14th Susquehanna River Symposium

HEALTHY RIVERS, HEALTHY COMMUNITIES

Community of South Renovo, along the
West Branch Susquehanna River in Clinton County, PA
[Nicholas A. Tonelli]

PROGRAM WITH ABSTRACTS

October 18-19, 2019
Bucknell University

www.bucknell.edu/riversymposium

2019 SUSQUEHANNA RIVER SYMPOSIUM

COMMITTEE

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

Karen Morin
Associate Provost, Bucknell University

Peter Jansson
Faculty Director, Center for Sustainability & the Environment, Bucknell University
Associate Professor, Department of Electrical Engineering, Bucknell University

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Photos (all used with permission):

Front cover: Community of South Renovo, along the West Branch Susquehanna River in Clinton County, PA. [Nicholas A. Tonelli]

Next page: Forest canopy beginning to show fall colors, Bald Eagle State Park, October 2018. [B. Hayes]

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

Rear cover. Community of Owego, along the North Branch Susquehanna River in Tiogo County, New York. [John Weisenfeld]

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 100 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:

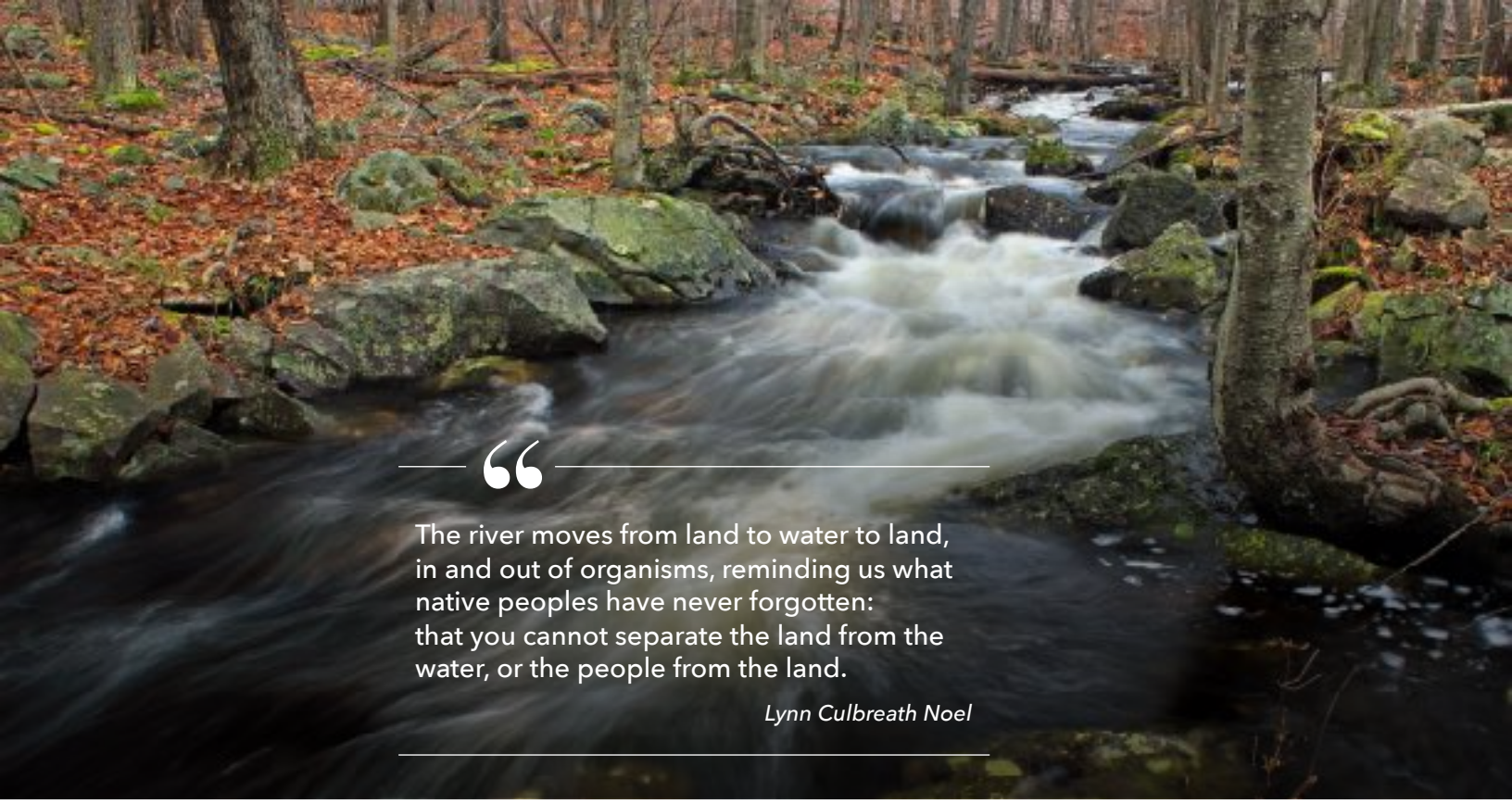
www.bucknell.edu/riversymposium.

"We labor long and earnestly for peace, because war threatens the survival of man. It is time we labored with equal passion to defend our environment. A polluted watershed can be as lethal as a bullet. "

- US Senator Alan Bible (Nevada)

PROGRAM WITH ABSTRACTS

CONTENTS



> The river moves from land to water to land, in and out of organisms, reminding us what native peoples have never forgotten: that you cannot separate the land from the water, or the people from the land.
>
> *Lynn Culbreath Noel*

FORWARD

HEALTHY RIVERS, HEALTHY COMMUNITIES

Rivers provide a wide range of benefits to society. They provide jobs and support key economic sectors, nurture social relations and spiritual well-being, and contribute to strategic goals such as food-energy-water security, poverty reduction and climate resilience. However, different types of benefits depend more or less on different indicators of river health, such as water quality, flows or biodiversity. Some benefits require good health across multiple indicators.

To a large extent the portfolio of benefits will depend on how the river and estuary is managed. Access to the watershed's natural resources tends to be socially differentiated. For example, over-exploitation of its ecosystems disproportionately affects the livelihoods of the citizens of its many river towns, now and for future generations. Bucknell feels that academic institutions play an important role in addressing these inequalities, environmentally, economically, socially, and spiritually. That is why we chose the theme "**Healthy Rivers, Healthy Communities**" for this year's River Symposium.

KEYNOTE SPEAKER. On Friday, from 7:30 to 8:00 p.m., Ann Pesiri Swanson will deliver the symposium's keynote address *"Chesapeake Bay: Lessons Learned from 40 Years of Watershed Management."* One of the nation's environmental leaders, Ann has championed conservation and environmental restoration projects throughout the Chesapeake Bay and mid-Atlantic region.

RESEARCH POSTERS. On Friday, from 8:00 to 10:00 p.m., over 100 students and faculty from 15 colleges and universities and 15 government agencies and environmental organizations will present their posters. 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. The abstracts begin on page 31.

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

- **Lisa K. Iulo** and **Robert Nicholas**, Penn State Institute for Resilient Communities, will deliver a plenary address entitled *"Local Resilience Related to Flood Risk in Susquehanna Region Communities."*
- **Geoffrey Smith**, Pennsylvania Fish and Boat Commission, and **Megan K. Schall**, Penn State Hazleton, will deliver a plenary address entitled *"It Takes a Village: Using Collaboration and Interdisciplinary Science to Unravel the Complex Dynamics of a Susquehanna River Fishery."*
- **Kelly Gutshall** and **Justin Spangler**, Land Studies, Inc., will deliver a plenary address entitled *"Restoring Floodplains - a Regional Approach to Improve Water Quality and Community Resiliency."*

Information about these invited speakers is available on pages 13-20.

BREAKOUT DISCUSSIONS. Following the plenary addresses, from 11:00 a.m. to 12:00 p.m., breakout discussions will explore three themes: (1) sustainable communities, (2) life below water, and (3) life on land.

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 12 oral presentations organized into four topical sessions:

- Community Networks, Watershed Management,
  Science Writing and Public Awareness
- Water Economics, Ecosystem Services, and Riparian Buffers
- Aquatic and Terrestrial Ecosystems
- Watershed Modeling, Hydraulic Engineering, and Geographic Information Systems (GIS)
- A schedule is available on pages 7-8 and abstracts on pages 21-30.

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 Pennsylvania Water Resources Research Center at Penn State. Special thanks are due to the staff of the Center for Sustainability and the Environment: Sean Reese, Peter Jansson, Samantha Myers, Shaunna Barnhart, Milton Newberry III, and Adrienne Goudy.

Best wishes for a great symposium!

Sincerely,

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

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

2019 SUSQUEHANNA RIVER SYMPOSIUM

SCHEDULE

FRIDAY, OCTOBER 18, 2019

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

7:00 - 7:05 p.m.

Welcome

Karen Morin
Associate Provost, Bucknell University

7:05 - 7:15 p.m.

Opening Remarks

John Bravman
President, Bucknell University

7:20- 7:30 p.m.

Recognition of H.W. "Skip" Wieder as Honorary Symposium Chair

John Dawes
Executive Director
Foundation for PA Watersheds

7:30 - 8:00 p.m.

Keynote Address

"Chesapeake Bay: Lessons Learned from 40 Years of Watershed Management"

Ann Pesiri Swanson
Executive Director
Chesapeake Bay Commission

8:00 - 10:00 p.m.

Poster Presentations and Evening Social

Room 276 (The Terrace Room) and Rooms 241 A-D

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 19, 2020

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

8:00 - 8:50 a.m.

The Terrace Room (Room 276)

Light Breakfast and Poster Presentations (self-guided)

Exhibitors can begin setting up in the Center Room (Room 256)

The Forum (Room 272)

9:00 - 9:05 a.m.

Welcome and Announcements

Elisabeth Mermann-Jozwiak, Provost, Bucknell University

9:05 - 9:15 a.m.

Indigenous People's Perspective

Sid Jamieson, FaithKeeper of the Greenwoods Land Conservancy
Cayuga Nation Iroquois

Plenary Presentations

9:15 - 9:45 a.m.

"Local Resilience Related to Flood Risk in Susquehanna Region Communities"

Lisa Iulo*, Robert Nicholas*, Nancy A. Tuana, Lara Fowler, Casey Helgeson, Lacey Goldberg, and Klaus Keller

Penn State Initiative for Resilient Communities (PSIRC)
The Pennsylvania State University

9:45 - 10:15 a.m.

"It Takes a Village: Using Collaboration and Interdisciplinary Science to Unravel the Complex Dynamics of a Susquehanna River Fishery."

Geoffrey D. Smith*

Division of Fisheries Management
Pennsylvania Fish and Boat Commission

Megan K. Schall

Department of Biology
Penn State Hazleton

Plenary Presentations (continued)

10:15 - 10:45 a.m.

"Restoring Floodplains - a Regional Approach to Improve Water Quality and Community Resiliency"

Kelly Gutshall* and **Justin Spangler***

LandStudies, Inc.

* denotes presenting author

Intermission

10:45 - 11:00 a.m.

Exhibits on display in the Center Room (Room 256), ELC

Breakout Discussions

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

1. **Sustainable Communities**
   Local resilience challenges related to flood risk
   Lisa Iulo and Robert Nicholas, leaders
   Arches Lounge (Room 304)
2. **Life below water**
   Complexities of large river ecosystems
   Geoff Smith and Megan K. Schall, leaders
   Terrace Room (Room 276)
3. **Life on land**
   Community benefits to restoring floodplains
   Kelly Gutshall and Justin Spangler, leaders
   The Forum (Room 272)

Lunch

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

Exhibits on display in the Center Room (Room 256), ELC

Oral Presentations

1:30 - 2:30 p.m.

Session 1. **Community Networks, Watershed Management, Science Writing and Public Awareness**
The Forum (Room 272)

Session 2. **Water Economics, Ecosystem Services, and Riparian Buffers**
Rooms 241, A - D

Exhibits

2:30 - 3:30 p.m.

Center Room (Room 256)

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

Oral Presentations

3:30 - 4:30 p.m.

Session 3. **Aquatic and Terrestrial Ecosystems**
The Forum (Room 272)

Session 4. **Watershed Modeling, Hydraulic Engineering, and Geographic Information Systems (GIS)**
Rooms 241, A - D

Looking Ahead

4:30 - 4:45 p.m.

The Forum (Room 272)

Reflect upon the events of the past 24 hours and share ideas for next year.

2019 SUSQUEHANNA RIVER SYMPOSIUM

ORAL SESSIONS

Session 1

Community Networks, Watershed Management, Science Writing and Public Awareness

The Forum (Room 272), Saturday, October 19, 2019, 1:30 - 2:30 p.m.

1:30 p.m. *"Mobilizing A Community Network"*
Carl Milofsky*

1:50 p.m. *"Managing All Water As One: The Spring Creek Watershed Case Study"*
Jessica Aiello* and Mark Gutshall

2:10 p.m. *"Science Writers on the Susquehanna: Endocrine-Disrupting Chemicals and Public Awareness"*
Justin Mando* and Michella Salvitti

Session 2

Water Economics, Ecosystem Services, and Riparian Buffers

Rooms 241 A-D , Saturday, October 19, 2019, 1:30 - 2:30 p.m.

1:30 p.m. *"Drought Status, Price, and the Effectiveness of Water Use Restrictions in Pennsylvania"*
Gregory Krohn*

1:50 p.m. *"Ecosystem Services in the West Branch Susquehanna Watershed: Assessment of Valuation Methods and Case Study of Carbon Sequestration and Storage"*
Kathryn S. Cantagallo* and Benjamin R. Hayes

2:10 p.m. *"Establishment of a Shrub Willow Riparian Buffer Trial in Sinking Spring, PA"*
Michelle Sarapiglia*

Session 3

Aquatic and Terrestrial Ecosystems

The Forum, Saturday, October 19, 2019, 3:30 - 4:30 p.m.

3:30 p.m. *"Factors Influencing Polyphosphate Storage in Stream Biofilms Across A Phosphorus Gradient"*
Steven Rier* and Aaron Gordon-Weaver

3:50 p.m. *"A Harbinger of Good Things to Come in Academic and Non-Academic Partnerships: Population Genomics and Conservation of Erigenia bulbosa (Apiaceae) in Pennsylvania"*
Angella McDonnell, Cheyenne Moore,* Scott Schuette, and Christopher Martine

4:10 p.m. *"Vertical Migration of Adult Plecoptera (Stoneflies) Above Forested Headwater Streams"*
Ruric Bowman,* Brittany L. Lenze, and Robert F. Smith

Session 4

Watershed Modeling, Hydraulic Engineering, and Geographic Information Systems (GIS)

Rooms 241 A-D , Saturday, October 19, 2019, 3:30 - 4:30 p.m.

3:30 p.m. *"Precision Nutrient and Sediment Modeling Using Subbasin Analysis in the Halfmoon and Pequea Creek Watersheds"*
Brian Gish*and Caitlin A. Giagola

3:50 p.m. *"Optimizing the Weir Equation for Nature-Like Fish Passages"*
Autumn Deitrick, Hassan Ismail, and Xiaofeng Liu

4:10 p.m. *"Status and Plans for a PA Hydrography Modernization"*
Eric Jespersen*

Abstracts for oral presentations are provided on pages 21 - 30.

* denotes presenting author.

INVITED SPEAKERS

Ann Pesiri Swanson

Executive Director
Chesapeake Bay Commission

Ann Swanson has served as a leader in the Bay restoration for 36 years, the last 31 as the Executive Director of the Chesapeake Bay Commission, a tri-state legislative authority serving the states of Maryland, Pennsylvania, and Virginia. It is the Commission's responsibility to sponsor legislation at the state level and to work with state legislators, members of the U.S. Congress, and the federal and state regulatory agencies to coordinate programs aimed at restoring the Chesapeake Bay.

Although Ann operates in a highly political environment, she is trained in the sciences. A trained wildlife biologist and forest ecologist, she graduated with honors from the University of Vermont and Yale University. She holds an honorary Doctor of Laws from the University of Vermont.

Ann has been recognized regionally, nationally and internationally for her work. She delivered a keynote address at the Stockholm Water Festival, chaired the University of Vermont's Rubenstein School of Environment and Natural Resources for 11 years, and has been recognized with awards by her colleagues in the Bay watershed, the governors of the region and the General Assemblies of Maryland, Pennsylvania and Virginia. Ann has been married for 35 years, is a published illustrator, an accomplished gardener, backpacker and sea kayaker, and is a mother of two boys.

Ann will deliver the keynote address entitled *"Chesapeake Bay: Lessons Learned from 40 Years of Watershed Management"* at 7:30 to 8:00 p.m. on Friday, October 18, 2019 in the Forum, Elaine Langone Center, Bucknell University.

Penn State Initiative for Resilient Communities (PSIRC)

Lisa Iulo*, Lara Fowler, Klaus Keller, Robert Nicholas*, and Nancy A. Tuana
The Pennsylvania State University

Urban centers and agrarian communities in the Susquehanna River basin are facing increased risks of floods – resulting in economic, environmental, and social stresses. These threats disproportionately affect low-income households, threaten municipal tax revenue, and undermine the river's potential as a cultural and recreational resource. Launched in January 2019, the Penn State Initiative for Resilient Communities (PSIRC) provides an environment of shared discovery where stakeholders, decision-makers, designers, and researchers spanning multiple disciplines come together to address local resilience challenges related to flood risk in small, riverine communities. Starting with a pilot project in partnership with the Borough of Selinsgrove, the tools, methods, and lessons learned will be generalized to inform decision-making for sustainability and resilience to riverine flooding in communities throughout the Chesapeake Bay Watershed and beyond.

Isle of Que in Selinsgrove, PA is flooded by the Susquehanna River during Tropical Storm Lee, September 8, 2011.

The PSIRC researchers above have prepared a plenary address entitled *"Local Resilience Related to Flood Risk in Susquehanna Region Communities"* that will be delivered by Lisa Iulo and Robert Nicholas at 9:15 - 9:45 a.m. on Saturday, October 19, 2019 in the Forum (Room272), ELC.

* denotes presenting author

Lisa Domenica Iulo

Associate Professor of Architecture
The Pennsylvania State University

Lisa D. Iulo is an Associate Professor of Architecture and Director of the Hamer Center for Community Design at the Pennsylvania State University. Her work has been recognized in research and design related to residential green building and affordable housing, energy efficiency and strategies for the implementation of renewable energy at the building and community scale. She has been working with colleagues to better understand the building/community relationships and opportunities where research, data and improved decision-making can inform the design of resilient sustainable homes, buildings and communities. With support from the Penn State Provost's Office, in support of the University Strategic Plan, Lisa and colleagues from across Penn State established PSIRC - the Penn State Initiative for Resilient Communities. Lisa has been a member of the architecture faculty at the Penn State since 2003. Her teaching and research is closely linked with outreach and community engagement with a goal of facilitating collaboration across disciplines.

Robert E. Nicholas

Associate Research Professor of Atmospheric Science
The Pennsylvania State University

Robert Nicholas is an atmospheric scientist with research interests in the areas of climate dynamics, empirical downscaling, uncertainty quantification, and Earth system modeling. His current work focuses on the development of decision-relevant climate data products, with a particular emphasis on agricultural, water resources, forestry, and biodiversity management applications. Much of this work takes place in the context of transdisciplinary collaborations with engineers, statisticians, philosophers, agricultural scientists, geographers, economists, and other Earth system scientists. He serves as the Assistant Director of Penn State's Earth and Environmental Systems Institute (EESI), Managing Director of the Program on Coupled Human and Earth Systems (PCHES), Lead for the NOAA Mid-Atlantic RISA (MARISA) Climate Information Office, and Director of a new NOAA-supported Coastal Climate Extension Program for the Chesapeake Bay region. Working in collaboration with his colleagues Lisa Iulo, Lara Fowler, Klaus Keller, and Nancy Tuana, Rob is a co-founder of the Penn State Initiative for Resilient Communities (PSIRC).

Geoffrey D. Smith

Susquehanna River Biologist
Pennsylvania Fish and Boat Commission

Geoffrey Smith is the Susquehanna River Biologist for the Pennsylvania Fish and Boat Commission (PFBC), based in Bellefonte, PA. This position focuses on managing game and non-game fish species in the large river reaches of the Susquehanna River and its tributaries. Since beginning at PFBC, the bulk of his time was spent working on population and health issues among Smallmouth Bass; a recreationally and locally economically important species at the Susquehanna River and its tributaries. This has included working with and coordinating a large, diverse group of governmental and academic researchers from across the mid-Atlantic Region to better understand factors contributing to disease among Smallmouth Bass. In addition to Smallmouth Bass, Geoff has diversified his research background to include understanding the dynamics of invasive Flathead Catfish in the Susquehanna and Delaware drainages in recent years.

Geoff holds a B.S. in biology from Lycoming College and M.S. from Marshall University in Huntington, WV. The majority of his career has been working on large river systems and the complex and unique factors that control them. This work has covered from the Delaware River to the Mississippi River and a lot of points in between

Geoff will deliver a plenary address entitled ***"It Takes a Village: Using Collaboration and Interdisciplinary Science to Unravel the Complex Dynamics of a Susquehanna River Fishery."*** at 9:45 - 10:15 a.m. on Saturday, October 19, 2019 in the Forum (Room272), ELC.

Megan Kepler Schall

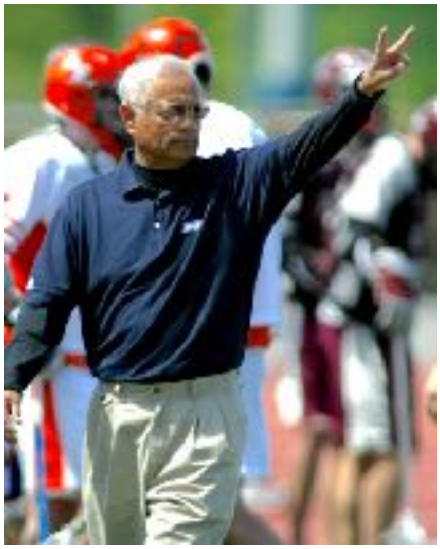
Assistant Professor of Biology
Penn State Hazleton

Megan Kepler Schall is an Assistant Professor of Biology at Penn State Hazleton. For the past six years, she has collaborated with a diverse group of stakeholders including state and federal agency partners, academic institutions, and anglers to study Smallmouth Bass populations in the Susquehanna River Basin. Through working in an interdisciplinary research team, she has worked on various research topics relating to fish health and fish ecology including topics such as population genetics, movement ecology, and parasite prevalence modeling. In her current role at Penn State Hazleton, she has set up a molecular genetics research lab and is continuing to work on interdisciplinary research that integrates fish ecology with fisheries management.

Megan has a B.S. degree in Biology from Lock Haven University, a M.S. in Wildlife and Fisheries Science from Penn State University, and a PhD in Ecology from Penn State University. Her dissertation produced four publications on research relating to Susquehanna River Smallmouth Bass.

Megan is co-author of the plenary address entitled ***"It takes a village: using collaboration and interdisciplinary science to unravel the complex dynamics of a Susquehanna River fishery"*** at 9:45 - 10:15 a.m. on Saturday, October 19, 2019 in the Forum (Room272), ELC.

Sid Jamieson



Cayuga Nation Iroquois
Bucknell University Lacrosse Coach (retired)

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 is a member of the Cayuga Nation and adapted his coaching style from his Native American heritage. His parents were both raised on the Six Nations Indian Reservation in Brantford, Ontario. Sid 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.

Sid will provide an Indigenous People's perspective at 9:05 - 9:15 a.m. on Saturday, October 19, 2019 in the Forum (Room272), ELC.

Kelly Gutshall

President
LandStudies, Inc.

Kelly Gutshall is president of LandStudies, Inc., an ecological restoration and design firm providing engineering, construction and maintenance services throughout PA and Maryland since 1989. A Penn State graduate of Penn State's school of landscape architect, Ms. Gutshall leads a firm of 35 employees with over $4 million annually in award-winning projects that have helped clients meet their goals while creatively addressing environmental challenges. As a recognized leader in ecological and sustainable design, she helped pioneer the concept of "Economic Ecology," an innovative approach that brings communities together to solve water issues and maximize economic and environmental returns on investment.

Kelly enjoys collaborating with community leaders to help change perceptions about the landscape from purely aesthetic, to one of working, functional environments. In 2015, she was recognized for her environmental contributions and named a Watershed Champion by the Alliance for the Chesapeake Bay.

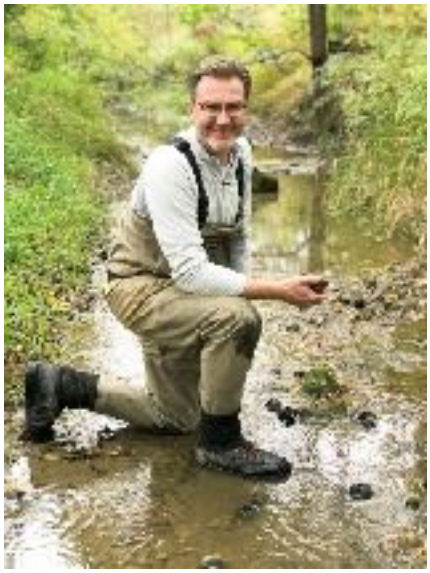
Kelly has championed the firm's science-based approach to planning and design, guiding the firm to find solutions to some of the most challenging problems of our generation.

She has been recognized for her environmental contributions through a myriad of awards over the years and generously volunteers her time to numerous organizations. For her work over her 35-year career, Gutshall received Penn Future's 2019 Woman of Lifetime Achievement in Conservation Award for her contribution to the protection and enhancement of Pennsylvania's natural resources.

Kelly will present the plenary address entitled ***"Restoring Floodplains - a regional approach to improve water quality and community resiliency"*** at 10:15 - 10:45 a.m. on Saturday, October 19, 2019 in the Forum (Room272), Elaine Langone Center, Bucknell University.

Justin Spangler

Water Resources Engineer
Land Studies, Inc.



Justin Spangler is a registered Professional Engineer with B.S. and M.S. degrees in Agricultural and Biological Engineering from Penn State and and North Carolina State. Since 2007, he has served as Project Manager at Land Studies, specializing in the design and implementation of Floodplain Restoration projects. His design philosophy employs the application of historical and geomorphic evidence to identify impairments which is used to return aquatic resources to their maximum ecological potential.

He manages cutting edge restoration projects that challenge the traditional expectations of ecological restoration.

Justin is co-author of the plenary address entitled ***"Restoring Floodplains - a regional approach to improve water quality and community resiliency"*** at 10:15 - 10:45 a.m. on Saturday, October 19, 2019 in the Forum (Room 272), ELC.

John Dawes

Executive Director
Foundation for Pennsylvania Watersheds.

John Dawes serves as Executive Director of the Foundation for Pennsylvania Watersheds which provides funding for mine reclamation and watershed restoration projects to local watershed groups. John has provided Pennsylvania with environmental and conservation leadership for more than 25 years. He advocates for conservation in Washington, D.C. and Harrisburg, supports conservation initiatives across the Commonwealth, and personally practices conservation on his 300-acre angus cattle farm in Huntingdon County.

John is presenting the Honorary Symposium Chair award to H. W. "Skip" Wieder at 7:20 p.m. on Friday, October 18, 2019 in the Forum (Room 272), ELC.

Honorary Symposium Chair

H. W. "Skip" Wieder

Executive Director (Emeritus)
Susquehanna River Heartland Coalition for Environmental Studies

H. W. "Skip" Wieder founded the Susquehanna River Heartland Coalition for Environmental Sciences (SRHCES) in 2005 to connect universities in central Pennsylvania with watershed groups, regulators, planners, private consultants, conservancies, and state and federal environmental agencies working in the region. His vision was to build relationships and collectively explore environmental sustainability issues in local communities, the Susquehanna River, and the Chesapeake Bay. Skip was instrumental in creating the first River Symposium, held in Oct. 2006, to increase public awareness of the work underway. Over the next 12 years, he secured over $4 million dollars to directly support of faculty research and student internships at the six colleges and universities in the SRHCES. These internships have had a huge impact on hundreds of students, many of whom upon graduation pursued careers in the environmental sciences, conservation, and academia.

Skip received B.S .and MBA degrees from Bucknell University, where he also played on the basketball team. He achieved the rank of Captain in the US Army and for his entire professional life has strengthened local communities by volunteering for a wide variety civic organizations. He recently retired after having served as Senior Vice President for Development at Geisinger, executive director of the SRHCES, and member of the board of directors for numerous foundations, conservancies, and WVIA public broadcasting station. Skip has led efforts to raise $125 million dollars to support health and environmental programs now garnering global attention. It a privilege to recognize him as the honorary chair of the 2019 Susquehanna River Symposium.

H. W. "Skip" Wieder (far right) with a group of 71 students, faculty, and guests presenting at the 12th Susquehanna River Symposium, *"The Spirit of Two Great Rivers: The Susquehanna and Delaware,"* November 10, 2017.

2019 SUSQUEHANNA RIVER SYMPOSIUM

CONTRIBUTORS

Schools, Colleges and Universities

Alvernia University
Bloomsburg University
Bucknell University
Cornell University
John Hopkins University
Juniata College
Lock Haven University
Lycoming College
Millersville University
North Dakota State University
Pennsylvania State University
Smith College
State University of New York College at Syracuse
SUNY College of Environmental Science and Forestry
Susquehanna University

Exhibitors

Agnes Revisited
American Dairy Association North East
Buffalo Creek Watershed Alliance
Chesapeake Bay Foundation
Chesapeake Conservancy
Merrill W. Linn Land & Waterways Conservancy
Middle Susquehanna RiverKeeper
PA Amphibian and Reptile Survey
Pennsylvania Emergency Management Agency
Pennsylvania Water Resources Research Center
Susquehanna Greenway Partnership
Susquehanna River Basin Commission

Agencies, Firms, and Organizations

Chesapeake Bay Commission
Chesapeake Bay Foundation
Chesapeake Conservancy
Chicago Botanic Garden
Geisinger Department of Epidemiology and Health Services Research
JMT Technology Group
Land Studies, Inc.
North Central Pennsylvania Conservancy
PA Department of Environmental Protection
PA Fish and Boat Commission
PA Mapping and Geographic Information Consortium
PA Natural Heritage Program, PA DCNR
RiverStewards
U.S. Geological Survey
Western Pennsylvania Conservancy

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 15 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

Pennsylvania Water Resources Research Center (PWRRC)

The Pennsylvania Water Resources Research Center (PAWRRC), founded in 1964, is authorized by Congress as one of the nation's 54 water resources research centers and institutes comprising the National Institutes of Water Resources. The program is administered by the U.S. Department of the Interior through the U.S. Geological Survey, in a unique Federal-State-University partnership. The institutes emphasize the role of University research, education, and outreach in advancing problems related to water quality and quantity. The PAWRRC is located at Penn State University, the primary land-grant University within Pennsylvania. At Penn State, PAWRRC is resides within and is administered by the Institutes of Energy and the Environment (IEE), organized under the Office of the Vice President for Research.

The Pennsylvania Water Resources Research Center cooperates with the National institutes of Water Resources, the U.S. Geological Survey, and Penn State Institutes of Energy and the Environment to support, coordinate and facilitate research through several programs:

Annual State Base Grants via USGS 104b. The PA-WRRC receives USGS 104B federal base funding from the USGS 104B program that is distributed via a small grants competition to researchers at academic institutions across Pennsylvania. Each federal dollar received through the program is matched with two non-federal dollars, and federal funds are not to used to pay indirect costs. PAWRRC uses the base grants to facilitate research on water resources issues, to help train new scientists, disseminate research results, and to cooperate with other colleges and universities and with other NIWR institutes to promote regional coordination. The FY 2019 USGS draft 104b and final 104b request for proposals describe the nationwide program and the role of PAWRRC. For applications from colleges and Universities in Pennsylvania, see the PA-WRRC 104b request for proposals.

Annual National Competitive Grants via USGS 104g. The U.S. Geological Survey in cooperation with the National Institutes for Water Resources supports an annual call for proposals to focus on water problems and issues that are of a regional or interstate nature or relate to a specific program priority identified by the Secretary of the Interior and the Institutes. The goals are to promote collaboration between the USGS and university scientists in research on significant national and regional water resources issues, promote the dissemination and results of the research funded under this program, and to assist in the training of scientists in water resources. See the FY 2019 104g request for proposals.

The PWRRC is a proud sponsor of this year's Susquehanna River Symposium.

PennState

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. There was a total of 18,277 words in the abstracts.

ORAL PRESENTATIONS

MOBILIZING A COMMUNITY NETWORK

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For twenty years we have worked with a number of public and nonprofit community organizations and institutions to create a Central Pennsylvania regional network that can act collectively on specific projects. Each organization acts in terms of its own self-interest but views the collective projects as both valuable to the region and to the individual organizations. The "Central Susquehanna Community Platform (exploresusquehanna.org)" is one of several projects that do this.

This presentation offers six processes or steps that together led the regional culture of collaboration to develop.

1. Developing a history of separate project partnerships that worked—a long history of community partnerships allows for more complex partnering.
2. Community learning helps actors learn what constitutes "a project" others can work on and that allows actors to support and collaborate with other organizations to pursue their self-interests via partnering.
3. Chaining projects occurs when partners to one undertaking find new projects for which they invite old partners to collaborate. Eventually there develop long chains of related projects. They may be linear—new partners are recruited to work with old pairs—or they may double back—new combinations of existing and experienced partners find new ways to work together.
4. Network matching, occurs when entrepreneurs involved in several networks see opportunities for disconnected individuals or groups to collaborate. Through this method collective value is dramatically increased.
5. Forum creation happens when a large number of actors are brought together to work on projects or in settings and when they come to see that there is value in a large scale partnership and that they share a collective identity.
6. Project specific, group mobilization, which can only succeed if otherwise fragmented partners with different access, different resources, and different skills come together to make a new project possible.

Community , Partnering , Regional planning , community mobilization

SCIENCE WRITERS ON THE SUSQUEHANNA: ENDOCRINE-DISRUPTING CHEMICALS AND PUBLIC AWARENESS

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This presentation details a pedagogical intervention focused on the Susquehanna River and endocrine disrupting chemicals (EDCs), which is part of Science Writing courses at Millersville University. Students from a wide range of scientific disciplines take Science Writing and each bring their own perspective to this project. Students are asked to adapt scientific research on EDC's for public consumption. Rather than view the issue of EDC's broadly, students must focus their efforts on specific local populations. Presenting this work and its outcomes are the professor of the course and a distinguished student who has participated in the project.

To adapt scientific discourse for local publics, students learn strategies that help them explain complicated science and they must study their audiences they wish to inform and influence. This work has led students in Nursing to write to their hospitals about proper disposal of excess medications, Biology students to amplify the impacts of EDC's on smallmouth bass in the Susquehanna, and Chemistry students to explain how EDC's get into our bodies. This presentation will outline some of these interventions as well as provide strategies for adapting complex science for public consumption, especially within local contexts.

Science Writing , Endocrine Disrupting Chemicals , Local , Public

RESTORING FLOODPLAINS - A REGIONAL APPROACH TO IMPROVE WATER QUALITY AND COMMUNITY RESILIENCY.

Kelly Gutshall, Land Studies, Inc., 315 North Street, Lititz, PA 17543, kelly@landstudies.com; **Justin Spangler**, Land Studies, Inc., 315 North Street, Lititz, PA 17543, justin@landstudies.com

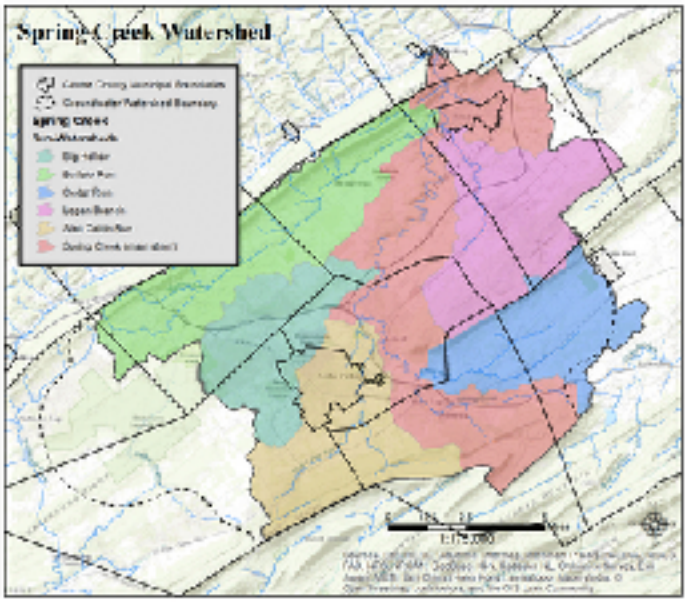
The impact of our agricultural heritage on the landscape is well documented. If you look closely, our seemingly pristine streams and woodlands are teaming with clues of the dramatic alterations that resulted from massive deforestation and our water powered industrial past. A proliferation of abandoned mill dams, buried corduroy roads, conveniently relocated tributaries, thick layers of fine laminated sediment, all provide hints of how dramatically we altered our stream valleys over the past 200 years. Restoring our stream and floodplain systems with an understanding of the legacy is providing answers to many of the most challenging water resource issues we are facing today…flood resiliency, water quality and bio-diversity. Public private partnerships are an important component in the strategy to restore floodplains to sustainable, multi-functional systems with regional benefits. Case studies outlining the challenges, benefits and returns on the investment will be presented.

MANAGING ALL WATER AS ONE: THE SPRING CREEK WATERSHED CASE STUDY

Jessica Aiello, RiverStewards, PO Box 273, Camp Hill, PA 17011, jessica@riverstewards.info; **Mark Gutshall**, RiverStewards, mark@riverstewards.info.

Municipal governments throughout Pennsylvania need to address their stormwater runoff, wastewater management, aquifer recharge, and other water quality issues affecting their local waterways, particularly those within a municipal separate storm sewer system (MS4) community or one with impaired waters subject to a total maximum daily load (TMDL). However, the budget and staff allocated to addressing point and non-point source water pollution in most municipalities is inadequate. This leads to permit violations and expensive fines that many municipalities cannot afford.

Because of the current individualized efforts among Pennsylvania municipalities at managing stormwater runoff and other water quality issues, and the slow progress this method makes, a new way of thinking is needed. RiverStewards Collaborative proposes a regional governance structure for the management of municipal water quality and quantity. During this session, we will present the findings from a pilot project that took place in the Spring Creek Watershed surrounding State College, PA using the One Water planning process (an integrated planning and implementation approach to managing finite water resources, developed by the Water Research Foundation), with the intent that it will inspire other municipalities and water utilities in Pennsylvania to use these ideals. Copies of a how-to white paper on the One Water process and the Spring Creek Watershed example will be available.



stormwater , municipal , water quality , water quantity

DROUGHT STATUS, PRICE, AND THE EFFECTIVENESS OF WATER USE RESTRICTIONS IN PENNSYLVANIA

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During droughts, governments and water suppliers typically implement non-price policies to encourage water conservation. The state of Pennsylvania requests voluntary reductions in residential water use during moderate droughts and imposes mandatory restrictions during drought emergencies. This study utilizes data on household water consumption to measure the effectiveness of the water use restrictions in Pennsylvania during the moderate drought years 2015-2017. Results suggest that voluntary water use restrictions have smaller than desired effects and that the effects are larger the higher the marginal price of water, perhaps reflecting a trade-off between non-monetary benefits and the welfare loss from reducing water usage. The effectiveness of voluntary water use restrictions also is found to increase with the length of the drought.

Drought, Water Conservation, Conservation Policy

ECOSYSTEM SERVICES IN THE WEST BRANCH SUSQUEHANNA RIVER WATERSHED: ASSESSMENT OF VALUATION METHODS AND CASE STUDY OF CARBON SEQUESTRATION AND STORAGE

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Ecosystem services (ES) are a focus of research worldwide; to estimate the value to humans offered by natural ecosystems such as forests, wetlands, and open space. Their benefits to society are widely accepted (e.g., crop production; recreation; erosion control; and carbon sequestration), but procedures to quantitatively link them to societal values are lacking. As a result, public perceptions, planning and development, and government policies are often uninformed regarding the economic value that ES provide the local and regional economy. This research is a first effort to critically review numerous evaluation methods and geospatial data availability to develop an ES model for the central Susquehanna Valley region.

One ES, carbon sequestration, was modeled for the West Branch Susquehanna River using ArcGIS and Stanford University's iNVEST model coupled with a digital terrain model. Findings include: a) geospatial data available at fine resolutions, but procedures that translate LULC to financial values are less precise; b) forest, urban, wetland, and cropland areas in the West Branch Susquehanna River contribute over $128 million in economic value; c) riparian corridors sequester as much as 2 billion tons of sediment that would otherwise be delivered to the Chesapeake Bay. This assessment showed the importance of forests and trees for carbon sequestration in the watershed. The modeling tools and lack of measured sequestration rates suggests that much more work is needed in the near future in order to accurately estimate sequestration at the entire watershed scale.

To refine the model on a smaller scale and serve as a guideline for informing carbon-offset trading currently done by Bucknell University, carbon storage was modeled using composite soil samples taken on all BU properties. Locations within each LULC class were randomly selected using arcGIS, then located in the field using a GPS. Dry combustion and elemental analysis for each sample was performed using a carbon-hydrogen-nitrogen (CHN) analyzer. Results were mapped in GIS and overlain with soil and LULC coverages. Measured %C compared favorably with values published by USDA for each soil type. BU properties were estimated to sequester a minimum of 21,729.51 mg C, with an economic value for stored carbon estimated to be over $6,170,000 (calculated using the GIS-based inVEST model). Carbon sequestration for forested regions is typically 3.5% of the carbon stored in soils, suggesting sequestration values for BU is as high as $115,500 annually. This low value suggests actual sequestration rates should be measured in the field to refine the biophysical sequestration table used in inVEST model, and more samples should be considered where high variability is found over short distances. Future research may study impacts of Bucknell's specific land use and land management on soil carbon sequestration and ways to increase the storage time of carbon in the soil.

ecosystem services , forests , carbon sequestration , Susquehanna watershed

ESTABLISHMENT OF A SHRUB WILLOW RIPARIAN BUFFER TRIAL IN SINKING SPRING, PA

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Nutrient overload into the Delaware River Basin and the Chesapeake Bay are of major concern for Pennsylvania, and there is recent interest in utilizing bioenergy crops like shrub willow as agricultural/riparian buffers in order to reduce run-off from agricultural land into our local waterways. Shrub willow bioenergy crops function well in this role, resulting in a high rate of biological nitrate removal and increases in soil microbial activity, thereby improving water quality of nearby sources. Shrub willow have an extensive fine root system making them an effective riparian buffer. The goal of this project was to establish a shrub willow buffer trial to evaluate the use of shrub willow bioenergy crops as a riparian buffer system to reduce run-off into waterways. The adjacent stream to the trial was monitored for water quality throughout the growing season of 2019 and is ongoing. Establishment of unrooted willow cuttings was poor with over 50% mortality. Much of this was due to the heavy rain and flooding events post-planting. This site will require new planting stock in the spring next year. New sites for buffer trials are also being evaluated.

shrub willow , riparian , water quality

FACTORS INFLUENCING POLYPHOSPHATE STORAGE IN STREAM BIOFILMS ACROSS A PHOSPHORUS GRADIENT

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Polyphosphate plays a myriad of physiological roles in organisms spanning every domain of life. Although likely important, we are just beginning to understand the role these phosphate chains play in the biogeochemistry of aquatic systems. The purpose of this study was to examine the polyphosphate content of stream biofilms in 20 streams sampled at base-flow throughout central Pennsylvania. These streams represented a gradient of potential phosphorus impact, driven by varying agricultural intensity in watersheds upstream of sample sites. We found that polyphosphate content as a proportion of total phosphorus content of the biofilm was positively related to algal biomass and negatively related to water column soluble reactive phosphorus (SRP). This relationship seems to be influenced mainly by the presence of Cladophora sp. in streams with low base-flow SRP. It is likely that the presence of polyphosphate in these high biomass assemblages might indicate a stress response to low phosphorus and possibly indicate a strategy for maximizing future uptake and storage of phosphorus delivered in storm runoff.

phosphorus , biofilms , nutrients

A HARBINGER OF GOOD THINGS TO COME IN ACADEMIC AND NON-ACADEMIC PARTNERSHIPS: POPULATION GENOMICS AND CONSERVATION OF ERIGENIA BULBOSA (APIACEAE) IN PENNSYLVANIA

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Erigenia bulbosa, harbinger-of-spring, is a spring ephemeral of rich, well-drained forests and woodlands of eastern North America. The species is fairly common throughout the Midwest, with the bulk of its distribution in Missouri, Illinois, Indiana, and Ohio. In Pennsylvania, *E. bulbosa* exhibits an east-west disjunct distribution where widespread western populations are contiguous with the Midwestern range and a handful of populations in the eastern part of the state are restricted to the lower Susquehanna River valley. The isolation of the eastern populations suggests a possible conservation concern for those plants, with an assumed higher risk of fluctuations in numbers of individuals and the potential for lower levels of genetic diversity. As a consequence, regulatory considerations have created confusion during the environmental review process and left the Pennsylvania Department of Conservation and Natural Resources in the difficult position of justifying regulations that vary by region. To better understand population dynamics of the species, botanists from Bucknell University and the Western Pennsylvania Conservancy are engaged in a collaborative effort to couple field-based assessments of *E. bulbosa* with a population genomics approach. Using single nucleotide polymorphisms from throughout the genome obtained via genotyping by sequencing (GBS) methodology, we find support for isolation of the disjunct populations and expect that populations in the East will continue to be threatened by land use and development along the Susquehanna River valley. This project is an important example of the strength of academic and non-academic partnerships in fostering outcomes that inform conservation of rare and special plants..

Erigenia bulbosa , forests, woodlands, botany, collaborative partnerships

VERTICAL MIGRATION OF ADULT PLECOPTERA (STONEFLIES) ABOVE FORESTED HEADWATER STREAMS

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Aquatic insects have a life cycle that includes a larval aquatic stage and an adult terrestrial stage. Adult insects generally stay above the channel, but dispersal through upland areas can connect populations. Little information exists about adult utilization of forest canopy habitats even though movement through the canopy may be an adaptation for dispersal and unique predators may exist in this environment. We examined the abundance of adult stream insects that move into the forest canopy compared to individuals found at ground level above the stream. During the summer and autumn 2018, we sampled adult stream insects using malaise and canopy traps and larval insects using a d-net at four streams in the Mosquito Creek Watershed (Lycoming County, PA). We deployed traps for 2-week periods in Jun/Jul and Sep/Oct. All adults were identified to order and all Plecoptera to family. Overall, we found higher abundance of individuals in the malaise traps, but contrary to our hypotheses, certain plecopteran families were not statistically more abundant at ground level than in the canopy. The results of this work demonstrate the importance of mature riparian canopies for maintaining stream insect populations and the importance of differences in life history among taxa.

Plecoptera , vertical migration , stream insects , dispersal

PRECISION NUTRIENT AND SEDIMENT MODELING USING SUBBASIN ANALYSIS IN THE HALFMOON AND PEQUEA CREEK WATERSHEDS

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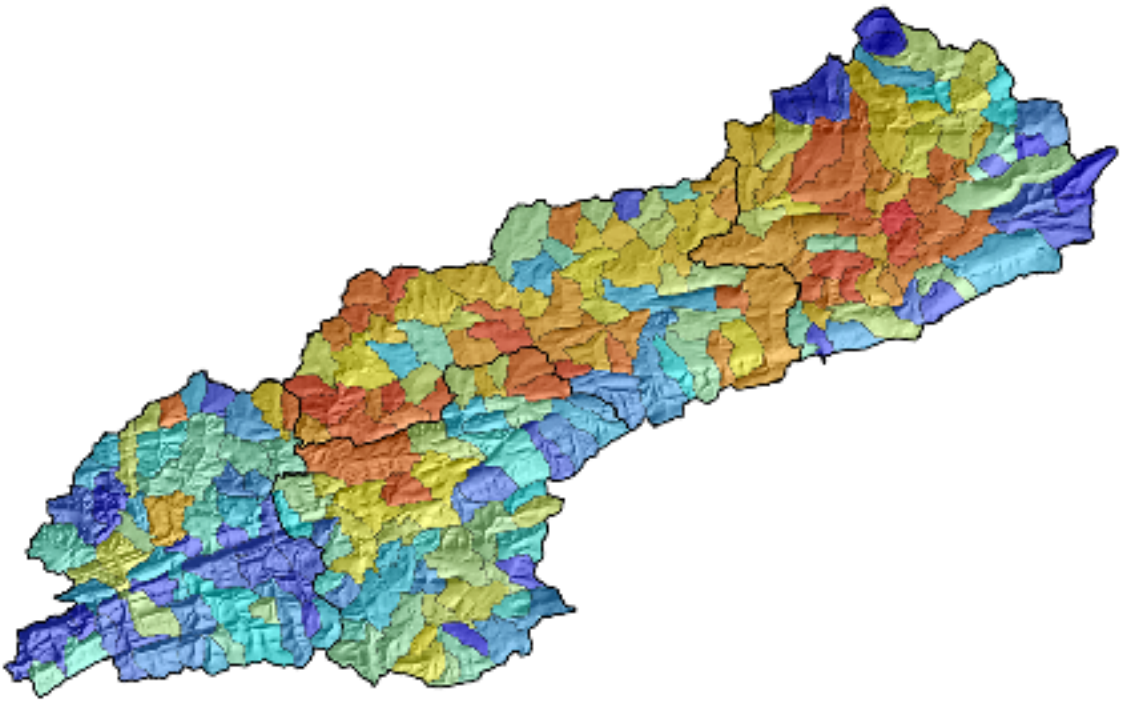
Hydrologic modeling of nutrient and sediment loading plays a key role in effective watershed and restoration planning. Selecting an appropriate model often calls for weighing the benefits of accuracy and precision versus efficiency. In particular, efficiency at larger spatial scales necessitates the aggregation of inputs, decreasing the model's ability to pinpoint load sources and determine the optimal placement of best management practices (BMPs). An alternative approach to maximize both precision and efficiency can be found in subbasin analysis. By dividing larger watersheds into smaller subbasins (¼ mi² to 2½ mi²), models utilizing broader aggregation can be employed rapidly without losing valuable spatial specificity. The Chesapeake Bay Foundation (CBF), with support from the Stroud Water Research Center (Stroud Center), explored this approach in the development of two Section 319 watershed implementation plans: Halfmoon Creek (23.8 mi², HUC-12, Centre and Huntingdon counties) and Pequea Creek (153.2 mi², HUC-10, Lancaster and Chester counties). Flow-path analysis was used to delineate subbasins in each greater watershed (45 in Halfmoon, 241 in Pequea) and combined with high-resolution land-use datasets developed by the Chesapeake Conservancy. Using the Watershed Multi-Year Model (GWLF-E, model algorithm developed by Scott Haag, Academy of Natural Sciences at Drexel University, and Barry Evans, Pennsylvania State University) within the Stroud Center's free Model My Watershed web interface, loading results (nitrogen, phosphorus, and sediment) were calculated for each subbasin and subsequently rejoined to the original spatial datasets. From this baseline, a variety of attainment-focused scenarios were developed and formed the foundation for the development of a community-driven implementation strategy. Ultimately, the subbasin approach yielded data with a high degree of geographic specificity while proving efficient in terms of both cost and time. Based upon this experience, this methodology could serve as an effective tool for watershed planning at a variety of scales.

Hydrologic Modeling , Precision Conservation , Section 319 , ModelMyWatershed



OPTIMIZING THE WEIR EQUATION FOR NATURE-LIKE FISH PASSAGES

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River connectivity, the continuous and unobstructed flow of water, has been interrupted around the world since the first dam was constructed nearly five millennia ago. Dams cause habitat fragmentation and decrease aquatic biodiversity by preventing fish migration. To better reestablish river connectivity versus technical fish passages, nature-like fish passages (NLFPs) have recently been constructed. NLFPs are expected to perform better than traditional fish passages because they mimic natural, uninterrupted river flow as a series of rock-pool steps.

NLFPs are constructed from boulders arranged to form a series of rock weirs that are anchored to the bed of a river. However, the traditional broad-crested weir equation fails to consider the complex flow through and over rock-weirs. The consideration of cross-channel weir shape is also unaccounted for, which in turn neglects the effects of nappe and interstitial flow interactions. In this work, the role of the cross-channel shape of rock weirs is studied through laboratory experiments.

In the set of 30 experiments, first the shortcoming of the traditional broad-crested weir equation is established, then the weir coefficient is calibrated for each rock-weir having varying combinations of cross-channel shape and crest length. It is expected that weirs of different shape, but the same crest length have different discharge coefficients, thus cross-channel geometry should be included in the predictive relationships used to design rock weirs for NLFPs.

River Connectivity , NLFPs , Weirs

STATUS AND PLANS FOR PA HYDROGRAPHY MODERNIZATION

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Our current water base map is the USGS' National Hydrography Dataset (NHD), with a scale of 1:24000 and constructed from 2D stream mapping assembled over 40 years. It is the basis for regulatory review and provides continuity and consistency across state and national programs. The value of that continuity is challenged in this age of high precision topographic mapping and aerial imagery, massive data handling capacity, and big data analytics.

PaMAGIC and DCNR Bureau of Geological Survey are collaborating to define and build modernized hydrography that integrates streams with precise topography from lidar in a way that supports dynamic national hydrography. This presentation will update attendees on the status and plans for completing a statewide lidar update and a basin-oriented approach to stream mapping and modeling.

Stream mapping , Lidar , Topography , Hydrography

RESTORING FLOODPLAINS - A REGIONAL APPROACH TO IMPROVE WATER QUALITY AND COMMUNITY RESILIENCY.

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Recreational fisheries are often socially and economically important on both local and regional scales. However, factors that can affect recreational fisheries are often diverse and occasionally beyond the scope of fisheries management. An apt example of this situation includes disease-related mortality of young-of-year Smallmouth Bass and subsequent population declines in the Susquehanna River. While early hypotheses as to the cause were simple, as data were collected, it was evident that the situation was far more complex than first realized and that understanding the contributing mechanisms required the expertise of multiple entities. We will discuss how a diverse set of agency and academic researchers partnered and leveraged their respective resources to confront this situation. We combined both the experience of collaborators with the development of new and novel techniques to gain an understanding of what was occurring in the Susquehanna River Basin. Because of this unique relationship and skill set, collaborators have gained great insight into the complex relationship involving pollutants and pathogens in the environment and how they affect fish health. Many of the techniques and practices employed for data collection for this research have now become incorporated into routine regulatory practices; leading to a better fishery management and environmental protection measures. As agency and academic resources continue to be overextended and new pathogens are discovered, and environmental stressors are increasingly complex, collaborations and interdisciplinary efforts like this will likely become the norm, if not a necessity.

LOCAL RESILIENCE RELATED TO FLOOD RISK IN SUSQUEHANNA REGION COMMUNITIES.

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Urban centers and agrarian communities in the Susquehanna River basin are facing increased risks of floods – resulting in economic, environmental, and social stresses. These threats disproportionately affect low-income households, threaten municipal tax revenue, and undermine the river's potential as a cultural and recreational resource. Launched in January 2019, the Penn State Initiative for Resilient Communities (PSIRC) provides an environment of shared discovery where stakeholders, decision-makers, designers, and researchers spanning multiple disciplines come together to address local resilience challenges related to flood risk in small, riverine communities. Starting with a pilot project in partnership with the Borough of Selinsgrove, the tools, methods, and lessons learned will be generalized to inform decision-making for sustainability and resilience to riverine flooding in communities throughout the Chesapeake Bay Watershed and beyond.

2019 SUSQUEHANNA RIVER SYMPOSIUM

POSTER PRESENTATIONS

CHEMICAL AND BIOLOGICAL DOCUMENTATION OF IMPAIRMENT/NON-IMPAIRMENT DUE TO ACID DEPOSITION IN THE HEADWATERS OF SWIFT RUN AND BEAR RUN, CENTRAL PENNSYLVANIA

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Appalachian Mountain headwater streams have a long history of being negatively impacted by acid deposition. Two such streams, Swift Run, near Troxelville, PA, and Bear Run, near Woodward, PA, were examined in this study. The underlying bedrock geology plays an important role in the ability of a stream to resist the lowering of pH due to the chemical composition of the rock, as well as certain nearby man-made structures such as limestone gravel roads, which add alkalinity to streams from the dissolution of calcium carbonate. From previous research, the Tuscarora Formation in Central Pennsylvania often is unable to provide sufficient alkalinity to headwater streams resulting in a drop in pH. This research aims to further examine the relationship between stream chemistry and ecology and the underlying bedrock geology beneath these streams through the measurements of pH, alkalinity, aqueous aluminum content, and fish counts (by angling to establish presence/absence).

At both Swift Run and Bear Run, the overall trend for both pH and alkalinity is an increase downstream. Swift Run watershed pH values ranged from 4.77 to 6.70 during the first round of sampling and 4.66 to 6.98 on a later date. Bear Run pH values are between 4.86 to 6.72. The two rounds of alkalinity sampling at Swift Run exhibit ranges from -1.7 to 3.3 and -1.8 to 4.9 mg/L as $CaCO_3$, respectively, and Bear Run alkalinity values are between -1.0 to 3.1 mg/L as $CaCO_3$. The highest observed aluminum values at Swift Run and Bear Run are 101 and 104 µg/L, respectively, less than the 200 µg/L lethal limit for brook trout. Except for one reach, fish sampling in 100-meter sections of Swift Run resulted in at least 12 strikes in each reach of stream. The most acidified reach had no fish present in 2008, but in this study, 3 strikes and 2 fish caught were recorded, suggesting that this reach is recovering.

Acid Deposition , Impaired Headwater Streams

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

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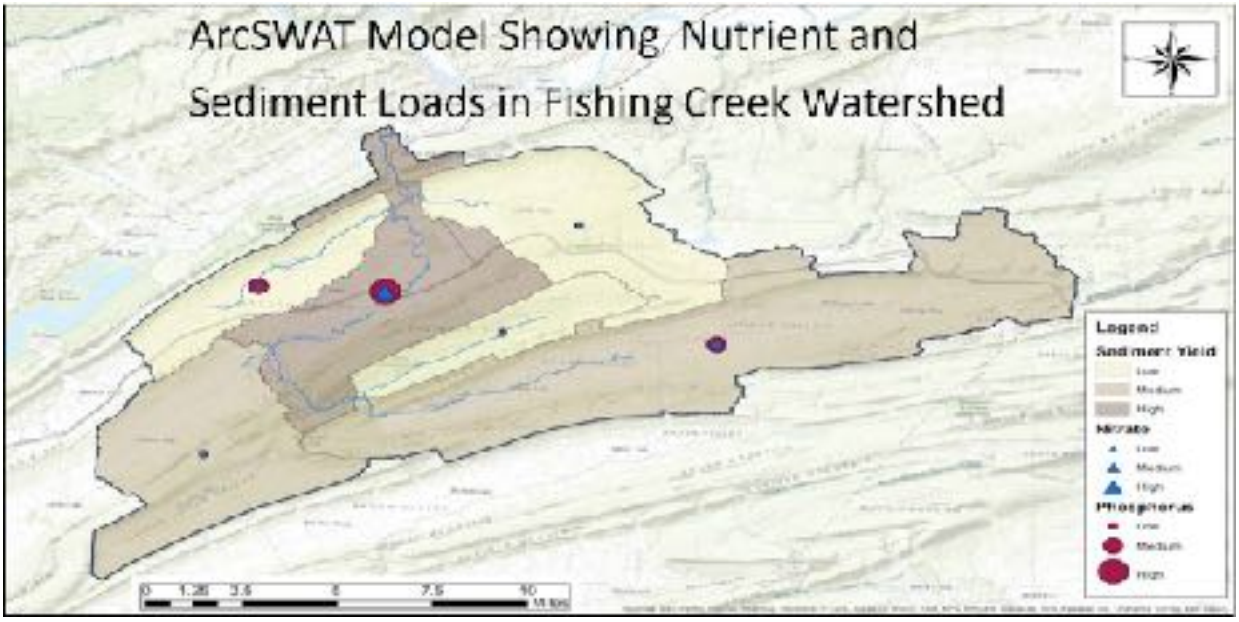
Agricultural non-point source pollution is the leading source of water-quality impairment to many of the nation's rivers, lakes, and estuaries, including the Chesapeake Bay. A Total Maximum Daily Load (TMDL) plan was developed by the US EPA in 2010 to reduce nutrient and sediment loads for the Bay. The 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 and during May-August in 2019. The results of this three-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, NO_3-N, NO_2-N, NH_3-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 land use 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.

Big Fishing Creek , WQI , Nutrients , Chesapeake Bay



NATIONAL FLOOD INSURANCE PROGRAM (NFIP) DATASET: INSIGHTS FOR PA

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In June 2019, the Federal Emergency Management Agency (FEMA) released a dataset that was derived from the national Flood Insurance Program (NFIP) system of record representing more than 2,000,000 claims transactions nationally. The dataset has 42 different variables for each of the transactions, related to the building's characteristics, policy, coverage, location and date. The dataset does not include the exact location of the buildings and the premium paid. However, another community/county level dataset is available for premiums that can be used to compare the amount paid on the claims with premium paid across different counties.

A primary data visualization has been done for Pennsylvania. R programming language and Tableau software have been used for the visualization. The visualization shows:

1) General spatiotemporal distribution of the claims and amount paid on building and content claims in PA
2) Buildings characteristics such as occupancy type in relation to the amount paid on the claims
3) Comparison of the claims within Special Flood Hazard Areas (SFHA) and outside of SFHA
4) The county-wide comparison of the premiums and amount paid on the claims

Given the continuing ambiguity on the relevance and effectiveness of NFIP program, this dataset provides an unprecedented opportunity for answering research questions that can 1) increase public awareness 2) inform local officials 3) and improve policy and priority setting in the NFIP program. This visualization is part of an on-going research study that investigate different characteristics of the dataset to answer scientific questions and localize the findings for informed future decision-making.

NFIP , Flood Insurance , Big Data , Data Visualization

DECISION ANALYSIS OF ELEVATING A HOUSE TO MANAGE DEEPLY UNCERTAIN FLOOD RISKS

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A common approach to reduce flood risks is to elevate a house. Deciding whether and, if so, how high to elevate a house is a nontrivial decision problem. One common guideline for this is the Federal Emergency Management Agency (FEMA) minimum elevation requirement for National Flood Insurance Program participants. This guideline recommends elevating the house to the Base Flood Elevation (the height of the 100-yr flood) plus one foot of freeboard. Is this recommendation economically efficient given uncertain flood hazard projections? Previous studies on this question break important new ground, but typically remain silent on the effects of key uncertainties (e.g., the flood hazard itself).

Here we conduct a cost-benefit analysis (CBA) under uncertainty to analyze four strategies: (1) repairing as floods occur, (2) elevating the house to the FEMA minimum recommendation, (3) elevating the house to a cost-optimal elevation that minimizes the total cost (current cost of elevating plus net present value of expected damages) and ignores uncertainties, and (4) elevating the building to the optimal elevation under uncertainty. We use as a case study an idealized house within a small Pennsylvania community and demonstrate the role of uncertainty quantification in the home elevation problem. Results show that consideration of uncertainty generally leads to higher CBA optimal elevation and that FEMA's recommendation can often be improved from a cost-benefit perspective.

Flood mitigation , Deep uncertainty , Elevating a house , risk management

AGNES REVISITED - A CALL TO PARTICIPATE IN RESEARCH ON THE HISTORY & LEGACIES OF THE 1972 FLOOD

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According to state climatologists, the Susquehanna River valley has entered an era of wetter and wilder weather. Overall annual precipitation is increasing while storm events are now both more frequent and more intense. How are residents, farmers, business owners, and municipalities preparing? Will lessons from past storms and floods help people adapt?

AGNES REVISITED explores these timely questions. Drawing on interdisciplinary methods and a commitment to public scholarship, the project focuses on the history and legacies of Tropical Storm Agnes of 1972. In its day, the storm and flood - known simply as "Agnes" - was the costliest natural disaster in American history. Pennsylvania felt the brunt of Agnes' impact with a staggering $2B in property damage, nearly 50 lives taken, and more than 200,000 left homeless. Recovery efforts established precedents in flood management as governmental agencies turned from dams and levees to implement 'non-structural' techniques like floodplain zoning ordinances. AGNES REVISITED returns to these events to understand what they can teach us about flood risk and flood resilience in PA today.

We are actively collecting data and want to connect with Symposium participants involved with Agnes. We are particularly interested in hearing from folks who experienced the flood and recovery in these towns: Tunkhannock, Wilkes-Barre, Lock Haven, Bloomsburg, Danville, Milton, Lewisburg, Sunbury, Selinsgrove, & Harrisburg. Please visit our table during the Symposium to learn more. You can also reach us at agnesrevisited@gmail.com with questions, ideas, resources, or to set up a time to chat.

Harrisburg, PA during Hurricane Agnes, 1972. Source: PA Trails of History

FLOOD RISK PROJECTIONS FROM FUTURE CLIMATE ACROSS SUSQUEHANNA RIVER BASIN

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Floods pose major risks to people and property. For all the efforts toward building communities' resilience to flood risk, flood inundation projections that incorporate the potential impact of climate change are a prerequisite for informed decision-making under environmental and demographic changes. Here we develop an integrated modeling framework to assess flood risks across the Susquehanna River Basin from current and projected future climate conditions. The framework samples future climate forcing scenarios and climate models to force a hydrologic model and generate discharge projections. Together with a statistical and hydraulic model, the projected discharges are then used to map the uncertainty of flood inundation projections for extreme flood events. The integrated framework accounts for the relative uncertainty contributions from (i) general circulation models, (ii) hydrologic model parameters, (iii) nonstationary extreme value distributions, and (iv) hydraulic model structure.

Flood , Susquehanna River , Climate Change , Uncertainty Quantification

Millennium bridge on Highway 17 between Apalachin and Campville, New York are flooded during Tropical Storm Lee (Sept 8, 2011). [photo courtesy of Bill Walsh, National Weather Service]

THE PENN STATE INITIATIVE FOR RESILIENT COMMUNITIES: RESILIENCE BY DESIGN

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Launched in January 2019, the Penn State Initiative for Resilient Communities (PSIRC) provides an environment of shared discovery where people can come together to address local resilience challenges of small, riverine communities vulnerable to flood risk. Working with local stakeholders and decision makers, PSIRC provides a way to leverage the resources of Penn State to help make an impact for local communities. By bringing together faculty, students, postdocs, and staff from multiple colleges, diverse disciplines, and established centers and institutes, this initiative works towards addressing riverine flooding and other related challenges to build more resilient communities in Pennsylvania and beyond. PSIRC is generously supported by the Office of the Provost through Penn State's Strategic Plan.

This collaboration provides a stable foundation to tackle the broad range of issues relevant to resilience and economic development in Pennsylvania river towns. Historically and culturally significant urban centers and agrarian communities in the Susquehanna River basin are facing increased risks of floods – resulting in economic, environmental and social stresses. Many of these river towns are facing similar pressure, including:

- Mandates for addressing storm water and nutrient management, crucial issues that left unaddressed negatively impact recreation river use and the quality of the Pennsylvania waterways and the Chesapeake Bay;
- Impact of flood insurance on property values, high costs for mitigation, and property abandonment resulting in personal economic stress and community degradation.

These threats disproportionately affect low-income households, threaten tax revenue, and undermine the river's potential as a cultural and recreational resource. Starting with a pilot project in partnership with the Borough of Selinsgrove, the tools, methods, and lessons learned will be generalized to inform decision-making for sustainability and resilience to riverine flooding in communities throughout the Chesapeake Bay Watershed and beyond.

Resilience , Design , Climate Change , Community

Susquehanna River floods residents in Selinsgrove, PA on the Isle of Que

SMALL-SCALE WATERSHED RESEARCH TO GUIDE CONSERVATION AND RESTORATION EFFORTS IN THE CHESAPEAKE BAY WATERSHED.

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In 2010, the largest and most complex total maximum daily load (TMDL) in the nation was developed for the Chesapeake Bay watershed for nitrogen, phosphorus and sediment. Watershed Implementation Plans (WIPs) specify how the Bay states will meet pollution allocations and each state must develop management strategies statewide and at the local (watershed) scale to prioritize resources to reduce loads to the bay. To achieve these goals for better water quality, the U.S. Geological Survey is partnering with local Pennsylvania water-resource managers in Turtle Creek (Union County) and Fishing Creek (Clinton County) to provide detailed small-scale watershed research to guide conservation and restoration efforts aimed at improving water quality of local groundwater, streams and the Chesapeake Bay.

Turtle Creek has an established TMDL for sediment and is the focus of a coordinated stream restoration effort. This research will utilize geomorphic assessments, lidar differencing and structure-from-motion techniques along a gradient of stream stability to determine if significant differences in sediment erosion and deposition from 2019 to 2022 exist between reference, restored and eroded stream reaches of Turtle Creek. Fishing Creek watershed has several impaired stream sections from nutrients/siltation and has shown elevated nitrate levels in groundwater. This study will use major-ion chemistry and the nitrogen and oxygen isotopic composition of nitrate in stream water during base flow to evaluate the occurrence and distribution of nutrients and describe biogeochemical processes affecting nutrient concentrations in water. These pilot projects will help demonstrate how coupling conservation management with tracking/verification can aid Pennsylvania's Phase 3 Watershed Implementation Plan (WIP) to reduce sediment and nutrient loads in the Pennsylvania portion of the Chesapeake Bay Watershed.

Chesapeake Bay, Nutrients, Sediment

NITROGEN IN THE CHESAPEAKE BAY WATERSHED: A CENTURY OF CHANGE, 1950 – 2050.

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A forthcoming USGS Circular aims to provide an understanding of how changes in environment and human activities in the past, the present, and into the future influence the export of nitrogen from the watershed to the Chesapeake Bay. This work includes an analysis of the spatial and temporal changes in the physical factors, source inputs, and management decisions. Past and current trends, and future scenarios of change are discussed. Major drivers include 1.) the changes in the mass of nitrogen introduced to the watershed each year through atmospheric deposition, urban activities, and agricultural activities, 2.) the effectiveness of management decisions to mitigate the export of nitrogen out of agricultural and urban areas, and 3.) the vital role that changing climate and hydrology play in determining the mechanisms and magnitude of nitrogen export from the watershed to the Bay. The analysis of past monitoring data provides perspective on relatively recent historical trends and is used as the foundation for predictive tools to provide hindcasts and forecasts for a century of change in the Chesapeake Bay watershed. This long-term perspective can help inform decisions that will better balance the application, production, and control of nitrogen in coastal areas.

Chesapeake Bay, Nitrogen, Eutrophication

PRELIMINARY RESULTS FROM A TEN-YEAR STUDY OF THE UPPER MAIN STEM OF THE SUSQUEHANNA RIVER USING METRICS GENERATED BY COLLECTIONS OF BENTHIC MACROINVERTEBRATES AND DIATOMS

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During the decade, 2009-2018, we used a multi-community effort to monitor and describe the state of the upper main stem of the Susquehanna River during respective summer and fall seasons. The upper main stem is formed by the confluence of the West Branch and the North Branch at Sunbury, PA. We maintained study sites along a transect that straddled Byers Island and was near the Shady Nook Boat Launch in Hummel's Wharf, PA. The upper main stem of the river flows in two broad shallow channels on either side of Byers Island. The western channel is the widest and has easier access, especially in the fall when water levels typically fell. The exceptions were major high water events in the fall of 2011 and 2018. Because the plumes of the two branches did not mix well, they remained chemically and physically distinct with the narrow mixing zone in the middle of the western channel.

Site 1 was on the western shore and in the West Branch Plume (WBP) while site 2 was on the shore of Byres Island in the North Branch Plume (NBP). We collected benthic diatom assemblages (BDA) on sandstone cobbles and glass slides and benthic macroinvertebrates (BMI) by standard rock baskets filled with number 4 limestone. We did use other collection methods, but they were relatively uninformative. We did not intend to conduct an exhaustive collection to characterize the respective communities. Rather, our purpose was to collect subsamples of these communities with standard methods and generate appropriate metrics of these well-studied and well-calibrated taxa.

Diatoms were identified to species and macroinvertebrates to family. Of the BMI metrics, the Hilsenhoff Biotic Index averaged 3.93 and 3.95 and %EPT averaged 72% and 70% for the WBP and NBP, respectively. Both metrics indicate very good water quality with the HBI between 3.76-4.25 and % EPT >55%. The BDA metrics describe both plumes as mesotrophic with low impact of organic pollution but moderate impacts of ambient phosphorus and nitrogen especially in the NBP.

Susquehanna River , Benthic Macroinvertebrates , Benthic Diatoms , Water Quality

THE CHALLENGES TO DAM REMOVAL ON THE SUSQUEHANNA RIVER – A FOCUS ON CONOWINGO AND ITS PJM SERVICES

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In the State of Maryland 5 dams provide 554 MW of renewable electrical capacity, the oldest and largest of these plants, Conowingo represents 500MW (90%) of the State's hydroelectricity. This dam is the last of four major hydroelectric facilities residing on the lower Susquehanna River before the river enters the Chesapeake Bay. The other dams the Holtwood, Safe Harbor and York Haven dams and all were the focus of much research shared during the 8th Annual Susquehanna River Symposium in October 2013. That one dam represents the challenges that hydroelectric (once favored as the means to harness the energy of a river) now faces in a world with elevated sensitivity to the environmental degradation of technological development. There have always been trade-offs between human development and our expansion as a species and the consequent negative impacts of that on the biosphere and other species. At the time of Conowingo's creation, electric power generation and flood control were the major human benefits which came at the cost of reduced fish migration and decimated fish populations, fragmented ecosystems, and sporadic heavy discharges of pollutants into the Chesapeake Bay during major flood events. Some researchers suggest that retiring dams such as this one to restore the environment can be accomplished by installing cheap photovoltaic (PV) power systems and energy storage. Our research reviews the current markets of the regional transmission organization (RTO), specifically energy, capacity and ancillary services to see if this type of substitution is viable from a grid operation perspective. Using data from Bucknell's residential micro-grid we verify that the energy portion of Conowingo could easily be offset by distributed PV. Further, by deploying thermal energy storage much of the capacity benefits provided by this facility could be met as well. However, meeting the ancillary services Conowingo provides the grid (specifically reactive power, regulation, synchronized reserve, and black start service) would present a challenge of significant complexity not easily matched at current market prices by available renewable technology.

Dam removal , PJM , Susquehanna River , Ancillary Services

ONGOING RESTORATION OF AN EASTERN HELLBENDER POPULATION IN THE UPPER SUSQUEHANNA RIVER DRAINAGE

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The eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*) has been a New York State "Species of Special Concern" since 1983, as stressors such as disease, invasive species, agricultural runoff and high sediment loads pose challenges to the state's populations. By 2014 hellbender sightings within the New York portion of the Upper Susquehanna River drainage were reduced to a single individual at one of the 23 historic sites within the watershed; in response we initiated an experimental headstarting effort coupled with site habitat enhancement. In August 2017 a cohort of 102 two-and-a-half-year-old juvenile hellbenders (collected from the wild as eggs and initially reared at the Bronx Zoo) was transferred to a facility in central New York and raised under various water and food source treatments to investigate the captive environment's influence on growth, health, and post-release outcome of repatriated individuals. After a year the juvenile hellbenders were PIT-tagged and released at the historic site following installation of sedimentary slab rock and 30 additional artificial habitat structures ("huts"). Monitoring efforts continue and consist of scanning the stream bottom with an radio frequency identification device (RFID) reader to locate tagged hellbenders; two in-stream RFID systems also temporarily bounded the release area to capture initial dispersal outside of surveys. In 2019 32.3% of the cohort has been accounted for at the site; at this time the rearing treatments do not appear to have significantly impacted survival or the other basic metrics we are examining. The juveniles have been recorded using both the placed slab rock and artificial habitat structures, but these structures have also led to the discovery of 10 additional adult hellbenders and six nests at the site to date.

hellbender , stream ecology , population restoration , species conservation

THE EVOLUTION OF ARTIFICIAL SHELTER DESIGN FOR THE EASTERN HELLBENDER SALAMANDER

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Artificial shelters for hellbender salamander conservation have been in field use in Missouri since 2014. The original Missouri model has morphed into a variety of designs, each attempting to ensure the endurance of the shelters despite the rigors of stream and river environments, but all with the goal of providing additional refugia and a means to more easily monitor population and individual health, and to provide access to fertilized hellbender eggs for head-starting. All of the designs in use today are made of concrete and contain an internal chamber with an access port (tunnel) for the hellbender to enter the chamber and another access port (lid) for access to the chamber by researchers. The Missouri model is constructed by hand-packing concrete around a chicken wire and hardware cloth frame. Building the wire frame and layering the concrete to form a chamber and entry tunnel is laborious. Further, a concrete saw is used to cut out the bottom of the shelter so that natural stream sediments form the floor of the chamber. While this design is still in use in Missouri, researchers in other states have shifted to poured concrete shelters and have attempted to deal with sediment deposition inside the shelters by having a hydrodynamic design and by having locking lids to avoid the problem of lid displacement. Some models have an open bottom, others have a solid bottom or a 2 or 3 piece design with a separate concrete bottom and lid. Our current one-piece design is unique in that we use ABS plastic fittings and pipe to create an entry tunnel (rather than concrete) and ABS clean-out fittings to provide an access port with little or no chance of losing the screw-cap cover. We retain the open bottom design and have added stainless-steel hose clamps as anchor points. As the use of the artificial shelters expands, regulatory agencies are refining their permit requirements and some are asking that shelters be anchored to the stream pavement, hence the addition of clamps for securing the refugia with steel cables and rebar.

Artificial Shelter , Refugia , Eastern Hellbender , Habitat

DESIGNATION OF THE EASTERN HELLBENDER AS THE PENNSYLVANIA STATE AMPHIBIAN: ROAD MAP TO THE PASSAGE OF THE HELLBENDER BILL

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Students from Harrisburg-area high schools joined the Chesapeake Bay Foundation's Student Leadership Council and embarked on a journey to explore what they could do to learn more about the Eastern Hellbender salamander and to participate in projects to conserve the declining species. Beginning in Fall 2016 and continuing through 2017, the student team gained field experience by joining research teams from Lycoming College and Buffalo State – they participated in collecting eDNA samples, installation of artificial shelters, and in securing native foods for hellbenders being raised in captivity (head-started) for future release-to-the-wild. The students also visited area zoos to learn how the facilities were contributing to hellbender conservation and providing outreach to the public through their educational venues. Having learned about the uniqueness of the rarely-seen North American giant salamander, the students sought to have the Eastern Hellbender designated as the Pennsylvania State Amphibian. They worked closely with State Senator Gene Yaw and other Pennsylvania legislators to draft a bill that was first introduced in the Senate in late 2017 -- the bill passed unanimously, but stalled when tabled in the house. In January 2019, Senator Yaw introduced a new bill that passed almost unanimously in the Senate (46-1) and eventually in the house with just six no votes. Governor Tom Wolfe signed the hellbender bill into law on April 23, 2019, in the presence of the students and their supporters in the state legislature, the Chesapeake Bay Foundation, Lycoming College, and the Pennsylvania Fish and Boat Commission.

Eastern Hellbender , State Amphibian , Hellbender Bill , Giant Salamander

MONITORING EASTERN HELLBENDER POPULATIONS USING ADVANCED RFID SCANNING TECHNOLOGIES

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The marking of animals with radio frequency identification device (RFID) tags has dramatically improved the ability of researchers to re-identify individuals when captured in the wild. In some species, such as migratory fish, the tags can be read as the fish swims through as narrow passage on a fish ladder, but for most species, the tags can only be read when the individual has been captured and the RFID tag is just a few centimeters from the tag reader. New technologies have recently made it possible to read tags from a greater distance, sometimes as far as 30 centimeters away, and through solid cover objects such as rocks, concrete, and logs. We can now read the RFID tags of Eastern Hellbender salamanders through the large thick rocks they use as refugia. This new ability eliminates the tremendous effort required to move rocks in order to capture individuals before their tags can be read. To test the effectiveness of this method, we scanned for RFID tags in a section of hellbender habitat, then lifted all of the large rocks in the study area to capture all resident hellbenders without knowing where our previous tag reads had taken place. Our initial scan noted 12 RFID-tagged hellbenders in residence at the site. Our rock lifting added one additional tagged hellbender whose tag was not read during the initial scan and 13 additional untagged hellbenders. We also did not find four of the tagged individuals noted during the initial scan. From this pilot study, we learned that not all tags will be read during a comprehensive scan and plan to do multiple scans to determine which factors block reading of the RFID microchips. Scans of other populations revealed the presence of hellbender tags in stream sediments. Most of the cast-off tags were recovered and were from hellbenders that had died from natural causes or predation. The majority of recovered tags were located at the shoreline edge, supporting the predation hypothesis. While it is possible that a few tags were dropped following implantation, we found that tag drops did not occur in any of the 99 juvenile hellbenders that we tagged in a hellbender reintroduction project in 2018. The new technology has also provided us with information on movements between widely-spaced hellbender populations.

Eastern Hellbender , Cryptobranchus , RFID , Population Ecology

Eastern Hellbender *(Cryptobranchus alleganiensis).* [photo courtesy of PA Amphibian and Reptile Survey]

CONTINUED CHEMICAL AND BIOLOGICAL RESPONSES TO BANK STABILIZATION AND RESTORATION OF AN AGRICULTURAL STREAM CHANNEL

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River and stream health are affected by water quality, composition of the river or stream bed, and the diversity of flow through the channel. Human actions affect these various aspects of streams, more often negatively, which causes impairment of biological communities in streams. The leading cause of human impact on streams in Pennsylvania is sediment and nutrients from agricultural land use, which impact organisms living in streams by degrading in-stream habitats and water quality. A way to restore impaired streams, used by many management agencies, is to stabilize stream banks and manage riparian areas to allow less sediment and nutrients to erode directly into the streams.

This study focuses on a particular site at Conley Run in central Pennsylvania that runs through an agricultural area. Conley Run is a stream that is agriculturally impaired but underwent bank stabilization and channel modification in spring 2017. We sampled in-stream habitat and benthic invertebrates in the "restored" reach of Conley Run both a year before and for two years after restoration. The restoration caused the stream to flow deeper and faster than before and to have a more diverse bed composition; however, benthic invertebrate communities showed little improvement one year after restoration. We will be analyzing data from two years after restoration to determine whether the restoration done in 2017 will continue to improve the health of Conley Run or if Conley Run will need more restoration efforts to realize ecological benefits.

Restoration , Impaired Streams , Benthic Invertebrates , Water Quality

IMPLEMENTING PRECISION CONSERVATION ON TURTLE CREEK WATERSHED

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The purpose of this research project was to determine the effectiveness of Precision Conservation methods applied to streams, as well as to improve this methodology. Through this, we expected to improve the ability to determine where sediment enters streams. Precision Conservation is a method created by the Chesapeake Conservancy that locates where non-point source pollution enters into streams.

Instead of accessing Buffalo Creek and Bull Run like the previous years, we decided to access Turtle Creek Watershed, also located in Union County. Sampling sites that were forested contributing areas were more accessible in Turtle Creek Watershed. We were also able to apply higher resolution digital elevation models (DEMs) and land cover data into GIS that was not available in the past.

By implementing ArcMap, a component of ArcGIS, we compared two different methods: Normalized Difference Flow Index (NDFI) and Overland Flow Sediment Index (OFSI). The Chesapeake Conservancy methodology accounts for the use of NDFI, while OFSI was based on our own methodology and past research that accounted for the Topographic Wetness Index (TWI) of the indicated area.

Lastly, we identified key sites within Turtle Creek Watershed. These sites consisted of both forested and agricultural contributing areas that drained through culverts. We planned to collect samples at these key sites during runoff events and conduct various water quality tests including total suspended solids (TSS) and turbidity. With results from various water quality tests and maps from ArcMap, we would be able to compare NDFI to OFSI and see which method out of the two is more accurate at predicting sediment load into streams.

Precision Conservation , GIS , Turtle Creek Watershed

DID IT WORK: QUANTIFYING THE EFFECTS OF A STREAM RESTORATION

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We completed a pre- and post-restoration stream ecosystem assessments on Kelso Run, a headwater tributary in the Little Juniata River watershed that supports a wild population of naturally reproducing trout. The purpose was to quantify changes as a result of in-stream habitat improvements, which included bank stabilization features, log cribs, and log dams to create plunge pools. The restoration seemed necessary as Kelso Run was significantly geomorphically altered by intense flood waters from Hurricane Ivan in 2004. We compared stream habitat conditions, fish assemblage structure, water quality, and benthic macroinvertebrates before and after habitat improvement over a 3-year period. Compared to before the restoration activities took place, we observed a significant improvement in fish habitat quality in a few key variables such as amount of fish cover and pools. We also observed a marginal increase in the percentage of fish sampled that were trout. As expected, we did not see any noticeable change in water quality. Additionally, benthic macroinvertebrate community composition did not change to a great extent. Using multiple IBI scores, we have not seen a great change in the health of the stream based on the macroinvertebrates inhabiting the water. Consequently, as expected, the biggest effect of the habitat improvement on this stream was seen in fish habitat parameters that were targeted for improvement. After two checks of the stream and electroshocking to see what fish are inhabiting the stream, we have found improvements in both the numbers of trout inhabiting the same length of water but also an increase in the density of trout in the stream. It may take more time to see noticeable changes in fish community structure as a result of habitat improvement, but only two years later, we are seeing trout populations increase. Evaluating conditions before and after restoration projects is an essential process in assessing habitat improvement success and estimating ecological lift as a consequence.

Restoration

DIET ANALYSIS AND PRESENCE OF MICROPLASTICS IN SMALLMOUTH BASS IN A FRESHWATER RIVER SYSTEM.

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Microplastics are an emerging concern in freshwater systems for many organisms, and the presence of them may affect the biological function of freshwater fish. A diet analysis was performed on Smallmouth Bass *(Micropterus dolomieu*) and they were tested for the presence of microplastics (plastic particles <5 mm). Two hundred and six Smallmouth Bass stomachs were collected between 2017 and 2019 from the Susquehanna River and a tributary known as Pine Creek. The diet analysis of Smallmouth Bass shows a large variety of prey items from several trophic levels suggesting that there are many pathways for the accumulation of microplastics. The primary diet item in 2017 and 2019 was crayfish (53.8% and 46% respectively), while in 2018, it was macroinvertebrates (39.5%). Analysis for the presence of microplastics using the wet peroxide oxidation procedure found that microplastics were present in diets at varying rates each year. In 2018, microplastics were present in 95.5% of the fish sampled. In 2017, 87.5% of the fish sampled contained microplastics. The average number of microplastics per fish varied per year with the samples from 2018 having 6.1 microplastics per fish and in 2017, there was an average of 2.3 microplastics per fish. 2019 microplastic data is currently being processed. One possibility for the differing number of microplastics could be the flow rate of the Susquehanna River, as higher flows may allow the river to gather more plastic waste and break it down faster. In 2019, the average flow has been 50,083 ft^3/second, in 2018, it was 49,950 ft3/second, and in 2017 the average was 31,070 ft3/second (USGS water flow data for Susquehanna River at Sunbury PA). Our study will help increase the knowledge of what Smallmouth Bass consume in their diet and the presence and concentration of microplastics in freshwater fish species found in the Susquehanna River.

Microplastics , Smallmouth Bass , Aquatic Contamination

DIET ANALYSIS AND PRESENCE OF MICROPLASTICS IN CHANNEL CATFISH IN THE JUNIATA RIVER

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Microplastics have emerged as a major concern in aquatic ecosystems. The scientific community has compiled substantial evidence that microplastics can impact individual species of marine mammals and fish, as well as cause disruption to food webs. While the presence of plastics and microplastics in marine systems is well documented, new research has shown that microplastics are now of emerging concern in freshwater ecosystems. Recent studies from the Susquehanna River have found the presence of microplastics in 83% of Smallmouth Bass stomachs. In order to determine whether microplastics are a threat to other fish species in the drainage, a dietary analysis will be performed on Channel Catfish collected from several sites on the Juniata River (Pennsylvania, USA). Five sites were selected based on access and depth, ranging as far upriver as Granville and as far downstream as Newport and covering approximately 40 miles of the river. Channel Catfish were specifically chosen due to their unique, highly variable diet and extremely acidic stomach. The stomachs of 75 individuals will be tested for evidence of the accumulation of microplastics. Stomach contents will be digested using a via the wet peroxide oxidation procedure. Our study will continue to provide new information about the presence of microplastics in an important benthic fish species of the Susquehanna River, and may give insight into the potential pathways of microplastic accumulation in freshwater systems.

Micro plastics , Channel Catfish , Dietary Analysis , Food Web

INFLUENCE OF INSTREAM OVIPOSITION MICROHABITAT ON AQUATIC INSECT DISTRIBUTION: DISCERNING THE MAGNITUDE OF EFFECT ON LARVAL COMMUNITIES

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Aquatic insects have complex life histories that involve interactions with both the terrestrial and aquatic environment, and the transition from one life stage to another often involves movement between the two. Complex life cycles combined with cross-ecosystem interactions make understanding population dynamics and predicting potential bottlenecks of aquatic insects difficult. While the influence of instream habitat and water quality on larval populations of aquatic insects are well studied, the influence of microhabitats used for selective oviposition by adults could be just as crucial to population persistence but is often overlooked in empirical studies. Studies have documented the link between oviposition habitat and distribution of larval populations for several aquatic insect genera, but other taxa might also depend on specific oviposition habitat for recruitment and survival. In addition to expanding our knowledge of oviposition behavior to include new taxa, this ongoing project studies how the availability and distribution of instream oviposition microhabitat influences density and distribution of insect larvae resulting from varying oviposition behavior by adults. By completing these objectives, we hope to underline the importance of including oviposition habitat for selective ovipositing taxa in future stream restoration projects to promote recolonization of benthic invertebrate communities in streams impacted by human activity.

aquatic insects , oviposition behavior , instream microhabitat , population dynamics

COMPETITIVE INTERACTIONS BETWEEN CREEK CHUB (*SEMOTILUS ATROMACULATUS*) AND BROOK TROUT *(SALVELINUS FONTINALIS*) UNDER THE INFLUENCE OF RISING TEMPERATURES

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The natural distribution of many freshwater fish species is limited by their thermal tolerances, both because a species cannot inhabit an area outside its tolerance range and because of increased stress when in environments approaching the limits of its tolerance range. Many species may mediate temperature change physiologically, behaviorally, or both but these changes often may alter or compromise interspecific dynamics through effects on feeding behavior, growth rate, immune responses, and social behavior. In central Pennsylvania, the Creek Chub (*Semotilus atromaculatus*) is found in both warm water streams and cold water streams, the latter of which is also home to Brook Trout (*Salvelinus fontinalis*). Brook Trout have a lower tolerance for warmer temperatures than Creek Chubs, and require higher oxygen concentrations which decreases in warmer waters. As the temperatures of waterways continue to increase due to anthropogenic climate change and land use, Brook Trout are hypothesized to be under more thermal stress which may negatively affect their ability to compete with Creek Chubs. To examine the influences that temperature has on competitive interactions between these species, we are observing feeding behavior, aggression, and space use differences at three different temperatures (16, 18, and 20o C) among dyad pairs for all combinations of species (Brook Trout/Brook Trout, Brook Trout/Creek Chub, Creek Chub/Creek Chub). We are using a within-between subjects experimental design with three species combination dyads being tested at three temperatures. In this experiment, we predict that with increasing temperatures, Creek Chubs will gain competitive advantages over Brook Trout. We predict that Creek Chubs will show lower feeding latencies and eat more than Brook Trout at higher temperatures. We also predict that Creek Chubs will interfere with Brook Trout feeding more at higher temperatures through increased aggression, intimidation, and spatial displacement of Brook Trout. Based on pilot data, we also expect an increase in exploitative competition, with Creek Chubs eating more food and having a higher feeding rate with increasing temperatures.

Brook Trout , Creek Chub , Competition , Climate change

MAKING THE READYSETFIT APP KAYAK-FRIENDLY

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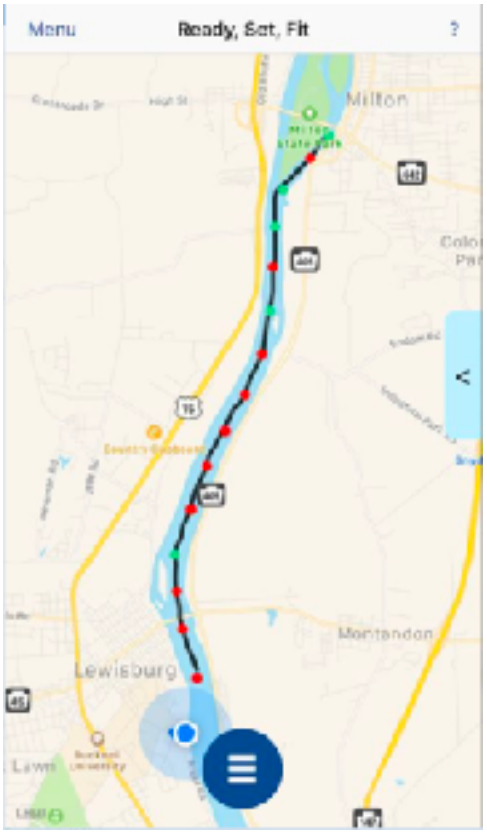
In response to the widely reported increase in obesity and related health problems in the US, a team of faculty, staff and students at Bucknell University have authored a mobile app that incentivizes exercise through the use of crowdsourced public-facing humanities content of local interest. ReadySetFit, available on both the IOS and Android phones, is a completely student-coded app that leverages a Google Maps platform and the Google My Maps application. The user can select from a set of walking paths that have been created using Google My Maps, which contain points of interest that present cultural/historical information to the user as he or she approaches the physical location of each point.

The app already hosts two dozen paths which range from paths on Bucknell's campus to historical paths in surrounding river towns to paths in historic Philadelphia. Over the past two years, the RSF app has focused on the walking-themed paths; however, the app features necessitate further development to be accessible not only to walking trails but also for other wellness activities, like kayaking and cycling. Therefore, this research project was designed to extend the app to make it accessible for water activities with the ultimate goal of guiding people to explore the historical and environmental beauty of the Susquehanna River, especially the West Branch, through kayaking. The outcome of the project led to adjustments of the existing geofence system, incorporations of river safety practices, and development of new kayaking paths.



The app aims to draw people of every fitness level interested in kayaking to visit the area and other to-be-developed areas, to immerse themselves in nature. The main objective of the app besides promoting a healthy lifestyle, is to better strengthen the connection between people and the surrounding environment. Through the app, users will receive environmental information about the area, which in turn brings various benefits to the environment. As the new paddling functionality aims to raise awareness and educate people to overcome ignorance regarding environmental issues, we anticipate that the users will be able to generate possible actions to positively address the environmental concerns at a local level.

kayak , river , recreation , health

MOBILE APP AND REWARDS PROGRAM IN LOCAL ECONOMIC REVITALIZATION

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Businesses use rewards programs to drive customer loyalty. However, rewards programs can be used to build partnerships and impacts beyond just one business. The Ready, Set, Fit (RSF) app is a free health and wellness app that connects physical fitness to place-based learning through themed walking paths. The app allows users to accumulate virtual miles through walking on designated themed local trails, including trails along the Susquehanna River. Such rewards programs can be developed through the RSF app, giving the app the potential to be used to further economic revitalization efforts in local communities while supporting public health and providing incentive for outdoor walking. Through online surveys to better understand public perceptions of and receptivity to such a rewards program using RSF in two Susquehanna River watershed towns, this research demonstrates that there is public interest in walking rewards programs that incorporate more paths in natural areas throughout the watershed. Additionally, a spatial analysis was conducted to identify potential RSF path expansion sites in nearby state parks.

Community Development , Economic Development , Sustainability , Loyalty Program

METADATA AND INFORMATION MANAGEMENT FOR DOWNSTREAM DISCOVERY AND USE: A CASE STUDY WITH THE SUSQUEHANNA RIVER SYMPOSIUM METADATA

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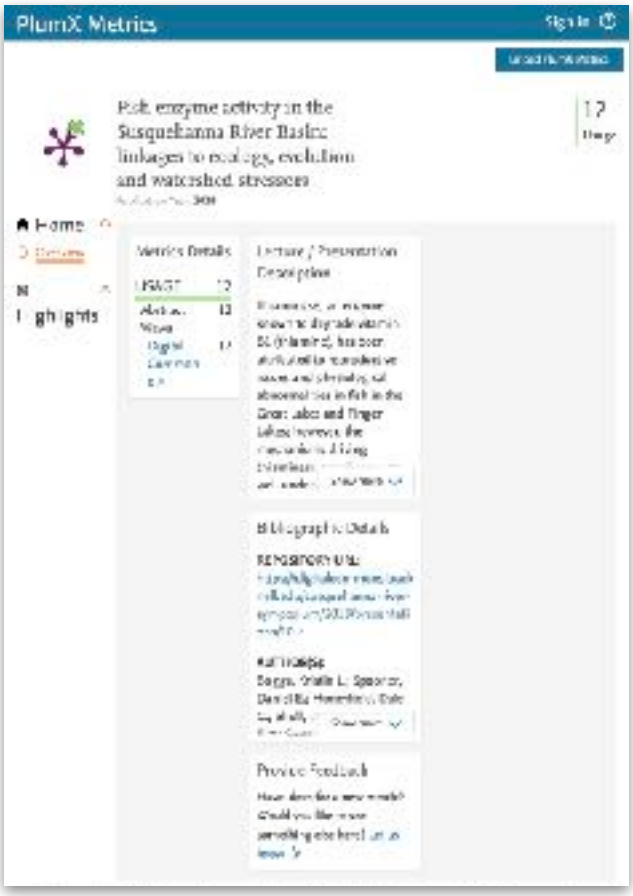
What is metadata? What is information management? How do these topics fit in with sustainable practices? This poster will define key terms and demonstrate how metadata is used to support discovery and reuse of a range of disciplinary information, from research data to conference proceedings. We will identify the policies, principles and procedures that guide best practices for information resource management, and outline the standards and technology that support use and reuse. Ultimately, we will show how clean, structured metadata can facilitate the entry of information into the broader river of disciplinary knowledge for wider dissemination, greater impact, and long-term use.

information resource management , sustainable practices , metadata



DECOMPOSITION, MICROBIAL PRIMING, AND MACROINVERTEBRATE CONSUMPTION RATES OF MAPLE AND OAK LEAVES IN AGRICULTURAL AND FORESTED STREAM MICROCOSMS

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As a secondary producer, macroinvertebrates are an essential part of any healthy stream ecosystem and vital in restoration projects as a food resource for secondary consumers like fish. Macroinvertebrates are also used as indicator taxa for stream health because they can only survive in specific conditions. We will compare the diet preference and assimilation efficiencies of macroinvertebrates between agricultural streams and forested streams to see if macroinvertebrates benefit more from slow decomposing leaves (Quercus) or fast decomposing leaves (Acer) at different densities. We will conduct a six-week lab study at the Susquehanna University Freshwater Research Institute using a 30L bench top multi-chambered experimental tank system (Pentair Aquatic Systems). Water will be obtained from a forested stream to prime the leaves. Each tank will have one of the five increasing densities of slow decomposing leaves and one of the five densities of fast decomposing leaves in it, along with two shredder species of macroinvertebrates (*Tipulidae* or *Limnophilidae*). We will compare the wet weights of each macroinvertebrate species throughout the study as well as the dry weights of each leaf to compare the amount consumed by each macroinvertebrate. We will then repeat the study during a second six-week trial in which the experimental system and leaves will be primed with water from an agricultural stream to see the effect it has on the macroinvertebrates diet compared to the forested stream. The significance of this research will aid in restoration efforts by providing us with what type of leaf and how many leaves is most beneficial to these macroinvertebrates and therefore stream ecosystems. This experiment is crucial to stream restoration projects because it looks at what is most beneficial to the secondary production of stream ecosystems in different situations such as forested or agricultural land use.

Decomposition , Macroinvertebrates

USE OF DIRECT OBSERVATION TO CHARACTERIZE THE NATURAL OUTDOOR RECREATIONAL ENVIRONMENT IN PENNSYLVANIA COMMUNITIES

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Living in areas with green and blue space (natural outdoor environments [NOEs]) is thought to benefit health. To rigorously measure such benefits requires direct observation of environmental conditions, as NOE quality influences their use. The Natural Environment Scoring Tool (NEST) assesses attributes influencing use of NOEs that support a variety of functions (e.g. exercise, relaxation). In a study of NOEs and health among residents of 40 boroughs in Central Pennsylvania, we evaluated NEST's feasibility to characterize boroughs' natural outdoor recreational environment and differences in borough NEST scores by community blue space access, greenness (based on the Normalized Difference Vegetation Index), and community socioeconomic deprivation (CSD). To select study communities, we stratified boroughs by proximity to the Susquehanna River. We identified NOEs within boroughs using databases of publicly-accessible recreation areas and Google maps, prioritizing locations along waterbodies, centrally-located parks, and state parks for observation. A trained observer conducted observations using NEST, evaluating 52 items across 7 domains and categorizing NOEs into typologies based on their intended use. We calculated domain scores and overall scores (weighted by typology) for each NOE and borough. On average, 3 NOEs were audited per borough (total = 114). Mean time to complete NEST was 13 minutes per NOE. Half of NOEs were town parks; 24% were blue space access areas. Overall NEST scores ranged from 30 to 86; open public spaces (e.g., town squares) and blue space access areas had the highest mean scores (59.5 and 57.5, respectively), formal recreation areas (e.g., sports fields) the lowest (47.8). Overall NEST scores were higher in boroughs adjacent to the Susquehanna River (mean score [standard deviation]) (56.2 [5.8]) versus non-adjacent boroughs (48.7 [9.2]). These findings were consistent with other measures of blue space access. Overall NEST scores were lower in boroughs with low (55.9 [7.3]) versus high (49.1 [8.3]) greenness. We found no difference in overall NEST scores by CSD. NEST provided a feasible approach for characterizing the quality of communities' natural outdoor recreational environment, which appeared highest in areas with greatest access to blue space, regardless of greenness or CSD.

natural outdoor environment , direct observation , river towns

CARBON STORAGE AND SEQUESTRATION ON BUCKNELL PROPERTIES: VALUING CAMPUS NATURAL CAPITOL

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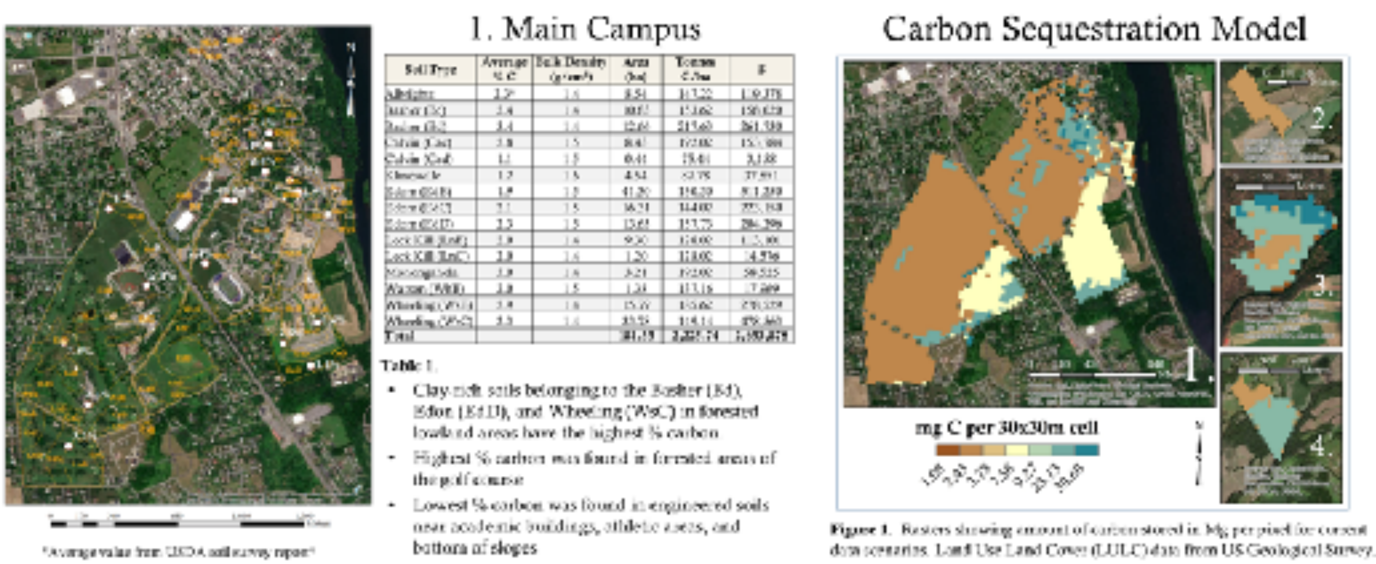
Carbon sequestration is the long-term storage of carbon in oceans, soils, vegetation, and geologic formations. On land, carbon values are linked to soil organic matter (SOM), which improves soil quality through increased retention of water and nutrients, resulting in greater productivity of plants in natural environments. This research tested several methods for measured carbon storage in soils and estimated sequestration rates on different land use land covers (LULC).

A total of 48 soil samples on 18 different LULC locations were collected on all Bucknell University properties, including main campus, Cowan Retreat Center, Mulberger farm, and Chillisquaque Natural Area. Locations within each LULC class were randomly selected using geographic information systems (GIS), then located in the field using a GPS. Composite soil samples for the upper 45cm were collected using a soil probe, taking care not to bias samples by including leaf litter and roots. Dry combustion and elemental analysis for each sample was performed using a carbon-hydrogen-nitrogen (CHN) analyzer. Results were mapped in GIS and overlain with soil and LULC coverages. Measured %C compared favorably with values published by USDA for each soil type. The lowest %C values were found in areas with weaker soil structures and SOM. These areas are typically highly susceptible to erosion and impaired water quality of both groundwater and surface waters.

This research provides a baseline for anticipated future studies of carbon sequestration and storage and serves as a guideline for informing carbon-offset trading currently done by the university. All properties were estimated to sequester a minimum of 21,729.51 mg C, with an economic value for stored carbon estimated to be over $6,170,000 (calculated using the GIS-based inVEST model). Carbon sequestration for forested regions is typically 3.5% of the carbon stored in soils. This suggest that the sequestration value for these properties are as high as $115,500 annually. This low value suggest that actual sequestration rates should be measured in the field to both calibrate the model and refine the biophysical sequestration table used in the INVEST model. More samples should be considered, especially where high variability is found over short distances. Future research may study the impacts of Bucknell’s specific land use and land management on soil carbon sequestration and ways to increase the storage time of carbon in the soil.

carbon sequestration , carbon storage , ecosystem services , susquehanna watershed



HOW DO COLD CLIMATE CONDITIONS AFFECT HYDROLOGIC PROCESSES?

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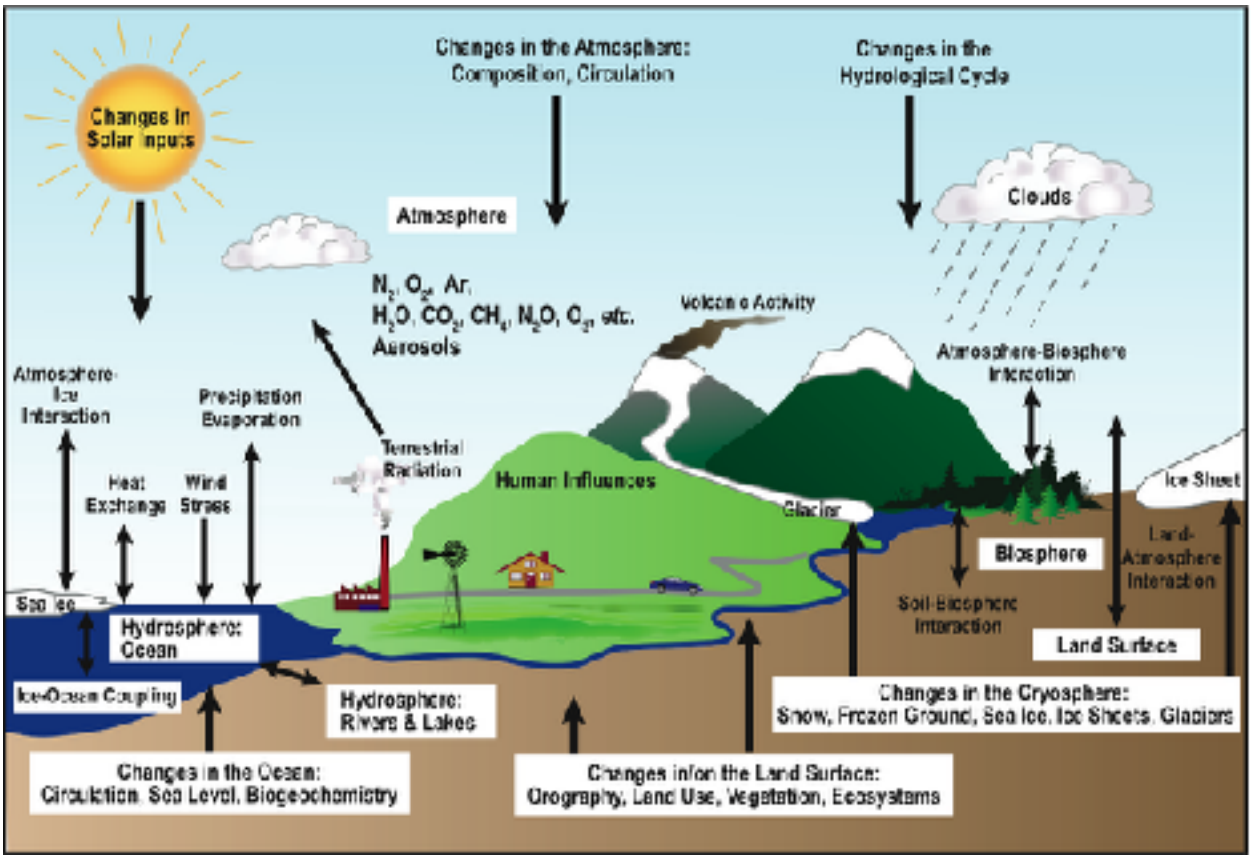
Cold climate regions are described by lingering winters, in which a thick snowpack layer covers the land surface, leading to a frozen-ground condition and recurring spring floods. Hydrologic models that do not account for cold climate characteristics cannot capture the recurring spring floods. The objective of this study is to evaluate the impacts of frozen-ground and snowmelt variations on hydrologic processes. The Macro-scale Hydrologic Processes Simulator (Macro-HyProS) was used to simulate different hydrologic processes for the Red River and Missouri River basins. Macro-HyProS is a daily grid-based hydrologic model that is developed to account for hydrologic complexities associated with cold climate regions. Results from this study indicated that concurring frozen ground condition and early-spring snowmelt events changed the magnitude and distribution of surface runoff and infiltration in the Red River basin. Moreover, simulation results in the Missouri River basin showed the significance of snowmelt variations under dry- and wet-year conditions.

Macro-scale Hydrology , Hydrologic Modeling , Frozen-ground , Snowmelt



Schematic view of the components of the climate system, their processes and interactions.
[Figure from the International Panel on Climate Change (IPCC); used with permission]

HOW ISLANDS IN THE MAIN STEM OF SUSQUEHANNA RIVER CAN BE TRACED BACK TO THE NORTH OR THE WEST BRANCHES OF SUSQUEHANNA RIVER

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Fluvial islands are important due to their hydrological and ecological characteristics. They can reveal a story about their geological history, about the islands' formations, and about the disturbance events they experienced up to the point of being studied. These islands can also be used to interpret some dynamic aspects of the current conditions of the Susquehanna River. In this study, two islands located 10.3 km south of the confluence of the north and west branches of the Susquehanna River, accessible from the Isle of Que, were selected to collect four indices. These indices included: 1) erosional state, 2) vegetation recruitment, 3) sediment distribution, and 4) use of the macroinvertebrate *Corbicula fluminea* as a bio-indicator species.

Six cores were extracted with a soil auger, divided into 20 cm segments each and processed through a sieve analysis and a hydrometer to study the particle size distribution. *Corbicula* were examined within each core and timeline of their distribution along the Susquehanna River was studied from literature. The presence of *Corbicula* may indicate that the quality of the river is adequate for the survival of aquatic species since they filter the water; yet, their invasive presence caused concern about the state of the river. Based on the sieve tests, preliminary data showed that there were several disturbance events noticeable in both islands. An unexpected large amount of coal was found in island 2 on the east part of the river, with the absence of *Corbicula* especially at the lower sections of the 3 cores. The 3 cores from island 1 on the west side of the river contain no coal. This led to the conclusion that the coal can represents one of the signatures (anthropogenic) of islands on the east part of the river made of material transported uniquely by the water of the north branch.

Fluvial Islands , Susquehanna River , Corbicula Fluminea , Sieve analysis

TEN YEAR PARTNERSHIP OF CWI WITH PA UNASSESSED WATERS PROGRAM

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This is the 10th year that Lycoming College Clean Water Institute (CWI) has partnered with PA Fish and Boat Commission in the Unassessed Waters Project. To date, the CWI team has completed a total of 547 assessments in over 20 watersheds in North Central PA (6 counties). At the end of 2018 the partners completed 4,687 of a total of 7,274 stream assessments. CWI completed 11.7% of the partner surveys. Data for this project has been logged into the PFBC Unassessed Waters data set for consideration in trout stream classification and protection. Over the years 43 % of the streams sampled contained reproductive trout populations with 12% considered class A or B trout streams. My analysis will focus on 22 stream surveys, out of 40 completed by CWI that I assisted in this year. Nine of the streams contained reproductive brown trout populations (class D), three streams were dry, three contained no fish populations and seven contained a diverse fish assemblage but no trout. A breakdown of the benefit and limitations of this program will be presented.

Unassessed waters , electrofishing , trout stream assessments

HERBICIDE EFFECTS ON THE FEEDING BEHAVIOR OF THE WOLF SPIDER *PARDOSA MILVINA*

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Herbicides can potentially impact feeding behavior of beneficial predators in agricultural systems and subsequently compromise integrated pest management efficacy. We measured variation in feeding behaviors of an agriculturally abundant wolf spider, *Pardosa milvina*, when exposed to soil with field-relevant concentrations of five commonly used herbicides. Tested herbicides included atrazine, S-metolachlor, rimsulfuron, mesotrione, glyphosate, a mixture of all five herbicides, and a distilled water control. Spiders were housed individually in containers with topsoil previously sprayed with a recommended herbicide dosage or water control. Tested spiders were collected from two adjacent fields: one kept under continuous crop rotation for over twenty years and sprayed with various combinations of all of these herbicides while the other was an alfalfa field with no pesticides applied for the last 12 years. Adult males and females from each plot were exposed to the seven treated soil substrates (N=1,214). Spiders were maintained on these treated substrates for 14 days and fed crickets *(Gryllodes sigillatus*). Their predatory behaviors toward an individual cricket were observed on untreated substrates. Individual spiders from each herbicide treatment were standardized for hunger then presented a cricket one week and two weeks after initial treatment exposure. We found no significant differences in lunge and prey capture latency for spiders across herbicide treatments during the first week of exposure, but large differences emerged by the second week. We also found large sex and collecting site differences in prey capture efficiency and weight change across treatments. Mesotrione and rimsulfuron-treated spiders showed the greatest weight loss between the first and second week of exposure while atrazine, glyphosate and s-metalachlor treated spiders gained more weight than the control group. Our results show that some herbicides can significantly reduce or increase feeding responses in this important agriculturally abundant predator.

herbicide , wolf spider , feeding interference , predation

LETHAL EFFECTS OF COMMON HERBICIDES ON AN AGRICULTURALLY IMPORTANT WOLF SPIDER *(PARDOSA MILVINA)*

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Herbicide use in crop systems has increased dramatically over the last fifty years yet the effects of chronic exposure to these chemicals on beneficial non-target arthropods have been poorly tested. We tested the lethal effects of field-relevant dosages of five commonly used herbicides on the economically important wolf spider, *Pardosa milvina*. Tested herbicides included atrazine, S-metolachlor, rimsulfuron, mesotrione, glyphosate, a mixture of all five herbicides, and a distilled water control. Spiders were housed individually in containers with topsoil previously sprayed with a recommended herbicide dosage or a water control. Tested spiders were collected from two nearby fields; one field was kept under continuous crop rotation for over twenty years and sprayed with various combinations of these herbicides while the other site had no pesticide application for the last 12 years but was maintained under alfalfa cultivation. Adult male and female spiders from each plot were exposed to the seven herbicide treatments (N=1,214). Spiders were maintained on these soil substrates for 52 days, fed weekly and checked for mortality daily. We found significant herbicide treatment effects with mesotrione being particularly lethal to wolf spiders while atrazine and S-metolachlor had modest, but significantly higher survival than the control group. We also found significant differences and treatment interactions by sex and collecting site. In general, male spiders showed significantly shorter survival and spiders from the pesticide-free site had longer survival than spiders collected from a field maintained under constant crop rotation. The mesotrione-treated spiders had significantly poorer survival than even the combined herbicide treatment suggesting a complex antagonistic interaction of some of these herbicides on wolf spider survival. Given that Pardosa is the second largest genus of spider, are found on six continents, and occur at high densities in most agricultural systems, use of mesotrione may be particularly counterproductive in systems that rely on integrated pest management and biocontrol using generalist arthropod predators

herbicide , mortality , wolf spider

EVALUATION OF BEST MANAGEMENT PRACTICES FOR STREAM RESTORATION PROJECTS

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Best Management Practices (BMPs) are often used to describe acceptable practices that could be implemented to protect water quality and promote soil conservation at any particular location. Toe logs, cross vanes, and riparian plantings are just a few of the many possible BMPs used in stream restoration projects to anchor bank sediments, control the direction of water flow, re-establish riffles and pools, and improve the overall aquatic habitat. Thirty-two sites were selected for evaluation of the physical characteristics of stream sediments, as well as fish and macroinvertebrate populations. These sites include forested streams used as a reference, impaired agricultural sites with no restoration, and those impaired sites with various implemented BMPs. A comprehensive analysis will be used to evaluate each BMP and infer which are best related to positive responses in sediment characteristics and fish and macroinvertebrate populations. The goal of this research is to create a functional ranking of BMPs or BMP categories in order to guide restoration managers toward the most effective techniques for the site-specific conditions.

NUTRIENT COMPOSITION AND SEDIMENT SIZE IN STREAM SEDIMENTS

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Precision conservation is using geospatial analysis of high-resolution datasets to determine the location where restoration will be the most effective based on elements like stream location, watershed size, and neighboring land use. For four years, Susquehanna University has worked with the Chesapeake Conservancy to study the effects of stream restoration throughout nine different watersheds in Union and Snyder counties. Sites were chosen using ArcGIS to determine priority locations in which to implement restoration practices and through landowner cooperation. Sites are tested before, during, and after restoration has been implemented to determine the effects of restoration and best management practices on factors such as species diversity, fish populations, water quality, mean grain size of sediments, and nutrient concentrations in stream sediment. At each site, a one hundred-meter reach is electroshocked for fish, and five sediment samples are taken from a pool, riffle, eddy, a run from pool to a riffle, and a run from a riffle to a pool. The sediment samples were analyzed for grain size and nutrient concentrations, including ammonia, nitrate, and phosphate. Stream restoration should help improve stream quality by reducing erosion and the amount of fine sediments entering the stream. Grain size is expected to increase, therefore, reducing nutrient concentrations that could be a source of pollution. Strong correlations were seen between mean grain size versus nitrate and ammonia concentrations, but the phosphate data is less conclusive. By studying nutrient concentrations and their correlation to mean grain size, we hope to demonstrate that best management practices can improve both fish and macro invertebrate habitat and reduce the potential nutrient storage in the stream channel.

Stream Restoration , Sediment , Nutrients , Grain Size

VARIABILITY OF WATER TEMPERATURE IN WEST BRANCH SUSQUEHANNA RIVER AND WHITE DEER CREEK, PENNSYLVANIA

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Despite its size and importance of the Susquehanna watershed, little is known about how water temperatures vary longitudinally and temporally within the river and its tributaries and how hydrologic and atmospheric processes affect these variations. Before this study, no temperature data had been collected on White Deer Creek, a forested watershed tributary to the West Branch of the Susquehanna River in Union County, Pennsylvania. This study also presents the first numerical model calibrated to temperature data for the West Branch of the Susquehanna River. Knowledge on temperature variability across the watershed is essential for forecasting the impacts of climate change on the health and reliency of aquatic ecosystems and availability of freshwater resources.

To assess longitudinal variations in White Deer Creek, a network of river bed temperature sensors were built and deployed at seven locations from the headwaters down to its confluence with the Susquehanna. On average, in the month of June, stream temperatures increased downstream by 1.2°C km^{-1} for the West Branch of the Susquehanna River and only 0.1°C km^{-1} for White Deer Creek. The much smaller increase in downstream temperatures along White Deer Creek reveals the importance of shading by the forest canopy and groundwater inputs along its length.

A one-dimensional numerical model (SSTEMP) was developed for the West Branch of the Susquehanna from Muncy to Lewisburg. Historical data was used to determine the input factors, including discharge, air temperature, relative humidity, wind speed, solar radiation, and water temperature. Discharge has the greatest impact on stream temperatures. In order to control for the impact of discharge, two models were created: one for a day with a low flow and one for a day with a high flow. Tributary inputs and groundwater upwellings cool the stream, which counteracts the warming of the stream from solar radiation and atmospheric processes. Turbulence causes both stream and river temperatures to be relatively uniform with depth.

In general, water temperatures are a subdued replica of air temperatures, with atmospheric and solar radiation effects having the greatest impact on diurnal variations in water temperatures in the stream. Peak diurnal water temperatures usually lag peak solar radiation by several hours every day. Water temperature peaks during the evening and is at its lowest during morning hours, with changes in water temperature at any location on White Deer Creek as much as 4.9°C over the course of a day.

TEN YEARS OF MONITORING THE SUSQUEHANNA RIVER NEAR THE SHADY NOOK, HUMMEL'S WHARF, PA

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The upper main stem of the Susquehanna River is formed by the confluence of the North Branch, primarily impacted by abandoned mine drainage, and the West Branch, primarily impacted by agriculture, at Sunbury, PA. The plumes of the branches remain chemically and physically distinct through the upper main stem and allow a transect below the confluence to be analyzed to integrate conditions of both branches. For the past decade (2009-2018) field measurements (using a YSI 556 multimeter) and laboratory analyses (using an ICS Dionex-2100) have documented chemical and physical parameters through the summer and fall seasons when not impacted by major flood events. Biological samples (benthic macroinvertebrates and diatom periphyton) were taken during the same periods at established sites across the river near the USGS Sunbury gage, facilitating insight on the dynamic nature of the river and the influence of discharge on the chemistry and biology of the river. Preliminary results show that discharge plays a major role in the characterization of the river. Correlations were found between agricultural activities and discharge, revealing how the river is impacted by agricultural land use, especially from the north branch. Nutrient concentration found in Susquehanna River during the month of Jun and July suggests contamination of groundwater by agricultural activities.

Susquehanna River , Nutrients , groundwater, water quality

GIS-BASED PRIORITIZATION SYSTEM FOR MS4 COMPLIANCE PROJECTS

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The Clean Water Act regulates point source discharges of pollutants into streams and rivers, which includes point source discharges. Thus, local governments and other entities that manage municipal stormwater systems must meet certain requirements for mitigating stormwater through the MS4 program. This research aims to determine a framework for prioritizing best management practices (BMPs) and locations in urbanizing areas to fulfill the MS4 requirements. This work is part of a broader initiative to build a college-community partnership and improve local water quality. A list of criteria for BMP selection and placement was generated and GIS data consistent with the criteria were created to generate a spatial model identifying ideal BMP types and locations. The criteria chosen included the areas outside of combined sewer systems, land parcel size, public ownership of land, locations of buildings and infrastructure, and within MS4 urban areas. We discovered that ideal locations for BMPs are limited in river-towns such as Williamsport, PA, and that prioritization systems may be useful among MS4 regulated regions.

Stormwater , MS4 , GIS , Urbanization

ANALYSIS OF TEMPORAL CHANGES IN THE PHYSIO-CHEMICAL ATTRIBUTES OF ROSE VALLEY LAKE (PENNSYLVANIA)

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Water resources are potentially at risk due to global climate change. Surface water habitats, such as Rose Valley Lake, are important for recreation, maintaining water quality, and providing habitat for fish and wildlife. As a man-made reservoir, human interactions directly through recreational activities and indirectly through catchment change are likely to alter biotic and abiotic conditions. We compared historical and contemporary measures of water quality to local climate, catchment land use/cover, and lake morphometrics. Rose Valley Lake is a 369-acre reservoir located in Lycoming County, PA and managed for recreational fishing and boating. Water quality was assessed at two separate sites on the lake in 2007, 2017, and 2019. All parameters were collected from the epilimnion of the lake, and included nutrients, turbidity, temperature, and Secchi disk depth. Chemistry samples were processed in CWI's lab. The USGS' StreamStats program and ArcMap were used to determine catchment size, land use/cover, and lake morphometrics. Temporal changes of lake attributes were compared to landscape predictor variables. We found that temporal changes and relationships to landscape features varied among lake attributes.

climate change , water chemistry , temporal change , land use/cover

ASSESSMENT OF STREAM QUALITY AND HEALTH AT BARNER GAP

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Clean water is especially important for biological diversity, productive streams and healthy fisheries. This study conducted during a Pennsylvania Department of Environmental Protection (PA-DEP) and Lock Haven University (LHU) Internship in April 2019, surveyed Barner Run, a second-order freestone tributary to Pine Creek in Bald Eagle State Forest, in the Penns Creek Watershed. This stream had not been previously surveyed by PA-DEP and could potentially represent a high-quality cold-water fishery (HQ-CWF) or exceptional value (EV) waterway that may qualify for special protection status under Commonwealth of Pennsylvania, Environmental Protection, Chapter 93 Water Quality Standards. The survey followed PA-DEP Instream Comprehensive Evaluation (ICE) protocols that included macroinvertebrate samples, habitat assessments, and water chemistry. Benthic macroinvertebrates were collected via D-frame kick nets and samples were subsampled and taxonomically identified in the PA-DEP Laboratory. Macroinvertebrate data was analyzed for Total and EPT Taxa Richness, Beck's Index, Hilsenhoff Biotic Index, Shannon Diversity, Percent Sensitive Individuals and Index of Biotic Integrity (IBI). Habitat was surveyed by assessing twelve parameters, including land uses such as percent forest, surrounding roads, camps, and other factors, as well as stream flow, erosion, and sediment within the stream. Water quality was evaluated by measuring pH, dissolved oxygen, temperature, specific conductance and alkalinity. Barner Run scores indicated excellent water quality in terms of water chemistry, habitat, and macroinvertebrate species diversity and abundance. The calculated IBI score of 79.9 points for Barner Run exceeded the 75.3 score for an adjacent exceptional value (EV) tributary of Pine Creek. This survey determined that Barner Run meets High-Quality Cold-Water Fishery criteria and should be considered as a candidate for Exceptional Value status in PA-DEP Chapter 93 Water Quality Standards.

Macroinvertabrate , Stream Quality , Species Diversity

EFFECT OF CLIMATE ON ADULT STONEFLY AND CADDISFLY ACTIVITY AND ABUNDANCE

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Climate change is expected to alter the timing of life cycle processes of aquatic organisms. Stream insects have a complex life cycle, and the duration of and transition among life stages is dependent on weather and climate. Thus, local weather should be related to adult insect activity and abundance. We examined the relationship of daily weather patterns with the abundance of adult Plecoptera and Trichoptera. Malaise and canopy traps were deployed at four streams in the Mosquito Creek Watershed (Lycoming County, PA) during a 14-day period in July. Traps were collected daily, and all Plecoptera and Trichoptera were identified to order. Water temperature, air temperature, and wind speed and direction sensors were deployed at each sample site, and a single rain gauge was deployed at the most central site. Abundances of adult insects were not related to terrestrial weather variables, but the abundances of Trichoptera and Plecoptera at ground level were related to water temperature. This indicated that terrestrial weather may not affect adult activity, and patterns of emergence may control adult abundance. Additionally, this result may contradict previous work suggesting that adult insects disperse through stream corridors.

stream insects , climate change , phenology , insect abundance

EXPLORING THE EFFECTS OF PESTICIDES ON TADPOLES

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The use of pharmaceuticals and personal care products (ppcp's) is nearly inescapable. Inevitably, these ppcp's become contaminants in both natural and man-made water systems and may cause adverse and unintentional effects in organisms utilizing these water sources. The usage of repellent ppcp's containing pesticides Permethrin and DEET have increased in recent times and in correlation with increased disease risks from both mosquito and tick-borne illnesses. Both chemicals are typically applied in the outdoor setting, and are not removed by waste-water treatment plants thus, they can directly or indirectly enter surface waters and groundwater. Permethrin and DEET have been shown to slow growth and can have lethal effects on aquatic organisms in larval and young age classes. To assess Permethrin and DEET's potential lethal and sublethal effects on aquatic organisms we exposed young tadpoles to environmentally relevant concentrations of these compounds in the laboratory setting. Laboratory frog eggs were hatched and the resulting tadpoles were separated into 4 trial groups per chemical and observed for behavioral and physical changes. We found that even at doses that are lower than what are found in surface waters, the chemicals affect the nervous system. In addition to mortality, we recorded sublethal effects including, paralysis, tremors, and altered stimuli response patterns. Lethality was only observed in the Permethrin trials at the experimental doses. Tadpoles are often used as one of several indicator species to detect potential dangers posed to human internal organ health. With the increase of contaminants in surface waters there may be unintended consequences that directly affect human health.

Pesticides , Toxicology , Amphibians , Neurotoxicity

CATCHMENT HYDROLOGY AND HABITAT ASSESSMENT OF LITTLE ARNOT CREEK WATERSHED, ALLEGHENY NATIONAL FOREST, PENNSYLVANIA

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In preparation for stream and floodplain resotration efforts to take place in the summer of 2020, this study characterized the hydrology, geomorphology, and conducted a thorough river survey following official federal protocol for Little Arnot Creek, a tributary of the Allegheny river. Previous river restorations have been primarily focused with stream bank stabilization; however, we plan to focus on adding large woody material to the river as a means of increasing aquatic and wetland habitat, and available food through trapping materials and raising the water table for the river basin. Hydroclimatic data collected this past year suggests that a lowered water table has caused groundwater to lose its moderating effect on much of Little Arnot's water temperature, despite the site having a well intact overstory providing adequate shade to the river. Furthermore, we believe a lack of stream complexity has decreased the trapment of adequate spawning gravels and deep pools necessary for the stream to maintain substantial populations of aquatic species.

This past summer, 2019, we conducted a river survey following rules and procedures of the National Forest Service's level II stream inventory protocol. This thorough effort has resulted in the most up to date and detailed characterization of both aquatic habitat and channel geomorphology for the stream. A study of this detail has never been done on an Allegheny tributary, despite historic interest from the Pennsylvania Fish and Boat Commission, and use of the region by timber, oil, and gas industries. Using the results of this survey, we found statistical data associating a lack of large wood in the stream with a lack of adequate aquatic pool habitats within Little Arnot Creek. Recent scientific studies have agreed that pool habitats are essential habitat for aquatic organisms, and essential for maintaining a more natural water table for a river basin. We hope that adding wood to the stream will increase these pool habitats, as well as trap finer gravels and food items to raise carrying capacity for the stream.

hydrology , habitat assessment , geomorphology

INFLUENCE OF CLADOPHORA SP. ON THE COMPOSITION AND SPATIAL DISTRIBUTION OF MACROINVERTEBRATE COMMUNITIES IN STREAMS: A LOOK INTO METHODS AND PRELIMINARY OBSERVATIONS.

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Much of the land within the Susquehanna River watershed is used for agriculture, which can add nutrients like nitrates and phosphates into streams during high rainfall events. The addition of these nutrients has the potential to cause large algal blooms. The genus of green alga, Cladophora, has been associated with larger blooms that can cover much of the cobble-sized substrate within streambeds. Cladophora is a relatively tough alga for many species of aquatic macroinvertebrates to eat. The purpose of our research is to better understand how the communities of macroinvertebrates can differ between areas in streams where Cladophora is present and where Cladophora is absent within the Susquehanna River watershed. To examine this, we visited 13 middle-order streams in Columbia, Montour, Northumberland, and Snyder counties. The streams covered a gradient of algal growth, with some streams having larger amounts of Cladophora, and some with less. Macroinvertebrates were collected using a Surber sampler by taking five composites and combining them to make one sample to preserve. The samples were preserved in 95% ethanol in the field and transported to Bloomsburg University to be identified. In streams where Cladophora was present, two 5-composite samples of macroinvertebrates were collected from different patch types within the same stream, one where Cladophora was present, and one where Cladophora was absent. In streams where Cladophora was not present, a single five-composite macroinvertebrate sample was collected. The communities will be compared both within different patches in the same streams, and between different streams using a non-metric multidimensional scaling (NMDS) ordination. This poster will display methods as well as preliminary observations made by researchers.

Macroinvertebrates , Cladophora , Community Composition

MORPHOLOGICAL DIFFERENCES BETWEEN A NATIVE, AN ESTABLISHED INVASIVE, AND A RECENTLY INVADING CRAYFISH IN EASTERN PENNSYLVANIA

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A common threat to native crayfish is ecological displacement by non-native crayfish. Some data suggest the native crayfish *Cambarus bartonii bartonii* (Common Crayfish) may be displaced to some extent by invasive crayfish species within the Susquehanna River watershed. We examined allometic measures of *C. b. bartonii*, the non-native, but long-established *Faxonius obscurus* (Allegheny Crayfish), and the more recently invading *Faxonius rusticus* (Rusty Crayfish) to determine whether morphology could explain potential for competitive replacement. Total length, arm length, chelae and rostrum length and width, telson width, and weight showed did not show significant differences ($p>0.05$). Dactyl lengths and weights of the three species differed significantly. Rostrum lengths differed between the two species of *Faxonious* and the species of *Cambarus*. The similarities in the lengths of the dactyls may suggest a likelihood of direct competition where these species co-occur. However, the small amount of morphological variation is not sufficient to explain competitive replacement in this river system.

morphometry , crayfish , ecology , invasive species

UPDATED CONSERVATION STATUS OF STATE-THREATENED PENNSYLVANIAN GRASS, *CHASMANTHIUM LATIFOLIUM*

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In Pennsylvania, *Chasmanthium latifolium* (Poaceae) is comprised of two metapopulations that exhibit an east-west disjunction within the state. Located in close proximity to rivers and streams, *C. latifolium* is fittingly referred to as river oats. Native to the southern midwest and the eastern half of the United States, C. latifolium reaches the northeastern edge of its range in Pennsylvania. Due to limited and isolated distribution, as well as declining populations, *C. latifolium* is considered a critically impaired plant by the Pennsylvania Natural Heritage Program. My study aims to achieve two main objectives: 1) survey populations and investigate the genetic diversity and connectivity of the two metapopulations, and 2) revise the conservation status and develop policies to better conserve this species that are scientifically informed. This research utilizes field surveys and herbarium specimens to investigate the natural history of the species. Additionally, double digest restriction-site associated DNA sequencing (ddRAD) will be used to generate genomic data for use in population genetics analyses. By employing iPyrad and R to synthesize these data, I will gain insight into gene flow and the genetic stability of these metapopulations. Ultimately, my research will provide an updated, scientifically-backed conservation status assessment of *C. latifolium* in Pennsylvania. This project will combine rare plant survey protocols with the Pennsylvania Natural Heritage Program and genetic work at Bucknell University to address broad conservation questions.

River Oats , Rare Plants , Population Genetics, Conservation

TRENDS IN COLIFORMS WITHIN URBAN STREAMS LOCATED IN LYCOMING COUNTY MS4

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Lycoming College Clean Water Institute assessed the urban streams and storm water outfalls in Lycoming County MS4 region between 2015 and 2019. Included in the County MS4 region are seven urban streams out of which five, on the North of West Branch Susquehanna River were assessed. The five major urban streams that were sampled as a part of this study were- Millers Run, Bulls Run, Grafius, McLure, and Tules run. At each of these sites, the field and laboratory water chemistry was performed to obtain pH, alkalinity, conductivity, nitrites, nitrates, phosphate, total dissolved solids (TDS), dissolved oxygen, turbidity, and aluminum, to monitor the water quality. Membrane filtration of the water sample was performed to plate samples of coliform bacteria, a species of bacteria found in human feces. Presence of *E. coli* indicates fecal contamination of water. Although collection and identification of aquatic macroinvertebrates and fish will play a crucial role in water quality interpretation, my project will concentrate on the coliform levels and what they indicate for water quality of urban streams. Obtained results will offer a crucial insight to government bodies and other organizations about the health of water which might lead to the establishment of future administrative plans regarding the decrease of urban and suburban wastes entering local water bodies.

urban streams , coliforms , MS4

IMPACTS OF SMALL IMPOUNDMENTS ON STREAM SYSTEMS: CASE STUDY OF WALKER AND FAYLOR LAKES ON MIDDLE CREEK, SNYDER COUNTY, PA

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In recent years, dams have received extensive scrutiny for their effects on stream and river systems throughout the United States. Dams vary greatly in size and scale, but investigations often focus on large-scale dams because of their visibility in the public eye and pronounced impact. This can result in smaller and less impactful impoundments being overlooked, despite the cumulative impacts these dams can have on higher order water systems. Two small water impoundments; Walker and Faylor Lakes located respectively on the north and west branches of Middle Creek in Snyder County, Pennsylvania have shown to impact their streams (Lachhab, et al. 2013). This study focused on using onsite physical properties and grab samples for chemical analysis in the laboratory to determine the effects of the two impoundments on their streams. To further correlate the physicochemical results, kick sampling for benthic macroinvertebrates and diatom data were used to build a comprehensive understanding of the impact of the two impoundments on their respective stream system. Both upstream and downstream sites from the dams were sampled. All sites were checked for T, pH, Ke, DO, TDS, ORP, COD, BOD_5, F, Cl, NO_2^-, Br, SO_4^{2-}, NO_3^-, P, K, NH_4, K, Mg^{2+}, and Ca^{2+}. A Water Quality Index (WQI) was constructed based on eleven parameters (Vicente, et al. 2009). All parameters; physical, chemical, benthic and diatom were positively correlated. The positive correlation of the data shows that the physical and chemical changes to the streams, caused by the dams and direct land are affecting the biological communities in the streams. Relatively, Walker Lake Dam was found to have a much greater negative impact on the north branch of Middle Creek and significantly degraded the water in relation to certain parameters. Faylor Lake Dam did not have as significant an impact on the west branch of Middle Creek.

Water Quality, Dams, Nutrient Cycle

DOCUMENTING AMPHIBIAN ABUNDANCE AND DIVERSITY USING ENVIRONMENTAL DNA (EDNA) WITHIN LITTLE ARNOT RUN AND WHITE DEER CREEK, PENNSYLVANIA

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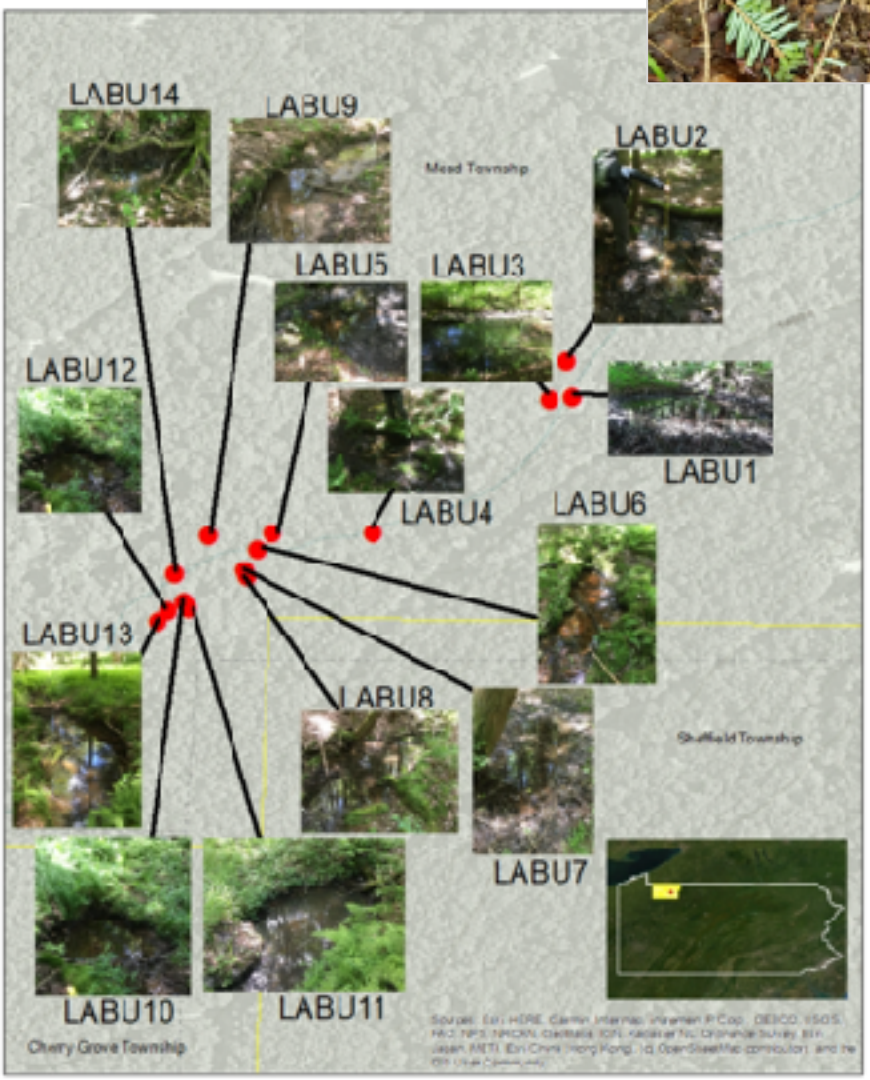
Amphibians typically utilize both land and aquatic habitat for their life cycle, which can make them more vulnerable to changes that occur within the ecosystem. Currently no data has been collected on amphibians in Little Arnot Run in the Allegheny National Forest which underwent changes to its forest structure due to mining and logging history. There are ongoing restoration efforts to add large woody debris along Little Arnot Run in the Allegheny National Forest to create more habitat both in and along the stream which fish and amphibians utilize. We are using White Deer Creek as a comparison site in order to evaluate the effect of the restoration efforts on amphibian biodiversity through environmental DNA analysis. My research this summer focused on characterizing the distribution of isolated lentic amphibian habitats along predetermined sections of stream.

The study sites included Little Arnot Run, within the Alleghany National Forest, and White Deer Creek, Union County. Fourteen locations were sampled both in spring and summer seasons along Little Arnot Run and eight along White Deer Creek. Sites were characterized as a disconnected side channel, depression, groundwater influenced, and/or valley capture. Water quality data was collected from each site using a Eureka Manta Sub 2 multi parameter water quality sonde. 1-liter water samples were taken from all sites and filtered within 24 hours in lab. Samples are stored in a -20°C freezer for future eDNA analysis. Using eDNA opposed to hand sampling will increase detection by obtaining amphibian DNA that gets discharged in the water even if they are not visibly detected. In the future, reapplying these methods after restoration could show the impact it may have to fish and amphibian habitat.



eDNA , amphibians , restoration

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

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In 2013 PA DEP completed a Total Maximum Daily Load (TMDL) for Wolf Run Watershed, a tributary to Muncy Creek and the West Branch Susquehanna River (Lycoming County). Wolf Run was designated impaired with recommended BMP's. The suggested BMPs were stream bank stabilization, riparian buffers, manure storage and reduction of animal and equipment crossing. In 2015 the Lycoming County Conservation District chose four farm sites to implement BMPs (site1-Artley Farm, site 2- Neece Farm1, site 3- Fry Farm and site 4 -Neece 2). The Clean Water Institute began pre/post monitoring Wolf Run in 2017. Between 2017-2019 the restoration phased in 2,300 feet of stream bank stabilization using PA Fish and Boat design for 240 feet of mudsill, 15 single log vanes, 7 multi-log vanes and 180 feet of toe logs. Also, an improved stream crossing was constructed to allow cattle and equipment. CWI survey included, water chemistry, coliform sampling, and electrofishing/ macroinvertebrate surveys. Total number of fish caught over three years was 1,299 (representing 15 sp.), The Artley Farm showed the lowest population size (530 per Km), with Shannon-Wiener Diversity of 2.45. While completing fish surveys in 2019 three of the four sites recorded brown trout (Salmo trutta). The site lacking brown trout in 2019 had them in 2018. Trout are returning to the restoration site.

Stream Restoration , BMP's, TMDL

STREAM RECONSTRUCTION AND HABITAT RESTORATION IN THE SUSQUEHANNA RIVER BASIN

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Union County Conservation District has partnered with Pennsylvania Department of Environmental Protection, PA Fish & Boat Commission and Northcentral Pennsylvania Conservancy on stream reconstruction and habitat restoration at several sites in the Susquehanna River Basin. The restoration process takes place along largely agriculturally impaired streams; log structures are secured throughout the stretch of creek, each having a significant impact on improving stream quality. Structures are put in place to work with the stream, not against it, increasing sinuosity and velocity, while decreasing width and temperature to encourage native aquatic species to return to previously impaired streams. When the construction process is complete, grading is done along the banks to create a gentle slope and open up a wide floodplain for natural rise and fall during heavy rain events. Finally, native grass seeds are spread along with native wildflowers and trees to begin creating and improving the buffer zone. The riparian buffer is put in place to ensure the integrity of the stream is maintained after all the restoration work is completed. We worked on two sites over the summer of 2019. One site was located at the Griffith Farm along Turtle Creek, a direct tributary into the West Branch of the Susquehanna. Turtle Creek is an ongoing restoration project for the Union County Conservation District. Over the past five years, the UCCD partnered with the aforementioned agencies have completed stream reconstruction and habitat restoration along the mainstem of Turtle Creek and by the end of next summer the entire creek will be restored. Another site was located at the Sabo family property along Buffalo Creek, also a direct tributary to the West Branch of the Susquehanna. Unlike Turtle Creek, Buffalo Creek is largely a well-maintained creek and restoration was done to ensure the quality of the stream be maintained and continued to be improved.

Susquehanna River, Restoration

WHAT LIES IN THE DARK: CUTTING OPEN BAPTISIA AUSTRALIS FRUITS IN SEARCH OF SEED PREDATORS

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Baptisia australis var. australis (L.) R. Br. (Fabaceae) is a rhizomatic perennial wildflower found in riparian, forest-edge, and prairie habitats throughout central and eastern North America. In Pennsylvania, it is classified as state-threatened due to habitat loss. Previous research in other areas of North America has found seed predation to be significantly damaging to *Baptisia australis* reproductive success, particularly due to lepidopteran and weevil larvae. No seed predation data has been collected for the Allegheny River metapopulation (consisting of the only extant populations in Pennsylvania), therefore our work examining seed predation in the region is novel. Fruits were gathered from six populations along the Allegheny River and preserved in an ethanol solution. The exterior was examined for holes, then the fruits were measured and dissected. Mature and immature seeds were counted, and any abnormalities inside, such as frass or larvae, were documented. Data obtained from dissecting fruits will help determine the level of seed predation that is currently occurring in Allegheny River populations of *B. australis var. australis*, as well as variation in average fruit length, seed count, and seed size. Our current findings suggest that lepidopteran seed predation is present in Pennsylvania, a previously unknown concern for this rare plant. This research serves two main purposes: to collect qualitative and quantitative data on threats to *B. australis var. australis* populations in Pennsylvania, and to contribute to future conservation of the species. Understanding the extent of seed predation in the Allegheny River drainage will aid in reassessing the conservation status of *B. australis var. australis*.

Baptisia , Fabaceae , Lepidopteran , Conservation

PRAIRIES IN PENNSYLVANIA? CONSERVATION OF STATE-THREATENED BAPTISIA AUSTRALIS VAR. AUSTRALIS

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In Pennsylvania *B. australis* var. *australis* (L.) R. Br. (Fabaceae) is comprised of two metapopulations along four waterways: the Allegheny River, Youghiogheny River, Clarion River, and Red Bank Creek. Despite the location of these watersheds within the greater Ohio River drainage, there is still considerable distance between the metapopulations. Because of its limited distribution and small number of extant populations, *B. australis* var. *australis* is considered state-threatened in Pennsylvania. The riparian prairie habitat that Pennsylvania *Baptisia australis* var. *australis* is restricted to is also in decline and considered vulnerable in the state. My work carries with it two main objectives: 1) Better understand the ecology and natural history of these metapopulations, including assessment of the status of the species in the state, and 2) What is the genetic structure of known native populations and how does it relate to the spatial structure of subpopulations? This research utilizes tools such as aerial imagery, field surveys, and herbarium collections in to examine the natural history of the species. In addition, ddRAD is used to collect genetic data for use in population genetics analyses. I plan to synthesize these data to gain insight into the metapopulation dynamics of this riparian system. My research will inform the conservation status of *Baptisia australis* var. *australis* in Pennsylvania, and clarify lingering uncertainties about gene flow in riparian plant populations. The project seeks to combine field opportunities surveying rare plants with the Pennsylvania Natural Heritage Program and genetic work at Bucknell University to answer broader conservation questions.

conservation , riparian , rare plant , population genomics

DIEL PH CYCLES OBSERVED IN LOYALSOCK CREEK

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Loyalsock Creek is a 64-mile long (with a 495 square mile drainage basin) tributary to the West Branch of the Susquehanna River. Sourcing in Wyoming County, the creek mainly flows through Sullivan and Lycoming Counties. In 2018, the creek was designated PA River of the Year by POWR. Using data logging instruments (including a MANTA Sonde) placed in Loyalsock Creek and the Lycoming Biology Field Station, INC., over the course of the summer of 2019, daily pH cycles were looked at to observe patterns as well as collect data from a set point in the creek. This point also was ¼ mile downstream of a USGS stream gage, so data was also compared to data from this gage. Various factors were looked at as to how they affect a stream's pH cycle, which introduced ideas for future work using the data loggers. The main factors observed were a stream's metabolism and its discharge over the course of time. Through storm events, low flow events, and other stream constituents, various patterns in pH and other parameters could be observed within Loyalsock Creek.

Loyalsock Creek , pH , metabolism

WATERDALE ENVIRONMENTAL EDUCATION CENTER SUCCESSFUL APPLICATION OF WATERSHED ECOLOGY AND STORMWATER CURRICULUM

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Curriculum development refers to the educational process by which instructors create and connect their content delivery and design. Experiential learning allows opportunities to learn through hands-on activities that occur outside the traditional classroom walls.

The curriculum developed for the Waterdale Environmental Education Center incorporates experiential learning opportunities that provide watershed sustainability education, water quality testing and effects of pollution on surrounding watersheds. Curriculum that meets state teaching standards have been developed for stormwater management, small stream habitats, and special/temporal variability within and across watersheds.

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) and other conservation groups. Waterdale is a resource for K-12 education outreach and for college research projects. My project will document success stories for application of hands-on programs in stream ecology and stormwater for 4-6th graders vs older high school students. What works and does not work in keeping the lesson plan focused in a field setting?

environmental education , stormwater curriculum , Waterdale Environmental Education Center

DESCRIPTION OF COMMON CRAYFISH (*CAMBARUS BARTONII BARTONII*), BURROWS IN JAKEY HOLLOW NATURAL AREA, COLUMBIA COUNTY, PENNSYLVANIA.

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Our study examined the distribution and characteristics of burrows belonging to the Common Crayfish, *Cambarus bartonii bartonii*, in the small tributary of Little Fishing Creek that runs through Jakey Hollow Natural Area. Although this is an abundant species in Pennsylvania, little is known about its burrowing behavior, and this native crayfish may be threatened by displacement from invading crayfish species. Therefore, it is important to describe the locations and characteristics of their burrows in order to document the habitat preferences of this species for future conservation. In our study, the substratum type that appeared to be most utilized by the Common Crayfish were the soil/clay and rocky substratum types. Statistical analysis suggested that the burrows were randomly distributed. Soil/clay and rocky habitats contained 80.5% of the burrows within our data set. This suggests that the vegetated habitats may be less important to the Common Crayfish than the rocky or soil/clay habitats. Additionally, we found no difference in burrow width or depth among substratum. Future, larger studies may show a clearer preference. However, our study does provide some insight regarding the management of habitat for this species by suggesting cut banks along the stream at Jakey Hollow should be maintained.

Crayfish , Distribution , Invertebrate

PRESENCE OF BRANCHIOBDELLIDAN ECTOSYMBIONTS ON THREE CRAYFISH SPECIES IN THE SUSQUEHANNA RIVER BASIN

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Relationships between organisms are important for the functions of ecosystems. Symbiotic relationships can be parasitic or mutualistic, and the type of relationship may be dependent upon environmental factors. There is evidence that crayfish possess a symbiotic relationship with annelids of the order Branchiobdellida. There is little known about the prevalence of these ectosymbionts on crayfish populations in Pennsylvania and the type of relationship between the two organisms. To gain more information, branchiobdellidan ectosymbionts were evaluated on three species of crayfish in Pennsylvania: the common crayfish (*Cambarus bartonii bartonii*), the Allegheny crayfish (*Faxonius obscurus*), and the rusty crayfish (*Faxonius rusticus*). Crayfish samples of each species were collected in the Susquehanna River basin, and the ectosymbionts were separated out after preservation. The ectosymbionts were mounted on slides for taxonomic identification by evaluation of the jaw structures, reproductive structures, and segmentation. Results showed that four different Branchiobdellida species of the genus *Cambarincola* were found on the native *C. bartonii bartonii* and the non-native *F. obscurus*. Only one species was found on the invasive *F. rusticus*. This preliminary study reveals that crayfish do possess ectosymbionts in Pennsylvania and that more research is needed to understand the relationships.

crayfish , ectosymbionts , Branchiobdellida , invasive

INFLUENCE OF AN UNUSED RESERVOIR ON WATER TEMPERATURE AND FISH COMMUNITIES IN THE HARVEYS RUN WATERSHED, CASTANEA, PA.

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The awareness of the impact that obsolete dams have on stream ecosystems is becoming widely recognized. Many dams inhibit fish migratory patterns, retain nutrients and sediment within the reservoir, and alter water temperature regimes below the dam. Fish and invertebrate populations are highly dependent on their aquatic habitats to supply necessary nutrients, space, and water quality in order to carry out biological processes. For this project, we evaluated the impact that a small, defunct dam is having on the stream communities by altering temperature regime. We deployed temperature loggers at multiple locations above and below the dam and analyzed the thermal data across multiple months including the warmest point of the year (July/August 2018). We compared the seasonal patterns in water temperature to the fish and invertebrate communities that we sampled in fall 2018. Throughout the warmer months of summer, the temperature below the dam was nearly 10°F warmer than the temperature found in free flowing sections above the reservoir. We found lower fish density, including lower trout density, below the dam along with differences in the invertebrate communities. Our study provides evidence to support recent efforts to remove the dam, which would allow downstream locations to return to normal thermal regime and reconnect the stream communities.

From The Branches to The Confluence

October 18-19, 2006

1st

Pennsylvania Abandoned Mine Drainage Remediation

September 28, 2007

2nd

The Susquehanna and Agriculture

September 12-13, 2008

3rd

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

Science, Conservation, and Heritage

November 26-27 2018

13th

Healthy Rivers, Healthy Communities

October 18-19, 2019

14th

Sustainable Watersheds *

November 6-7, 2020

15th

** 2020 symposium theme is tentative and subject to change*

Susquehanna River Symposia

2018 to 2020

POSTER AND ORAL PRESENTATION

AUTHOR INDEX

AUTHOR INDEX (continued)

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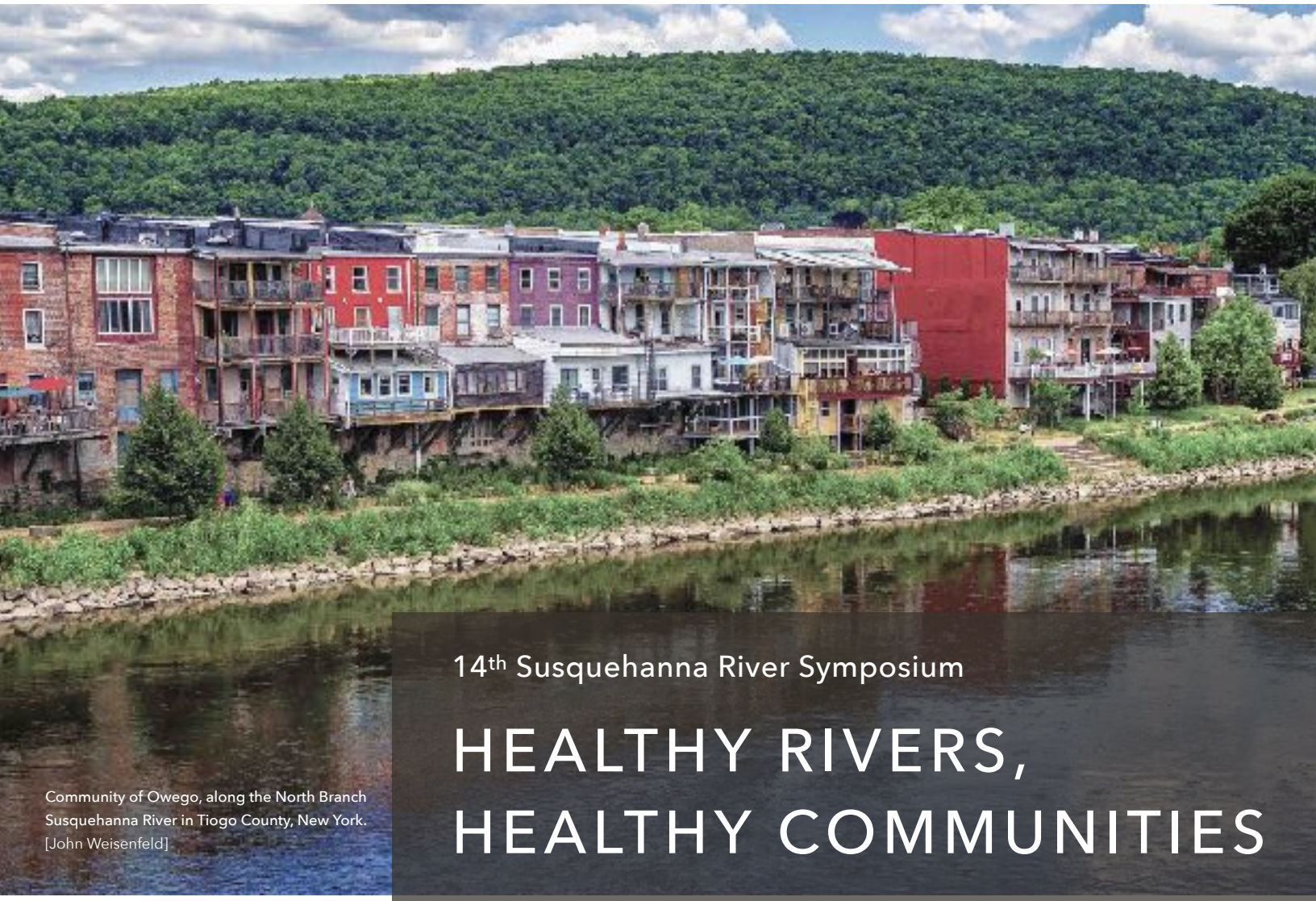

Community of Owego, along the North Branch Susquehanna River in Tiogo County, New York. [John Weisenfeld]

14th Susquehanna River Symposium

HEALTHY RIVERS, HEALTHY COMMUNITIES

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