Oral Presentations

Abstracts for oral presentations are provided on pages 17 - 32.
* denotes presenting author.

Session 1

Agriculture, Nutrients, and Water Quality

The Forum (Room 272), Saturday, November 11, 2017, 1:45 - 2:30 p.m.

1:45 p.m. *"Boots on the Ground: Agricultural Technical Assistance in the Chesapeake Bay Watershed."*
Ann Swanson,* Ann Jennings, and Marel King

2:00 p.m. *"Rapid assessment of stream ecosystem function across an agricultural impact gradient in central Pennsylvania."*
Steven T. Rier,* Jennifer A. Tuomisto, Corey J. Conville, and Aaron Gordon-Weaver

2:15 p.m. *"Transport of nitrogen rich groundwater to surface waters by riparian macropore flow in an agriculturally dominated watershed."*
Brian Redder,* Anthony Buda, Casey Kennedy, Gordon Folmar, and Elizabeth Boyer

Session 2

Aquatic and Terrestrial Ecology 1

Rooms 241, A and B, Saturday, November 11, 2017, 1:45 - 2:30 p.m.

1:45 p.m. *"How social media led to the discovery of a "new" species on the Shikellamy Bluffs."*
Christopher T. Martine* and Scott Schuette

2:00 p.m. *"Comparing relative abundance and population characteristics of Flathead Catfish across a range of establishment levels at the Susquehanna River."*
Geoffrey D. Smith,* Danielle Massie, and Tyler Wagner

2:15 p.m. *"Temporal and spatial variation in endocrine disrupting compounds and young-of-the-year smallmouth bass health in the upper Juniata River system."*
George T. Merovich,* Ryan E. Heisler, Logan R. Stenger, Katie Mattas, Francesca, M. Ferguson, Grace Noll, and Ryan Braham

Session 3

Watershed Stewardship, Sustainability, and Education 1

Rooms 241, C and D, Saturday, November 11, 2017, 1:45 - 2:30 p.m.

1:45 p.m. "*Informing and Involving the Next Generation of Leaders in the River.*"
Mark Gutshall* and James Reeb

2:00 p.m. "*The View Below: Connecting People to the Susquehanna and Delaware Rivers through Snorkeling.*"
Keith J. Williams*

2:15 p.m. "*Innovative Approaches to Watershed Health Education and Community Awareness/ Engagement.*"
Jerry A. Griffith* and Michael J. Griffith

Session 4

Stream Restoration

Gallery Theater (Room 301), Saturday, November 11, 2017, 1:45 - 2:30 p.m.

1:45 p.m. "*Advantages of Stream Corridor Restoration as a BMP in the Chesapeake Bay Watershed MS4 Program.*"
Todd Moses,* Michael Lower, and Carrol Ehrhardt

2:00 p.m. "*Future History of Pennsylvania Anthracite Abandoned Mines.*"
Michael C. Korb*

2:15 p.m. "*Adaptive Stream Restoration Strategies that Add Large Woody Material to Headwater Streams to Improve Aquatic Life, Channel Complexity, Hyporheic Exchange, and Floodplain Connectivity.*"
Benjamin R. Hayes* and Nathan Reigle*

Session 5

Watershed Mapping and Modeling

The Forum (Room 272), Saturday, November 11, 2017, 3:15 - 4:00 p.m.

3:15 p.m. "*Mapping Runoff Flow Paths and Their Pollution Contribution Potential: The Impact of Crops as a Land Cover Category.*"

Chanda Singoyi,* Richard D. Crago, and Luyang Ren

3:30 p.m. "*Precision Conservation in the Susquehanna River Watershed: Tools and High-Resolution Datasets for Watershed Organizations and Community-Based Strategies for Success.*"

Adrienne R. Gemberling* and Jennifer A. Soohy

3:45 p.m. "*Updated Lidar for PA - Status and Plans.*"

Eric Jespersen*

Session 6

Aquatic and Terrestrial Ecology 2

Rooms 241A and B, Saturday, November 11, 2017, 3:15 - 4:00 p.m.

3:15 p.m. "*Conservation Threats and Opportunities for the Giant Eastern Hellbender Salamander in the Susquehanna River Watershed.*"

Peter J. Petokas*

3:30 p.m. *"Seasonal and Diel Signature of Eastern Hellbender Environmental DNA."*

Mizuki Takahashi*

3:45 p.m. "*Implementing an Ecosystem Services Approach in the Delaware River Basin: Successes, Challenges, and Future Directions.*"

Daniel E. Spooner,* Christopher Huber, Heather S. Galbraith, and Barbara St. John White

Session 7

Watershed Stewardship, Sustainability, and Education 2

Rooms 241C and D, Saturday, November 11, 2017, 3:15 - 4:00 p.m.

3:15 p.m. "*Forty-Mile Stories: Student Storytelling on the Susquehanna River.*"
Justin D. Mando* and Madeline Giardina

3:30 p.m. *"Engaging Non-Traditional Citizen Scientists in Watershed Protection."*
Carol Parenzan*

Session 8

Flood Hydrology and Policy

Gallery Theater (Room 301), Saturday, November 11, 2017, 3:15 - 4:00 p.m..

3:15 p.m. "*Flood Mitigation for Pennsylvania's Rural Communities: Community-Scale Impact of Federal Policies. Findings of the September 2017 report to the Center for Rural Pennsylvania.*"
L. Donald Duke* and Lara Fowler

3:30 p.m. "*Hydrologic analysis of a 100-year flood event in a small rural watershed in Clinton County, PA.*"
Md. Khalequzzaman*

Oral Presentations

BOOTS ON THE GROUND: AGRICULTURAL TECHNICAL ASSISTANCE IN THE CHESAPEAKE BAY WATERSHED

Ann M. Swanson,, Executive Director , Chesapeake Bay Commission, 60 West Street, Suite 406, Annapolis , MD, 21401, aswanson@chesbay.us; **Ann F. Jennings**, Virginia Director, Chesapeake Bay Commission, ajennings@chesbay.us; **Marel A. King**, Pennsylvania Director, Chesapeake Bay Commission, c/o Senate of Pennsylvania, Rm G-05 North Office Bldg, Harrisburg, PA 17120, mking@chesbay.us.

To meet water quality goals for Chesapeake Bay and its tributaries, widespread adoption of agricultural best management practices (BMPs) is required. While most discussion of policy to achieve these goals has focused on support of the practices themselves, implementation will not be possible without the conservation professionals who advise farmers, write farm-specific environmental plans, engineer practices and guide their implementation. This report will identify the types of technical assistance providers, their current funding sources, and recommendations to improve technical assistance delivery to farmers.

Keywords: agriculture, technical assistance, BMP, funding

RAPID ASSESSMENT OF STREAM ECOSYSTEM FUNCTION ACROSS AN AGRICULTURAL IMPACT GRADIENT IN CENTRAL PENNSYLVANIA

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The capacity to reliably assess the functional integrity of stream ecosystems is at the heart of stream assessment and restoration. However, direct measures of ecosystem function are often cumbersome, expensive and have not been used widely enough to develop predictive models relating functional indicator responses to the myriad of potential stressors. The goal of this project was to utilize a suite of "rapid" ecosystem assessment protocols to examine the response of 19 stream ecosystems spanning a gradient of agricultural impact in central Pennsylvania. We measured ecosystem metabolism (diel oxygen data coupled with inverse modeling), nitrogen and phosphorus uptake in portable mesocosms, photosynthetic capacity (pulse amplitude modulated fluorometery) and extracellular enzymes (β-glucosidase, β-xylosidase, alkaline phosphatase, leucine-aminopeptidase, β-N-acetylglucosaminidase and phenol oxidase). Our preliminary results indicate that, although stream size and underlying geology are potentially important covariates, these "rapid" protocols for characterizing ecosystem function responded well to variations in nutrient concentrations, canopy cover and sedimentation observed across this agricultural gradient.

Keywords: ecosystem metabolism, periphyton, algae, stream assessment

TRANSPORT OF NITROGEN RICH GROUNDWATER TO SURFACE WATERS BY RIPARIAN MACROPORE FLOW IN AN AGRICULTURALLY DOMINATED WATERSHED

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Nitrogen (N) pollution continues to be a major concern in the Chesapeake Bay watershed due to its potential contributions to climate change, negative health effects, and the decline in quality of aquatic ecosystems. Groundwater in Pennsylvania can have elevated concentrations of dissolved N that can migrate to surface waters, either by diffuse discharge through the streambed or by macropore flow in the riparian zone. These riparian seeps show significant variability in both discharge and nutrient concentrations. In this study, we use stream measurements to differentiate and quantify contributions of groundwater discharge from matrix flow in the streambed and riparian seeps. A combination of differential stream gauging, streambed measurements of hydraulic head and conductivity, and water chemistry, were used to solve for riparian groundwater flux using a reach mass balance equation. A 175m stream reach was identified in a heavily cultivated 45 hectare watershed in east-central Pennsylvania in the headwaters of the Susquehanna River.

Despite air-water manometers readings from piezometers installed in the shallow streambed (30 cm) indicating a losing reach, discharge substantially increased (36-66%) throughout the reach consistently throughout the study period. Using the mass balance approach, riparian groundwater fluxes contributed 85-206 $m^3 d^{-1}$ of water, while transporting 1.48- 3.98 kg N d^{-1} through this fractured aquifer system. Throughout the winter/spring recharge period (Jan-May), there was a constant increase in both flow and N transport from these macropore riparian seeps. Chemical data for the stream, streambed, and shallow ground waters suggest that the stream is disconnected from the underlying aquifer and that groundwater riparian seeps supply essentially all of the water and N to the system. The results from this study, and water chemistry comparison between stream, shallow groundwater, deep groundwater, and riparian seeps, provide insight into the sources of these inputs and help determine the transport and fate of N in a fractured system. This information is important for planning mitigation techniques and best management practices. Further analysis of water isotopes and hydrometric data will be used to test our hypothesis of a perched stream disengaged from the aquifer below.

Keywords: water quality, agriculture

HOW SOCIAL MEDIA LED TO THE DISCOVERY OF A "NEW" SPECIES ON THE SHIKELLAMY BLUFFS

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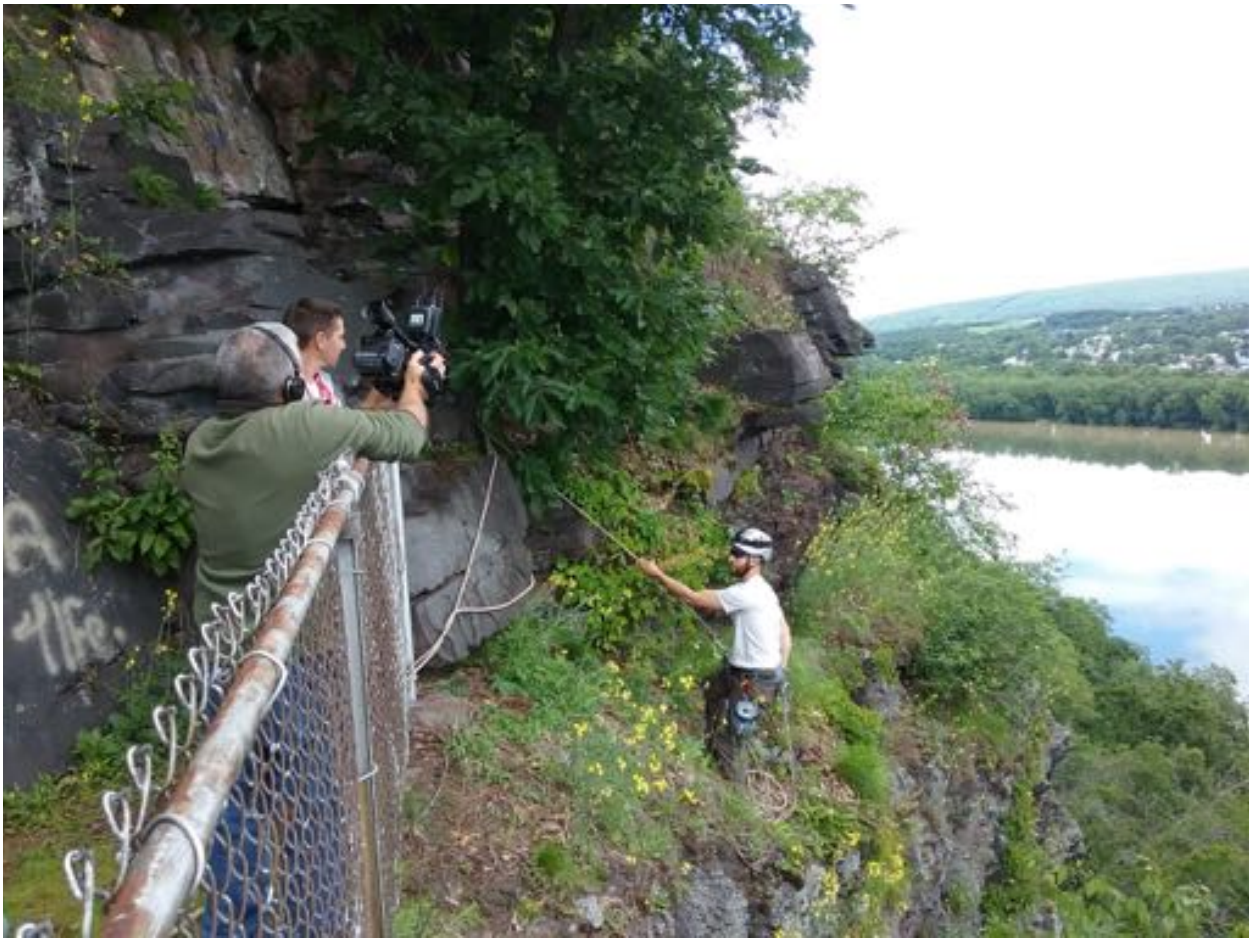
In the summer of 2017, a group of scientists and students conducted a survey of the cliffside flora above the bank of the West Branch Susquehanna River at Shikellamy State Park. The primary goal of the survey was to locate individuals of the golden corydalis (*Corydalis aurea*), a state-endangered species only known in Pennsylvania from this single site. During the course of the survey, numerous specimens identified as *Heuchera americana* (American alumroot) were also collected. A photo of one specimen was posted to Twitter, kicking off an electronic discussion that, in turn, led to a series of new collecting trips and establishment of the first state records for the globally-imperiled *Heuchera alba* (white alumroot). Before the Tweet, this species was previously recorded from just a few localities in Virginia and West Virginia. Through a collaboration between the Pennsylvania Natural Heritage Program and Bucknell University, we are now evaluating the biology and status of the species in the state and what its discovery here means for the conservation of the species across its now-expanded known range. Likewise, the presence of rare plants on some local cliffs suggests the need for additional surveys of bluff habitats throughout the Susquehanna Valley.

Keywords: botany, endangered species, biodiversity, science communications



COMPARING RELATIVE ABUNDANCE AND POPULATION CHARACTERISTICS OF FLATHEAD CATFISH ACROSS A RANGE OF ESTABLISHMENT LEVELS AT THE SUSQUEHANNA RIVER.

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Flathead Catfish were first documented in the Susquehanna River in 2002 downstream of Safe Harbor Dam, York and Lancaster counties, Pennsylvania. Since that time the species has increased in range and abundance throughout the Susquehanna Basin. In 2016, we initiated a study to evaluate abundance and growth characteristics of Flathead Catfish along a gradient of establishment in the Susquehanna River. We used baited, tandem hoop nets at 12 randomly selected locations within each reach to evaluate relative abundance (CPE, catch per effort) and provide individuals for age and growth analysis. Temporal replicates we also set at a portion of the sites to evaluate variability in CPE between sets. Age was determined using lapilli otolith for each fish (n=142) and von Bertalanffy growth estimates determined using R software package to evaluate differences in growth parameters among different levels of establishment. Growth rates were similar among reaches however maximum age and CPE differed among reaches. These data along with other North American populations are currently being used to evaluate factors affecting population characteristics to inform management of both native and non-native populations in Pennsylvania and elsewhere.

Keywords: invasive species, Flathead Catfish, Susquehanna, von Bertalannffy

TEMPORAL AND SPATIAL VARIATION IN ENDOCRINE DISRUPTING COMPOUNDS AND YOUNG-OF-THE-YEAR SMALLMOUTH BASS HEALTH IN THE UPPER JUNIATA RIVER SYSTEM

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Over a 2-year time frame in summer 2016 and 2017, we quantified the dynamics of endocrine disrupting compounds (EDCs) in the upper Juniata River system. EDCs have been implicated as a likely cause of declines in recruitment and thus adult smallmouth bass (SMB) populations in the lower Juniata and Susquehanna Rivers since 2005. We studied the mainstem of the upper Juniata River (near Mapleton), and 5 other major tributaries in the drainage system. Specifically, we quantified EDC levels (estradiol equivalents, EEQ in ng/L) across a range of flow types at 9 different sites and subsequently looked at how these hydrologic conditions (e.g., peak storm flows vs. ascending flow, vs. base flows, etc.) and landscape characteristics among sites may explain the variation in EDCs. In addition, we measured EDC levels along a continuum of the Juniata River downstream of a waste water treatment plant to quantify decay patterns once entering water. Finally, at each site we collected information on young-of-the-year (YOY) SMB condition and diet. We used non-lethal gastric lavage techniques to extract diet contents and sacrificed a subset of individuals to estimate efficiency. EDC concentrations varied widely within sites at the same time, within sites at different times, among sites, and between years, but levels thus far in our surveys have not surpassed 1 ng/L, a threshold considered to be a concern for fish health. Initial analyses indicate that river discharge and flow characteristics related to storm runoff cannot explain variation in EDCs, nor have we identified landscape characteristics at 2 spatial scales that can explain variation. Thus far, we could not detect a trend in EDC concentrations downstream of the waste water treatment plant. In 2016, YOY SMB were numerous and were in excellent health, but were nearly absence during the same time in 2017. Most individuals contained at least some prey items, which on average consisted of about half aquatic prey and half terrestrial or neustonic prey. Rusty crayfish diet lacked resemblance to diet in YOY SMB. After gastric lavage, only a few fish were found to have some stomach contents remaining when dissected in the lab. Furthermore, nearly all YOY SMB fully recovered from field lavage experiences. Our study has identified levels of EDCs in the upper Juniata River systems that should be considered important for addressing ecological health in the broader Susquehanna River basin. Advancing our understanding of the dynamics of these emerging contaminants and their potential effects on smallmouth bass will require tracking and measuring specific compounds. We found gastric lavage to be a safe and effective technique to study YOY SMB feeding ecology without having to kill numerous individuals of this popular gamefish.

Keywords: endocrine-disrupting compounds, young of the year smallmouth bass, Juniata River watershed, storm flows

INFORMING AND INVOLVING THE NEXT GENERATION OF LEADERS IN THE RIVER

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RiverStewards is a new non-profit consortium of educational institutions, private sector companies, non-profit organizations, communities, government agencies, and individuals working to conserve one of our most significant ecological, economic and recreational resources in central Pennsylvania, the Susquehanna River. *RiverStewards* brings together those interested in the river to make a significant, collective social impact through inter-academic applied research, eco-tourism, reports from river guides and their clientele, and other deliberate cross-sector actions. We recognize the value of the Susquehanna River's social return on investment, which considers the environmental and social values that the river gives to us all, in addition to the economic benefits. Through our continued collective efforts and communication, we raise awareness of the river's importance and how we can sustain it.

We consider *RiverStewards* as the "Economic Value Curator for the Susquehanna," seeking to inform and involve the next generation of leaders in caring for the river.

During this session we will discuss the upcoming projects of *RiverStewards* and its partners, focusing on the economics and people that stem from the Susquehanna River. These projects include academic studies done by college students and professors along the length of the river in Pennsylvania. We will explore the content of these upcoming studies, including the ways we are informing and involving Millennials and members of Generation Z in the effort. We will also discuss how your organization can get involved in one or more of the projects.

Keywords: economics, student research, ecology, youth empowerment

THE VIEW BELOW: CONNECTING PEOPLE TO THE SUSQUEHANNA AND DELAWARE RIVERS THROUGH SNORKELING

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We often perceive that there isn't much to see beneath the surface of our nation's freshwater rivers and streams, but once we look underwater, an amazing world appears. Fish of incredibly diverse colors, shapes, and behaviors live in freshwater ecosystems. The streams themselves create other worldly, breathtaking streamscapes, giving humans willing to submerge themselves the opportunity to witness incredible ecological feats such as thousand-mile fish migrations, predator-prey interactions, or the vibrant-colors of mating displays. The underwater world of our rivers and streams is unexpected, largely unnoticed, and amazing! They are thriving aquatic communities, composed of subjects intimately tied to one another, and humans, through an aquatic matrix.

Snorkeling establishes powerful connections between people and rivers, and is one of the most intimate interactions we can have with a river, experiencing the movement and organisms of a moving water body on its own terms. Snorkeling allows us to bond with subjects that are intertwined in these aquatic communities, granting us new perspectives and reasons to care about the importance of clean water. The ways in which rivers, and the creatures that live in them, are woven into our cultural and natural heritage become apparent.

The Susquehanna and Delaware rivers support underwater communities that are unexpected in a heavily farmed and developing landscape. This presentation will explore the Delaware and Susquehanna from beneath the surface, and will show the importance of connecting people to these rivers through snorkeling.

Keywords: education, outreach, connection

INNOVATIVE APPROACHES TO WATERSHED HEALTH EDUCATION AND COMMUNITY AWARENESS/ ENGAGEMENT

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Berks Nature, a non-profit conservation organization, is the leading agent for conservation of the environment in Berks County, Pennsylvania. Its mission includes land protection, water conservation, environmental education and community engagement. This presentation highlights the organization's innovative approaches to water conservation, watershed education and community engagement in support of healthy watershed ecosystems in the Delaware and Susquehanna River Basins.

Berks Nature has spent the past ten years addressing these water resources and gaining support for the restoration and protection of water resources. Our partnerships across the region in developing and implementing watershed management plans received statewide recognition, as we are a proud past-recipient of the Governor's Award for Watershed Stewardship. We enjoy partnerships with organizations that share a goal of improving and protecting the Schuylkill River Watershed – the Philadelphia Water Department, the William Penn Foundation, the Schuylkill River Heritage Area, the Schuylkill Action Network, and RiverPlace Development Corporation.

This presentation will focus on three areas in which *Berks Nature* is addressing the integrity of the Delaware and Susquehanna River Basins: 1) watershed health awareness, 2) training of community volunteers, and 3) a stream and wetland restoration project.

Specifically, *Berks Nature* hosts events such as Aquapalooza and River Days for children and the public alike. Berks Nature also hosts an annual "State of The Environment" meeting, which may be unique for similarly-sized conservation organizations in the region, and which publishes environmental indicators that describe conditions and trends in the County's water resources. Secondly, engagement includes training volunteers, including an "Ambassador" volunteer program for interested laypersons, educators, and professionals alike who help both to educate and to perform water quality sampling in streams across the county and collect data for the international citizen-science project GLOBE. Finally, we discuss the educational and outreach opportunities afforded by a stream and wetland restoration project immediately adjacent to Berks Nature's brand new headquarters and education center.

Keywords: community awareness and education, watershed planning sustainability, watershed monitoring

ADVANTAGES OF STREAM CORRIDOR RESTORATION AS A BMP IN THE CHESAPEAKE BAY WATERSHED MS4 PROGRAM

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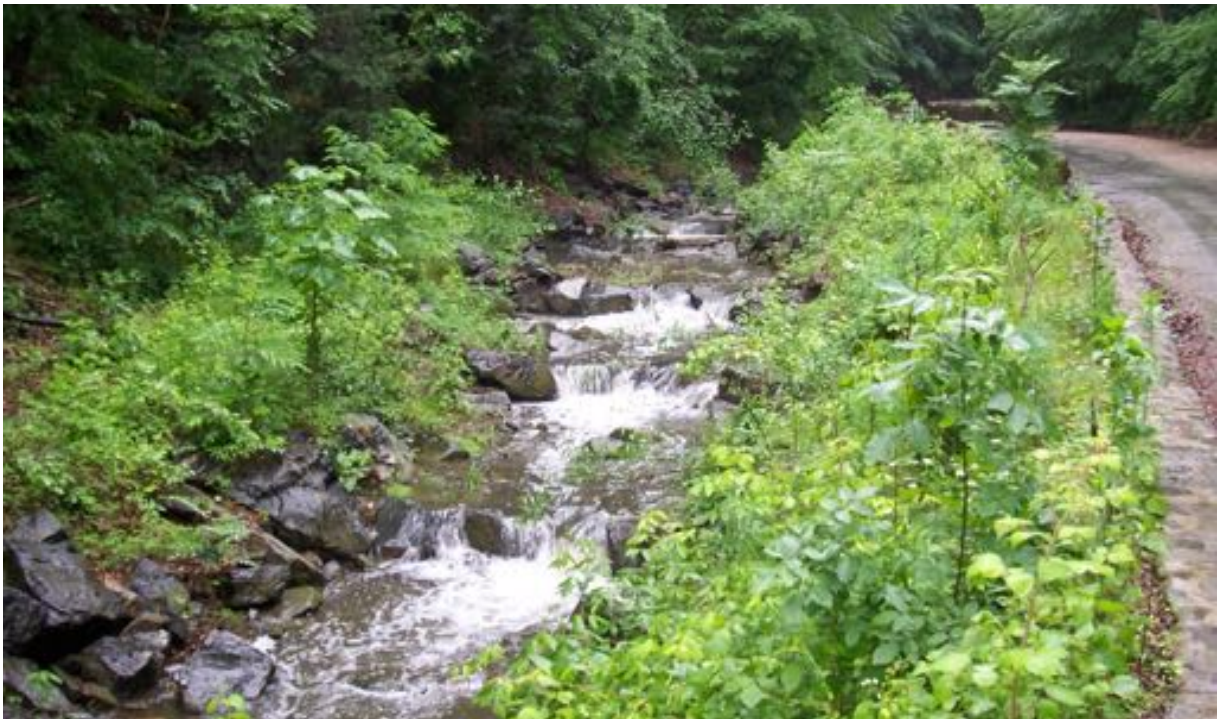
Stream Restoration (SR) is among the structural Best Management Practices (BMPs) acceptable for pollution reduction credits under the Municipal Separate Storm Sewer System (MS4) permit program. An important advantage of SR over other, infiltration-based MS4 BMPs, such as rain gardens and permeable pavement (here termed Green Stormwater Infrastructure, or GSI), is that SR directly reduces channel erosion, the principal source of fine sediment pollution in anthropogenic streams. Even when widely deployed, GSI cannot prevent the largest, most intense rainstorms (≥2 inch per hour) from generating high peak flows in channels because runoff from such storms tends to exceed the infiltration capacity of GSI facilities, causing much of this runoff to overflow and quickly drain to receiving streams. Peak flows from such heavy rainstorms are the main cause of channel erosion and the incidence of such storms is increasing in the USA.

Acquiring MS4 credit via SR can also piggyback on essential projects addressing failing municipal infrastructure, such as sanitary sewer line exposure due to stream erosion. In such cases, MS4 program benefits are acquired as streamside property owners realize the tangible benefits of continued sewer operation and land preservation. Stream restorations are also a proven way to enhance community livability in public open spaces such as parks and downtowns. People are naturally attracted to flowing water within accessible green spaces and SR in such areas can make these key locations for urban revitalization and economic re-development.

SR can also provide an economic advantage with respect to long-term maintenance, which is required with all MS4 BMPs. While many SRs can be allowed to re-naturalize and become largely self-maintaining, upland GSI landscaping must be maintained to accommodate societal norms of tidiness and attractiveness in the built landscape. Also, these facilities must not only be maintained for appearance but for continued function (e.g. infiltration capacity). Many upland GSI BMPs such as rain gardens will therefore require renewal of the soil media and replanting after a limited number of years of receiving pollutant-laden runoff from grimy impervious surfaces. Permeable pavements likewise have known long-term maintenance costs and a limited effective lifespan.

Keywords: stream restoration, stormwater management, MS4 Program, pollution reduction



ADAPTIVE STREAM RESTORATION STRATEGIES THAT ADD LARGE WOODY MATERIAL TO HEADWATER STREAMS TO IMPROVE AQUATIC LIFE, CHANNEL COMPLEXITY, HYPORHEIC EXCHANGE, AND FLOODPLAIN CONNECTIVITY

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Sustainable and effective stream restoration strategies should focus on assisting the recovery of ecological integrity in degraded sections of a watershed by (1) reestablishing hydrologic, geomorphic, and ecological processes and (2) replacing lost, damaged, or compromised biological elements. This presentation provides examples of chop-and-drop adaptive restoration techniques used in headwater streams in Pennsylvania and Maine that can be applied to watersheds throughout the Mid-Atlantic and New England. The streams contain coarse channel sediments that are naturally sorted into a complex network of log jam/step/pool and gravel bars. In their equilibrium state, the channels have a braided or multi-threaded pattern, with numerous side channels and depressions present across their floodplains. However, during the 19th and 20th century, many of these watersheds were clearcut and the streams channelized, straightened, bermed, and "cleaned" of logs and large boulders. Their braided patterns were reduced to a single channel to facilitate seasonal log drives or route flood waters quickly downstream.

We have been experimenting with new, adaptive restoration strategies such as "chop and drop," where selected trees in a riparian corridor are strategically felled directly into the channel and the stream self-adjusts over during high water events. Larger "digger" logs promote step-pool formation and finer "sweeper" branches promote bar formation, improve grain size distribution of the channel bed sediments, and spawning habitat for fish. Channel complexity and aquatic habitat is greatly increased. The hyporheic zone is also improved, with increased groundwater-surface exchange and transfer of carbon and nutrients between the forested floodplain and stream. In selected reaches, larger trees are being dropped into the stream at the head of the braid bar to redirect a portion of high-water flow to the abandoned side channels, thereby reconnecting the stream to its floodplain. This results in sediment being filtered out, water quality improved, groundwater recharge increased, and downstream flood peaks reduced. Chop and drop restoration approaches improve carbon sequestration within the local watershed system and the branches and leaves provide a food for macroinvertebrates and shelter for fish, amphibians, and reptiles. Compared to traditional methods, project costs can be reduced by orders of magnitude, because these methods require less materials and human resources to complete.

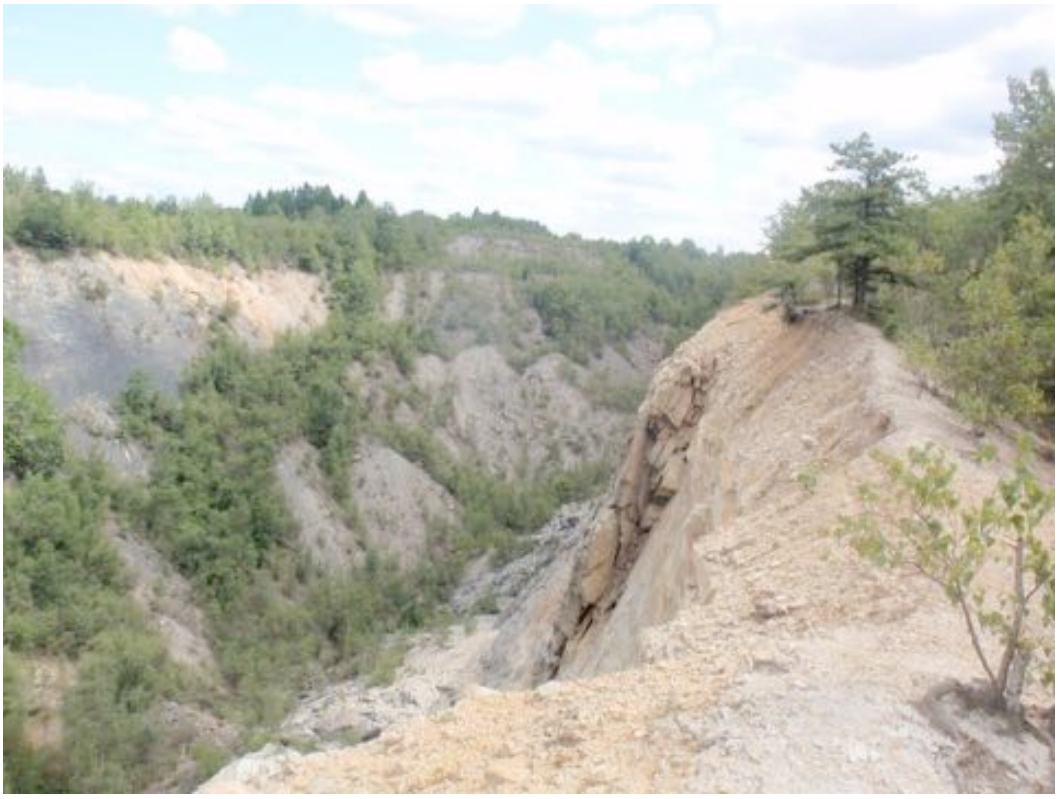
Keywords: stream restoration, chop-and-drop, floodplain reconnectivity

FUTURE HISTORY OF PENNSYLVANIA ANTHRACITE ABANDONED MINES

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

The Anthracite Coal Region is a historically important coal-mining area in the Susquehanna and Delaware watersheds, located in portions of 12 counties in Northeastern Pennsylvania.
Pennsylvania and the United States would not be what we know today without the past's 250 years of anthracite mining. The story of the Anthracite Coal Region is one of a remarkable heritage involving working-class culture, innovative technology and corporate will. Hundreds of thousands of men in NEPA created modern America by digging coal. Our industry produced over five billion tons of anthracite which drove the Industrial Revolution. Doing so, we altered rural America, provided thousands of jobs and homes for immigrants, and produced a curious legacy, both fascinating and offensive.
We went from unspoiled Appalachian landscapes to 400 square miles of abandoned mines – thousands of miles of underground openings, gaping strip pits, man-made mountains of waste piles, silt-filled creeks, dangerous highwalls, open shafts and portals, hundreds of miles of technicolor, pollutant-laden streams. Pennsylvania has been the leader in enacting mine reclamation and clean water legislation and providing funding for restoring land and water resources and the environment degraded by legacy coal mining practices, including measures for the conservation and development of soil, water, woodland, fish and wildlife, recreation resources and agricultural productivity. Federal funding from the OSMRE, EPA, ARC and EDA has been key for cleanup of legacy coal issues. Industry sources also are working to address the problem, most notably the independent power producers (IPPs) who burn waste coal to produce power.
Progress has been made, but future improvement is uncertain because much of the future support of legacy remediation is fragile – citizen coalitions are working to deal with the inevitable depletion of the Growing Greener II bond program and the 2021 expiration of the Surface Mine Control and Reclamation Act, funding of other Federal Agencies is involved in budget debates, and waste coal IPPs have competitive price issues. In this presentation, I plan to talk about the past, present and future of abandoned mines in the Anthracite Coal Region. What we've done, what we're doing, and what can be done with the resources we have and may have in the future.

Keywords: abandoned mines, mine drainage, reclamation



MAPPING RUNOFF FLOW PATHS AND THEIR POLLUTION CONTRIBUTION POTENTIAL: THE IMPACT OF CROPS AS A LAND COVER CATEGORY

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High resolution land use and land cover (LULC) and digital elevation models (DEMs) can be used to map stormwater runoff flow pathways, and to estimate, based on land use, the likelihood of the flow path to contribute pollutants to a stream. Pioneered by Jeffrey Allenby and Conor Phelan at the Chesapeake Conservancy, this is an example of Precision Conservation--the use of high-resolution remotely-sensed data to identify priority sites for conservation. For each cell in a watershed, all the upstream cells that contribute overland flow to that cell are counted in two ways. The "unweighted" count is simply the number of contributing cells, and the "weighted" count sums up a weighting factor attributed to each contributing cell, based on the cell's LULC classification. For example, forests (weight 2) have a lower potential for contributing pollution than parking lots (weight 10). The weighted and unweighted contributing areas for each cell are combined into an index called NDFI, which theoretically varies from -1 to 1, with larger values indicating greater potential to contribute pollution.

This study centers on whether NDFI values are impacted by inclusion of crops as a LULC category, because many available LULC maps lump crops and other low vegetation into a single category. A simple rule-based procedure was used at Bucknell during the summer of 2015 to develop a LULC for the Buffalo Creek watershed near Lewisburg, PA. This map includes both low vegetation (weight 5) and crops (weight 7). A second map was developed in which crops were given the same weight as low vegetation (weight 5). Differences between the two estimates of NDFI are greatest for smaller channels in agricultural regions of the watershed.

Keywords: precision conservation, runoff, GIS, flow-path mapping

PRECISION CONSERVATION IN THE SUSQUEHANNA RIVER WATERSHED: TOOLS AND HIGH-RESOLUTION DATASETS FOR WATERSHED ORGANIZATIONS AND COMMUNITY-BASED STRATEGIES FOR SUCCESS

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To pilot a new innovative approach to conservation, Chesapeake Conservancy, Susquehanna University, Bloomsburg University, the Chesapeake Bay Foundation, and the Pennsylvania Department of Conservation and Natural Resources are collaborating to harness newly available high-resolution GIS datasets and tools to conduct precision conservation in an effort to better focus restoration efforts on the ground. This project aims to demonstrate improved efficiency, effectiveness, and returns on investment through better site selection prioritization and support technology transfer to broaden adoption across multiple regions in the Susquehanna.

This talk will outline community-based tools for implementation partners and landowners created in our pilot region of Centre and Clinton counties, monitoring work associated with Precision Conservation, and high-resolution datasets available for watershed groups across the Susquehanna River Watershed. In the future, we will be scaling these tools across the Susquehanna River Watershed to guide best management practice implementation where we can achieve the greatest water quality benefits and inform landowners of restoration opportunities as well as the conservation professionals who can provide assistance with projects.

Keywords: conservation, watershed, GIS, prioritization

UPDATED LIDAR FOR PA - STATUS AND PLANS

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Pennsylvania was one of the first states to have complete topography (2-foot contours) derived from lidar data. Collected between 2006 and 2008, that data has empowered researchers, conservancies, private developers, regulators, and innovators in the understanding and management of PA's natural resources and infrastructure.

The rate of change in lidar technology and the cumulative changes wrought by man and nature over the last decade dictate that we plan and execute the collection and use of updated topography. Furthermore, advances in data analytics and data handling capacity offer heretofore impossible change detection capabilities; forest growth and fragmentation patterns over the last 10 years are clear examples of potential comparisons.

This session will describe progress in the update process including: areas already updated, parties interested in completing a statewide update, and activities of the newly formed PA Lidar Working Group.

Keywords: LiDAR, topography, change detection, remote sensing

CONSERVATION THREATS AND OPPORTUNITIES FOR THE GIANT EASTERN HELLBENDER SALAMANDER IN THE SUSQUEHANNA RIVER WATERSHED

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Catastrophic flood events, urban development, road and highway construction, industrial discharge, and forestry and agricultural practices have all impacted the ecology of streams and rivers in the Susquehanna River watershed in ways that have restricted, diminished, or eliminated quality habitat for the giant Eastern Hellbender salamander. In addition, crayfish invasions and amphibian disease epidemics have further stressed hellbender populations. The Eastern Hellbender has experienced range-wide local extinctions since the late 1990's and is currently a candidate species for federal listing as threatened or endangered. Conservation efforts to restore the giant salamander to its former range have been constrained by past land use practices and multiple stressors, but innovative methods to restore salamander populations have already yielded impressive results. Instream habitat structures have been installed to serve as salamander habitat and are already occupied by wild hellbender populations. The rearing of hellbenders from eggs to adult size by conservation organizations is nearing completion and captive-reared animals will soon be released to restore or augment declining populations.

Keywords: Eastern Hellbender, Applied Conservation, Head-starting, Habitat Restoration

SEASONAL AND DIEL SIGNATURE OF EASTERN HELLBENDER ENVIRONMENTAL DNA

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Examination of environmental DNA (eDNA) is a non-invasive conservation tool that has been used for the detection of aquatic organisms. When coupled with quantitative PCR (qPCR), eDNA sampling may be utilized to infer seasonal or diel activities of target species. In order to survey the status of eastern hellbender (*Cryptobranchus a. alleganiensis*), a fully-aquatic cryptic salamander of conservation concern, through eDNA analyses, we collected water samples monthly from 13 sites across eight tributaries of the Susquehanna River in Pennsylvania, USA, from June through October 2014. We also examined the effects of the breeding season, diel nocturnal activity, and stream environmental variables on eDNA concentration estimates. We repeatedly detected hellbender eDNA from all four tributaries with previously known records, as well as from downstream sites of two of the four tributaries without known records. In the known tributaries, we observed notable increases in eDNA concentrations during the September breeding season, suggesting possible reproductive events. However, such seasonal eDNA signature was lacking from the eDNA positive sites of the unknown tributaries. In contrast to our prediction, there was no difference in eDNA estimates between day and night samples, indicating that diel activity was inconsequential to eDNA estimates. Our findings concur with recent studies on the importance of temporal sampling in interpreting eDNA signature in relation to life histories of target species. Further studies are needed to characterize the core habitats of the newly found populations for the future management of the declining hellbender populations.

Keywords: Cryptobranchus a. alleganiensis, diel activities, eDNA, hellbender

IMPLEMENTING AN ECOSYSTEM SERVICES APPROACH IN THE DELAWARE RIVER BASIN: SUCCESSES, CHALLENGES, AND FUTURE DIRECTIONS

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The concept of ecosystem services (ES) to define, promote, and conserve natural resources has increased over the past decade. Loosely defined as the benefits that humans gain from the natural environment, the application of ES as a potential management tool is desirable. In theory, ES have the capacity to articulate and leverage key ecological processes, that otherwise may go unnoticed, into environmental policy and management decisions. By extension, this approach serves to justify conservation or restoration actions, and their associated benefits, that may be gained or lost given management intervention. In practice, ES are difficult to implement for three reasons: biophysical (ecosystem process) and societal (value) parameters are difficult to quantify; both vary across time, space, and proximity to human activity; and once parameterized, are difficult to translate to other systems. Here, we use biofiltration of water provisioned by freshwater mussels as a model system to highlight potential opportunities, caveats, and research needs associated with the valuation of natural capital.

FORTY-MILE STORIES: STUDENT STORYTELLING ON THE SUSQUEHANNA RIVER

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We present a narrative approach to cultivating identification with and value to the Susquehanna River through experiential, place-based learning. This stems from work completed in a course titled "Environmental Advocacy Writing" and will be divided between the instructor's perspective and a student's perspective on the project, engaging pedagogy on environmental writing, science writing, and experiential learning.

This presentation represents the pilot of a larger project, supported by River Stewards, which will divide the river into twelve 40-mile sections and engage students in the process of developing narratives that promote the spirit of the diversity along this river, the common waters that run through these communities, and efforts in addressing environmental issues. Communication efforts often treat rivers as a single body that connects all communities along its course. This approach differs by dividing the river into twelve sections treated as both distinct and interconnected units. We anticipate people will more easily identify with the river when divided into distinct localities. Just as we are all simultaneously proud Americans and proud Pennsylvanians, we wish citizens to identify as stewards of the Susquehanna River as well as stewards of the Dauphin Narrows, Lake Clarke, or the Isle of Que. This particular presentation focuses on student writing on the area around Wrightsville and Columbia. We intend to both present our initial work on this project and cultivate interest for future collaboration with universities along the course of the Susquehanna.

Keywords: environmental advocacy, science writing, narrative, experiential learning

ENGAGING NON-TRADITIONAL CITIZEN SCIENTISTS IN WATERSHED PROTECTION

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What do prisoners, paddlers, parochial school students, and an energetic puppy all have in common? They are all engaged in citizen scientist work with Middle Susquehanna Riverkeeper. In this short presentation, explore outside the traditional citizen scientist box and discover ways to engage community members in your work while learning more about Middle Susquehanna Riverkeeper's newly launched programs with Pennsylvania State Department of Correction's SCI Quehanna Bootcamp, American Canoe Association-Pennsylvania, Our Lady of Lourdes Regional School, and "Little Keeper" Susquehanna, who is being trained to sniff out sewage leaks in the watershed and will serve as a spokes-dog for a new poop-to-power initiative. Curious? Join us.

Keywords: citizen scientists, community engagement, watershed protection, innovation

FLOOD MITIGATION FOR PENNSYLVANIA'S RURAL COMMUNITIES: COMMUNITY-SCALE IMPACT OF FEDERAL POLICIES. FINDINGS OF THE SEPTEMBER 2017 REPORT TO THE CENTER FOR RURAL PENNSYLVANIA

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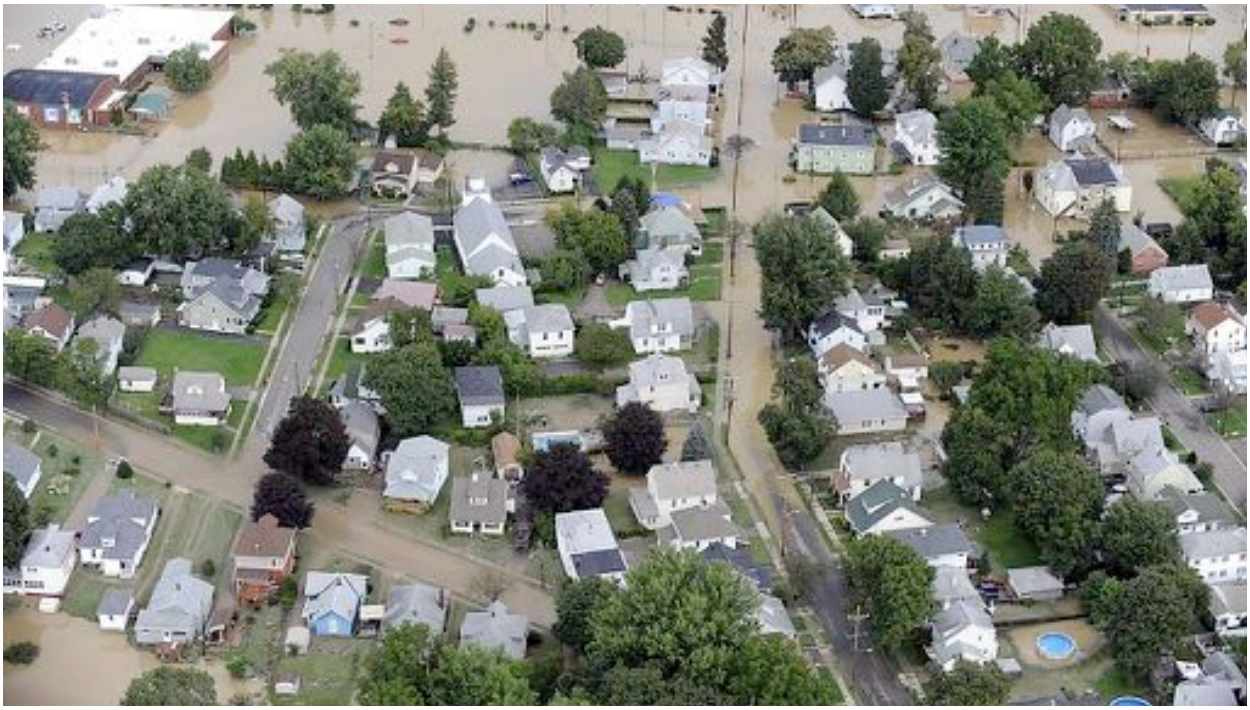
In the US, many flood mitigation actions and decisions are made at the municipal level, though subject to Federal and State-level rules, requirements, regulations, and incentive programs. Many communities throughout the U.S. actively seek to reduce flood safety threats and property damages to their residents, including by taking advantage of available federal and Commonwealth programs. However, different communities' needs, geography, demography, preferences, and priorities are tremendously diverse, especially in a region like Pennsylvania where local government consists of some 2,500 separate counties, cities, boroughs, and townships – each responsible for their own decisions about many of the most crucial land use, building code, and mitigation activities. Therefore Federal and Commonwealth programs, designed to reach as many locations as possible, necessarily fail to accommodate the highly diverse conditions of local communities, and while those programs are intended to promote and support local efforts, in practice many of those programs inhibit or preclude some activities that would be best suited for some localities. This research highlights some of the ways in which programs succeed for some Pennsylvania communities, and ways in which they fail for some of those same communities, at meeting their local needs. Further, the research shows many communities are not aware of available resources, have expressed a need for increased resources and institutional support from those programs, and desire additional programs. The research focuses especially on FEMA's National Flood Insurance Program, a Federal program intended to provide disaster relief for individuals and firms who experience flood damages – but with premiums that vary from highly subsidized to full "actuarial" rates, and currently facing Congressional action to decide whether to remove all subsidies (with profound economic impacts on policy holders) or continue subsidies that seem to encourage over-development in the floodplains of the nation. The research also focuses on the Community Rating System, a program intended to encourage communities, individuals, and firms to undertake more extensive mitigation beyond the bare minimum, but with such programmatic complexities that many communities fail to take full advantage.

Keywords: Flood mitigation, Rural communities, River communities, Flood insurance



HYDROLOGIC ANALYSIS OF A 100-YEAR FLOOD EVENT IN A SMALL RURAL WATERSHED IN CLINTON COUNTY, PA

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The US EPA reports precipitation from extremely heavy storms has increased 70 percent in the Northeast since 1958 (2016). NASA warns that Northeast will experience more heavy downpours and changes in patterns of precipitation will pose growing challenges to many aspects of life (2017). As per the IPCC (2007), evidence indicates that the net damage costs of climate change are likely to be significant and to increase over time.

The residents of Sugar Run sub-watershed (1.25 mi^2) within the Beech Creek watershed in Clinton County, PA experienced a total of 6.5 inches of rain in two hours on June 27, 2013. This event resulted in a flash flood that caused $17 million damage to property, one casualty, and 32 miles of road damage in the area. The amount and the intensity of rainfall corresponded to a 100-year event for the region. However, the rain event was localized in nature and did not have much impact on nearby USGS gaging stations. Field data on personal property and infrastructure damage caused by the flood were documented during and after the flood. The extent and the nature of the flood were analyzed using several hydrologic theories to determine frequency of the rain event, velocity and discharge of the Sugar Run at bankfull stage and flood stage, peak discharge during the flood, time of concentration of surface run-off following the rain event, and the duration of storm flow. The velocity of the flow (0.8 ft sec^{-1}) and discharge (<1 ft^3 sec^{-1}) in Sugar Run during normal flow conditions were determined to compare with values calculated for the flood event. The data show that the calculated flow velocity at bankfull stage (6 ft sec^{-1}) and the peak discharge during the flood (690-780 ft sec^{-1}) were an order of magnitude higher as compared to those values during normal flow conditions.

Based on hydrologic analysis of the data, it is concluded that the flood water must have been flowing at 0.6 ft sec^{-1}, which corresponded to a peak discharge rate of 690 ft^3 sec^{-1} over the floodplain (with a cross sectional area of 1180 ft^2) in Sugar Run during the flood peak discharge. The calculated values are in agreement with eyewitness accounts. The hydrologic methods applied to verify the field evidence and reported observations about the flood damage proved to be valuable tools, which can be used to predict the extent of future floods caused by similar intense precipitation events in small watersheds.

Keywords: heavy downpours, flash flood, small watershed, rural PA