15th Annual River Symposium

WATERSHEDS, ECOSYSTEMS, AND SUSTAINABILITY

Pine Creek watershed in north central Pennsylvania
[Nicholas A. Tonelli]

PROGRAM WITH ABSTRACTS

November 6-7, 2020

riversymposium.scholar.bucknell.edu

2020 RIVER SYMPOSIUM

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Photos (all used with permission):

Front cover: Pine Creek, PA. [Nicholas A. Tonelli]

Next page: Forest canopy beginning to show fall colors, Allegheny National Forest. [B. Hayes]

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

Rear cover. Bald Eagle State Forest near The Hook Natural Area, Union County, PA [B. Hayes]

Welcome!

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

It features keynote and plenary addresses, special breakout discussions, and oral and poster presentations from over 100 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 our region.

All events are held virtually via Zoom. All events are free and open to the public. To register and access links to the various sessions, please visit:

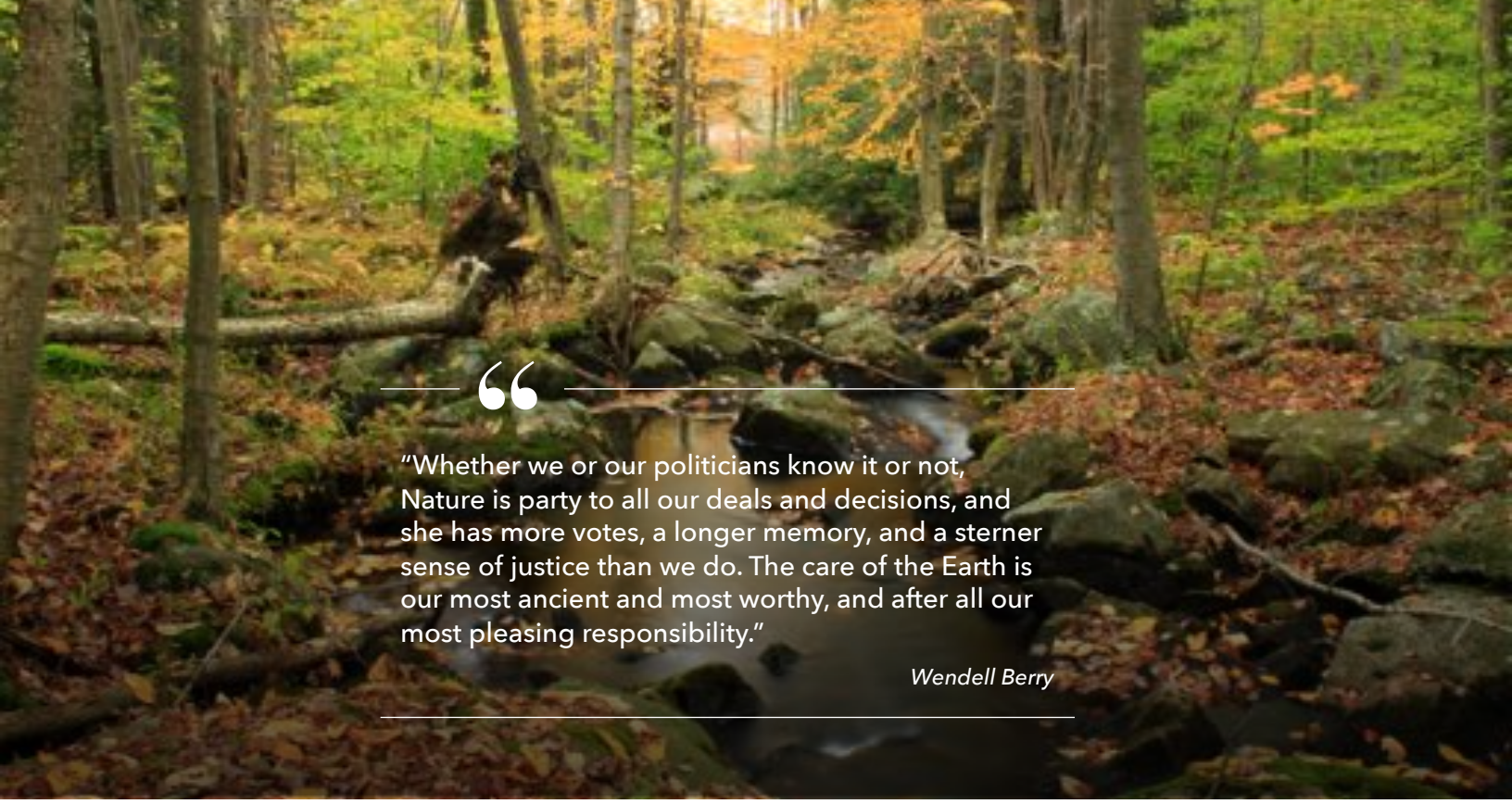
riversymposium.scholar.bucknell.edu

"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



"Whether we or our politicians know it or not, Nature is party to all our deals and decisions, and she has more votes, a longer memory, and a sterner sense of justice than we do. The care of the Earth is our most ancient and most worthy, and after all our most pleasing responsibility."

Wendell Berry

FORWARD

WATERSHEDS, ECOSYSTEMS, AND SUSTAINABILITY

This year marks the 15th anniversary of the River Symposium, which from its beginning has focused on interconnectedness of all things, especially the Susquehanna River and the Chesapeake Bay. The symposium has explored many different topics, including abandoned mine discharge, agriculture, Native Americans, river and community health, longitudinal trends, and much more. It has strengthened community, promoted scholarly research, and brought people together.

Join me in celebrating these statistics: over the past 15 years, 961 students and faculty authors from 39 universities and 53 environmental groups, state and federal agencies, and Geisinger have given 1,703 poster and 424 oral presentations and 87 exhibits. The caliper and significance of their work has been truly remarkable!

The symposium's primary goal has always been to draw together people from all walks of life who share a common interest in rivers, watersheds, communities and the connections therein. As visualized in the word cloud on page 17, this year's symposium explores watersheds, ecosystems, restoration, and conservation - all key components of sustainability.

KEYNOTE SPEAKER. On Friday, from 7:30 to 8:00 p.m., Cynthia Adams Dunn, Secretary of Pennsylvania Department of Conservation and Natural Resources, will deliver the keynote address *"The Future of Conservation"* A nationally-recognized leader in environmental conservation, Secretary Dunn provides leadership to DCNR's vast network of state forests, parks, conservation initiatives, recreational activities, and educational programs.

RESEARCH POSTERS. On Friday, from 8:00 to 10:00 p.m., students and faculty from five universities and Geisinger will present their posters. This is a great way for everyone to intermingle and make new connections. Research posters are available on the website and abstracts are on pages 37 - 51.

SPECIAL SESSIONS and BREAKOUT DISCUSSIONS. On Saturday, from 9:00 a.m. to 12:00 p.m., special discussion sessions are devoted to addressing three important issues in the watershed sciences this year:

- **Conducting Field and Laboratory Research During Pandemics.** The COVID-19 pandemic has impacted everyone's lives and this session is a way for everyone to share their stories and ideas about ways to advance research when one can't be in the field or laboratory.
- **A Path to increasing diversity, equity, and inclusion in the watershed sciences and environmental conservation.** Listen to stories "from the field" and identify actions the watershed sciences and environmental conservation movement should take to reduce racial discrimination and eliminate individual and systemic racism. Generate and share strategies that your organization has been able to improve diversity and inclusion, phase out microaggressions, and create a healthy environment for all.
- **Science and Communications.** Explore ways to better disseminate and communicate your science to the public, policymakers, reporters, voters and other key audiences. How to use social media and other platforms to disseminate information and promote watershed sciences, environmental restoration, and many other issues associated with sustainability.

LUNCHEON PLENARY ADDRESS. Brenda Sieglitz, Manager of the 10 Million Trees Partnership for the Chesapeake Bay Foundation will deliver a plenary address "Clean Water Grows on Trees: Finding Roots through Collective Impact" on Saturday, Nov. 7, from 12-1 p.m. More about Brenda and her plenary address is presented on page 13.

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

- Ecology I - Native Plant Communities
- Hydrology I - Floods and Hydrography
- Stream Restoration I - Live Staking / Riparian Corridor Management
- Ecology II - Aquatic Ecosystems and Restoration
- Hydrology II - Stormwater
- Stream Restoration II - Improving Stream-Floodplain Connectivity
- Watershed Restoration: The 10 Million Trees Partnership
- Stream Temperatures
- Science Communications and Education

A detailed schedule of oral presentations for each session is on pages 7 - 11. Abstracts for the oral presentations are on pages 18-36.

WRAP-UP DISCUSSION. From 3:40 to 4:00 pm, after the oral sessions are over, everyone is invited to gather together for a 20-minute wrap discussion. We'll reflect upon the events of the symposium and share ideas for next year.

ACKNOWLEDGEMENTS. This symposium would not be possible without the generous support of the **Pennsylvania Water Resources Research Center at Penn State**, Dr. Elizabeth W. Boyer, Director. Special thanks are also due the symposium committee: Sean Reese, Peter Jansson, Samantha Myers, Adrienne Goudy, Jeff Campbell, Jesse Greenawalt, Brandon Karcher, and Lily Parker.

Best wishes for a great symposium!

Sincerely,

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

Symposium Chairman

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

2020 RIVER SYMPOSIUM

SCHEDULE

FRIDAY, NOVEMBER 6, 2020

All events will be held virtually via Zoom. Please visit the symposium website for more details.

7:00 - 8:00 p.m.

Zoom link: https://bucknell.zoom.us/j/97049165173?pwd=OTdzYWl1SHhOMVFPK1h3MFgvTHd0QT09

7:00 - 7:10 p.m.

Welcome and Announcements

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

7:10 - 7:25 p.m.

Opening Remarks

John Bravman
President, Bucknell University

7:25- 7:30 p.m.

Symposium Overview

Benjamin Hayes
Chair

7:30 - 8:00 p.m.

Keynote Address

"The Future of Conservation"

Cynthia Adams Dunn

Secretary, Pennsylvania Department of Conservation and Natural Resources

8:00 - 10:00 p.m.

Poster Presentations

Abstracts for all poster presentations are available on pages 37-51.

Session #1: 8:00-9:00 p.m.

Biology, Water Chemistry and Community Health

Zoom link: https://bucknell.zoom.us/j/94065780403?pwd=NmVSLy9XUTJrT0lRZVVbTBFUDg4dz09

Session #2: 9:00 - 10:00 p.m.

Watershed Sciences and Sustainability

Zoom link: https://bucknell.zoom.us/j/98723616915?pwd=RzEzUVpka3hWb1VwYTFqR3Eya3NUQT09

Session #3: 8:00 - 10:00 p.m.

Graduate School Opportunities

Zoom link: https://bucknell.zoom.us/j/95332145953?pwd=NkszREdURFlXendpeVpqcTZTQlRUZz09

SATURDAY, NOVEMBER 7, 2020

All events will be held virtually via Zoom. Visit the symposium website for links to sessions and other details.

Special Sessions and Breakout Discussions

9:00 - 10:00 a.m.

Conducting scientific research during pandemics

The COVID-19 pandemic has impacted everyone's lives and this session is a way for everyone to share their stories and ideas about ways to advance research when one can't be in the field or laboratory.

Leaders: Benjamin Hayes (Bucknell University)
Mohamed Khalequzzaman (Lock Haven University)

Zoom link: https://bucknell.zoom.us/j/98636167579?pwd=S3hkbzF0bDhVZFloTG43SXhEYVk3UT09

10:00 - 11:00 a.m.

A path to increasing diversity, equity, and inclusion in the watershed sciences and environmental conservation

Listen to stories "from the field" and identify actions the watershed sciences and environmental conservation movement should take to reduce racial discrimination and eliminate individual and systemic racism. Generate and share strategies that your organization has been able to improve diversity and inclusion, phase out microaggressions, and create a healthy environment for all.

Leaders: Milton Newberry III and Tanisha M. Williams (Bucknell University)

Zoom link: https://bucknell.zoom.us/j/95904778556?pwd=TkZCQjRTR084Ym5FNVNBMTBFejBKUT09

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

Communicating your science to the public, policy makers, voters, reporters, and other key audiences

Explore ways to better disseminate and communicate your science to the public, policymakers, reporters, voters and other key audiences. How to use social media and other platforms to disseminate information and promote watershed sciences, environmental restoration, and many other issues associated with sustainability.

Leaders: John Zaktansky (Middle Susquehanna River Keeper), Christopher Martine (Bucknell University), and Justin Mando (Millersville University)

Zoom link: https://bucknell.zoom.us/j/92650495467?pwd=S284alBJWkkvZ3lrdk1yK0hZU0todz09

Plenary Address

12:00 - 1:00 p.m.

"Clean Water Grows on Trees: Finding Roots through Collective Impact"

Brenda Sieglitz

Director, Keystone 10 Million Trees Partnership, Chesapeake Bay Foundation

Zoom link: https://bucknell.zoom.us/j/93092360306?pwd=U3ZCU0JkVVdaQ1grdzZ0SklBYmpsZz09

Oral Presentations - First Group

1:00 - 2:00 p.m.

Session 1A

Ecology I - Native Plant Communities

Moderator: Christopher Martine

Zoom link: https://bucknell.zoom.us/j/96409218355?pwd=USt3amcycHozRVRtL2dFNjc1TFhPUT09

Session 2A

Hydrology I - Floods and Hydrography

Moderator: Richard Crago

Zoom link: https://bucknell.zoom.us/j/92456095519?pwd=M2JGbHd4SktJMjJHNlpKK2xmK20zUT09

Session 3A

Stream Restoration I - Live Staking / Riparian Corridor Management

Moderator: Adrienne Gemberling

Zoom link: https://bucknell.zoom.us/j/98390311774?pwd=Z0szWi9JNkNidGRyVkxpeVlkVGhTZz09

Oral Presentations - Second Group

2:00 - 3:00 p.m.

Session 1B

Ecology II - Aquatic Ecosystems and Restoration

Moderator: Mizuki Takahashi

Zoom link: https://bucknell.zoom.us/j/98221246765?pwd=U3dQdlBVWjYyUk5jV2RzMmcxd2xHUT09

Session 2B

Hydrology II - Stormwater

Moderator: L. Donald Duke

Zoom link: https://bucknell.zoom.us/j/98871749980?pwd=eHk1TDRtclZKMkl1aXNwL1BmdFFnZz09

Session 3B

Stream Restoration II - Improving Stream-Floodplain Connectivity

Moderator: Benjamin Hayes

Zoom link: https://bucknell.zoom.us/j/96756551279?pwd=K0dDcjlRTlczclNmRi9FZnR5TVBRUT09

Oral Presentations - Third Group

3:00 - 3:40 p.m.

Session 1C

Watershed Restoration: The 10 Million Trees Partnership

Moderator: Brenda Sieglitz

Zoom link: https://bucknell.zoom.us/j/93062980153?pwd=OHU3RTFWUUozR21mTVJ3OWllSnpVQT09

Session 2C

Stream Temperatures

Moderator: Peter Mark Jansson

Zoom link: https://bucknell.zoom.us/j/91331051213?pwd=bURGZUJuK2twZkVBcndpZjlBZU83Zz09

Session 3C

Science Communications and Education

Moderator: Robert Smith

Zoom link: https://bucknell.zoom.us/j/92111427628?pwd=TkRRK2FLRjBKTXFXcHRYSHY2eVloQT09

Wrap-Up and Looking Ahead

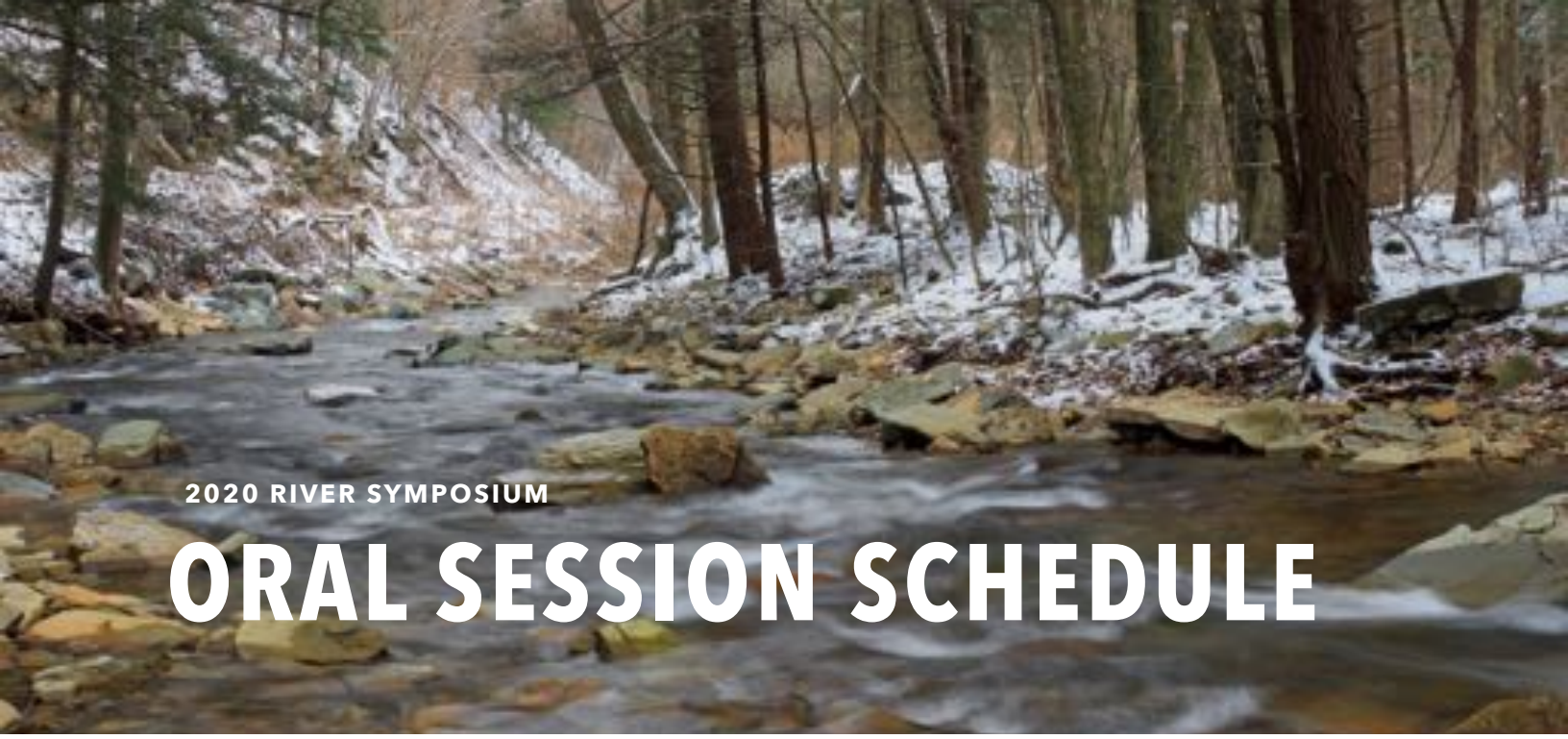
3:40 - 4:00 p.m.

Moderator: Benjamin Hayes

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

Zoom link: https://bucknell.zoom.us/j/99699182914?pwd=Z05uU2s3K0RxYVRqZGFmZUYzMzRCZz09

Ann Pesiri Swanson, Executive Director of the Chesapeake Bay Commission and the symposium's Keynote Speaker (front center) and H.W. "Skip" Wieder, Founding Director of the Susquehanna River Heartland Coalition for Environmental Studies and the symposium's Honorary Chair (right rear), with a group of 75 students, faculty, and guests presenting at the 14th River Symposium, *"Healthy Rivers, Healthy Communities,"* October 18-19, 2019.



2020 RIVER SYMPOSIUM

ORAL SESSION SCHEDULE

Session 1A

Ecology I - Native Plant Communities

Saturday, November 7, 1:00 - 2:00 p.m.

Zoom link: https://bucknell.zoom.us/j/96409218355?pwd=USt3amcycHozRVRtL2dFNjc1TFhPUT09

1:00 p.m. *"Conservation genomics of Pennsylvania-threatened Baptisia australis var. australis: an investigation in riparian gene flow"*
Cheyenne Moore,* Angela McDonnell, Scott Schuette, and Christopher Martine

1:20 p.m. *"Genetic diversity & connectivity of Chasmanthium latifolium (Poaceae) in Pennsylvania & the effect on conservation status"*
Jonathan Hayes,* Tanisha M. Williams, Angela McDonnell, Rachel Goad, Scott Scheutte, and Christopher Martine

1:40 p.m. *"Carrying Capacity in Suburban Ecological Communities "*
Zachary R. Groff*

Session 1B

Ecology II - Aquatic Ecosystems and Restoration

Saturday, November 7, 2:00 - 3:00 p.m.

Zoom link: https://bucknell.zoom.us/j/98221246765?pwd=U3dQdlBVWjYyUk5jV2RzMmcxd2xHUT09

2:00 p.m. *"Assessment of small tributaries as possible habitats for larvae and juveniles of Japanese giant salamanders, Andrias japonicus, by coupling environmental DNA with traditional field surveys"*
Brianna Bjordahl* and Mizuki Takahashi

2:20 p.m. *"Improving stream restoration projects: how instream habitat influences recruitment and distribution of aquatic insects"*
Catherine R. Billé*, Belinda Wan, and Matthew M. McTammany

Session 1C

Watershed Restoration: 10 Million Trees Partnership

Saturday, November 7, 3:00 - 3:40 p.m.

Zoom link: https://bucknell.zoom.us/j/93062980153?pwd=OHU3RTFWUUozR21mTVJ3OWllSnpVQT09

3:00 p.m. *"Research on Methods for Forested Buffer Restoration: Stone Mulch vs. Herbicide Spots and Four Types of Tree Shelters"*
David Wise,* Charles Dow, and Calen Wylie

3:20 p.m. *"Reforesting Reclaimed Mine Lands in Pennsylvania"*
Thomas Clark*

Session 2A

Hydrology I - Floods and Hydrography

Saturday, November 7, 1:00 - 2:00 p.m.

Zoom link: https://bucknell.zoom.us/j/92456095519?pwd=M2JGbHd4SktJMjJHNlpKK2xmK20zUT09

1:00 p.m. *"Pennsylvania Elevation-Derived Hydrography Data"*
Ellen Fehrs*

1:20 p.m. *"How a Karst Watershed Swallowed Half of the Excess Rainfall in Its Wettest Year Ever"*
Todd Giddings*

1:40 p.m. *"Improving Riverine Flood Hazards Estimation Using an Integrated Modeling Approach"*
Sanjib Sharma*

Abstracts for oral presentations are provided on pages 18 - 36.
** denotes presenting author.*

Session 2B

Hydrology II - Stormwater

Saturday, November 7, 2:00 - 3:00 p.m.

Zoom link: https://bucknell.zoom.us/j/98871749980?pwd=eHk1TDRtclZKMkI1aXNwL1BmdFFnZz09

2:00 p.m. *"Stormwater Offsets: Applying Agricultural BMPs to help meet Municipal Obligations"*
Harry Campbell*

2:20 p.m. *"Challenges, barriers, and misunderstandings for implementing small-municipality MS4 programs"*
Leslie Rieck,* Craig Carson, Robert J. Hawley, Madison Heller, and Mikel Paul

2:40 p.m. *"GIS-Based Prioritization System for MS4 Compliance Projects"*
Bailey Schwenk* and Robert Smith

Session 2C

Stream Temperatures

Saturday, November 7, 3:00 - 3:40 p.m.

Zoom link: https://bucknell.zoom.us/j/91331051213?pwd=bURGZUJuK2twZkVBcndpZjlBZU83Zz09

3:00 p.m. *"Aquatic Warming Stripes: Visualizing Climate Change Impacts to Freshwater Ecosystems"*
Matthew Shank*

3:20 p.m. *"Unmanned Aerial Infrared and Visual Light Data Collection on the West Branch Susquehanna"*
Nicholas C. Marino* and Robert W. Jacob

Abstracts for oral presentations are provided on pages 18 - 36.
** denotes presenting author.*

Session 3A

Stream Restoration I - Live Staking / Riparian Corridor Management

Saturday, November 7, 1:00 - 2:00 p.m.

Zoom link: https://bucknell.zoom.us/j/98390311774?pwd=Z0szWi9JNkNidGRyVkxpeVlkVGhTZz09

1:00 p.m. *"Restoration Reports: A landowner outreach and communication tool from design to farmer outreach"*
Adrienne Gemberling,* Emily Mills, and Margot Mays

1:20 p.m. *"Viability of live stake species: bud production, herbivory, and the effects of rooting hormone and herbicide treatments"*
Rose Wetzel,* Jonathan Niles, Adrienne Gemberling, and Matthew Wilson

1:40 p.m. *"Evaluating the Impact of Stream Restoration Techniques on Bank Erosion and Stream Morphology at an Unnamed Tributary of Pine Creek near Woodward, Central Pennsylvania"*
Emily Haas,* Ellen Chamberlin, and Shaun Parrish

Session 3B

Stream Restoration II - Improving Stream-Floodplain Connectivity

Saturday, November 7, 2:00 - 3:00 p.m.

Zoom link: https://bucknell.zoom.us/j/96756551279?pwd=K0dDcjlRTlczclNmRi9FZnR5TVBRUT09

2:00 p.m. *"Adaptive Management of Aquatic and Riparian Ecosystems Utilizing Large Woody Materials on the Allegheny National Forest: Setting the Stage for the Little Arnot Run Watershed Restoration Project"*
Luke Bobnar,* Charles M. Keeports, Benjamin R. Hayes, Grace M. Tillotson, and Christopher M. Dempsey

2:20 p.m. *"Fluvial geomorphology and hydrology of Little Arnot Run, Allegheny National Forest"*
Benjamin R. Hayes,* Charles M. Keeports, Luke Bobnar, Grace M. Tillotson, and Christopher M. Dempsey

2:40 p.m. *"Using large woody debris in streams to restore biodiversity of complex valley floor landscapes"*
Matthew E. McTammany* and Catherine M. Billé,

Abstracts for oral presentations are provided on pages 18 - 36.
** denotes presenting author.*

Session 3C

Science Communications and Education

Saturday, November 7, 3:00 - 3:40 p.m.

Zoom link: https://bucknell.zoom.us/j/92111427628?pwd=TkRRK2FLRjBKTXFXcHRYSHY2eVloQT09

3:00 p.m. *"Outreach, Education, and Curriculum Development for an Urban Stormwater College-Community Partnership"*

Brooke Millisock,* Melvin Zimmerman, and Robert Smith

3:20 p.m. *"Going Rogue: Science communication lessons from Twitter "alt" government accounts"*

Matthew Wilson* and Elizabeth Perkin

Abstracts for oral presentations are provided on pages18 - 36.

** denotes presenting author.*

INVITED SPEAKERS

Cynthia Adams Dunn

Secretary
Pennsylvania Department of Conservation and Natural Resources

Cynthia Adams Dunn serves as the sixth secretary of the Pennsylvania Department of Conservation and Natural Resources (PA DCNR), the agency where she has worked under three governors in multiple positions over the last two decades. A nationally-recognized leader in environmental conservation, Secretary Dunn provides leadership to DCNR's vast network of state forests, parks, conservation initiatives, recreational activities, and educational programs.

A native of Pennsylvania and trained wildlife biologist and watershed ecologist, Dunn has received numerous awards, including the Frances E. Flanigan Environmental Leadership Award from the Alliance for the Chesapeake Bay, the Conservationist of the Year award from the Pennsylvania Federation of Sportsmen's Clubs and Pennsylvania Wildlife Federation, and the Conservationist of the Year award from the Appalachian Chapter of the Audubon Society.

Previously, Secretary. Dunn had served as the president and chief executive officer of PennFuture, a statewide environmental advocacy organization. She served as Pennsylvania Deputy Secretary of Conservation and Technical Services from 2007 until 2013.

When not championing the efforts of DCNR, Dunn enjoys the natural and recreation resources the agency works hard to protect and promote through hobbies that include birding, canoeing, fishing, and hiking.

The Pennsylvania Department of Conservation and Natural Resources (PA DCNR) has been a strong supporter of the Susquehanna River Heartland Coalition for Environmental Studies and the River Symposium for the past 15 years. We are delighted that Secretary Dunn will deliver the keynote address entitled *"The Future of Conservation"* at 7:30 to 8:00 p.m. on Friday, November 6, 2020.

Brenda Lee Sieglitz

Manager, Keystone 10 Million Trees Partnership
Chesapeake Bay Foundation

Brenda Lee Sieglitz is the Keystone 10 Million Trees Partnership manager. Based in Harrisburg, she leads the collaborative effort, coordinated by the Chesapeake Bay Foundation, of over 100 national, regional, state and local agencies, as well as conservation organizations, watershed groups, conservancies, outdoors enthusiasts, businesses and individuals willing to plant trees. She is an award-winning author, PA Master Naturalist, and has held leadership and mentorship roles with the Susquehanna Valley Chamber of Commerce, Lancaster Chamber, Team Sarcoma: Keepin' it Kevin, and Lancaster Against Pipelines, and has volunteered with National Park Service, Lancaster Conservancy, and Hospice & Community Care.

Brenda will deliver Saturday's plenary address entitled *"Clean Water Grows on Trees: Finding Roots through Collective Impact"* at 12:00 to 1:00 p.m. on Saturday, Nov. 7 via. the Zoom session: https://bucknell.zoom.us/j/93092360306. Participants are encouraged to grab some lunch and listen to her address.

"Clean Water Grows on Trees: Finding Roots through Collective Impact"

The collective strength of our experience, initiative, and ideas is necessary for us to create systemic change in Pennsylvania and plant 10 million trees by 2025. The Chesapeake Bay Foundation supports the current K10M Partnership strategy assists agencies, businesses, organizations and landowners with funding for tree plantings and innovative ideas that lead to increased demand and guarantee supply of native trees. This session will showcase how partners are collaborating across the Commonwealth to meet the challenges and opportunities towards the Chesapeake Bay Blueprint and Pennsylvania clean water goals.

The Chesapeake Bay Foundation has played a major role in the River Symposium over the past 15 years. We are pleased to feature the CBF's 10 Million Trees Partnership and the important role it plays in watershed restoration efforts across the Commonwealth. See page 15-16 for more information.

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

Keystone 10 Million Trees Partnership

Saving the Chesapeake Bay hinges on first saving rivers and streams in PA, the Chesapeake Bay Foundation believes the work of many hands planting many trees can be a difference-maker in getting the Commonwealth back on track.

CBF launched the Keystone 10 Million Trees Partnership in 2018, focused on Pennsylvania's Clean Water Blueprint goal of planting 95,000 acres of forested buffers by the end of 2025.

Adding 10 million new trees alongside streams, streets, and other priority landscapes in Pennsylvania's portion of the Bay watershed would accelerate the Keystone State as much as two-thirds toward the 95,000-acre target.

Since 2018, cumulative efforts by CBF, the partnership and others across Pennsylvania have planted roughly 1.74 million trees.

The partnership is a collaborative effort of 147 partner groups representing national, regional, state, and local agencies, conservation organizations, watershed groups, conservancies, outdoors enthusiasts, businesses, and individuals.

The partnership's success is rooted in the determination of many hands and on full display during COVID-19 restrictions. Of 95,000 trees distributed for spring planting in 2020, about 84,000 went into the ground. The remaining 11,000 trees are being kept in partner greenhouses and will grow into larger stock for future plantings.

Focus shifted to fall plantings and about 47,000 trees were delivered in September to pick-up points. Because of spring cancellations, the fall 2020 number of trees is more than double what was planted in fall of 2019.

Tree numbers are only going to grow.

For the next two years, CBF issued requests for proposals (RFP) and is planning to spend about $2.6 million on 710,000 trees, shelters, and stakes for the partnership. CBF contracted for 210,000 trees, stakes, and shelters for 2021.

For 2022, CBF awarded bids to four growers for a total of 500,000 trees and supplies. Forward contracting is new to CBF and provides a boost to businesses from guaranteed sales, and the diversity of the plants to CBF partners.

Efforts by many hands to plant many trees in the Commonwealth will take shape in a variety of programs and benefit from a growing number of funding sources.

A grant by the National Fish and Wildlife Foundation awarded to CBF and matching funds will provide nearly $2 million to plant and maintain 360 acres of new trees and boost efforts in eight Pennsylvania counties toward achieving local plans for cleaner water.

CBF is also leading a three-year study of the practice of silvopasture, supported by a grant from the Northeast Sustainable Agriculture Research and Education Program Research under the U.S. Department of Agriculture.

This research will look to guide farmers on how to get productive trees established in active pastures given predation, livestock damage, limited resources, and different types and quality of forage and soils.

A major reason Pennsylvania continues to lag so far behind in implementing clean water practices is a lack of adequate investments of financial and technical assistance at the state and federal levels.

When it comes to adding trees and other important pollution practices on farms and other important landscape, CBF has been proud to work collaboratively to establish a few funding streams.

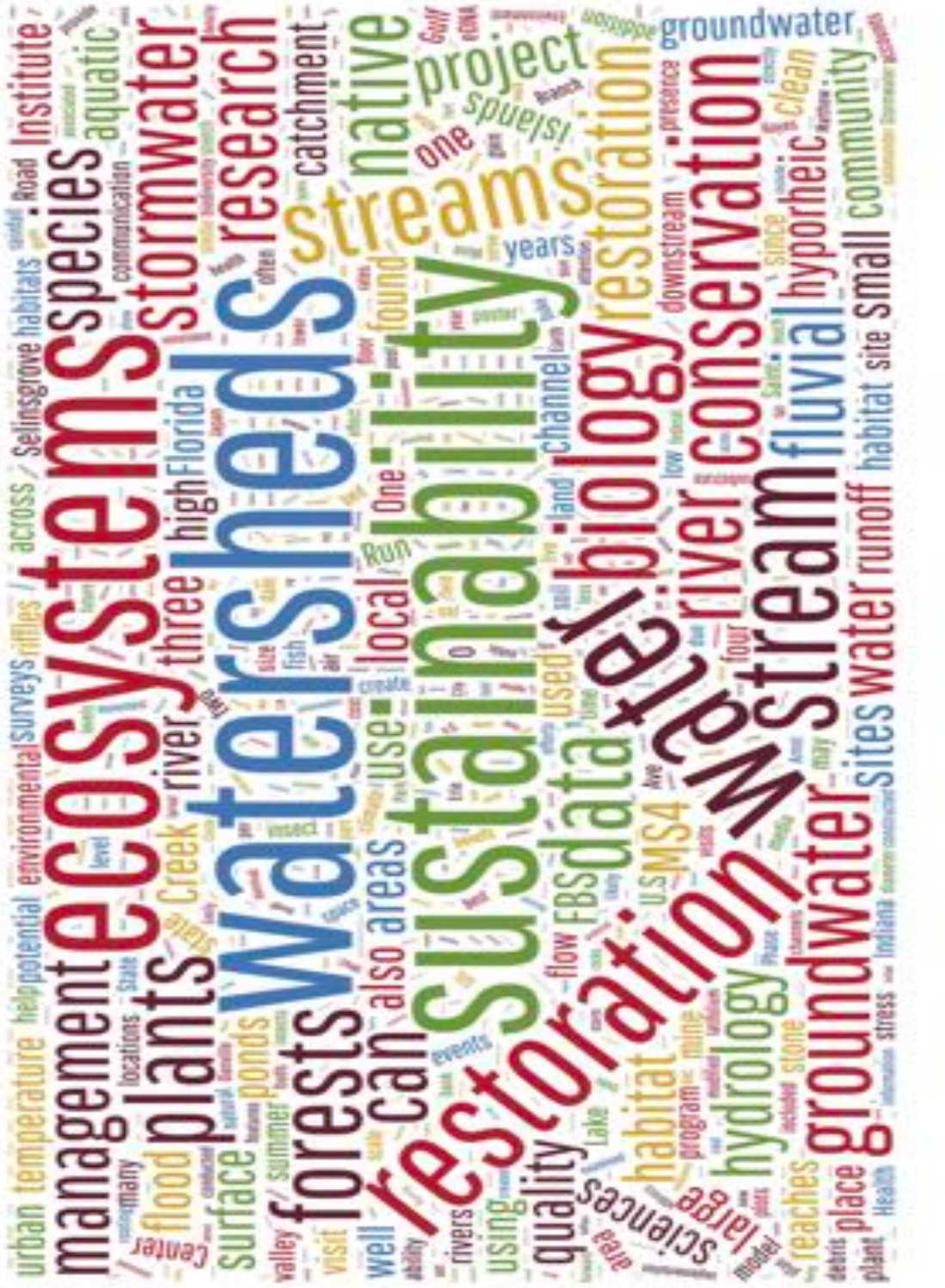
CBF was instrumental in the Pennsylvania General Assembly's passage last year of the Keystone Tree Restricted Account, which created a voluntary $3 check-off box on Pennsylvania's driver's license and vehicle registration online renewals to buy, plant, and maintain more trees across the Commonwealth. These voluntary donations will support the existing TreeVitalize and Riparian Forest Buffer Grant programs through the Department of Conservation and Natural Resources.

CBF, Pennsylvania Farm Bureau, Sand Penn State Agriculture and Environmental Center worked jointly to propose programs that would direct funding to conservation districts, and provide the needed technical assistance to farms and the flexibility to determine conservation practices specific to local watershed needs.

The bill introduced by State Senator Gene Yaw (R-Lycoming) will create the Agricultural Conservation Assistance Program (ACAP). ACAP will provide the funding support that farmers in Pennsylvania want and need so they can keep soil on the land, reduce pollution, and protect their long-term viability.

To learn more about the Keystone 10 Million Trees Partnership visit www.TenMillionTrees.org.

Keystone
10 MILLION TREES
PARTNERSHIP



A "word cloud" visualization of the most frequently words in the oral and poster abstracts contributed to this symposium (pages 18-51). Their relative size denotes greater prominence to the words that appear most frequently. A total of 14,537 words were analyzed.

2020 RIVER SYMPOSIUM

ORAL PRESENTATIONS

CONSERVATION GENOMICS OF PENNSYLVANIA-THREATENED BAPTISIA AUSTRALIS VAR. AUSTRALIS: AN INVESTIGATION IN RIPARIAN GENE FLOW

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The perennial wildflower, *Baptisia australis* var. *australis* (L.) R. Br. is found along only four waterways in Pennsylvania: the Allegheny River, Youghiogheny River, Clarion River, and Red Bank Creek. Because of its limited distribution and small number of extant populations, B. australis var. australis is considered state-threatened in Pennsylvania. In addition, the riparian prairie habitat that Pennsylvania *Baptisia australis* var. *australis* is restricted to is also in decline and considered vulnerable in the state. Because of conservation concerns for Baptisia australis var. australis in Pennsylvania, gaining insights into the natural history and genetics of the taxon is useful for conservation practitioners.

This project seeks to determine the genetic structure and health of known native populations and apply that information to understanding riparian gene flow, as well as establishing conservation units. Genotyping-by-sequencing (GBS) was used to collect genomic data for use in population genetics analyses. My work synthesizes these data to gain insight into the metapopulation dynamics of this riparian system and examine patterns of gene flow. We found that there are three genetic groups of Baptisia australis var. australis in Pennsylvania, with one of these showing internal genetic structure. This finding can be applied to management units for the taxon. Some Pennsylvania populations are becoming increasingly isolated as well as dwindling in population size, making now an ideal time to collect seeds and facilitate gene flow while levels of inbreeding are relatively low. My research will inform the conservation status of Baptisia australis var. australis in Pennsylvania, as well as clarify lingering uncertainties about gene flow in riparian plant populations.

Keywords: Fabaceae, conservation, Baptisia, riparian, population genomics, rare species, Pennsylvania, metapopulation, Natural Heritage Program

GENETIC DIVERSITY & CONNECTIVITY OF CHASMANTHIUM LATIFOLIUM (POACEAE) IN PENNSYLVANIA & THE EFFECT ON CONSERVATION STATUS

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Chasmanthium latifolium (Poaceae) is a rhizomatous perennial plant species that lives in close proximity to rivers and streams, making it fittingly referred to as river oats. Native to the southern midwest and the eastern half of the United States, *C. latifolium* reaches the northeastern edge of its range in Pennsylvania. *Chasmanthium latifolium* (Poaceae) is comprised of two metapopulations that exhibit an east-west disjunction within Pennsylvania, one metapopulation around the Allegheny River, and one around the Susquehanna River. Due to the limited and isolated distribution of the species within the state, as well as declining populations, *C. latifolium* is considered a critically imperiled (S1) plant in Pennsylvania by the Pennsylvania Natural Heritage Program (PHNP) but is ranked as tentatively undetermined by the state.

My study aims to achieve two main objectives: 1) investigate the genetic diversity and connectivity of the two metapopulations, and 2) revise the conservation status and develop scientifically informed policies to better conserve this species. This research utilizes a genotype-by-sequencing (GBS) approach to generate genomic data for use in population genetics analyses. By employing iPyrad and packages in the R statistical computing software to synthesize these data, I will gain insight into gene flow and the genetic stability of these metapopulations. Ultimately, my research will provide an updated, scientifically-backed conservation status assessment of *C. latifolium* in Pennsylvania. This project will combine rare plant survey protocols by the Pennsylvania Natural Heritage Program and Western Pennsylvania Conservancy and genetic work at Bucknell University to address broad conservation questions.

Keywords: River Oats, Rare Plants, Populations Genetics, Conservation

CARRYING CAPACITY IN SUBURBAN ECOLOGICAL COMMUNITIES

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Regionally in the northeastern hardwood forest ecosystems, the use of alien plants for ornamental horticulture, the escaping of those plants as invasive species, and the deliberate removal of native vegetation in the process greatly limits carrying capacity for migratory birds. Invasive plant species disrupt the natural succession of unused farmlands and open spaces.

Before suburban sprawl, the spaces between cities were greater and provided a corridor between natural areas. The carrying capacity of highly developed areas can be improved by directly improving the abundance and biodiversity of native vegetation in the first trophic level. By eliminating invasive plant species, replacing alien ornamental species with native alternatives for specialist and generalist insect species, and reducing lawn area, native insect populations increase thereby improving carrying capacity and breeding success of migratory birds. This also has implications for mitigation efforts for other ecosystem processes affected by anthropogenic and environmental risks.

ASSESSMENT OF SMALL TRIBUTARIES AS POSSIBLE HABITATS FOR LARVAE AND JUVENILES OF JAPANESE GIANT SALAMANDERS*, ANDRIAS JAPONICUS*, BY COUPLING ENVIRONMENTAL DNA WITH TRADITIONAL FIELD SURVEYS

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Demographic assessments of all four cryptobranchid salamander species have continued to indicate declines over the past several decades. One of the conservation challenges facing all cryptobranchid salamanders is the paucity of information about larvae and juveniles. Larvae and juveniles have only rarely been encountered during field surveys, even in streams where adults have commonly been found. In the case of the Japanese giant salamander (*Andrias japonicus*), several lines of evidence imply that larval and juvenile age classes use different habitats than adults such as small tributary streams, which have been overlooked by conservation monitoring surveys in Japan. We examined small tributary streams as possible habitats for young *A. japonicus* by integrating eDNA analysis with traditional field surveys. During the summer of 2018, we surveyed three first-to-third order tributaries of the Ichi River in Hyogo Prefecture, Japan, and collected water samples from each stream (Stream A: 465 m stretch, N=8; Stream B: 955 m stretch, N=21; Stream C: 2,331 m stretch, N=22) for eDNA analyses. Although no *A. japonicus* were observed during the eDNA water sampling, we repeatedly detected *A. japonicus* eDNA in all streams. Given this result, we conducted field surveys in the summer and fall of 2019, consisting of a daytime survey and a nighttime survey for each of the three streams. During the daytime surveys, we found no *A. japonicus* in Streams A and B, whereas in Stream C we found one larva, one juvenile, and one new nest with a large adult male actively guarding, from sampling sites that showed notably higher eDNA concentrations. During the nighttime surveys, we found five adults and one juvenile from Stream A, one adult from Stream B, and 13 adults from Stream C. These results suggest the importance of small tributary streams for *A. japonicus*, especially for smaller breeding adults and likely for larval and juvenile development. There are numerous previously unsurveyed small tributary streams throughout the range of *A. japonicus*. Our results suggest that the coupling of eDNA analysis with field surveys provides an efficient monitoring tool to examine those overlooked habitats, which would further emphasize the importance of including small tributaries in the conservation management of *A. japonicus* and potentially the other cryptobranchid salamanders.

Keywords: Amphibia, Caudata, Cryptobranchidae, declines, conservation, eDNA, Japan, stream salamanders

IMPROVING STREAM RESTORATION PROJECTS: HOW INSTREAM HABITAT INFLUENCES RECRUITMENT AND DISTRIBUTION OF AQUATIC INSECTS

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Aquatic insects have complex life cycles which often involve interactions with aquatic and terrestrial environments. Many insects rely on the presence of instream habitats, like riffles, to successfully complete multiple life stages. Riffles are particularly important for recruitment of insects that exclusively oviposit (lay eggs) on microhabitat like rocks or organic material. Riffles are also home to diverse larval communities that often serve as a source of individuals to proximal downstream habitat. We sought to investigate the extent to which instream habitat limits recruitment and community diversity of aquatic insects due to lack of suitable oviposition habitat and isolation of instream habitat patches.

To accomplish this, we constructed nine gravel and cobble riffles in a small central Pennsylvania stream previously lacking coarse inorganic and emergent substrate. These riffles were constructed in sets with different inter-riffle distances (15, 10, or 5 m) to determine if distance to upstream riffle and oviposition habitat affected downstream benthic invertebrate density. Benthic and drift samples were collected directly below each riffle and set of riffles every two weeks from September-October 2019. Riffles were also sampled for aquatic insect eggs, which were reared to adulthood in the lab. Composited Surber samples were also taken from constructed riffles and non-riffle habitat at the end of the experiment to compare community diversity between habitat types.

Initial results suggest that addition of emergent substrate increased insect recruitment to our stream, as 88% of egg masses were found on emergent rocks in riffles compared to 12% of egg masses on fully submerged rocks. Egg masses from *Hydropsyche* sp. (Trichoptera) and Chironomidae (Diptera) were found on both types of substrate, while *Baetis* sp. (Ephemeroptera) egg masses were only found on emergent rocks, which suggests that recruitment of taxa with selective oviposition behaviors could be limited by availability of emergent rock substrate. Additionally, larval insect densities were higher in reaches with riffles spaced 5 m apart (276.3 +/- 29.6) than in the control reach upstream of the constructed riffles (mean 113.7 +/- 7.6; ANOVA with Tukey's pairwise comparison, $p < 0.05$). This study increased our knowledge of insect oviposition behavior and showed that providing oviposition and riffle habitat for aquatic insect taxa could improve recolonization and ecological recovery following restoration of habitat-limited streams. We suggest strategic riffle addition, including emergent substrate, as an augmentation of conventional structural restoration practices in streams.

Keywords: aquatic macroinvertebrates, oviposition, restoration ecology, small streams

RESEARCH ON METHODS FOR FORESTED BUFFER RESTORATION: STONE MULCH VS. HERBICIDE SPOTS AND FOUR TYPES OF TREE SHELTERS.

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Stone Mulch as an Alternative to Herbicide Spots in Buffer Plantings: For forested buffer restoration, protecting sheltered trees from rodent damage with 2A modified stone provides a cost-effective alternative to glyphosate herbicide applications. For roughly 15 years, herbicide applications have been a standard prescription for this protection. Concerns for workers, environment and cost led Stroud Water Research Center to test alternatives beginning in 2013, including vole guards, 2" clean stone, and 2A modified stone, which is a mix of particle sizes from very fine to roughly ¾" long dimension. Second generation trials tested 2A modified stone mulch vs. herbicide application. Two stone mulch amounts were tested: 20" diameter x 2" thick (roughly 40 lb) and 12" diameter x 2" thick (roughly 20 lb). Herbicide spots were 36" in diameter, applied 2x/year. Through three growing seasons, either 2A modified stone treatment was as effective as herbicide spots on survivorship, with a slight decline in growth rate for stone treatments. Stone mulch costs roughly 1/3 the cost of typical four-year herbicide applications, and requires 1 mobilization vs. 8 for herbicide use. Loss of stone due to flooding appears to be a minor concern. Access/logistics of getting stone to some sites can be challenging.

Trials of Tree Shelters - Tubex Combitube TM, Plantra TM and Suregreen TM: Tree shelters are commonly used in hardwood plantings to aid growth and survivorship. Stroud Center's tests of Tubex Combitube (vented), Standard Tubex (non-vented) and Plantra (vented) - all 5' tall – showed no significant differences in growth or survivorship through three years. Tests of Combitube vs. Plantra vs. Suregreen TM (vented) showed no significant differences after one growing season. Among these commonly used shelters, data to date show that secondary considerations (cost, ease of use, availability and other aspects of performance) can guide selection.

Keywords: forested buffer, rodent, herbicide, stone mulch, tree shelter, survivorship, growth

REFORESTING RECLAIMED MINE LANDS IN PENNSYLVANIA

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The Appalachian Regional Reforestation Initiative (ARRI) of the Federal Office of Surface Mining (OSM) is an effort to return mining sites into a forested land use through their recommended Forest Reclamation Approach (FRA). This approach includes working with mining companies to plant trees instead of the creation of compacted grasslands upon reclamation OR reverting previously compacted reclaimed mine lands to forest through site preparation which can include herbicide competitive grasslands, the reduction of compaction through soil-ripping, and the replanting of tree seedlings at a minimum of 700 per acre. An ad-hoc group comprised of members from the Pennsylvania Department of Environmental Protection, Pennsylvania Department of Conservation and Natural Resources, Pennsylvania Game Commission, Chesapeake Bay Foundation, Pennsylvania Environmental Council, Susquehanna River Basin Commission (SRBC), and the Foundation for Pennsylvania Watersheds have begun to coordinate yearly site preparation and reforesting projects particularly focusing on the later of the two approaches; reverting previously compacted mine lands to forest. Tom Clark, Mine Drainage Program Coordinator for the Susquehanna River Basin Commission, will describe that process, give project examples, and explain how you can become a part of the reforestation solution in Pennsylvania.

Keywords: Reforestation, Reclamation, Mine

One year old trees at Round Knob, PA

PENNSYLVANIA ELEVATION-DERIVED HYDROGRAPHY DATA

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The Pennsylvania Department of Conservation and Natural Resources (DCNR) Bureau of Geological Survey (BGS) has compiled a comprehensive workflow that will be used to generate hydrography data for the new elevation-derived Pennsylvania Hydrography Dataset (PAHD). This workflow relies primarily on geomorphon classification of (QL Level 2) lidar-derived elevation data as a means of identifying potential flowpath geometries which are subsequently winnowed to remove artifacts and other irrelevant features. The geomorphon areas that remain are further processed to create a vector flowpath network. Final steps in the workflow assign attributes, some from the NHD, others by running specific tools. The end goal is a scale-equivalent and dynamic hydrography dataset for the state of Pennsylvania, created using derivatives created from quality level (QL) 2 Light Detection and Ranging (Lidar) elevation data. For the purposes of this project, "scale-equivalent" is defined as horizontal accuracy to one meter and vertical accuracy to half a meter at a 1:2,400 scale with reference to the most current elevation data. This presentation briefly examines the major components of the most current methodology for producing flowpath geometries.

Keywords: hydrography, GIS, geomorphons, Lidar, elevation data

HOW A KARST WATERSHED SWALLOWED HALF OF THE EXCESS RAINFALL IN ITS WETTEST YEAR EVER

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63.75 inches of rainfall and snowmelt water made 2018 the wettest year in 122 years of record for the Spring Creek Watershed in Centre County, PA. Yet it experienced very limited overbank stream flooding even though its 30-year average annual precipitation of 40.66 inches was exceeded by 57%. This presentation will explain how the unique combination of its hydrogeologic characteristics enabled this karst watershed to convert the excess rainfall into stored groundwater recharge instead of floodwater runoff. Much of the storm-water runoff from the watershed's surrounding mountain ridges flowed into sinkholes at the base of the ridges and was directly converted into groundwater recharge, thereby mitigating storm-water flooding. You will learn the details of how this watershed's unique carbonate flow systems took in and stored 38 billion gallons of groundwater recharge from the 70 billion gallons of above-normal precipitation for a capture ratio of 55%.

Keywords: watershed, karst, wettest, recharge

IMPROVING RIVERINE FLOOD HAZARDS ESTIMATION USING AN INTEGRATED MODELING APPROACH

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Floods drive devastating climate-related disasters. These risks are expected to rise with environmental and demographic changes. A sound understanding of dynamic flood hazards is crucial to inform the design and implementation of flood risk management strategies. We develop a framework to assess riverine flood risks for current and projected climate conditions. We implement the framework for rivers across the state of Pennsylvania, United States. Our projections suggest that flood hazards across Pennsylvania are overall increasing with future climate change. The analysis requires an integrated approach since the uncertainty in flood inundation projections is impacted by uncertainties surrounding climate change, and hydrodynamic model structure and parameter. We will discuss how this framework can provide regional and dynamic flood-hazard assessments and help to inform the design of risk management strategies.

Keywords: Flood hazards, extreme flows, integrated modeling system, flood mapping, uncertainty analysis.

During Tropical Storm Lee, September 9, 2011, residents of Johnson City,, N.Y. were evacuated as homes and businesses were inundated by flood waters from the Susquehanna River. Photo: Brett Carlsen

STORMWATER OFFSETS: APPLYING AGRICULTURAL BMPS TO HELP MEET MUNICIPAL OBLIGATIONS

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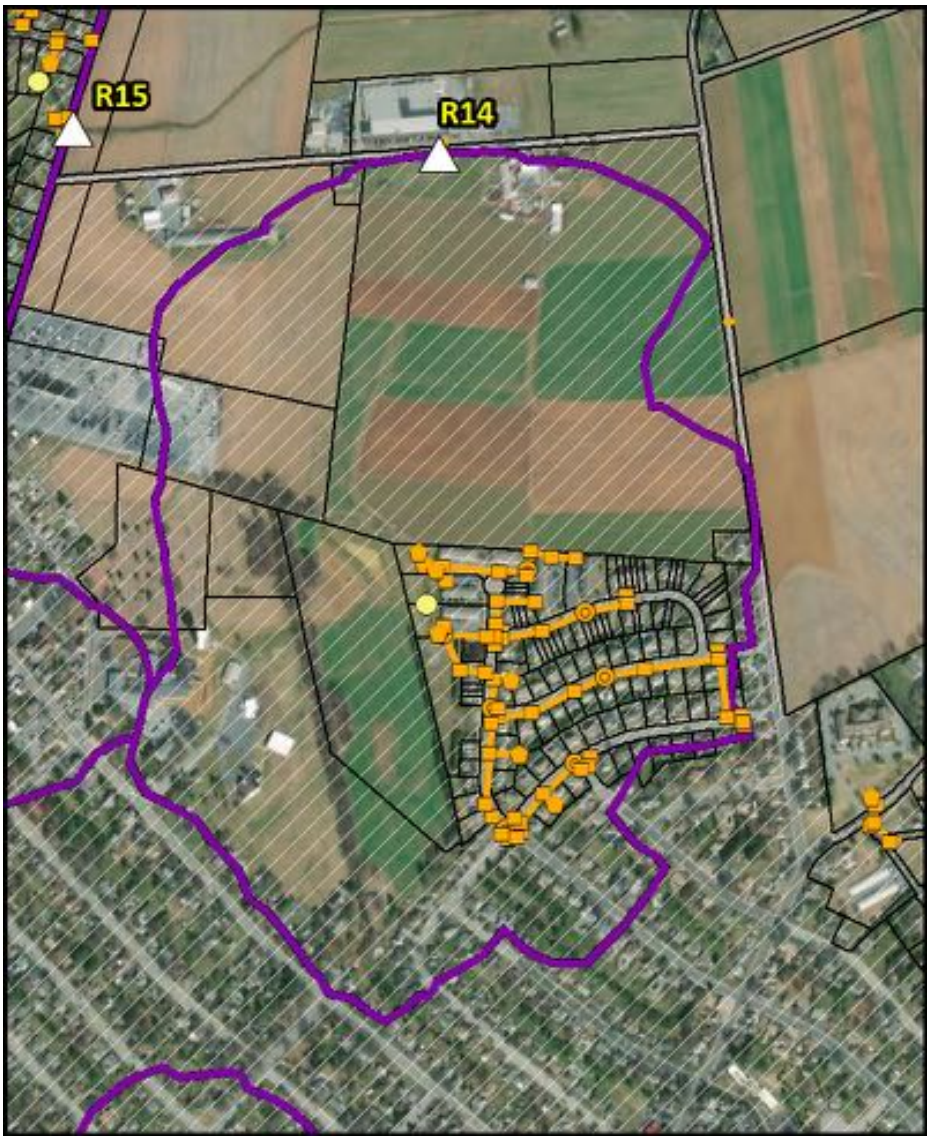
This presentation will summarize the findings and recommendations of a USDA NRCS Conservation Innovation Grant that explored the feasibility of municipalities achieving required stormwater pollutant reductions by implementing select best management practices on agricultural lands. project team worked directly with four municipalities in Lancaster County to gauge municipal interest in these types of partnerships, identify potential projects, and develop preliminary cost comparisons between agricultural stormwater projects and urban stormwater projects. Project partners included representatives of CBF, RETTEW Associates, Red Barn Consulting, Land O Lakes, and Quantified Ventures.

Keywords: Agriculture, Stormwater, Water Quality, Cost-efficiency, Pollution Reductions



CHALLENGES, BARRIERS, AND MISUNDERSTANDINGS FOR IMPLEMENTING SMALL-MUNICIPALITY MS4 PROGRAMS

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Federal regulations for municipal separate storm sewers (MS4) in the United States have been in place since 1990 as part of the Nation Pollutant Discharge Elimination System (NPDES), aiming to reduce sediment and pollutant loads originating from urban areas. However, small-municipality MS4 permittees frequently face several common challenges, barriers, and misunderstandings in their efforts to regulate stormwater. We summarize common challenges and misunderstandings concerning MS4 management and offer real-world examples of effective approaches for satisfying MS4 requirements. For example, many municipalities see no funding mechanism for implementing stormwater plans, and small municipalities are at a particular disadvantage in the absence of direct federal or state funding. Taxes are a potential mechanism yet often unpalatable to local municipalities. Grants or the creation of a stormwater utility can offset costs to local communities but also face barriers to implementation. Additionally, best management practices (BMPs) can improve stormwater quality but benefits to the local community from improved water quality are often poorly understood or mischaracterized. In spite of this, there are several MS4 management approaches that may be more approachable, including forming coalitions, forming stormwater utilities, and establishing monitoring programs. Small municipalities can benefit greatly from a realistic, facts-based clarification of MS4 policies and practices that lays out all of the options available to achieve NPDES requirements.

Keywords: Phase II MS4, urban stormwater, best management practice, municipality, stakeholders

GIS-BASED PRIORITIZATION SYSTEM FOR MS4 COMPLIANCE PROJECTS

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

Keywords: Stormwater, MS4, GIS, Urbanization

AQUATIC WARMING STRIPES: VISUALIZING CLIMATE CHANGE IMPACTS TO FRESHWATER ECOSYSTEMS

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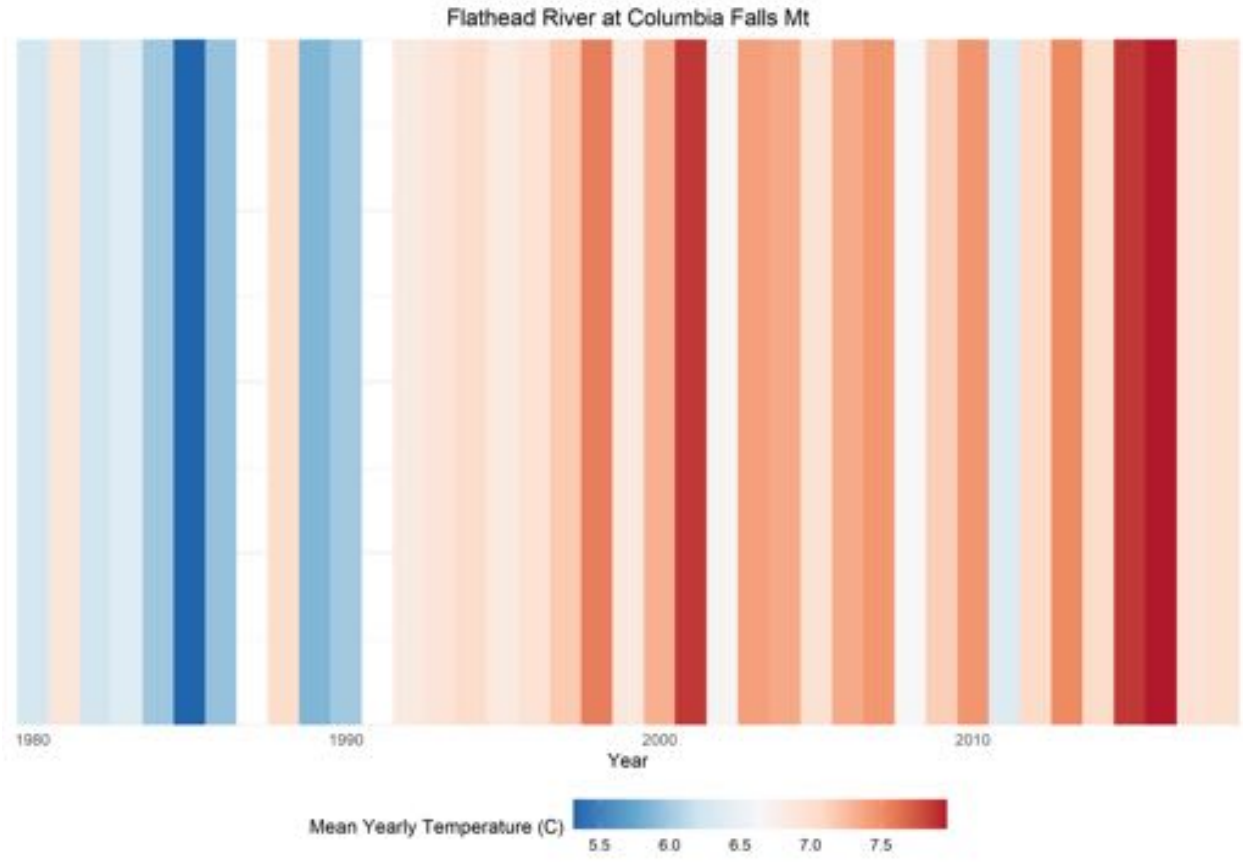
Warming stripes plots are a simple yet powerful way to convey large amounts of data. These plots show a series of bars filled with colors that represent annual temperatures, which allows clear communication of temperature changes throughout time. To date, air temperature data has most often been portrayed using warming stripes plots. I have adapted this concept to visualize water temperature data in rivers and streams. I acquired U.S. Geological Survey water temperature data across the U.S., comprised of >2.2 million observation from 224 stations across the U.S. that have been continuously monitoring water temperature for ≥10 years. These observations were summarized into mean annual temperature and presented in a website that allows users to view sites interactively on a map, and then view warming stripe plots of their choosing. The results demonstrate that although freshwater ecosystems are complex and dynamic, water temperatures are rising rapidly. This is consistent for watersheds in arctic and tropical climates alike. This presentation will provide an overview of the methods employed, a tutorial of the interactive website, and an invitation for those with additional data to contribute so that spatial coverage is enhanced. Currently, stations available within Pennsylvania are limited to the Delaware River watershed; datasets within the Susquehanna River are of significant interest.

Keywords: Climate change, data visualization, rivers, streams, freshwater



UNMANNED ARIAL INFRARED AND VISUAL LIGHT DATA COLLECTION ON THE WEST BRANCH SUSQUEHANNA

Marino, Nicholas C., Department of Geology, Bucknell University, One Dent Drive, Lewisburg Pennsylvania 17837 ncm015@bucknell.edu; **Jacob**, Robert W., Department of Geology, Bucknell University, One Dent Drive, Lewisburg Pennsylvania, 17837.

One of the most crucial processes that occurs in the environment is the movement of groundwater and surface water from high elevation to low elevation. This process would not be possible without rivers like the Susquehanna River, draining both ground water and surface water from the central- western areas of Pennsylvania into the Chesapeake Bay. With this being said, it is very important that we understand the processes by which rivers gain or lose water, in order to better understand the watershed as a whole. One of the best ways to better our knowledge of a river is by understanding how they gain or lose water. Finding areas of surface water discharge into river is fairly straight forward but identifying areas where groundwater discharges into the river is much more difficult. Recent technological advances have allowed for the use of thermal drone imaging to detect sites of ground water discharge into rivers by detecting differences in temperature signature within the river. This method works for giving us a better idea of where groundwater discharges, but the cameras ability to see changes in heat signature, as well as quality of the thermal image typically set an obstacle since these zones of discharge are mostly small and the thermal imaging doesn't have high enough resolution to be able to see small regions of discharge.

We have collected airborne thermal data using a drone (Ebee) along a 2230-meter stretch of the West Branch Susquehanna River adjacent to Bucknell University. 2830 photos were acquired as both visible light images and thermal images over an area of 1.59 km^2 for an estimated 2.6 cm/pixel visible light resolution and 15 cm/pixel thermal resolution. The images are being processed and analyzed to evaluate drone infrared imaging and its ability to detect changes in heat signature in the river. The stretch of the river investigated includes definitive surface water tributaries into the river and sections with no tributaries. Given that the locations where surface water discharge enters the river is known, it is possible to use this information to detect other temperature changes within the river in order to find areas where ground water may be discharging into the river. This could help us pinpoint where groundwater discharge may be occurring, and then in the future, it would be possible to carry out geophysical testing of sediment and rock permeability and therefore develop an accurate understanding of where permeable areas reside near the Susquehanna River

The initial evaluation of the data indicates that there are significant changes in the temperature of earth's surface related to buildings, as well as subtle changes within the river. We expect to present available results and interpretations based on the available processed data and relative potential contribution of surface water temperature changes in ground water.

RESTORATION REPORTS: A LANDOWNERS OUTREACH AND COMMUNICATION TOOL FROM DESIGN TO FARMER OUTREACH

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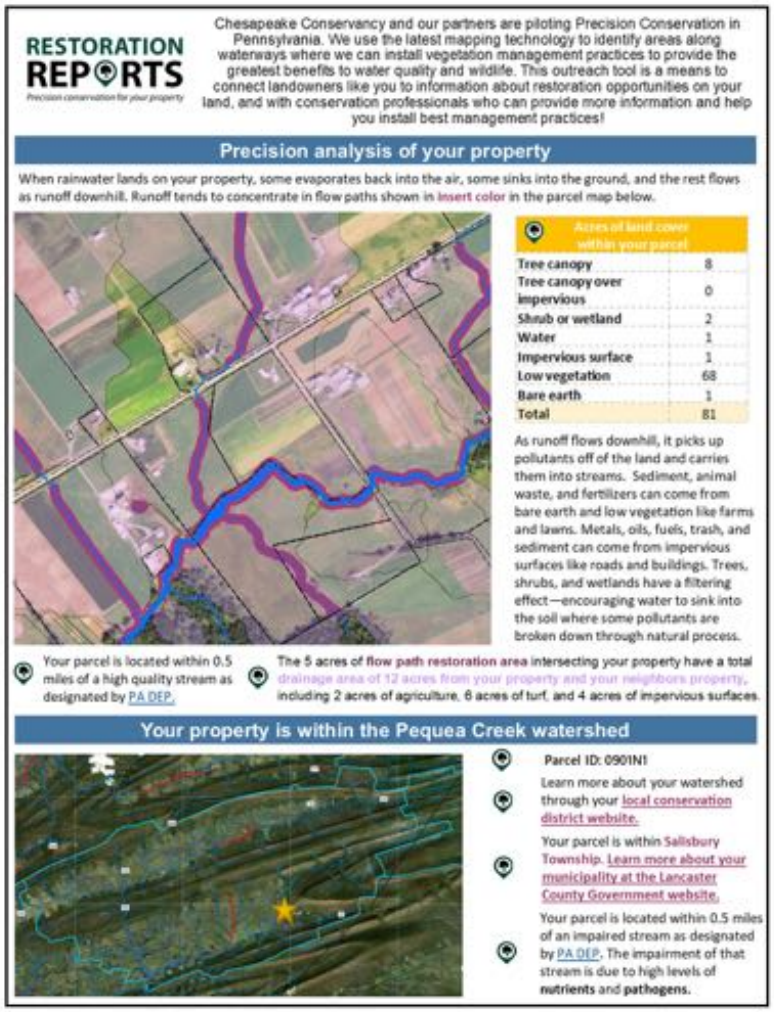
If you are a landowner interested in installing conservation practices on your property, it can be daunting to figure out the full scope of options and who to contact to start this process. This challenge has been known to inhibit many individual property owners who own farms, woodlands, or residential property from pursuing conservation practices on their land, because the number of opportunities are overwhelming and a starting point is hard to identify.

Chesapeake Conservancy and American Farmland Trust have partnered to create a science-communication tool to summarize opportunities in an easy-to-digest printout for restoration practices specific to a landowner's property. **Restoration Reports.com** is an easy-to-use online tool where a landowner can enter their address and management priorities, and receive a customized, understandable report of potential conservation and restoration practice options. Using high-resolution data and the latest geospatial technology, the Conservancy can tailor each report to the property level, and suggest appropriate points of contact for a landowner to get started. This presentation will discuss the challenge of reaching property owners in conservation and present a case study of how this tool was developed using GIS technology and applied to American Farmland Trust's Women for the Land Initiative-to reach women landowners and land managers. Restoration Reports is now available for landowners in nine Pennsylvania counties.



VIABILITY OF LIVE STAKE SPECIES: BUD PRODUCTION, HERBIVORY, AND THE EFFECTS OF ROOTING HORMONE AND HERBICIDE TREATMENTS

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Live stakes are woody cuttings from wetland tree species that can root naturally when pounded into the ground. The use of live stakes in riparian and wetland restoration is becoming an increasingly popular technique because of its relatively low costs and maintenance requirements. However, the success of live stakes depends on species, environmental conditions, and planting conditions such as artificial rooting hormone or weed control strategies. The impact of such factors has not been widely studied, and much more research is available for western species and conditions than for those of eastern North America. We collected data in May 2020 using a common garden experiment with 1,550 stakes of nine native Pennsylvania species, where manipulated variables included the use of herbicide to control invasive species and rooting hormone to encourage root growth of stakes. Stakes were randomly blocked by species, and we examined what effect the use of herbicide, the use of rooting hormone, herbivory, presence of poison hemlock, species, stake diameter, and planting depth of stakes had on survival and number of buds produced. Our preliminary mixed effects model suggests that there is a positive relationship between stake diameter and number of buds and that when rooting hormone was used, stakes had more buds on average. It also suggests that most the species had similar high initial survival rates (>80%), except northern spicebush (57%), and that most species were consumed by herbivores at similar rates, except elderberry, which had more than twice the herbivory of any other species. When poison hemlock was present, stakes also had more buds on average. We hope to provide an analysis that will help conservation professionals gain insight into which local live stake species are most able to survive and quickly produce buds, and whether the use of rooting hormone or presence of poison hemlock impact survival or growth. Due to the global coronavirus pandemic, our site was not maintained this summer and is significantly overgrown. Therefore, we will repeat data collection in the coming months to identify which species are likely to have the greatest success at sites where maintenance is difficult or impossible.

EVALUATING THE IMPACT OF STREAM RESTORATION TECHNIQUES ON BANK EROSION AND STREAM MORPHOLOGY AT AN UNNAMED TRIBUTARY OF PINE CREEK NEAR WOODWARD, CENTRAL PENNSYLVANIA

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Soil bioengineering techniques are commonly used and effective in stream restoration projects in the United States. Live staking, specifically, is a soil bioengineering technique that is considered to be an economically viable and easy technique for stream restoration. Evaluations of restoration success rarely focus on the geomorphology of a stream, and commonly focus on the riparian ecosystem. This research project is investigating the impact of live staking on bank erosion and stream morphology in an unnamed tributary of Pine Creek near Woodward, Central Pennsylvania, approximately 20 miles west of Bucknell. This tributary has both a restored section that has undergone live staking, and an unrestored section. It is also the subject of ongoing ecological studies by the Penn's Valley Conservation Association (PVCA), but there have not yet been any studies implemented on the geomorphology of the tributary. For this research project, we are comparing the restored section to the unrestored section of the tributary to evaluate how live staking is affecting bank erosion, stream morphology, and soil organic matter (SOM). Field methods we are using include drone-based photogrammetry, surveying with a terrestrial LiDAR Scanner, high-resolution GPS data with a Trimble Real-Time Kinematic GPS unit, and soil sampling along the floodplain of the tributary using a soil corer. Preliminary results suggest that the range of soil organic carbon in the floodplain soils is 0.5 to 2 percent. The soils are primarily a silty loam containing significant amounts of orange mottles and rootlets. The current state of the stream includes silt on the stream bed, undercut banks, and a very low current. This baseline data will be a fundamental part of a long-term study of the geomorphic processes acting in a bioengineered riparian ecosystem.

ADAPTIVE MANAGEMENT OF AQUATIC AND RIPARIAN ECOSYSTEMS UTILIZING LARGE WOODY MATERIALS ON THE ALLEGHENY NATIONAL FOREST: SETTING THE STAGE FOR THE LITTLE ARNOT RUN WATERSHED RESTORATION PROJECT

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Trees and fallen woody materials in streams and floodplains create a diversity of habitats for many species. Centuries of removing wood to straighten streams and reduce localized flooding have negatively impacted aquatic and riparian habitats, as well as have exacerbated flooding downstream. The U.S. Forest Service at the Allegheny National Forest (ANF), Western Pennsylvania Conservancy, and other partners are utilizing adaptive management restoration techniques to reestablish historic densities of woody materials in streams across the ANF to restore pre-disturbance ecological conditions. In the Little Arnot Run watershed, project partners are intensively monitoring physical (e.g. streamflow, water table depth, and water quality) and biological (e.g. fish, aquatic insects, and riparian vegetation) parameters to quantify the adaptive management restoration technique's effects on aquatic and riparian ecosystems. The focus treatment reach on Little Arnot Run is moderately incised and has a relic railroad grade that has cut off the stream from the floodplain. This project will utilize excavators to harvest logs and rootwads materials from local uplands and utilize them to build large wood structures (e.g. cross-channel jams) to raise the bed of the stream in key locations. In addition, barriers such as berms and railroad grades will be removed or cut through to create side channels and reconnect flood flows to the floodplain. The goals of the project are to restore fluvial processes and aquatic habitat, improve water quality, improve distribution of gravel and fines, reconnect floodplains and hyporheic zones, and sequester carbon. This presentation will discuss the location, history, and ecology of the watershed, proposed restoration techniques and goals, and briefly outline several monitoring parameters being developed and implemented.

Keywords: adaptive management, large wood, hydrology

FLUVIAL GEOMORPHOLOGY AND HYDROLOGY OF LITTLE ARNOT CREEK, ALLEGHENY NATIONAL FOREST, PENNSYLVANIA

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To help direct stream restoration activities scheduled to begin in 2021 in the Little Arnot Run (LAR) watershed of the Allegheny National Forest (ANF), we have been characterizing the factors controlling the geomorphic processes operating with the watershed, focusing mainly in the middle and lower reaches. Baseline hydroclimatic data are being collected using a network of instruments, including weather station, piezometers, stream gages, water quality sonde, and temperature sensors place on the bed of the stream. Synoptic measures of flow velocity, shear stress, and discharge are also collected at selected locations in the channel.

A survey of stream and floodplain features along a 6.8 km length of the lower and middle reaches of the valley was conducted to characterize LAR at the reach- and channel-unit scale. The survey included inventory of LWD, the dimensions of channel features such as pool/riffle/run/glide/cascades along with width/depth measurements, pebble counts, and additional notes on channel bed and bank material, evidence of historic alteration, etc. Average fast water depths ranged from 0.5 to 1.2 ft; pool depths ranged from 0.6 to 2.1 ft; average wetted widths ranged 14.1 in upper reaches to 16.2 in lower reaches. Average woody material in size class/500 ft was 2.3 in steep upper reaches and increased to 6.5 in lower reaches, with distinctly less woody material <<1.6) in the proposed restoration reach, where the channel was dredged, straightened, and modified for log drives and construction of a steam railroad in the 19th century.

At the reach scale, channel slopes varied from 0.09 to 0.18 and averaged 0.014, hydraulic radius 1.4 and roughness coefficients on the order of 0.042. Bed sediment size decreased in a downstream direction, with pools consisting predominantly of well-sorted sand and fine gravel (D_{50} = 20 to 80mm) and riffles consisting of cobble-boulder in riffles (D_{50} = 20 to 80mm). Bankfull velocities are estimated to range from 3.5 to 6.9 ft $s^{-}1$, with most bed material and large woody debris mobile. Primary controls on the channel morphology are bank material (% clay and silt), root strength, channel slope, and water and sediment discharge.

Most of the stream is shaded completely by mature forests, with little to no direct solar radiation. Diurnally, water temperatures vary between 2 and 4°C, showing the greatest variability during the low-flow periods in late summer and winter, when air temperatures vary considerably and buffering from groundwater inputs are low. Seasonal 2019 stream temperatures varying cyclically, with average temps of 34° during the winter (Dec.-Feb.), 43.5°F during the spring (Mar.-May), 61°F during summer (Jun.-Aug.) and 46°F during the fall (Sep.-Nov.). During the summer months, temperatures increased 1.2°F/km in a downstream direction, largely the result of long-wave atmospheric radiation during the day.

No overbank floods occurred since monitoring began in Dec. 2018. Flows in the stream are relatively short lived, reflect rainfall-runoff and snowmelt, with a time of concentration of less than 6 hours and long recession curve, depending on the amount and duration of rainfall or snowmelt. Following rainfall-runoff events, as stream levels rise the potentiometric surface slopes away from the channel and down-valley. Falling-head tests conducted in three piezometers screened in the valley fill deposits indicate that intrinsic permeability (k) of the coarse valley alluvium ranges from 4 x 10^{-5} m $s^{-1}$to 8 x 10^{-4} m s^{-1}, suggesting hyporheic exchange rates could be very high.

Keywords: stream restoration, large woody debris, stage 0, fluvial geomorphology, hydrology

USING LARGE WOODY DEBRIS IN STREAMS TO RESTORE BIODIVERSITY OF COMPLEX VALLEY FLOOR LANDSCAPES

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Valley floor landscapes contain a variety of aquatic and semiaquatic habitats that depend on interactions between microtopography and the groundwater table. Historical logging in Pennsylvania frequently used stream channels to move timber downstream to mills along rivers, resulting in catastrophic channel erosion that deepened stream channels, lowered groundwater tables, created single-channel streams, and reduced stream-floodplain connections. These hydrologic and morphologic changes reduced the number, complexity, and area of aquatic habitats across valley floors. However, restoring large woody debris to stream channels can reverse these degradation processes by retaining sediment and organic debris, building up stream bed elevations, and elevating the water table, all of which could combine to reconnect stream and groundwater with former aquatic habitats across the valley floor. Increasing the variety and area of aquatic habitats across the valley floor will likely increase local biodiversity of many groups of organisms, from plants to amphibians, and could lead to higher connectivity and gene flow of certain habitat-limited populations across the region. Large woody debris additions are being performed in several streams in Allegheny National Forest to restore natural channel processes, complex valley floor ecosystems, and corresponding biodiversity. This talk will explore some of the possible ecological benefits of large woody debris additions for aquatic communities in Allegheny National Forest and will consider protocols for assessing biodiversity in restored valley floor landscapes.

Keywords: stream, biodiversity, restoration, large woody debris

OUTREACH, EDUCATION, AND CURRICULUM DEVELOPMENT FOR AN URBAN STORMWATER COLLEGE-COMMUNITY PARTNERSHIP

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Stormwater runoff can cause poor water and habitat quality in waterways draining catchments with a large percentage of urban development. Afflicted by the urban stream syndrome, federal regulations require local municipalities to mitigate the effects of stormwater as a point-source pollutant. These projects can benefit the environmental condition of urban streams and decrease flood damages for local communities while helping municipalities comply with federal regulations. Local municipalities, however, rarely have the technical knowledge in hydrology, engineering, stream ecology, education, and social science to design a holistic management program. Universities and colleges have the opportunity and expertise needed to help local government a) share with communities the latest research on green infrastructure and b) help them plan and implement projects with effective ecological and regulatory effective outcomes. The Lycoming College Clean Water Institute is developing outreach and education programs and providing technical expertise to support local municipalities. These efforts include developing a stormwater curriculum and an extension website that communicates topics in urban stormwater. This presentation will summarize current progress and future plans for this student-driven interdisciplinary project.

Keywords: stormwater, outreach, green infrastructure, community partnership, Urban stream syndrome

GOING ROGUE: SCIENCE COMMUNICATION LESSONS FROM TWITTER "ALT" GOVERNMENT ACCOUNTS

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Microblogging platforms provide an opportunity to reach audiences with a speed and scale much greater than traditional communication methods. They also present a vast source of publicly available data to analyze and identify successful or ineffective past practices in communication. Following the 2017 presidential inauguration ceremony, the active restriction of science communication by the Trump administration led to the creation of many unofficial and alternative, or "alt", Twitter accounts for government agencies to maintain communication. Alt accounts quickly attracted many followers (e.g., 15 accounts with >100,000) and received a large amount of media attention. We analyzed tweets from paired "alt" and official U.S. government agency accounts to compare communication strategies and determine what elements of a tweet make it more likely to accrue attention (likes or shares). We found adding links, images, hashtags, and mentions, as well as expressing angry and annoying sentiments all increased retweets and likes. Evidence-based terms such as "peer-review" had high retweet rates; but linking directly to peer-reviewed publications decreased attention compared to popular science websites. Word choice and attention did not differ between account types, indicating topic was more important than source. The number of tweets generated, and attention received by, alt accounts rapidly decreased after the creation of these accounts, demonstrating the importance of timeliness in science communication on social media. Together our results show potential pathways for scientists to increase efficacy in social media communications.

Key Words: Social media, text sentiment, microblogging, mixed models, targeted outreach, science communication, Web 2.0

2020 RIVER SYMPOSIUM

POSTER PRESENTATIONS

[Photo: Nicholas A. Tonelli]

BACTERIAL DIVERSITY IN THE SUSQUEHANNA RIVER AT BUCKNELL LANDING

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The microbiome of the Susquehanna River is largely neglected in the scientific literature. In the last decade our lab has been exploring the metabolic diversity of bacteria in the Susquehanna and other local water systems using traditional microbiological as well as genomic and metagenomic techniques. Our first analyses focused on the cyanobacterial community and found great diversity in this group. *Pseudanbaena* sp SR411 and sp. Roaring Creek were isolated from the Susquehanna River and Roaring Creek reservoir, respectively and are filamentous, nonheterocystous cyanobacteria that exhibit chromatic acclimation. Subsequent microbiological and genomic characterization indicate that, though similar in some respects, they differed in the ability to fix nitrogen. SR411 has the genes encoding nitrogenase while sp. Roaring Creek does not. The identification of a potential nitrogen fixing bacteria in the Susquehanna River has lead us to look for additional, non-photosynthetic, nitrogen fixing bacteria in the river. Using culture based techniques we have isolated and begun characterization of 10 putative nitrogen fixing bacteria, three of which have been sequenced. Here we present preliminary analysis of these genomes.

Keywords: *microbiome, bacterial diversity*

A LONG-TERM STUDY OF SALAMANDER POPULATIONS IN THE SUSQUEHANNA RIVER VALLEY

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Amphibians have many biological characteristics that make them sensitive to changes in environmental conditions, particularly climate change. These characteristics allow researchers to use amphibians as indicators of environmental change and explore ways to mitigate adverse effects. The eastern red-backed salamander, *Plethodon cinereus,* can be used as a model organism in understanding the effects of a changing environment as it is abundant and widely distributed. Following systematic methods of SPARCnet, the Salamander Population and Adaptation Research Collaboration Network, we are investigating the population dynamics of *P. cinerus* in Selinsgrove, PA. We set up three mark-recapture plots, each containing 50 coverboards, in an area of known salamander presence. During each sampling event, we record soil and air temperature, as well as relative humidity. We measure the size and determine the sex of each salamander and mark each uniquely using visual implant elastomer. We describe our results from sampling events in Fall 2020 including the sex and size distributions of individuals found in the three plots. This long-term research will allow us to gain a comprehensive understanding of the population demographics, such as growth, survival, and movement of individuals over time. Results will contribute to the research network database and will be used to examine demographic patterns of the species across its range. We expect these efforts to lead to a better ability to predict the consequences of climate change and more effective management techniques.

PRELIMINARY RESULTS FROM A STUDY OF THE IMPACT OF WALKER LAKE ON THE NORTH BRANCH OF MIDDLE CREEK USING METRICS GENERATED BY DIATOM BIOFILM COMMUNITIES

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Middle Creek is a tributary of the main stem of the Susquehanna River, and its watershed is confined mostly to Snyder County. The upper reaches of the stream are defined by two major branches, the North Branch and the West Branch, each of which is interrupted by a reservoir, Walker Lake and Faylor Lake, respectively. Walker Lake is an impoundment of a deep V-shaped valley and is 9-10 meters deep at the dam, which allows it to be stratified in the summer and winter. Summer stratification produces an anoxic hypolimnion, which is drawn off by the bottom outflow dam into the North Branch. During September of 2019 and 2020, the hypolimnion of Walker Lake became anoxic and its outflow below the dam had a strong odor of hydrogen sulfide and deposits of iron (III) oxide-hydroxide covered the cobbles and small boulders. The purpose of this preliminary investigation is to explore the impact of the bottom outflow below the dam and at sample sites downstream before and after fall turnover on the diatom biofilm communities and use them as proxies for the state of the stream. We examined four sites on the North Branch: above the lake (1.5 km above the lake), Walker Lake, below the dam at its outflow, and a site 1.2 km downstream called Old Bridge. Field measurements with a YSI 556 multimeter of pH, conductivity, and % oxygen saturation showed clear impacts when the lake was stratified but began to moderate following fall turnover. The loss of alkalinity and conductivity were particularly noticeable. The alkalinity decreased by 35% between the above site (2,350 µeq/L) and below the dam (1,514.4 µeq). Before turnover, at the below site, biofilm diatoms were scarcely found such that the phytoplankter, *Asterionella formosa*, which had been flushed from the lake, was the most abundant diatom species encountered from the stones collected at the site. Following turnover, however, the biofilm community reestablished itself and was dominated by *Achnanthidium minutissumum* in November 2019. Preliminary metrics based on diatom community analysis before and after turnover suggest that the above lake site was impaired by agriculture (indices indicating high levels of sedimentation and nutrient runoff), but the reservoir did not function as a sediment or nutrient trap. Instead, the downstream sites showed higher impairment than the above lake site.

TEMPORAL AND SPATIAL VARIABILITY OF FECAL INDICATOR BACTERIA IN SOUTHWEST FLORIDA TIDAL STREAMS

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In the U.S., surface water is subject to regulatory limits for fecal indicator bacteria (FIBs) including fecal coliforms, e. coli, and Enterococci, which serve as indicators of possible contamination with human wastes and the negative health effects that can accompany it. Data from 20 years of sampling show that, among other waterbodies, tidal streams in urbanized parts of Southwest Florida have repeatedly, and by large magnitudes, exceeded the federal standards for both Enterococci (30 MPN/100mL geometric mean [GM] and 130 MPN/100mL Ten Percent Threshold Value [TPTV]) and e. coli (70 MPN/100mL GM and 410 MPN/100mL TPTV) in three target streams: Estero River, Spring Creek, and Imperial River. This research conducted a small number of sample events (3 to 8 times over one year) on a fine spatial resolution (more than one sample per linear kilometer on three 8-km stream reaches.. Results were, as expected, not able to identify or compensate for variations – especially varying tides, flows, storm events, and human activities – but showed surprisingly strong ability to document differing pollutant tendencies in different portions of each reach. Upstream reaches of Estero River extending beyond residential development, and routinely showed very small FIB concentration, while, upstream reaches of Spring Creek and Imperial River, more densely developed, routinely had very high FIB concentration, documenting that human land use affects FIBs more powerfully than other potential source (sediments, soils, non-human animals, etc). Two reaches of Estero River near privately-operated small wastewater treatment plants showed higher concentrations in nearly every sample, documenting those as sources of particular concern. In all three streams FIBs were in high concentration near the mouth, suggesting that resuspension of estuarine sediments and/or inland movement of estuarine waters influence bacteria concentrations, a mechanism for future research to target.

Keywords: Fecal Indicator Bacteria, FIB, tidal streams, SW Florida, variation

PRE-RESTORATION SUMMARY OF ORGANIC MATTER CONTENT IN LITTLE ARNOT CREEK, ALLEGHENY NATIONAL FOREST

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Many small streams in Pennsylvania have become incised due to human activity. This channel deepening has led to a myriad of issues including stream bank erosion and increased discharge during storm events. Headwater streams serve as a critical link between terrestrial and downstream ecosystems in transporting organic material. Both dissolved (DOC) and particulate organic carbon (POC) play a role in the global carbon cycle and serve as an energy source for aquatic heterotrophic bacteria. In the Allegheny National Forest, we are implementing adaptive management strategies on Little Arnot Creek to document changes in organic material. These improvements include the placement of whole trees (with canopy and rootwad), as well as logs in the stream and floodplain. Restoration work is scheduled to begin in the summer of 2021. The goals of the project are to slow the movement of water, raise the water table, disperse more water onto the floodplain, and to increase the storage capacity of organic material within the watershed. We have collected replicate water samples monthly since September 2019 to assess baseline conditions of DOC and POC concentration and DOC quality (absorbance and fluorescence). Water samples are collected by hand at six permanent stations on Little Arnot Creek. We also collect water from a two stations within Cherry Run (control stream). Preliminary data suggests the DOC concentration and quality vary seasonally and that POC concentrations are low.

Keywords: fluvial, stream restoration, organic carbon, long-term monitoring

COLIFORM TRENDS IN URBAN STREAMS RECEIVING STORMWATER WITHIN LYCOMING COUNTY MS4

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The Clean Water Institute at Lycoming College has been conducting field and laboratory analysis on the urban streams of Lycoming County MS4 region since 2015. The County MS4 includes 9 municipalities/boroughs. Over 200 stormwater outfalls 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. Quarterly and in some cases monthly samples for chemical analysis (pH, alkalinity, temperature, dissolved Oxygen (DO), conductivity, Total Dissolved Solids(TDS), nitrite, nitrate, orthophosphate, total phosphorus) as well as coliforms have been collected from 1-3 sites within 8 urban streams for two years. Membrane filtration was specifically carried out on the water samples to identify the presence of E.coli in them. Fecal contamination may be an indicator of sewage input. This paper provides the trend in coliform count over the years since 2017. The examination of data trends serve as a baseline to be used to implement projects that seek to improve the water quality of the urban streams of Lycoming County MS4 region.

Keywords: urban streams, stormwater , coliforms

ANALYZING THE IMPACT OF MINE DRAINAGE RESIDUALS ON PHOSPHORUS SEQUESTRATION AND AGRICULTURAL PRODUCTION

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Waterways throughout Appalachia and other areas in the United States are impacted by acid mine drainage. Treatment of mine water often results in large quantities of solids, also known as mine drainage residuals (MDRs), that are typically disposed by burial, landfilling, or pumping back into mine pools. We hypothesize that mine drainage residuals could be beneficially reused in agriculture applications to sorb water extractable phosphorus, potentially increasing the amount of bioavailable phosphorus for crop growth and reducing nutrient runoff to nearby waterways. To test this hypothesis, a greenhouse study was performed to determine if mine drainage residuals could be used to sorb nutrients from dairy manure, reduce nutrient runoff, and improve ryegrass yield. Before the greenhouse study, sorption experiments confirmed that phosphates in manure could sorb onto the mine drainage residuals. Additional leaching experiments are also in progress to determine if the sorbed phosphorus is bioavailable for plant growth. For the greenhouse experiments, varying amounts of mine drainage residuals were mixed with cow manure before application to a nutrient deficient soil. Rye grass was then grown in a greenhouse, harvested and weighed. Treatments included a negative control with no manure, a positive control with manure, manure treated with 12 g/L MDR (low dose) and 60 g/L MDR (high dose). Rye grass yield was monitored in the different treatments for 166 days. The addition of the MDR to the manure, even at the highest rate, had no detrimental impact to rye grass yield. Both MDR and positive control treatments had statistically similar yields but were greater than the yields of the negative control. These results indicate that beneficially reusing MDRs in agriculture could help reduce nutrient runoff without impacting crop yield.

Keywords: Stream Restoration, Acid Mine Drainage, Nutrient Pollution

READY SET FIT AND COVID-19: CHALLENGES TO COLLABORATIVE COMMUNITY-ENGAGED STUDENT RESEARCH IN A PANDEMIC

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This poster discusses how the current public health crisis has affected what has been a productive and innovative collaboration between Bucknell students, faculty, and staff and community leaders in the post-industrial river town, Milton, especially The Improved Milton Experience (TIME). Until the outbreak of the pandemic, Bucknell, DCNR and TIME worked together to develop walking paths in the Milton area that accessed historical and cultural information through mobile technology. By coupling an already existing historical walking tour with a free mobile app (Ready, Set, Fit), residents could walk around the downtown following set paths, learn about its history, and then record their physical activity. Local downtown businesses also agreed to participate in an incentive scheme for walkers, with the initiative being supported by a local hospital. In addition, through collaboration with the Pennsylvania Department of Natural Resources' (DCNR) "Think Outside" program, a walking route was developed in the Milton State Park, an island which lies a short distance by foot from the downtown.

However, problems with both the goals of the incentive scheme and the sudden curtailing of university support for community-engaged research during the pandemic have thrown challenges in the way of sustained collaboration. How can we respond more agilely to such situations? How can we ensure that collaborations continue? Drawing on prior summer research by a student, Hongyi Wang, into the relationship between incentive schemes and community involvement, this poster investigates the challenges to the incentive program structure pre-pandemic. The poster will then explore the problems encountered by the RSF team during the pandemic and suggest better ways the university can move forward.

Keywords: community wellness mobile technology COVID-19

FACTORS RELATED TO RECREATIONAL VISIT FREQUENCY TO FRESHWATER 'BLUE SPACE IN PENNSYLVANIA: THE ROLE OF RESTORATION AND ASSOCIATIONS WITH PERCEIVED STRESS

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Spending time in areas with aquatic features ('blue space') may benefit health through 'restoration' from attentional fatigue and emotional stress. Salutogenic effects of blue space remain underexplored, particularly in non-coastal and non-urban areas, as do correlates of visit frequency to freshwater blue space (FBS). We surveyed adults in 40 small towns in central/northeast Pennsylvania to understand their seasonal visitation patterns to FBS, characteristics that predict visit frequency, and associations between FBS visit frequency and perceived stress. Of 10,000 mailed questionnaires, 1,122 individuals (11%) responded and provided information to characterize FBS visit frequency. Perceived stress was evaluated with a scale of 10 items regarding stressful feelings in the past month. A restoration outcomes scale from FBS was calculated for respondents who reported visiting FBS (n=868). Analyses included multivariate multinomial regression to examine predictors of FBS visit frequency and linear regression to evaluate FBS visit frequency in association with perceived stress, using mixed effects models with a random effect for town of residence to account for spatial clustering. Nearly one-fifth (19%) of respondents reported never visiting FBS, 27% had low visit frequency (1-3 days/season), 35% moderate frequency (4-15 days/season), and 19% high frequency (≥ 16 days/season). Higher education was associated with more frequent blue space visits across all categories of visit frequency. Greater physical activity and living closer to FBS access points were associated with moderate and high visit frequency. High restoration was associated with greater visit frequency among those who visited FBS. Individuals who experienced high restoration were more likely to report the presence of nature as important in enhancing visits to FBS and stress relief as the most important benefit of FBS visits. FBS visit frequency was not associated with perceived stress. Findings highlight the socioeconomic patterning of FBS visits, the importance of access to facilitate visits, and perceived psychological benefits to FBS visits among the most frequent visitors.

Keywords: health, stress, restoration, recreation, epidemiology

PUBLIC PERCEPTIONS OF BROWNFIELDS IN A REVITALIZING COAL TOWN: A COMMUNITY-ENGAGED COURSE WITH A COVID-19 PIVOT

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Environmental justice in coal regions tends to be tied to the active and legacy mining impacts of coal extraction on natural and human communities. However, in Pennsylvania's anthracite coal mining region, there is a history of diverse industrial land uses in addition to coal extraction. These former industrial sites, often integrated in residential neighborhoods, now create a patchwork of brownfields with varying degrees of contamination. Such sites are both a potential asset (for creative redevelopment) and liability (depending on presence of contamination) for revitalization efforts.

This poster investigates four brownfields in the City of Shamokin – the former Shroyer's Dress Factory, Eagle Dye Works, Eagle Silk Mill, and Korbich Lumber. In spring of 2020, students in an integrated perspectives course, *Changing Place: Politics and Geographies of Environmental Justice,* conducted a community research project on these four sites at the invitation of the City. The COVID-19 pandemic necessitated a change in the project approach, however, we were still able to conduct survey research on public perceptions of Shamokin, these four brownfields, and what the public believed should be done with them. This poster summarizes key survey findings and reflects on the challenges posed to engaged pedagogy due to the COVID-19 pandemic.

Keywords: Brownfields, Environmental Justice, Coal Region, Community Engagement

A MULTIPHASE GEOMORPHIC MODEL OF ISLAND FORMATION IN THE SUSQUEHANNA RIVER

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There are over a thousand islands in the Susquehanna River drainage basin that are mapped as Recent to Late Illinoian stratified drift deposits (0 to 198,000 yrs); these islands can be characterized as anthropogenically influenced islands, bedrock islands, recent alluvial channel bar islands, relict braid stream bar features, incised deltaic islands, and incised terrace deposits. This study introduces a multiphase geomorphic model that attempts to describe how some of the islands may have formed over time. We examined aerial images and maps of terraces and islands using Google Earth Pro, GIS data, and historical maps to investigate the influence of storms on terrace incision.

This model involves 5 potential phases which influence Pleistocene terrace deposits from Barton, NY to Lancaster, PA. Phase 1 consists of the initial scouring of floodplain terrace deposits by high discharge, high-magnitude regional storm events (hurricanes, tropical depressions, snow melt events, and northeasters); this produces a temporary stream that drains the terrace. Phase 2 includes incision of the terrace by later storms; intermittent streams continue to erode the floodplain sediments producing permanent channels. Phase 3 involves the river flowing through the eroded channel, detaching a newly formed island from the terrace during normal flow of the river. Phase 4 continues the process, allowing the islands to be subject to stream incision, similar to phase 1. Finally, Phase 5 is characterized by an abundance of midstream islands and the presence of multithread stream flow.

Many islands on the Susquehanna River can be characterized using this multiphase model. With global climate change and increased precipitation predicted for the future, islands may develop faster from terraces or large islands. An improved understanding of fluvial processes may help us better manage property along the floodplain and floodway.

Keywords: Island formation, multiphase model, Susquehanna River, Geomorphic

CREATING A BETTER SYSTEM: MANAGING STORMWATER AND FLOODS IN PENNSYLVANIA

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Stormwater and flood water are managed separately in Pennsylvania due to legislation in the 1970s. Already one of the most flood prone states in the U.S., Pennsylvania faces increased flood and stormwater management challenges going forward. Although Pennsylvania has 2,472 communities enrolled in the National Flood Insurance Program (NFIP), 15 communities are suspended from the NFIP – more than any other state – and 43 communities with identified flood hazard areas are not participating at all. Pennsylvania has more than 19,000 miles of impaired rivers and streams, with stormwater being a significant factor. However, Pennsylvania's stormwater management plans are woefully inadequate. Such plans are supposed to be updated by counties every five years; at this time, only 2 counties are compliant, 30 have not updated their stormwater management plan within five years, and 34 counties do not have a stormwater management plan for the majority of their watersheds if any.

To address how Pennsylvania might better manage these issues going forward, this study analyzed both flood and stormwater laws and implementation at the federal, state, and local level, then compared how these issues are managed by other states. This study offers ideas on how Pennsylvania could create a better flood and stormwater management system to increase compliance, protect people living in flood hazard areas, and reduce the effects of stormwater runoff pollution.

Keywords: Law, floods, Pennsylvania, stormwater

WATERSHED AWARENESS USING TECHNOLOGY AND ENVIRONMENTAL RESEARCH FOR SUSTAINABILITY (WATERS)

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The Watershed Awareness using Technology and Environmental Research for Sustainability (WATERS) project, funded by the National Science Foundation (NSF), develops and researches a student-centered, universally accessible curriculum for teaching water concepts & career awareness. Applying Universal Design for Learning (UDL) principles, the project increases awareness of, and engagement with, water concepts and career pathways for more learners. The WATERS project focuses on a single, targeted goal: to build, deploy, and research a student-centered, universally accessible curriculum for learning water concepts and water career awareness in order to increase student interest in STEM careers by broadening the population of students who believe they have the ability and skills to pursue STEM careers. This poster explores the research questions and methods that will be used to address these questions along with the timeline for data collection.

Keywords: watershed education, meaningful watershed education experience, watershed sustainability, environmental education, education, water education

WOLF RUN RESTORATION PROJECT: CONTINUATION OF MONITORING FOUR FARMS COMPLETING BMP'S IN PARTNERSHIP WITH LYCOMING COUNTY CONSERVATION DISTRICT.

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The aim of this study is to look at density and diversity of fish surveys since the institution of the Total Maximum Daily Load (TMDL) for Wolf Run watershed. The TMDL was developed in 2002 because of major impairments seen. Since then, the TMDL has been completed in 2013 by Pennsylvania DEP. In 2015 the Lycoming County Conservation District identified four farm sites for participation in Best Management Practices (BMP) and yearly evaluation.

The Clean Water Institute interns this summer were tasked with helping complete the annual fish surveys for the four farm sites. In addition to the fish survey, monthly water chemistry and coliform samplings were collected. Then, the macroinvertebrate samples were completed in October 2020. The fish surveys have been collected since 2017, a year before the project was completed for a base survey. Interpretation of the fish surveys was completed through a program called MicroFish and the Shannon-Weiner Diversity Index. The density of fish found at farm sites 2-4 have gone up an average of 1000 fish per kilometer. The one exception being site 1 (Artley Farm), which saw a slight decrease. The diversity index shows a consistent trend, with some minor fluctuations. Furthermore, an Index of Biological Integrity shows that none of the sites are impaired biologically and are improving since the input of the BMP's. Site 3 (Fry Farm) is still close to impairment, but is continuing to improve annually. By 2025 it is predicted that these sites will no longer be impaired, and the levels of nitrogen, phosphorus, and sediment will be extensively lowered with an increase in diversity and density. Finally, Lycoming College CWI will continue to partner and assist on this project.

Keywords: stream restoration, BMP's, Fish population

ROLE OF CONSTRUCTED STORMWATER DETENTION PONDS VS NATURAL SYSTEMS IN MITIGATING FLOODING FROM A SUBURBAN UNIVERSITY CAMPUS IN SOUTHWEST FLORIDA

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Florida regulations require residential and commercial developments to install stormwater detention ponds, for the purpose of reducing nutrient pollutants in runoff to receiving waters. The 800-acre main campus of Florida Gulf Coast University (FGCU), in southwest Florida, mitigates flooding not only with its ponds – 15 designed ponds, of an aggregate 17 acres – but with its 400 acres of open space, most of which contain functioning wetlands.

Stormwater ponds are widely seen by residential communities as providing flood mitigation (Catalo and Duke, 2018), but that is not a stated regulatory purpose and not an appreciable effect: previous research on FGCU ponds quantified a consistent elevation change with rainfall magnitude after dry-season storms (Rodriguez and Duke 2018) but no correlation with short-term precipitation during the wet season, when nearly all of southwest Florida's potentially-damaging, high-precipitation events occur (Krueger and Duke 2019). This present research continues investigation of surface water elevation and precipitation, adding to the 4-year record of 24-hour interval data with automated sensors collecting data on 10-minute intervals. Quantitative results demonstrate the campus surface water responds differently during each of three stages. During Stage 1, encompassing the dry weather season, most runoff enters the 17 acres of ponds, which have enough capacity to capture all runoff from impervious surfaces. The campus enters Stage 2 when ponds spill over into adjacent wetlands, nearly tripling surface area and vastly increasing capacity to detain runoff: elevation per unit rainfall rose less than half as far as during a comparable rainfall event during dry season. When precipitation ceased, surface elevation declined rapidly during Stage 2, hypothesized to be driven by sorption into newly-hydrated soils and enhanced groundwater recharge from increased wetted surface area. Stage 3 is infrequently activated – when precipitation occurs atop standing water in Stage 2 – and storage increases another order of magnitude as constructed drains direct flow into nearly 300 acres of Stage 3 wetlands. Discharge from the campus, which occupies the top of the Estero River watershed, occurs only when intense precipitation occurs atop fully saturated, high-elevation Stage 3 conditions, as in Hurricane Irma in 2017; essentially zero water left campus during wet seasons in 2019 and 2020.

Conclusions are that surface water elevation rises considerably more per unit precipitation when only FGCU's ponds are capturing runoff, and less when the wetland storage system is activated. Flooding is mitigated much more effectively by the wetlands than by stormwater detention ponds, as Stage 2 wetland geometry in effect increases storage capacity of individual ponds, while Stage 3 wetlands, intended for habitat preservation, add immense additional detention capacity. The wetlands also produce more rapid water level decline than ponds, so they recover to pre-flood capacity much more quickly than a system of ponds alone.

The research's broader implications are that wetland systems, though shallow, have a prodigious effect at detaining peak runoff, because storage capacity is dominated by surface area rather than depth: ponds detain runoff only to the extent they can accommodate vertical rise, and their depth below surface is of no consequence. Southwest Florida's suburban residential land use, dotted with thousands of ponds, in most developments have very little wetland open space (Wilkey et al, 2018), and consequently limited capacity to detain runoff and mitigate flooding

SUSTAINABILITY AT BUCKNELL: A LOCAL-TO-GLOBAL COMMUNITY LEARNING

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Sustainability is the ability of a community to endure and remain resilient socially, technologically and environmentally. A the most local level, a community is a collection of families and globally, a collection of nations. On this local-to-global continuum are institutions, corporations and political units such as states, counties, cities and townships. Governance processes in these communities must recognize contemporary challenges and constraints to deploy appropriate technologies and build infrastructure for local resilience and endurance with global equity. As a community, Bucknell University Strategic Plan for 2025 stipulates the development and implementation of an environmental sustainability plan. This paper presents the process of simultaneously developing and implementing the sustainability plan through four transdisciplinary and cross-functional working groups of students, staff and faculty.

Keywords: *Sustainability, Community, Learning, Working Groups, Simulteanous Planning and Implementation, Local-to-Global*

ECOLOGICAL VITALITY: THE CRITICAL THIRD LEG OF SUSTAINABILITY@BUCKNELL

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Sustainability@Bucknell praxis can be viewed in multidimensions with three critical legs on the tripod of both short- and longer-term resiliency and endurance of the campus community. These three legs are waste reduction, decarbonization and ecological vitality. Ecological vitality deals with natural habitat diversity and overall balance through effective conservation, restoration and protection. These three legs of sustainability are both interrelated and interdependent. An effective management for ecological vitality will results in both waste reduction and decarbonization. Each leg of the sustainability tripod required effective management, leadership and governance processes. At Bucknell, these processes are driven by key stakeholder groups beginning with the Environmental, Social and Governance (ESG) Subcommittee of the Board of Trustees (BOT) to the individual students, faculty, staff and the larger local-to-global Bucknell community. The paper presents the structural and process mechanisms established and implemented to ensure Bucknell's journey towards ecological vitality through conversation and restoration.

Keywords: *Ecological Conservation and Restoration, Vitality, Natural Habitat, Biodiversity, Stakeholder Groups*

LEVERAGING THE BUCKNELL GREEN FUND FOR A MORE SUSTAINABLE KINNEY NATATORIUM

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The Bucknell Green Fund is a revolving loan fund that pays for campus sustainability projects that have economic, environmental and social benefit. The annual cost savings associated with the reduction in resource consumption, revolve back into the Green Fund each year for 10 years, thus making the fund a self-sustaining mechanism to drive sustainability on campus.

Kinney Natatorium is a top rated, high quality, olympic size swimming and diving facility for NCAA division 1 athletes and regional high school competitions. Natatorium operations create a significant environmental footprint as they are intense consumers of energy, used to maintain water and air quality and clarity, 24/7. Additionally, precious, potable water must be continuously consumed and chemically treated and discharged to the municipal wastewater plant for treatment and eventual discharge into the Susquehanna river.

The intent of this abstract is to highlight a demonstration of three Green Fund projects that support triple bottom line facilities management, advancing sustainability at Bucknell University:

1. Activated glass pool filter media project: superior to sand as a water filtering media, resulting in premium water quality and clarity, lower chloramine levels for swimmers, 50% reduction in chlorine usage and 300,000 gal/yr water savings due to less filter backwashing required.
2. Sump pump project: a portable pump was regularly used to draw groundwater from beneath the pool floor and sent to the sewer (reducing hydraulic pressure). A permanent pumping system was installed and piped to fill the pool, thus reducing potable water usage by 230,000 gal/yr.
3. Air quality controls system upgrade: three very large air handlers that heat, cool, ventilate and dehumidify Kinney Natatorium were retrofitted with fan motor VSD's and a new digital controls system allowing for a synchronous and optimal energy efficient equipment operation, ensuring better, proper pool water evaporation rates, extension of equipment life and an overall better air quality for occupants.

Keywords: Water conservation, energy efficiency, air quality,

THE MASTER OF SCIENCE IN BIOLOGY PROGRAM AT BLOOMSBURG UNIVERSITY

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The Master of Science Degree is rapidly becoming *the* professional working degree in Biology. This degree provides the advanced training in the biological sciences and supporting disciplines which working biologists need. Bloomsburg University is a great choice for graduate school. The Department of Biological and Allied Health Sciences faculty members represent a diverse range of specialties. Every faculty member holds a Ph.D. and has extensive research experience. There are many options for Thesis research projects, as well as for collaboration with local agencies, government institutions, and medical research centers. The M.S. in Biology requires 30 credits of coursework at the graduate level. Advanced courses in biology and appropriate supporting disciplines are selected under the guidance of an Advisory Committee selected by the student from among the appropriate Graduate Faculty. Independent research and professional development under the mentorship of faculty are central components of the Master of Science Program. Under the guidance of their personal Advisory Committee, all students propose scholarly research at the frontier of their area of specialization, conduct independent research producing new insights, and write a manuscript of sufficient scope and quality for publication. In many cases these Theses and other scholarly manuscripts are published and become part of the scientific cannon. Students typically take 1 – 2 years to complete their coursework, research, and program requirements.

Keywords: *Graduate Program, Biology*

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

2006 to 2008

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

2009 to 2011

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

October 12-13, 2012

7th

A Fragmented Systems - Dams On The Susquehanna

October 18-19, 2013

8th

Science and the River

November 21-22, 2014

9th

River Symposia

2012 to 2014

The River, Its Landscape and Our Lives

November 13-14, 2015

A Tale of Two Rivers: The Susquehanna and Delaware

November 11-12, 2016

The Spirit of Two Great Rivers

November 10-11, 2017

River Symposia

2015 to 2017

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

2018 to 2020

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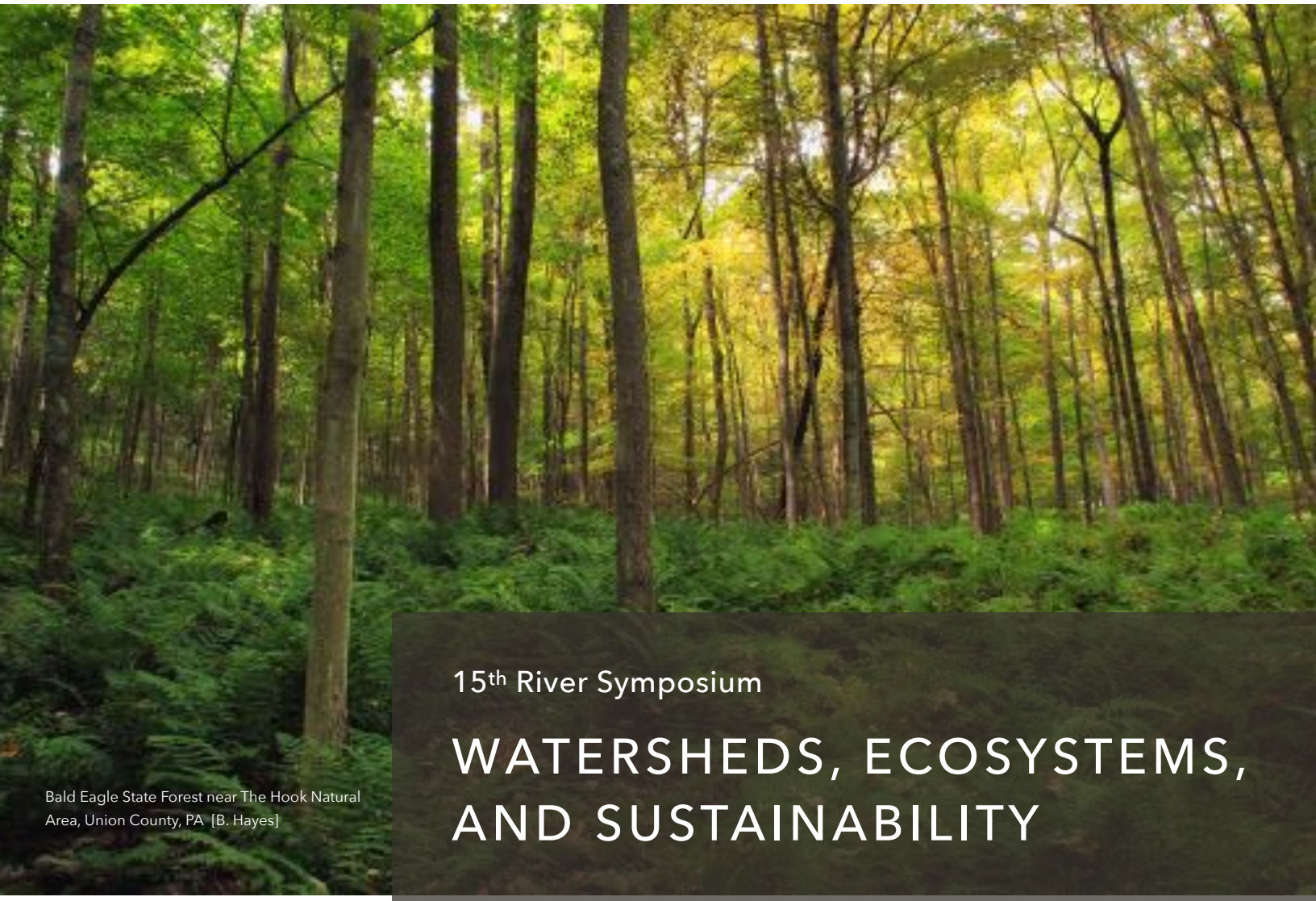

Bald Eagle State Forest near The Hook Natural Area, Union County, PA [B. Hayes]

15th River Symposium

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