculate a Water Quality Index score on a scale of 0 to 100.

The results of these two studies indicate the following: (1) high nitrate and phosphate concentrations correlate to both specific point as well as non-point sources; (2) the Big Fishing Creek watershed contributes to nutrient and sediment loads of the Chesapeake Bay watershed at a much higher rates than the average values observed by the Susquehanna River Basin Commission at locations that are situated upstream and downstream of this study area; and (3) for the Chesapeake Bay TMDL plan to succeed, the landuse practices in watersheds for the first and second order streams that are dominated by agriculture and karst topography need to be targeted for implementation of BMPs.

Keywords: Water Quality, Chesapeake Bay, TMDL

POLYPHOSPHATE STORAGE DYNAMICS ACROSS A GRADIENT OF PHOSPHOROUS ENRICHMENT

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Accurately assessing how algal-dominated biofilms in streams respond to anthropogenic phosphorous enrichment is crucial for ensuring sustainable agricultural land use. Understanding phosphorous storage dynamics particularly in the form of polyphosphate can assist in creating more effective nutrient criteria. The purpose of this study is to examine polyphosphate storage dynamics across a gradient of agricultural impairment in 19 Pennsylvania streams. This study sought to determine the quantity of Polyphosphate stored in response to phosphorous availability. Results indicate biofilms are able to store polyphosphate in both low and high concentration SRP streams. These results may give evidence to support both the “overplus” response and the “luxury” response at both ends of the phosphorous gradient

Keywords: Phosphorus, polyphosphate, algae, agriculture

CURRICULUM DEVELOPMENT FOR EXPERIENTIAL LEARNING OPPORTUNITIES AT WATERDALE ENVIRONMENTAL EDUCATION CENTER

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The best means to protect and conserve a watershed is through exposure and education. The purpose of my research was to update and create new curricular materials for implementation of experimental learning activities at the Waterdale Environmental Education Center. Located within the Mosquito Creek Watershed in Duboistown, PA, the Waterdale Lodge is the center for a cooperative collaboration of public water supply utilities, academic institutions, and local and state conservation organizations. The catchment in for the Mosquito Creek Valley feeds into the West Branch Susquehanna River. The Waterdale Environmental Education Center is a community partnership between the Lycoming College Education and Biology Departments and Clean Water Institute, along with the Williamsport Municipal Water Authority (WMWA). Waterdale is a resource for K-12 education outreach and for college research projects.

Educational efforts at Waterdale include scavenger hunts, aquatic macro invertebrate sampling and identification, tour of water filtration plant, water monitoring and testing, and demonstrations utilizing stream model, groundwater model and Enviroscape model.

Curricular development refers to the educational process by which instructors create and correct their content delivery and design. Experiential learning allows students opportunities to learn through hands-on activities that occur outside the traditional classroom walls. The curriculum developed for the Waterdale Environmental Educational Center incorporates experiential learning opportunities that promote watershed sustainability education, water quality testing, and effects of pollution on surrounding watersheds, storm water management, small stream habitats, and spatial and temporal variability within and across watersheds. The objective of the Waterdale curriculum guide is to provide the content necessary for scientific fieldwork and teaching experiences in a real-world environmental setting, utilizing local resources and academic professionals.

Keywords: environmental education, watershed

PROGRESS ON THE RESTORATION OF AN EASTERN HELLBENDER POPULATION IN THE UPPER 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.

In the fall of 2014, fertile hellbender salamander eggs were collected in Pennsylvania and reared by the Wildlife Conservation Society at the Bronx Zoo until age 2-1/2 years, then transferred to a newly-constructed rearing lab in central New York. We assessed the growth and health of 100 juvenile hellbenders at the lab on a monthly basis. Three weeks before the release date, we implanted a microchip beneath the skin of each individual. Prior to release, we installed 200 pieces of sedimentary slab rock in the stream channel at the release site to serve as natural habitat. We also constructed and installed 20 artificial habitat structures and wire cages in the stream channel to serve as "soft release" locations. In order to continuously monitor the juveniles following their release, we installed two state-of-the-art solar-driven instream antenna systems at the release site. Following two weeks of acclimation inside the soft release environments, the juveniles were released to the wild and are currently being monitored by instream and hand-held antenna systems.

Keywords: Eastern Hellbender, restoration ecology, population augmentation, habitat enhancement

GROWTH AND MORTALITY OF WALLEYE IN SELECT NEW YORK WATERS 1991–2010

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Abstract: Walleye (*Sander vitreus*) is a popular sportfish in North America and is actively managed to support fisheries throughout New York State (NYS). Successful recruitment in most fish populations is strongly linked to survival and growth of a typically vulnerable young of year class. The ability to quantify survival and growth of stocked fish in particular has the potential to enhance ongoing management efforts and better predict changes in population dynamics. However, estimation of growth parameters is often difficult in data-limited populations.

We used Bayesian hierarchical methods to fit von Bertalanffy growth models to length-at-age data for walleye collected from various waters in southeastern NYS. This approach allowed us to share information across walleye populations to estimate growth parameters and total annual mortality in waters sampled by state biologists 1991–2010. The model also provides region-wide estimates of life-history parameters. Walleye growth rates (k) were similar between waterbodies, but maximum size of walleye caught was notably smaller in Canadarago Lake than in other lakes. On a regional scale, average annual mortality for walleye was 0.41(95% CRI: 0.32–0.50), as estimated from life-history invariants. Future work on Percids in this region will investigate number of factors that influence length at age.

Keywords: Bayesian, von Bertalanffy, growth, models

IMPROVING THE YIELD OF ENVIRONMENTAL DNA FROM FILTERED AQUATIC SAMPLES

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The analysis of environmental DNA (eDNA) is a promising conservation tool to provide information about the presence/absence of rare or invasive species that are difficult to physically locate. In aquatic environments, eDNA analysis has been successfully implemented to monitor a variety of species, however further research is needed to improve methodology used in eDNA analysis.

The aim of the present study is to investigate the effect of the DNA extraction process and the effect of the filter preservation method on eDNA yield. We analyzed field-collected water samples for eDNA of the Eastern Hellbender, a fully-aquatic giant salamander that was once locally common but is now declining in its number. Water samples from sites of interest were filtered and the filters were stored in the laboratory until we extracted DNA from these filters and then performed quantitative PCR to detect Eastern Hellbender DNA.

To improve eDNA recovery from filters, we tested whether the use of bead beating, where small silica beads are vortexed with the filter during DNA extraction, would increase eDNA yield by removing DNA trapped on the filters. In addition, we examined whether preservation of the filters in ethanol or storage at -20°C before extraction would yield more eDNA. We found that bead beating during DNA extraction significantly increased the estimated amount of eDNA extracted compared to controls and that preservation at -20°C also significantly increased estimated concentrations of eDNA obtained compared to preservation in ethanol.

Keywords: environmental DNA, Eastern Hellbender, Cryptobranchus alleganiensis alleganiensis, bead beating

BIOLOGICAL EFFECTIVENESS OF INSTREAM BANK RESTORATION STRUCTURES ON FISH POPULATIONS

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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 assemblages. In recent years, farmers have begun to adopt a variety of best management practices including restricting livestock access to the stream, enlarging riparian buffers and constructing stream bank stabilization structures. Efficacy of these management practices is needed to determine ecological benefits to stream species. To determine the biotic response to installation of stream bank restoration structures, we conducted pre and post-restoration sampling at 16 study sites in central Pennsylvania from 2015-2018. Stream assessments consisted of backpack electrofishing a 100m site for fish species enumeration and identification, and collection of standard water chemistry data. We found increases in different fish species abundance post-restoration, likely due to decreases in sedimentation, and increases in habitat availability. Our results suggest that simple streambank restoration projects and best management practice plans could improve the health of not only local watersheds in central Pennsylvania, but also the Susquehanna River watershed and even the Chesapeake Bay.

Keywords: ecological restoration, stream bank protection, sediment reduction, fish populations

TEMPERATURE-BASED COMPETITIVE INTERACTIONS BETWEEN BROOK TROUT AND CREEK CHUBS; IMPLICATIONS OF CLIMATE CHANGE

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Water temperature can strongly influence competitive interspecific behaviors of many fish species because of species-level differences in thermal tolerance. Global warming may negatively impact competitive advantages among cold freshwater fish due to induced thermal stress that can influence feeding and social behavior, growth rates, and species phenology. Small coldwater streams in the Appalachian Mountains are facing stream temperature increases from global climate change and deforestation. The common cyprinid species, Creek Chub (*Semotilus atromaculatus*) is found in both warm and cold water streams and is sympatric and syntopic with Brook Trout (*Salvelinus fontinalis*) in Pennsylvania headwaters. Because of broader thermal tolerances among Creek Chub, increased stream temperatures may enlarge Creek Chub ranges while contracting that of Brook Trout. To date, the effects of temperature on these species competitive interactions is largely unknown. Previous research shows that Brook Trout should respond negatively to increases in stream temperature because they have a much lower thermal maximum and a much higher demand for increased oxygen concentrations than Creek Chubs, which have been found to be able to adjust rapidly to changing landscapes and stream conditions. We predict that when Brook Trout and Creek Chubs are kept together in high water temperatures, Creek Chubs will show aggressive behaviors and take preferential feeding habitat from thermally stressed Brook Trout. We measured feeding and aggressive behaviors among three combinations of conspecific and heterospecific dyads of Creek Chub and Brook Trout within laboratory raceways at three different temperatures (16°C, 18°C, and 20°C). We used a within-between subjects experimental design with three between-species treatments (Creek Chub pairs, Brook Trout pairs, chub/trout pair) and three within-temperature treatments among each dyad. Behaviors measured included feeding latency, feeding rate, aggressive bumps, and displacement during feeding. We also documented submissive and defensive behaviors including freezing, dropping, and avoidance among each pair.

Keywords: temperature, competition, climate change, competitive interaction

INCORPORATING DIATOM COLLECTION AND ANALYSIS IN COMBINATION WITH BENTHIC MACROINVERTEBRATES, FISHERIES SAMPLING, AND WATER QUALITY COLLECTION TO DESCRIBE A MORE HOLISTIC REPRESENTATION OF WATER QUALITY CONDITIONS

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Diatoms are photosynthetic unicellular, microorganisms (algae) that are distinguished by their silicified (SiO2-nH2O) cell walls. Physical factors, such as light, nitrogen (N), phosphorus (P) and stressors such as pH, temperature, and toxins directly affect diatoms. Diatoms have fast growth rates (from hours to days) compared to fish and benthic macroinvertebrates and they reproduce and respond rapidly to environmental changes. The sensitivity of diatoms to stream conditions make these microorganisms highly valuable indicators, can provide early warning indicators of pollution increases and could likely be used describe habitat restoration success. Many diatom species have been calibrated to environmental measures and numerous diatom indices can be used for analysis. Diatom assemblages and water chemistry have been studied but not applied to stream restoration success criteria in Maryland.

This project incorporates diatoms as part of pre-construction monitoring for a stream restoration project along Reddy Branch in Brookeville, MD in combination with benthic macroinvertebrate sampling, fisheries sampling, and water quality collection. We assumed that the combination of metrics for biological quality elements (BQE) is a consistent way to describe pre-construction conditions at a Reference Station (RED-01) and two stations within the Mitigation Site (RED-02 and RED-03). We tested our hypothesis by sampling benthic macroinvertebrates, diatoms, fish and water quality at the three sites in 2016.

We compared the relevance of the different types of results (classical biological indices, taxonomic and non-taxonomic metrics, and physicochemical parameter values) to determine any differences between the Reference Station and the Mitigation Site Stations. The diatom, benthic, and fish metric results all showed similar scores/ratings for the three sampling stations along Reddy Branch, which is generally rated as Good to Excellent. The incorporation of diatom sampling and analysis supported the results collected for fish, benthic macroinvertebrates, and water quality parameters. The higher number of indicial metrics calculated for diatoms was useful in describing the full existing conditions at the Sampling Stations. It would be recommended to collect more than one season of diatoms since the cost is significantly lower compared to the cost of fish and benthic collection and analysis. Following construction of the restoration site (planned for 2018), the same post-construction physical and biological data will be collected and the results of post-construction will be compared to the baseline to determine success of the stream and wetland restoration project.

Keywords: diatom, water quality, benthic macroinvertebrate, indicators

CWI MONITORING FOR LYCOMING COUNTY CONSERVATION DISTRICT'S WOLF RUN RESTORATION PROJECT

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In 2018 the Lycoming County Conservation District completed restoration projects at 2 of the 4 sites along Wolf Run (Lycoming County). Wolf Run is a tributary to Muncy Creek watershed and drains into the West Branch Susquehanna River. Pervious study indicated impairment due to non-point agriculture run off, limited or absent riparian buffers, 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. Best Management Practices (BMP's) for heavy use area protection and manure management started in 2014. Bank stabilization is designed to stabilize 2,880 feet of stream bank and will prevent 397.80 pounds of Nitrogen, 182.70 pounds of Phosphorus, and 69.4 tons of sediment will be prevented from entering Wolf Run. 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. Orthophosphate and Total Phosphorous were found to exceed the healthy water quality concentrations. Total number of fish caught over two years was 686 (representing 15 different species). The Index of Biological Integrity was also used and no sites in 2017 and 2018 were impaired (≤60). This is the second year of the preliminary survey. The Lycoming County Conservation District is planning to finish this project in the fall of 2019.

Keywords: stream restoration, BMP

URBAN STREAMS AND STORM WATER ACCESS IN LYCOMING COUNTY MS4 REGION

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Lycoming College Clean Water Institute assessed streams and stormwater out falls within the Lycoming County MS4 region between 2015-2018.There are 205 outfalls in the Lycoming County MS4. The County MS4 area also includes seven urban streams with five on the North side of the West Branch Susquehanna River that were sampled as part of this study (Grafius Run, McClure Run, Millers Run, Bull Run and Tules Run). Water monitoring included dissolved oxygen, pH, temperature, nitrates, nitrites, phosphorous, conductivity, TDS, alkalinity and aluminum. A 2014-2015 PADEP evaluation of Millers Run lists aluminum and agricultural as impairments. Current velocity during low and high flow events were also attempted. Coliform and Macroinvertebrate collections assisted in water quality interpretations. Biotic Index scores for the urban streams indicate fair to significant organic pollution. Water quality interpretation was evaluated with reference to number of stormwater outfalls previously recorded by the Clean Water Institute within the MS4. Results offer insight to community and governing bodies to better establish future administrative plans on decreasing the amount of urban and suburban pollutants from entering local waterways.

FIELD AND LAB EXPERIMENTS EXAMINING THE EFFECTS OF ELEVATED SOIL TEMPERATURE ON THE GROWTH OF *CIRSIUM ARVENSE* (CANADA THISTLE)

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Canada thistle (*Cirsium arvense*) is an invasive species of plant from Europe that reproduces using both seeds and rhizomes. This species spreads easily into disturbed patches in riparian forests and may alter ecosystem structure and function. Increased temperatures resulting from global climate change may increase the growth and reproduction of Canada thistle and other invasive plants, which could increase colonization rates in disturbed environments. Using lab- and field-based approaches, we examined if elevated soil temperature affected plant height and plant biomass of Canada thistle. Laboratory and field studies both examined individual Canada thistle plants growing from rhizomes in one gallon pots. Initial rhizome biomass and aboveground biomass of the plant the rhizome originated from were measured for use as covariables. Plants used for the lab-based experiment were grown in the greenhouse under ambient or warmed soil conditions. Soil temperature was increased about 5 degrees Celsius using soil warming mats. Plants used for the field-based experiment were grown outside at the Waterdale Environmental Education Center. Sixteen plants were randomly assigned to one of three treatments (48 plants total). Four pots were grouped together and covered with 1) black plastic sheeting (to increase temperature), 2) white plastic sheeting (to mimic ambient conditions), and 3) no plastic sheeting (a control to determine the effect of the plastic). The soil temperature of the pots were monitored during both experiments using soil temperature loggers, and air temperature was monitored during the field experiment. We measured plant mortality, plant above ground biomass, and plant height for the lab experiment and plant mortality, insect damage, above ground biomass, and belowground biomass for the field experiment. The lab experiment resulted in no effect of the treatment on aboveground biomass, but we did find a significant difference in plant height by the end of the study. Mortality, insect damage, and plant biomass varied among treatments for the field experiment, but did not represent a clear effect of temperature. The plastic sheeting, however, demonstrated an effect on plant growth. We also report on our secondary goal of developing a cost effective model system for examining the effects of increased soil temperature on plant growth.

Keywords: Cirsium arvense, Canada thistle, invasive species, riparian forest

LITHOPHILIC FISH POPULATIONS INCREASE WITH COARSER SEDIMENT IN RESTORED STREAMS

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Stream restoration projects attempt to improve fish habitat, prevent erosion, and enhance recreational opportunities. Several streams in Montour, Union, and Centre counties have been identified by high resolution topographic and land cover data developed by the Chesapeake Conservancy and are receiving stream restoration. Sampling of fish populations and sediments were performed on both pre-restoration and post-restoration sites through electrofishing and sediment dredging. Fish species were identified, counted, and measured on site. Sediment samples were processed through sieving and a hydrometer analysis to determine grain size from clay to 16-millimeter coarse fragments. A trend was identified between coarser grain size and lithophilic fish populations. These correlations reveal the ecological benefits of stream restoration techniques and serve as a justification to continue with the practice.

Keywords: stream restoration, precision conservation, stream sediments, fish ecology

EXPLORING NITROGEN FIXATION IN THE SUSQUEHANNA RIVER

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Nitrogen is a key component of all proteins and thus is required for growth and development of all forms of life. The most abundant form of nitrogen is dinitrogen gas (N_2) in the atmosphere. However, none of this nitrogen is available for biological use. Dinitrogen must be converted to fixed biological forms—principally as ammonium, NH_4, which can be easily incorporated into amino acids for protein synthesis. The production of NH_4 from N_2 is called nitrogen fixation. Biological nitrogen fixation is restricted to a few members of the Domain Bacteria and Archaea, but within these domains, nitrogen fixation is found in many different phyla. After identifying a nitrogen fixing cyanobacteria (*Pseudanabaena* strain SR411) in the Susquehanna River, we wondered how widespread nitrogen fixation was in the microbial community of the Susquehanna River. We are taking a two prong approach to determine how prevalent nitrogen fixation is in the microbial community. First, we are isolating and characterizing bacteria that are capable of fixing nitrogen and second, we are using a metagenomics approach to PCR amplify nitrogenase genes from environmental DNA.

Keywords: nitrogen fixation, microbiology

ASSESSING HEALTH OF THE LITTLE JUNIATA RIVER WATERSHED

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The Little Juniata River is a popular coldwater fishery, however we do not know many of the details of the health of the watershed. Therefore, we initiated a study to quantify the health of the Little Juniata River and its tributaries so that we can classify conditions at the watershed scale. We collected water quality and benthic macroinvertebrates from 38 sites, and we plan on collecting fish and habitat on most of those same sites. This current presentation focuses on our findings for the main stem of Little Juniata River only. We identified benthic macroinvertebrate samples from 10 main stem sites and examined the patterns in community structure as it related to water chemistry and land use attributes. We also calculated the PA IBI from benthic macroinvertebrate data at each site, and then constructed an empirical model that relates PA IBI scores to landscape conditions. We obtained land use data from the Chesapeake Conservancy Landscape Data Project and we analyzed relationships at the segment-level watershed scale. We found that benthic macroinvertebrate assemblages varied greatly among sites on the main stem. Water quality stayed relatively constant. Our analyses herein detail the relationship between benthic macroinvertebrates and land use patterns, and how it can be used for predicting conditions in un-sampled reaches of the main stem. Similar techniques can be used for the entire watershed. Being able to classify stream conditions will allow us to identify high quality areas for conservation and will allow us to identify low quality areas that can be targeted for restoration.

Keywords: river health, IBI, landscape conditions

Little Juniata River
(Photo: Nivek Holodeck)

DO MALE AND FEMALE MUSSELS HAVE PREDICTABLE SIZE CHARACTERISTICS?

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Abstract: Freshwater mussels are vastly understudied group of animals and as a result, basic life history characteristics are unknown for many species. In some species, gravid females display a deceptive lure made from part of its mantle, but unless the female is displaying the lure, it is difficult to quickly and accurately determine the sex of mussels based on their external morphology. This study determines the relationship between sex and morphology of *Lampsilis cariosa* and *Eliptio complanata*, two species native to the Susquehanna River. Using live mussels, samples of gonadal fluid were extracted from the visceral mass and examined to determine the sex of each individual. These data were then compared to three measurements of the corresponding shell: length, width, and girth. Determining the sex of live animals has important implications for future studies of mussel biology, begging questions related to their reproduction, demography, and population distribution.

MEASURING SUCCESS OF RIPARIAN BUFFERS

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Stream sediment samples have been collected from sites across Centre, Clinton, and Montour counties for two years as part of a collaborative effort between multiple institutions headed by the Chesapeake Conservancy. A Mann-Whitney U test comparing site data from the summer of 2017 and the summer of 2018 was performed separately on forested reference sites, various farm streams with post-restoration data, and farm streams along Elk Creek with data collected before and after riparian buffers were restored and stream structures implemented. This analysis has shown that the changes in mean grain size, organic matter, carbon to nitrogen (C:N) ratio, and percent of fine particles in the sites where restoration has been completed have not only been healthier but are statistically significant as well. The C:N ratio and mean grain size are larger, the amount of organic matter has decreased, and there is less fine particles in the sediment. When comparing the post-restoration farm streams and the forested reference sites, there are not as many statistically significant changes as seen in Elk Creek and not all of the significant changes are conducive to stream health. These changes within Elk Creek and their statistical significance show that stream restoration projects improve stream quality for healthier insect and fish communities.

Keywords: riparian buffer, stream restoration

STATUS OF *BAPTISIA AUSTRALIS* (FABACEAE) IN PENNSYLVANIA AND THE POTENTIAL IMPACT OF ESCAPED CULTIVATED GENOTYPES: PRELIMINARY OBSERVATIONS

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Baptisia australis (L.) R. Br. (Fabaceae) is an attractive native wildflower that is widespread in the Midwest and throughout eastern North America. The vigorous perennial habit, showy purple flowers, and historic use in textile dyes have made the species a favorite in cultivation. Many of the readily available "native varieties" are hybrids, however, with a pedigree combining up to three genetic lineages to express more robust characteristics. Use of these hybrids in residential and commercial landscape applications poses the potential for release of non-native genotypes via pollinators and seed dispersal into wild native populations. Although widespread in North America, populations of *B. australis* in the eastern portion of its range occur sporadically across the landscape in a variety of habitats ranging from rich woods and alluvial thickets to cedar glades and gravel bar river scours. Within Pennsylvania, two extant native metapopulations of *B. australis* are known: one from gravel bars and river scour grasslands along the upper Allegheny River and the other from scour zones along the Youghiogheny River. Despite both of these watersheds ultimately flowing to the Ohio River drainage, there is considerable distance between these *B. australis* metapopulations. The limited distribution and few remaining populations of B. australis in Pennsylvania qualifies it for state threatened conservation status. Given that the species is of conservation concern, we are interested in exploring the potential impact on native populations of the introduction of non-native hybrid genetic material from native garden and restoration plantings. While still in its early stages, this study seeks to answer the following research questions; 1) What is the status of the remaining wild populations of B. australis in Pennsylvania? 2) What is the genetic structure of those known native populations? 3) Is there genetic evidence of non-native hybrids in the native populations? and 4) What is the relationship of population sizes to the ecological condition of the plant communities that harbor the species? Preliminary findings based on initial field surveys are presented.

LIMNOLOGICAL EVALUATION OF INDIAN PARK POND

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The Indian Park Pond is a 1.86-hectare (4.6 acre) man made pond located in Montoursville Borough, Lycoming County. The pond is actually a series four separate depressions. This 2018 study is a follow-up evaluation of the trophic state of the pond first completed in 2014. According to the Lake Assessment Protocol of the PADEP, the main concerns with water quality associated with Pennsylvania lakes deal with eutrophication, mainly cultural eutrophication caused by human activity. Interns from Lycoming College's Clean Water Institute conducted tests to assess the pond's trophic state and analyze the health of the pond. The Carlson's Trophic Index was calculated based on total phosphorous, Chlorophyll-a, and Secchi disk depth indicates the pond to be in a hypereutrophic state. Additional data collected were fish diversity, macroinvertebrate diversity, macrophyte diversity, coliform bacteria, zooplankton and other chemical parameters. These data help by the Borough evaluate the recreational use of the pond. High coliforms due to large density of waterfowl, thick aquatic plant and low dissolved oxygen are all concerns for future maintenance and use.

Keywords: trophic state, pond

COMMUNITY-BASED MONITORING OF IMPACTS OF AMD AND MARCELLUS SHALE DRILLING ON WATER QUALITY IN BEECH CREEK AND CLEARFIELD WATERSHEDS

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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 quality. Beginning in 2008, the area experienced another wave of resource extraction related to Marcellus Shale gas-well drilling, which has raised concerns among citizens and the scientific community about potential impacts on water quality 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 on a long-term basis. On average, a total of 20 samples have been collected monthly from Beech Creek and Clearfield County watersheds for laboratory analysis. The parameters monitored included, but are not limited to, temperature, pH, TDS, total Fe, Al, Ba, Cl, and SO4. These parameters were determined using HACH DR6000 Spectrophotometer, HACH multi-parameter probes, and titration methods. These parameters were chosen due to their association to both AMD and Marcellus Shale drilling activities. Our results indicated that the legacy of AMD damage in these watersheds prevails.

Keywords: AMD, water quality, Marcellus Shale

THE EFFECTS OF ROAD SALT (NaCl), PREDATION, AND COMPETITION ON THE GROWTH AND DEVELOPMENT OF SPOTTED SALAMANDERS (*AMBYSTOMA MACULATUM*) AND WOOD FROGS (*LITHOBATES SYLVATICUS*)

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Road de-icing salts - primarily NaCl - are frequently used in the northern regions of the United States during the winter and early spring months. As a result, much of the road runoff into surrounding aquatic habitats contains road de-icing salts. Previous studies have found road salt contaminations in vernal pools that pond-breeding amphibians commonly use, 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. During the spring and summer of 2017, we conducted an outdoor mesocosm experiment in which we created eight experimental conditions with three main factors: presence/absence of NaCl (1000 mg/L Cl^-), presence/absence of interspecific competition between the two amphibian species, and presence/absence of predatory dragonfly nymphs (Family Libellulidae). Our experiment revealed that salt delayed hatching and increased deformity in spotted salamander hatchlings. Additionally, salt significantly decreased salamander and frog survivorship, with the presence of wood frog tadpoles further exacerbating the decrease in salamander survivorship. The presence of salt also increased frog body size, while the presence of predators decreased frog body size. However, there was an interactive effect between salt and predators, with the presence of salt negating the effect of predator on body size. Salt also decreased the proportion of metamorphosed salamanders. Overall, our data suggest that the application of road de-icing salt has many far-reaching impacts on amphibians and their ecosystem.

Keywords: pollution, amphibians

FOREST COMMUNITY SURVEY AT LYCOMING BIOLOGY FIELD STATION (LBFS)

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In 2018, Lycoming College acquired land to establish the Lycoming Biology Field Station (LBFS) along Rt. 87 (Lycoming County). The Lycoming Biology Field Station Inc. is a nonprofit corporation and wholly-owned subsidiary of Lycoming College. The field station consists of 116 acres with two houses, a barn, outbuildings, two farm fields, forested area, and a section of the Loyalsock Creek. During the summer of 2018, Clean Water Institute (CWI) interns surveyed the field station to analyze tree density and habitat. The Point-Quarter survey uses transects to collect data in the forest community to assess tree diversity and habitat. Ten transects were tracked during this study in different sections of habitat. The College Biology Department intends to use this area for field courses in Aquatic Biology, Ecology, Plant Science, Vertebrate and Invertebrate Zoology, Environmental Biology as well as student research and practica projects. Additional use of the facility will be to support projects associated with the college's Sustainability Committee, Outdoor Leadership and Education (OLE), Center for Energy and the Future (CEF), Archeology, Clean Water Institute (CWI), Lycoming Environmental Awareness Foundation (LEAF), and in program development in education and other departments. Analysis from 10 transects indicate Sugar Maple (63.3%), Black Walnut (49.5%), and Sycamore (36.3%) have the highest importance values for the tree community. The average density of trees for all transects was 40 trees/hectare (2.47 acres). This study is ongoing and tree assessments will continue to further evaluate the property.

Keywords: field station, forest community

DIET ANALYSIS AND PRESENCE OF MICROPLASTICS IN SMALLMOUTH BASS IN THE SUSQUEHANNA RIVER.

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Microplastics are an emerging concern in freshwater systems for fish and other organisms, and the presence of them may impact the diet of freshwater fish. A diet analysis was performed amongst Smallmouth Bass, *Micropterus dolomieu* collected from the central portion of the Susquehanna River and its tributaries. We examined frequency of occurrence, percent composition by number of organisms present and inspected stomachs for the presence of microplastics (plastic particles less than 5 millimeters in length). The stomachs of 36 Susquehanna River originated Smallmouth Bass were examined for evidence of accumulation of microplastics. Diet analysis thus far indicates a variety of forage (Cambaridae, Ephemeroptera, Plecoptera, and Diptera) being consumed by Smallmouth Bass. Analysis for the presence of microplastics will be conducted with a wet peroxide oxidation procedure. Previous research using this method found that microplastics had a high level of occurrence (83%) in Smallmouth Bass stomachs. Our study will help increase the knowledge base of the what Smallmouth Bass consume in their diet and the presence and concentration of microplastics in freshwater fish species found in the Susquehanna River.

Keywords: microplastics, smallmouth bass, diet, Susquehanna River

THE ASSESSMENT OF ROSE VALLEY LAKE

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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. Carlson's Trophic State Index (TSI) for lakes was created so that scientists can measure and record on a scale of 0 to 100. Each major division (10, 20, 30, etc.) represents a doubling in algal biomass. The index score/ calculation uses data on Secchi disk transparency, chlorophyll, and total phosphorus. These quantities and other biologically helpful nutrients are the primary factors of a body of water's TSI. Nutrients such as nitrogen and phosphorus have a tendency to be limiting resources in standing water bodies, so amplified concentrations tend to result in increased plant growth, a body of water's trophic index is used to make a rough estimate of a lakes biological condition. Over the last decade the lake has been changing from mesotrophic to eutrophic. This year the lake appears to be trending from Eutrophic to Hypereutrophic (TSI of 60-100).This trend indicates the lake is in transition from the highest amount of biological activity to possible reduction in water quality. In addition, zooplankton samples were taken and show a dominance of rotifers especially Keratella.

Keywords: trophic state, lake

PERCEPTIONS OF THE SUSQUEHANNA RIVER'S INFLUENCE ON THE HEALTH AND WELLBEING OF RIVER TOWN RESIDENTS

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Growing evidence indicates blue space, characterized by proximity to bodies of water, may benefit human health and wellbeing. Research evaluating benefits is key to supporting conservation and development of blue spaces. The goal of this study is to evaluate how the Susquehanna River and other Pennsylvania waterways influence resident health and wellbeing. To inform study development, we interviewed 7 key informants from non-governmental organizations and local and state government and 16 residents from communities representing the three Susquehanna River branches. Key informants believed the river is increasingly viewed as a recreational and tourism asset, but that it remained underappreciated and underutilized. Some communities view it as a liability given fears about flooding and related economic consequences.

Key informants reported river access influenced use of and connection to the river, with access impeded by financial, knowledge, perceptual, and physical barriers. Though satisfied with their own access, resident interviewees similarly viewed widespread river use as hampered by insufficient access, along with its "invisibility as a destination" and perceptions of it as "destructive and dirty." Many described an affinity for blue space and a personal attachment to the Susquehanna, and highlighted its beauty, recreational assets, and importance as wildlife habitat. Resident interviewees had varied interactions with the river, ranging from frequent paddling excursions to occasional riverfront walks, that changed seasonally and over their life course. Both sets of interviewees said the river benefited individuals by providing a calming space that allowed for connection with nature, a source of recreation and physical activity, a sense of place, and a community connecting point.

They described the Susquehanna River as a defining feature of river towns that benefited communities recreationally, aesthetically, and economically, but that a stronger connection between commercial main streets and riverfronts was needed. Future work includes a survey of river town and non-river town residents to evaluate associations of river interactions with health behaviors and outcomes, and direct observation of study towns to evaluate river access points, natural recreation areas, and commercial areas.

Keywords: Blue space, health, qualitative research

West Branch Susquehanna River at Watsontown, PA

TRACKING DIURNAL AND SEASONAL MOVEMENT OF BROWN TROUT IN THE LITTLE JUNIATA RIVER

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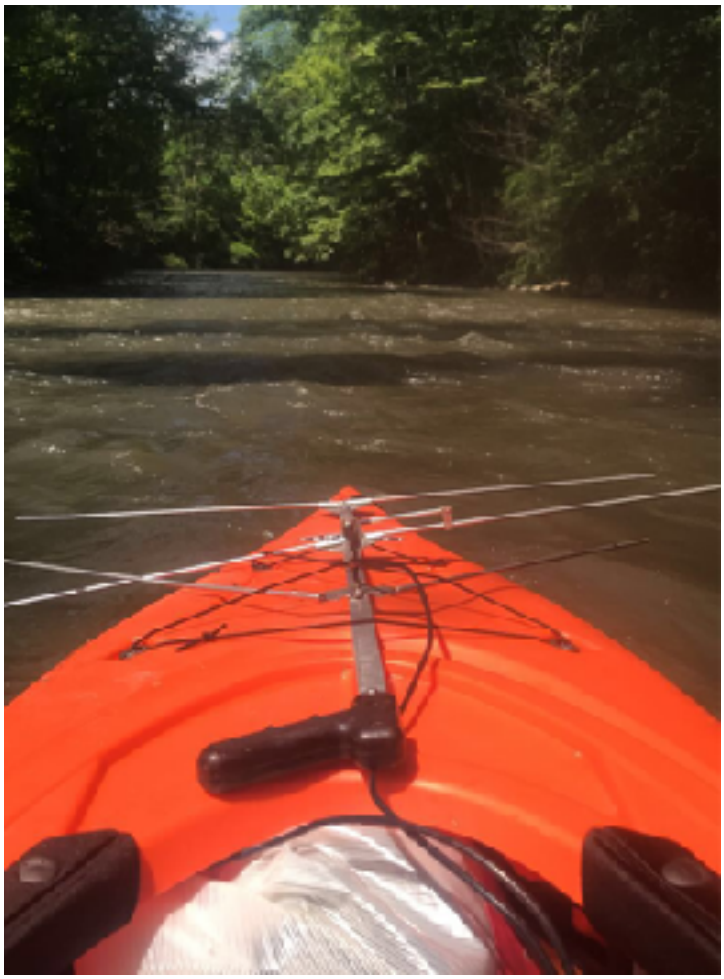
As anthropogenic influences continually alter the natural state of the aquatic environment, species become increasingly susceptible to varying ecological conditions. To track the behavior of brown trout (Salmo trutta), researchers from Juniata College implanted Lotek NTQ-6-2 transmitters into 45 brown trout from the upper, middle and lower parts of the Little Juniata River. We recorded the location of the fish twice a week for one year by driving, walking and sometimes kayaking the river. We conducted habitat surveys at several points along the river including the three study sites, and measured average distance to cover; average flow; percent pool and riffle; and the percent of different substrate types. To identify temperature changes along the river, we attaching temperature loggers to kayaks and floated a 26-mile stretch. We found that tagged trout were not found in stretches of the river warmer than 72° C. We also set up stationary data loggers for 24-hour periods at several sites to record daily movement. Brown trout displayed highest movement during dawn and dusk. We found significant difference in site fidelity across the three study sites, and we attributed some if this variability to difference in habitat quality. We also found that site fidelity varied by season. During the spawning period (October, November and December), fish from two of the sites showing lower site fidelity and an increase in site fidelity at the third site. Again, this difference could be explained by habitat variability. Finally, we plan to compare fish distribution with other factors such as land use/cover, distance to closest tributary and macroinvertebrate density and diversity at the study sites.

Keywords: brown trout, movement, transmitters, Juniata



AERIAL INSECTIVORE RESPONSE TO ACID MINE DRAINAGE IN PENNSYLVANIA STREAMS

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Acid Mine drainage (AMD) is the runoff of acidic water from metal or coal mines into aquatic ecosystems. Acid Mine Drainage increases stream acidification, metal concentrations, and sedimentation which can decrease food web complexity by negatively affecting insect and bird diversity. Stream acidification reduces acid-sensitive macroinvertebrate taxa that are important food sources to aerial insectivore birds foraging along riparian communities. Despite the known effects of acidification on stream biodiversity, little is known about the nest density of aerial insectivore birds foraging along riparian ecosystems impacted from AMD. This study quantified differences in water quality, nest density, and nest activity for all aerial insectivores nesting along ten sites that vary with respect to acid mine drainage in six creeks. The field water quality parameters that were taken were pH, temperature, depth, dissolved oxygen concentration, and conductivity using a sonde. Turbidity and Alkalinity were also measured from samples collected the same day. Nest density was recorded by taking under-bridge nest tallies, species of each nest, and recording whether the nest was active or not. Streams impacted from historical acid mine drainage were Catawissa Creek, Shamokin Creek, and Nescopeck Creek. Streams not impacted from AMD were Huntington Creek, Fishing Creek, and Roaring Creek. All data was collected between June 2018 until October 2018. Our data suggests AMD impacted sites had lower nesting densities and reduced number of active nests. Additionally, the water quality parameters recorded at sites impacted from AMD indicated reduced pH, alkalinity, dissolved oxygen concentration, and an increase in turbidity, and conductivity.

Keywords: Acid mine drainage, riparian bird community membership, pollution , aerial insectivores

WORTH THE TIME: UNDERSTANDING THE IMPROVEMENT OF WATER AND FISH HEALTH AFTER A STREAM RESTORATION

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Stream fish habitat restoration is a major business and is especially popular in cold-water systems to improve trout populations. In this study, we compared stream habitat conditions and the fish assemblage before and after a habitat improvement project on Kelso Run, a headwater stream in the Little Juniata River watershed, that was geomorphically devastated by flood waters from Hurricane Ivan in 2004. Located in Blair County, Kelso Run is a 1.34 mile tributary to Bells Gap Run that supports a wild population of naturally reproducing trout. Acted on by members of the Little Juniata River Association, Pennsylvania Trout Unlimited, and students from several colleges including Juniata College, the restoration's mission was to improve the health of the stream and trout by filling in gaps in the banks of the stream and providing more pools for trout to reside in. We sampled macroinvertebrates, fish, habitat, and water quality to quantity the ecological lift due to the efforts. Compared to before the restoration activities took place, we observed a significant improvement in fish habitat quality in a few key variables such as cover and pools. We also observed a slight increase in the percentage of fish sampled that were trout. Over time, we expect this value to increase as trout move in and decide to reside there. Along with this improvement, we are in the process of assessing the other data for improvements, such as in the quality of the benthic macroinvertebrate assemblages. Evaluating conditions after restoration projects is an essential process in assessing restoration success.

Keywords: restoration

DIATOM COMMUNITY ANALYSIS OF PENNS CREEK MOUNTAIN HEADWATER STREAMS, A STUDY IN COMMUNITY SIMILARITY

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Penns Creek Mountain, located in northcentral Pennsylvania, gives rise to a series of streams that are fed by a perched water table and continue to flow throughout the year. For the past four years, we have studied five of the streams that flow down the north side of the ridge and feed Penns Creek. Of the streams studied, Lick Run and Coral Run appear to be most similar regarding physical, geological, and chemical characteristics. During summer 2018 we focused on these two streams to study diatom community diversity between similar streams and diversity between biofilm communities within the same streams 100 meters apart, which we called Lick up, Lick down, Coral up, and Coral down. We used Green Gap, another of the headwater streams which has been studied for four years for comparison. The temperature over the past four summers averaged 12.72°C-13.20°C. The conductivity averaged 19.26µs/cm (18.16-21.17), and the percent oxygen saturation has remained at or above 100% saturation at all locations (117.54%-121.14%). The pH has been stable overall at all locations (6.33-6.58), while alkalinity averaged at 200.27µeq/L ($\bar{x}$=177.33-237.34µeq/L). Diatom biofilm was collected from stones at each site and then chemically processed to clean the diatom frustules for observation and enumeration with a JEOL 6010 LV scanning electron microscope. Diatom communities at all sites over this summer had an average species richness of 24 taxa (20-30). The Bray-Curtis similarity index indicated a moderate overlap (43-59%) between the Lick and Coral locations and low to moderate overlap (35-50%) with the Green Gap site. Despite the Bray-Curtis results, the sites display the same two dominant taxa (*Achnanthidium deflexum* and *Nupela lapidosa*). Though the particular members of the diatom community varied, metrics such as the Sedimentation index range of 0.67-8.67% (SED, $\bar{x}$=3.65%), Shannon Diversity Index range of 1.80-3.09 (SDI $\bar{x}$=2.38), Shannon Evenness range of 57-81% (SE $\bar{x}$=71.48%), Pollution Tolerance Index range of 2.66-3.34 (PTI $\bar{x}$=2.98), and the Generic Diatom Index range of 16.59-19.15 (GDI, $\bar{x}$=17.66) all are consistent with a stream of high-water quality.

Keywords: diatom, headwater streams, stream assessment

GENOMIC AND PHYSIOLOGICAL ANALYSIS OF A NOVEL CYANOBACTERIUM, *PSEUDANABAENA* STRAIN SR411, ISOLATED FROM THE SUSQUEHANNA RIVER.

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Cyanobacteria, oxygenic photosynthetic bacteria, are important primary producers in aquatic ecosystems. In an aquatic system, scattering, depth and competition can alter the abundance of specific wavelengths available for photosynthesis. As photosynthetic organisms, cyanobacteria are dependent on the availability of light for survival. Cyanobacteria use light harvesting antennae that, in some species, are altered to best absorb the light wavelengths available. Specifically, some cyanobacteria alter their light harvesting antennae to absorb green light when red light, the preferred wavelength, becomes limiting. This gives them a fitness advantage over organisms only able to use RL. While exploring the variety of cyanobacteria found in the Susquehanna River, our lab isolated a cyanobacterium able to alter the protein composition of its light harvesting antennae allowing it to use green light for photosynthesis. Previous work in the lab has identified this cyanobacterium as a novel strain of *Pseudoanabeana* and its genome has been sequenced and submitted to GenBank. Analysis of the genome of *Pseudanabeana* strain SR411 indicates that, in addition to being photosynthetic, it contains the genes necessary for nitrogen fixation. Here we present preliminary genomic and physiological analyses of the nitrogen fixation capabilities of SR411.

Keywords: cyanobacteria, nitrogen fixation, photosynthesis

ESTIMATING AND COMMUNICATING HYDROLOGIC ENSEMBLES IN THE MID ATLANTIC

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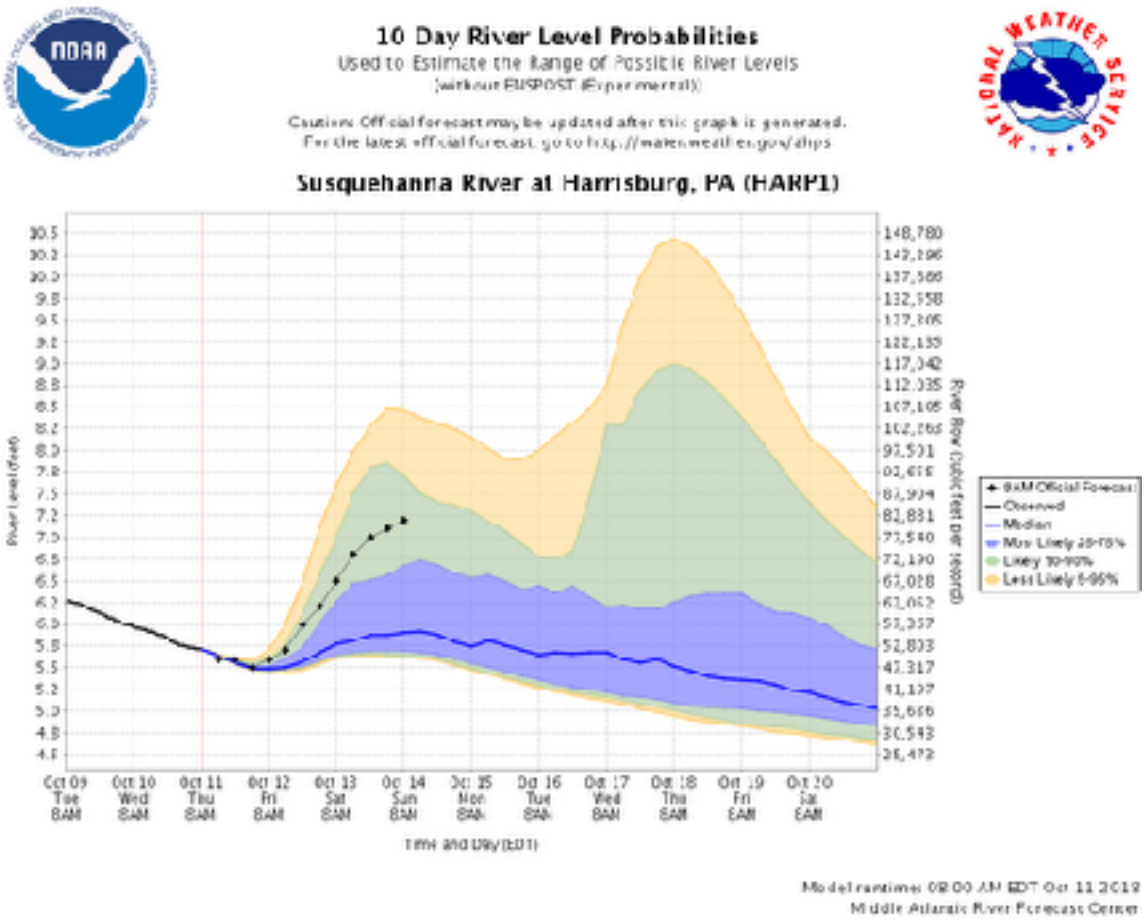
The Middle Atlantic River Forecast Center (MARFC) has begun widespread implementation of the national Hydrologic Ensemble Forecast Service (HEFS) across the Mid-Atlantic US. HEFS is a software suite to provide ensemble river forecasts with forecast durations from a few days out to weeks, months, and even a year into the future. Initial implementations of HEFS utilize the GEFS (Global Ensemble Forecast System) and the CFSv2 (Climate Forecast System) for precipitation and temperature forcings and use various procedures to minimize bias to forcings errors as well as hydrologic model errors.This presentation will discuss two aspects of MARFC's implementation of HEFS. The first piece will address what HEFS is and how it is being implemented specifically in the Mid-Atlantic. We will look at some case studies and hindcast validation results that have been performed prior to implementation. We will also address some of the implementation challenges specifically associated with reservoir modeling with long term ensembles.The second phase of the presentation will present a social science study that has been led by Nurture Nature Center and East Carolina University. This study looked at how we can be improving some of the HEFS product suite in order to make the probabilistic information contained in the products more understandable to a broad variety of users, including the public, emergency managers, and water resources managers.

Keywords: river forecasting, ensembles, social science



DEVELOPMENT OF SPOTTED SALAMANDERS WHEN FACED WITH POLLUTION AND PREDATION

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Salt (NaCl) pollution from salting roads during the winter has been more disruptive in ecosystems, particularly in freshwater aquatic ecosystems in which various amphibian species breed. The spotted salamander (*Ambystoma maculatum*) in particular has been found to be affected by this salt pollution, showing delayed hatching or deformities. Their egg clutch is surrounded by multiple gelatinous layers. These layers are often eaten away by predators such as wood frog tadpoles (*Lithobates sylvaticus*), exposing the salamander embryos to the environment. Thus, the presence of wood frog tadpoles may exacerbate the effect of salt pollution on the salamander embryos. In spring 2018, we conducted a laboratory experiment with a factorial design involving the presence or absence of road salt, wood frog tadpoles, and jelly layers surrounding the salamander eggs. Daily, we monitored hatching and mortality of the salamander embryos and also measured body length and developmental stages of hatchlings. We predicted that the presence of salt, presence of predators, and the absence of a jelly layer would cause greater mortality and earlier hatching in salamanders that would also result in less developed hatchlings. Preliminary data analyses show that the presence of wood frog tadpoles decreased hatching success while the presence of jelly layers also decreased the hatching success of the salamanders. Both salt pollution and the presence of jelly layers increased the incubation period. These preliminary results suggest that while salt pollution negatively affected the development of the salamanders, it did not interact with the other variables such as the presence/absence of predatory tadpoles and the presence/absence of jelly layers.

Keywords: Spotted Salamanders, pollution, development, conservation

Spotted Salamander
(Ambystoma maculatum)

VARIATIONS IN EXPORT OF NITRATE AND OTHER SOLUTES ACROSS LITHOLOGIES AND LAND USES IN A HUC 10 WATERSHED WITHIN THE SUSQUEHANNA RIVER BASIN

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From catchment to watershed scale, the critical zone community is asking the question of what to measure—and where to measure it—to constrain models and make informed observations about critical zone processes. One of the primary goals of the Susquehanna Shale Hills Critical Zone Observatory (SSHCZO) is to scale-up hydrologic models from the catchment scale at Shale Hills (0.08 km2), Garner Run (1.21 km2), and Cole Farm (0.43 km2) catchments to the larger watershed scale of Shavers Creek watershed (~120 km2). The increase in drainage area of three orders of magnitude introduces a challenge of increased spatial heterogeneity in lithology, relief, and land use. Shavers Creek is an upland watershed within the Susquehanna River Basin (SRB) that drains a variety of lithologies and is overlain by both agricultural and forested land uses. To address the challenge of spatial heterogeneity in Shavers Creek, several synoptic sampling campaigns have been performed to develop datasets of solute fluxes at high spatial resolution in Shavers Creek. In addition, three monolithologic subcatchments have been monitored in regions of homogeneous land use. These data sets include hydrologic data collected from both forested (Shale Hills and Garner Run) and agricultural lands (Cole Farm). Using Cole Farm as a proxy for agricultural land use in Shavers Creek provides insight into groundwater quality in the agriculturally developed portion of the uplands of the SRB. Synoptic sampling data sets were collected during periods of both high and low hydrologic connectivity within the watershed. These data sets, combined with long term data from the SSHCZO subcatchments, show that the surface and ground water sources appear to have geochemical homogeneity during wet periods, but during dry periods, the various stream sites in Shavers Creek and its major tributaries become geochemically distinct, instead reflecting the solute signatures associated with local land uses and lithologies. This geochemical homogenization that occurs during wet periods is observed via principal component analysis which shows that stream water chemistry in Shavers Creek clusters together, close to the values associated with headwaters and precipitation.

Keywords: Synoptic Sampling, Scaling Up, Agriculture

Student measuring soil respiration in the Shale Hills catchment

DO FISH PREFERENTIALLY ASSOCIATE WITH GRAVID MUSSELS?

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Freshwater mussels in the bivalve family Unionidae are understudied in the Susquehanna River watershed. Mussels have interesting reproductive requirements: many require their larval young to associate with a fish host in order to grow. Host attraction strategies have been documented by gravid female mussels, but little is understood about their effectiveness. Our study was designed to explore the relationship between the mussels and their hosts. Both known and suspected fish host species of the yellow lampmussel (*Lampsilis cariosa*) were introduced into simple Y-maze tanks with gravid female mussels present. We recorded the behavior of both the fish and the mussels; specifically, we measured the time the fish spent in proximity to the mussel. This pilot study did not find an association between the fish behavior and the presence of the mussel. We suspect that expanding the sample size may reveal most specific information about any host-attraction strategy used by this species.

LACK OF LATERAL MIXING DOWNRIVER OF TRIBUTARY CONFLUENCES

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The river continuum concept describes changes to physical conditions, such as stream width, depth, and turbidity, that cause the habitat gradient of rivers to affect ecosystem metabolism. In studying metabolism throughout the Susquehanna River in Pennsylvania, we found evidence of lateral mixing patterns. We arranged our study sites into two groups based on major confluences: Group A - Milton (West Branch), Danville (North Branch), and their downriver site Isle of Que (Main Stem); Group B - Greenwood (Juniata River) and its downriver match Fort Hunter (Lower Stem). Numerical modeling of river water mixing calculated that lateral diffusion will be completed at a distance of 25 to 37 channel widths downflow of the confluence at low flow and high flow, respectively. Previous research shows faster lateral dispersion for stretches with sharp curves and more islands, so we expected relatively rapid mixing due to the many islands mid-channel throughout our study reach. If complete mixing were to occur 30 widths downriver, we would expect lateral diffusion to be complete approximately 25 km downriver of the group A confluence and 36 km downriver of the group B confluence. We did not observe complete mixing within these distances.

To test extent of mixing, we took lateral transect samples at each site and compared upriver-downriver pairs: Milton-Que, Danville-Que, Greenwood-Fort Hunter, and Que-Fort Hunter. We found similar water chemistry for Milton-Que West, Danville-Que East, and Greenwood-Fort Hunter West. The Fort Hunter transect retained some similarity to the Isle of Que transect. Water chemistry similarities show a pattern between tributaries and corresponding sites downflow. Lateral stratification may have profound effects on river ecology, affecting predictions about species and their suitable habitats and having repercussions on ecosystem metabolism. Based on our observations, water sampling in large rivers should take multiple samples throughout a lateral transect: a single bank sample will unlikely be representative of the entire area. Further research on this may look to quantify exact river size (width, depth, flow rate) at which lateral incongruity becomes apparent or how tributary size affects lateral mixing.

Keywords: river, mixing, ecology

HABITAT CHANGES IN AGRICULTURAL STREAMS AFTER IMPLEMENTING CHANNEL AND RIPARIAN MANAGEMENT

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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 Northcentral 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 sampled Conley Run in October 2017 to quantify changes in water quality, and surveyed again in May 2018 to quantify water quality as well as 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 expected Conley Run to have faster velocity, more variable depth, less silt and more coarse substrates, and decreased width compared to pre-restoration conditions. We found an increase in velocity, decreased silt which is related to increased course substrate, and a decreased width, as we predicted. However, depth variability did not increase as we predicted. 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: agriculture, stream, restoration

Jason Fellon, PA DEP Watershed Specialist assessing restoration efforts on Conley Run, Union County, PA

ASSESSMENT OF GROUNDWATER VULNERABILITY IN OHL RESERVOIR WATERSHED USING A GIS-BASED MODIFIED DRASTIC MODEL

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This study was designed to assess the potential for groundwater contamination in the watershed surrounding Ohl Reservoir, which is a source of public drinking water supply for the greater Lock Haven area in Clinton County, PA. This study area is vulnerable to groundwater contamination from various factors including agricultural practices and anthropogenic influences. The DRASTIC model has been in use since 1987 to determine potential vulnerability for groundwater contamination using seven hydrogeologic parameters that influence and control groundwater movement through soil and aquifer layers, namely the depth to the groundwater table (D), net recharge (R), aquifer media (A), soil media (S), topography (T), impact of the vadose zone (I), and hydraulic conductivity (C). All of these parameters were determined for the study area, and were converted into ArcGIS data layers that were compiled into two groundwater vulnerability index maps, one using standard procedure and the other using a modified net recharge values. All of these parameters were determined using standard weights, ranges, and ratings published in the literature. The standard vulnerability index map shows the agricultural land areas have the potential for higher groundwater contamination. The modified vulnerability index map showed relatively lower potential for groundwater contamination for 94.3% of the study area including the agricultural land; however, the reservoir and wetland areas show a higher susceptibility for groundwater contamination.

Keywords: GIS, groundwater, DRASTIC

Spillway to Warren H. Ohl Reservoir
(Clinton County, PA)

ANALYZING SOFT SEDIMENT CORES TO DECIPHER POST-DAM ACCUMULATION HISTORY IN KELLER RESERVOIR, CLINTON COUNTY, PENNSYLVANIA

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The Keller Reservoir in Clinton County, PA, serves as the source of drinking water supply for 19,500 subscribers. The reservoir is located within the McElhattan Creek Watershed and drains 18 mi2 area. The dam was originally constructed in 1956 and is fed by two contributing streams, namely McElhattan Creek and East Kammerdiner Run. These creeks carry a substantial amount of sediments that eventually deposit in the reservoir. Sediment accumulation poses a problem by decreasing water storage in human-made reservoirs and by increasing cost to the water filtration plant. A ground penetrating radar (GPR) survey revealed the bathymetry and sediment-bedrock interface in the reservoir; however, determination of the thickness of sediments accumulated since the construction of the dam posed a challenge. Additionally, an ArcSWAT model for the watershed was developed to determine sediment yield and accumulation patterns within the study area. Undisturbed sediment cores were collected from different locations within Keller Reservoir to verify the results of the ArcSWAT model in the field. These cores helped reveal the thickness of sediments accumulated since the inception of the dam; while x-ray fluorescence (XRF) analysis helped determine the origin of these sediments.

Keywords: GPR, ArcSWAT, sediment analysis

Keller Reservoir
(Clinton County, PA)

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

2006 to 2008

Cultures At The Confluence - Native Americans

September 26, 2009

River Health and The Chesapeake Bay

October 22-23, 2010

River Towns in the 21st Century

October 18-19, 2011

Susquehanna River Symposia

2009 to 2011

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

2012 to 2014

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

2015 to 2017

Susquehanna River Heartland Coalition for Environmental Studies

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 13 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.

www.srhces.org

13th Susquehanna River Symposium

"Science, Conservation and Heritage"

October 26-27, 2018

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