Delaware River Water Gap

Program with Abstracts

11th Annual Susquehanna River Symposium

"A Tale of Two Rivers: The Susquehanna & Delaware"

November 11-12, 2016

www.bucknell.edu/riversymposium

11th Annual

SUSQUEHANNA RIVER SYMPOSIUM

November 11-12, 2016

Elaine Langone Center
Bucknell University

This symposium brings the public together with faculty, students, scientists, engineers, consultants, watershed groups, and state and federal agencies to share some of the findings of our research within the watershed and discuss the long-term health, value, and sustainable management of the Susquehanna and Delaware watersheds and their estuaries.

KEY CONTRIBUTORS

- BCSE Watershed Sciences and Engineering Program
- Susquehanna River Heartland Coalition for Environmental Studies
- Stroud Water Research Center
- Susquehanna River Basin Commission
- Delaware River Basin Commission
- U.S. Geological Survey
- U.S. Fish and Wildlife Service
- PA Fish and Boat Commission
- PA Department of Environmental Protection
- Penn State University
- University of Delaware Water Resources Center
- Center for Water Security and Cooperation
- Academy of Natural Sciences at Drexel University, Delaware Watershed Initiative Team

Welcome!

The Bucknell Center for Sustainability and the Environment welcomes you to the 11th Annual Susquehanna River Symposium. Additional funding for this event is also provided by the Provost's Office of Bucknell University and the Degenstein Foundation.

All events will be held in the Elaine Langone Center on the campus of Bucknell University and are free and open to the public. Parking is available on Moore Avenue and 7th Street. Maps and lodging information can be found online at:

www.bucknell.edu/riversymposium.

RESEARCH POSTERS AND EXHIBITS

Research posters by faculty and students, research scientists, planners, and engineers from 24 schools, colleges, and universities and 21 agencies and organizations. Exhibits by 18 companies, academic programs, conservancies, and organizations. All working to study, restore and protect the Susquehanna and Delaware watersheds and their coastal areas.

HONORARY SYMPOSIUM CHAIR

Franklin L. Kury
Pennsylvania House of Representatives (1966-1972) and Pennsylvania State Senate (1972-1980).
Helped enact many environmental laws, including the Pennsylvania Clean Streams Act.
Author of *"Clean Politics, Clean Streams: A Legislative Autobiography"* 2011 Lehigh University Press.
Lawyer with Reed Smith (1983 - 2003) and Malady & Wooten (2003 - 2016).

SYMPOSIUM COMMITTEE

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

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

Jessica Newlin, Ph.D., P.E.
Interim Executive Director, Bucknell Center for Sustainability and the Environment

Matthew McTammany, Ph.D.
Professor of Biology, Bucknell University

Carol High
Operations Manager, Bucknell Center for Sustainability and the Environment

Belinda Bergin
Administrative Assistant, Bucknell Center for Sustainability and the Environment

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

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

Barbara Altmann, Ph.D.
Provost, Bucknell University

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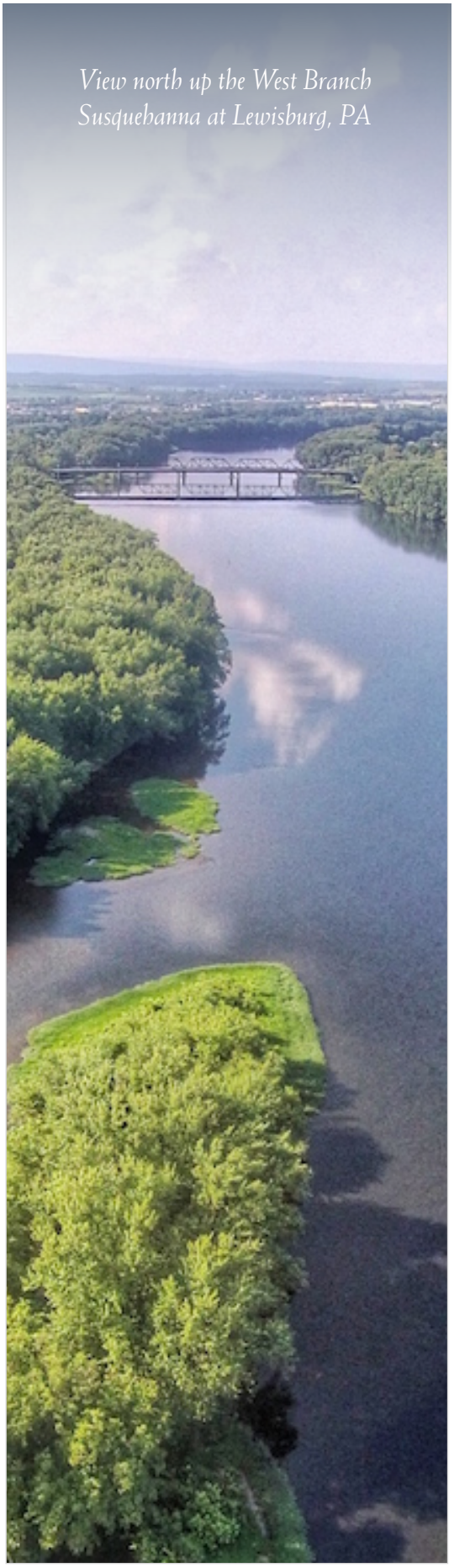


View north up the West Branch Susquehanna at Lewisburg, PA

"A Tale of Two Rivers: The Susquehanna & Delaware"

Greetings!

On behalf of all the members of the organizing committee, I would like to welcome you to the 11th Susquehanna River Symposium, *"A Tale of Two Rivers: The Susquehanna and Delaware."* This year, we are including both the Susquehanna and the Delaware watersheds, to look for similarities and distinct differences between them. Our goal is to gather scientists, engineers, planners, managers, policy-makers, conservationists, and the public to discuss issues facing both watersheds and their estuaries.

This year's symposium features over 80 oral and poster presentations by students and faculty from 24 schools, colleges and universities and 21 government agencies and environmental organizations. There are 18 exhibits by environmental consultants, watershed groups, conservancies, and other organizations working to protect and restore the watersheds throughout the mid-Atlantic region. It a privilege to host such a prestigious group and we encourage everyone to network and build lasting relationships.

We are also pleased to offer our first pre-symposium workshop, *"Correlation of in-stream turbidity with the arrangement of catchment roads using precision analytics"* led by James Shallenberger. It features innovative digital mapping and analytical tools to identify areas areas susceptible to sedimentation from roads or pipelines.

Dr. Bernard Sweeney, President and Senior Research Scientist at Stroud Water Research Center will deliver the keynote address entitled *"The Susquehanna and Delaware Rivers: A Sad Tale with a Happy Ending"* on Friday evening at 7:30 p.m. Earlier we will introduce Franklin L. Kury as the honorary chair of this year's symposium in recognition of the lasting significance of his efforts to enact major environmental legislation and policies in Pennsylvania, including the Clean Streams Law, and numerous water quality, flood plain and storm water management laws.

The symposium is greatly enriched by the contributions of Saturday plenary speakers, which include: Dr. Raymond Najjar (Penn State University), Jeffrey Chaplin (U.S. Geological Survey), Gerald Kauffman (University of Delaware), and Alexandra Campbell-Ferrari (Center for Water Security and Cooperation). I'd also like to thank our invited panelists, including Luke Wilson (Center for Water Security and Cooperation), Andrew DeHoff (Susquehanna River Basin Commission), Marel King (Chesapeake Bay Commission), and Pamela Bush (Delaware River Basin Commission). More information about each of these individuals is available on pages 12-16.

Saturday's plenary presentations will provide a framework for 11 a.m.-12:15 p.m. breakout discussions along four important topics:

1. Climate change impacts
2. Regional groundwater resources
3. Economic value of watersheds
4. Sustainable watershed management

Everyone is welcome and encouraged to participate in these breakout sessions. The discussions are engaging and relevant, and provide you the chance to ask questions and explore the topics in greater detail.

Saturday afternoon will feature 20 oral presentations organized into three topical sessions: (1) fish, (2) ecology and water quality, and (3) watersheds and water use. Talk times and locations are provided on pages 8-9.

On Saturday evening, we are especially excited to host a networking social that features exhibits from 18 companies, organizations, and environmental groups working throughout the Susquehanna and Delaware watersheds. Food and refreshments will be available and we'll give awards for the best student presentations.

This symposium would not be possible without the generous support of the Provost's Office at Bucknell University, the Susquehanna River Heartland Coalition for Environmental Studies, and the Degenstein Foundation. Special thanks are also due the symposium committee for planning and organizing this event: Jessica Newlin, Matthew McTammany Sean Reese, Carol High, Belinda Bergin, and H.W. "Skip" Wieder.

Best wishes for a great symposium!

Sincerely,

Ben

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

Symposium Chairman

Friday, November 11th

THE FORUM (ROOM 272), ELAINE LANGONE CENTER

7:00 - 7:05 p.m.

Welcome

Jessica Newlin

Interim Executive Director
Bucknell Center for Sustainability and the Environment

7:05 - 7:20 PM

Opening Remarks

John Bravman

President
Bucknell University

7:20 - 7:30 p.m.

Value of Collaborative Partnerships for Watershed Research

H.W. "Skip" Wieder

Executive Director
Susquehanna River Heartland Coalition for Environmental Studies

Franklin L. Kury

Honorary Symposium Chair

7:30 - 8:00 p.m.

Keynote Address

"The Susquehanna and Delaware Rivers: A Sad Tale with a Happy Ending"

Bernard W. Sweeney

Director, President, and Senior Research Scientist
Stroud Water Research Center

TERRACE ROOM (ROOM 276) ELAINE LANGONE CENTER

8:00 - 10:00 p.m.

Scientific Research Posters and Evening Social

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

Terrestrial Ecosystems

Sedges emerge from the damp leaves on the forest floor on the floodplain of Kettle Creek in the West Branch Susquehanna River.

Saturday, November 12th

ROOMS 241A-D, ELAINE LANGONE CENTER

8:00 - 8:50 a.m.

Light Breakfast

THE FORUM (ROOM 272), ELAINE LANGONE CENTER

9:00 - 9:10 a.m.

Welcome and Announcements

Barbara K. Altmann

Provost
Bucknell University

Plenary Speakers

9:10 - 9:30 a.m. *Forecasting the impact of climate change on the hydrology and coastal conditions in the Susquehanna and Delaware Rivers and their estuaries.*

RAYMOND G. NAJJAR
Professor of Oceanography
Pennsylvania State University

9:30 - 9:50 a.m. *Assessing regional groundwater quality in the Susquehanna and Delaware watersheds.*

JEFFREY CHAPLIN
Supervisory Hydrologist
U.S. Geological Survey

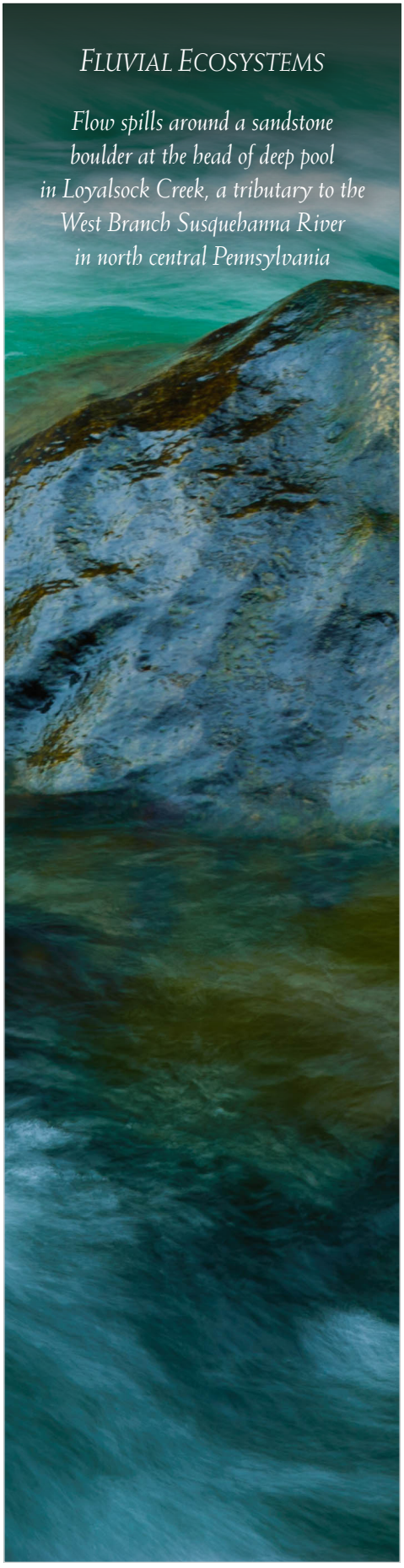
9:50 - 10:10 a.m. *Estimating the economic value and importance of ecosystem services in the Susquehanna and Delaware watersheds.*

GERALD J. KAUFFMAN
Executive Director
University of Delaware Water Resources Center

10:10 - 10:30 a.m. *Examining the critical role that water law, interstate compacts, and river basin commissions play in developing sustainable watershed management plans for the Susquehanna and Delaware River basins.*

ALEXANDRA CAMPBELL-FERRARI
Executive Director
Center for Water Security and Cooperation

10:30 - 10:45 a.m. **Questions for plenary speakers and setting goals for the morning's breakout discussions.**



FLUVIAL ECOSYSTEMS

Flow spills around a sandstone boulder at the head of deep pool in Loyalsock Creek, a tributary to the West Branch Susquehanna River in north central Pennsylvania

Saturday, November 12th

10:45 - 11 a.m.
Intermission

ELAINE LANGONE CENTER

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11 AM - 12:15 p.m.
Breakout Discussions

Topic 1	**Climate Change Impacts**	Arches Lounge (Room 304)
Topic 2	**Regional Groundwater**	Room 241, Sections A and B
Topic 3	**Economic Value of Watersheds**	Room 241, Sections C and D
Topic 4	**Sustainable Watershed Management**	Center Room (Room 256)

WALLS LOUNGE (ROOM 231), ELAINE LANGONE CENTER

12:30 - 1:30 p.m.
Lunch

ELAINE LANGONE CENTER

1:30 - 4:00 p.m.
Oral Presentations

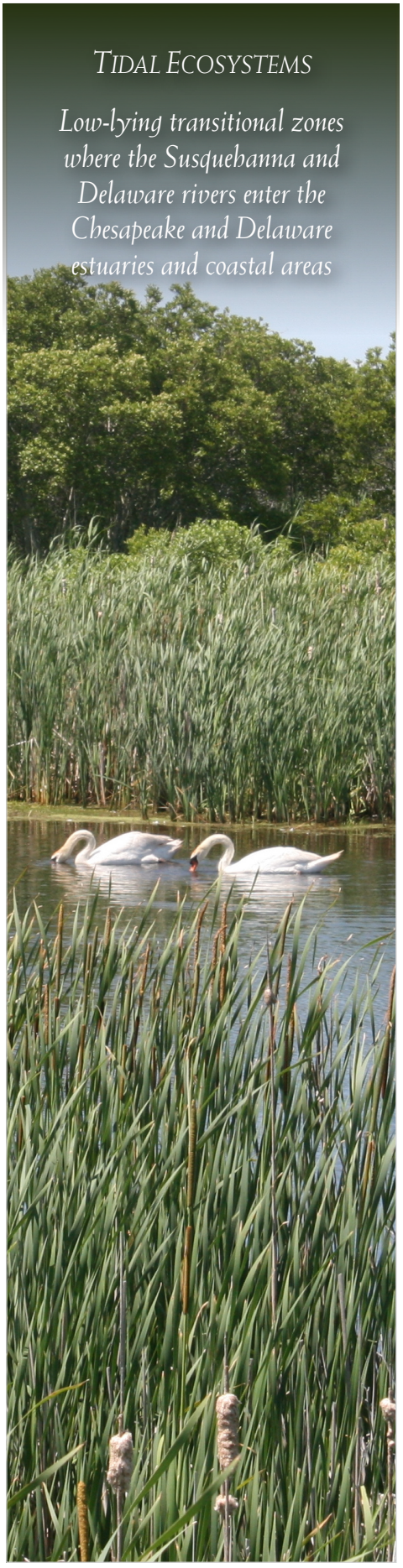
Session 1	**Fish**	The Forum (Room 272)
Session 2	**Ecology and Water Quality**	Center Room (Room 256)
Session 3	**Watersheds and Water Use**	Gallery Theater (Room 301)

THE TERRACE ROOM (ROOM 276)
ELAINE LANGONE CENTER

4:00 - 6:00 p.m.
Exhibits and Networking Social

Agency exhibits, display tables, and social to make new connections and network with other participants. Visit exhibit booths and enjoy conversations over food and drinks. Interact with representatives from state and federal environmental agencies, private consultants and industry leaders, private foundations, and conservancies and watershed groups.

Representatives from the morning's breakout sessions will summarize their discussions. Awards will be given for best student presentations.



Oral Presentations

Saturday, November 12, 2016, 1 - 4 p.m.

** denotes presenting author. Abstracts for oral presentations are provided on pages 17 - 27.*

Session #1 - Fish

The Forum (Room 272, Elaine Langone Center)

1:30 p.m. *Coldwater Heritage Partnership: Protecting and Enhancing Coldwater Resources in the Susquehanna and Delaware River Basins*
MacArthur, T.* *(abstract on page 17)*

1:50 p.m. *Brook and Brown Trout Thermal Habitat Use During the Summer*
Ouellet, V.* and Daniels, M. *(abstract on page 17)*

2:10 p.m. *Initial Findings of the Freshwater Research Initiative funded Susquehanna River Basin-Wild Trout Initiative*
Detar, J.* and Kristine, D. *(abstract on page 18)*

2:30 p.m. **Break**

2:40 p.m. *Assessment of Road Culverts as Passage Barriers to Wild and Stocked Trout in Pennsylvania Headwaters*
Rogers, K.*, Janetski, D., Rummel, S., and Lavelle, K. *(abstract on page 18)*

3:00 p.m. *Examination of Thiamine Deficiency and Water Quality as Potential Causes of Smallmouth Bass Decline in the Susquehanna River*
Spooner, D. E.*, Shull, D. , Honeyfield, D. C., Wertz, T. *(abstract on page 19)*

3:20 p.m. *Recent Changes in Population Characteristics of Smallmouth Bass at the Middle and Lower Susquehanna River and Lower Juniata River*
Smith, G.*, Lehman, D., and Kuhn, K. *(abstract on page 19)*

Session #2 - Ecology and Water Quality

Center Room (Room 256, Elaine Langone Center)

1:30 p.m. *Being a Social Caddisfly: Making the Case for Incorporating Societal Objectives to Help Achieve Ecological Improvements for Urban Streams*
Smith, R.F.* *(abstract on page 20)*

1:50 p.m. *Bats: The Decline of an Integral Component of Watershed Ecosystems*
Collins, J.* *(abstract on page 20)*

2:10 p.m. *The Bogs of Loyalsock State Forest*
Katz, H.M.* (*abstract on page 21*)

2:30 p.m. **Break**

2:40 p.m. *Instream Ecosystem Processes and Stream Health: Assessing Ecosystem Services Provisioned by Native Freshwater Mussels in the Delaware and Susquehanna Rivers*
St. John White, B.*, Spooner, D. E., Galbraith, H.S., Huber, C., Quay, B. (*abstract on page 21*)

3:00 p.m. *Response of Stream Biofilms to Pulsed Versus Steady-State Phosphorus Additions*
Gordon-Weaver, A.M.*, Rier, S.T., Tuomiso, J.(*abstract on page 22*)

3:20 p.m. *Increasing Occurrence of High Fecal Indicator Bacteria (FIB) in Headwater Streams Within the Lower Delaware River Watershed.*
Arscott, D.B.*,Kan, J.,Jackson, J.K., Morgan, S.A., Egan, J. M. (*abstract on page 22*)

3:40 p.m. *Detection and Monitoring of Environmental Triclosan Degradation Gene Expression In Situ*
Putt,A. D.*, Kagle, J. (*abstract on page 23*)

Session #3 - Watersheds and Water Use

Gallery Theater (Room 301, Elaine Langone Center)

1:30 p.m. *Evaluating Low Impact Development as a Mitigation Strategy for Alleviating Combined Sewer Overflows*
Bushey, J.*,Fleischmann, C., Hays, J., and Heineman, M. (*abstract on page 23*)

1:50 p.m. *Quality Survey of the Lock Haven Public Drinking Water Headwater System*
Bell, M.L.*, and Khalequzzaman, M. (*abstract on page 24*)

2:10 p.m. *Cumulative Water Use and Availability Study for the Susquehanna River Basin*
Balay, J.W.*, Zhang, Z., Zimmerman, J.L, and Markowitz, G. (*abstract on page 24*)

2:30 p.m. **Break**

2:40 p.m. *Runoff Flow Path Mapping at Bucknell*
Crago, R. D.*, Glathar, J.,Ren, L.,and Singoyi,C. (*abstract on page 25*)

3:00 p.m. *Land Use Dynamics in the Delaware River Basin*
Jantz,C.A.*, Drzyzga , S.A.,Yáñez Morillo, A., and Price, A. F. (*abstract on page 26*)

3:20 p.m. *Pilot Project - Enhancing the National Hydrography Dataset for Pennsylvania*
Jespersen, E.* (*abstract on page 26*)

3:50 p.m. *One Project, Two Watersheds*
Parenzan, C.* (*abstract on page 27*)

Key Contributors

Schools, Colleges and Universities

Allegheny College
Bloomsburg University
Bucknell University
Florida Gulf Coast University
Indiana University of Pennsylvania
Juniata College
Kings College
Lafayette College
Lock Haven University
Lycoming College
Mansfield University
Millersville University
Pennsylvania State University
Saint Francis University
Selinsgrove Area School District
Shippensburg University
Susquehanna University
Temple University
Trinity College
University of Connecticut
University of Delaware
University of Illinois
University of Pennsylvania
U.S. Coast Guard Academy

Agencies and Organizations

Alliance for the Chesapeake Bay
CDM Smith, Inc.
Center for Water Security and Cooperation
Chesapeake Bay Commission
Chesapeake Conservancy
Coldwater Conservancy
County Planning Directors Association of Pennsylvania
Delaware River Basin Commission

Agencies and Organizations *(continued)*

Delaware Water Resources Center
Illinois State Water Survey
Middle Susquehanna River Keeper
Normandeau Associates Inc.
PA Department of Environmental Protection
PA Fish and Boat Commission
PA Mapping and Geographic Information Consortium
PA Trout Unlimited
Stroud Water Research Center
Susquehanna River Basin Commission
U.S. Fish and Wildlife Service
U.S. Geological Survey
White Clay Creek Wild and Scenic Rivers Program

Exhibitors

Academy of Natural Sciences at Drexel University Delaware Watershed Initiative Team
Alliance for the Chesapeake Bay
Chesapeake Conservancy
Conservation Union
EA Engineering, Science and Technologies, Inc.
Environmental Solutions & Innovations, Inc.
Land Studies, Inc.
Mid-Atlantic Dairy Association
Middle Susquehanna River Keeper
MSISA Program, Millersville University
Normandeau Associates, Inc.
Northcentral Stream Restoration Partnership
PA Water Resources Research Center
PA Amphibian and Reptile Survey
Rummel, Klepper, and Kahl, LLP
Susquehanna Greenway Partnership
Susquehanna River Basin Commission

Franklin L. Kury *Honorary Symposium Chair*

Franklin Kury brings to his work the unique perspective of one who has been both inside and outside the legislature. Elected to the Pennsylvania House of Representatives for three terms (1966–1972), he was a leader in the enactment of environmental laws, such as the Clean Streams Act, that are seen as the culmination of the environmental revolution that marked the end of the exploitation of the state's natural resources by the coal, steel and railroad industries. He was the author and lead advocate for the environmental amendment to the state constitution that declares a right to a clean environment by the people and makes the state government the trustee of the public natural resources.

In 1972 he was elected to the first of two terms in the Pennsylvania State Senate, where he became a leader in government reform. He chaired the special committee that reformed the process for Senate confirmation of gubernatorial nominations and the committee that modernized the Public Utility Commission and created a consumer advocate. Kury also led a six-year struggle that resulted in the enactment of the state's flood plain and storm water management laws. He retired voluntarily from the Senate in 1980 and turned to full-time law practice.

As a lawyer with Reed Smith (1983 - 2003), a major law firm headquartered in Pittsburgh, and Malady & Wooten (2003 - 2016), one of Harrisburg's premier government affairs firms (see www.malady-wooten.com), he counselled clients and advocated for them on state legislative matters.

In 2011 *Clean Politics, Clean Streams: A Legislative Autobiography* was published by the Lehigh University Press. In October 2015 his second book, *Why Are You Here? A Primer for State Legislators and Citizens*, was published by the University Press of America, an imprint of Rowman & Littlefield.

A native of Sunbury, Northumberland County, Pennsylvania, Kury graduated from Trinity College (Hartford, CT) and the University of Pennsylvania Law School. He is married to the former Elizabeth Heazlett of Pittsburgh, and they are the parents of three sons. They reside near Hummelstown in Dauphin County, Pennsylvania.

Bernard W. Sweeney

Keynote Speaker

Dr. Sweeney is Director, President, and Senior Research Scientist of the Stroud Water Research Center in Avondale, PA, where he has served for the past seventeen years. He also is an adjunct professor in the Department of Biology at the University of Pennsylvania. From 1978 to 1999, Dr. Sweeney served as Curator and Vice President of the Environment Group at the Academy of Natural Sciences of Philadelphia.

Dr. Sweeney's research interests include: the role of water quality monitoring in conservation; population and community ecology of temperate and tropical aquatic invertebrates; pollution assessment in temperate and tropical streams using macroinvertebrates; the role of streamside forests in the structure and function of stream and river ecosystems; factors affecting the growth and survivorship of trees in riparian forests; the effects of global warming on stream ecosystems; movement of pollutants along the river-estuary-marine gradient; genetic variation and gene flow among populations of stream insects; the effects of diel and seasonal temperature change on aquatic insect populations; evolution of facultative parthenogenesis in aquatic insects; bioenergetics and secondary production of aquatic insects; and the bioassay of toxic materials in aquatic systems.

His work is widely published in journals such as *Freshwater Science*, *Journal of the American Water Resources Association*, *Ecological Applications*, and *River Research and Applications.*

Dr. Sweeney's keynote address is entitled *"The Susquehanna and Delaware Rivers: A Sad Tale with a Happy Ending"* and will be delivered on Friday, Nov. 11 from 7:30 to 8:00 p.m. in the Forum (Room 272), Elaine Langone Center.

Raymond G. Najjar

Plenary Speaker

A world-renowned scientist studying the impact of climate change on watersheds and oceans, Professor Najar holds joint appointments in the Department of Oceanography and the Department of Geosciences at the Pennsylvania State University. He received his B.E. in Mechanical Engineering from the Cooper Union for the Advancement of Art and Science and Ph.D. from the Department of Atmosphere and Ocean Science at Princeton University. He serves as Co-Chair of the Science Steering Group of North American Carbon Program and on the Science and Technical Advisory Committee of the Chesapeake Bay Program.

Dr. Najjars's research interests include numerical modeling of hydrologic and atmospheric processes, boundary layer dynamics, ocean and estuary mixing, and climate change. His work is widely published in journals such as *Science*, *Climate Change*, *Global Biogeochemical Cycles*, *Journal of Geophysical Research*, *Journal of Marine Research*, *Limnology and Oceanography*, and *Estuarine, Coastal, and Shelf Science.*

Dr. Najjars's plenary presentation is entitled *"Forecasting the impact of climate change on the hydrology and coastal conditions in the Susquehanna and Delaware Rivers and their estuaries"* and will be delivered on Saturday, Nov. 12 from 9:10 to 9:30 a.m. in the Forum (Room 272), Elaine Langone Center.

Following the plenary speaker session on Saturday morning, Dr. Najjar will help lead a breakout discussion on *Climate Change Impacts* from 11 a.m. to 12:15 p.m. in Arches Lounge (Room 204), Elaine Langone Center.

Jeffrey J. Chaplin

Plenary Speaker

Mr. Chaplin is a Supervisory Hydrologist with the U.S. Geological Survey's Pennsylvania Water Science Center (PA-WSC) in New Cumberland, Pennsylvania. He currently serves as the Groundwater and Water Quality Section Chief at the PA-WSC where he has worked for the past 15 years. He received his B.S. in Plant Biology from Ohio University and a M.S. in Water Resources Management from the University of Wisconsin – Madison.

Mr. Chaplin has led a variety of water-resources studies on a wide range of topics including abandoned mine drainage, monitoring of created wetland and riparian systems, and determining the effects of dam removal on water quality and channel morphology. Recent projects include monitoring stream water chemistry in selected areas of the Marcellus Shale Play, and investigating water-quality factors related to smallmouth bass population declines in the Susquehanna River.

Mr. Chaplin has published many USGS publications and reports, including: *Development of Regional Curves Relating Bankfull-Channel Geometry and Discharge to Drainage Area for Streams in Pennsylvania and Selected Areas of Maryland, Streamflow and water-quality monitoring in response to young-of-year smallmouth bass (Micropterus dolomieu) mortality in the Susquehanna River and major tributaries, with comparisons to the Delaware and Allegheny Rivers, Pennsylvania,* and *Physical and vegetative characteristics of a relocated stream reach, constructed wetland, and riparian buffer, Upper Saucon Township, Lehigh County, Pennsylvania,* 2000-04.

Mr. Chaplin's plenary presentation is entitled *"Assessing regional groundwater quality in the Susquehanna and Delaware watersheds"* and will be delivered on Saturday, Nov. 12 from 9:30 to 9:50 a.m. in the Forum (Room 272), Elaine Langone Center.

Following the plenary speaker session on Saturday morning, Mr. Chaplin will help lead a breakout discussion on *Regional Groundwater Assessments* from 11 a.m. to 12:15 p.m. in Room 241 (Sections A and B), Elaine Langone Center.

Gerald J. Kauffman

Plenary Speaker

Since 2003, Dr. Kaufman has served as Director of the University of Delaware–Water Resources Center (UDWRC) , one of the 54 National Institutes for Water Resources (NIWR) supported by the U.S. Geological Survey at land grant universities in the United States. He holds joint faculty appointments in the Department of Civil and Environmental Engineering, School of Public Policy, and Geography Departments at the University of Delaware. He received his B.S. in Civil Engineering, with a focus on Water Resources from the Rutgers University, Level III Certification in Public Manager Program from Rutgers University, Master's in Public Affairs (MPA) in Watershed Policy from the University of Delaware, and Ph.D. in Marine Policy from the University of Delaware.

Ray's research interests watershed policy, planning, and management. Jerry serves as Delaware's first "Water Master" appointed by the Water Supply Coordinating Council Act of 2000 and co–chairs the Christina Basin Clean Water Partnership, an interstate effort between the U.S. Environmental Protection Agency, Delaware River Basin Commission, State of Delaware, and Commonwealth of Pennsylvania.

Dr. Kauffman's is the author of the upcoming book *Sustainable Watershed Management* (Wiley) and is widely published in journals including: *Water Economics and Policy, Journal of the American Water Resources Association (JAWRA*), and *Water Resources Management.*

Dr. Kauffmans 's plenary presentation is entitled *"Estimating the economic value and importance of ecosystem services in the Susquehanna and Delaware watersheds"* and will be delivered on Saturday, Nov. 12 from 9:50 to 10:10 a.m. in the Forum (Room 272), Elaine Langone Center. He will also lead a breakout discussion on *Economic Value of Watersheds* in from 11 a.m. to 12:15 p.m. in Room 241 (Sections C and D), ELC.

Alexandra Campbell-Ferrari

Plenary Speaker

Alexandra Campbell-Ferrari is the Executive Director of the Center for Water Security and Cooperation (CWSC) and Professorial Lecturer in Law at The George Washington University Law School. Ms. Campbell-Ferrari co-founded the CWSC after researching European and Spanish water law and watershed management as a Fulbright Scholar in Madrid. Ms. Campbell-Ferrari's experience spans both the private and public sector, and she has practiced with Sullivan & Worcester LLP's Environmental, Energy and Natural Resources practice and worked with the Office of the Connecticut Attorney General, the U.S. Environmental Protection Agency, the Natural Resources Defense Council's Water Program, the U.S. Department of Justice, Environment and Natural Resources Division's Environmental Crimes Section, and the U.S. Department of Energy. During her time in practice, Ms. Campbell-Ferrari focused primarily on water, environmental and energy issues, and co-authored an amicus brief on water issues in a case before the U.S. Supreme Court. Ms. Campbell-Ferrari's current research concentrates on U.S. and European water law including interstate water compacts and river basin management.

Ms. Campbell-Ferrari is a Phi Beta Kappa graduate of Bucknell University and The George Washington University Law School, and is a member of the Massachusetts, New York and District of Columbia bars.

Ms. Campbell-Ferrari's plenary presentation is entitled *"Water Stewardship Across State Borders"* and will be delivered on Saturday, Nov. 12 from 10:10 to 10:30 a.m. in the Forum (Room 272), Elaine Langone Center.

Luke P.H. Wilson

Invited Moderator, Panel Discussion

Luke Wilson is the Deputy Director of the Center for Water Security and Cooperation (CWSC) and a Professorial Lecturer in Law at The George Washington University. Mr. Wilson focuses primarily on the public international law issues surrounding water resources and manages CWSC's international efforts. Mr. Wilson joins the CWSC from a niche private practice where he specialized in advising attorneys, arbitrators and clients on issues of international law. In addition to his practice, Mr. Wilson previously worked as a law clerk at the International Court of Justice, as a consultant with the World Bank, and at the U.S. Department of Justice, Manhattan District Attorney's Office and U.S. Department of State. Mr. Wilson's current research interests include the resolution of water conflicts through international dispute resolution and the applicability of human rights to water availability

Mr. Wilson earned his LL.M. in International and Comparative Law with highest honors and his J.D. with honors from George Washington Law, where he was Executive Articles Editor of *The George Washington International Law Review*. He is a member of the Massachusetts, New York and District of Columbia bars and is admitted to the bar of the U.S. Supreme Court.

Mr. Wilson will be moderating a panel discussion *"Developing sustainable watershed management plans for the Susquehanna and Delaware River basins"* which will be held on Saturday, Nov. 11 from 11 a.m. to 12:15 p.m. in the Center Room (Room 256), Elaine Langone Center.

Marel A. King

Invited Panel Speaker

Marel King is the Pennsylvania Director of the Chesapeake Bay Commission (CBC). Her focus areas have included the federal Farm Bill, the emerging regional biofuels industry, and implementation of the Commonwealth's Chesapeake Bay Tributary Strategy and Total Maximum Daily Load under the federal Clean Water Act. Prior to joining the Commission staff, she was Director of Regulatory Affairs and then Director of Natural Resources in the Governmental Relations Division of the Pennsylvania Farm Bureau. Marel serves on the Board of Directors of the Susquehanna Greenway Partnership, Susquehanna Valley Regional Board of Economics Pennsylvania, the Perry County Cooperative Extension Board and as an Elder of the Duncannon Presbyterian Church. She has recently served on the WITF Community Advisory Board and is a past chair of the Pennsylvania Bar Association's Agricultural Law Committee.

Ms. King received her J.D. from the Dickinson School of Law of the Pennsylvania State University and her B.S. in Dairy and Animal Science with High Distinction and with Honors in Agricultural Economics and Rural Sociology from the Pennsylvania State University. She was captain of the two-time national champion Holstein Dairy Quiz Bowl Team in her days as a 4-H member and stays active in the dairy industry by assisting with her family's ice cream business. She enjoys competitive baking and non-competitive fly fishing.

Ms. King is one of four invited speakers contributing to the panel discussion *"Developing sustainable watershed management plans for the Susquehanna and Delaware River basins"* which will be held on Saturday, Nov. 11 from 11 a.m. to 12:15 p.m. in the Center Room (Room 256), Elaine Langone Center.

Andrew D. Dehoff

Invited Panel Speaker

Since 2013, Andrew has served as Executive Director of the Susquehanna River Basin Commission (SRBC), where he had previously been a senior water resources engineer involved in many aspects of water resources management, including water availability and safe yield analyses, reservoir operations, and drought and flood management. Mr. Dehoff then served two three-year stints managing first the Planning and Operations program and most recently the Project Review program at the Commission. The latter work in the Commission's regulatory program entailed directing the review of applications and formulation of recommendations and policies related to proposed surface and ground water withdrawals, interbasin transfers, and the consumptive use of water by industries, public water suppliers, power generation facilities and the natural gas industry. Mr. Dehoff earned his B.S. and M.E. in Civil Engineering from the University of Virginia, and has been a licensed professional engineer in Pennsylvania since 2001.

Mr. Dehoff is one of four invited speakers contributing to the panel discussion *"Developing sustainable watershed management plans for the Susquehanna and Delaware River basins"* which will be held on Saturday, Nov. 11 from 11 a.m. to 12:15 p.m. in in the Center Room (Room 256), Elaine Langone Center.

Pamela M. Bush

Invited Panel Speaker

Pamela M. Bush is an attorney and regional planner who has served as Secretary and Assistant General Counsel at Delaware River Basin Commission (DRBC) since September of 1999. Ms. Bush has assisted in developing policy and regulations relating to the full spectrum of commission programs. Notable initiatives in which Ms. Bush has played a key role include amending DRBC's Special Protection Waters (SPW) regulations in July 2008 to expand coverage to the entire 197-mile non-tidal Delaware River, and the promulgation of a new DRBC regulation providing for point source dischargers to develop and implement Pollutant Minimization Plans to reduce PCB contamination in the Delaware Estuary. The regulation was subsequently adapted and approved by the State of New Jersey for state-wide application.

Ms. Bush earned her J.D. in 1997 from the University of Virginia, where she was a Hardy Cross Dillard Scholar. She earned her Master of Regional Planning degree in 1989 from Cornell University, where she was a Sage Graduate Fellow and departmental thesis prize winner. Ms. Bush received her B.A., Magna cum laude in 1983 from Yale University, where she was Phi Beta Kappa. Ms. Bush is a member of the Pennsylvania Bar.

Ms. Bush is one of four invited speakers contributing to the panel discussion *"Developing sustainable watershed management plans for the Susquehanna and Delaware River basins"* which will be held on Saturday, Nov. 11 from 11 a.m. to 12:15 p.m. in the Center Room (Room 256), Elaine Langone Center.

Abstracts (Oral Presentations)

COLDWATER HERITAGE PARTNERSHIP: PROTECTING AND ENHANCING COLDWATER RESOURCES IN THE SUSQUEHANNA AND DELAWARE RIVER BASINS

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While Pennsylvania has over 86,000 stream miles, fewer than 30% are considered high quality coldwater fisheries and fewer than 2% are designated as highly reproductive waters that contain naturally reproducing trout. The Coldwater Heritage Partnership (CHP) program, a collaborative effort between the PA Fish & Boat Commission, PA DCNR, Foundation for Pennsylvania Watersheds, and PA Council of Trout Unlimited, takes a proactive approach to identify and protect these coldwater ecosystems for future generations. The CHP program provides coordination, technical assistance and funding support to conservation organizations for the evaluation and protection of PA's most outstanding coldwater resources. The CHP's competitive grant program provides funding for conservation planning and restoration implementation projects. Coldwater Conservation Plans are keys to building local awareness of and support for the watershed. With financial and technical support from CHP, conservation organizations, community members, municipalities, and state agencies partner to: 1) gather existing and current data about the ecosystem; 2) identify potential threats, impacts, and opportunities; 3) formulate a plan of action for conservation and protection for the watershed; and 4) provide education to communities on best management practices for coldwater protection. In-stream, riparian and trout habitat improvement projects recommended in these or other approved planning documents are also funded by CHP grants. Such projects include stabilizing stream banks, creating and improving in-stream habitat, removing dams, managing and eliminating invasive species, and planting native species along riparian buffers. Approximately 70 Coldwater Conservation Plans have been completed for counties in the Susquehanna and Delaware River Basins. At least 13 restoration projects have been completed or are currently being implemented. Successful CHP applicants have included local Trout Unlimited chapters, watershed associations, land trusts and conservancies, and county conservation districts. Those who benefit from the grants and their outcomes, however, include trout and other coldwater species, local communities, anglers, and anyone else who enjoys visiting, exploring, and recreating along PA's beautiful rivers and streams.

Talk No. 1 in Session #1: Fish
Presentation Time: 1:30 p.m. - The Forum (Rm. 272)

Keywords: Conservation Planning, Habitat Restoration, Grants , Coldwater Resources

BROOK AND BROWN TROUT THERMAL HABITAT USE DURING THE SUMMER.

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We measured the thermal regimes of key trout (Salvelinus fontinalis and Salmo trutta) habitats during summer 2016 (from June to August) in three different tributaries of Loyalsock Creek: Little Bear Creek, Dry Run and Ogdonia Creek. Within each stream, five reaches were selected for electrofishing surveys conducted in mi-June and end of August to evaluate: 1) the number of fish by age class and 2) their use of the thermal habitat. The habitat position of each fish sampled was noted during each survey.

The results showed that Little Bear Creek is significantly colder than Ogdonia Creek and Dry Run ($p < 1.78E-06$). Ogdonia Creek presents the warmest temperature regime of the three studied streams ($p = 0.00296$), with maximum daily values up to 22.03 and 24.90oC from upstream to downstream; reaching the critical thermal tolerance value for brook trout.

Brook trout juvenile abundance is statistically different across the three streams ($p < 0.003$), with Dry Run having the highest abundance. At the beginning of the summer, there were less adult and juvenile brook trout in Ogdonia Creek. While in August, Ogdonia had the higher brook trout juvenile abundance, especially in the upper stream sites ($p < 0.05$). Brown trout abundances were different for Little Bear and Dry Run at the beginning of the summer ($p < 0.05$), with Little Bear Creek having the lower values. By August, only Ogdonia Creek showed a higher abundance of young of the year brown trout.

Young of the year brown trout almost always occupy the top part of the riffles when both species are present and show higher weight values then brook trout. By August, more young of the year brook trout are observed at the edges of cooler pools, leaving the warmer riffles. From the position recorded and the abundances per sites at the beginning and the end of the summer, the brook trout seem to display more movements toward the cooler pool and upstream reaches.

Those results are important to understand the dynamics between both species. Brook trout seem to move toward the cooler upstream reaches throughout the summer, which are known to have less aquatic macroinvertebrate abundance. This adds to the extra energetic expenditures from moving upstream, therefore potentially affecting the growth of brook trout compared to brown trout, which seem to be able to exploit the same thermal habitat throughout the summer.

Talk No. 2 in Session #1: Fish
Presentation Time: 1:50 p.m. - The Forum (Rm. 272)

Keywords: habitat, trout, thermal regime, refugia

INITIAL FINDINGS OF THE FRESHWATER RESEARCH INITIATIVE FUNDED SUSQUEHANNA RIVER BASIN-WILD TROUT INITIATIVE

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In 2016, the Freshwater Research Initiative provided a grant to the Pennsylvania Fish and Boat Commission which funded a seasonal position to aid in collecting biological data on wild trout and other fisheries resources in the West Branch Susquehanna and Middle Susquehanna drainages. The seasonal staff assisted PFBC biologists in collecting important information on wild trout resources as part of the Unnassessed Waters Initiative and other programs. The data collected will be used to guide future management and protection of the streams. As part of their training, the seasonal staff also assisted in collecting information on various lake and river surveys in the Susquehanna watershed. The presentation will provide a summary of the work which was accomplished with the Freshwater Research Initiative grant.

Talk No. 3 in Session #1: Fish
Presentation Time: 2:10 p.m. - The Forum (Rm. 272)

ASSESSMENT OF ROAD CULVERTS AS PASSAGE BARRIERS TO WILD AND STOCKED TROUT IN PENNSYLVANIA HEADWATERS

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One of the primary threats to brook trout in Pennsylvania is population fragmentation due to habitat alteration. Road culverts in particular can isolate populations by reducing access to upstream spawning habitat. To categorize the degree to which culverts prevent fish movement, watershed managers use physical measurements to classify the passability of the each culvert. The North Atlantic Aquatic Connectivity Collaborative (NAACC) conservatively categorizes culverts as "no AOP (Aquatic Organism Passage)" or "red culverts" when they are considered a barrier to aquatic organisms. The Little Bear Creek watershed, a wild trout stream in the Loyalsock watershed, contains three culverts categorized as "reduced AOP" or "gray culverts" that require further investigation to determine actual organism passage. It is unknown whether these gray culverts are indeed barriers to migratory fish, especially native trout. To measure how passable these culverts are, we tagged 546 wild trout in 2015 and 2016 with passive integrated transponder (PIT) tags, distributed up and downstream of each culvert site and a control site without a culvert. Results show that trout are differences in movements between culvert types, implicating a barrier issue in Little Bear's tributaries. The only metal corrugated culvert in the watershed, which lies on the upper most extent of Sand Spring Run, has proven to be the most passable of the culverts with an average of 0.85 movements per day. A small box culvert on the lower extent of Sand Spring Run had an average of 0.1 movements per day. The largest culvert, a more recently built box culvert close to the mouth of Red Run, had an average of 0.01 movements per day. None of the movements in Red Run were upstream movements. The barrier-free site on Painter Run resulted in an average of 0.27 movements per day. We will further test for correlations of trout movements with daily stream conditions such as temperature and water level. By "ground-truthing" culvert assessment methods, we anticipate our study will ultimately help watershed managers better prioritize culverts for removal or replacement.

Talk No. 4 in Session #1: Fish
Presentation Time: 2:40 p.m. - The Forum (Rm. 272)

Keywords: barriers, headwater streams, road culverts, brook trout

EXAMINATION OF THIAMINE DEFICIENCY AND WATER QUALITY AS POTENTIAL CAUSES OF SMALLMOUTH BASS DECLINE IN THE SUSQUEHANNA RIVER.

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In 2005, abnormalities and increased mortality were first observed in young of the year (YOY) Smallmouth bass (*Micropterus dolomieu*) (SMB) in the lower reaches of the Susquehanna River including the Juniata River. Since then, both YOY and adult populations have remained surprisingly low, with little indication of rebound. Despite considerable investment of effort and resources, causes of the problem remain inconclusive and likely point to multiple interacting stressors within the ecosystem. We evaluated the hypothesis that the limitation of dietary thiamine (B1) negatively impacted the health of SMB populations. We characterized a suite of thiamine forms (free thiamine and phosphorylated thiamine) in adult and YOY SMB at sites varying in anthropogenic activity within the Susquehanna River watershed. We also conducted visual assessments to evaluate if thiamine status correlated to the intensity of fish abnormalities. Young-of year SMB were further assessed for dietary thiaminase activity, an enzyme known to degrade thiamine. Neither thiaminase activity nor thiamine status significantly correlated to the extent of physical abnormalities. Nevertheless, various metrics of water quality including phosphorus and suspended sediment were highly correlated to thiamine status and identity (phosphorylated versus free thiamine). These results suggest that while thiamine limitation may not directly impact SMB populations, there is a potentially strong link between watershed activities and overall nutritional status. More studies are needed to assess the ecological significance of these patterns.

Talk No. 5 in Session #1: Fish
Presentation Time: 3:00 p.m. - The Forum (Rm. 272)

Keywords: Water quality, Smallmouth bass, Ecological nutrition, Environmental health

RECENT CHANGES IN POPULATION CHARACTERISTICS OF SMALLMOUTH BASS AT THE MIDDLE AND LOWER SUSQUEHANNA RIVER AND LOWER JUNIATA RIVER

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Wide-spread disease related mortality of young-of-year Smallmouth Bass beginning in 2005 affected recruitment and resulted in a substantial decline in abundance of adult Smallmouth Bass in popular and locally important recreational fisheries in the middle and lower Susquehanna River and lower Juniata River. In recent years, the prevalence of disease has decreased; resulting in increased recruitment and changes in population characteristics. Catch rates of adult Smallmouth Bass (age-1 and older) determined during nighttime boat electrofishing surveys conducted at the middle Susquehanna River, lower Susquehanna River, and lower Juniata River have increased recently and have been at or above the long-term median values during 2014 and 2015 at all three reaches. Additionally, electrofishing catch rates of Smallmouth Bass 375 mm and longer in total length have varied but remained similar to or increased at all three reaches. The age and size distribution of Smallmouth Bass has also changed in recent years at the middle Susquehanna River as the catch rate of smaller and younger fish has increased during the 2013 -2015 surveys. This represents a shift towards a population age and size structure more similar to the pre-2005 period. We will discuss recent data analysis that was conducted, in part, though funding provided by the RK Mellon Freshwater Research Initiative at Susquehanna University.

Talk No. 6 in Session #1: Fish
Presentation Time: 3:20 p.m. - The Forum (Rm. 272)

Keywords: Smallmouth Bass, population characteristics, Susquehanna River, Juniata River

BEING A SOCIAL CADDISFLY: MAKING THE CASE FOR INCORPORATING SOCIETAL OBJECTIVES TO HELP ACHIEVE ECOLOGICAL IMPROVEMENTS FOR URBAN STREAMS

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In 2014 at the 3rd symposium on Urbanization and Stream Ecology, an international working group of stream ecologists from academia, government, and private industry sought to develop an alternative framework for restoring streams in urban landscapes. Urban streams are often altered by human actions in ways that limit the potential outcomes of restoration projects. We proposed the Urban Stream Renovation (USR) framework as a novel alternative to current approaches for improving ecosystem structure and function of urban streams. The USR framework differs from other approaches by 1) using a flexible approach focused on developing ecosystem structure and function within the context of a highly modified urban landscape and 2) integrating societal and ecological outcomes. Aspects of the socio-cultural linkages of streams with urban communities and the hypothesized effects of these linkages on stewardship will be discussed, and case studies will be presented to provide real world examples of some of these linkages. The BSR framework will be discussed to solicit input, feedback, and criticisms about the potential for this approach to achieve ecological improvements in urban streams at broad spatial and temporal scales.

Talk No. 1 in Session #2: Ecology and Water Quality
Presentation Time: 1:30 p.m. - Center Room (Rm. 256)

Keywords: urban streams, restoration, societal outcomes, stewardship

BATS: THE DECLINE OF AN INTEGRAL COMPONENT OF WATERSHED ECOSYSTEMS

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The decline of biodiversity across the globe has become a central concern in the field of conservation biology. Globally, populations of bats are thought to have declined markedly over the past 50–100 years. Until recently destruction of habitat was likely the largest threat to North American bats. The newest threat to bats—white-nose syndrome—is caused by a fungus (*Pseudogymnoascus destructans*) that afflicts cave-obligate species during hibernation. White-nose syndrome was first reported in 2007 and has since spread throughout portions of the United States and Canada. Estimates of mortality for hibernating bats two years after infection by the fungus vary from 69% to 98%, depending on locale and species.

Riparian and river areas are often considered good habitat for bats, which is likely related to a high density of prey. There are many species of bat, dependent on waterbodies, including the Indiana bat (*Myotis sodalis*), which is listed as federally endangered. Management of watersheds, including structural changes to waterways and surface runoff mitigation, is known to have impacts on bat ecology. The drastic decline of bats due to white-nose syndrome makes it more important than ever to consider the interdependent relationship of bats and watersheds.

Talk No. 2 in Session #2: Ecology and Water Quality
Presentation Time: 1:50 p.m. - Center Room (Rm. 256)

Keywords: Bats, White-nose syndrome, Endangered Species

THE BOGS OF LOYALSOCK STATE FOREST

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Along the Wisconsin Glacier's terminal moraine lies tens of thousands of bogs. About 100 of these are in the Loyalsock State Forest (LSF) between Ralston, on Route 14 and Hillsgrove, on Route 87 in Pennsylvania. This 35,000 acre (14,000 hectare) forest includes a variety of bog types. The area drains two watersheds, The Lycoming Creek watershed and the Loyalsock Creek watershed. Bogs are distinctive wetlands and have low pH and nutrients and are considered low productivity systems. This five year project, 2013-2017 is now nearing the end of year four.

One of the characteristics, as data is collected to describe the bogs, is that bogs take many different shapes. As a general rule the bogs follow the traditional early, mid, and late successional character. The hydrology of bogs are distinctive and many bogs have waterways flowing through them, regardless of successional stage. These bogs are described as "Fens." Other bogs have no waterway visible and several are stand-alone bogs with no apparent connection to a run or stream. Size ranges from 1/4 acre (0.1 hectare) or less to as large as 80 acres (32 hectares). Out of the 64 wetlands examined to date, eight have Pennsylvania threatened and endangered plant species, seven in the Lycoming watershed and one in the Loyalsock watershed. The remaining 56 bogs lack these plants. At least two bogs are seasonal in that they hold water only after snow melt or heavy rain, like vernal ponds they dry up during the summer season. Two locations, out of the 64 are vernal ponds, and are co-located within the larger bog/forest area.

As a general rule the bogs tend to be remote and can be difficult to find. Only one out of the 64 sites is near a wood road. The remaining 63 sites are deep into the woods. Use of satellite imagery is necessary to locate these bogs. Basic data to describe the location, physical size, hydrology, dominant plant type, insect/arachnid, fish, amphibian, reptile, bird, and mammals are included in the bog description when found on the bog site. Water quality examination is currently limited to pH, total dissolved solids and temperature. This presentation will describe the bog types, including some historical influence to explain bog varieties. These range from human activities such as splash dam construction, usually from the 1870 through 1930 lumbering period, to the natural activities of beaver impoundment. Both satellite and color photos will be used to give the audience a sense of what these bogs look like. The presentation will end with a brief effort to understand how the bogs fit into our current concept of ecological services.

Talk No. 3 in Session #2: Ecology and Water Quality
Presentation Time: 2:10 p.m. - Center Room (Rm. 256)

Keywords: Bog, Fen, Hydrology, Dominant species

INSTREAM ECOSYSTEM PROCESSES AND STREAM HEALTH: ASSESSING ECOSYSTEM SERVICES PROVISIONED BY NATIVE FRESHWATER MUSSELS IN THE DELAWARE AND SUSQUEHANNA RIVERS

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Instream ecological processes regulate stream health at multiple spatial and temporal scales. The effectiveness of these key ecological services, however, may vary across a spectrum of ecological condition. Native freshwater mussels capture, remove and recycle sediment and nutrients from the water column through biofiltration and biodeposition activities. In addition to water purification, mussels also provision key bioavailable nutritional resources to the surrounding foodweb, supporting biodiversity. These ecosystem services are critical to freshwater ecosystems, including the Delaware and Susquehanna Rivers. Mussels are highly abundant and well-documented in the upper and middle Delaware River, where a collaborative, interdisciplinary study has been launched to 1) Evaluate biofiltration, nutrient flux and retention by mussels, 2) Quantify the economic value of freshwater mussel ecosystem services and 3) Develop a predictive model to estimate ecological and economic benefits and losses associated with predicted changes in the Delaware River basin related to factors including ecological flows and land use. Challenges may be associated with transferring this approach to other rivers and streams, as efficiency and effectiveness of instream ecosystem processes like mussel biofiltration vary with environmental conditions, as do costs and benefits associated with removal of particular nutrients and sediments. This challenge is relevant to the Susquehanna River, where nutrient loading is high, mussel abundance and juvenile recruitment are limited, and human-derived watershed stressors may confound or compromise the benefit of mussel-provisioned ecosystem services.

Talk No. 4 in Session #2: Ecology and Water Quality
Presentation Time: 2:40 p.m. - Center Room (Rm. 256)

Keywords: ecosystem services, freshwater mussels, biofiltration, nutrient cycling

RESPONSE OF STREAM BIOFILMS TO PULSED VERSUS STEADY-STATE PHOSPHORUS ADDITIONS

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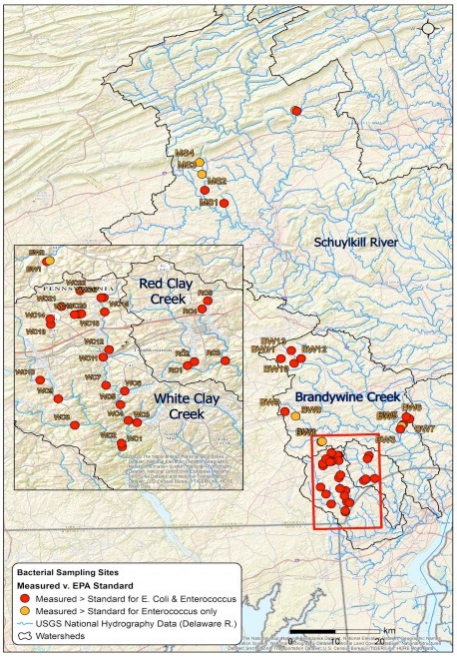
Our current understanding of how algal-dominate biofilms in streams respond to phosphorus (P) enrichment is largely based on the assumption that streams have a constant P supply. However, in reality natural streams experience large swings in P concentrations due to runoff and in-stream biotic and abiotic uptake. The purpose of this study was to compare the effects of a steady-state P release versus successive pulse events on algae-dominated biofilms colonizing artificial streams. One treatment (n=4) was maintained at a constant 12 μg P/L, another was subjected to weekly 8 h pulses at 252 μg P/L (n=4) and a third treatment was maintained below P detection limits (n=4). Both the steady-state and the pulse treatments received an equivalent amount of P by the end of the experiment. Preliminary pulse amplitude modulation fluorometry data indicate that algae treated with the phosphorous pulse had a greater photosynthetic capacity and ability to utilize the phosphorus.

Talk No. 5 in Session #2: Ecology and Water Quality
Presentation Time: 3:00 p.m. - Center Room (Rm. 256)

Keywords: Phosphorous, Biofilm



INCREASING OCCURRENCE OF HIGH FECAL INDICATOR BACTERIA (FIB) IN HEADWATER STREAMS WITHIN THE LOWER DELAWARE RIVER WATERSHED

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According to United States' Environmental Protection Agency (EPA), bacteria and pathogen contamination has been ranked as the leading cause for impaired and threatened waters nationwide including streams in the Delaware River Watershed. Historic bacteria samples from the lower Delaware River Basin have primarily been collected from larger streams at the base of contributing sub-watersheds. As a result, there is little information on the status of bacterial contamination in headwater streams in this region. Headwaters constitute more than three quarters of the stream length in these watersheds and significantly influence water quantity and quality (physical, chemical and biological). In this study, we monitored fecal indicator bacteria (FIB) including total coliform, *E. coli* and *Enterococci* at 46 upstream sites across Delaware River Watershed, including the White Clay Creek, Red Clay Creek, Brandywine Creek, and the Schuylkill River. These data indicated an increasing occurrence of high FIB in the watershed. The concentrations of total coliform, *E. coli* and *Enterococci* were significantly higher than the EPA standards, suggesting a rising public health threat, a potential risk for surface-fed drinking water suppliers, and a challenge for watershed managers. Relationships between concentrations of FIB and landuses and other stream and watershed physical factors (e.g., watershed size, population density, location of known point sources) are also explored and discussed. Finally, molecular source tracking methods were used to identify the possible sources for FIB contamination, and our results indicated that headwaters are more susceptible to local landuses, and the bacterial contaminations are likely related to agriculture, urbanization, mushroom operations, and wildlife.

Talk No. 6 in Session #2: Ecology and Water Quality
Presentation Time: 3:20 p.m. - Center Room (Rm. 256)

DETECTION AND MONITORING OF ENVIRONMENTAL TRICLOSAN DEGRADATION GENE EXPRESSION IN SITU

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Triclosan (TCS) is a broad-spectrum antimicrobial that blocks the active site of the enoyl-acyl carrier protein reductase enzyme, therefore preventing the formation of fatty acids in bacteria. Due to TCS being a potential environmental and health hazard, it was recently included on a list of antibacterial compounds banned by the FDA. *Sphingomonas sp*. RD1 is known to degrade TCS utilizing a TCS-inducible oxygenase encoded by the genes tcsAB. In order to detect to use of tcsAB for degradation of TCS in situ, a PCR-produced DNA fragment containing the tcsAB promoter region was inserted upstream of the lux cassette of pUCD615, thus creating a plasmid that will luminesce when activated by TCS presence. The plasmid was transformed into RD1 creating a TCS presence reporter strain for application in wastewater discharge. In addition, environmental presence of this pathway was investigated by two approaches: 1) BLAST searches of publicly available metagenomes of sewage and activated sludge and 2) tcsA PCR on DNA extracted from wastewater treatments in south central Pennsylvania. Although no instances of tcsA were detected in metagenomes, PCR (confirmed by sequencing) indicated the presence of tcsA in one sewage sludge sample. Attempts to isolate the tcsA-containing bacteria from that sludge sample have resulted in one putative tcsA-containing strain.

Talk No. 7 in Session #2: Ecology and Water Quality
Presentation Time: 3:40 p.m. - Center Room (Rm. 256)

Keywords: Water Quality, Plasmid, Microbiology, antibiotic

EVALUATING LOW IMPACT DEVELOPMENT AS A MITIGATION STRATEGY FOR ALLEVIATING COMBINED SEWER OVERFLOWS

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Combined sewer systems, designed to collect both stormwater and sewage, are present in 700 United States cities, including many in the Susquehanna and Delaware River valleys. These systems were designed to overflow during precipitation events, discharging stormwater, toxins, pathogens, and human and industrial waste to nearby surface waters. We investigated the effectiveness of low impact development (LID), a method of preserving natural watershed hydrology, for reducing combined sewer overflow (CSO) at the watershed scale. An EPA Storm Water Management Model (SWMM) of the Park River Watershed in Hartford, Connecticut is used to evaluate the effect of reducing impervious cover (IC) on CSO. To simulate green infrastructure, simulations were performed for IC reductions up to 30% for storm recurrence intervals from three months through 50 years. Hartford's target for CSO control in most areas of the city is the elimination of CSO in a "typical" year. When a 5% reduction in IC is simulated, runoff for a 1-year design storm is reduced 13 million gallons (MG) from a base case of 74 MG, and three of 44 initial overflows are eliminated. A hypothetical 30% IC reduction reduces runoff by 58 MG, eliminating 23 CSO locations. Overflow volume reduction continues to increase for all storm sizes; however, the number of CSO eliminated decreases. In a 25-yr storm, no CSO is eliminated with a 5% IC reduction. Results demonstrate that although LID implementation reduces stormwater volume, LID alone cannot eliminate CSO in Hartford for the storm sizes and IC reductions considered. While cost analysis demonstrates the financial benefit of using grey infrastructure in tandem with green infrastructure for stormwater management, the practicality of LID implementation may not exist. Watershed-level modeling, such as that performed in this investigation, can be useful in identifying target areas for LID implementation, avoiding costly individual hydrologic analysis of LID features during each design.

Talk No. 1 in Session #3: Watersheds and Water Use
Presentation Time: 1:30 p.m. - Gallery Theater (Rm. 301)

Keywords: combined sewer overflows, stormwater, low impact development, watershed

QUALITY SURVEY OF THE LOCK HAVEN PUBLIC DRINKING WATER HEADWATER SYSTEM

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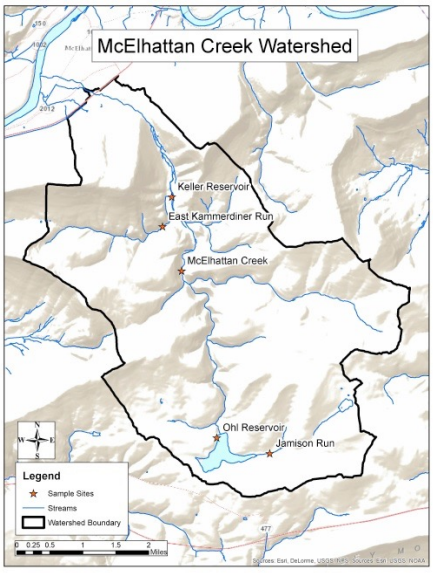

Surface water within the McElhattan Creek watershed serves as the source of drinking water for 18,000 subscribers of the Central Clinton County Water Filtration Plant. The purpose of this study is to assess the quality of source water within the system.

Grab samples at 5 locations were collected on a monthly basis throughout the summer of 2016. Utilizing ArcGIS mapping software, a Hydrolab MS5 MiniSonde, and Hach laboratory equipment, data was collected, processed, and analyzed to evaluate baseline water quality. A special focus was given to total organic content due to its impacts on the final outcome of the treatment process. Field parameters included temperature, pH, conductance, TDS, DO, ORP, and chlorophyll-a. Additional lab analysis yielded results for COD, BOD, TOC, hardness, alkalinity, NH_3-N, NO_3-N, NO_2-N, PO_4-P, Cl-, and SO_4-2. Water Quality Index (WQI) was calculated using the results (Vincente et al., 2009).

The WQI values ranked the system as excellent. Throughout the course of the study period, none of the parameters tested presented results that warranted alarm when compared to published drinking water standards. Parameters such as NO_3-N topped out at less than 1/10 the MCL of 10 mg/L, with other parameters following similar patterns of results well below the EPA's MCL. On average, nutrients such as NH_3-N and NO_3-N were below or equivalent to the natural background levels suggested by USGS literature (U.S. Geological Survey, 1999).

Understanding the seasonal and daily fluctuations of various biological and chemical parameters in a drinking water system is imperative to effective and efficient water treatment. Analytical methods, geospatial representations, operations performed, and equipment used in this study will have similar application for understanding drinking water source systems in other regions.

Talk No. 2 in Session #3: Watersheds and Water Use
Presentation Time: 1:50 p.m. - Gallery Theater (Rm. 301)

CUMULATIVE WATER USE AND AVAILABILITY STUDY FOR THE SUSQUEHANNA RIVER BASIN

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The Susquehanna River Basin Commission's Cumulative Water Use and Availability Study represents the most comprehensive evaluation of water use and availability throughout the Basin conducted to date. The scope of the study entailed (1) quantification of consumptive use (CU); (2) determination of water capacity and availability; (3) development of a GIS-based tool; and (4) consideration of protection, mitigation and enhancement measures. The 10-digit Hydrologic Unit Code was the target spatial scale for the study and included 170 watersheds in the Basin.

The Commission defines CU as the loss of water due to a variety of processes by which the water is not returned to the Basin. A water use database was developed by integrating Commission, New York, Pennsylvania, and Maryland records. Estimates of unregulated CU by the self-supplied residential and agricultural sectors were generated. Projections of CU in 2030 were developed based on trend analysis and published forecast information.

Water capacity is the natural ability of a watershed to sustainably provide streamflow over time, during varied climatic conditions (NJ Highlands Council, 2008). A literature review identified several approaches that were evaluated for quantifying water capacity for Basin watersheds. Water availability is defined as the hydrologic capacity of a watershed to sustain additional water demands, considering current water uses and conditions (Global Environmental Management Initiative, 2012). Water availability was calculated by subtracting cumulative CU from water capacity.

A suite of management measures was evaluated for their effect on cumulative water use and availability during simulated drought conditions. A data-driven GIS-based tool was developed that allows users to delineate a watershed, generate watershed characteristics and flow statistics, compute current and projected CU, and calculate water capacity and availability. An interactive, public-facing web map was also developed that displays information including approved and reported CU, water capacity, and water availability summarized by watershed.

This presentation will cover the methods, results, and recommendations associated with each of the study components, with an overview of the functionality afforded in the planning tools that were developed.

Talk No. 3 in Session #3: Watersheds and Water Use
Presentation Time: 2:10 p.m. - Gallery Theater (Rm. 301)

Keywords: Susquehanna River, Water Use, Water Availability, Water Resources Planning

RUNOFF FLOW PATH MAPPING AT BUCKNELL

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Precision Conservation combines high resolution, remotely-sensed land surface data with analysis through a Geographic Information System (GIS). This particular application, pioneered by the Chesapeake Conservancy, can identify precise locations where concentrated storm runoff leaves individual fields, and provides a metric that estimates how likely the flow is to discharge harmful pollutants downstream. The analysis was applied to the Buffalo Creek watershed in Union County, PA during the summer of 2015. During the fall semester in 2015, the students in CEEG 421 (Hydrology) reproduced the analysis in the Bucknell GIS lab and identified sites on local farms that could benefit from better stormwater management practices. In collaboration with the Buffalo Creek Watershed Alliance (BCWA), students visited some of the farms, interacted with the farmers, and inspected the sites they identified. Working in groups of three, they designed engineered treatment facilities such as constructed wetlands, ponds, and filter strips. Research during the summer of 2016 is testing the validity of the metric used; alternatives will be suggested and tested as well. Finally, a similar class project is planned for the Fall 2016 offering of CEEG 421, and improvements to the project motivated by lessons learned the first time will be discussed.

Talk No. 4 in Session #3: Watersheds and Water Use
Presentation Time: 2:40 p.m. - Gallery Theater (Rm. 301)

Keywords: Runoff, Mapping, GIS, Student Projects

LAND USE DYNAMICS IN THE DELAWARE RIVER BASIN

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The Delaware River Basin is an important region that hosts more than 8.2 million residents and provides ecosystem services that support multiple commercial, industrial, recreational and residential uses. The purpose of the project is to provide useful tools to decision makers across the 43 counties that intersect the basin in Pennsylvania, New York, New Jersey, Delaware, and Maryland. The tools include: a) a high-resolution (1m) LiDAR-based land cover dataset for all 43 counties that cover, in whole or in part, the basin; b) geoprocessing tools for evaluating and visualizing alternate scenarios of future land cover changes; and c) a feasibility study that gauges the willingness and abilities of stakeholder groups to participate in a long-term monitoring program. This project is one of many funded by the William Penn Foundation to develop tools and on-the-ground projects in support of Basin-wide water quality restoration and protection. In this paper we will describe our overall project, which includes collaborations with the University of Vermont and the USGS, as well as what we have learned so far regarding land use dynamics in the Basin.

Talk No. 5 in Session #3: Watersheds and Water Use
Presentation Time: 3:00 p.m. - Gallery Theater (Rm. 301)

PILOT PROJECT - ENHANCING THE NATIONAL HYDROGRAPHY DATASET FOR PA

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The National Hydrography Dataset (NHD) is a mature and robust product to depict surface water resources, and is a uniform dataset nationwide. Pennsylvania (PA) currently has complete NHD coverage at 1:24000 scale, generally suitable for display on topographic quadrangles. Between 2005 and 2010 the PAMAP Program, in partnership with the National Map, produced consistent statewide color imagery and topography suitable to support production of local resolution (1:2400) NHD, but suffered complete cut of state funding after 2010. Since that time technologies and project needs have made the incompatibilities between the PAMAP imagery and topography and the current NHD more apparent. Furthermore, the importance of the Susquehanna River drainage into to the Chesapeake Bay has heightened awareness of the contributions of stormwater systems to sediment and nutrient loads.

Since late 20113, the Pa Mapping and Geographic Information Consortium (PaMAGIC) has been developing the concept of an integrated water base map with the following characteristics:

- Designed as default and authoritative water data basemap allowing for collaboration across organization lines
- Spatially compatible with current mapping such as PAMAP imagery and LiDAR.
- Includes man-made stormwater infrastructure.
- Provides reference basis for regulatory and analytical studies, modeling and data.

The United States Geological Survey (USGS) awarded the PaMAGIC an NHD Support Grant under Cooperative Agreement Number G15AC00516. This presentation will describe the pilot project performed during 2016 in Lancaster County to advance development of improved statewide hydrography.

Talk No. 6 in Session #3: Watersheds and Water Use
Presentation Time: 3:20 p.m. - Gallery Theater (Rm. 301)

Keywords: NHD, hydrography, base map, surface water

ONE PROJECT, TWO WATERSHEDS

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What special challenges arise when a single linear project has the potential to impact two distinct watersheds, each with their own set of regulatory agencies? Using the PennEast Pipeline Project – a proposed 118-mile, 36-inch-diameter underground pipeline designed to deliver up to one billion cubic feet of natural gas per day – as an example, Middle Susquehanna Riverkeeper Carol Parenzan, who holds an environmental engineering degree with a water focus from Penn State and has experience in subsurface utility exploration and mapping, will provide an overview of the project, show the planned route in the Susquehanna River and Delaware River watersheds, provide historical background information for the project area, outline regulatory agencies involved with project approval, and address some of the complicating factors with this specific project as it weaves its way through the two watersheds.

Talk No. 7 in Session #3: Watersheds and Water Use
Presentation Time: 3:50 p.m. - Gallery Theater (Rm. 301)

Keywords: Susquehanna River, Delaware River

Abstracts (Research Posters)

FLOODING IN PENNSYLVANIA'S SMALL COMMUNITIES: POLICY ANALYSIS OF MITIGATION STRATEGIES AND FLOODPLAIN MANAGEMENT

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In the United States, flood mitigation is primarily the responsibility of local governments, though powerfully influenced by multiple federal and state programs, incentives, and regulations. One such program is the Federal Emergency Management Agency (FEMA's) National Flood Insurance Program (NFIP), which provides disaster-relief funding to property owners but is available only in municipalities that meet programmatic requirements including adopting floodplain ordinances with specified provisions. This research conducted policy analysis of a sample of small, rural Pennsylvania municipalities, as part of a larger project investigating the impact of U.S. and Pennsylvania flood programs funded by the Center for Rural Pennsylvania. Research objectives were: to assess the penetration of FEMA's NFIP requirements in small communities at risk from flood damages; and evaluate ways in which communities adapt floodplain ordinances to their priorities, local conditions, and needs. The researchers analyzed in detail the ordinances of eight case study communities; compared them to the minimum standard specified by FEMA; and used public reports, Internet sources, phone interviews, and site visits to determine the kinds of measures taken by municipalities beyond the minimum required to be eligible for NFIP. Findings indicated penetration of the program is essentially complete: all eight case study communities had adopted NFIP-approved floodplain ordinances, and all reported this to be routine in all at-risk communities of which they were aware. The eight ordinances showed little variation, with few, and minor, provisions beyond the minimum specified. The eight communities did show notable differences in the way the ordinances were implemented: some municipalities rigidly decline land uses that vary from the ordinances, while others actively encouraged property owners to apply for variances, while working extensively to adopt alternate protections not stated in the ordinances that would effectively reduce flood damages and safety risks. The latter approach appeared to be widely used in boroughs with old, historic districts, where new development is scarce and existing land uses in the flood plain are important economically, historically, and culturally. The research concluded that FEMA's powerful mechanism, tying minimum requirement to eligibility for disaster relief, has been successful in driving Pennsylvania municipalities to adopt ordinances that in essence constitute a national program of local actions based on NFIP's model ordinances.

STREAM TEMPERATURE AND STRESS PROTEIN REGULATION IN BROOK TROUT

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Climate change is one of the most pervasive threats to coldwater fish populations. With increased stream temperatures, organism-level changes can be seen as fish adjust their behavior and metabolic rate to prevent physiological stress and death. However, preceding these changes, cellular-level response to heat can be detected through the increased expression of genes that produce stress proteins. These proteins assist in cell development and repair, and prevent tissue death during stressful conditions. Stress protein regulation has received considerable attention in laboratory studies; however, few studies have documented protein regulation in natural populations where environmental stochasticity is greater and there is the potential for adaptation to chronic stress. We sampled four populations of brook trout in the Loyalsock Creek watershed to determine temporal and spatial trends in thermal preferences and temperature stress adaptation. A non-lethal gill biopsy was taken from radio tagged fish, allowing us to collect repeated samples on uniquely identified individuals over multiple seasons. Gene expression of stress proteins in the gill was used to evaluate individual responses to thermal stress. We detected differences in regulation beginning at 13°C, which is considerably lower than brook trout thermal tolerance. In the future, we will determine whether there are population-level differences in gene expression and continue collecting samples to quantify regulation in fall and winter.

PATTERNS OF GROUND SPIDER COMMUNITY DIVERSITY AND RICHNESS ACROSS RIPARIAN BUFFERS DOMINATED BY JAPANESE KNOTWEED (*FALLOPIA JAPONICA*)

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Due to federal and state regulations riparian buffers are ubiquitous landscape features across much of the U.S. In Central Pennsylvania, the understory of riparian buffers is increasingly dominated by the invasive shrub Japanese knotweed (*Fallopia japonica*). Due to knotweed's moisture tolerance it does not occupy all of the buffer, creating a gap between the monospecific stand of knotweed and the water's edge. It is unknown if animal communities differ between buffer dominated by knotweed and buffer without knotweed abutting the river. To further our knowledge of this issue we are studying ground spider communities at five points across the buffer gradient. A total of 50 pitfall traps were placed at two sites along the Isle of Que. Ten traps were installed at each habitat type: the field past the buffer's edge, the buffer and knotweed edge, the knotweed-inhabited buffer center, the opposite knotweed edge, and nearest the river. Across this riparian habitat gradient, traps placed in the center of knotweed stands had the least spiders with lowest diversity compared to traps in other regions. Traps placed on the field edge of the knotweed captured the most spiders with the greatest diversity. The pitfall traps are checked after being open both overnight and during the day to observe any differences in nocturnal and diurnal spider diversity, and overall, at least twice as many nocturnal spiders were captured as diurnal. It is expected that spider diversity would be significantly different inside of the knotweed stands than outside in either direction, but diversity would peak at the edges of the knotweed where these habitats overlap. These potential changes in spider diversity can be attributed to factors such as sunlight exposure, proximity to water, and frequency of disturbance.

ASSESSMENT OF AQUATIC INSECT COMMUNITIES IN PASSIVE ABANDONED MINE DRAINAGE REMEDIATION SITES

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In addition to protecting headwater streams from abandoned mine drainage (AMD), constructed passive treatment systems also provide potentially-valuable habitat for aquatic organisms. To determine if these treatment systems create communities similar in diversity to those in unpolluted ecosystems, we compared aquatic insect communities inhabiting AMD remediation sites to those in non-AMD ponds. Our study sites consisted of seven AMD treatment systems and three non-AMD sites located in Cambria and Somerset Counties, Pennsylvania. Each sampled pond was sorted into one of three categories by severity of pollution: High Pollution (AMD entry ponds), Low Pollution (AMD exit ponds), or No Pollution (non-AMD control sites). Insect communities were sampled by sweep net in May and June 2016 and evaluated across pollution category by comparing total number of individuals, family richness, species richness, and species diversity (Shannon index). Species-level taxa were estimated by sorting the individuals by morphotype (recognizable taxonomic units). We found that aquatic insect communities in AMD systems compared favorably to those in natural ecosystems in some, but not all, measures. There were no significant differences across pollution level for either the number of individual insects or for Shannon diversity index values. However, there were significantly more aquatic insect morphotypes (species) and insect families in non-AMD ponds compared to either the high- or low-pollution AMD ponds. Water quality data indicated that our AMD ponds varied substantially across many variables, including pH, conductivity, sulfate, and metal content, and that these measures often did not differ between our qualitative "low" and "high" AMD classifications. Future work will consist of identifying individuals to the species level to replace the uncertainly in using morphotypes, further collection of specimens, and further refinement of data analysis using ordination methods.

CO_2 STORM HYSTERESIS IN KARST SPRINGS

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Studying how the chemistry of karst spring water reacts to periods of increased discharge can provide insights into how these systems store and transmit water. Changes in the partial pressure of carbon dioxide (PCO_2) in karst spring water during storm events, in combination with cation analysis, is helpful in discriminating different water types contributing to flow during storm events. Arrival times of these source waters can be used to infer recharge and flow patterns within karst systems.

Direct field PCO_2 data is difficult to acquire and CO_2 degassing from automatically-collected storm samples inhibits meaningful PCO_2 measurements. To assess CO2 in storm samples, PCO2 values were calculated through solution modeling in PHREEQc using alkalinity measurements, temperature, ion, and pH data. Storm events were captured at Springhouse Spring and Smullton Sinks, located in Centre County, PA, under both dry and wet antecedent conditions. Under dry antecedent conditions, both springs exhibited stable Mg/Ca and PCO_2 values, even after rainfall events. During wet periods, clockwise Mg/Ca hysteresis patterns were observed in storm responses at both Smullton Sinks and Springhouse Spring after rainfall events.

The absence of an observed chemistry change at Springhouse Spring after a rain event during dry antecedent conditions likely indicates that unmixed recharge in small- to medium-sized storm events did not reach the spring. In contrast, similar storm events produced a response at the spring during wet antecedent conditions. This suggests that, given substantially dry antecedent conditions, only baseflow (matrix water) discharges from the spring, even during storm events.

During wet antecedent conditions at Smullton Sinks, one captured storm exhibited clockwise Mg/Ca hysteresis with an initial rise in Mg/Ca, suggesting piston flow. This storm event exhibited counterclockwise PCO_2 hysteresis, supporting the piston flow interpretation with low PCO_2 matrix water arriving at the spring first, followed by high PCO_2 soil/epikarst water. Like at Springhouse Spring, the lack of Mg/Ca or PCO_2 hysteresis at Smullton Sinks after rainfall events during dry antecedent conditions suggests that flowpaths responsible for transporting storm event water to the spring may become inactive during dry antecedent conditions.

PHYSIOGRAPHIC PROVINCES HELP US TO PREDICT BROOK TROUT POPULATIONS

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Brook trout (*Salvelinus fontinalis*) are a native and keystone species in Pennsylvania whose habitat is restricted by land development, water quality, climate change, altering stream channels, and physical obstructions. These can all restrict fish movement in otherwise suitable habitat, but the effect may be different in different parts of the state. We analyzed terrain, soil, land use, and mining and oil/gas drilling record to determine linear relationships with brook trout populations. We generated watersheds in 4 different physiographic provinces within Pennsylvania and predicted populations would vary through different physiographic provinces but would remain fairly similar within the same physiographic province. For the Southeastern USA Plains province, we found that as cultivated cropland increased brook trout population decreased, as the watershed size increased brook trout population decreased, and as forest cover increased brook trout population also increased. These factors are significantly correlated with brook trout population and we hope to develop significant relationships in other physiographic provinces.

SEASONAL CHANGES IN HELLBENDER (*CRYPTOBRANCHUS ALLEGANIENSIS*) ENVIRONMENTAL DNA CONCENTRATIONS IN THE SUSQUEHANNA RIVER WATERSHED

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Worldwide, amphibians are in immense decline, with nearly 1/3 of amphibian species being threatened or extinct. The Hellbender (*Cryptobranchus alleganiensis*) is the largest amphibian in North America and the third largest amphibian in the world. Its populations are currently in decline. It can be found under large rocks in flowing water from the Susquehanna River in Pennsylvania down through the Appalachian Mountains. In the past the only method to find individuals was to lift up a large number of rocks, heavily disturbing their habitat and potentially harming animals. Environmental DNA technology was developed as a non-invasive method to detect and monitor hellbender populations. The technology only requires a water sample, which is then filtered and analyzed using PCR to test for traces of environmental hellbender DNA. We began the eDNA project in 2014 to survey hellbender populations in the Susquehanna River watershed. The technology successfully identified streams that had known hellbender populations, and also indicated the existence of hellbenders in other streams that were not previously known to contain hellbenders. The concentrations of hellbender eDNA peaked in September during the breeding season. We had found that sampling during day or night, temperature, and conductivity did not affect the eDNA concentrations. We continued to collect water samples from various sites along the Susquehanna River throughout the summer of 2016 to better characterize the newly found Hellbender populations through eDNA technology.

COMPARISON OF POPULATION CHARACTERISTICS OF INVASIVE FLATHEAD CATFISH ACROSS THREE REACHES OF THE SUSQUEHANNA RIVER, PENNSYLVANIA.

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There have been no comprehensive surveys to document the current range and population characteristics of Flathead Catfish in the Susquehanna River since their first detection in 2002 below Safe Harbor Dam, Lancaster County, Pennsylvania. In this study we set out to evaluate the population characteristics of Flathead Catfish within three reaches of the Susquehanna River between Sunbury, Pennsylvania and the Maryland border with different presumed degrees of establishment. We randomly selected three segments within each the three larger reaches for comparison. Flathead Catfish were collected using baited, 1.2 m diameter hoop nets fished in tandem with three nets in a series to allow for comparisons with systematic surveys in their native range. Nets were fished for 72 hours each with four series of nets used to characterize each segment with equal effort expended among the three reaches. A portion of the sets within each of the larger reaches were replicated within 7 days of the initial sets to estimate detection probability. In this poster we will compare relative abundance and population characteristics of Flathead Catfish among the three reaches within the Susquehanna River and will discuss implications of future range expansion.

ARE STREAMFLOW REGIMES CHANGING IN THE UPPER DELAWARE RIVER AND SUSQUEHANNA RIVER BASINS?

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The combined impacts of hydroclimatic change and urbanization are widely expected to increase the frequency and magnitude of flooding in the northeast U.S., with potential implications to floodplain mapping, land management, and public policy. Extreme events such as Irene (2011) and Sandy (2012), and the recent updating of FEMA floodplain maps have generated increased public and media attention to climate change and flooding. As part of a senior elective course in hydrology we examined, using a variety of streamflow metrics, a select set of long-term streamflow records from watersheds of varying size in the upper Delaware and upper Susquehanna River basins to assess whether the expected effects of climate change are evident in the data. This poster will report the results of our study, and will illustrate the practical difficulty in identifying the signature of changing climate, given inherently variable rainfall data, nonlinear watershed response to rainfall, varying spatial scales of data, dam construction and flow regulation, and land-use change.

Keywords: climate, land-use, flooding, streamflow

INTEGRATED WATER RESOURCE MANAGEMENT - ONE WATER!

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One Water!

The County Planning Directors Association of Pennsylvania (an Affiliate of the County Commissioners Association of Pennsylvania) is proposing a poster on the topic of One Water! - Integrated Water Resource Management. The CPDAP One Water Task Force has been working on advocacy and policy development for the implementation of the State Water Plan. One of the identified steps in the State Water Plan is to encourage Integrated Water Resource Management. The Co. Planners have produced two important documents and have been working to implement the concepts of One Water at the county level with Data (science) and Policy. To that end we would like to present a poster depicting the data and policy necessary to integrate these important water resource processes into the myriad facets of planning in the Commonwealth.

EVALUATION OF THREE STREAM RESTORATION PROJECTS IN LOYALSOCK CREEK WATERSHED

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During the past 10 years, fish habitat structures consisting of root wads, log vanes, mudsills and other constructed materials have been placed along streams and creeks in North Central PA (Lycoming and Sullivan Counties). Three of the projects in the Loyalsock Creek Watershed have involved monitoring by Lycoming College's Clean Water Institute.

Pre and post monitoring of fish populations and water quality (based on chemistry and macroinvertebrates) were completed along Mill Creek and Wallis Run (Lycoming County) and Elk Creek (Sullivan County), where structures have been added over the past several years. All sites have shown significant increases in trout populations since the installation of the fish habitats, which were designed and permitted by the PA Fish and Boat Commission. Funding for the construction on these projects included Chief Oil and Gas (Elk Creek project), Growing Greener grants to the Rose Valley/Mill Creek Watershed Association(Mill Creek Project)and Anadarko Oil and Gas /North Central Pennsylvania Conservancy (Wallis Run project). Other project partners included Lycoming and Sullivan County Conservation Districts, Loyalsock Creek Watershed Association, PA Fish and Boat Commission.

The Mill Creek project occurred in two phases starting in 2007. Wallis Run was also phased in starting in 2010. The latest project on Elk Creek (two phases in 2015 and 2016) restored habitats that had been destroyed by flooding in the years leading up to and including 2011, when Tropical Storm Lee caused hundreds of millions of dollars in flood damage to residential areas in Pennsylvania alone. In 2015, Phase I on Elk Creek began with 12 multi-log veins. In 2016 Phase II occurred with a 220' mud sill was put in to reduce bank erosion and to also help bring back trout populations.

CATALOGING AND MONITORING MS4 STORM WATER OUTFALLS WITHIN AN URBANIZED AREA OF LYCOMING COUNTY

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During 2015-2016, monitoring, cataloging, and verifying of storm water outfalls, following PA-DEP protocols, within Lycoming County MS4 region was contracted between Lycoming County and the Lycoming College Clean Water Institute (CWI). The urbanized area of Lycoming County consists of 8 municipalities and boroughs. This project was started in 2010, by Lycoming County, to locate and monitor storm water entry points to the West Branch Susquehanna River, and its tributaries, as part of Pennsylvania's commitment to the Chesapeake Bay inititive. Initially, 260 outfalls were located and put into the Lycoming County GPS database. In 2016, Clean Water Institute interns were tasked with locating and verifying outfalls, from previous studies, within the urbanized area of Lycoming County. Using the DEP protocol, each outfall was cataloged based on GPS location, pipe diameter, pipe material, and pipe shape. Outfalls were split between flow or no flow present categories. Flowing outfalls were further analyzed based on odors, floatables, turbidity, and color. Samples were collected at flowing outfalls and analyzed for pH, alkalinity, conductivity and TDS could be measured. All outfalls were assessed for exterior damage, deposits, stains, abnormal vegetation, poor pool quality, and pipe benthic growth. Based on these parameters, each outfall was rated on the potential of it being a site for illegal disposal of contaminants. Overall, 250 outfalls were located and verified for the summer of 2016.

Keywords: MS4, Storm water

WATERDALE ENVIRONMENTAL CENTER – A LINK BETWEEN WATERSHED ISSUES AND EDUCATIONAL OUTREACH

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Located within the Mosquito Creek Watershed in Duboistown, PA, is the historic Waterdale Lodge, which is the center for a cooperative collaboration of public water supply utilities, academic resources, and local and state conservation organizations. The Waterdale Environmental Education Center is a community partnership between the Lycoming College Education and Biology Departments and Clean Water Institute, along with the Williamsport Municipal Water Authority (WMWA). Waterdale is a resource for K-12 education outreach and for college research projects. Educational efforts at Waterdale include scavenger hunts, aquatic macro invertebrate sampling and identification, water filtration plant tour, water monitoring and testing, and demonstrations of the Enviroscape model.

A review of watershed lessons geared for different age groups and a review of 2015-2016 outreach programs will be highlighted. During the summer of 2016, a fully posted and written guide to a nature trail was created from an existing hiking path and surround area and added to the Waterdale curriculum. The nature trail includes 90+ stops and tours a lot of the Mosquito Valley and the grounds owned and operated by the WMWA. The trail works as an arboretum, with a full written booklet/trail guide that has been produced with a map of the trail and information pertaining to each stop along the way, which includes information ranging from the genus species names of the attraction at each stop to interesting but typically unknown facts about each species. The stops along the way are each numbered with postings or hammered on marking onto each site. The trail includes not only tree, shrub, and flowering plant species, but also a tour of the different ecological areas (wetlands, valleys, etc.), but also different signs of animal life, beaver carvings and groundhog dens, just to name a couple.

CONTRIBUTION OF LYCOMING COLLEGE CWI TO THE PFBC UNASSESSED WATERS PROJECT (2010-2016)

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This is the 7th year that Lycoming College CWI has participated with PA fish and Boat Commission in the Unassessed Waters Project. To date, the CWI team has completed a total of 501 streams in the Loyalsock, Lycoming, and Pine Creek Watersheds (about 20% of the total amount of streams sampled for this project). In the past 3 years, streams in the Genesee, Alleghany, White Deer Hole Creek, Black Hole Creek, Quenshukeny, Pine Run, and Antes Creek watersheds, as well as unnamed tributaries in Tioga County have been completed. Data for this project has been logged into the PFBC Unassessed Waters Data set for consideration of trout stream protection. The number of class A, B, C, D, and E streams from each watershed will be presented. On average, 50% of the streams sampled support wild trout and nearly 20% are considered class A or B trout streams. A breakdown of the benefit and limitations of this program will be presented. In addition, a comparison of the Alleghany Plato Region and the Ridge-Valley Plato Region will be done, in terms of supporting trout populations. In 2016, Lycoming College sampled 46 streams in the Lycoming, Pine, and Larrys Creek watersheds. Additional Creeks in the Tioga River Watershed were also sampled.

Keywords: unassessed waters, Lycoming CWI

MOVERS AND STAYERS: WHAT FACTORS INFLUENCE BROOK TROUT MOVEMENT BEHAVIOR?

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Despite decades of research, the cause of individual differences in trout movement behavior remains unknown. In particular, models characterizing movement as a function of habitat quality or fish phenotype fail to fully explain the leptokurtotic distribution that describes the movement behavior of many salmonid populations. This suggests that movement may be a physiological property with genetic control. We completed a multi-season movement study of native brook trout (*Salvelinus fontinalis*) populations in the Loyalsock Creek watershed to determine whether movement can be predicted by fish genotype. Using radio telemetry, we tracked the movements of 166 brook trout in three tributaries to Loyalsock Creek in 2016. A blood sample and gill biopsy were taken from each tagged fish multiple times throughout the study for genomic sequencing and to measure temporal variation in gene expression. We found high individual variability in movement behavior with the majority of fish remaining sedentary, but some making long-distance movements upstream. We will continue exploring genetic correlates to movement and quantify environmental variables that many influence movement behavior. As mobile individuals are less susceptible to the lethal effects of local habitat loss and maintain population connectivity, this finding could have implications for trout conservation and management.

Keywords: brook trout, telemetry, fish movement, behavior

CHARACTERIZING SOURCES OF TURBIDITY IN STREAM SEDIMENT IN THE MARCELLUS SHALE GAS-WELL DRILLING REGION IN CENTRAL PENNSYLVANIA

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Throughout the development of the Marcellus shale infrastructure and industry in Pennsylvania, the impacts and cost-benefit have been vigorously debated. It is important for the public, as well as the science community, to fully understand the impacts Marcellus activities have on the environment. One such concern is a possible increase in stream turbidity caused by an upswing in Marcellus shale infrastructures, including construction and modification of existing gravel roads.

Sediments collected from streambeds, farmlands, stream banks, and gravel roads were analyzed using x-ray fluorescence (XRF) to determine elemental composition. The results were compared using a variety of graphical and statistical methods, such as ternary diagrams, XY scatter plots, and the student's t-test.

A characteristic geochemical signature was created for each landuse by symbolizing the data of the elements, such as Ca, Si, Sr, Al, K, Mn, Ni, and Zn present in the sediment samples. By using the student's t-test, it was determined that stream sediments and gravel road sediments were statistically separated in regards to Mn, yet similar to one another when comparing Al+K, Sr, Si and Ca. However, sediments from streambeds, farm lands, and stream banks were found to be statistically similar when comparing Al+K, Sr, Ca, Mn, and Si, with a 95% confidence level. Based on the graphical representation and statistical differences in elemental compositions between the samples, it appears that gravel roads, farm soil, and stream bank sediments have a similar level of impact on turbidity in receiving streams.

Methods used to determine the sources of stream turbidity in this study will be applicable to identify impacts that landuse and gravel roads have on other waterways.

ANALYSIS OF SOIL GEOCHEMISTRY IN TRIBUTARY ALLUVIAL DELTAS OF THE SUSQUEHANNA RIVER

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Alluvial soils form because of periodic sedimentation during high stormwater events and give a picture of the overall environmental impacts of land use in the watershed. Intensive coal mining operations throughout northeastern Pennsylvania since the 1800's has resulted in erosion and stream transport of contaminants associated with anthracite extraction. Deltaic landscapes at the mouth of large tributary streams to the North Branch Susquehanna River (NBSR) have provided an unknown rate of catchment and long term storage of coal contaminated alluvial sediment. Our goal of this research is to quantify the amount of coal grains and heavy metals within alluvial soils deposited along NBSR deltaic deposits from two streams draining coal mining regions as well as two mixed agricultural watersheds. Six representative deep soil cores (>100 cm depth) were augured within the study deltas to quantify overall coal storage at depth. Ten surface samples (0-10 cm depth) were also extracted from each delta (n = 40) to map the spatial distribution of contaminants in these landscapes. Ongoing X-Ray Fluorescence (XRF) analysis and coal grain counts at 100x magnification are being completed to quantify relationships between heavy metal pools and alluvial coal deposition. Grain counts showed coal contamination extending from modern times (surface deposits) through historical mining periods (deposits at depth). In tributary deltas draining anthracite mining basins the percentages of coal in the sand fraction of alluvial soils ranged from 50-60% in deep horizons deposited during historical mining periods and averaged 5% in the modern surface layers. Results from the mixed agricultural tributary deltas showed between 30-40% coal grains at depth and averaged 2% near the surface. One crucial ecosystem services of these forested deltas is that they continue to trap contaminated alluvium from floodwaters, resulting in storage of coal in the soils of these landscapes.

SPATIAL AND TEMPORAL VARIATIONS IN TRACE METAL CONTENTS IN SALT MARSHES SEDIMENTS IN WALLOPS ISLAND, VIRGINIA

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Salt marshes accumulate sediments and trace metals from sources that are present around them. The continuous sedimentation of salt marshes facilitates analysis of historical changes of the trace metals accumulation. The primary objective of this study was to evaluate the changes in trace metal content of salt marsh sediment in Wallops Island and surrounding areas along eastern shores of Virginia. Several one-foot core samples were collected from salt marshes on Wallops Island, Toms Cove, and Greenbackville. Based on assumed sedimentation rate of 2-3mm per year, this study allowed us to see changes in various metal content in the sediments approximately for the last 120 years. After acquiring our 7 hand augured samples we sliced them into one-inch interval, which represented an 11-year of sedimentation. One inch samples were then visually analyzed by hand looking at the decrease of plant material and, then were analyzed using the XRF (X-Ray Fluorescence) machine for determination of the metal contents. While testing with the XRF the main trace metals of interest we found in the sediments were Lead (Pb), Arsenic (As), and Titanium (Ti). As hypothesized data showed a decreasing trend of metal content towards the surface of the cores. We concluded that this decrease in metal content is due to stricter regulations put on by the government, such as the use of unleaded fuel in motor vehicles and, restrictions of arsenic in certain pesticides.

LONG-TERM TRENDS IN AMD AND MARCELLUS RELATED PARAMETERS IN BEECH CREEK AND CLEARFIELD WATERSHEDS, PA.

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The primary objective of the community-based monitoring projects was to assess changes in water quality parameters in Beech Creek and Clearfield County watersheds in relation to the impact of coal mining legacy and the Marcellus Shale gas-well development. Five samples were collected from the Beech Creek watershed during 2010 to 2016 and five samples were collected from Clearfield County watersheds during 2012 to 2016 on a monthly basis; and were analyzed for various parameters, including, but are not limited to pH, TDS, SO4-2, Fe, and Ba content. These parameters were determined using HACH DR6000 Spectrophotometer and multi-parameter probes.

While the pH values for all locations in Beech Creek and Clearfield County watersheds show a decreasing trend over the study period, the Beech Creek at Monument in the Beech Creek watershed and Stony Run in the Clearfield County watersheds consistently showed the lowest pH values which ranged between 3.2 and 6.5. Of the five locations in the Beech Creek watershed, the Beech Creek at Monument showed the greatest variations in TDS, Ba, SO4-2, and Fe values. The Stoney Run in the Clearfield County watersheds showed the greatest variations in TDS, Ba, SO4-2, and Fe values. The Ba values for four out of five locations in the Clearfield watersheds increased to a value between 10 and 19mg/L during 2014 to 2015. The reason for this sudden increase in Ba values is not fully known, and warrants further investigation.

The history of Marcellus Shale drilling, as well as the legacy of coal mining in the Beech Creek and Clearfield County watersheds appeared to correlate to the fluctuations in the analyzed parameters: however only further study can help determine the underlying causes of those fluctuations.

ACCLIMATION AND CARE OF EASTERN HELLBENDER SALAMANDERS (*CRYPTOBRANCHUS ALLEGANIENSIS ALLEGANIENSIS*) IN A CAPTIVE SETTING

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Few data are available regarding captive acclimation of Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*), large, imperiled, fully aquatic salamanders native to the eastern United States. However, ex situ research may be necessary to evaluate potential causal agents of decline and elucidate unknown aspects of their biology which cannot be adequately assessed in situ, yet are critical for developing effective conservation programs. As part of a conservation-driven ex situ study, we prepared two 8.4 m x 0.8 m indoor raceways at the U.S. Fish and Wildlife Northeast Fisheries Center in Lamar, Pennsylvania in order to temporarily house Eastern Hellbenders. Raceways were lined with natural cobble substrate. Ceramic and slate cover tiles were placed in the raceways to serve as refugia. Raceway water was composed of reverse osmosis water reconstituted to match the chemical characteristics (e.g., pH, conductivity) of the hellbender source stream. Raceways were subjected to natural light cycles via large windows, and a pumping system generated a current down each raceway. Native fish were placed into raceways several weeks prior to hellbenders to establish a nitrogen cycle. Water quality including ammonia, nitrite, and nitrate levels was monitored and maintained via biweekly 30% water changes. Following the preparation of raceways and with a permit from the Pennsylvania Fish and Boat Commission, in May 2016 we collected four Eastern Hellbenders measuring 29.7 cm, 35.7 cm, 42.0 cm and 45.0 cm total length (TL) from a tributary of the Susquehanna River in eastern Pennsylvania and placed the two larger hellbenders together and the two smaller hellbenders together in each of the raceways. We monitored feeding behavior and weight as proxies for acclimation to captive conditions. Hellbenders were provided with prey items (e.g., crayfish, earthworms) and allowed to feed ad libitum. Fish and prey organisms were subjected to species-specific decontamination protocols, established by the St. Louis Zoo, prior to deposition into the raceways. Hellbenders were observed to begin feeding and pursuing prey after two weeks in captivity. By week six, hellbenders had lost an average of 5% of their weight from the week of capture. By week ten, all hellbenders weighed within 1-2% of their capture weights, suggesting acclimation had occurred within this time period. Smaller individuals gained weight faster than larger individuals, suggesting a shorter acclimation period for small size classes. These data and observations suggest an approximately ten-week acclimation period for Eastern Hellbenders. Closely matching water quality (e.g., pH, conductivity) and physical (e.g., flow, substrate) parameters of the hellbender source stream, as well as collection of Eastern Hellbenders near the beginning of a season of increased feeding and activity, may have facilitated a relatively rapid acclimation period for *C. alleganiensis*. Our results suggest mimicking the source stream conditions and timing transfer into captivity with seasonal activity periods may facilitate conservation research and programs that require temporary or long-term maintenance of captive Eastern Hellbender populations.

ASSESSING VARIOUS ANTHROPOGENIC IMPACTS IN SMALL STREAMS WITH DIATOM NUTRIENT AND AMD GUILDS IN CAMBRIA COUNTY, PENNSYLVANIA

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Diatoms and water chemistry were collected from four small streams in Cambria County, Pennsylvania. The streams were affected by a range of anthropogenic sources such as waste water treatment and acid mine drainage. Diatoms were identified to species level and placed into indicator guilds for nitrogen, phosphorus, and acid mine drainage (AMD). It was hypothesized that diatom guilds would correlate with their respective environmental variables despite the small sample size. However, this did not happen as water chemistry correlated weakly with diatom nutrient and AMD guilds. Nitrate and pH did have a significant negative correlation with species richness and diversity which these variables may have inhibited diatom composition. A more rigid sampling regiment may resolve these issues, while this study can provide a basis for monitoring both nutrient and AMD pollution in Cambria County streams.

BROOK TROUT POPULATION RESILIENCY TO CATASTROPHIC LATE SUMMER FLOODS.

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There are few studies on the effect of natural stochastic events such as flooding on salmonid populations because these events are unpredictable and systematically challenging to study. Severe flooding events from hurricanes and tropical storms are likely to increase under climate change; thus, understanding how these events impact salmonid populations is important for understanding vulnerability. The Loyalsock Creek watershed (Pennsylvania, U.S.) experienced extreme flooding in early September 2011, as over 250 mm of rain fell and peak flows exceeded the previous records. To evaluate brook trout (*Salvelinus fontinalis*) population responses, one year of pre-flood data was compared to four years of post-flood surveys in 30 streams. Brook trout density varied substantially across years with pronounced differences between age classes, with the summer after flooding having a 23-fold increase in young-of-year (YOY) brook trout density and an adult density decrease of one-half. Overall density increased significantly, and a high density was maintained for the duration of the study following the flood. Changes in stage-specific biomass mirrored those of density, with a 46-fold increase in YOY biomass density after the storm and a 40% decrease in adult biomass density. However, increases in YOY biomass were offset by declines in adult biomass, such that overall biomass density did not differ significantly among any study years. Results indicate that density-dependent recruitment makes brook trout highly resilient to late summer/fall floods even when mortality rates are high. Strong compensatory reproduction suggests that brook trout are well adapted to short-term stochastic disturbances. Given the proper conditions and timing of catastrophic flooding events, brook trout can quickly rebound from short-lived late summer/early fall events.

SUSQUEHANNA UNIVERSITY AND THE PFBC UNASSESSED WATERS INITIATIVE IN THE SUSQUEHANNA BASIN 2011-2016

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Since 2011 Susquehanna University has been a partner of the Pennsylvania Fish and Boat Commission's Unassessed Waters Initiative. This cooperative program between the PFBC and colleges and universities seeks to collect biological data on previously unsampled (unassessed) streams across Pennsylvania to determine their status as possible new Wild Trout streams. Prior to this program which began in 2010, only 8% of the 62,725 streams across Pennsylvania had been sampled for biological data by the PFBC. Since 2011, we have surveyed almost 700 previously unassessed waters as part of the program. Sample sites have been predominately across north central Pennsylvania including the following major watersheds: Loyalsock Creek, Schrader Creek, Lycoming Creek, Buffalo Creek, Penns Creek, White Deer Creek, First Fork Sinnemahoning Creek. We have found wild trout (brook and brown trout) in ~ 50% of the streams, thereby increasing the environmental protection these streams are afforded by the state. The Unassessed Waters Initiative has led to the designation of almost 1000 new wild trout streams across the state, with many more to be added in the future.

MOVEMENT DYNAMICS AND POPULATION GENETICS OF SMALLMOUTH BASS IN THE SUSQUEHANNA RIVER BASIN

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Smallmouth bass (*Micropterus dolomieu*) are an important sportfish within the Susquehanna River basin that have had a recent history of documented fish health problems and endocrine disruption. In addition to studying the many potential risk factors associated with disease and endocrine disruption (e.g., bacteria, parasites, contaminants), it has also been the goal of researchers and managers to gain a broader understanding of ecological and genetic attributes of smallmouth bass within the Susquehanna River Basin. This may help provide insight into understanding relationships between various risk factors and fish characteristics (i.e., exposure to contaminants, connectivity of fish within the system). To accomplish this goal, radio-telemetry and population genetics were used to investigate ecological and genetic structuring. Radio-telemetry was used to investigate movement of smallmouth bass in a section of the West Branch of the Susquehanna River and two tributaries. Radio-tagged smallmouth bass used river and tributary habitats for varied life history needs including spawning and overwintering. Fish were also capable of long-range movements upwards of 30 miles to reach various habitats, although movement patterns between fish were variable. To investigate genetic structure of smallmouth bass across the Susquehanna River Basin, fin clip samples were collected from 24 sites within the Susquehanna River Basin and one out of basin site during spring 2015. These sites included both river and tributary sites, but encompassed a larger study area than the telemetry study. In general, a lack of genetic differentiation within the Susquehanna River Basin was found (mean pairwise FST =0.01, 29% pairwise comparisons significant). The out of basin site was the most different genetically from the Susquehanna River sites (mean pairwise FST=0.07). The combined results of the telemetry and the genetic research demonstrated that fish interactions may be occurring at different scales, including more localized ecologically defined groups during spawning and overwintering, and a broader lack of genetic structure where admixing or straying may be occurring across a larger area.

IDENTIFICAITON AND ANALYSIS OF TWO NOVEL CYANOBACTERIA FROM LOCAL WATER

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Two novel, chromatically acclimating, freshwater cyanobacteria, strain RC610, and another strain strain SR411 were collected and isolated from local water sources, Roaring Creek in Pennsylvania in 2010 and the Susquehanna River in 2011; these strain have not been previously characterized. Theses strains were isolated from separate environmental samples and cultured in the lab. Through a combination of observed physical characteristics (such as cell shape, filament length and color changes) and genetic similarities (based on whole genome shotgun sequencing) to known species, we classified and named the strains for the genus and the location where each strain was collected. We cataloged the genomes in the NCBI database and this information is available for public use. We are currently conducting a similar analysis for SR411. We are analyzing and annotating the genomes using the online RAST server. RC610 and consists of 5,478,524 base pairs and contains 5546 putative coding sequences (potential genes). Of these 5546 potential coding sequences, 3 have been identified as potential sensor kinases, which detect changes in ambient light wavelength to allow the organism to alter pigment composition of its light-harvesting antenna to optimize photosynthesis in its aquatic environment. Experimental findings (measuring the ratio of pigments in cells) are used to classify the chromatic acclimation abilities of the strains. This ability is not common to all cyanobacterial strains. These findings provide a strong foundation for future work on this species as well as expanding our knowledge of the aquatic microbes that inhabit our water sources.

Keywords: Cyanobacteria, Genome , Chromatic Acclimation, Microbes

MEASURING VARIATION IN THE MACROINVERTEBRATE POPULATION OF A HEADWATER STREAM: MAY - SEPTEMBER 2016

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The presence and/or absence of specific macroinvertebrate species has been widely used as a surrogate for determining water quality in Pennsylvania (Hussain 2012). Mansfield University students are beginning a long term macroinvertebrate study of regional streams. However, before using one-time sample collections to investigate local water quality we must first determine the natural seasonal variation for individual species and the overall macroinvertebrate population structure. To this end, macroinvertebrates were collected from Mill Creek, a 3rd order tributary to the Tioga River, located in the headwaters of the Susquehanna River watershed. To date three population samples have been collected from the same location on Mill Creek (May, July, and September of 2016). Field methods, laboratory methods and specimen identification and analysis followed the Pennsylvania Department of Environmental Protection's protocol for freshwater wadeable streams (PADEP). Noticeable differences from May to July include a 29% decrease in Mayfly populations, a 69% decrease in stonefly populations, a 1007% increase in water penny populations and a 39% increase in non-biting midges. Analysis is currently ongoing.

References: Hussain, Q. A. (2012). Macroinvertebrates in streams: A review of some ecological factors. International Journal of Fisheries and Aquaculture, 4(7):114-123., PADEP. 2015. An Index of Biotic Integrity for Benthic Macroinvertebrate Communities in Pennsylvania's Wadeable, Freestone, Riffle-Run Streams. Pennsylvania Department of Environmental Protection, Bureau of Clean Water, Harrisburg, PA.

Keywords: Macroinvertebrates, Headwaters, Seasonal Variation, Pennsylvania

CHARACTERIZATION OF A NOVEL CYANOBACTERIUM ISOLATED FROM THE SUSQUEHANNA RIVER

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Cyanobacteria are important primary producers in aquatic ecosystems. They are oxygenic photosynthetic bacteria and use light harvesting structures called phycobilisomes. Phycobilisomes are light harvesting antenna that, in some species, are altered to best absorb the light wavelengths available. In an aquatic system, scattering, depth and competition can alter the wavelengths available for photosynthesis. Red light (RL) is important to photosynthetic organisms as it is used by chlorophyll to generate ATP. Thus, RL can be a limiting resource in a competitive environment. Organisms able to capture other wavelengths of light and transfer that energy to chlorophyll in the reaction centers, have a fitness advantage over organism only able to use RL. Some cyanobacteria produce a protein, phycoerythrin, that is able to absorb green light (GL) wavelengths. In times when RL is limiting, these organisms can use GL to maintain photosynthetic efficiency. In a shallow water system like the Susquehanna, competition likely is the predominate factor influencing the use of phycoerythrin as depth will not cause reduction in RL availability. Our questions include: are phycoerythrin producing cyanobacteria present in the Susquehanna? What proportion of cyanobacteria in the Susquehanna produce phycoerythrin? What individual strains of cyanobacteria can be isolated from the Susquehanna? We are currently focusing on the last question. During the summer of 2016, five cyanobacterial strains were isolated from the Susquehanna at the Bucknell Landing in Lewisburg. Cyanobacteria that produce phycoerythrin were chosen for further characterization. Here we present a first characterization of strain SR616C,a filamentous, phycoerythrin producing cyanobacteria.

Keywords: cyanobacteria,

BIOLOGICAL EFFECTIVENESS OF INSTREAM RESTORATION

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Agriculture impacts stream ecosystems through a variety of means including increases in sedimentation, increased runoff of pesticides and nutrients all of which can create changes in stream habitats, as well as shifts in fish and benthic macroinvertebrate assemblages. In recent years, however, many farmers have become open to changing farming practices. In conjunction with the Montour, Northumberland, Snyder and Union County Conservation districts, seven local farmers agreed to have riparian habitat restoration projects constructed on streams that run through their property. In order to test the biotic response to the restoration process, we conducted pre-restoration sampling in summer 2015, and post restoration sampling in summer 2016, with another post restoration sample to be conducted in summer 2017. Stream assessments consisted of benthic macroinvertebrate sampling according to Pennsylvania Department of Environmental Protection protocol, backpack electrofishing of a 100 meter site, and collection of standard water chemistry data. After the restoration process was complete, a one-year post restoration sampling was conducted yielding positive increases in overall fish populations at sample sites. Overall fish populations increase at Little Shamokin Creek (163.6%), Turtle Creek (50.9%), Limestone Run A (190.3%), Limestone Run B (69.6%), and Limestone Run C (134.05%). With an increase in riparian buffers and increased retention of stream bank sediment, the streams are seeing a positive increase in stream biota due to likely decreases in sedimentation, and increases in habitat.

Keywords: Instream Restoration, Fish Assemblage, Benthic Macroinvertebrates, Biotic Response

MACROINVERTEBRATE RECOVERY: A STUDY OF BRADLEY RUN AN IN-SITU CO-TREATMENT OF ACID MINE DRAINAGE AND MUNICIPAL WASTE WATER

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Bradley Run, a small stream located near Gallitzin, PA is impacted by an acid mine drainage (AMD) discharge which is nearly adjacent the effluent of a poorly functioning municipal waste water (MWW) treatment plant. This situation has led to an opportunity to study in-situ co-treatment of AMD and MWW. The Center for Watershed Research and Service (CWRS) at Saint Francis University has been studying the water quality of Bradley Run for 3 years now via teams of undergraduate students overseen by tenure-track faculty and a postdoctoral researcher in the context of summer research experiences and the environmental engineering field measurements class taught on campus. The research mainly focused on the chemistry occurring in the stream. During the month of May 2016, CWRS funded student research to examine that macroinvertebrate population in four locations, varying in distance from the MWW and AMD discharges, including an upstream reference location. Macroinvertebrates and water quality data was gathered on five different dates and analyzed. The macroinvertebrates were counted and water quality scores were calculated for each site per sampling date, as well as an overall average for each site. On average the upstream and culvert locations had a fair water quality score (20 to 40), while the pole line and bridge locations averaged at a fair score (<20). While it appears that the stream recovers quickly based on the data collected, more research needs to be completed to get a definitive answer on the quality of Bradley Run, especially at the pole line and bridge locations.

Keywords: Macroinvertebrates, Acid Mine Drainage, Municipal Waste Water , Co-Treatment

THE EFFECT OF TEMPORAL CHANGES IN PHOSPHOROUS SUPPLY ON STREAM BIOFILMS

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The effects of phosphorous (P) on freshwater systems is well-studied. However, the influence of storm runoff, sediment dynamics and autotrophic and heterotrophic microbial metabolism on the P cycle in streams and rivers is poorly understood. The focus of this project was to evaluate how potential indicators of P limitation in stream biofilms in Fishing Creek near Bloomsburg, Pennsylvania respond to temporal changes in P supply. We measured alkaline phosphatase activity, P uptake, biofilm polyphosphate concentrations, biofilm total P, chlorophyll fluorescence, and water column P concentrations twice a week throughout the summer of 2016. Preliminary results indicate a correlation between these indicators of the phosphorus limitation and changes in phosphorus supply associated with drought and local storm events.

Keywords: Phosphorous limitation, freshwater biofilm, Phosphorous fluctutations, microbial metabolism

A MICROBIOME ANALYSIS OF THE WEST BRANCH SUSQUEHANNA RIVER AT LEWISBURG

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The West Branch of the Susquehanna River is considered a highly impacted water source due to a long history of agriculture, logging, and mining. As a result, there have been major implications on the community of microorganisms that inhabit the river. Since microorganisms are extremely susceptible to their environment, we expect to see variable community compositions that are dependent on spatial-temporal factors along the river. Just upstream of Bucknell Landing, Buffalo Creek, a water source heavily influenced by agricultural runoff and limestone deposition, runs into the west bank of the river. On the east bank a water treatment plant also influences the river composition. We sampled surface water and sediment from Bucknell Landing at three locations across the river over a 4-month period between June and September and isolated the environmental metagenomic data of microorganisms. While sampling we measured pH, dissolved oxygen, temperature, conductivity, and salinity. We found that a temporal scale seems to have the greatest influence on the diversity of microorganisms across the surface water and river sediments of the West Branch of the Susquehanna River as compared to spatial samples. We see relative similarities in the phylum data across the west bank, middle channel, and east bank at particular sampling periods rather than similarities in location across sampling periods. There is very little data on the community structure of microorganisms in both branches the Susquehanna River as it is generally overshadowed by work done in the downstream Chesapeake Bay. Our findings can instruct further investigations of the watershed including the spatial and temporal variability of microorganisms in the longest non-navigable river that has been heavily impacted throughout its history including damming, agriculture, logging, acid mine drainage, and hydraulic fracturing.

THE EFFECT OF ABIOTIC FACTORS ON THE DENSITY OF JUVENILE AND ADULT TERRESTRIAL SALAMANDERS IN FORESTS OF THE NORTHEASTERN UNITED STATES

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Terrestrial salamanders of the order Caudata are typically found in deciduous and coniferous forests in the northeastern United States. Previous studies have shown that terrestrial salamanders prefer cool, moist habitats and are normally found under cover objects including leaves, logs, and rocks. However, few studies have examined the specific relationships between abiotic factors and the density of salamanders in different stages of growth (juvenile vs. adult). Thus, our study focuses on these relationships. We hypothesize that a higher density of adult salamanders will be present farther away from the stream while juvenile salamanders will be found at a higher density closer to the stream, where temperatures are likely to be cooler and the soil more moist. To test our hypothesis, we will sample salamanders under natural cover objects on transects oriented parallel to a stream at increasing distances at State Game Lands 212 in Selinsgrove, PA. On each transect, we will measure several abiotic factors (soil temperature, soil moisture, air temperature, humidity, and light exposure) to examine how these factors influence species composition and the density of salamanders in different life stages.

Keywords: salamander, density, abiotic, moisture

AN INVESTIGATION INTO THE ROLE OF GROUNDWATER AS A POINT SOURCE OF EMERGING CONTAMINANTS TO SMALLMOUTH BASS IN THE SUSQUEHANNA RIVER BASIN.

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Since 2005, high young-of-year natural mortality rates and declines in adult indices of abundance have been observed in some smallmouth bass populations in the Chesapeake Bay Watershed, and specifically in the Susquehanna River Basin. Endocrine disrupting compounds (EDCs) are hypothesized to be a contributing factor to the observed population dynamics. In order to better understand these compounds in the environment and their effects of fish populations, further research is needed into exposure pathways. In particular, there is a paucity of information on the role of groundwater as a source of EDCs for aquatic organisms. In fact, current research at river sites throughout the Chesapeake Bay Watershed, including in Pennsylvania – where surface water, stream sediment, and adult/young-of-year smallmouth bass are sampled for contaminants - led to the hypothesis that groundwater could be a potential exposure pathway for EDCs. Therefore, the objective of this research was to investigate the role of groundwater as a point source of emerging contaminants to smallmouth bass in the Susquehanna River Basin. Using thermal cameras to locate areas of groundwater upwelling, we sampled groundwater using drive-point piezometers from two sites in Pennsylvania . Samples were taken weekly starting before the smallmouth bass spawning season and continued for 15 weeks throughout the summer. As an initial water chemistry analysis, total estrogenicity was quantified through a bioluminescent yeast estrogen screen to use as an indicator of the presence of estrogenic EDCs. Surface water total estrogenicity samples were also taken at these sites to compare with the groundwater samples. Preliminary analyses suggest that groundwater samples may be an important pathway of exposure, especially given the use of these areas for spawning by smallmouth bass.

Keywords: Emerging Contaminants , smallmouth bass, ,

THE EFFECTS OF ESTROGEN, PROGESTERONE, AND TESTOSTERONE ON ZEBRAFISH CAUDAL FIN REGENERATION

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Regeneration is one of the most prominent areas studied in zebrafish (*Danio rerio*) due to their natural ability to regenerate their fins. Interestingly, studies have shown steroid hormones can affect the rate of regeneration. It was demonstrated that glucocorticoids were sufficient at blocking caudal fin regeneration. However, it remains unknown the effects of other steroid hormones on fin regeneration. Due to the high use of contraception that contains estrogen and/or progesterone and increasing use of testosterone in males to treat erectile dysfunction these hormones have been found in wastewaters. It has been reported the levels of these hormones in streams near urban environments are increasing. Therefore, this project investigates the effects of estrogen, progesterone, and testosterone on caudal fin regeneration. The zebrafish are housed in 1 liter tanks with increasing levels of estrogen: 0 ng/L, 1 ng/L, 5ng/L and 10 ng/L. These levels are similar to those found in urban waters. Caudal fin amputation of the fish is achieved by using a scalpel under the effects of the anesthetic and then placed into treatment tanks. Regeneration was measured by growth of caudal fin using a Leica E24HD stereomicroscope each week. Caudal fin regeneration was complete after the third week. Preliminary results suggest increasing amounts of estrogen retard the regeneration rates of the caudal fin. More trials must be completed to determine if this delay in growth is statistically significant. Furthermore, future studies will determine if progesterone and/or testosterone play a role in caudal fin regeneration.

MEDIA-FACILITATED IRON OXIDIZING BIOREACTOR FOR ACID MINE DRAINAGE TREATMENT

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Treatment of Acid Mine discharges in mountainous terrains are limited by available space, often excluding active bacterial remediation methods. Vertical flow treatment pond sediments were isolated using selective media for iron oxidizing bacteria. Following aerobic and facultative anaerobic conditions, an MES and ferrous sulfate iron assay identified twenty-two morphologically unique iron oxidizing bacteria, eight of which produced strong oxidative responses. DNA was sequenced for the eight using sanger sequencing. Following an analysis in BLAST, two sequences were identified as having similarity to *Pseudomonas spp*. A RAST analysis of the species with the highest percent identity to the iron-oxidizing isolates showed multiple genes utilized for iron acquisition and metabolism. Bioreactors were inoculated with a nutrient broth to supplement nutrient inputs in the microbial community. Treatments supplemented with broth produced similar pHs and some produced a lower specific conductance than other compost treatments.

Keywords: Acid Mine Drainage, Microbial Bioremediation, water quality,

ARE FOREST ROADS AND STREAMS BARRIERS TO THE MOVEMENT OF RED-BACKED SALAMANDERS (*PLETHODON CINEREUS*)?

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Landscape features such as roads and streams can inhibit movement of species with poor dispersal capabilities and high sensitivity to habitat alteration. Terrestrial salamanders are generally thought of as incapable of long distance movements. However, records indicate that individuals will travel up to 90 meters to return to their territories. Different sexes and size classes of salamanders may vary in their motivation to move across a landscape. Our study examines whether forest roads and streams are potential obstacles in the movement of red-backed salamanders (*Plethodon cinereus*). The red-backed salamander is abundant and widely distributed, and behaviorally and physiologically similar to other terrestrial salamander species. We began an experimental study at Camp Karoondinha in Millmont, PA in June 2015 to quantify recapture rates of P. cinereus after displacement across roads and streams. We use displacement as a method for understanding the movement capabilities of salamanders to navigate different distances and across barriers through forest. All salamanders collected within six plots (40 coverboards each) were marked using visible elastomer and then assigned to either the control (placed under the same coverboard) or a treatment (displaced 25 or 50 m through either the forest or across a stream or road). Of our current sample size (192 marked individuals), 23% have been recaptured. Approximately 39% of individuals in the control, 26% displaced 25 and 50 meters into the forest, and 16% and 8% displaced over a barrier, 25 or 50 m respectively, were recaptured in their original cover board plot. Our results suggest that P. cinereus are capable of moving across barriers but return rates are reduced with greater distance and when an obstacle is present. We expect to continue our study until summer 2017 and then compare return rates across treatments, sexes and size classes to better understand how landscape permeability affects terrestrial salamander movement.

Keywords: salamander, movement, displacement, landscape permeability

EXAMINING SOIL INVERTEBRATE POPULATIONS TO BETTER UNDERSTAND THE IMPACTS OF CLIMATE CHANGE ON TERRESTRIAL SALAMANDERS

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Climate change is an increasingly prevalent topic as it affects species globally. Amphibians may be especially sensitive to climate change because of their specific habitat requirements. Invertebrates are the primary food source for terrestrial salamanders and a decline in their populations could initiate a trophic cascade, leading to a decline in salamander abundance. At Camp Karoondinha in Millmont, Pennsylvania, we examined the abundance and diversity of terrestrial soil invertebrates in an artificial climate change scenario. By studying invertebrates, we can gain an understanding of both the effects of climate change on terrestrial salamanders, specifically the red-backed salamander (*Plethodon cinereus*). Our study site is composed of nine plots with cover board arrays where we have examined the demography of *P. cinereus* since 2013. In three of the nine sites, we applied a snow removal treatment to imitate potential impacts due to climate change anticipated in the northeastern U.S. We collected three leaf litter and soil samples from each site in spring and fall 2015 and processed the samples in Berlese funnels to collect invertebrates. We quantified the invertebrates and identified them to class level (*Collembola*, *Diplopoda*, etc.). We also used gastric lavage to collect the stomach contents of *P. cinereus* in order to determine which invertebrates serve as their primary food sources. We found no significant differences in invertebrate abundance and diversity between snow removal and control sites from spring and fall 2015. Spring 2016 samples have been examined and fall 2016 sampling is in progress. The gastric lavage results indicate that the invertebrates consumed by red-backed salamanders are similar in composition to those found in the leaf litter. We expect our results to provide insight into how climate change will impact terrestrial salamanders in northeastern U.S. forests.

Keywords: soil invertebrates, climate change, salamander, diet

ANALYZING THE ABIOTIC FACTORS THAT CONTRIBUTE TO RED-BACKED SALAMANDER GROWTH

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Red-backed salamanders (RBS, *Plethodon cinereus*), are a terrestrial species found in moist cool soils throughout eastern North America. Within these terrestrial areas, many abiotic factors contribute to the growth of RBS, such as soil temperature, soil moisture, soil pH, air temperature, and the light environment. Our study explores the relationships between these abiotic factors and salamander growth. We are quantifying these abiotic variables at 15 forested cover board plots at Camp Karoondinha located in Millmont, PA. Simultaneously, we are quantifying growth by measuring and marking each RBS found at these plots from March to December 2016. We expect that abiotic factors will impact RBS growth, with faster growth in sites that have cooler temperatures and moist soils.

Keywords: Red-backed salamanders, abiotic factors, salamander growth,

ANALYSIS OF SUSQUEHANNA RIVER WATER FOR METALS USING GRAPHITE FURNACE ATOMIC ABSORPTION SPECTROSCOPY

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The concentrations of several metals (cobalt, lead, barium, iron, copper, and zinc) in samples from the Susquehanna River collected over several months were determined. Through serial dilution, standards were prepared and analyzed via furnace mode (zinc by flame) by atomic absorption spectroscopy to generate calibration curves, which were then used to calculate the concentration of the target metals in the river water samples. There was only one detectable concentration of cobalt in the samples evaluated, and only the digested samples yielded any detectable concentration of lead, but most of the others were below the lowest standard. Each sample displayed some concentration of barium, all within the range of the standard solutions. Likewise, each sample showed some concentration of iron. For copper, no accurate results were obtained because a strong correlation could not be produced at the ppb level using the furnace mode. Samples were also evaluated for zinc at the ppm level using flame atomization, however no sample produced an appreciable concentration.

Keywords: metals, atomic absorption, river water,

LINKING PATTERNS IN ENDOCRINE-DISRUPTING COMPOUNDS TO STORM DISCHARGE AND YOY SMB HEALTH IN THE UPPER JUNIATA RIVER WATERSHED

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Population declines and disease incidence in smallmouth bass (*Micropterus dolomieu*) in the Susquehanna River basin have been linked to endocrine-disrupting compounds (EDCs) as a likely causative agent. Nothing is known about this link in the upper Juniata River basin and how EDCs patterns may vary with hydrologic conditions. Consequently, we sampled water in the basin for EDCs across a range of discharges to identify possible connections between storm flow and spikes in EDC concentrations. We surveyed young-of-the-year (YOY) smallmouth bass populations, collected information on their diet, and recorded incidence of disease as well. We found high variation in EDCs concentrations (measured as total estrogenicity) at the site level and across the watershed. EDC concentrations varied with discharge. YOY smallmouth bass were in excellent condition and sustained very few abnormalities. Nearly all individuals had abundant prey items in the stomach. Much of this study is still on-going, including histopathological analysis of fish, but early indications suggest that EDCs are present in quantities that should be considered important for addressing smallmouth bass anomalies in the broader Susquehanna River basin.

TOWARDS SEASONAL OPTIMIZATION OF THE BUFFALO CREEK ACID PRECIPITATION TREATMENT SYSTEM (BCAPTS) IN UNION COUNTY, PENNSYLVANIA

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Acid deposition occurs when acids drop from the atmosphere to the ground's surface. Gases and ions such as sulfur dioxide, nitrogen oxide and ammonia are transferred to Earth's surface though wet and dry deposition, primarily acid rain. Pennsylvania, specifically Buffalo Creek in Union County, suffers from acid deposition due to fossil fuel combustion products carried by prevailing winds. Some sandstones underlying headwater streams are not efficient in self-remediation. In 2009 a passive, limestone based treatment system (BCAPTS) was implemented to add alkalinity, raise pH and lower Al concentrations in the stream. After startup, downstream sites show a pH upwards of 7 with Al levels less than 0.1 mg/L. Sites upstream show a pH of around 4, and Al levels at 0.2 mg/L. These data, which suggest the BCAPTS is working well, were primarily collected in late spring and early summer. This study attempts to optimize the system's efficiency in a wider variety of hydrological conditions. One pressure transducer and three stage boards were installed to monitor the stream's water levels. Titrations were performed to determine alkalinity concentrations. A hydrologic rating curve was developed to show relationships between influent and effluent stream height and alkalinity loading. Additionally, a relationship between vertical flow wetland (VFW) standpipe height and alkalinity loading from the system was developed to determine the best VFW residence time for alkalinity optimization. Surveying of hydraulic head differences within the system and differential equation modeling to predict flow rates in the system were used to give preliminary predictions on how changing hydrologic conditions will aid or hinder the system. Combining analysis of these results will allow synthesis of various factors that contribute to an optimal treatment system. These findings will provide a basis for future alkalinity optimization of BCAPTS.

IN SEARCH OF DATA - FISHING CREEK HYDRO WATCH SUMMER 2016

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The Fishing Creek Hydro Watch project spent Summer 2016 acquiring information to form the basis of a hydrologic monitoring and flood forecasting system for Fishing Creek in Columbia County, PA, a flood prone but data-poor watershed. Precipitation data from a variety of sources in and around the watershed, including personal weather stations, were downloaded and tidied up in preparation for precipitation pattern analyses. Stage-only data from two USGS gages were compiled. Discharge data collection at three staff gage locations continued in order to develop ratings curves and to track stream response to precipitation events. The staff gages now have instructions which allow citizen scientists to text water level data to a publicly viewable webpage. In addition, a wide variety of geologic, topographic, geographic, and hydrologic data were assembled in a GIS-based hydrologic atlas.

Keywords: Fishing Creek, flooding, staff gage, Columbia County

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

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Headwater streams are an important part of the river continuum and make up for more than 90 percent of the streams within a major rivers watershed (Leopold et al. 1964). Little is known about headwater streams and their impact on larger stream systems. The headwaters of Penn's Creek provide clean water to a large river system and increase Penns creek's volume as it makes its way to the Susquehanna River. To understand the impact of these headwaters, a study was conducted along the same elevation of four headwater streams and longitudinally along Green Gap: one of the 4 streams. All four streams are located on the northern versant ranging from beginning to end over the same elevations. In addition, the 4 streams flow over the same geological outcrop formations. Grab samples and physical data were performed onsite and long term data was completed by sondes, pressure transducers and temperature loggers. Chemistry of the streams was analyzed using Piper Diagrams, and Stiff Diagrams. Water quality was assessed using Water Quality Index (WQI). The Piper Diagrams indicated that the streams were a bicarbonate type water while the stiff diagrams analyzed the change in the water chemistry down the slope. Transversal (data from the 4 streams along the same elevation) analysis showed similar analysis which prove that the baseflow were originated from similar formations. Longitudinally the pH (5.2) of the stream at the spring indicated that the $CaCO_3$ was in a lower concentration and the water was not gaining $CaCO_3$ from the sandstone formations. However as the water flow downstream, the geology changed to a shale formation releasing $CaCO_3$ and neutralizing the high bicarbonate water to a pH of 6. Diagrams showed that the streams were high in calcium and Magnesium, which characterize water in this type of geological formations.

LAKE BATHYMETRY ANALYSIS OF PECKS POND IN PIKE COUNTY, PA USING GROUND PENETRATING RADAR AND GEOGRAPHIC INFORMATION SYSTEMS.

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Pecks Pond is an anthropogenic recreational lake that is planned for a drawdown of its water and a reconstruction of a new earthen dam. The lake is located in Pecks Pond, Pennsylvania which is in the center of Pike County, south of route 84. Several studies have been completed prior to the restoration scheduled for September 2016. In this study, a bathymetry was carried out as a one of the approaches for evaluation and assessment. Prior to the drawdown of the pond, we used the Ground Penetrating Radar (GPR) with 400 MHz antenna to identify the depth of sediments, as well as locating the bedrock. Data was combined with Lidar data in ARCMap and ARCScene to create a three dimensional model. A number of Georadar transects have been taken and several observations were made to assess the magnitude of the sediment along these transects. The bathymetry of the lake was conducted to identify the depths of sediment and its relationship to the aquatic invasive vegetation that is becoming excessively populating the entirety of the lake which caused eutrophication of the lake. The drawdown is expected to eliminate or limit future growth of vegetation. In addition, the study focused on pairing GPR surveys with GPS for georeferencing to achieve accurate bathymetric. Surveys were taken parallel to the dam and spillway that identified an area of depression that would represent a stream before the dam and lake were created. This area of depression led directly to the spillway of the dam, which is planned to be expanded. Future transects will be taken for ground-truthing once the drawdown has ended and also right after the new dam is put into place.

WHAT IS THE BEST WATER QUALITY INDEX (WQI) TO ASSESS HEADWATER STREAMS?

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Water quality index (WQI) uses many weighted, measurable parameters to give one number to express the quality. The quality of the five Penns Creek headwaters in Bald Eagle State Forest, PA were assessed using different WQI. Data was collected from June 2015 to July 2016. One site from each of the streams was evaluated. The main collection of data was from an Ion Chromatography System and YSI multimeter. The comparison of five water quality indices using similar and different equations and parameters was summarized and

	Henstep	Coral	Lick	Green Gap	Little Weikert
WQI_1	84.23	84.61	85.77	86.54	84.23
WQI_2	85.81	85.16	88.06	89.35	87.74
WQI_3	100.00	100.00	100.0	100.00	100.00
WQI_4	87.19	86.88	89.06	88.75	88.13
WQI_5	82.00	80.00	80.00	82.00	80.00

conclusions were drawn.

All of the numbers fall under the category of "good water quality" to "excellent water quality". All numbers in the second index are greater than the first because the second includes more ion concentrations. The third is the highest because it includes only simple, positive parameters. Index 4 and 5 are from the same paper only with different weights and parameters. Index 5 is an underestimation. From the data collected and other resources, a new WQI will be created to more accurately express the true quality of these specific streams.

MICROBEADS, BPA, AND NANOPARTICLES: HOW SMALL NOVEL CONTAMINANTS AFFECT STREAM ECOSYSTEM FUNCTION IN THE WEST BRANCH SUSQUEHANNA WATERSHED

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Microbeads, BPA and titanium dioxide (TiO_2) are novel particulate contaminants found in surface waters. Nano-TiO_2 is commonly used in numerous pharmaceutical and personal care products (PPCP) ranging from make-up to pill casings, and is an additive in food and household products. Micro plastics are common in surface waters as a result of fragmentation of larger plastics or prevalence of micro-beads in PPCPs. Many of these contaminants are not able to be effectively filtered out of wastewater treatment plants and have continuous inputs from landscapes. Despite the commercialized use, increased presence in surface waters, and toxic effects on stream organsims, little information exists on how micro-contaminants affect stream ecosystems as a whole. We examined the effect of various concentrations of nano-TiO_2 , BPA, and microplastics on stream ecosystems by measuring the response of algal and microbial communities to acute (12 hr) and chronic (22 day) exposures. We measured gross primary production (GPP), community respiration (CR), and chlorophyll a (chl a) concentrations on intact algae from a local tributary of the West Branch Susquehanna River. We expected metabolic function of both algal and microbial components of the benthic biofilm to decline with exposure due to sensitivities to metal oxides and BPA leaching from plastics. BPA most strongly decreased biofilm chl a. Chl a was not significantly affected by microbead exposure (though it declined) and there was an increase in chl a with exposure to nano-TiO_2. We found exposure to any of the concentrations of nano-TiO_2 tested caused CR to decrease compared to controls, but, GPP either increased or stayed the same as our controls. We found algal chl a concentraions to increase in the high exposure treatment. Since nano-TiO_2 had a negative effect on the microbes, we hypothesized that either autotrophs were released from microbial competition and increased chl a production, or that shading from TiO_2 particles may have caused increased chl a production. Additional studies investigating the effects of higher concentrations and longer exposure times to these compounds are warranted.

Keywords: novel contaminants, PPCPs, Ecosystem function, BPA

COMPARISON OF POPULATION CHARACTERISTICS OF INVASIVE FLATHEAD CATFISH ACROSS THREE REACHES OF THE SUSQUEHANNA RIVER, PENNSYLVANIA.

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There have been no comprehensive surveys to document the current range and population characteristics of Flathead Catfish in the Susquehanna River since their first detection in 2002 below Safe Harbor Dam, Lancaster County, Pennsylvania. In this study we set out to evaluate the population characteristics of Flathead Catfish within three reaches of the Susquehanna River between Sunbury, Pennsylvania and the Maryland border with different presumed degrees of establishment. We randomly selected three segments within each the three larger reaches for comparison. Flathead Catfish were collected using baited, 1.2 m diameter hoop nets fished in tandem with three nets in a series to allow for comparisons with systematic surveys in their native range. Nets were fished for 72 hours each with four series of nets used to characterize each segment with equal effort expended among the three reaches. A portion of the sets within each of the larger reaches were replicated within 7 days of the initial sets to estimate detection probability. In this poster we will compare relative abundance and population characteristics of Flathead Catfish among the three reaches within the Susquehanna River and will discuss implications of future range expansion.

Keywords: Flathead Catfish, population characersitics , invasive species , Susquehanna River

SPECIES AND POPULATION-LEVEL DIFFERENCES IN SUBMERSION TOLERANCE AMONG RIPARIAN AND NON-RIPARIAN SPIDERS

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Spiders that inhabit dynamic boundaries between terrestrial and lotic systems are under constant risk of flooding. Many species may have evolved adaptations to respond to rising water either through avoidance or submersion tolerance. Mechanisms for coping with periodic flooding have important implications for predicting species composition, recolonization, and resilience against flood-related disturbance for riparian arthropod communities. We examined submersion tolerance of spiders by taxon and microhabitat, comparing web-building and cursorial, riparian and non-riparian, and ground-dwelling versus more arboreal species. We submerged individual spiders for three hours in distilled water and recorded survival, activity level immediately after removal, and activity level eight hours after removal (N = 2,111). Recovery time comparisons of submerged spiders were also made with spiders in sealed versus open containers as well as for periods longer than three hours. During trials we noted that most but not all spiders formed plastrons (breathing bubbles) during submersion. We found large differences in submergence tolerance by guild and habitat. Web-building spiders and vegetation-dwelling cursorial spiders showed poor survival post-submersion, even those that live on overhanging vegetation along rivers and streams. Most ground-dwelling cursorial spiders including wolf spiders and fishing spiders showed no negative effects of submersion and most were active the entire time of submergence. Wolf spiders submerged within sealed containers showed similar recovery times compared to spiders submerged in open containers, suggesting that plastrons provided sufficient oxygen over short submergence periods. We also found significant differences in submersion tolerance between populations of wolf spiders of the same species within the riparian zone compared to populations from other habitats, indicating population-level local adaptation to flooding. This pattern was not seen over small spatial scales however. Population-level differences in submersion tolerance indicate that riparian ground spiders likely persist during flood events rather than being recolonized by new spider populations.

Keywords: submergence tolerance, flooding, species differences, local adaptation

VARIATION IN MERCURY LEVELS AMONG RIPARIAN AND NON-RIPARIAN SPIDER SPECIES.

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Mercury is a persistent environmental contaminant that primarily originates from coal-fired power plants but may arise from other sources including uncontrolled mine fires. Variation in total mercury uptake and mobilization through the apex arthropod community is poorly understood. We measured total mercury among ground and web-building spiders at sites along the Susquehanna River near a coal-fired power plant and compared total mercury levels to spiders from uncontrolled coal fire burn sites (Centralia, PA and Laurel Run, PA) and reference sites away from the river or point sources of mercury pollution (agricultural fields and headwater streams). We measured total mercury across species, age classes, and sexes for several species of ground spider and a web-building spider at these sites. Spiders from mine fire sites had total mercury levels 2.5 times higher than those in riparian zones adjacent to the power plant and about six times higher than those from agricultural fields or riparian zones away from power plants. We found a significant interaction in total mercury levels between sex and species suggesting possible trophic dimorphism among some species or significant sex-based differences in mercury exposure. We also measured methyl mercury (MeHg) among select arthropods along one site near a former coal-fired power plant. Both MeHg and total mercury levels tended to be higher among male spiders. Total mercury was concentrated in the abdomens of ground spiders compared to legs and cephalothorax. Wolf spiders had MeHg levels 8-20 times higher than ground locust or caddisflies from the adjacent water. Wolf spider eggsacs had MeHg levels ca. 3/4th that of the mother. The mechanism for biomagnification remains unclear, but intraguild predation and MeHg transfer to eggsacs among females may be contributing to sex differences. MeHg is capable of being transported and biomagnified vertically in terrestrial environments through lycosids while mine fire sites are capable of mobilizing mercury trophically across the apex arthropod community.

Keywords: MeHg, spider , biomagnification, riparian

BRINE SHRIMP IN VORTEX FLUID FLOWS

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These exploratory experiments focus on how fluid flows affect the motion of wild type swimmers in a two-dimensional fluid flow. Specifically, we are looking at brine shrimp, which are wild-type swimmers, in a flow composed of an array of vortices. Trajectories of the shrimp in the vortex flow are compared for different ratios of the (no-flow) swimming speed and the characteristic fluid velocity.

Source of support: NSF STEM Grant #DUE-1317446, #DMR-1361881

Keywords: Swimmers, Fluid Flow, Vortex, Reaction Fronts

ESTIMATION OF DAILY NET ECOSYSTEM PRODUCTION RATES IN THE SUSQUEHANNA RIVER USING INVERSE MODELING WITH DISSOLVED OXYGEN

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Ecosystem metabolism of rivers can be estimated from rate of change of dissolved oxygen in the water and was originally calculated directly from point-by-point change in dissolved oxygen concentration. New methods, termed "inverse modeling," fit observed diel dissolved oxygen concentrations to theoretical dissolved oxygen curves by finding the metabolic and reaeration rates that generate best-fitting oxygen data. Various inverse modeling methods were used to analyze dissolved oxygen data from two Susquehanna River locations near Lewisburg, PA in summer 2010. These methods use known models relating dissolved oxygen and net ecosystem production and statistical packages in R to estimate gross primary productivity and ecosystem respiration of rivers based on dissolved oxygen concentration, water temperature, barometric pressure, depth, and photosynthetically active radiation. Outputs from each method were then compared to each other and to the traditional calculation method. Inverse modeling methods produced similar results to traditional calculation, but were significantly faster and required few user decisions, thus reducing possible inconsistencies between users running the models. Inverse modeling will be used to estimate daily rates of ecosystem respiration and gross primary production of the Susquehanna River North and West Branches over 7 years.

Keywords: metabolism, inverse modeling, net ecosystem production, dissolved oxygen

CRAYFISH EXPLORATORY BEHAVIOR

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The invasive Rusty Crayfish (*Orconectes rusticus*) is established in sections of the Susquehanna River, and seems to be excluding its predecessor the Allegheny Crayfish (*Orconectes obscurus*). We hypothesized that this displacement is a function, at least in part, of greater exploratory behavior by Rusty Crayfish. To determine if exploratory behavior differs between these species, we introduced 30 crayfish of each species into 10-gallon aquaria and recorded their movements for five minutes by video. From these recordings we measured the total distance traveled, the numbers of stops, perimeter departures, direction changes, and wall ascents.

Keywords: crayfish, behavior, rusty crayfish, allegheny crayfish

CRAYFISH AGGRESSION: RUSTIES VS. ALLEGHENIES

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Allegheny Crayfish (*Orconectes obscurus*) are being displaced by invasive Rusty Crayfish (*Orconectes rusticus*) in sections of the Susquehanna River. We hypothesized that this displacement could be due in part to the aggression of Rusty Crayfish. We tested this by introducing paired Rusty and Allegheny Crayfish into 10-gallon aquaria and video recording their behavioral response. Thirty crayfish of each species, ranging in size from 25mm to 35mm (carapace length, CL) were paired for testing. An individual of each species (same gender and of similar CL) were placed into isolation chambers in a ten gallon tank for five minutes prior to testing. The crayfish were then released into the aquaria and videotaped for five minutes. The recordings were then used to determine which crayfish exhibited aggressive and dominant behaviors.

Keywords: crayfish, behavior, aggression, Rusty Crayfish

THE OCCUPANCY RATE OF ARTIFICIAL COVER OBJECTS IN A RIPARIAN FOREST: GRASS VS. LEAF LITTER AND THE INFLUENCE OF PRECIPITATION

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Artificial cover objects (ACOs) have been widely used to monitor salamanders in forest habitats. We took advantage of an extended summer dry spell to investigate the occupancy rate of ACOs placed in riparian forest areas comprised of grass vs. leaf-litter habitat. We hypothesized that the lack of precipitation would favor salamander use of ACOs in grass habitat (faster occupancy rate), and that precipitation events would increase the occupancy rate of ACOs in both habitats. ACOs were deployed at the beginning of September and checked weekly through October. The ACOs were placed in 5X5 grids 1.5 m apart; three grids were randomly placed in each habitat type (N=75 ACOs for each habitat type). Salamanders found beneath ACOs were identified to species and returned to where they were found. Other organisms observed beneath the ACOs were also noted.

Keywords: ACO, salamanders, leaf litter,

MERCURY CONTAMINATION OF SALAMANDER PREY FROM A RIPARIAN FOREST

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Artificial cover objects (ACOs) are a common method used to study salamanders in forests. Previous investigations by Mangan revealed Hg contamination in salamanders collected beneath ACOs in a riparian forest. As a result, we hypothesized that a primary pathway for Hg contamination of salamanders would be their prey. Using artificial cover objects in a riparian forest, we sampled potential salamander prey organisms for total mercury to see if any of these organisms contributed significant amounts of Hg to salamanders.

Keywords: ACO, salamander, mercury, prey

A STUDY OF DIATOM COMMUNITIES IN THE UPPER MAIN STEM OF THE SUSQUEHANNA RIVER DURING VARIOUS DISCHARGE REGIMES, 2014-1016

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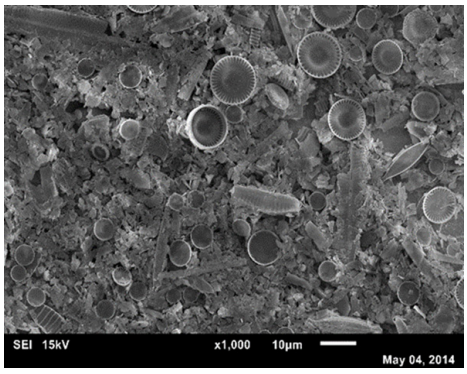
The upper main stem of the Susquehanna River is formed by the confluence of the West and North Branches, each of which is chemically and physically distinctive. The upper main stem retains the signatures of the two branches due to weak lateral mixing, and we refer to them as the West Branch plume (WBP) and the North Branch plume (NBP). Thus, characterization of the diatom communities requires samples taken from sites that occur in the plumes of both branches. Since 2009, we have monitored the upper main stem at an established transect that straddles Byers Island near Shamokin Dam, PA and below the Adam T. Bower inflatable dam at Sunbury, PA. During the summers of 2014-2016 the upper main stem experienced different discharge regimes: high (2015), moderate (2014), and low (2016). Attached diatom communities were sampled from stones which were prepared for examination by scanning electron microscopy. The Pollution Tolerance Index (PTI) and Shannon Diversity Index (SDI) values showed very little variation between WBP and NBP (2.7-2.9, 2.1-2.4, respectively). We found the greatest species richness in the diatom communities during 2014 (73 species) while years 2016 and 2015 were somewhat comparable (42 and 37, respectively). Biofilm communities of the NBP were dominated by small *biraphid* species (e.g. *Rhoicosphenia abbreviata*, and *Encyonema appalachianum*), but the same communities of the WBP were dominated by *monoraphid* species (e.g. *Achnanthidium deflexum, Ach. minutissium, and Cocconeis placentula*). Small centric species (e.g. *Discostella pseudostelligera*) dominated in the NBP during low flow (2016) and moderate flow (2014) years. Despite similarities in community metrics and dominant taxa, the Proportional Bray-Curtis similarity values between the three years for the WBP and NBP are low to low moderate overlap (40.3% and 46.3%, respectively).

Keywords: Bioflims , Diatoms, Susquehanna River



VARIABILITY OF DIATOM COMMUNITIES IN FIVE HEADWATER STREAMS OF CENTRAL PENNSYLVANIA DURING THE SUMMERS OF 2015 AND 2016.

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From May to the beginning of July 2016, we sampled five headwater streams that flow down the north slope of Penns Creek Mountain (Bald Eagle State Forest, western Union/ Snyder counties), each in a separate cut along the ridgetop. The streams drain a perched water table underlain by impervious sandstone, are approximately two meters wide, and are wadeable. Throughout the reaches studied the streams are shaded by a mixed forest of hemlock and birch with a substrate of small boulders, cobble, and sand. Because of the uniform geology, hydrology, and land use, the chemical and physical properties of the streams are very similar. Conductivity (11-29 μs/cm) and buffering capacity (57.37-304 μeq/L) are low, pH varied between 4.85 and 6.84, but the average pH remained below 6. Stones and sediment were collected at each sample site and biofilms were removed chemically. Diatoms were cleaned by a standard method using HCl and H2O2, identified to species, and counted using a JEOL 6010 SEM. Although the summers of 2015 and 2016 varied greatly in the amount and frequency of rainfall, there was little change in the chemical and physical properties of the streams, allowing for the samples from the two years to remain comparable. As expected, the diatom communities at all sites during both years showed a high Shannon Diversity in both 2015 and 2016 (2015 SDI; 2.6-3.3 versus 2016 SDI; 2.76-3.15) and a high species richness (35-52 taxa in 300 valves in 2015 and 35-49 taxa in 300 valves in 2016). Despite comparable species richness and Shannon Diversity values, the diatom communities showed great variation in species composition from year to year, with the only common dominant species being *Nupela lapidosa*. Particular members of the communities varied in occurrence and importance such that the Proportional Bray-Curtis similarity index describes communities whose average similarity is only 29.8% (16-49%) for 2016 and 29.87% (8-43%) when comparing the same sites from 2015 to 2016. Thus, there does not seem to be a defined diatom community for these headwater streams, either from stream to stream or year to year, despite their similarities in abiotic parameters.

Keywords: headwater stream, diatom communities,

ASSESSMENT OF THE BENTHIC MACROINVERTEBRATE COMMUNITIES OF THE UPPER MAIN STEM OF THE SUSQUEHANNA RIVER DURING SUMMER 2016.

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This is a report of year eight in a long-term study of benthic macroinvertebrate communities (BMI) in the upper main stem of the Susquehanna River from mid-summer collections. The benthic communities reflect both water quality (assessment) and habitat variation (temporal and spatial). As assessment tools, BMI are useful in studying long-term trends because of their life histories that can span months to years. The study site is a transect that straddles Byers Island near the Sunbury Generation LP and below the Adam T. Bower inflatable dam at Sunbury, PA. The four sample locations are within the plume from the West Branch (site 1) and plume of the North Branch (sites 2-4). We follow the EPA guidelines for passive sampling in non-wadeable streams with the use of rock baskets and Hester-Dendy Multiplate samplers, which emphasize drifting and colonizing animals. To estimate communities in the riverine system, we actively sample using a two-kick method at 100-meter intervals for a 500-meter reach. Currently, samples are being processed with identifications to the family level from which metrics such as %EPT and the Hilsenhoff Biotic Index will be generated. We will report on BMI communities between the different sites and between years for a high flow year (2015; summer average: 25,540 cubic feet/second) and a low flow year (2016; summer average 12,187 cubic feet/second). That BMI communities are sensitive to discharge can be seen in the depression of %EPT between 2014 (an average discharge summer) and 2015 (a high discharge year) from 97% to 85%, respectively.

Keywords: Benthic Macroinvertebrates, Susquehanna River,

HABITAT PREFERENCES, AND POPULATION STRUCTURE AND STABILITY, IN TWO EASTERN HELLBENDER META-POPULATIONS IN A TRIBUTARY OF THE WEST BRANCH OF THE SUSQUEHANNA RIVER

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Two meta-populations of the Eastern Hellbender salamander (*Cryptobranchus a. alleganiensis*), in a single tributary of the West Branch of the Susquehanna River, were surveyed for population parameters (density, sex ratios), habitat preferences (rock size, location within the stream channel), and local distribution in August 2016. Our overall objective was to determine if the two populations were stable or if they were in decline. Analyses of population data show that density, habitat preferences, and distribution did not change since a similar survey of the two meta-populations three years earlier. Analyses of habitat use show that hellbenders take up residency in or near the thalweg, where the majority of cover rocks are located. Peripheral cover rocks are only rarely used by hellbenders. We found a positive relationship between the size (total body length) of hellbenders and the size (length) of the cover rocks. Population size/age structure and sex ratios were similar between sample years. Sex ratios tend to favor males over females. Migrations between the meta-populations were documented in 2016 and during prior surveys. Most migrants were young males and all movements were in an upstream direction. The results of this study indicates ongoing stability in this tributary despite significant declines and local extinctions in eastern hellbender populations throughout the Susquehanna River watershed. Concurrent with population monitoring, we supported applied conservation initiatives that include installation of artificial instream habitat structures and the collection of fertile eggs for head-starting juvenile hellbenders for future reintroduction into the watershed.

Keywords: Eastern Hellbender, Population Dynamics, Habitat Selection, Stability

INDIVIDUAL AND POPULATION HEALTH FOR TWO EASTERN HELLBENDER META-POPULATIONS IN A TRIBUTARY OF THE WEST BRANCH OF THE SUSQUEHANNA RIVER

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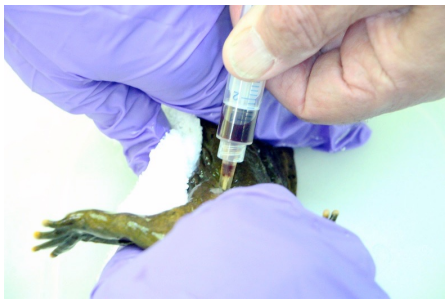
Two meta-populations of the Eastern Hellbender salamander (*Cryptobranchus a. alleganiensis*), in a single tributary of the West Branch of the Susquehanna River, were surveyed for overall population health and for individual health parameters during August 2016. Our overall objective was to establish baseline health conditions in a watershed where shale gas extraction ongoing and is expected to expand. Captured individuals were sexed, measured for length and weight, then assessed for external indicators of health, including evidence of infection, presence of parasites (external leeches and internal subcutaneous nematodes), open sores, healed wounds, scarring, loss of eyes, toes, limbs, and portions of the tail. Skin swabs were taken to test for the presence of chytrid fungus (*Batrachochytrium dendrobatidis*) infection and nearly 40% of individuals were shown to be infected. Blood was collected from the caudal vein of thirty-six individuals. The whole blood was centrifuged to generate plasma samples that were submitted to an independent lab for analysis of 13 blood chemistry parameters. Microhematocrits were taken by micro-centrifuging whole blood collected in capillary tubes. Blood smears were created and dried in the field, and later fixed and stained for determining white blood cell differentials, and to facilitate counts of micronuclei and the number of blood parasites (we focused on trypanosomes). No blood parasites were observed. Total body length/mass ratios were calculated to assess general health and to compare the results to similar measures taken during a study of the two meta-populations three years earlier. Despite generally low body weights, most individuals seemed otherwise healthy and were vigorous. Concurrent studies of population structure and density show no evidence of change in the number of individuals at the two sites since prior surveys in 2013 and 2011. The results of this study indicates ongoing stability in the two meta-populations despite significant declines and local extinctions in eastern hellbender populations throughout the Susquehanna River watershed.

Keywords: Eastern Hellbender, Health, Blood Chemistry, Population Stability



BENTHIC MACROINVERTEBRATE COMMUNITIES OF FIVE HEADWATER STREAMS IN CENTRAL PENNSYLVANIA DURING THE SUMMERS OF 2015 AND 2016.

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This was the second year of a survey of five headwater streams in Bald Eagle State Forest (Henstep, Coral Run, Little Weikert, Green Gap, and Lick Run), each of which forms a separate cut on Penns Creek Mountain. The study sites are shaded by a mixed forest of hemlock and birch with a substrate of small boulders, cobble, and sand. Because of the uniform geology, hydrology, and land use, the chemical and physical properties of the streams are very similar. Conductivity (11-29 μs/cm) and buffering capacity (57.37-304 μeq/L) are low, pH varied between 4.85 and 6.84, but the average pH remained below 6. We sampled each stream for benthic macroinvertebrates (BMI) using the six kick method within a one-hundred-meter reach. In addition, we collected BMI at three additional sites as a longitudinal study of Green Gap to its confluence with Weikert Run. From the eight sites our preliminary findings indicate a relatively diverse community with the number of families ranging from 11-22 per sample. Some of the dominant families included *Chironomidae, Elmidae*, and *Leuctridae*, but each one was dominant in different streams. Compared to samples taken during the summer of 2015, we saw a higher Proportional Bray-Curtis similarity in communities between streams during 2016 (24%-55% and 36%-80%, respectively). The Hilsenhoff Biotic Index for each site ranged from 3.6-5, which was between the very good/good range in quality of stream. The overall Shannon Diversity Index (SDI) for 2016 was 1.3-2.6, which was lower than in 2015 (2.4-3.1). As for the longitudinal study, all four sites along Green Gap have moderate similarity (average 56%), which was lower than expected for a small 3 km stream.

Keywords: Benthic Macroinvertebrates, headwater streams

A LONGITUDINAL STUDY OF DIATOM COMMUNITIES AT THE CONFLUENCE, UPPER MAIN STEM, AND TRIBUTARIES OF THE SUSQUEHANNA RIVER

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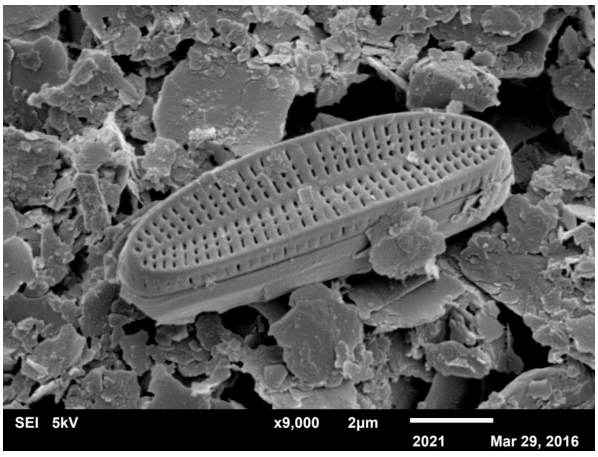
We analyzed diatom epilithic communities taken in late June 2016 from nine sites, three on the upper main stem of the Susquehanna River (Shady Nook, Port Trevorton, Liverpool), one on the lower North branch (Northumberland), one on the lower West Branch (Milton), and four above the confluence of key tributaries (Buffalo Creek, Penns Creek, Middle Creek, East Mahantango Creek, and Wiconisco Creek) as part of a multi-community study focused on Young-of-Year smallmouth bass survival. Stones with intact biofilms were collected and chemically treated using a standard method of HCl and H2O2. We counted and identified diatoms in the samples to the species level using a JSM-6010LV SEM and found between 23 and 34 species at each site. We identified 87 species in our analysis of all nine sites, and used Proportional Bray-Curtis to compare the respective diatom communities, most of which fell into the moderately similar range (40-59% similar). The lowest similarity between two sites was 29%; the highest was 79%. The Pollution Tolerance Index (PTI; 2.4-3.1), and the Shannon Diversity index (SDI; 2.1-2.8) showed little variation. Broader patterns of variation occur in the Trophic Diatom Index (TDI; oligotrophic to mesotrophic) and the Sedimentation Index (SED; 50.8% to 6.6%). These data present a mosaic of patterns we are still trying to analyze.

Keywords: Diatoms, Susquehanna River, Biofilm,



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