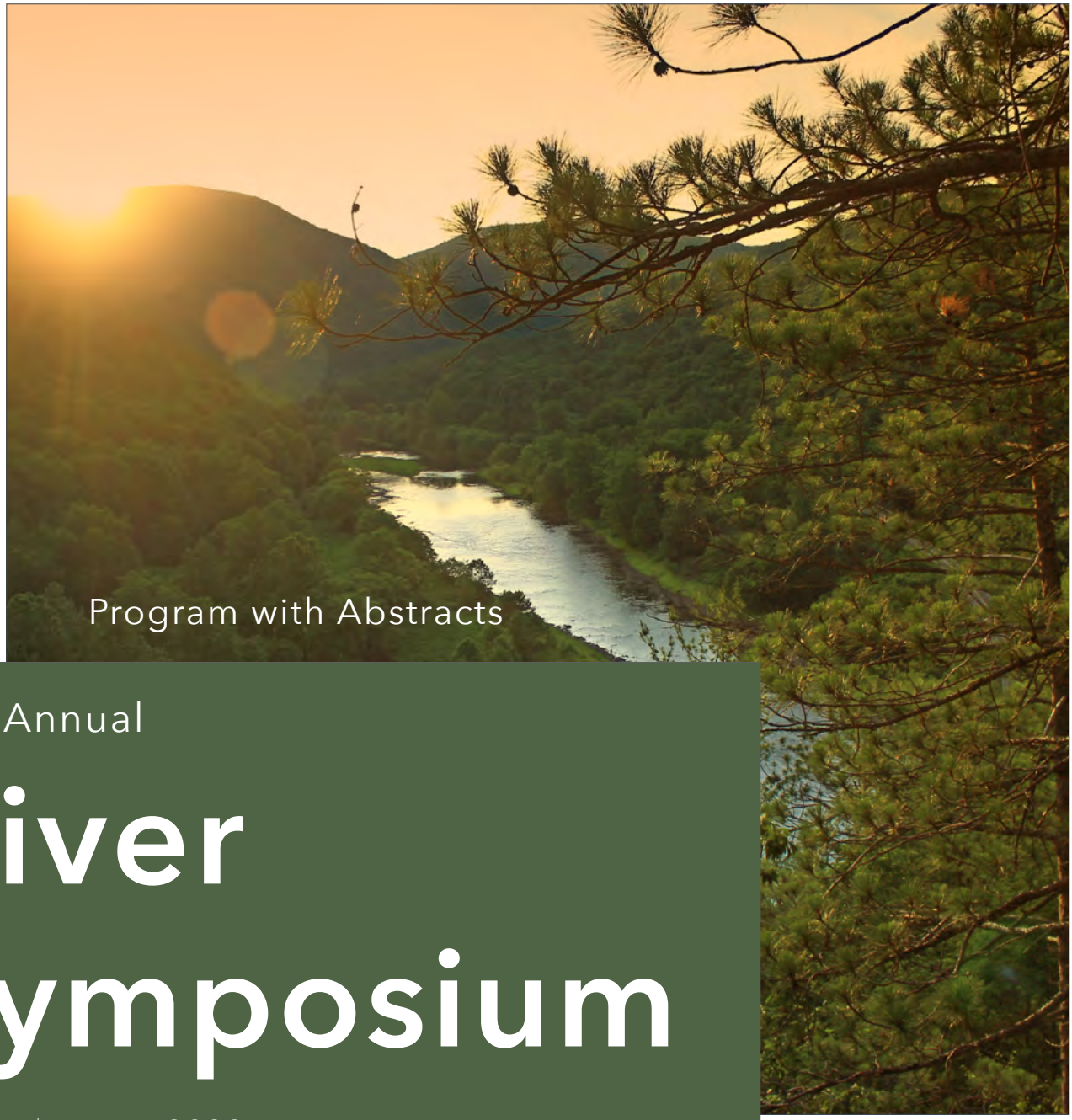


Program with Abstracts

17th Annual

River Symposium

November 4-5, 2022

Bucknell UNIVERSITY
Center for Sustainability & the Environment

Connecting people from watersheds across the mid-Atlantic region and United States. Exploring emerging issues and possible solutions. Inspiring one another to become catalysts for positive change toward a sustainable future for the planet.

2022 RIVER SYMPOSIUM

COMMITTEE

Benjamin Hayes
Director, Watershed Sciences and Engineering Program
Center for Sustainability and the Environment

Sean Reese
Program Scientist, Watershed Sciences and Engineering Program,
Center for Sustainability and the Environment

Matthew Higgins
Professor, Department of Civil and Environmental Engineering
Faculty Director, Center for Sustainability & the Environment

Sid Jamieson
Bucknell Lacrosse Coach (Emeritus)
Haudenosaunee Nation

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

Janeen Putnum
Operations Director, Center for Sustainability and the Environment

Krista Smith
Office Assistant, Center for Sustainability and the Environment

Jesse Greenawalt
Event Technology Specialist
Library & Information Technology

Jeffrey Campbell
Senior Event Technology Support Specialist
Library & Information Technology

George Lincoln
Senior Event Technology Support Specialist
Library & Information Technology

Photos (all used with permission):

Front cover: Chesapeake Conservancy staff work with community partners to install vegetation and structures to reduce nutrient and sediment runoff and improve water quality on Elk Creek, a tributary of Penns Creek, in Centre County, PA. [Chesapeake Conservancy]

Next page: Allegheny National Forest. [Benjamin Hayes]

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

Rear cover. Unnamed tributary on south end of Gouldsboro Lake, Monroe County [Nicholas A. Tonelli]

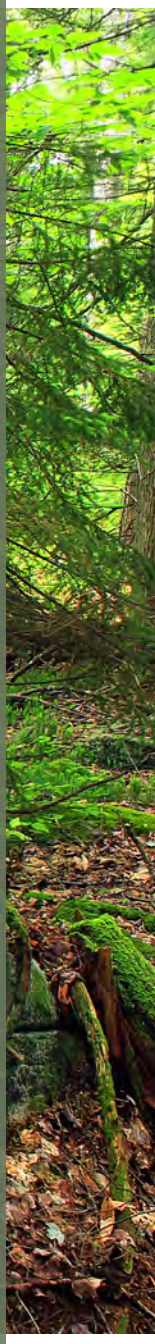
Welcome!

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 restoration and management strategies that will improve the health of watersheds and the ecosystems and communities living therein.

It features keynote and plenary addresses, exhibits, and oral and poster presentations from 123 students, faculty, consultants, agencies, and watershed groups. Our goal is to cultivate knowledge, and discovery, all the while increasing awareness of the watershed restoration and conservation work under way throughout the Susquehanna and Chesapeake region.

All events are free and open to the public. Oral presentations are both in person and virtually via Zoom. To register and access links to the various sessions, please visit:

riversymposium.scholar.bucknell.edu

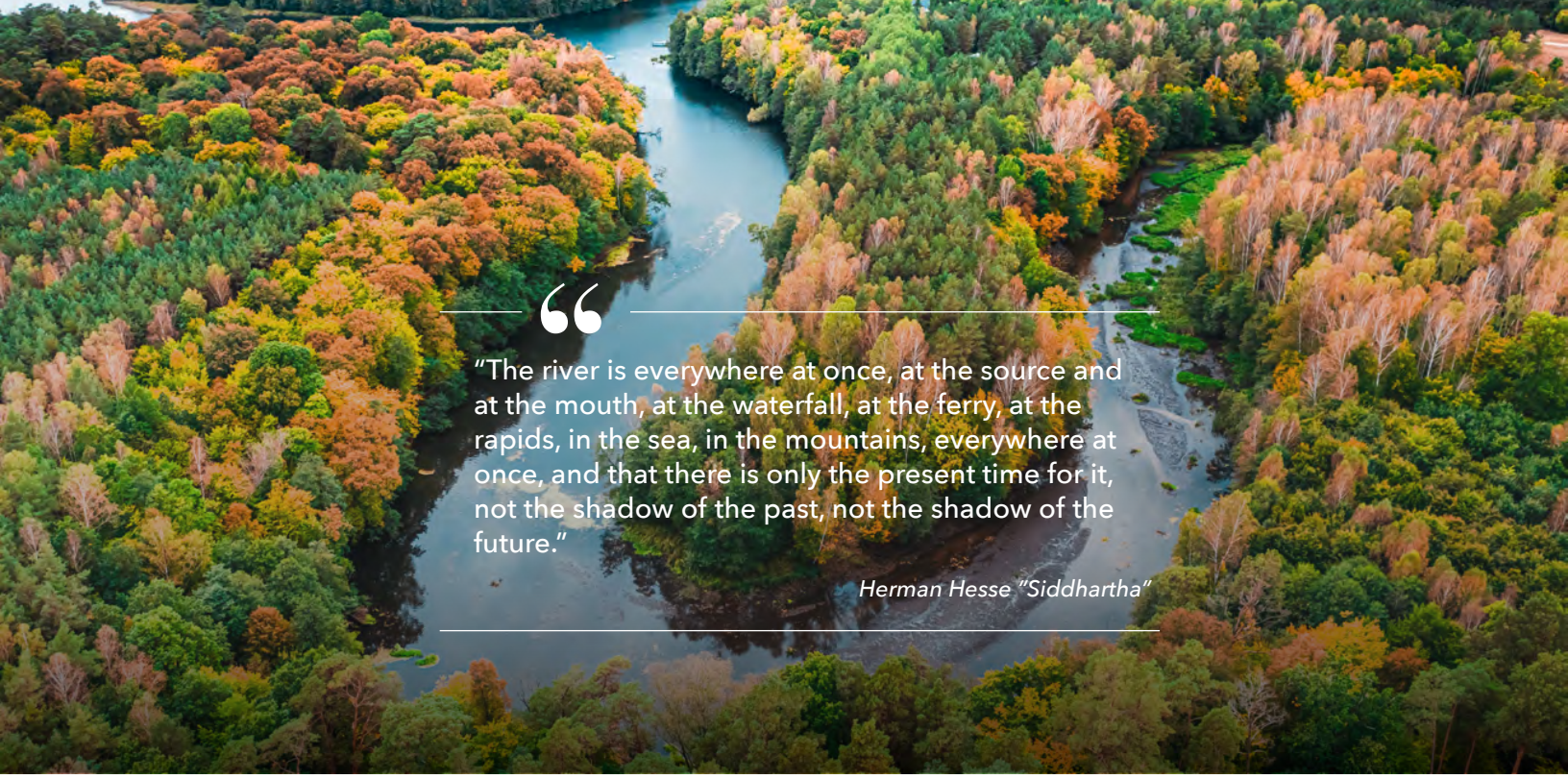


"Who can place in one pan of some cosmic scales the trinkets of modern civilization and in the other the song of thrush in the windless twilight?"

- Rachel Carson

PROGRAM WITH ABSTRACTS

CONTENTS



FORWARD

THE RIVER IS EVERYWHERE

The above quote *“The River Is Everywhere,”* comes from Herman Hesse’s novel, *Siddhartha* (published in 1922), which centers around a fictional man who is on journey to discover himself. A river runs through the heart of his journey and along the way he sees how he can learn from it. Its voice is one he has known since childhood and discovers that a river is like the life of any person. It is unchanging and yet it is always changing within, deeper inside beneath the surface.

Like Siddhartha, we have much to learn from rivers. When we recognize our interconnections with them, our passion to understand and protect planet Earth deepens. New science about the fate of freshwater ecosystems finds that only 17% of rivers globally are both free-flowing and within protected areas, leaving many of highly-threatened systems – and the species that rely on them – at risk.

Globally, populations of freshwater species have already declined by 84% on average since 1970,. Degradation of rivers is the leading cause of this decline. Lakes, ponds, and free-flowing rivers and other naturally functioning freshwater ecosystems sustain biodiversity and the food supply chain, drinking water, economies, and cultures for billions of people worldwide. Therefore, their protection is critical.

The body of work presented at this year’s symposium addresses a growing calls to study and protect Pennsylvania rivers as life corridors in a changing climate. Rivers play a critical role in providing ecosystem services and livelihoods around the world. We must act now to protect our rivers, because failing to do so will have lasting consequences for decades to come.

KEYNOTE SPEAKER. On Friday, from 7:30 to 8:00 p.m., **Sid Hill**, Tiahdahton (Chief) of the Onondago and Keeper of the Flame for Six-Nation Haudensaunee Confederacy will deliver the keynote address *"Haudenosaunee Ways of Honoring Nature"*.

RESEARCH POSTERS. On Friday, from 8:00 to 10:00 p.m., over 100 students and faculty from 23 universities and organizations will present their work. An evening social will follow, which is a great way for everyone to intermingle and make new connections and refuel old.

The posters will remain on display in the Terrace Room through Saturday's symposium events. Their abstracts are on page 27-55 in the proceedings.

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

- **Betty Lyons**, American Indian Law Alliance and United Nations, will deliver a plenary address entitled ***"Haudenosaunee Perspective on Climate Change."***
- **Lance Wilt**, Outcast Anglers, will deliver a plenary address entitled ***"Lessons Rivers Teach Us."***
- **Jeff Janvrin**, Wisconsin Department of Natural Resources, will deliver a plenary address entitled ***"Upper Mississippi River Restoration – From a Partnership's Vision to over 100,000 Acres of Rehabilitated and Enhanced Habitat."***

EXHIBITS. In the Center Room (Room 256) are 7 exhibits by watershed groups, conservancies, and other organizations working to protect and restore the watersheds throughout the mid-Atlantic region. From 11:00 to 4:00 p.m., representatives will be at their exhibits to answer any questions and provide you information.

LUNCH. Lunch will be served from 12:00 to 1:00 p.m. in Walls Lounge (Room 213).

ORAL PRESENTATIONS. Saturday afternoon features 18 oral presentations organized into six topical sessions:

- Large-Scale Watershed Studies
- Hydrology and Ecology
- Best Management Practices
- Watershed Restoration
- Policy and Planning
- Education and Conservation

A detailed schedule of oral presentations for each session is provided on pages 16-30.

WRAP-UP DISCUSSION. From 4:00 to 4:15 pm, everyone is invited to gather together for a 15-minute wrap discussion. We'll reflect upon the events of the symposium and gather suggestions for next year.

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**, Dr. Andrew Warner, Director.

Special thanks are due the symposium committee: H.W. "Skip" Wieder, Sid Jamieson, Sean Reese, Matt Higgins, Janeen Putman, Krista Smith, Maggie O'Connell, Milton Newberry III, Shaunna Barnhart, Jeff Campbell, Jesse Greenawalt, and George Lincoln.

Best wishes for a great symposium!

Sincerely,

Benjamin R. Hayes, Ph.D., P.G.
Symposium Chairman
Director, Watershed Sciences and Engineering Program
Center for Sustainability & the Environment
Bucknell University

17TH ANNUAL RIVER SYMPOSIUM

SCHEDULE

FRIDAY, NOVEMBER 4, 2022

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

7:00 - 8:00 p.m.

Zoom link: https://bucknell.zoom.us/j/98802003953?pwd=ajAxUEFNYldMNEt1NVNremp2eDBSQT09

7:00 - 7:05 p.m.

Welcome and Announcements

Matthew Higgins

Faculty Director, Center for Sustainability and the Environment, Bucknell University

7:05 - 7:20 p.m.

Opening Remarks

John Bravman

President, Bucknell University

7:20- 7:30 p.m.

Comments and Special Introductions

Benjamin Hayes

Symposium Chair

7:30 - 8:00 p.m.

Keynote Address

"Haudenosaunee Ways of Honoring Nature"

Sid Hill

Tadodaho, Onandago Nation

Keeper of the Flame (Spiritual Leader), Haudenosaunee Confederacy

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 150 students and faculty from 23 universities and colleges throughout the mid-Atlantic region, and state and federal environmental agencies, consulting firms, watershed groups, and other organizations.

Abstracts for poster presentations are on pages 37-51.

SATURDAY, NOVEMBER 5, 2022

All oral presentations will be held both in-person and virtually via Zoom.
Visit the symposium website for links to individual talks and other details.

Plenary Addresses

Zoom link: https://bucknell.zoom.us/j/93628504827?pwd=NkhSVEZBampJQ1ZWVWJ6ZnpIV1dRUT09

9:00 - 9:30 a.m. - The Forum (Room 272), Elaine Langone Center

Haudenosaunee Perspective on Climate Change

Betty Lyons

American Indian Law Alliance and United Nations

9:30 - 10:00 a.m.

Lessons Rivers Teach Us

Lance Wilt

Outcast Anglers

10:00 - 10:30 a.m.

Upper Mississippi River Restoration – From a Partnership's Vision to over 100,000 Acres of Rehabilitated and Enhanced Habitat

Jeff Janvrin

Wisconsin – Department of Natural Resources

Exhibits

11:00 a.m. - 4:00 p.m. - The Center Room (Room 256)

Susquehanna Greenway Partnership, Chesapeake Bay Foundation, Buffalo Creek Watershed Alliance/ Merrill Linn Conservancy for Land and Waterways, Middle Susquehanna River Keeper Association. Friends of R.B. Winter State Park, Ready, Set, Fit!, Union County Conservation, Shamokin Creek Restoration Alliance, Chesapeake Conservancy.

Lunch

12:00 - 1:00 p.m. - Walls Lounge (Room 213)

Oral Presentations - First Group

1:00 - 2:00 p.m.

Session 1A **Large-Scale Watershed Studies** (The Forum, Room 272)

Zoom link: https://bucknell.zoom.us/j/92029188026?pwd=c3Exd0cwYTlrdDZPdG1PeEFhcEhjdz09

Session 2A **Watershed Restoration** (Gallery Theater, Room 301)

Zoom link: https://bucknell.zoom.us/j/98948705495?pwd=eGx4L2ozdTNNN3E1eHFRWXZCcExnQT09

Oral Presentations - Second Group

2:00 - 3:00 p.m.

Session 1B **Hydrology and Ecology** (The Forum, Room 272)

Zoom link: https://bucknell.zoom.us/j/92029188026?pwd=c3Exd0cwYTlrdDZPdG1PeEFhcEhjdz09

Session 2B **Policy and Planning** (Gallery Theater, Room 301)

Zoom link: https://bucknell.zoom.us/j/98948705495?pwd=eGx4L2ozdTNNN3E1eHFRWXZCcExnQT09

Oral Presentations - Third Group

3:00 - 4:00 p.m.

Session 1C **Best Management Practices (BMPs)** (The Forum, Room 272)

Zoom link: https://bucknell.zoom.us/j/92029188026?pwd=c3Exd0cwYTlrdDZPdG1PeEFhcEhjdz09

Session 2C **Education and Conservation** (Gallery Theater, Room 301)

Zoom link: https://bucknell.zoom.us/j/98948705495?pwd=eGx4L2ozdTNNN3E1eHFRWXZCcExnQT09

Wrap-Up and Looking Ahead

4:00 - 4:15 p.m.

Moderator: Benjamin Hayes

Reflect upon the events of the past 24 hours and share ideas for next year's River Symposium.

2021 RIVER SYMPOSIUM

ORAL SESSION SCHEDULE

Session 1A

Large-Scale Watershed Studies

The Forum (Room 272), Saturday, November 5, 1:00 - 2:00 p.m.

Zoom link: https://bucknell.zoom.us/j/92029188026?pwd=c3Exd0cwYTlrdDZPdG1PeEFhcEhjdz09

1:00 p.m. *"Nitrogen in the Chesapeake Bay Watershed: A Century of Change, 1950 – 2050"*

John W. Clune,* Paul D. Capel, Matthew P. Miller, Douglas A. Burns, Andrew J. Sekellick, Peter R. Claggett, Richard H. Coupe, Rosemary M. Fanelli, Ana Maria Garcia, Jeff P. Raffensperger, Silvia Terziotti, Gopal Bhatt, Joel D. Blomquist, Kristina G. Hopkins, Jennifer L. Keisman, Lewis C. Linker, Gary W. Shenk, Richard A. Smith, Alexander M. Soroka, James S. Webber and Qian Zhang.

1:15 p.m. *"Dams, Reservoirs, and Nutrients in the Chesapeake Bay Watershed: Past trajectories and future horizons"*

Meter Kimberly J. Van Meter*

1:30 p.m. *"Data Driven Approaches to Better Estimate River Channel Geometry over the Continental United States (CONUS)"*

Shuyu Y. Chang,* Laura Manuel, Zahra Ghahremani, Mohammad Erfani, Kimberly Van Meter, Ehab Meselhe, Jen pierce, Erfan Goharian, Sagy Cohen, and Chaopeng Shen

1:45 p.m. Panel Discussion/Q & A

Abstracts for oral presentations are provided on pages 16 - 30.

** denotes presenting author.*

Session 1B

Hydrology and Ecology

The Forum (Room 272), Saturday, November 5, 2:00 - 3:00 p.m.

Zoom link: https://bucknell.zoom.us/j/92029188026?pwd=c3Exd0cwYTlrdDZPdG1PeEFhcEhjdz09

2:00 p.m. *"How Does Urbanization and Region Matter? Determining Metrics of Stream Flashiness for the Delaware Watershed."*

Rachel Hurley,* David Brandes, and Christa Kelleher.

2:15 p.m. *"Status of the Eastern Hellbender in the Loyalsock Creek Watershed"*

Peter Petokas

2:30 p.m. *"Linking in-stream and landscape-level conditions to macroinvertebrate assemblages in the Little Juniata River watershed"*

Brenden Nauman* and George Merovich

2:45 p.m. Panel Discussion/Q & A

Session 1C

Best Management Practices (BMPs)

The Forum (Room 272), Saturday, November 5, 3:00 - 4:00 p.m.

Zoom link: https://bucknell.zoom.us/j/92029188026?pwd=c3Exd0cwYTlrdDZPdG1PeEFhcEhjdz09

3:00 p.m. *"Identifying Best Management Practices (BMPs) through Remote Sensing"*

Brian Gish,* Caitlin Glagola, Katie Leaverton, Elena Wills, and Molly Finch

3:20 p.m. *" Union County Buffer Maintenance Program"*

Elizabeth Reitzloff* and David Staebler

3:40 p.m. *"Is Buffalo Creek in Union County safe for recreation?"*

Melanie Gamboa,* Carley Gwin,, Deborah Sills, Jessica Newlin, Gerald Heckler, David Staebler, and John Capwell

Abstracts for oral presentations are provided on pages 16 - 30.

** denotes presenting author.*

Session 2A

Watershed Restoration

Gallery Theater (Room 301), Saturday, November 5, 1:00 - 2:00 p.m.

Zoom link: https://bucknell.zoom.us/j/98948705495?pwd=eGx4L2ozdTNNN3E1eHFRWXZCcExnQT09

1:00 p.m. *"Construction Methods and Initial Salmonid and Wetland Monitoring of the Little Arnot Run Large Wood Restoration Project"*

Luke Bobnar,* Charles M. Keeports, Grace M. Tillotson, Daniel E. Fenstermacher, and Benjamin Hayes.

1:15 p.m. *"Summary of Water Quality Monitoring for the Little Arnot Run Large Wood Restoration Project"*

Charles M. Keeports,* Luke Bobnar, Christopher Dempsey, Benjamin Hayes, and Grace M. Tillotson.

1:30 p.m. *"Summary of organic matter content changes in Little Arnot Run, Allegheny National Forest"*

Chris Dempsey, Grace Tillotson, Luke Bobnar, and Charles M. Keeports,

1:45 p.m. Panel Discussion/Q & A

Session 2B

Policy and Planning

Gallery Theater (Room 301), Saturday, November 6, 2:00 - 3:00 p.m.

Zoom link: https://bucknell.zoom.us/j/98948705495?pwd=eGx4L2ozdTNNN3E1eHFRWXZCcExnQT09

2:00 p.m. *"Social and economic benefits of nature: Recognizing the interconnectedness of a healthy environment with healthy community and healthy people and how that translates into economic vitality and resiliency.*

Nicole Faraguna*

2:15 p.m. *"Resilience Convergence during County & Local Driven Hazard Mitigation Plan Implementation & Grant Development Sessions"*

Thomas Hughes,* Angel Gillette, and Bobby Cobelli

2:30 p.m. *"Alabama Water Institute's New NOAA Cooperative Institute for Research to Operations in Hydrology"*

Zachary Krauss*

2:45 p.m. Panel Discussion/Q & A

Abstracts for oral presentations are provided on pages 16 - 30.

** denotes presenting author.*

Session 2C

Education and Conservation

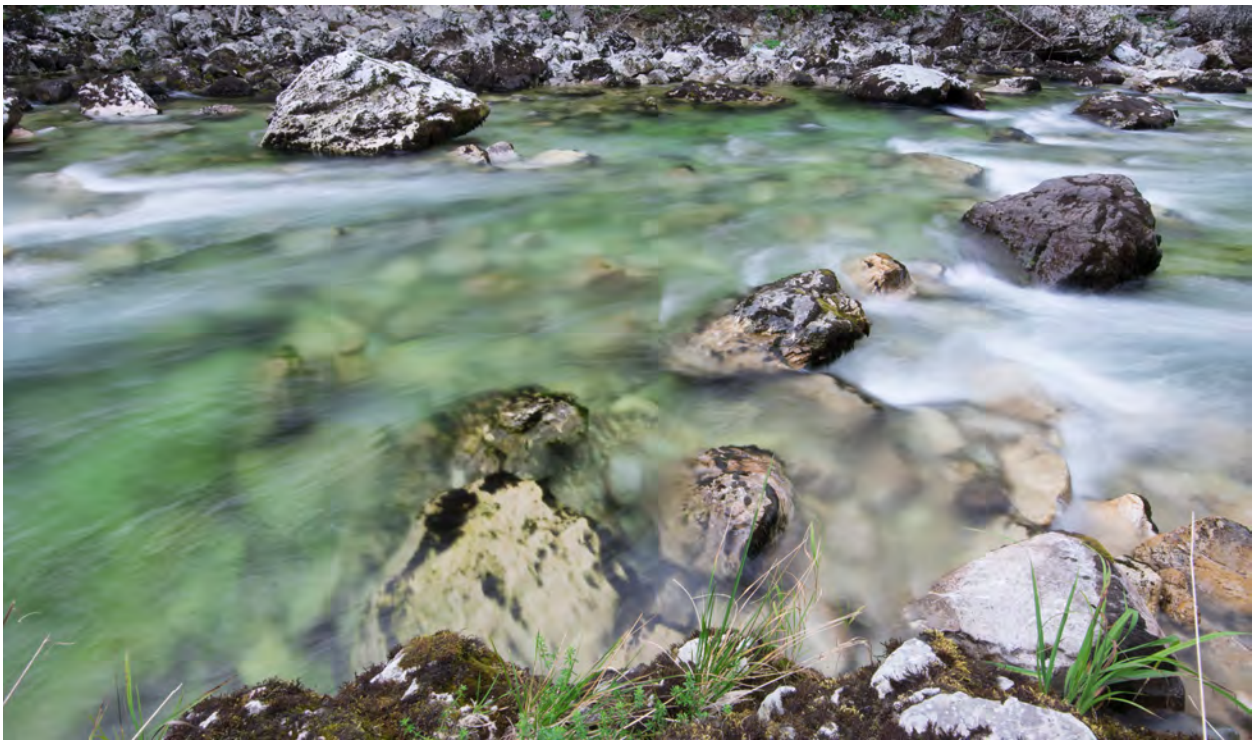
Gallery Theater (Room 301), Saturday, November 6, 3:00 - 4:00 p.m.

Zoom link: https://bucknell.zoom.us/j/98948705495?pwd=eGx4L2ozdTNNN3E1eHFRWXZCcExnQT09

3:00 p.m.	*"Empowering Everyday People to Make realistic Changes"*
	John Zaktanski*
3:15 p.m.	*"Regenerative agriculture methods sequester carbon and prevent nutrient run-off and soil erosion at Bucknell Farm"*
	Jen Schneidman Partica*
3:30 p.m.	*"The Bucknell Greenway: A Living and Learning Laboratory in the Susquehanna Greenway"*
	Paul Siewers*
3:45 p.m.	Panel Discussion/Q & A

Abstracts for oral presentations are provided on pages 16 - 30.

** denotes presenting author.*



2022 RIVER SYMPOSIUM

INVITED SPEAKERS

Sid Hill

Tadodaho, Onondaga Nation
Keeper of the FlameHaudenosaunee Confederacy

Sid is a member of the Onondaga Nation and chosen to be their Tadodaho, or Spiritual Leader, of the Haudenosaunee, or Six Nations/ Iroquois Confederacy, which includes the Onondaga, Oneida, Cayuga, Mohawk, Seneca, and Tuscarora peoples. In this role, he presides over the Grand Council of the Iroquois League of Nations. As such, he a recognized leader of all indigenous people across the United States.

Among his many duties, he oversees their ceremonies, helps to preserve his people's culture, and provides a voice from the Haudenosaunee point of view to the wider world.

Sid teaches about our deep interconnectness with Mother Earth and shares his people's concern for the environment, particularly Lake Onondaga, which is sacred to all Haudenosaunee nations. It where hundreds of years ago, their leaders came together to form the confederacy. The Haudenosaunee ancestral lands cover 4,000 square miles in central and northern New York.

Tadodaho Hill will deliver the keynote address entitled *"Haudenosaunee Ways of Honoring Nature"* at 7:30 to 8:00 p.m. on Friday, November 5, 2022

.

Betty Lyons (Gaeñ hia uh)

Onondaga Nation, Snipe Clan
President & Executive Director, American Indian Law Alliance

Betty Lyons, president and executive director of the American Indian Law Alliance (AILA), is an Indigenous and environmental activist and citizen of the Onondaga Nation. Her native name, Gaen hia uh, meaning 'small sky,' was given to her by her Snipe Clan mother and has developed her love for the earth from her deep connection to her culture.

Growing up, she learned a deep respect for the earth and the responsibility to protect it. Lyons worked together with the NOON organization (Neighbors of the Onondaga Nation) to educate and teach local communities about the culture of the Onondaga Nation to further a better understanding and to bridge the gap between the communities.

Betty Lyons, President & Executive Director of the American Indian Law Alliance (AILA), is an Indigenous and environmental activist and citizen of the Onondaga Nation. Betty has worked for the Onondaga Nation for over 20 years. Ms. Lyons serves as a member of the Haudenosaunee External Relations Committee and has been an active participant at the annual United Nations Permanent Forum on Indigenous Issues (UNPFII) since the first session in 2001 as a delegate of the Onondaga Nation. Betty attended Cazenovia College and is a Bryant Stratton College Graduate of the Paralegal Program.

Betty continues to work for the protection of Indigenous peoples who are fighting to protect their traditions, territories, resources, and care for Mother Earth. Out of her concern for Indigenous peoples and Mother Earth, Betty serves on numerous boards like: 4 The Future Foundation, Connie Hogarth Center, Center for Earth Ethics, The MOST, Skä•noñh- Great Law of Peace Center Academic Collaborative, and is Co-Chair of the Center of Earth Ethics Advisory Board.

She is also the hardworking mother of Garett and Sid Jr.

Ms. Lyons will deliver a plenary address entitled *"Haudenosaunee Perspectives of Climate Change"* at 9:0 to 9:30 a.m. on Saturday, November 6, 2022 in The Forum (Room 272), Elaine Langone Center.

Lance Wilt

Outcast Anglers
Lamar, Pennsylvania

Lance Wilt was born and raised in central Pennsylvania and has worked as a fly-fishing guide for the past two decades in North and South America. He has authored several technical articles in industry leading publications and has been featured in multiple bestselling fly-fishing books. Lance coached the United States Youth Fly Fishing Team to our country's first gold medal in international competition in 2011.

His professional experiences range from remote pack -n trips into Northern Canada and the Western Rockies, walk/wade and float trips in the remote corners of Southern Chilean Patagonia, stalking wary trout on Central Pennsylvania spring creeks, to running river trips on Pennsylvania's larger river systems for bass, large trout, and musky. Lance's life and livelihood have revolved around water and the connections he has made with it, its inhabitants, and the people that use it are lasting and far reaching.

Lance will deliver a plenary address entitled *"**Lessons Rivers Teach Us**"* at 9:30 to 10:00 a.m. on Saturday, Nov. 5, 2022. in The Forum (Room 272), Elaine Langone Center.

Jeff Janvrin

Mississippi River Habitat Specialist
Wisconsin Department of Natural Resources

The focus of Jeff's 32 plus year career has been coordinating Wisconsin's participation in the selection, design, and monitoring of over 40 federally funded Upper Mississippi River Restoration (UMRR) Habitat Rehabilitation and Enhancement Projects (HREPs). The geographical extent of the Mississippi River he works on is the 231 miles of river between Pool 3 near Prescott, Wisconsin, and Pool 12, at the Illinois and Wisconsin border near Dubuque, Iowa. Jeff is active on many different multi-agency coordination bodies and planning efforts that comprise the UMRR partnership. Jeff is also active in promoting awareness of Mississippi River history and management through presentations, publications, and development of a Mississippi River activity guide for formal and non-formal educators.

In 2003 Jeff was awarded the Department of the Army Commander's Award for Public Service in acknowledgement of his contributions to the Upper Mississippi River partnership and work on Habitat Rehabilitation and Enhancement Projects.

Jeffwill deliver a plenary address entitled *"Upper Mississippi River Restoration – From a Partnership's Vision to over 100,000 Acres of Rehabilitated and Enhanced Habitat"* at 10:00 to 10:30 p.m. on Saturday, Nov. 5 in The Forum (Room 272), Elaine Langone Center.

[Photo: Unnamed stream in Gouldsboro State Park by Nicholas A. Tonelli]

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 River Symposium.

PennState

A "word cloud" visualization of the oral and poster abstracts contributed to this symposium (pages 16-54). Their relative size denotes greater prominence to the words that appear most frequently. A total of 16, 310 words were analyzed.

2022 RIVER SYMPOSIUM

ORAL PRESENTATIONS

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

John W. Clune, U.S. Geological Survey, Water Resource Science Center, 215 Limekiln Road New Cumberland, PA 17070. jclune@usgs.gov; Paul D. Capel, Matthew P. Miller, Douglas A. Burns, Andrew J. Sekellick, Peter R. Claggett, Richard H. Coupe, Rosemary M. Fanelli, Ana Maria Garcia, Jeff P. Raffensperger, Silvia Terziotti, Gopal Bhatt, Joel D. Blomquist, Kristina G. Hopkins, Jennifer L. Keisman, Lewis C. Linker, Gary W. Shenk, Richard A. Smith, Alexander M. Soroka, James S. Webber and Qian Zhang

Inputs of nutrients and sediment increased several-fold during the 18th through 20th centuries compared to pre-European settlement and have taken a toll on ecological and economic aspects of the Chesapeake Bay and surrounding watershed. By the mid- to late-20th century, substantial degradation of water quality compelled bold measures, including establishing the Chesapeake Bay Program partnership in 1983 and the nation's largest and most complex total maximum daily load (TMDL) in 2010. Monitoring and modeling of water quality has expanded to provide a better understanding of the fate and transport of nitrogen in the watershed. Our ability to improve the nitrogen balance in the Chesapeake Bay is dependent on our understanding of how a changing climate, population, land use, and management decisions at all levels of government impact the health of the Bay. A newly published USGS NAWQA circular provides a century-long understanding of how the long-term human activities and environmental changes in the watershed have influenced the export of nitrogen to the Bay and makes forecasts of future effects. This presentation will provide a unique synthesis of the story of nitrogen since early European settlement, with a particular focus on the past and future scenarios for the nitrogen in the Chesapeake Bay watershed from 1950 to 2050. The science, management, and regulatory efforts to save the Chesapeake Bay are unprecedented and if the Nation's largest estuary can rebound, they will serve as a model for the world.

DAMS, RESERVOIRS, AND NUTRIENTS IN THE CHESAPEAKE BAY WATERSHED: PAST TRAJECTORIES AND FUTURE HORIZONS

Kimberly J. Van Meter, Department of Geography, Pennsylvania State University, 302 Walker Building, University Park, PA 16802**;** vanmeterKVM@psu.edu;

River damming has been practiced for millenia to provide irrigation for agriculture, to prevent downstream flooding, and to generate both mechanical and electrical power. The reservoirs behind these dams impede water flow and increase residence times along the land-ocean aquatic continuum, leading them to act as sediment traps and in-stream reactors for nutrients. Global-scale work suggests that reservoirs in major river systems may lead to the denitrification of up to 50% of total riverine N inputs. The Chesapeake Bay Watershed is home to thousands of dams, from small mill dams to the large Conowingo Dam on the lower Susquehanna River. Recent work has shown that the biogeochemical functionality of the Conowingo Reservoir has changed over time, and that the reservoir system has become less efficient at retaining both sediments and nutrients. Other work has shown that mill dams, which have led to significant accumulation of legacy sediments and nutrients, are now contributing to increased suspended sediment loads to the Chesapeake Bay due to channel incision and widening. Across the Chesapeake Bay Watershed, however, there is little understanding of the cumulative effects of the many dams and reservoirs on nutrient loading to the Bay, and of how these effects may change under future scenarios, including a changing climate, aging infrastructure, and increased removal of small dams. Here, I will discuss the current state of knowledge regarding the changing effects of dams and reservoirs on Chesapeake Bay Watershed nutrient loads. I will then present the results of our new work, in which we use both data synthesis and a process-based modeling approach to quantify the time-varying effects of reservoirs on riverine N loading across the Chesapeake Bay Watershed, and to explore the long-term implications of these effects for Chesapeake Bay water quality.

[Photo: Arron Harrington]

DATA DRIVEN APPROACHES TO BETTER ESTIMATE RIVER CHANNEL GEOMETRY OVER THE CONTINENTAL UNITED STATES (CONUS)

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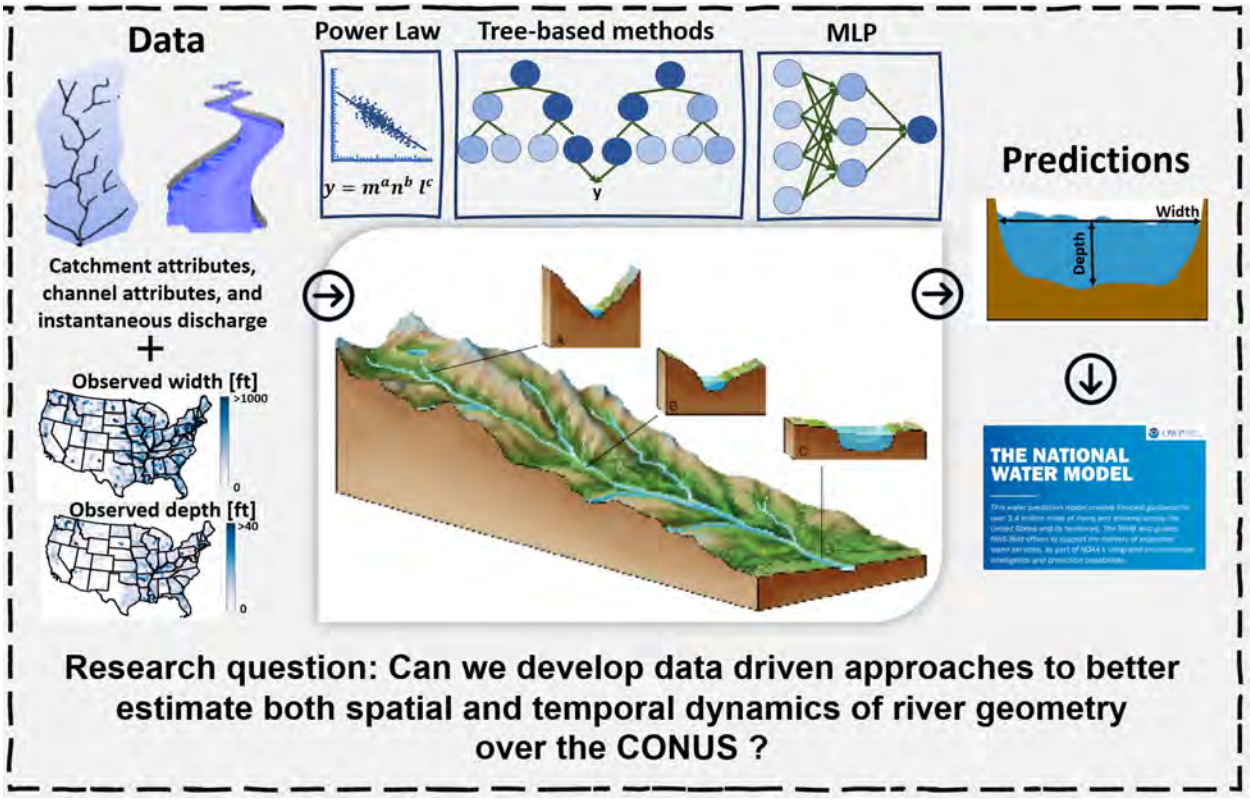
The representation of river channel geometry is important for hydrologic and hydraulic modeling of natural systems. However, an entire subfield of hydraulic geometry from the 1950s to present has largely focused on empirical power-law relationships between streamflow or drainage area and river mean depth and width. These well-established, commonly applied regional hydraulic curves do not consider many potentially relevant climatic, geological, anthropogenic, and catchment factors, and are limited in accuracy. Therefore, improvements over simplistic channel representations will more closely approximate the true channel shape dynamics and potentially improve continental-scale hydrology simulations, especially flooding inundation mapping. This work reports high-quality machine learning channel geometry models using an unprecedentedly large continental-scale dataset. This knowledge paves the way for developing end-to-end models customized for many continental-scale hydrology models, such as the National Water Model (NWM)'s Next Generation framework, which aims to integrate different models and promote model interoperability.



HOW DOES URBANIZATION AND REGION MATTER? DETERMINING METRICS OF STREAM FLASHINESS FOR THE DELAWARE WATERSHED

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Increasing frequency of intense rainfall events and flood damages in the northeastern U.S. suggest a corresponding increased need for a quantitative understanding of the drivers of flash-flooding, and improved flash flood warning systems. Although several metrics of stream flashiness are available, the effectiveness or sensitivity of the various measures has not been well established. Moreover, watershed behaviors are very dependent on region, urbanization, and other watershed characteristics. We focus on the Mid-Atlantic where heavy precipitation and large flood events have increased in recent decades, and urbanization over the past century has transformed flow regimes of many streams. The dataset includes streams with a continuous flow record from 2010 to present, limited reservoir storage and flow regulation, and drainage area less than 250 sq km. We show that rural and suburban watersheds behave similarly in regard to flashiness, whereas urban watersheds are distinctly different, with the cutoff of urban vs suburban at 75% development. Moreover, our findings suggest that flash flood models and determining flow metrics should be unique by region.

[Image: Rachel Hurley]

STATUS OF THE EASTERN HELLBENDER IN THE LOYALSOCK CREEK WATERSHED

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The Eastern Hellbender salamander (*Cryptobranchus a. alleganiensis*) underwent a precipitous decline in the Loyalsock Creek watershed from 2006-2010, and regular annual searches of two historic hellbender locations generally failed to find hellbenders at those sites. Although hellbender sightings in the watershed are occasionally reported by sportsmen and recreationists, no comprehensive survey has been conducted to determine if viable hellbender populations still exist in the main stem. During July and August of 2021 and 2022, SCUBA surveys were made of deep-water sites in the main stem, as deep as 10m, to determine the availability of food resources (crayfish), water quality, habitat availability, and the presence or absence of hellbender salamanders. We found abundant Rusty Crayfish (*Faxonius rusticus*) at all sites between Montoursville and Forksville, but no viable crayfish populations between Forksville and World's End State Park. Water quality was within normal limits, but habitat quality varied from site-to-site. Most survey sites had zero, one, or two adult hellbenders in residence, but we also found two deep water sites with three or more adults. Most individuals were inaccessible and deep inside crevices and caves within solid bedrock, or beneath massive rock slabs atop the stream pavement. The sites with the largest number of hellbenders also had the lowest density of crayfish prey. Of the nine captured adults, 5 were females and 4 were males which means that some reproduction likely takes place each year. However, no population recovery can be assumed as no larvae, juveniles, or sub-adults were observed during either year and the number of adults is far below the typical adult density of one adult per linear meter of stream length.

[Photo: Peter Petokas]

LINKING IN-STREAM AND LANDSCAPE-LEVEL CONDITIONS TO MACROINVERTEBRATE ASSEMBLAGES IN THE LITTLE JUNIATA RIVER WATERSHED

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The Little Juniata River is a renowned wild brown trout fishery that drains central Pennsylvania to the Susquehanna River at Duncannon. Despite numerous anthropocentric factors that continue to threaten watersheds world-wide, little is known about the conditions in the Little Juniata River watershed that supports its popular cold-water fishery. Consequently, we conducted a watershed-wide study to classify current ecosystem conditions. We surveyed basic water chemistry and benthic macroinvertebrate assemblages, and we also measured in-stream physical habitat conditions and examined land use land cover data for 46 different sites throughout the watershed. Macroinvertebrate IBI scores varied widely from pristine to highly degraded. Both IBI scores and macroinvertebrate assemblages varied with water chemistry and with various measures of in-stream condition and watershed-scale land use. Landuse relationships will allow us to model in-stream conditions across the watershed in un-samples tributaries to provide insight for prioritizing restoration and protection efforts in the watershed.Alabama Water Institute's New NOAA Cooperative Institute for Research to Operations in Hydrology

[Photo: Blaire County Water]

IDENTIFYING BEST MANAGEMENT PRACTICES (BMPS) THROUGH REMOTE SENSING

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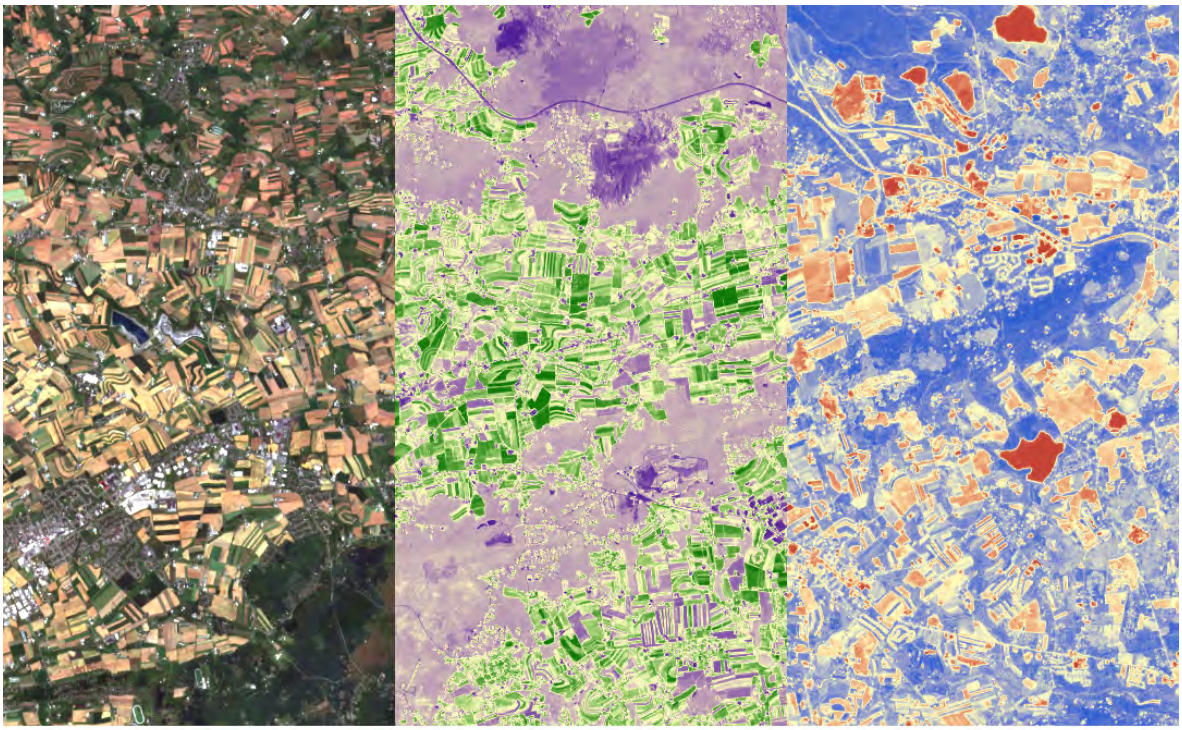
Best management practices (BMPs) are at the core of restoring ecological communities and reducing excessive nutrient and sediment loads in our broken waterways. In determining the best application of these tools, documenting existing BMPs, assessing their current impacts, and identifying opportunities for greater implementation are key. This presents watershed planners with a challenge: how do we build BMP inventories while balancing efficiency and accuracy, particularly at larger scales? Methods such as field surveys and transects are often employed, but are labor- and resource-intensive, must be completed in inflexible time windows, and are susceptible to human errors and biases. In other instances, aggregated datasets at the county, regional, or state level are used, saving time and resources, but doing so at the expense of valuable geographic specificity. Even when detailed, spatially-specific data exists, it is often rendered inaccessible due to issues of cost, confidentiality, and/or propriety. Thankfully, remote sensing offers an alternative approach that can increase efficiency, accuracy, availability, and scalability in documenting BMPs. The Chesapeake Bay Foundation (CBF) explored a variety of such methodologies in the development of two Section 319 watershed implementation plans: Marsh Creek (44.5 mi^2, HUC-12, Centre County) and the Upper Conestoga River (61.1 mi^2, HUC-12, Lancaster, Berks, and Chester counties). CBF was able to establish the location and extent of multiple BMPs (cover crops, tillage, riparian buffers, etc.), assess relevant conditions and detrimental practices (bank loss, winter manure spreading, etc.), and track changes over time. All data that was used is publicly available, free of charge, with subsequent analysis having been completed using ArcGIS, Google Earth Engine, and/or ENVI software packages. The results have demonstrated high degrees of spatial and temporal accuracy, ease in scalability, and efficiency in terms of cost, labor, and time. Ultimately, the inventories CBF derived from remote sensing will be used in hydrological modeling, development of community-driven strategies, and tracking BMP implementation going forward. Based on CBF's experience, these methodologies serve as effective tools for watershed planning, with future opportunities throughout the Susquehanna River Watershed and beyond.



UNION COUNTY BUFFER MAINTENANCE PROGRAM

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Chesapeake Conservancy has partnered with Union County Conservation District, Alliance for the Chesapeake Bay, and Buffalo Creek Watershed Alliance to create a pilot streamside tree stewardship program in Union County. The partnership has worked together to create a local branch of Alliance for the Bay's Riparian Ranger program to address growing buffer maintenance needs in the county. This presentation will highlight the need for the program from the perspective of the Conservation District, along with the role they played to make the program successful. We will also highlight Chesapeake Conservancy's role, the importance of volunteers, scaling this program to new regions, and more. This presentation will emphasize the importance of maintaining buffers and how to do it successfully at a larger scale

IS BUFFALO CREEK IN UNION COUNTY SAFE FOR RECREATION?

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Many of Pennsylvania's waterways are unfit for drinking and recreation due to bacterial impairment, and this is not a new problem. Nearly ten years ago the then-chairman of the Buffalo Creek Watershed Alliance of the Linn Conservancy (BCWA), Ben Hoskins, penned a letter to the editor of Sunbury's The Daily Item, detailing bacterial pollution in Buffalo Creek and Limestone Run in Union County, PA. Our work, a collaboration between the Department of Civil and Environmental Engineering at Bucknell University and the BCWA, shows that ten years later, high levels of fecal bacteria continue to make Union County's waterways unsafe for recreation. The main goal of this project is to conduct microbial source tracking (MST) to determine the source(s) of bacterial pollution at different locations along Buffalo Creek. This summer we monitored 14 sites along Buffalo Creek (12) and Limestone Run (2) for total fecal coliforms and specifically E.coli. We also monitored the following standard water quality parameters: TSS, turbidity, DO, pH, conductivity, and temperature. A Spearman correlation indicated significant ($p<0.01$) negative monotonic correlations between temperature and total coliforms, as well as DO and turbidity and DO with total coliforms; thus as one parameter increases, the other decreases. Positive monotonic correlations were identified between turbidity and total coliforms, turbidity and TSS, and E. coli with total coliforms; when one parameter increases the other does as well, but not necessarily in a linear fashion. Bacterial results show that all 14 sites sampled were unsafe or impaired for recreational use, based on levels of E. coli and DEP recommendations. Preliminary MST is underway and potentially will reveal the animal source(s) of the fecal coliform contamination from these same locations, which will aid in the BCWA's efforts to limit the entrance of these pollutants into Buffalo Creek and other Union County waterways.

CONSTRUCTION METHODS AND INITIAL SALMONID AND WETLAND MONITORING OF THE LITTLE ARNOT RUN LARGE WOOD RESTORATION PROJECT

Luke Bobnar, Western Pennsylvania Conservancy, 159 Main St, Ridgway, PA 15853, lbobnar@paconserve.org; **Charles M. Keeports**, **Grace M. Tillotson, Daniel E. Fenstermacher**, U.S. Forest Service, 4 Farm Colony Dr, Warren PA, 16365; **Benjamin Hayes**, Watershed Sciences and Engineering Program, Bucknell Center for Sustainability and the Environment, One Dent Dr, Lewisburg, PA 17837

Unregulated, historic human activity associated with the extraction of renewable and non-renewable resources has had a profound impact on aquatic and riparian ecosystems broadly in Pennsylvania, and in the Allegheny National Forest in particular. The historic removal of timber from upland, riparian, and stream channel areas; berming and road-building activities for timber removal or mineral resource development; and channelizing of streams to facilitate these activities have reduced the connectivity of stream-valley ecosystems. Project partners identified Little Arnot Run (6.05 stream miles, 3.7 square mile watershed) in Warren County, PA, as a model 'working watershed' to install and quantify the effects of adding large woody materials to the stream channel and floodplain, while simultaneously removing sections of historic berms to re-establish connections between the channel and floodplain. This presentation will discuss construction methods and monitoring parameters undertaken by the USDA Forest Service and Western Pennsylvania Conservancy at Little Arnot Run (treatment site) and Cherry Run (control site) including salmonid breeding activity and changes to wetland areas. In Little Arnot Run 287 pieces of large wood (trees > 6" DBH with limbs and with or without rootwads) were added to approximately 1,700 linear feet of the mainstem and a 14.6-acre area of the floodplain in late August-early September, 2021. Directional felling began in late March, 2022, and was completed in May, 2022. Approximately 732 pieces of large wood (cut boles with no rootwads) were installed over 2.66 miles of the Little Arnot mainstem and perennial to intermittent tributaries upstream of the heavy equipment work area. Salmonid breeding activity (creation of redds) decreased at Little Arnot and Cherry Run from 2020 to 2021, though less so in the treatment watershed. Young of the year (YOY) salmonids were observed in both watersheds in the spring following construction, with some in Little Arnot inhabiting former hemlock-beech upland areas. Pre-construction to post construction wetland delineations showed a net increase of 0.35 wetland acres in Little Arnot as well as several areas observed to be likely transitioning to a wetland condition, while no net loss or gain in wetland acreage was observed in Cherry Run. Monitoring efforts are ongoing, and projected to continue for the next 10 years.

[Photo: Luke Bobnar]

SUMMARY OF WATER QUALITY MONITORING FOR THE LITTLE ARNOT RUN LARGE WOOD RESTORATION PROJECT

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Legacy human activity associated with the extraction of renewable and non-renewable resources has had a profound impact on water quality broadly in Pennsylvania, and in the Allegheny National Forest in particular. During the 1800's to early 1900's, the removal of timber from upland, riparian, and stream channel areas; berming and road-building activities for timber removal or mineral resource development; and channelizing of streams to facilitate these activities have reduced organic retention and connectivity of stream-valley ecosystems which has had negative effects on water quality. Project partners identified Little Arnot Run in Warren County, PA, as a model 'working watershed' to install and quantify the effects of adding large woody materials to the stream channel and floodplain, while simultaneously removing sections of historic berms to re-establish connections between the channel and floodplain. This presentation will discuss project objectives and water quality monitoring undertaken at Little Arnot Run (treatment site) and Cherry Run (control site). One of the project goals is to improve water quality within the watershed, including nutrient retention and cycling and reduction of dissolved inorganic aluminum. We have collected replicate water samples monthly since September 2019 to monitor a variety of parameters. Water samples are collected by hand at six stations on Little Arnot Run and two stations on Cherry Run. At this time there are insufficient results to detect changes in response to restoration work that was initiated in August 2021 and completed in May 2022. Since 2019, notable seasonal and spatial variations in pH and dissolved inorganic aluminum have been observed within each watershed.

SUMMARY OF ORGANIC MATTER CONTENT CHANGES IN LITTLE ARNOT RUN, ALLEGHENY NATIONAL FOREST

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Due to human activity, many headwater streams in Pennsylvania have become incised, resulting in a myriad of issues including stream bank erosion and increased discharge during storm events. Small streams serve as a critical link between terrestrial and downstream ecosystems in transporting organic material. Both dissolved (DOC) and particulate (POC) organic carbon play a role in the global carbon cycle and serve as an energy source for aquatic heterotrophic bacteria. In the Allegheny National Forest, the primary cause of moderate vertical incision of streams can be traced back to timber harvesting practices of the late 1800's to early 1900's that removed trees from along and within stream corridors. Additionally, Little Arnot Run was likely channelized by an old railroad grade that ascends the valley. To improve floodplain connectivity, we implemented adaptive management strategies by placing whole trees (with canopy and rootwad) and cut logs in the stream channel and its floodplain. One of the project goals was to increase carbon storage within the watershed. We have collected replicate water samples monthly since September 2019 to monitor changes in DOC and POC concentration and DOC quality (absorbance and fluorescence). Water samples were collected by hand at six stations on Little Arnot Run and two stations on Cherry Run (i.e. control sites). Since 2019, there has been a strong seasonal cycle in the organic carbon data. Results to date indicate little change in DOC concentration/quality and POC concentration in response to restoration work that was initiated in August 2021 and completed in May 2022.

[Photo: Little Arnot Run, Allegheny National Forest]

PRELIMINARY ASSESSMENT OF PLANT COMMUNITY COMPOSITION OF THE LITTLE ARNOT RUN LARGE WOOD RESTORATION PROJECT

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The Allegheny National Forest and partners identified the Little Arnot Run watershed in Warren County, PA, as a model 'working watershed' to restore natural connections between the creek channel and floodplain lost as this area was developed for timber and natural gas extraction. In this presentation, we will review the methods used and baseline survey results of vegetation monitoring to assess the change in plant community composition of Little Arnot Run's riparian ecosystem over the next 10 years following addition of large woody materials to the stream channel and removal of historic berms installed to control flooding. We recorded all species of vascular and non-vascular plants along five transects across the Little Arnot Run valley prior to restoration activities, which were initiated in August, 2021 by Allegheny National Forest and Western Pennsylvania Conservancy and completed in May, 2022.

RESILIENCE CONVERGENCE DURING COUNTY & LOCAL DRIVEN HAZARD MITIGATION PLAN IMPLEMENTATION & GRANT DEVELOPMENT SESSIONS

Thomas Hughes, PA Emergency Management Mitigation, Insurance and Resilient Communities Office at Pennsylvania Emergency Management Agency - Harrisburg, PA, 17104, thughes@pa.gov; **Angel Gillette,** Federal Emergency Management Agency, Region III, **Bobby Cobelli**, Susquehanna River Basin Commission, 4423 N Front St, Harrisburg, PA 17110

PEMA/SRBC Plan Implementation Grant Development Meetings Discussion The Pennsylvania Emergency Management Agency (PEMA) and the Susquehanna River Basin Commission (SRBC) will be convening a two-part Hazard Mitigation Plan Implementation and Grant Development (PIGD) Workshop in November (Day 1 – 3 offerings, same information 4 hours) and in December (Day 2 – 3 offerings same information 4 hours) within the UPPER Pennsylvania area of the Susquehanna River Basin. Local Flood resilient partners will register for the introductory webinar that fits your schedule and the federal and state partners will assist the locals in development flood resilient applications for future funding opportunities at no cost for the development and build in local management costs for the execution of these projects. SRBC, PEMA And FEMA are making sure river towns and communities are aware of this great opportunity and a registration site can be reached at: https://mdw.srbc.net/plan-implementation-grant-development-meetings/index.html The purpose of the introductory webinar is to prepare attendees for the PIGD Workshops which are designed to help municipalities connect the dots between Hazard Mitigation Planning and Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance (HMA) grant application development and access other funding streams for possible cost share. Through these efforts, municipalities and eligible authorities will be equipped with tools to advance their mitigation, recovery, and resilience priorities. PEMA is committed to providing applicants office hours to fully develop their applications as well – if the FEMA funds can't be obtained, communities will be well on their way for other potential funding streams. These efforts are being funded by FEMA Flood Mitigation Assistance (FMA) Advanced Assistance grant awards. The goal of the awards is ultimately for PEMA to advance a resolution with multiple project applications from the Middle Susquehanna Watershed for FEMA funding approval. PEMA and SRBC will assist municipalities in developing, selecting, and prioritizing complete grant application proposals for existing local project priorities for Federal Emergency Management Agency (FEMA) and other potential funding and cost-share opportunities, as well as get the process started in the FEMA GO (Grants Outcome) on-line platform.

ALABAMA WATER INSTITUTE'S NEW NOAA COOPERATIVE INSTITUTE FOR RESEARCH TO OPERATIONS IN HYDROLOGY

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The Alabama Water Institute (AWI) is an interdisciplinary water research institute at the University of Alabama. AWI's mission is to provide actionable, novel solutions for a more water-secure world by training the next generation of scientists. In April of 2022, AWI was awarded the first NOAA Cooperative Institute to be located within the National Weather Service. The $360 million Cooperative Institute for Research to Operations in Hydrology (CIROH) is a consortium of 28 academic and private partners who will work together, in unison with the National Water Center, to create the next generation of flood prediction in the United States. This talk will give a brief overview of AWI and CIROH.

EMPOWERING EVERYDAY PEOPLE TO MAKE REALISTIC CHANGES

John Zaktansky, Middle Susquehanna RiverKeeper Association, 112 Market Street
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Middle Susquehanna Riverkeeper John Zaktansky, is a member of the Waterkeeper Alliance. A global movement uniting more than 300 Waterkeeper groups around the world, focusing citizen action on issues that affect our waterways, from pollution to climate change. The Waterkeeper movement patrols and protects over 2.75 million square miles of rivers, lakes, and coastlines in the Americas, Europe, Australia, Asia and Africa. In 2004, nine individual Riverkeeper programs within the Chesapeake Bay watershed came together as a regional coalition of Waterkeeper programs to build regional campaigns. The growth of the network of Waterkeepers has doubled since 2004 to now include 17 Waterkeepers. Riverkeeper John Zaktansky will offer a short overview about the importance of translating complex river topics in a way that best engages, educates and empowers everyday people to make realistic changes. This will include some examples and tips that can be used on a variety of topics to help simplify the message without losing the true essence of the impacts and urgency the topic may deserve

REGENERATIVE AGRICULTURE AT BUCKNELL FARM: CARBON SEQUESTRATION, WATERSHED AND SOIL CONSERVATION

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The Bucknell Farm, established in 2018, is a 5 acre regenerative farm, located on Bucknell University's campus. Every farm has an obligation to prevent nutrient runoff and soil erosion. Over the past four years, student farmers, working alongside farm staff, have implemented key regenerative techniques supporting soil and watershed conservation. On a steep slope, they have started an orchard using contour ditches and berms to catch rainwater as it runs downhill. This prevents farm nutrient runoff into local streams and soil erosion, while providing additional water to fruit trees. Their vegetable crop rotation includes cover crops, which sequester carbon in the soil, fix nitrogen instead of using synthetic fertilizers, and suppress weeds. Additionally the Bucknell Farm participates in Pasa Sustainable Agriculture's Soil Health Benchmark Study with over 100 other vegetable, row crop and pastured livestock farms in our region, to learn how farm field management practices impacts soil health, carbon sequestration and crop yield. (https://pasafarming.org/soil-health-benchmark-study/) These regenerative techniques are rooted in thousands of years of indigenous farming practices, both historic and contemporary.

THE BUCKNELL GREENWAY: A LIVING AND LEARNING LABORATORY IN THE SUSQUEHANNA GREENWAY

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The national greenway movement has affected the mid-Susquehanna Valley through the Susquehanna Greenway Partnership and the establishment of the Captain John Smith Chesapeake Bay National Historic River Trail, among other efforts. Bucknell University is establishing a Bucknell Greenway that it is hoped will integrated with those earlier projects. Current efforts include developing faculty and staff plans for curriculum and research on the Greenway, restoration of micro-habitats along the corridor loops, design of links to river and creek corridors, and ongoing work by students on public storytelling and art projects featuring historic aspects of the landscape, continuing the Stories of the Susquehanna Valley project. The project takes inspiration from the indigenous wisdom of the Seventh Generation concept featured in public art on the Bucknell campus, in developing links between human and non-human residents and landscapes of the watershed. In addition it draws on fields of environmental semiotics and environmental philosophy related to the work of Pennsylvania semiotician Charles Peirce of Milford and his friend and neighbor Gifford Pinchot, and nature writings by James Fenimore and Susan Fenimore Cooper at the headwaters of the Susquehanna. This paper will indicate those Native and Pennsylvanian philosophical roots as underpinnings for the projects being pursued "on the ground" to help further Bucknell's goal of a sustainable university campus, and indicates ways in which the Susquehanna watershed's landscape can help build human community with nature today.

2022 RIVER SYMPOSIUM

POSTER PRESENTATIONS

[Photo: Unnamed stream in Gouldsboro State Park by Nicholas A. Tonelli]

MICROBIAL EXTRACELLULAR ENZYMES RESPOND TO BROWNING AND ALTRERATIONS TO THE RIPARIAN AND UPSTREAM FOREST COVER IN HEADWATER STREAMS

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Headwater streams flowing through forested landscapes receive much of their energy from terrestrial sources consisting of coarse, fine, and dissolved organic matter (OM). Most of this OM is broken down and processed by bacteria and fungi. These microorganisms produce extracellular enzymes to facilitate the catabolism and uptake of carbon and nutrients from recalcitrant OM. The relative activities of these different extracellular enzymes can potentially indicate the relative importance of the various organic compounds fueling these systems. Because spatial cover and composition of forest cover likely influences the quantity and type of OM fueling these systems, we hypothesized that changes in upstream and adjacent forest cover would be reflected in biofilm extracellular enzyme activities. Furthermore, because freshwater systems are at an elevated risk of stream browning due to climate change, we also hypothesized that differences in stream browning would also be reflected in the extracellular enzymes. We tested this hypothesis by sampling 46 headwater streams throughout the upper Delaware River basin. We sampled epilithic biofilms for biomass, nutrient content, and the activities of seven extracellular enzymes. For each stream, we also measured ecosystem respiration, gross primary productivity, total nitrogen, total phosphorus, dissolved organic carbon, chromophoric dissolved organic matter (CDOM), specific UV absorbance, adjacent canopy cover and upstream forest cover. This allowed us to investigate potential linkages between the response of extracellular enzymes in biofilms and both riparian canopy cover and upstream land cover, as well as the CDOM concentrations that influence stream browning. Relationships between extracellular enzyme activity and canopy cover were found during this investigation.

LONG TERM ANTHROPOGENIC PHOSPHORUS SINKS AND SOURCES ACROSS THE CONTINENTAL US

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The overuse of phosphorus (P) from fertilizers and detergents and the intensification of livestock production have led to an increase in the incidence of eutrophication events and harmful algal blooms. Excess P can accumulate across the landscape, becoming long-term sources of P in surface waters. The lack of understanding of the sources, sinks, and storage of P across US watersheds precludes the development of meaningful policies to improve water quality. Thus, it is crucial to develop comprehensive datasets to quantify the trajectory of different sources of P across spatial scales. Here, we construct a comprehensive, 88-year (1930 to 2017) dataset of county-scale P surplus trajectories across the continental US. P surplus is the difference between P inputs (inorganic fertilizer, manure, human waste, atmospheric deposition, detergents) and non-hydrological output (crop uptake). We find regions that are accumulating and depleting in P stores and changes in the dominant sources of P over the past 88 years. We also find that the national P use efficiency (PUE), the ratio of P removed from crop uptake to the P supplied through fertilizers, varies in space during the past decades. At the national scale, we observed a downward trend in PUE after 1930 until the 1970s, at which point PUE began to increase. Insights from P surplus and usage trajectories can improve our understanding of long-term nutrient dynamics and can work as a powerful tool for modelling the impacts of nutrients on past, present, and future environmental outcomes.

ROLE OF NUTRIENTS IN MEDIATING THE EFFECTS OF ALGAL-PRODUCED LABILE CARBON EXUDATES ON THE DECOMPOSITION OF DETRITAL ORGANIC MATTER IN STREAMS

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Exudates from primary producers can either increase or decrease the rates of terrestrial organic matter decomposition in streams. However, the factors that determine if this priming effect is positive or negative are not fully understood. The goal of this study it to better understand whether microbial biomass, enzymes activities, and decomposition rates are affected under different nutrient and light conditions. The experiment will include 12 rain gutters submerged in the stream. Six were covered with black shades and the other six covered with clear plexiglass. Each gutter will contain cotton strips and wood veneer. In three of the blacked out rain gutters and three of the clear covered rain gutters, packets of slow dissolving fertilizer pellets are attached to create high nutrient treatments. After being submerged in the stream for one month, cotton and veneer decomposition will be measured using tensile strength and percent biomass lost. Other tests will include measuring bacterial biomass, fungal biomass, and algal biomass, biofilm N and P, enzyme activities, and fungal sporulation rates. We hypothesize that there will be slower rates of decomposition in the high light and low nutrient conditions due to more labile carbon algal exudates than the algae in low light and high nutrient conditions. This will lead to a negative priming where microbes and fungi will prefer to consume the labile carbon than the recalcitrant detritus carbon source. The results of this study can be used to further understand priming and its roles in climate change, carbon movement, and ecosystem management.

SPATIAL AND TEMPORAL VARIATIONS IN STREAM AND GROUNDWATER TEMPERATURES IN A FORESTED CATCHMENT IN ALLEGHENY NATIONAL FOREST PA

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This study looks at stream and groundwater temperature in Little Arnot Run watershed, which drains an area of 9.5 km2 in the Allegheny National Forest. Temperature data were collected from 4 stream gage stations, 13 piezometers, and a weather station, from 2019 to present. This data was combined with weather station data to continue to find key factors that influence the spatial and temporal variability in both in-stream and adjacent unconfined aquifers. In August 2021, modifications to the valley floor included the addition of large woody debris and grade control structures in the channel as well the partial removal of berm on the floodplain. These activities modified the groundwater elevation and amount of water diverted to abandoned side channels. Lateral variations. At two locations, a line of piezometers and stream gages provided a glimpse into lateral variations stream to a distance of up to 300m from the channel. As expected, stream temperatures are cooler than the groundwater during the fall and winter months (September to April), reflecting long-wave radiation losses and lower air temperatures. During the spring and summer months (April to September), groundwater is cooler closer to the stream and gets warmer moving further away. Groundwater flow is away from the stream. After the restoration project, the stream temperature moves closer to the groundwater temperatures, likely due to more hyporheic exchange. Longitudinal variations. As the stream flows down through the watershed longitudinally, the temperature of the stream and groundwater changes depending on the season and the restoration work done. The biggest trends in groundwater can be seen in the winter and summer seasons. In winter, as the water moves downstream, the groundwater gets cooler. Due to the restoration work, during the winter the groundwater significantly drops in temperature in the restoration area zone. In the summer months, groundwater slowly warms up moving downstream. In comparison the water temperature within the stream for winter months actually increases moving downstream while in the summer months stream temperature slowly increases. Restoration work to the stream causes warming to the stream in winter months and cooling to the stream during summer months. This study will continue to collect data and monitor the gage-stations and piezometers to assess long term changes to the watershed due to the restoration work. Other factors like solar radiation seem to not be a dominant factor influencing spatial variations due to tree canopy cover. Latent heat transfer from air is important as evident in seasonal and diurnal. However, the dominant influence is tributary inflows during rainfall events and hyporheic exchange during base flow conditions during the summer and fall.

USE OF SEX-LINKED GENES IN EASTERN HELLBENDERS (*CRYPTOBRANCHUS A. ALLEGENIENSIS*) TO ASSESS POPULATION DEMOGRAPHICS

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The ratio of sex in a population gives us valuable insight into the management of wildlife species, especially for endangered species. Due to ongoing climate issues, the population of eastern hellbenders (*Cryptobranchus a. alleganiensis*) have been drastically declining in recent decades. Even though eastern hellbenders exhibit behavioral sexual dimorphism, males and females do not show distinct morphological differences. The most reliable external morphological feature between sexes is swelling around the cloaca, although this is only expressed during the breeding season. This makes traditional methods of identifying the sex of eastern hellbenders a difficult task outside the breeding season, which can be troublesome to field researchers and facilities that keep captive eastern hellbenders in a number of ways. However, we are able to utilize the fact that *Cryptobranchus* salamanders possess a ZW system of female heterogamety to perform genetic assays on W sex chromosomes and identify sex-linked genes. By analyzing tissue samples of specimens, we are able to determine their genotypic sex. This technique was used to assess the demographic of a hellbender population in Buffalo, NY. Our research will help assess the health of known hellbender populations and inform better conservation efforts.

VISUALIZATION OF ACID MINE DRAINAGE IN THE SHAMOKIN CREEK WATERSHED

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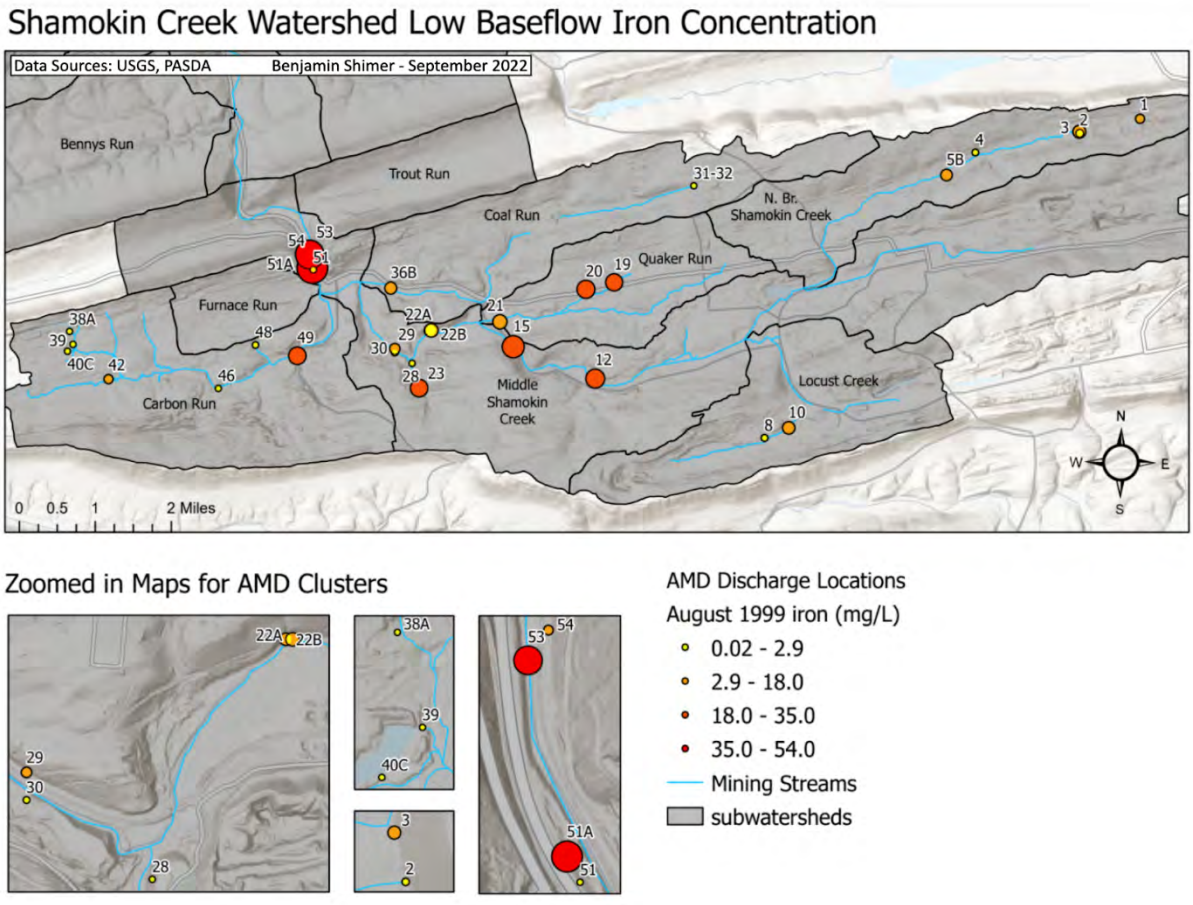
The Shamokin Creek Watershed is located in the anthracite region of Pennsylvania and experiences significant consequences from the rise and fall of coal mining in the area. The economy and environment saw downturns in the region, with the latter specifically seen through acid mine drainage: a chemical reaction that occurs between water and mining waste that can leak into nearby waterways. This has negatively impacted the Shamokin Creek and its surrounding tributaries, and the mining history has residual consequences on the socioeconomic status of the area as well. Through the Katherine Mabis McKenna Foundation Summer Environmental Internship and Bucknell's Center for Sustainability & the Environment, a partnership with the Shamokin Creek Restoration Alliance (SCRA) was established to use GIS to visualize and analyze socioeconomic data, potential mining factors, and water chemistry data related to acid mine drainage and mining legacy in the Shamokin Creek watershed. Data collection and visualization of socioeconomic data demonstrates the areas near AMD discharge points to have markedly higher rates of household poverty, vacancy, and disability while having lower median incomes and education rates compared to state averages and even nearby towns. Mining factors that could influence acid mine drainage were mapped including the general mining region, mine slopes, drifts, and shafts, mine spoils, and boreholes. These were presented along with nearby streams and showed hundreds of locations where water could be entering mines to react with mine waste and be discharged as acid mine drainage into the Shamokin Creek watershed. Mapped water chemistry data at discharge locations and stream locations identifies the chemical composition of each discharge and how it has impacted the creeks and streams that make up the watershed. AMD discharge chemistry can guide optimal treatment processes. Various stream samples in the maps are not compliant with PA's water quality standards for pH, iron concentration, and aluminum concentrations.



PHYSICAL DIFFERENCES BETWEEN TWO RESERVOIRS IN THE UPPER MIDDLE CREEK DRAINAGE AND THEIR IMPACTS ON SELECT DOWNSTREAM CHEMICAL AND PHYSICAL PARAMETERS DURING JUNE AND JULY 2021 AND 2022

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We studied two reservoirs in the upper Middle Creek system in Snyder County Pennsylvania during the summer months of June and July, 2021-2022 to assess the influence of each reservoir on its respective stream system when they could become stratified. Our results provide some insights into the variability of impoundment morphometric parameters and their influences on selected chemical and physical parameters. Upper Middle Creek has two major branches, North Branch and West Branch with reservoirs interrupting flow of each one. The two reservoirs are about 4km apart, but they differ in most morphometric measures (e.g. length, mean depth, volume, and size of the drainage basin). The North Branch reservoir is called Walker Lake, which is long and deep (length=3.5km, mean depth=4m, volume=3.88km3, and drainage basin=45.6km2). A bluff on the south side of Walker shelters the reservoir from mixing, and the relatively small drainage basin provides low flushing rates, both of which allow the reservoir to stratify throughout the summer. Faylor Lake, on the West Branch, is rounded and shallow (length=0.80km, mean depth=1.5m, volume=0.86km3, and drainage basin=85.86km2) and rarely stratifies. Trends in temperature reflected the topography and drainage of the two systems; for instance, Walker Lake is deep (maximum depth = 9m) and narrow, but Faylor Lake is shallow (maximum depth = 3.5m) and wide. A reflection of the differences in depth and concomitant stratification is reflected best in each reservoir's influence on stream temperature. The average percent temperature decrease in the stream below Walker Lake was 27% while Faylor Lake warmed its stream by 16% in 2021 and 25% in 2022. Productivity of these impoundments is high, reflected by their impacts on alkalinity and conductivity. The drop in alkalinity from above to below Walker Lake averaged 32% while Faylor Lake fell 24% during the sample period of 2021 and 2022. We interpret the changes in alkalinity to reflect the precipitation of calcium carbonate following the disequilibrium of inorganic carbon by high carbon dioxide uptake during photosynthesis. Conductivity shows a very similar trend with conductivity decreasing by 25% and 30% in the Faylor and Walker systems, respectively. Production in Walker Lake is dominated by Cyanobacteria species, which tend to form surface blooms and shade the lower levels of the water column. Faylor Lake is shallower and dominated by Chlorophyta and the free-floating macrophyte Ceratophyllum, which suggests that the water column has sufficient light to support photosynthesis.

DIFFERENTIAL SIZE AND GROWTH OF MALES AND FEMALES IN A PENNSYLVANIA POPULATION OF THE EASTERN HELLBENDER

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We used RFID scanning, rock lifting, and hand capture to collect morphometric and growth data for a discrete population of the Eastern Hellbender in north-central Pennsylvania. Using historic data and newly collected measurements, we assessed growth and health changes among male and female hellbenders. Adult hellbenders exhibit size dimorphism with females attaining a larger average total body length and mass. Based on a significant difference in scaled mass index (SMI), females seem to be healthier than males. SMI analysis of historic data also suggests that the sample of hellbenders collected during this study were healthier in 2022 than they were in 2013. Age and growth rate were estimated from historic annual growth data. Males initially grew more rapidly than females, but then plateaued while females continued significant growth, thus explaining why females reach a larger average total body length and mass.

PENNSYLVANIAN AMPHIBIAN GUIDE

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Amphibians are abundant forms of wildlife in aquatic freshwater as well as ecosystems. As a critical indicator of environmental health, the importance of education regarding local species and their conservation requires emphasis. The aim of this project is to create an interactive and online Pennsylvanian Amphibian Guide which enables users to identify the various amphibian species recorded throughout the state of Pennsylvania while being provided educational information in a way that is clear and concise. The project utilizes Microsoft PowerPoint software to create an interactive and visually appealing field guide that learners of various ages and educational backgrounds can find useful. Within the guide, local amphibian species will each have a dedicated slide where the Takahashi lab's main foci of Ecology, Ethology and Conservation act as the lens in which species information is organized. The interactive features of the guide take advantage of PowerPoint's Icons, which can be found throughout the presentation acting as visual cues for information. When embedded with hyperlinks, the inserted icons become an efficient navigational tool as well as a simple gateway to increased understanding, whether that be through supplementary audio, or video self-produced by the lab. Upon completion, the Pennsylvanian Amphibian Guide will be available on the Takahashi Lab website as an educational resource for current and future lab members along with the general public with the hopes of increasing overall recognition and understanding for our state's Amphibian species.

QUANTIFYING MICROPLASTICS IN FRESHWATER FISH IN CENTRAL PENNSYLVANIA

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Microplastics are small plastic particles measuring less than 5 millimeters in size. Microplastics have recently been recognized as a prominent contaminant worldwide, negatively affecting terrestrial, freshwater, and saltwater ecosystems. Microplastics are deemed as microparticles prior to chemical composition identification by a micro-fourier transform infrared microscope (micro-FTIR), which is the case for this study. Virtually no research has investigated microparticle contamination in remote, forested freshwater stream ecosystems in Pennsylvania. At five streams in central Pennsylvania, we assessed microparticle contamination across two trophic levels of fish, apex predators (brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*) and tertiary consumers (eastern blacknose dace (*Rhinichthys atratulus*)). Unblocked wadeable electrofishing protocols were used with a Smith Root LR 24 to collect fish from the five streams (n=50 total, n=5 per trophic level, n=10 per stream). Fish were immediately euthanized with Tricaine (MS 222) and put on ice in darkened coolers. In the lab, gastrointestinal tracts of fish were removed and placed in a 10% potassium hydroxide (KOH) solution for digestion for 48 hours. Microparticles were obtained through vacuum filtrating with glass fiber 45-millimeter filter papers, and analyzed under an Olympus sz61 dissecting microscope at 45x magnification. We found that nearly all fish samples across all sites and trophic levels possessed microparticles. Overall, eastern blacknose dace possessed a total of 134 microparticles while sampled brook and brown trout microparticle count totaled 94. Eastern blacknose dace possessed more microparticles compared to trout at every tributary. We believe that this disparity in microparticle count is being driven by divergences in feeding strategies, morphological differences, and contrasts in life histories between the two trophic levels. More research is necessary to elucidate findings

ASSESSMENT OF INJURY RATE IN RELATION TO BODY SIZE AND SEX IN JAPANESE GIANT SALAMANDERS, *ANDRIAS JAPONICUS*, BY USING LONG-TERM MONITORING DATA

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Intrasexual selection occurs when members of the same sex within a species compete with each other, often over access to resources, social rank, or mates. Japanese giant salamanders (*Andrias japonicus*), a fully aquatic species endemic to Japan, serves as an excellent model species to study intrasexual selection in the form of male-male competition. Prior to the breeding season in late August and early September, male A. japonicus must find suitable nesting sites. Nesting sites have limited availability, and larger and more dominant males will compete to occupy the spaces and act as den masters. Den masters guard their nesting sites from other male intruders. Subordinates often fight against den masters due to the benefit of increasing their own fitness of becoming den masters while risking getting injured, suggesting that males likely have more extensive injuries than females as a result of this male-male competition. In addition, subordinates tend to be smaller suggesting that males with smaller body size are likely to be injured more often. To test these predictions, we examined field data collected from captured individuals between 2008–2018 by the researchers at the Hanzaki Research Institute of Japan. There are five giant salamander species in the world and they are distributed in Japan, China, and the US. To our knowledge, this institute in Japan is the only one that has long-term monitoring data on giant salamanders, and thus no studies were conducted to examine injuries among giant salamanders to date. The field data included not only basic body measurements (e.g., body size and body mass) but also any visible injuries to the captured individual. We scored injuries for each part of the body separately, and then totaled all the injuries to give each individual an overall injury score. We also noted the sex of individuals when it was known. We will analyze whether sex and body size are significant variables affecting injury prevalence among giant salamanders. Our results will reveal if injury and sex are related and thus contribute to our understanding of intrasexual selection in *A. japonicus*.

RESTORATION MEASURES ON STREAM BIOFILM AND FISH ABUNDANCE IN THE LITTLE ARNOT WATERSHED, PA

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The legacy effects of human disturbance are long lasting in forested watersheds. Common disturbances found in the mid-Atlantic region of the US include historic railroad structures, natural gas extraction infrastructure and timber harvest practices. Restoration techniques that reconnect channel flow and riparian areas and increase large woody debris can provide greater connection of streams to nutrient fluxes, groundwater, and habitat for algae and fish. Our project evaluates the influence of stream restoration techniques including chop and drop and large-scale earth movement on habitat, fish abundance and biofilm biomass in the Little Arnot (LiAR) watershed in northwestern Pennsylvania. Our before-after and control-impact design includes 2 years of habitat, fish, and algal measures pre-restoration in LiAR and in the undisturbed control watershed. Our findings suggest that the LiAR watershed lacks large wood and is nutrient limited. Habitat quality is poor due to lower abundance of deep pools, low photosynthetic active radiation, and low residence time due to high in-stream water velocity. Wood restoration and rechannelization efforts occurred in late 2021 and early 2022 and we present the emerging results of re-channeling and flooding and increased light availability. Such large wood restoration projects reconnect the stream to its floodplain, decrease downstream flooding, and restore biological functions but take many years of monitoring to best assess success of these mitigation efforts.

QUANTIFYING ECOLOGICAL CONDITIONS OF THE LITTLE JUNIATA RIVER MAINSTEM

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The Little Juniata River is a popular coldwater fishery, however we do not know many of the details of the health of the river. Benthic macroinvertebrates are excellent indicators of local river conditions. Therefore, we sampled benthic macroinvertebrates at 14 different sites along the mainstem to classify conditions along the river continuum using the Pennsylvania Index of Biotic Integrity. We also collected basic water chemistry and landscape data for each location to relate to biotic condition (IBI) and assemblage structure. We obtained landuse data from the Chesapeake Conservancy Landscape Data Project. We used an interpolation method to estimate IBI scores for unsampled river segments and calculated area-weighted IBI scores we call ecological units (EUs). Historical EUs assume IBI scores of 100 for each river segment. We found that IBI scores and assemblage structure varied greatly among sites on the main stem, generally improved in a downstream direction, but were generally poor overall. Water quality stayed relatively constant. Local landuse data also did not explain much variation in assemblage structure. More investigation is needed, especially in regards to detailed water chemistry, to understand remarkably poor IBI scores in these excellent brown trout waters. Our analyses herein detail methods for predicting conditions in un-sampled reaches of the mainstem. Similar techniques can be used for entire watersheds. Mapping EUs along the mainstem in comparison to historical conditions may be a strategy to identify hot spots for protection and restoration.

IDENTIFYING TRANSIENT STORAGE ZONE & CIVIL INFRASTRUCTURE INTERACTIONS IN LOCAL STREAMS NEAR LEWISBURG, PA

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The goal of the presented work is to quantify the extent of impacts of civil infrastructure such as bridge crossings, culverts, and land use changes on transient storage zones and stream flow processes. While water moves through the main channel of a stream it flows in and out of many transient storage zones along the way. Transient storage zones can take various forms, including slower-moving flow on the sides of channels and porous material in the channel bed and banks. These various flow processes result in exchanges of solute mass between the main channel and the transient storage zones, affecting the water quality and health of the surrounding ecosystem. Land use changes and the presence of bridges or culverts alter the characteristics of transient storage zones and interrupt the natural flow processes and exchanges with transient storage zones. For example, the connectivity between surface water and groundwater is reduced when the bridge substructure is built or a culvert is installed without a natural channel bottom. A bridge or culvert also has an effect that can potentially last for a greater distance than the reach directly surrounding the infrastructure. We used ArcGIS to analyze land use, infrastructure, and stream data in the Buffalo Creek Watershed. Field observations were used to help verify the ArcGIS data analysis and assumptions. Overall, we estimated that approximately 2% of Buffalo Creek could be impacted by the presence of bridge and culvert infrastructure, approximately 3% of the 30-m stream buffer zone has high impact land use, and 27.5% has medium impact land use. Future work is also discussed that could quantify the impacts of land use and infrastructure on transient storage zone processes.

EVALUATION OF THE REACH AND CATCHMENT LEVEL EFFECTS OF RIPARIAN BUFFERS ON FISH COMMUNITIES

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Land transformation from forested to agriculturally dominated landscapes has caused many negative impacts on aquatic habitats. The conversion, coupled with farming and livestock practices, creates complex physical, chemical, and in-stream habitat stressors on stream communities. Riparian buffers have been a key practice used to mitigate impacts of agriculture on stream communities, however, it is not clear how the size, distribution, and types of riparian buffer contribute to cumulative benefits of riparian buffers. This study aims to evaluate reach scale and catchment scale effects of land cover type (agriculture, forest, newly installed riparian buffers, established buffers) on water temperature and chemical parameters within six watersheds in Centre and Lycoming counties. Temperature loggers were deployed from May to October 2022, at transitions between landcover types on 6 watersheds and temperature data was used to calculate average, maximum, and minimum daily temperature for each reach. An upper and lower site was established in each watershed where the fish community was assessed in July and chemical characteristics were measured monthly. Fish diversity was higher in the lower sites. Temperature consistently increased in reaches with heavy agricultural use, and watersheds with historically higher agricultural use tended to have higher concentrations of nitrogen and phosphorus. By determining impacts at the reach-scale, cumulative-scale impacts can be better understood. Understanding impacts at this scale can aid restoration partners to target agricultural land where riparian buffers may provide the greatest benefit on stream health.

PHYSICAL DIFFERENCES BETWEEN TWO RESERVOIRS IN THE UPPER MIDDLE CREEK DRAINAGE AND THEIR IMPACTS ON SELECT DOWNSTREAM CHEMICAL AND PHYSICAL PARAMETERS DURING JUNE AND JULY 2021 AND 2022

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Human activity heavily affects streams through agriculture as it alters the abiotic environment fish depend on. Changes in the environment can influence the way fish interact with one another depending on if they are in forested or farm streams. Understanding the relationships between body condition of fish species is important because interactions between species can be context-dependent on environmental factors. As streams are altered by humans, environmental changes begin to diversify resulting in new species interactions, such as competition, impacting body condition of one or more species. The intention of this study is to look at the relationship between body condition of blacknose dace and sculpin to see their impact on each other, and how environmental conditions are linked to this relationship. Data for this study was collected in summer of 2022 by sampling fish communities from 35 farm and forested stream sites by electroshocking and recording each fish's length and weight. Comparisons between species are made in R using Fulton's condition factor for body condition and total fish counts by species. Changes in environment between farm and forested streams can be linked to an increase in sculpin and simultaneous decrease in the body condition of blacknose dace, potentially a result of increased competition and changing behaviors. I will investigate the relationships between species' body conditions relative to each other and the location they were collected to see if environmental changes impact which species wins and losses in competition. From there, lab investigations can be made to observe the behaviors that are the driving forces behind species-specific changes. These results are important as they provide implications for how cause and correlation field data can be interpreted.

EFFECTS OF DROUGHT CONDITIONS ON BROOK TROUT, *S. FONTINALUS* IN LOYALSOCK STATE FOREST

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As climate change continues to harm ecosystems, understanding the relationship between extreme weather events and population dynamics is becoming increasingly important. Droughts are estimated to occur more frequently, and the response of aquatic species to this threat remains uncertain. Based on abundance and body condition of young-of-year brook trout, *Salvelinus fontinalis* and wetted widths collected over 12 years at sites in the Loyalsock watershed, as well as local climate and discharge data in these regions, general additive models will be produced to assess how brook trout populations respond to drought-like conditions. It is expected that young-of-year abundance and body condition will decrease as values for wetted width, precipitation, and discharge also decrease. The changing climate has the potential to strongly influence brook trout populations, so management actions, including restoration of habitat connectivity, should be prioritized to maximize the resiliency of populations in response to extreme events.

PLANKTON COMMUNITIES IN THE UPPER MIDDLE CREEK SYSTEM IN SNYDER COUNTY PENNSYLVANIA, SUMMER 2022

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The upper Middle Creek system in Snyder County Pennsylvania provides some insights into the variability of impoundment morphometric parameters and their influences on their respective plankton communities. Upper Middle Creek has two major tributaries, North Branch and West Branch, each with a reservoir- Walker Lake and Faylor Lake, respectively. Walker Lake is larger and deeper than Faylor Lake and stratified throughout the study period, 7 June through 1 August 2022. This study examines lake plankton communities including zooplankton and phytoplankton, which showed very different trends through the study period, 7 June through 1 August 2022. In general, the phytoplankton communities differed according to the dominant primary producers. Cyanobacteria and chlorophytes dominated the phytoplankton communities in both reservoirs. Walker Lake was dominated by *Gomphosphaeria lacustris, Aphanizomenon flos-aquae, Coelastrum* sp., *and Pandorina morum*. While, Faylor Lake was dominated by *Planktothrix sp., Pandorina morum, Volvox sp., and Coelastrum* sp. Phytoplankton samples were taken at 0.5m and preserved in the field with Lugol's iodine. Cells were counted using a Nikon Eclipse ni using a Palmer-Maloney counting cell at 200x, and taxa were then weighted for biovolume in the analyses. Initially (7 June), taxa richness (X) was 22 and 31 for Walker and Faylor, respectively. Shannon Diversity (H) was similar for both, as well (0.80 and 0.96, respectively). During early summer, taxa richness of the Walker Lake phytoplankton community became less diverse (X=22, H=0.80). By 5 July taxa richness peaked at 22 and Shannon Diversity rose to 1.68. By middle July taxa richness and Shannon Diversity began to decline as a surface bloom of cyanobacteria covered the of the lake. On 1 August, taxa richness had fallen to 9 and Shannon Diversity had fallen to 1.16. Throughout the study, the phytoplankton community of Faylor Lake was more complex than that of Walker Lake. Chlorophytes dominated the phytoplankton community of Faylor Lake in the early summer. This trend was interrupted by a brief bloom of cyanobacteria on 20 June resulting in a taxa richness of 37 and Shannon Diversity of 0.85. The chlorophytes recovered then declined again repeatedly through June and July for the duration of the sample period. In the latter half of the study period, chlorophytes and cyanobacteria became abundant in Faylor Lake. Zooplankton showed similar trends between the two reservoirs. Zooplankton collections were taken using an 80µm mesh plankton net and preserved in the field with 95% ETOH. Preserved samples were identified and counted using a Sedgewick-Rafter counting cell with a Nikon SMZ-1270 Stereomicroscope. We recorded individual animals by species within groups: rotifers, copepods, and cladocerans. Zooplankton taxa richness at the species level in both reservoirs ranged from (8-17) throughout the study. Initially (7 June), taxa richness (X) was 8 and 9 for Walker and Faylor, respectively. Shannon Diversity (H) was similar for both as well (1.37 and 1.70, respectively). *Cladoceran* communities in both reservoirs were dominant, specifically *Daphnia mendotae* and *Bosmina longirostis* in Walker and Faylor, respectively. This trend changed when copepods dominated in both reservoirs, specifically nauplii on 13 June till the end of summer. On 13 June, the taxa richness (x) was 17 and 14 with a Shannon Diversity (H) of 2.09 and 1.95 in Faylor and Walker lakes, respectively. However, on the last sample date, 1 August, the rotifer community rose to dominance, specifically *Notholca acuminata* in Faylor. The taxa richness (x) for Faylor Lake was 13, with a Shannon Diversity (H) of 1.58. In both reservoirs, herbivorous taxa were the significant trophic group, comprising 71% in Walker and 65% in Faylor. In Walker detritivores increased in population (48%) on 13 June, while in Faylor herbivorous taxa sustained until 15 July, when detritivores increased in population (69%). On 19 July the detritivores formed the principal trophic group in both reservoirs, which continued through the rest of the summer, except for Faylor lake on 1 August, when herbivorous taxa became most abundant. Although these two reservoirs appear similar, the overall diversity (H) of the phytoplankton communities is significantly different, while the zooplankton communities remain more similar. We suspect that thermal stratification in Walker Lake isolated the epilimnion throughout the summer and encouraged the development of a dense surface bloom of cyanobacteria, eliminating other phytoplankton taxa through shading and most zooplankton. Faylor Lake, which never stratified, maintained its relative complex structure throughout the study.

FUNCTIONAL TRAITS AS INDICATORS FOR AGRICULTURE IMPACTS ON STREAM FISH COMMUNITIES

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Impacts of agriculture on freshwater systems brings detrimental effects to communities. This changes community structure through modifying the environmental conditions that can exceed tolerances of some species. I used functional traits to explore agricultural impacts on freshwater fish communities. Functional traits and functional groups have been emerging and useful metrics for analyzing community structure and interactions among fishes. The application of functional groups can classify individuals or groups of species into alike roles and tolerances in the ecosystem. This is valuable in the sense of weighing characteristics that represent the studied stream by the sampled species: inherently considering both interspecific and intraspecific interactions with the environment. I plan to compare functional groups among stream systems against the impacts of agriculture for 33 sites across nine watersheds in central PA streams. We collected data representing the streams through electroshocking and collecting physical characteristics in the summer season, which are now compiled and reclassified into functional groups. I expect to find differences between streams in what functional groups are dominant in the systems, and the evenness of functional groups among the sampled streams. This can be important to understand the difference between agriculture impacted streams and their less impacted reference streams. These methods and results could improve our understanding of community structure and anthropogenic influences.

USING STABLE ISOTOPE ANALYSIS TO INVESTIGATE TROPHIC POSITIONING OF FLATHEAD CATFISH IN THE SUSQUEHANNA RIVER BASIN, PA

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Flathead Catfish (*Pylodictis olivaris*) are an aquatic invasive species that were first documented in the Susquehanna River in 2002. Since that time, they have expanded throughout much of the system and into a major tributary (i.e., Juniata River). Flathead Catfish are a long-lived, predatory species with the potential to reach large sizes (e.g., >25 kg and >1200mm). Research efforts to date in the Susquehanna River Basin have provided insight on the distribution, range inhabited, and population characteristics (e.g., size structure, individual growth rates), and diet composition. Yet, little information is currently available on the community-level impacts of invasion including the short-term and long-term trophic effects that these fish have on other species. Importantly, it is not known if Flathead Catfish are competing with other predatory fish species for food resulting in dietary shifts or limited food availability. Indirect effects are hard to quantify; however, stable isotope analysis provides a way to identify potential competition that results in alterations to food web structure and energy flow. Stable isotope analyses using nitrogen and carbon isotopes can be used to evaluate trophic positioning, nutrient enrichment with dietary changes, and the basal source of nutrient inputs in the system. In this study, muscle samples were collected from 35 Flathead Catfish from two sites in the Susquehanna River. Nitrogen and carbon isotopic ratios will be used to compare differences between sites and fish length. Specifically, examining Flathead Catfish isotopic signatures will provide insight to researchers and managers on the Flathead Catfish's trophic positioning within invaded systems. Therefore, the results of this study will be used to inform future efforts in identifying the direct and indirect effects Flathead Catfish have on the trophic structure and energy flow of aquatic communities within the Susquehanna River.

IMPACTS OF RESERVOIRS ON UPPER MIDDLE CREEK DURING SUMMER 2022 BASED ON CALIBRATED DIATOM METRICS

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Located in Western Snyder County Pennsylvania, the Upper Middle Creek System has two major branches, North Branch and West Branch, each interrupted by a reservoir - Walker Lake and Faylor Lake, respectively. Both reservoirs have bottom outflow dams feeding the lower reaches of the two branches of upper Middle Creek. The streams that supply the reservoirs differ in size. Above Walker Lake the stream is approximately 3 meters wide, and above Faylor Lake the stream is approximately 7 meters wide. Additionally, two spring fed ponds now flow into the North branch of Middle Creek. Due to physical characteristics and reduced inflow, Walker Lake is stratified during the summer. Throughout the period of stratification, the hypolimnion of Walker Lake becomes hypoxic. In contrast, Faylor Lake does not undergo such stratification. The outflow of the hypolimnion from Walker Lake releases hydrogen sulfide and generates a buildup of iron (III) oxide-hydroxide on stones. The stream below Faylor Lake remains relatively stable throughout the season.

This study examines benthic diatom communities as surrogates for the state of the streams above and below the impoundments from 8 June through 1 August, a period during which Walker Lake is stratified. Initially, the goal was to analyze impacts of stratification downstream of Walker Lake; however, stratification already began when we took the first samples. The Walker system showed an average difference of 10°C between the epilimnion and hypolimnion and cooled the stream system by 3°C relative to the average upstream difference from above to below the lake. In contrast, Faylor Lake does not stratify but warms the stream relative to the stream site above the lake by 5°C. Measures of alkalinity and conductivity follow the same trends as temperature. To analyze impacts of the reservoirs on the two stream systems, we used diatom community metrics such as the Shannon Diversity Index (SDI) and Bray-Curtis community similarity comparisons (average percent overlap of taxa). For all four sites, above and below each respective reservoir, SDI was relatively high, ranging from approximately 1.99 to 2.94. The diatom communities above and below each reservoir showed little similarity except on 1 August in the Faylor system. Taxa richness (TR) decreased significantly in the Walker system but did not in the Faylor system. Calibrated metrics such as the Agricultural Guild (AG), Sedimentation Index (Sed. Index), Total Phosphorous (TP) and Total Nitrogen (TN) Indices all suggested that a change occurred in late June as central Pennsylvania experienced unusually dry conditions. Percent Agricultural Guild, a set of diatom species that increase through agricultural impacts, was high for most samples taken above and below the respective impoundments. The AG dropped to 25% (above Faylor) and 10% (below Faylor) on 1 August when the streams were experiencing base flow due to the dry conditions. Although sedimentation, as inferred from the Sedimentation Index, did not seem to have an impact downstream from Faylor Lake, it began to have an impact downstream of Walker Lake by the end of June. However, the deposition of iron (III) oxide-hydroxide on the stones

downstream of Walker formed a solid coating by 1 August and did not support diatoms that increase under conditions of sedimentation. Total Nitrogen and Total Phosphorus indices increase through the summer in the Walker system, but they generally declined in the Faylor system. Metrics that respond to organic pollution are the Pollution Tolerance Index (PTI, range 1-4) and Generic Diatom Index (GDI, range 4-20). PTI and GDI values generated by diatom communities suggest that both the Walker and Faylor systems are impaired. In addition, the Trophic Diatom Index, a metric that estimates the trophic condition of a stream, generated values that fall between mesotrophic and eutrophic environments. Most of the metrics are similar to those of summer 2021, despite 2022 experiencing a notably drier summer. Differences between the two years are interesting. The Total Phosphorus Index and % Agricultural Guild were significantly higher in 2022 than 2021 below Walker Lake, which underscores the impaired nature of the Walker Lake system.

EVALUATING WALLEYE (*SANDER VITREUS*) SPAWNING EFFORT ON CONSTRUCTED ROCK RUBBLE REEFS IN RAYSTOWN LAKE

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In this study we are currently evaluating the use of constructed rock rubble by walleyes for spawning in 2 locations of Raystown Lake. We created custom mesh-covered traps and deployed these in Apr 2022 to collect eggs during the spawn in 18 different locations at mile markers (MM) 14 and 15 before construction of the reefs. Our pre-construction sampling accounted for a total area of 2,500 m2 for over 2,600 trap-days from Apr 1 to May 6. During this time, we collected 51 walleye eggs. Numbers were highest from Apr 15 to Apr 29, with a total of 40 eggs collected. Average water temperature at this time was 10o C (50o F). Non-target collections were dominated by amphipods (scuds) but we also collected a possible Esocid egg, white perch eggs, and a juvenile green sunfish. In Apr and May of 2023, after rock rubble reefs are in place, we will sample the same areas again, over constructed reefs and in control areas, to complete this BACI-designed (before-after-control-impact) study. Perhaps what we learn could help with future habitat restoration for walleye spawning so that the walleye fisheries in the lake could depend less on stocking efforts and save management dollars for other needs. Key words: BACI design, lake habitat restoration, egg collection devices

HUNGRY HUSKIES: INVESTIGATING FOOD INSECURITY AMONGST BLOOMSBURG UNIVERSITY STUDENTS

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Food insecurity is a social problem described as not having adequate and safe resources to nutritional food or not having ways to acquire food in socially acceptable ways as deemed by society. There is limited research done on the topic of food insecurity amongst college students. The research that has been conducted has found that college students are at a much higher risk of being food insecure than other populations in the United States, college students' rates of food insecurity are between 21% and as high as 68% (Cady, 2014; Chaparro, et al., 2009; Owens, et al., 2020; and Payne-Sturges, et al., 2018). According to the United States Department of Agriculture, the national average of food insecurity is around 14% (2018). Understanding the prevalence of food insecurity and the barriers that may exist can be helpful to understand what programs can be implemented to help students on college campuses access food resources. Many colleges have begun to implement on campus food pantries for students to access yet few students are accessing this resource. Research suggests that there are barriers that keep students from accessing food resources. According to research these barriers include feelings of embarrassment, social stigma, lack of information about resources, location and hours of operation, and feelings of not deserving or needing the food pantry. (Brito-Silva, et al., 2022; Chaparro, et al., 2009; and El Zein, et al., 2018). This study focuses on the prevalence of food insecurity and the barriers that may exist amongst Bloomsburg University students. The Center for Community Research and Consulting conducts the Civic and Environmental Worldview and Engagement (CEWE) Survey each year at Bloomsburg University, this survey was used as well as my own survey to find the prevalence of food insecurity on campus. Since 2017, there has been steady increase in food insecurity according to data extracted from the CEWE Survey. The food insecurity variable from the CEWE Survey was created by combining three question options into a single variable. The CEWE Survey found that roughly 25% of students attending Bloomsburg University are considered to be food insecure. The Hungry Huskies Survey that was conducted focused on prevalence and barriers. The most common barriers students believe exist with food insecurity is social stigma and lack of knowledge about resources.

CONSERVATION OF A RARE SPECIES: TAXONOMIC UNCERTAINTY AND THE POTENTIAL ROLE OF A NARROWLY-OCCURRING SPECIALIST POLLINATOR.

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Heuchera alba and *H. pubescens* (*Saxifragaceae*) are closely related species of the Appalachian Region of eastern North America that are difficult to distinguish morphologically. *Heuchera pubescens* is currently understood to occupy a range from Kentucky to Pennsylvania, with the distribution of *H. alba* restricted to Virginia and West Virginia – plus a recently-recorded extension into Pennsylvania discovered with the help of Twitter. In addition to the discovery of *H. alba* in Pennsylvania, a pollinator known as the alumroot cellophane bee (*Colletes aestivalis*) was seen visiting its flowers - the first state record of this bee in over a century. The uncovering of *H. alba* as well as its specialized pollinator in Pennsylvania has challenged historical perceptions of Heuchera distributions in the state, particularly as this relates to current records for *H. pubescens*. Through a partnership between Bucknell University and the Western Pennsylvania Conservancy, substantial fieldwork was completed this past summer, including the collections of *H. alba* samples and *C. aestivalis* at multiple sites. It was found that records for *H.* pubescens in the Susquehanna River Valley can instead be attributed to *H. alba*. This finding has potential implications for the assessment of the true distribution for both species and the genetic status/health of each species in the local region. Our lab will now use population genomics to generate measures of genetic diversity and population structure, with the goal of updating the conservation status for each study species and to inform future conservation management of *H. alba, H. pubescens*, or both. We also hope to assess the link between genetic structure among *H. alba* populations and its reliance on a habitat-specific oligolectic bee.

OCCURRENCE AND MOVEMENT OF A NON-INDIGENOUS CRAYFISH IN THE RAYSTOWN LAKE REGION

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Non-indigenous crayfishes are increasingly significant global threats to freshwater ecosystems. Yet, little information seems to exist for current crayfish distributions in central Pennsylvania including the occurrence of non-natives that imperil native crayfish biodiversity. During surveys to document crayfish distributions in the upper Juniata River basin, we believe we discovered a new occurrence of the non-native Virile crayfish (*Faxonius virilis*) in Raystown Lake and a few tributaries. The first specimen was collected in July 2021, and during 2022 many more individuals were found, including young of the year, indicating a potentially growing population. This species has a history as an invasive species, and is commonly found in lakes and streams. During fall of 2022, we conducted a mark-recapture study to track the movement in a small tributary of Raystown Lake. Results suggest that individuals are moving from their captured area and may rapidly expand their range in the region. It may be in the best interest of the Pennsylvania Fish and Boat Commission and United States Army Corps of Engineers to act rapidly in response to this species presence in Raystown lake. Key Terms: *Faxonius virilis*, invasive species, Raystown Lake, mark-recapture

SENIOR DESIGN PROJECT: SHAMOKIN CREEK AMD RESTORATION

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The Shamokin Creek watershed is located in Northumberland County and extends into Columbia and Montour Counties, Pennsylvania. The watershed was home to anthracite coal mining starting in the 1800s which has led to severe acid mine drainage (AMD). The release of AMD has polluted streams with large concentrations of ferrous iron, ferric iron, sulphuric acid, aluminum hydroxide, and other dissolved compounds. The focus of our research is first to complete a preliminary analysis of the site's history, characteristics, and governing constraints and criteria. Once a tributary or site along Shamokin Creek is selected, a conceptual design of the reclamation system will be produced along with an assessment of alternative designs. Additionally, a model of the treatment system will be developed for educational purposes and provided to the Shamokin Creek Restoration Alliance (SCRA). Carl Kirby, a former professor at Bucknell, has provided our group with extensive background information on Shamokin Creek's chemical characteristics, history, and existing treatment systems. It is crucial that remediation efforts are implemented to improve the ecosystem and protect the well-being of the public inhabiting the Shamokin Creek watershed.

ASSESSING CHANGES TO STORM EVENT DISCHARGE IN LITTLE ARNOT RUN PRE AND POST LARGE WOOD ADDITION

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Headwater drainages, first and second order streams, are critical components of surface water flows. During rainfall (storm) events these systems determine the timing and volume of water that access floodplain systems. They are often the first to receive large influxes of water which increases the stream discharge. As a result of climate change, more precipitation is falling on watershed during storm events, which can lead to increased discharge and/or flooding (stormflow). One method of managing storm flow is to introduce large woody material in strategic locations of a headwater stream channel and its floodplain. This could mitigate downstream flooding by distributing stormflow across the valley. At Little Arnot Run in the Allegheny National Forest, adaptive management strategies were used to control discharge during storm events. We deployed pressure sensors at two locations within our study watershed and collected cross section data to monitor discharge. Our goal was to determine if there have been changes in peak hydrograph height and width (time) prior to and after implementation. Pressure sensor data was converted into estimated discharge using the Manning equation. We selected multiple large storm events at both study sites. Graphs of each storm event were plotted in Microsoft Excel and then imported into ImageJ. We analyzed changes in peak height and peak width to determine differences between pre and post implementation. Wood additions occurred in April 2022 through May 2022. Our data spans from September 2020 through September 2022.

LOYALSOCK CREEK ASSESSMENT 2021-2022

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During the summer of 2022, the Lycoming College Clean Water Institutes' annual monitoring of the Loyalsock Creek, a 65-mile long tributary of the West Branch of the Susquehanna River, that primarily flows through both Lycoming and Sullivan counties, was conducted. Water chemistry as well as quality was evaluated at ten different sampling sites that span the length of the Loyalsock. Water chemistry performed at each site included dissolved oxygen (ppm), water temperature (°C), pH, alkalinity (ppm), conductivity (µS), total/ortho-phosphorus (ppm), and nitrates/nitrites (ppm). In addition, water quality was gauged from analysis of macroinvertebrate kick samples (collected following PA DEP protocols with D-frame (500µ) kick-nets) and calculation of corresponding Hilsenhoff Biotic Index scores. Coliform data were also collected following the HACH m-ColiBlue24 protocol. Water Quality data taken near the USGS gauge station on the "sock" near Loyalsockville indicates that since the 1960" s, mean pH and alkalinity has improved and nitrogen values have decreased. Hilsenhoff Biotic Index scores indicate excellent to good water quality. Overall, the water chemistry and water quality data support that the water of the Loyalsock has improved and has maintained its status as an exceptional value stream.

LOYALSOCK CREEK AMD

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Coal mining first became prominent in Sullivan County, specifically in the town of Lopez, in the late 1800's. Around 1950, companies closed up their sites and withdrew mining operations. Despite these sites shutting down more than 60 years ago, the effects of mining on local environments in Lopez can still be seen today. Acid mine drainage is the result of ground water streams contaminating with mines that were closed improperly. From this contamination, the water develops properties such as high acidity, low alkalinity, and high levels of heavy metals such as aluminum, manganese and iron. These ground water streams then feed into above ground tributaries to the Loyalsock Creek. Passive treatment wetland treatment systems were developed between 1999-2001 at three discharge sites near Lopez (Connell mine B, C and the Lewis Gutten Drift). The Eastern PA Coalition of Abandoned Mine Reclamation (EPCAMR; with support of the Loyalsock Creek Watershed Association) has been monitoring these sites for several years now. In 2021, a TU- TAG grant supported a study by Hedin Environmental that concluded the efficiencies of the treatment systems are decreasing with time but still functioning. Lycoming College Clean Water Institute in cooperation with the Eastern PA Coalition of Abandoned Mine Reclamation (EPCAMR) has been monitoring these AMD effected streams since 2021. Pre and post-treatment pH and alkalinity continue to improve as well as a 60% reduction in aluminum, iron and manganese concentrations going into Loyalsock Creek. The monitoring is helpful to establish data trends and suggest changes or updates that need to be made to the treatment systems.

CONTINUED MONITORING OF WOLF RUN FARM SITES UNDER BMP'S IN PARTNERSHIP WITH LYCOMING COUNTY CONSERVATION DISTRICT

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The purpose of this study was to evaluate the water quality of Wolf Run (Lycoming County, PA) before and after the implementation of BMPs on four farms by Lycoming County Conservation District. Specifically, four farm sites along Wolf Run were chosen to implement BMPs, phased in over 6 years, in response to PA DEP's completion of a Total Maximum Daily Load (TMDL) on the Wolf Run watershed in 2013. CWI surveys began in 2017. CWI surveys included water chemistry, coliform sampling, and electrofishing/macroinvertebrate surveys. Water chemistry testing indicated a significant increase in pH and alkalinity as well as conductivity and TDS comparing levels from the first three years of testing to the last three. Additionally, the levels of phosphorous significantly decreased from 2017 to 2022. Over the past six years the surveys have shown an increase in density in certain fish species along the sites, including an increase in brown trout. In the summer of 2020, brown trout were identified at every site compared to the summer of 2018 where they were only identified at one site (Site 4). A total of 19 different fish species were identified from 2017 to 2022. This summer, 2022, 14 of those species were found. In 2022 the population densities ranged from 2280 fish/km (Site 1) to 7700 fish/km (Site 2). The population density of trout at each site has also increased since 2017, when there were no trout found at any site. In 2022 trout population density ranged from 30 trout per km (Site 1 and 3) to 250 trout per km (Site 2). From 2018-2022 The Hillsenhoff Biotic Index scores, which are an indication of water quality based on macroinvertebrate data, showed all sites scores as Good (4.51-5.50). In Summary, both water quality and fish population density/diversity has improved over the six years of study.

WATER CHEMISTRY TRENDS IN URBAN STREAMS RECEIVING STORMWATER WITHIN LYCOMING COUNTY MS4

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The Clean Water Institute (CWI) at Lycoming College has been analyzing the water quality of 9 urban streams in the Lycoming County MS4 region since 2015. Over 250 stormwater drains empty in those streams namely Grafius Run, McClure Run, Millers Run, Bull Run, Mill Creek, Tules Run, Mosquito Creek, Hagerman Run and Bottle Run. The municipalities in the MS4 region are currently developing Best Management Practices (BMPs) as part of their permit for the National Pollutant Discharge Elimination System (NPDES). This permit requires them to reduce the levels of nitrogen, phosphorus and sediment loads as part of the Lycoming County Community Action Plan (CAP) by 2025. The interns at CWI have been sampling the stream water annually for the analysis of parameters such as pH, alkalinity, temperature, dissolved oxygen, conductivity, total dissolved solids, turbidity and the concentrations of nitrate, nitrite, total phosphorus, and ortho-phosphorus. By gathering data over the years, we were able to observe trends in some parameters. This poster will focus on the trends in water chemistry (nitrate, nitrite, total phosphorus, and ortho-phosphorus) at the different sampling sites of Millers Run and Bull Run from 2017 to 2022. The observations in this project can be significant in monitoring the water quality and implementing necessary BMPs to improve the water quality of the urban streams of Lycoming County MS4 region.

COLIFORM TRENDS IN URBAN STREAMS RECEIVING STORMWATER WITHIN LYCOMING COUNTY MS4

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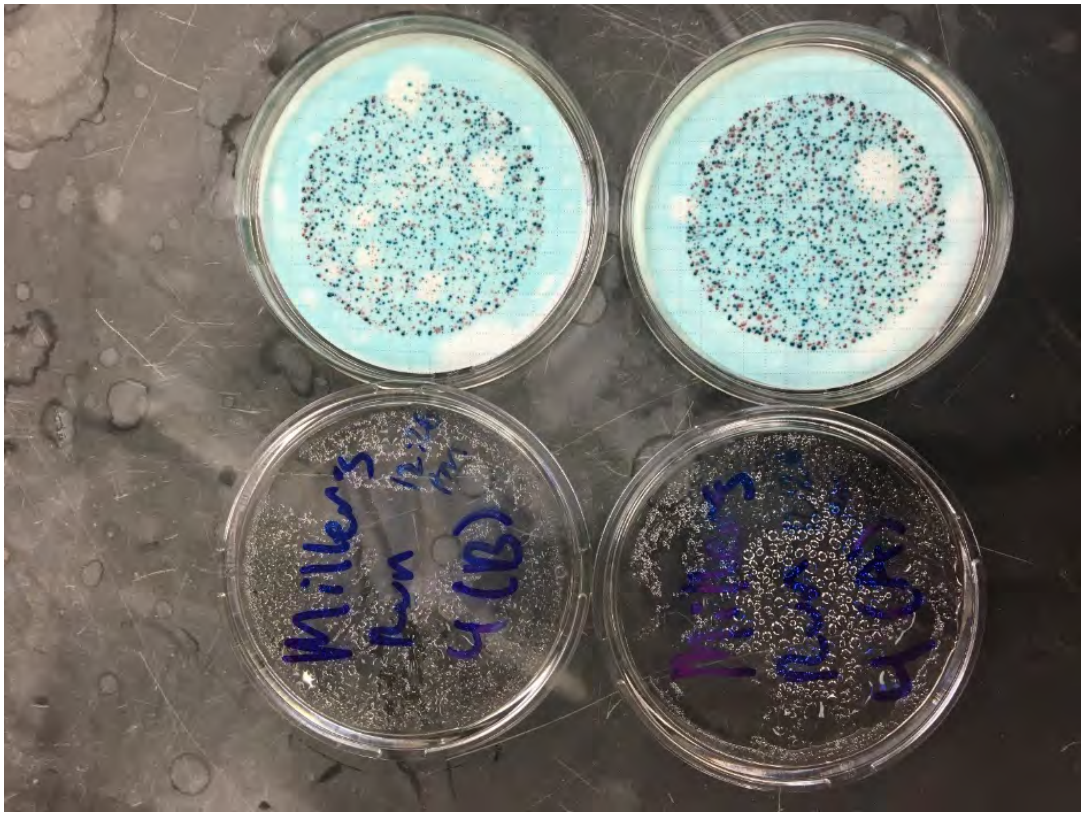
Lycoming College Clean Water Institute (CWI) has been assessing the water quality of the urban streams in the Lycoming County MS4 region since 2015. The County MS4 includes 9 municipalities/boroughs; over 250 stormwater outfalls that empty into 8 urban streams (Grafius Run, McClure Run, Millers Run, Bull Run, Mill Creek, Tules Run, Mosquito Creek and Hagermans Run) plus Lycoming Creek, Loyalsock Creek and the West Branch Susquehanna River. Each of these municipalities/boroughs are in the middle of developing BMP's as part of their NPDES permit requirements to reduce nitrogen, phosphorus and sediment loads as part of Lycoming County CommunityAction Plan (CAP) by 2025. CWI interns have been collecting data on water quality parameters since 2015. Having collected enough data over the years, we have been able to observe trends in certain parameters which can be significant in motoring the water quality of these streams. This poster will focus on the trends in coliform bacteria in two major urban streams (Miller's Run and Bull Run), over the past two years 2021-

2022. Coliform bacteria are single-celled organisms occurring as a natural component of lakes, rivers, streams. Most of the bacteria are harmless to humans but those coming from the intestinal tract of warm-blooded animals (fecal bacteria, also known as *E. coli*) can cause sickness and even diseases. Membrane filtration is performed on the water samples and the filters are incubated in petri dishes with coliform media for the bacteria to grow. The bacteria are then counted as colonies. Total coliforms and *E. coli* colonies are distinguished by color. Presence of E. coli indicates fecal contamination. Our data show that there is a significant difference between the 2021 and 2022 mean for Bull Run. For Millers Run, there is no significant difference between he 2021 and 2022 mean. However, more than 50% of sites from 2021 to 2022 surpassed the standard *E. coli* count limit. This calls for a close and continuous monitoring of the coliform levels in these streams to detect the source of the problem. The examination of data trends serves as a baseline to be used to implement projects that seek to improve water quality of the urban streams of Lycoming County MS4 region.



ROSE VALLEY LAKE TROPHIC SURVEY

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Rose Valley Lake is a 389-acre reservoir located in Lycoming County, Pennsylvania. The reservoir is managed by the PA Fish and Boat Commission. The reservoir serves as the headwater of the Mill Creek Watershed and flows into the Loyalsock Creek. The Lycoming College Clean Water Institute (CWI) has partnered with the Loyalsock Creek Watershed Association since 2000 to perform chemical and biological surveys on the health and productivity of Rose Valley Lake using Carlson's Trophic State Index (TSI). This index reflects the amount of algal biomass in a lake, which is used to classify the lake onto a continuum of trophic states. These data also contribute to the North American Secchi Dip-In, which began in 1994 and has since accumulated over 100,000 entries in their databases. In 2022, Rose Valley Lake appears to be trending toward further eutrophication. In 2012, Rose Valley Lake was considered mesotrophic and had an average TSI value of 50.00, while in 2022 the lake is eutrophic and the average TSI value has increased to 62.94. Zooplankton samples were also taken, and show that rotifers are most abundant and have the highest population density in the lake. This project is important because the data tracks eutrophication trends and acts as an indicator for changing water quality and overall lake health.

SINGLE ACCELEROMETER-BASED BEHAVIORAL MONITORING OF FRESHWATER MUSSELS

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Freshwater mussels are both an important and threatened part of our ecosystem. Freshwater mussels are extremely efficient in cleaning natural water resources, yet surprisingly little is known about the behaviors of these animals, making threat mitigation difficult. As activity recognition based on the use of accelerometers is known to be effective in humans and other animals, this work applies such methods to the study of freshwater mussels in order to aid further scientific study. In this paper, we present results from a laboratory experiment where an STMicroelectronics inertial measurement unit (IMU) was attached to the shell of a mussel for approximately 24 hours. Over this period, we observed several interesting behaviors and verified the sensor arrangement can differentiate active and inactive periods as well as quantify gape frequency, duration, and intensity. Our future work is to develop a mussel sensor network where multiple mussels can be monitored in situ for an extended period of time. By better understanding the behavior of these animals, we aim to develop new ways to quantify ecosystem health and more effective conservation strategies.

A GEOCHEMICAL AND MICROBIOLOGICAL ANALYSIS OF THREE ABANDONED MINE DRAINAGES IN THE MIDDLE ANTHRACITE BELT IN NORTHUMBERLAND COUNTY, PA

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In 2020 we began a project characterizing chemistry and microbes at abandoned mine drainage (AMD) sites in the Middle Anthracite Belt in eastern Pennsylvania. The three AMD sites we sampled drain different mine pools, each with unique chemical characteristics and microbial assemblages. Discharge sites were Big Mine Run (BMR) near Ashland, PA (fed from the Centralia pool); Sterling Discharge (SD) near Shamokin, PA, fed from the Henry Clay-Sterling pool; and the inflow to the Scarlift Site 15 AMD treatment system (SL) near Ranshaw, PA, sourced from the Corbin Mine Pool. Dissolved oxygen (DO), pH, and conductivity were measured in situ, then samples collected and returned to the lab for analysis. Alkalinity and acidity were analyzed within 4 hours. Subsamples were preserved for later analysis of 11 selected metals, 7 simple cations, and 8 anions. Each discharge was geochemically unique in terms of pH (4.38, 6.12 and 4.46 for BMR, SD, and SL), DO (10.08, 1.72, and 2.52 mg/L for BMR, SD, and SL), and conductivity (843, 659, and 560 µS/cm for BMR, SD, and SL). Iron concentrations were relatively low at BMR (3.6 ppm compared with 16.7 and 13.6 ppm for SL and SD), but BMR had the highest concentrations of Al (4.4 ppm, compared with 3.8 ppm for SL and <0.5 ppm for SD) and Mn (5.3 ppm, compared with 2.7 and 2.1 ppm for SL and SD). Alkalinity was detected at SD (61 mg/L as CaCO3) but not at the other sites. Yellow boy (orange deposits on the rocks and bottom) was collected at all sites and genetic material isolated and sent to GeneWiz for taxonomic analysis. Each of the sites had a distinct collection of Operational Taxonomic Units (OTUs), with many OTUs in common but in very different relative abundances. Half or more of the OTUs were unclassified; of the genera identified, many have been demonstrated to be important in iron and sulfur biogeochemical cycles. SL was dominated by *Gallionella*, followed by *Sulfurimonas* and *Sulfuicurvum*. BMR was also dominated by *Gallionella* to a lesser extent, with *Hyphomicrobium* and *Bradyrhizobium* next highest in abundance. SD was dominated by *Gallionella*, followed by *Geobacter* and *Rhodoferax*. *Gallionella's* presence at SD and SL was surprising; it is known mostly from near neutral pH environments, only recently being reported in an acidic environment.

FINDING FORGOTTEN WATER: ARTERIAL WATERWAYS IN THE AMERICAN ANTHROPOCENE

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In central Pennsylvania, numerous towns have old mill races and dam fragments, canal beds and railway bridges, duck ponds and playgrounds: all artifacts pinned to persistent and living waterways that find their way to the Susquehanna River. What starts as a farm pond or spring meanders through subdivisions, industrial property, and parks, then hides under pavement and in back alleys. Sometimes these runs and creeks are daylighted or restored, sometimes they insist on reappearing in flood and storm, but often, these watery places are minimized until they vanish, from view and then from memory. This project maps the historical tapestry of freshwater in the landscape of the central Susquehanna valley. Christopher Magoc has observed that the Mid-Atlantic is "wrinkled" with interior waterways of significance that, in microcosm, tell us much about North America's environmental history (2015). Reading the Susquehanna and its tributaries as the upper waters of the Chesapeake, we have a wonderfully expansive landscape which records the environmental choices and costs of modern America. What we often think of as "small town America" has, in fact, shared with larger cities fundamental attitudes and practices toward freshwater that sketch a story of urban North America. Much of the scholarship we have about riverine environments stems (so to speak) from the life sciences, but an historical perspective can offer valuable context to explain our current state, and highlights the human experience of and contribution to environmental change. This story focuses on two Limestone Runs in the neighbouring riverfront towns of Lewisburg and Milton, Pennsylvania. In particular, it explores how these waterways serve as measures of the Anthropocene, or the period defined by the indelible mark of human intervention on the physical world: through a development ethos that privileges extraction, expansion, and mass, and an escalating and unsustainable reliance on fossil fuels. We see these imperatives even in smaller communities (including a Ford dealership in Lewisburg, and a Chef Boyardee plant in Milton. What could be more American?) This project relies on archival records, notably maps, surveys, and photography. At the same time, it raises two important methodological questions: - How do we research "vanished" environmental features? This includes working with students tracking these waterways by foot and en vélo. - What do physical changes to water say about the ways in which we understand and value water, culturally and politically?

MERCURY IN HELLGRAMMITES OF THE SUSQUEHANNA RIVER

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The Susquehanna River, like many waterbodies in the U.S., is contaminated with mercury. This contamination has led to consumption advisories for gamefishes such as walleye and smallmouth bass. The study of mercury in the invertebrate food web of the river is essential to understanding mercury dynamics within this system. To date, mercury contamination has not been measured in large, benthic macroinvertebrates in the Susquehanna River. We measured total mercury (THg) concentrations in hellgrammites collected from eight locations along 280 km of the river to determine if the concentrations differed by site. We found statistically significant differences in THg concentrations in hellgrammites from among the locations sampled. In general, we observed a statistically significant increasing trend in THg concentration moving from downriver to upriver locations. This finding parallels the PA Department of Environmental Protection/ Fish and Boat Commission fish consumption advisory that ends at the confluence of the North and West Branches of the Susquehanna River and is reinforced by similar results of THg concentrations measured in crayfish at these locations, i.e., differences among the sites and an increasing trend in concentration moving upriver.

THE ADDITION OF LARGE WOODY DEBRIS TO FORESTED STREAMS HISTORICALLY IMPACTED BY LOGGING

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We measured Large Woody Debris (LWD, wood > 10 cm in diameter) in both old growth forest and second-growth forest streams in Pennsylvania in summer 2021 to determine if there was a significant difference in LWD volume comparatively. We calculated LWD volume for each of the 7 sites (4 old-growth, 3 second-growth) by measuring diameter and length of every piece of wood that intersected a 100-m long transect down the center of each stream channel. Our data suggest that there was in fact a significant difference in the volume of LWD in old-growth streams compared to second-growth streams. LWD volume in old-growth streams averaged 0.020 m^3/m^2, whereas LWD volume in second-growth streams averaged 0.0026 m^3/m^2. Streams in old-growth forests likely had a higher average volume of LWD because old-growth forests have not been logged, which allowed LWD to remain in these streams, and the trees have been allowed to mature, which provides a source of new LWD. Second-growth forests have experienced logging, which resulted in removal of LWD from stream channels, and the trees are typically younger than old-growth forests and do not contribute as much new LWD to streams. Restoration in some of these second-growth streams implemented the addition of LWD in fall 2021 in an attempt to change the valley floor habitat. LWD was again measured in summer 2022 at two of the second-growth sites: Little Arnot Run 1, which was subject to LWD additions, and Cherry Run, which was used as a reference site. The goal of these measurements was to compare the difference in LWD in the streams pre- and post-restoration and determine its potential impact. Our data shows that Cherry Run had a volume of 0.0045 m^3/m^2, while Little Arnot Run had a volume of 0.015 m^3/m^2. In reference to the previous year's old-growth and second-growth sites' volumes, Cherry Run in 2022 shows similar results to the second-growth streams' volume from 2021, while post-restoration Little Arnot Run 1 shows similar results to the volume in old-growth streams from 2021. The large addition of LWD and similarities in volume to previous findings could then suggest a future improvement of the health of streams by restoring them close to how they looked and functioned prior to logging.

HANDS-ON LEARNING USING A REMOTELY OPERATED VEHICLE FOR BRIDGE INSPECTION

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Emerging technologies present opportunities to provide undergraduate students with affordable and safe hands-on learning in environments that are more closely aligned with civil engineering practice than traditional college laboratories. Chasing Dory, a consumer-grade remotely operated vehicle (ROV), is an emerging technology that can be used to simulate underwater bridge inspections. Civil engineering technology students enrolled in a senior geotechnical engineering technology course at Pennsylvania College of Technology used a Chasing Dory to gain knowledge about bridges through field work. As an introductory activity, the students participated in a field trip to the north abutment of Maynard St. bridge over the West Branch Susquehanna River in Williamsport, Pennsylvania. The instructor used the bridge as a full-scale model, the students referred to PennDOT's as-builts on their mobile devices, and the Chasing Dory was demonstrated. A 20-item survey designed to measure the students' confidence related to identifying elements of a bridge was administered before and after the field trip. The students' overall confidence score increased ($M = 1.54$, $SD = .94$) from pre-test to post-test, $t(16) = 6.75$, $p < .001$. Teams of students then selected bridges over waterways in North Central Pennsylvania and performed independent underwater investigations using the Chasing Dory with the primary objective being to assess if scour was present. The students completed reflections before and after their field work. The responses were processed with word cloud generators and frequently used words were examined qualitatively. The theme from the reflections before the student field work was that the students are keenly aware of the civil engineer's moral obligation to be a steward of society and the environment. The theme from the reflections after the student field work was that varying operational challenges were encountered depending on site conditions and these challenges were resolved differently. The students constructed posters to synthesize their experience using a Microsoft PowerPoint template that included resources. Among the information presented in the posters was pictures taken with the Chasing Dory and hydrological, geotechnical, and transportation data. Using a Chasing Dory in this work allowed the instructor to implement innovative instructional methods and assessment tools that helped enhance the student hands-on learning experience and reinforce knowledge that was acquired earlier in the civil engineering technology program.

River Symposia

2006 to 2008

From The Branches to The Confluence

October 18-19, 2006

1st

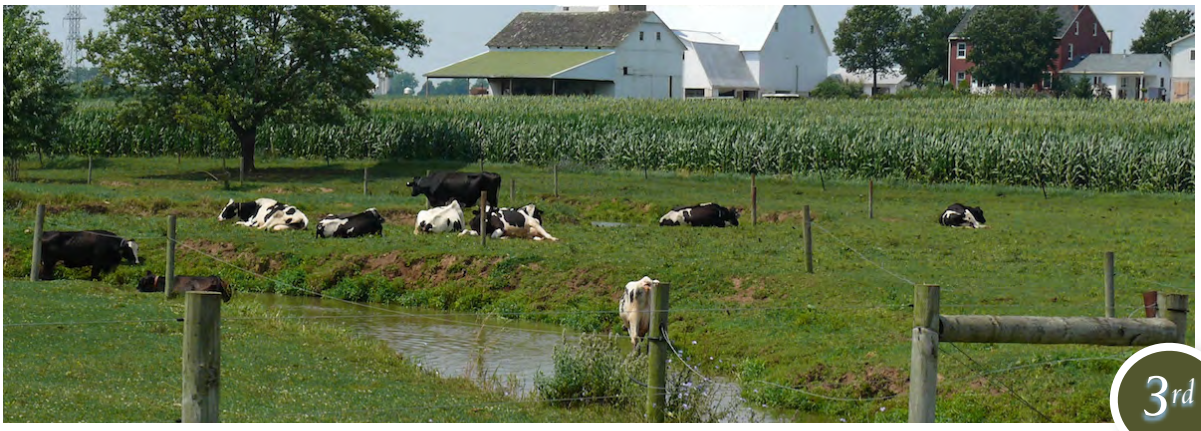
Pennsylvania Abandoned Mine Drainage Remediation

September 28, 2007

2nd

The Susquehanna and Agriculture

September 12-13, 2008



3rd

River Symposia

2009 to 2011

Cultures At The Confluence - Native Americans

September 26, 2009

4th

River Health and The Chesapeake Bay

October 22-23, 2010

5th

River Towns in the 21st Century

October 18-19, 2011

6th

River Symposia

2012 to 2014

Wasn't That A Mighty Storm! Flooding In The Susquehanna — October 12-13, 2012

7th

A Fragmented Systems - Dams On The Susquehanna — October 18-19, 2013

8th

Science and the River — November 21-22, 2014

9th

River Symposia

2015 to 2017

The River, Its Landscape and Our Lives

November 13-14, 2015

10th

A Tale of Two Rivers: The Susquehanna and Delaware

November 11-12, 2016

11th

The Spirit of Two Great Rivers

November 10-11, 2017

12th

River Symposia

2018 to 2020

Science, Conservation, and Heritage

November 26-27 2018

13th

Healthy Rivers, Healthy Communities

October 18-19, 2019

14th

Watersheds, Ecosystems, and Sustainability

November 6-7, 2020

15th

River Symposia

2021 to 2023

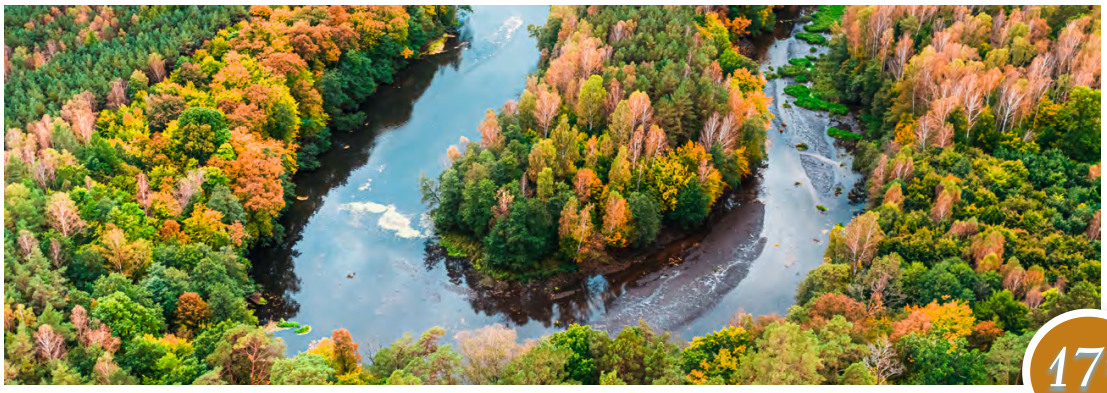
Restoration to Resilience: Creating Partnerships

November 5-6, 2021

16th

The River is Everywhere

November 4-5, 2022



17th

A Fresh Look at Riverine Ecosystems

November 3-4, 2023

18th

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

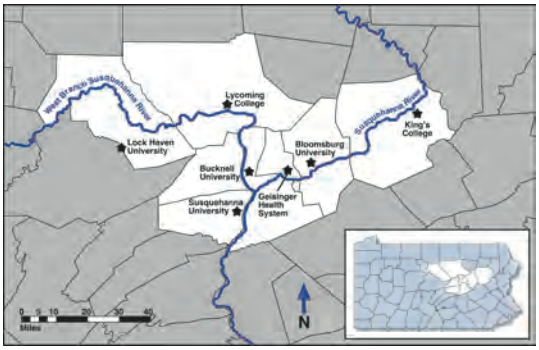
The **Susquehanna River Heartland Coalition for Environmental Studies** has played a major part of the River Symposium since its beginning 16 years ago. Established in 2005 by H. W. "Skip" Wieder, the SRHCES is a unique collaboration of regional universities, environmental agencies, watershed groups, and the Geisinger Health System, all working together on interdisciplinary research projects in the "heartland" of the Susquehanna River basin.

Its members meet quarterly 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.



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