NC STATE UNIVERSITY | Stream Restoration Program

EcoStream

Stream Ecology and Restoration Conference

Ridgeline to Thalweg

August 22-25, 2016

Renaissance Asheville Hotel

Asheville, North Carolina

ncsu.edu/srp/conference

Hosted by

NC State University Stream Restoration Program

NC Sea Grant

NCSU Department of Biological & Agricultural Engineering

North Carolina Cooperative Extension

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Conference Proceedings

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Continuing Education Credits

Professional Engineers may earn 12 PDHs for the Tuesday and Thursday sessions plus 4 PDHs for the Watershed Planning Workshop on Wednesday. The NC Board of Landscape Architects has approved 10 continuing education credits for the conference, course number 11684. Planners may earn 12 CMs, American Planning Association course #9106400. Other professionals may appeal to their respective boards to obtain professional education credits.

About the Conference

EcoStream - Stream Ecology and Restoration Conference is NC State University Stream Restoration Program's biennial southeast stream restoration conference. With preserving, enhancing, and restoring the entire riparian ecosystem in mind, EcoStream is the primary conference that focuses on stream restoration for the southeast region. This conference facilitates discussions among restoration practitioners, managers and scientists towards advancing ecological restoration to better achieve functional inter-connectedness of wetlands, streams, hydrology, riparian corridors and the biologic communities they support. Through presentations, panel conversations, exhibits and networking among peers and colleagues, the 2016 EcoStream conference will continue to influence the future of stream restoration in the Southeast.

The 2016 EcoStream Conference will focus on a holistic, watershed approach to stream ecology and restoration: Ridgeline to Thalweg. This watershed-focused agenda includes sessions on topics such as emerging technologies, urban environments, riparian buffers, TMDL, partnerships, and more. The conference also features a special watershed planning workshop and interactive field tours of stream sites throughout the Asheville region.

NC State University faculty developed the Stream Restoration Program (SRP) as a comprehensive education program to improve the practice of stream restoration. SRP is a team of faculty, staff, and students working to improve water quality and aquatic ecology through research, demonstration projects, and education. SRP offers a series of River Course workshops in which professionals learn about stream assessment, design, construction, vegetation installation, invasive plant management and monitoring. The SRP has established more than 60 grant-funded projects across the state to demonstrate and evaluate stream restoration practices in a variety of watershed conditions. In addition, NC State University has provided leadership since 1998 in organizing the biennial Southeast Stream Restoration Conference, now branded EcoStream. Starting in Elkin, eleven conferences have been held at cities across North Carolina with 300-500 attendees, 30-45 exhibitors and 70-85 oral presenters. EcoStream provides a valuable forum for exchanging ideas and experiences and encourages continuing research and development in addition to enhancing networking among restoration professionals.

Asheville, North Carolina, located in the Blue Ridge Mountains, is the perfect setting for the 2016 EcoStream Conference, which will represent the 12th regional stream restoration conference for the southeast. Situated in Buncombe County, Asheville is located in a mountain landscape where the waterways and land are inextricably linked. A vibrant downtown, excellent facilities, and abundant surrounding rivers and waterfalls provide an excellent setting for a productive forum for sharing ideas and information relevant to stream ecology and restoration.

We thank the conference sponsors, who have made this event possible. Over 30 companies involved in all aspects of stream restoration are providing support and exhibits throughout the conference. As a result of this tremendous support, we are able to provide social events on all three nights of the conference to offer fun networking opportunities and a taste of Asheville.

Planning Committee

Barbara Doll, Conference Co-Chair
Extension Assistant Professor, NC State University
Water Protection & Restoration Specialist, North Carolina Sea Grant

Karen Hall, Conference Co-Chair
Extension Assistant Professor, NC State University

Julia Fiore, Conference Coordinator
NC State University

Christina Shepard, Conference Coordinator
NC State University

Program Committee

We gratefully acknowledge our conference partners for their help in planning and promoting the 2016 EcoStream Conference!

- American Rivers
- Auburn University
- Blue Ridge Conservancy
- Blue Ridge Resource Conservation & Development Council, Inc.
- Cawaco RC&D
- Duke Energy
- Engineering303
- Haywood Waterways Association
- Hiwassee River Watershed Coalition, Inc.
- Jennings Environmental
- Kimley-Horn
- Michael Baker International
- North Carolina Department of Agriculture and Consumer Services
- North Carolina Department of Environmental Quality
- North Carolina Forest Service
- North Carolina Wildlife Resources Commission
- North State Environmental
- South Carolina Department of Natural Resources
- South Carolina Department of Transportation
- Stream Mechanics
- Tennessee Stream Mitigation Program
- U.S. Army Corps of Engineers
- U.S. Department of Agriculture – Natural Resources Conservation Service
- U.S. Environmental Protection Agency
- U.S. Fish & Wildlife Service
- University of Georgia
- University of Kentucky
- Wildlands Engineering
- Zink Environmental

Social Networking Events

Evening socials courtesy of our Hellbender Sponsors:

Baker Grading and Landscaping

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Opening Reception at Twisted Laurel – Monday, August 22 – 6:00-9:00 pm

Start the conference off with networking, drinks, and hors d'oeuvres at Twisted Laurel, just around the corner from the Renaissance at 130 College Street. Attendees will receive two red drink tickets at the door.

Poster Reception at Renaissance Hotel – Tuesday, August 23 – 5:10-7:00 pm

Join us for a reception in the exhibit hall and pre-function corridor and enjoy drinks and hors d'oeuvres while visiting the poster presentations and sponsor exhibits. Two yellow drink tickets will be provided in your name badge.

Conference Social at Salvage Station – Wednesday, August 24 – 5:00-9:30 pm

Enjoy an evening by the French Broad River with local beer, barbeque, and live music at Salvage Station, 468 Riverside Drive. Dinner by Luella's Bar-B-Que (including vegetarian options) and music by Uptown Drive Bluegrass Band. Two green drink tickets will be provided in your name badge, and a complementary shuttle will be available to and from the hotel.

Special Thanks to our 2016 Sponsors!

This event is made possible by the generous support of our sponsors.

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Exhibitor List

Exhibits are displayed in Salon C and the pre-function corridor. Join us for a poster and exhibit reception on Tuesday, August 23, 2016 5:10-7:00 pm.

Acer Environmental, LLC
P.O. Box 366
Buford, GA 30515
404-520-9422
acerenv.net

Altamont Environmental, Inc.
231 Haywood Street
Asheville, NC 28801
828-281-3350
altamontenvironmental.com

ArborGen, Inc.
168 Lenox Place
Athens, GA 30606
912-655-1725
arborgen.com

Atlanta Hobby
6110 Parkway North Drive
Cumming, GA 30040
678-513-4450
atlantahobby.com

Backwater Environmental
P.O. Box 1654
Pittsboro, NC 27312
919-523-4375
backwater.biz

Baker Grading & Landscaping
1000 Bat Cave Road
Old Fort, NC 28762
(828) 668-5060
bakergrading.com

Civil & Environmental Consultants, Inc.
325 Seaboard Lane, Suite 170
Franklin, TN 37067
800-763-2326
cecinc.com

Copperhead Consulting
11641 Richmond Rd, PO Box 73
Paint Lick, KY 40461
859-925-9012
copperheadconsulting.com

Ecosystem Planning & Restoration, LLC
559 Jones Franklin Road, Suite 150
Raleigh, NC 27606
919-388-0787
eprusa.net

Equinox Environmental
37 Haywood Street, Suite 100
Asheville, NC 28801
828-253-6856
equinoxenvironmental.com

Ernst Conservation Seeds
8884 Mercer Pike
Meadville, PA 16335
800-873-3321
ernstseed.com

Hazen & Sawyer
4944 Parkway Plaza Boulevard
Charlotte, NC 28217
704-941-6994
hazenandsawyer.com

Jewell Engineering & Ecology, PC
PO Box 2294
Kernersville, NC 27285
540-685-3419
jewellengr.com

JMT
1130 Situs Court, Suite 200
Raleigh, NC 27606
984-269-4910
jmt.com

KCI Technologies
4601 Six Forks Rd., Suite 220
Raleigh, NC 27609
919-278-2514
kci.com

Kee Mapping & Surveying, PA
88 Central Avenue
Asheville, NC 28801
828-575-9021
keemap.com

Mellow Marsh Farm
1312 Woody Store Rd
Siler City, NC 27344
919-742-1200
mellowmarshfarm.com

Michael Baker International
797 Haywood Road, Suite 201
Asheville, NC 28806
828-412-6101
mbakerintl.com

North State Environmental
2889 Lowery Street
Winston Salem, NC 27101
336-725-2010
nsenv.com

Redwing Ecological Services, Inc.
1139 South Fourth Street
Louisville, KY 40203
502-625-3009
redwingeco.com

Resource Institute, Inc.
2714 Henning Drive
Winston-Salem, NC 27106
336-750-0522
resourceinstituteinc.org

River Works, Inc.
6105 Chapel Hill Road
Raleigh, NC 27607
919-582-3574
riverwork.com

RIVERMorph
10509 Timberwood Circle, Suite 100
Louisville, KY 40223
866-748-6673
rivermorph.com

RK&K
81 W. Mosher Street
Baltimore, MD 21217
410-728-2900
RKK.com

RoLanka International, Inc.
155 Andrew Dr
Stockbridge, GA 30281
678-779-4138
rolanka.com

S&ME, Inc.
6515 Nightingale Lane
Knoxville, TN 37909
865-970-0003
smeinc.com

Shamrock Environmental
6106 Corporate Park Drive
Browns Summit, NC 27214
800-881-1098
shamrockenviro.com

Stantec Consulting
601 Grassmere Park Rd
Nashville, TN 37211
615-829-5474
stantec.com

Timmons Group
1001 Boulders Parkway, Suite 300
Richmond, VA 23225
804-200-6500
timmons.com

Wildlands Engineering
1430 S Mint Street, Suite 104
Charlotte, NC 28203
704-332-7754
wildlandseng.com

WK Dickson & Co., Inc.
616 Colonnade Drive
Charlotte, NC 28205
704-334-5348
wkdickson.com

Wolf Creek Engineering
12 1/2 Wall Street, Suite C
Asheville, NC 28801
828-449-1930
wolfcreekeng.com

Wright Contracting
453 Silk Hope Liberty Road
Siler City, NC 27344
919-663-0810
wright-contracting.com

EcoStream 2016 - Stream Ecology & Restoration Conference

Ridgeline to Thalweg

MONDAY, AUGUST 22, 2016			
6:00-9:00 pm	*SOCIAL at Twisted Laurel, 130 College St, Asheville, NC 28801*		
TUESDAY, AUGUST 23, 2016			
8:15 am-12:00 pm	**GENERAL SESSION**		
Location	**Grand Ballroom**		
8:15 - 8:30	Conference Welcome - **Barbara Doll,** Extension Assistant Professor, NC State University, and Extension Specialist, NC Sea Grant		
8:30-9:00	The Role and Benefit of Upland and Stream Corridor Restoration Practices in the Chesapeake Bay Watershed TMDL - **Tom Schueler,** Chesapeake Stormwater Network		
9:00-9:30	Watershed Resource Registry - An Integrated Approach to Watershed Management - **Ralph Spagnolo,** US Environmental Protection Agency & **Michael Herzberger,** Maryland Environmental Service		
9:30-10:00	Functional-Based Watershed Planning Priorities - **Nancy Daly,** NC Division of Mitigation Services		
10:00-10:30	*Break*		
10:30-11:00	The Evolution of Watershed Improvement Project Selection in the City of Charlotte - **Marc Recktenwald,** City of Charlotte		
11:00-11:30	Restoration Planning at the Intersection of Landscape and Climate Change: A Case Study With Brook Trout in the Chesapeake Bay Watershed - **Todd Petty,** West Virginia University		
11:30-12:00	Barrier Prioritization Tools for Identifying Restoration Sites in the Southeast - **Erin McCombs,** American Rivers		
12:00-1:20	*Lunch*	*Lunch*	*Lunch*
1:20-3:00 pm	**CONCURRENT SESSION 1**		
Location	**Salon A**	**Windsor Ballroom**	**Salon B**
Session Title	***A. Stream Restoration as a Component of TMDL Management***	***B. Partnerships & Public Perception***	***C. Quantifying Functional Uplift***
Moderator	Andy Painter, NC Division of Water Resources	Andrea Hughes, US Army Corps of Engineers	Tim Baumgartner, NC Division Mitigation Services
1:20-1:40	**Roger Windschitl**- TMDL Compliance: The Maryland State Highway Administration's Multi-faceted Planning and Implementation Approach to Achieving Established NPDES Municipal Separate Storm Sewer	**Annemarie Abbondanzo** - Partnerships in Action: Working Collaboratively to Develop, Promote, and Expand Economically, Scientifically, and Socially Sound Ecological Restoration	**Paxton Ramsdell** - A Function-Based Approach to Stream Mitigation Policy
1:40-2:00	**Josh Gilman** - Stream Restoration Toward TMDL Compliance and MD SHA Implementation Examples	**Callie Moore** - Recruiting Volunteer Labor in Maintaining Restoration Project Buffers Long-Term	**Cidney Jones** - Stream Lift Quantification Tool Case Studies
2:00-2:20	**Josh Running** - How much money is good data worth? An examination of the monetary impacts that occur within the range of variables associated with nutrient reduction estimates from TMDL based stream projects in Maryland and Virginia	**Tim Schueler** - Public Perception of Stream Restoration: Results of a Web-Based Survey	**Tom Barrett -** Developing a Large Woody Debris Performance Standard for Stream Restoration Projects
2:20-2:40	**Ashley Hall** - Exploring Stream-Focused BMPs for VDOT and Other Linear Entities	**Weibin Xu** - Recreational Value of Riparian Vegetation in Public Green Spaces, Sydney, Australia	**Ron Johnson** - Cat Creek Stream and Wetland Restoration - A Functional Evaluation in Retrospective
2:40-3:00	**Daren Pait** - Using Stream Restoration to Meet Chesapeake Bay TMDL Requirements – The Design of Stoney Run and a Summary of its Nutrient Reduction Credits	**David Woodie** - Correcting the Past	**Lisa Fraley-McNeal & Bill Stack** - Stream Restoration as Part of a Comprehensive Watershed Restoration Framework to Meet Water Quality Objectives
3:00-3:30	*Break*	*Break*	*Break*

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Ridgeline to Thalweg

TUESDAY, AUGUST 23, 2016 Continued			
3:30-4:50 pm	CONCURRENT SESSION 2		
Location	Salon A	Windsor Ballroom	Salon B
Session Title	*A. Prioritizing Restoration Opportunities*	*B. Improving Macroinvertebrate Habitat*	*C. Emerging Technologies*
Moderator	*Ron Johnson, AECOM*	*Jake Byers, Michael Baker International*	*Rachel Smith, Henderson County SWCD*
3:30-3:50	**Angela Allen** - Identifying and Prioritizing Stream Restoration and Stormwater Control Measure Projects in the City of Durham Little Lick Creek Watershed Improvement Plan	**Ward Marotti** - Benthic Macroinvertebrate Habitat Enhancement and Relocation: Smith Creek, NC	**Ken Barry** - Comparison of 2D Modeling Approaches
3:50-4:10	**Devin Schenk** - The Nature Conservancy's Watershed-Based Site Selection Approach: Endeavoring to Improve Results and Increase Benefits	**Kevin Tweedy** - Innovative Approaches to Improve Macrobenthic Invertebrate Communities Through Stream Restoration	**Nathan Ober** - A Live Demonstration of 3D Stream Restoration Design Using AutoCAD® Civil 3D® 2016 Corridors
4:10-4:30	**Will Wilhelm** - Rehab is Not Just for Celebrities and Bad Knees. Our Urban Waterways Need Some Too	**Anthony Roux** - Evaluation of the Relationship Between Stream Habitat Quality and Species Traits in Piedmont Streams in North Carolina	**Matthew Cusack** - Integrating Light Distance And Ranging (LiDAR) Elevation Data into Jurisdictional Determinations and Conservation Easement Design
4:30-4:50	**Amber Coleman** - Watershed Assessment to Identify Stream Restoration and Stormwater Management Opportunities in Morrisville, NC	**Sandra Clinton** - Pre-restoration Monitoring of a Forested Urban Watershed Provides Knowledge of How Urban Streams Function	**Marla Denicola** - Comparison and Use of Aerial and Terrestrial LiDAR for Stream Restoration
5:10-7:00 pm	*POSTER PRESENTATIONS & RECEPTION at Exhibit Hall (Salon C)*		

WEDNESDAY, AUGUST 24, 2016	
7:30 am-4:30 pm	FIELD TOURS & SPECIALTY WORKSHOP
7:30-4:30	**Tour:** Cane River Dam Removal and Grassy Creek Stream Restoration with zipline or tubing
8:00-1:00	**Tour:** Mills River Stream Restoration Project with Mountain Biking or Hiking to Reference Streams
8:30-4:00	**Tour:** Western North Carolina Watershed Initiative Stream Restoration
9:00-2:45	**Tour:** Drone Technology
10:00-3:00	**Specialty Workshop:** Watershed Planning Workshop at Windsor Ballroom
1:30-4:15	**Tour:** Tour de Asheville: Urban Stormwater Bike Tour
5:00-9:30 pm	*SOCIAL at the Salvage Station, 468 Riverside Dr, Asheville, NC 28801*

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Ridgeline to Thalweg

Thursday, AUGUST 25, 2016			
8:30-9:50 am	**CONCURRENT SESSION 3**		
Location	**Salon A**	**Windsor Ballroom**	**Salon B**
Session Title	***A. Addressing Nutrient Pollution***	***B. Rural Restoration & Monitoring***	***C. Dam Removal & Fish Passage***
Moderator	*Amanda Gumbert, University of Kentucky*	*Scott McClendon, US Army Corps of Engineers*	*Steve Kichefski, US Army Corps of Engineers*
8:30-8:50	**Durelle Scott** - Greenhouse Gas Emissions Across a Stream-Riparian-Upland Gradient: What Does This Mean for Floodplain Restoration?	**Yixiong Cai** - Stream Rehabilitation for Biodiversity Hotspots in Face of Climate Changes	**Kris Bass** - Power Dam: Linking Dam Removal and Sediment Transport Modeling with Downstream Restoration
8:50-9:10	**Erich Hester** - Effects of In-stream Structures and Floodplain Restoration on Removal of Excess Nutrients	**Oakes Routt & Kevin Rexroat** - Hatchery Creek Stream Restoration Project – Monitoring Protocols to Evaluate Impact of Project on Various Trout Life Stages	**Jake McLean & Andrew Bick** - Considerations for Dam Removal and Aquatic Organism Passage Projects
9:10-9:30	**Michael Mallin** - Protecting Coastal Streams: the Wilmington Experience	**Greg Jennings** - Stream and Wetland Restoration at Rendezvous Mountain State Forest and Grassy Creek	**Kristen (Cannatelli) Coveleski** - Dam Removal: Turning Restoration Goals into a Successful Project.
9:30-9:50	**Steven Hall** - Nitrogen Absorption Rates by Plants and Sessile Animals: Restoring and Maintaining Stream/Estuary Waters	**Wanda Lawson** - Using Stream Restoration for Pollution Reduction: Elm Fork and Minors Creek Stream Restoration Case Study	**Eric Merriam** - Use of Telemetry, Genetics, and Isotope Analysis to Characterize Brook Trout Response to Culvert Replacement in an Appalachian Watershed
9:50-10:20	*Break*	*Break*	*Break*
10:20-11:40 am	**CONCURRENT SESSION 4**		
Session Title	***A. SPECIAL SESSION***	***B. Riparian Buffer Monitoring & Management***	***C. Sediment Sources and Modeling***
Moderator	*Nancy Daly, NC Division of Mitigation Services*	*Eve Brantley, Auburn University*	*Jamie Blackwell, NC Division of Mitigation Services*
10:20-10:40	Watershed Resource Registry-An Integrated Watershed Approach to Natural Resource Protection and Management **Ralph Spagnolo**, US Environmental Protection Agency and **Michael Herzberger**, Maryland Environmental Service	**Michele Goodfellow** - Riparian Habitat Quality Assessment Following Stream Restoration	**Kurt Cooper & Nora Korth** - Holistic Stormwater Management Partnered with In-Stream Restoration to Reestablish Stream Integrity
10:40-11:00		**Alea Tuttle** - Meeting Vegetation Success Criteria: Should We "Hedge" our Bets with Supplemental Plantings?	**Trae Timmerman** - Automated Geospatial Model Development for Stream Bank Erosion Spatial Vulnerability Determination for Coastal and Upland Streams
11:00-11:20		**Karen Hall** - Vegetation in NC Wetlands: What We Hope to Learn About Anthropogenic Environmental Changes Through Long-Term Monitoring	**Mike Miller** - Process-Based Restoration of Streambed Sediment Disturbance Regime
11:20-11:40		**Timothy Ormond** - Productive Food Forest Systems for Riparian Buffers	**Mitchell McMillan** - Streambank Erosion Model for the Northern Gulf of Mexico Coastal Plain
11:40-12:40	*Lunch*	*Lunch*	*Lunch*

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Thursday, AUGUST 25, 2016 Continued			
12:40-2:00 pm	**CONCURRENT SESSION 5**		
Session Title	***A. SPECIAL SESSION***	***B. SPECIAL SESSION***	***C. Working in Confined Corridors***
Moderator	*Wendy Patoprsty, Blue Ridge Conservancy*	*Tony Able, US Environmental Protection Agency*	*Shawn Wilkerson, Wildlands Engineering, Inc.*
12:40-1:00	Using Stream Restoration on UGA's Campus as a Focus for Engaging all Three Land Grant Missions in Sustainability **Laurie Fowler, James Wood and Jon Calabria,** University of Georgia	Leave it to Beavers: Natural Systems Restorations in Urban Environments **Nancy Jones** and **Kevin McCauley,** Blue Heron Nature Preserve, **Elizabeth Suddeth**, Georgia Gwinnett College and **Amber Hughes**, Georgia State University	**Isaac Hinson**- Lessons Learned in the Design, Construction, and Monitoring of a Large-Scale RSC
1:00-1:20			**Jeffrey Duke** - When Stream Restoration Meets Mastodon
1:20-1:40			**Bob Siegfried** - Root Step / Pool Channels: Biologically Controlled, Steep Coastal Plain Channels
1:40-2:00			**Ian Turner** - Headwaters, Hatfields, and Hollows: Stream restoration in the West Virginia Coalfields
2:00-2:20	*Break*	*Break*	*Break*
2:20-3:40 pm	**CONCURRENT SESSION 6**		
Location	**Salon A**	**Windsor Ballroom**	**Salon B**
Session Title	***A. Urban Restoration Case Studies***	***B. Tidying Up A Bit***	***C. Diversifying Habitat in the Urban Environment***
Moderator	*Crystal Amschler, US Army Corps of Engineers*	*Calllie Moore, Hiwassee River Watershed Coalition*	*Paul Wiesner, NC Division of Mitigation Services*
2:20-2:40	**Alex James** - How Can One Little Creek Cause So Much Trouble? Overcoming Boundary Lines, Budget Constraints and Other Issues During An Urban Stream Restoration	**Matthew Gramza** - Pipeline Stream Crossing Exposure Repair, A More Sustainable Approach	**Crystal Taylor** - Engineers and Biologists: It Takes A Village
2:40-3:00	**Kelly Mattfield** - Multiple Elements/Multiple Benefits – East Jesters Creek Phase 5	**Udare Santha** - Improved Innovative Stream Bank Restoration Techniques	**Todd St. John** - Simultaneously Improving Drainage and Water Quality by Restoring Streams, Wetlands, and Tidal Marsh in Wilmington NC
3:00-3:20	**David Tuch & Grant Ginn**- New Belgium Brewery: Brownfields to Green Infrastructure	**Jeffrey Opel** - The Use of Compost Based Structural BMP to Stabilize Stream Channels	**David Phlegar** - Restored Water Quality and Habitat Functions by Use of Created Floodplain Sloughs Along South Buffalo Creek in Greensboro, NC
3:20-3:40	**Eve Brantley** - Athletes and Infrastructure: Parkerson Mill Creek Urban Stream Enhancements	**Mitch Woodward** - Hands-On Stream Repair Workshops for Homeowners	**Justin Barrett** - Restoring Alabama's Coast: Case Study on Natural Channel Design for Applied Shear Stress, 2-Dimensional Modeling and Project Implementation
3:40-4:00	*Break*	*Break*	*Break*
4:00-5:00 pm	**GENERAL SESSION**		
Moderator	*Karen Hall, NC State University*		
4:00-4:20	Compensatory Mitigation Performance Evaluation - **Brian Topping,** US Environmental Protection Agency		
4:20-4:40	Tennessee, North Carolina, and South Carolina: How Many Credits Would Your Stream Mitigation Project Generate? - **Joshua White,** Civil & Environmental Consultants, Inc.		
4:40-5:00	Stream Mitigation in North Carolina, a Regulatory Perspective - **Scott McLendon,** US Army Corps of Engineers		
5:00	*Summit Adjourned*		

Directory of Poster Presentations

Posters are displayed in the Windsor Hallway. Join us for a poster and exhibit reception on Tuesday, August 23, 2016 5:10-7:00 pm.

1. **Stormwater management as a prescription for "urban stream syndrome" – Kristan Cockerill** and William P. Anderson, Jr., Appalachian State University

2. **Brandenbark™: Mitigation/Management Tool for Projects Involving Bark Roosting Bats – Alexi Dart-Padover**, Joshua Adams, Piper Roby, Price Sewell, and Zachary Baer, Copperhead Environmental Consulting; Mike Brandenburg, DPW Natural Resource Branch

3. **Using Photogrammetry to Document Stream Topography – Caleb Duke**, Eve Brantley, and Thorsten J. Knappenberger, Auburn University

4. **Large scale dispersal of brook trout in a restored central Appalachian watershed – Benjamin Harris** and Todd Petty, West Virginia University

5. **Design Guidance Synthesis and Summary for In-Stream Structures – Elizabeth Hickman** and Tess Thompson, Virginia Tech

6. **Watershed-scale brook trout restoration efforts within a high-elevation Appalachian stream network – Paul Kinder**, Todd Petty, and Eric Merriam, West Virginia University

7. **Hydrologic and Water Quality Performance of Regenerative Stormwater Conveyance Installed to Stabilize an Eroded Outfall in Durham, NC – Kevin Koryto**, NC State University

8. **Nitrogen and phosphorus removal in ecological drainage ditch used to treat domestic sewage in a small catchment of the upper Yangtze River – Mathieu Nsenga Kumwimba** and Bo Zhu, Chinese Academy of Sciences

9. **New Stormwater Management Metrics for North and South Carolina to Address Receiving Stream Geomorphology: Proposed Methods and Anticipated Results – Charlie Stillwell**, NC State University

10. **Brook trout response to habitat enhancement construction in an Appalachian river main stem – Cory Trego, Eric Merriam**, and Todd Petty, West Virginia University

11. **Effects of Agricultural Restoration Practices on Stream Health in the Shenandoah Valley, Virginia – Bruce Wiggins**, Kristianna Bowles, Amanda Crandall, and Jessie Doyle, James Madison University

Field Tours – Wednesday, August 24

Meet in the pre-function corridor at least 15 minutes prior to departure time. Each tour has a different departure and return time. Breakfast will be provided in the hotel 7:00-9:00 am, and lunch will be provided on the tours. Tours are included in conference registration. Please stop by the registration table with questions or to confirm your tour.

The field tours are sponsored by our Stonefly Sponsors. Special thanks to Civil & Environmental Consultants, Ecosystem Planning & Restoration, Wildlands Engineering, and Stantec for their support!

Tour of Cane River Dam Removal and Grassy Creek Stream Restoration (zipline or tubing)
This tour will visit two recently completed stream restoration projects. The first stop will be the Cane River Dam removal project in Burnsville. In addition to removing the dam for mussel habitat, 2,500 feet of stream restoration was completed. We will then travel to nearby Spruce Pine to visit the Grassy Creek project. Both restoration projects feature in-stream structures (boulder and log vanes), channel relocation, bank stabilization (toe wood), and habitat for aquatic organisms, including hellbender. Tour participants will then be dropped off for either a zipline or tubing adventure, and a few seats are available for participants that only want to visit the stream restoration projects. The zipline will feature expansive views of the Asheville skyline and tubers will float down the nearby French Broad River.
Depart 7:30 AM
Return approx. 1:30 PM for stream sites only, 4:30 PM for zipline and tubing participants

Mills River Stream Restoration Project (mountain biking or hiking)
The group will walk along a 2000-foot restoration project on the North Mills River, with discussions about in-stream structures (boulder and log vanes), bank stabilization (toe wood), and habitat for aquatic organisms. In addition macroinvertebrate sampling and observation of benthic organisms will be demonstrated. The mountain bike tour will include a vigorous mountain bike ride through trails in the Pisgah National Forest. The trail ride will cover 10 miles on a moderate to intense trail through variable terrain. The hiking tour will lead participants through the National Forest to observe morphological and biological conditions in high-quality streams in and around Bent Creek. Participants should plan to hike up to 4 miles at a brisk pace through variable terrain.
Depart 8:00 AM
Return approx. 1:00 PM

Western North Carolina Watershed Initiative Stream Restoration Bus Tour
This tour will make stops at various stream restoration projects in western NC. These restorations are part of the Western NC Stream Restoration Initiative. This is an innovative and large-scale effort to improve the aquatic resources and agricultural capacity throughout western NC. This part of the state traditionally has been underserved by programs to improve water quality. Over 30 miles of degraded streams and impaired fisheries habitats have been identified by the USDA-NRCS in the initial first round assessment. Given that mountain trout fishing annually contributes over $174 million to the NC economy, clean water is essential to western

NC. The goals of this initiative are to reduce stream bank erosion, enhance water quality, stabilize agricultural lands, improve fisheries resources and boost economic opportunities. We will tour three sites in Haywood and Macon Counties. Two of these sites were completed in 2015 and involved re-construction of channel dimensions and floodplain benches along with installation of in-stream structures and toe-wood. Depending on the construction schedule, it is anticipated that the third site will be under construction during our visit. Representatives from the Western Initiative as well as stream designers will be on site to discuss each project and answer questions.
Depart 8:30 AM
Return approx. 4:00 PM

Drone Technology Tour
This tour will feature use of drones for stream data collection and will include a tour of a recently constructed stream restoration project. The Timmons Group will be on hand to demonstrate collecting of imagery, video and topo data at the restoration site. In addition, Cliff Whitney from Atlanta Hobby, an expert on drone technology, will be on site to exhibit various drone models and discuss their application. Atlanta Hobby is one of the largest designers and builders of Quad Copters and Drones in the country and they handle federal licensing of drones for commercial use.
Depart 9:00 AM
Return approx. 2:45 PM

Tour de Asheville: Urban Stormwater Bike Tour
This tour will visit an assortment of old and new stormwater projects including rain gardens and stormwater wetlands, paddle trail access facilities and stream restoration efforts. The route will travel down Asheville's French Broad River and Hominy Creek greenways and includes stops in West Asheville and at multiple city parks. Get to know West Asheville and enjoy a mostly shady ride along some of Asheville's most scenic greenways.
Please note: lunch will be served in the hotel from noon-1:00 pm.
Depart 1:30 PM
Return approx. 4:15 PM

Concurrent Specialty Workshop – Wednesday, August 24

Watershed Planning Workshop
What watershed plans are already developed? How can multiple watershed plans combine together to be more useful? Where is the best place to spend money for improving my watershed? This workshop will explore these and other questions facing agencies, municipalities and watershed organizations. You will learn about the NC Watershed Stewardship Network, a newly formed program intended to empower more effective watershed stewardship. You will also learn about online tools to connect people and share resources, how to leverage limited resources to more efficiently improve watershed health and how to better communicate on the ground watershed efforts and program. Professional engineers earn 4 PDHs.
Workshop in Windsor Ballroom 10:00 AM to 3:00 PM

Oral Presentation Abstracts

The Role and Benefit of Stream Restoration in Restoring the Chesapeake Bay

Tom Schueler
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Abstract: The Chesapeake Bay TMDL requires nutrient reductions on the order of 15 to 40% from existing urban watersheds by the year 2025. This presentation reviews the mix of upland and stream corridor restoration practices that are needed to meet watershed nutrient reduction targets. Major upland practices include stormwater retrofits, urban nutrient management, street cleaning and LID practices installed at new and redevelopment sites. Stream corridor practices include a diverse assortment of stream restoration techniques, storm drain cleanouts and eliminating nutrient discharges from grey infrastructure.

The presentation will review the science and lessons learned from the expert panel that developed the sediment and nutrient crediting protocols for stream restoration practices, with an emphasis on implementation and permitting issues. The potential significance of other stream corridor practices to achieve nutrient reduction targets will also be discussed. The presentation will conclude with some observations on how the TMDL process will influence the practice of urban watershed management in the coming years.

About the Speaker: Tom Schueler has more than 30 years of experience in practical aspects of

stormwater practices to protect and restore urban watersheds. He currently directs the Chesapeake Stormwater Network, a non-profit organization devoted to implementation of more sustainable stormwater practices across the Chesapeake Bay watershed. Tom also directs the Chesapeake Bay Stormwater Training Partnership, which provides webcasts, workshops and on-line training modules to train engineers on new practices. Tom also currently serves as the stormwater coordinator for the EPA Chesapeake Bay Program, and has and has guided eight expert panels to define removal rates for urban BMPs, including stormwater retrofits, stream restoration, stormwater retrofits, LID practices, urban nutrient management, homeowner BMPs, enhanced erosion and sediment control, nutrient discharges from grey infrastructure and street cleaning. Tom also is active in promoting better stormwater regulations and permits in communities across the Bay. Tom has written more than a dozen local and state stormwater engineering design manuals. Tom founded the Center for Watershed Protection in 1992, and loves stream walks, good scotch, and bad dogs.

Watershed Resource Registry: An Integrated Approach to Watershed Management

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Abstract: The Watershed Resources Registry (WRR) is an interactive GIS-based screening tool, a product of the Green Highways Partnership and Maryland State Highway Administration's Route 301 Project, created to improve resource planning and mitigation decision-making using a watershed approach, by integrating regulatory and non-regulatory programs. Historically, program management decisions have been constrained by the "stovepipe" or programmatic nature of the agencies' legislation. This narrow approach, while useful for specific resource protection, impedes broad-based collaborative planning and application of environmental programs. The element that makes the WRR unlike many other mapping and targeting tools is the level of agency collaboration and program integration. As a result, a Technical Action Committee (TAC), consisting of staff from partner agencies including: U.S. Environmental Protection Agency (EPA), Region 3; U.S. Army Corps of Engineers (Corps), Baltimore District; Maryland Department of the Environment (MDE); State Highway Administration (SHA); U.S. Fish and Wildlife Service (FWS); Maryland Environmental Services (MES); Maryland Department of Natural Resources (DNR); and the U.S. Federal Highway Administration (FHW A), collaboratively strategized the development, progress, and future of the WRR, and uses it as a vehicle to discuss how to reduce cost and maximize environmental benefit. The WRR was designed to address priority resources goals, identify watershed needs, and to facilitate the integration of multiple local, state, and federal environmental program goals at a watershed level (CWA 319, 401, 402, 404, 303(d), Green Print, Rural Legacy, NEPA, TMDL Implementation, stormwater management, etc.). Using available data from various organizations, the WRR reveals a comprehensive picture of watershed conditions and identifies opportunities for aquatic and terrestrial creation, restoration, enhancement and preservation. The WRR currently identifies ecological opportunity areas throughout the state of Maryland and scores each opportunity area with a score from one to five stars (five stars indicating the greatest ecological value). These scores are based upon eight suitability analyses for both preservation and restoration opportunities for: Wetlands, Uplands, Riparian corridors, and Stormwater areas. The TAC is also currently working on the development of a suitability analysis for Stream Stability to be incorporated into the registry. The WRR is currently available to the general public for the state of Maryland via the Watershed Resources Registry Outreach Website and Web Application found at http://www.watershedresourcesregistry.com/. It is currently being used by the partner agencies as well as other agencies that have recently become familiar with the WRR. Agencies

are currently using it for an array of activities such as: targeting strategies for TMDL implementation and CWA §404 NEPA related projects, targeting ecological opportunities for preservation and restoration, and in support of MD E's In-Lieu Fee program for tidal and non-tidal wetland permitting activities, among other things. Additionally, the EPA uses the WRR to gather information prior to conducting site visits and to provide supportive materials for briefings and other projects. As a result of overwhelming interest in the WRR following a national workshop, EPA Region 3; the Corps, Philadelphia District; Delaware Department of Natural Resources & Environmental Control (DNREC), Delaware Department of Transportation (DelDOT) and MES are currently developing a WRR Delaware and Pennsylvania. Using a "skeletal" prototype solely consisting of national and federal data layers, and the Delaware and Pennsylvania TAC is determining which specific state and/or local data layers would be the most beneficial for state specific goals.

About the Speakers: Ralph Spagnolo is the Watershed Restoration Program Manager for the

Water Protection Division of the U.S. Environmental Protection Agency. Ralph promotes the integration of regulatory and non-regulatory Sections of the Clean Water Act using the watershed approach. Ralph is the EPA lead for the implementation of the WRR in Region III. He coordinates state and local governments, the private sector and watershed organizations with federal water programs. Mr. Spagnolo serves as the national representative for EPA on the National Technical Committee for Hydric Soils and the Wetland Delineation Manual. He also is an adjunct professor at Cabrini College in Pennsylvania.

Michael Herzberger is a GIS Manager for the Maryland Environmental Service, an independent State Agency created to protect the state's air, land and water resources. Mr. Herzberger is responsible for oversight of various GIS-based services for numerous entities within the public sector. Michael has a B.S. in Geography and Environmental Planning and a minor in GIS from Towson University located in Baltimore, Maryland (2005).

Functional-Based Watershed Planning Priorities

Nancy Daly
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Abstract: In support of the 2008 Federal Mitigation Rule (33 CFR Parts 325 and 332), the NC Division Mitigation Services (DMS) is transitioning to functional based watershed priorities. Throughout its program history, DMS has defined priorities for restoration within spatial boundaries defined by 14-digit hydrologic units. New datasets are available to evaluate functions at a finer resolution. Using new datasets and modeling tools, DMS, in partnership with UNC-Chapel Hill and Duke, developed a statewide modeling approach to evaluate hydrology, water quality and habitat at a catchment scale based upon the National Hydrograhy Dataset Plus (v2) dataset. United States Geological Service (USGS) regional regression equations and the Spatially Referenced Regressions of Watersheds (SPARROW) model (Smith et al, 1997; Schwarz et al, 2006) are used to evaluate hydrology and water quality, respectively. The maximum entropy model (Maxent) is used to evaluate habitat suitability for representative fish indicator species. By incorporating new data and tools, DMS is able to identify watersheds of greatest functional concern with the best opportunity for improvement. This strengthens DMS ability to define watershed-specific goals and may be used to support implementation of projects that focus on functional priorities.

About the Speaker: Nancy Daly is the Watershed Planning Supervisor for the NC Division of Mitigation Services (DMS). Ms. Daly currently oversees development of watershed planning activities for DMS and coordinates DMS activities with other state agencies and conservation programs. Ms. Daly has sixteen years of experience including five years with the private sector performing stream and wetland restoration and two years with a non-profit land conservation organization conducting watershed analyses and landowner outreach. Ms. Daly received a B.S. in Biology from UNC-Chapel Hill and a M.S. in Biology from UNC-Wilmington.

The Evolution of Watershed Improvement Project Selection in the City of Charlotte

Marc Recktenwald
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Abstract: Charlotte Storm Water Services (CSWS) watershed improvement project selection has evolved over the last two decades. What started with a few industrious staff members looking for more natural approaches to address stream erosion issues on a few sites is now a comprehensive watershed improvement program that includes a Stream and Wetland Mitigation Bank, a Post Construction Stormwater Control Fee In-lieu program, and dedicated CIP funding. Throughout the development of the program the City has utilized watershed based approaches to identify projects that address the conditions in its watersheds. As CSWC moves forward, the City will continue to refine its site selection approach as a part of strategic and watershed planning process. It will also work to develop new partnership opportunities in the public and private sector. This presentation provides a brief history of the development of past project selection tools and a look into how the program plans to build upon those tools to address future needs and partnership opportunities.

About the Speaker: Marc Recktenwald is the Water Quality and Environmental Permitting Program Manager for the City of Charlotte. His team is responsible for the protection and improvement of the City's surface waters. Their responsibility includes implementation of the City's NPDES Phase I permit and the development and implementation of watershed improvement projects through multiple funding sources including a mitigation bank and In-lieu fee program. He accepted this position in January 2014 after eleven years with the North Carolina Ecosystem Enhancement Program. He has a B.S in Natural Resources from NC State University College of Physical and Mathematical Sciences and has over 20 years of experience in surface water related compliance and ecosystem services.

Restoration Planning at the Intersection of Landscape and Climate Change: A Case Study With Brook Trout in the Chesapeake Bay Watershed

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Abstract: The Chesapeake Bay Watershed Agreement recently established a management outcome focused on restoring and sustaining naturally reproducing brook trout populations in the Chesapeake Bay's headwater streams. Through funding by the North Atlantic Landscape Conservation Cooperative, we created a predictive model for brook trout within the Chesapeake Bay watershed that produced the following outcomes: 1- an accurate statistical model linking present-day brook trout distributions to land use conditions throughout the Chesapeake Bay watershed; 2- independent measures of anthropogenic stress (imperviousness, agriculture, and mining) and natural habitat quality (water temperature and precipitation), which allow for priority conservation areas to be identified at multiple spatial scales; 3- predictions of likely future conditions of brook trout population status under a range of climate change scenarios; 4- a web-based decision support tool that provides a user-friendly interface to examine and manipulate data and model results; 4- the ability to query, map and download data and model results, and an ability to integrate other relevant data and model products (e.g., EBTJV Patch Classification, TNC dispersal barriers, etc.); 5- a sophisticated, interactive optimization and ranking algorithm that allows for construction of multiple, optimized conservation strategies that vary depending on user-defined preferences; 6- the ability to simulate brook trout population response to spatially-explicit changes in land use within the context of current or future climate; and 7- the ability to download or print data or maps created within the web-based decision support tool. Combined, the modeling results along with the publically accessible web application will improve public awareness of conditions and vulnerabilities of the Chesapeake Bay's headwater streams and empower resource managers to implement scientifically-defensible conservation actions.

The web tool can be accessed at: www.fishhabitattool.org

About the Speaker: Todd Petty is a Professor of Aquatic Sciences at West Virginia University

and serves as Associate Dean of Academic Administration in the Davis College of Agriculture, Natural Resources & Design. He earned a bachelor's degree in Biology from the University of Virginia (1990), and an M.S. and Ph.D. in Forest Resources and Ecology from the University of Georgia (1994, 1998). After a one-year post-doctoral fellowship, he joined the WVU faculty in 2000, where he teaches courses in river ecology, watershed restoration, and vertebrate population dynamics. Dr. Petty studies watershed scale processes influencing water quality and stream fish and invertebrate assemblages. Through this research,

Dr. Petty's lab has developed an analytical process used to target high priority areas for protection and restoration of aquatic diversity. Statistical tools and data are now available through an on-line analytical system at www.fishhabitattool.org. This research is being applied to efficient restoration of fisheries throughout the Great Plains, Lake Superior, the Ohio River basin, and the Chesapeake Bay watershed. Dr. Petty's research has been funded in recent years by the USEPA, the USFWS, USGS, the WV Department of Environmental Protection, the North Atlantic Land Conservation Consortium, and the National Science Foundation.

Barrier Prioritization Tools for Identifying Restoration Sites in the Southeast

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Abstract: While some of the over 80,000 dams in the United States play an important role in water supply, flood control, and irrigation, many no longer serve their original purpose, are poorly maintained, and are good candidates for removal. Dam removal is gaining momentum as a restoration tool to increase aquatic connectivity, public safety, and recreational opportunities. American Rivers has documented the removal of more than 1,200 dams across the United States and maintains an interactive map of known projects. With limited resources and thousands of dams to prioritize for removal, information to guide the process is of principal importance. This presentation will cover the best tools for prioritizing dams for removal in the Southeast and review the general steps for a dam removal.

About the Speaker: Erin McCombs is a biologist and ecologist with particular expertise in freshwater mussels. Within American Rivers' Restoration Program, Erin facilitates and manages river restoration activities like dam removals across North Carolina, South Carolina and Tennessee. She works to establish collaborative partnerships to facilitate cost effective restoration projects, increase communication between researchers and practitioners, and further the science of restoration ecology. In the Blue Trails Program, Erin protects rivers and riverside lands by enabling communities to embrace their local streams through healthy recreation.

TMDL Compliance – The Maryland State Highway Administration's Multi-faceted Planning and Implementation Approach to Achieving Established National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permitting Goals

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Abstract: The Chesapeake Bay has long been a treasured natural resource and economic driver for the mid-Atlantic region. For decades, the health of the Bay has been in a degraded state due to increased sediment, phosphorus and nitrogen inputs resulting in poor water quality, habitat and fisheries. However, based on the Chesapeake Bay Foundation's 2014 State of the Bay Report; the Bay is improving, but is still considered dangerously out of balance. The Chesapeake Bay Total Maximum Daily Load (TMDL) was implemented in 2010 with the focus of reaching goals by 2025.

The MD SHA was issued its NPDES MS4 permit in October 2015 and has implemented a multi-faceted approach to treat stormwater runoff and attain its set waste load allocation/TMDL goals for receiving waters through reforestation, stormwater management, stream restoration and outfall stabilization. Due to the extensive network of roads and facilities managed by the MD SHA, this program has required significant planning, agency coordination, accounting, landowner interaction, design implementation and overall program management. This presentation focuses on a discussion of MD SHA's overall TMDL goals and the process required to implement projects from initial planning through design, construction and monitoring to achieve the restoration of twenty percent of previously developed impervious land as described in Maryland's Watershed Implementation Plan (WIP).

About the Speaker: Roger Windschitl is a Principal and Senior Environmental Scientist with Stantec's Environmental Services group in Laurel, MD. Throughout his 20 years of experience working with the transportation, utility, and environmental industries, he has led assessment, permitting and restoration projects that have included water quality evaluations, geomorphic studies, site searches, urban channel restorations, and wetland mitigation designs. Roger is currently assisting the Maryland State Highway Administration with the implementation of stream restoration projects in support of its TMDL program as a project manager.

Stream Restoration toward TMDL Compliance and MD SHA Implementation Examples

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Co-Author: Harry Canfield

Abstract: Many MS4 NPDES stormwater permits promote implementation of structural BMPs toward improving water quality, and ultimate achievement of the designated use classification for streams both within their political boundary, as well as the adjacent receiving network. This is often attempted by the responsible MS4s treating runoff before discharging to the receiving stream. While that's all well and good, the responsible MS4 may not necessarily achieve their ultimate goals.

It has become more widely noted that much of the measured pollutant load may actually reside within the stream in the form of instability and associated lateral and vertical erosion (and associated nutrients). In some cases, the stream of interest itself may actually be a greater source of impairment than the contributing watershed.

While not typically outlined in great detail within the MS4 stormwater permit, stream restoration may provide more benefit per unit cost, than more conventional structural BMPs. For this reason, water quality improvement projects should strongly consider assessing the conveyance network, in addition to other sources within the contributing watershed.

By sharing experiences from MD SHA project examples this presentation will put into context the practice of quantitative watershed assessment and subsequent stream restoration as measures toward optimizing water quality benefits. This talk aspires to encourage dialogue outside of the mitigation box, toward the water quality mandates as a means to more efficiently promote cumulative water quality benefits over time.

About the Speaker: Josh Gilman is an engineer with Stantec. His experience includes regional curve studies and other stream research as well as rural and urban stream improvement projects. As a member of the Stantec Team, Mr. Gilman provides a range of support with various projects including design, construction, and monitoring of stream restoration and related water resource management.

How much money is good data worth?
An examination of the monetary impacts that occur within the range of variables associated with nutrient reduction estimates from TMDL based stream projects in Maryland and Virginia

Josh Running
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Abstract: Beginning in 2010 with the establishment of Total Maximum Daily Loads (TMDL's) within the 6 Bay States and DC, municipalities have been scrambling to implement projects across the mid-Atlantic to meet nutrient reduction requirements. The projected overall costs of this massive Bay clean-up effort are staggering and have Municipal Separate Storm Sewer System (MS4) localities re-prioritizing capital improvement projects and tax money allocations in an effort to meet these goals. Throughout Virginia an estimated $7B-$10B will be spent on storm water management projects alone. Stream restoration has come to the forefront of these efforts as preliminary cost-benefit data analysis exposes the economic advantages of stabilizing stream bank erosion as a nutrient management practice. The Chesapeake Bay Program Office (CBPO) estimates that 418 miles of stream restoration will occur in Maryland and Virginia by 2025 strictly for the purpose of meeting TMDL requirements.

Costs to implement these types of projects can vary based on complexity and scale, and are often driven by nutrient removal crediting and the associated best "bang for the buck". However, there is a lack of quality data available across the Bay watershed, often leading to utilizing non-validated curves and standard rates that fall outside what some would consider applicable for the region. This presentation will use case study data from several projects in Virginia and Maryland, examining costs per pound of nutrient removed, and the sensitivity that nutrient soil concentration rates, bulk density, and erosion rate curves play in accurately estimating outputs and costs in the implementation of these projects.

About the Speaker: Josh Running is a Senior Environmental Planner and Associate for Stantec. He has been working in the stream restoration field for 15 years and received his BS in Watershed Management, with a Minor in Soil Science, from UW – Stevens Point. He lives in Williamsburg, VA with his wife, Amanda, dogs (Casey and Conway) and cats (Eve and Walle). He is an avid outdoorsman and enjoys a cold beer from time to time.

Exploring Stream-Focused BMPs for VDOT and Other Linear Entities

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Co-Authors: Katie Shoemaker, EEE Consulting, Katie.shoemaker@eee-consulting.com; Tracey Harmon, VDOT, tracey.harmon@vdot.virginia.gov

Abstract: VDOT has an extensive history of providing post-construction management for discharges of stormwater from its right-of-way. Over those years, VDOT has maintained an adaptable stormwater program that evolves with the needs and demands of Virginia's stormwater program. With the recent changes to Virginia's stormwater regulations and the approval of the Chesapeake Bay Watershed TMDL, VDOT will need to identify and incorporate other innovative practices to meet State and Bay goals.

For this project, VDOT explored the possibility of expanding its suite of Best Management Practices (BMPs) to incorporate stream and riparian restoration projects more effectively into their capital improvement processes to reduce pollutant loadings. VDOT received matching funds through a grant partnership with the Chesapeake Bay Program and National Fish and Wildlife Foundation (NFWF) to restore an area within its right-of-way system using stream restoration, land conversion within the riparian area, and buffering sheet flow along the stream's edge.

As part of the project, VDOT is reviewing the "lessons learned" to evaluate the effectiveness of these non-structural practices. This report will assist VDOT and its personnel at all levels with understanding these new practices. With a better understanding of the process VDOT can implement these new practices at a statewide level for its reductions in the Chesapeake Bay watershed and meet Chesapeake Bay Total Maximum Daily Load goals.

About the Speaker: Ashley Hall is a senior engineer at Stantec in Richmond, Virginia, and played a large role in developing VDOT's TMDL Action Plan for the Chesapeake Bay. Ashley has been a member of numerous TMDL Technical Advisory Committees for pollutants such as bacteria, sediment, PCBs, and chloride; and has also participated in the development of policies and permits at the state level. Ashley serves on the Virginia Water Environment Association Stormwater Committee and the ASCE Stormwater Technical Advisory Committee.

Using Stream Restoration to Meet Chesapeake Bay TMDL Requirements – The Design of Stoney Run and a Summary of its Nutrient Reduction Credits

Daren Pait
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Abstract: Stream restoration has become one of the most widely used tools by localities in Virginia for Chesapeake Bay TMDL compliance. Over the past three years the Virginia Department of Environmental Quality awarded more than $52 million to municipalities for water quality improvement projects through the Stormwater Local Assistance Fund (SLAF). For the most recent round of SLAF awards, announced in March of 2016, stream restoration projects accounted for nearly 70% of the awarded funds. Stormwater facility retrofits and new stormwater treatment facility projects were awarded the remaining 30%. Stream restoration is proving to be much more cost effective than more traditional stormwater treatment facility practices for the purpose of TMDL compliance in the Chesapeake Bay. The construction cost for achieving one pound of phosphorus credit via stream restoration is in some instances half the cost of achieving the same credit by constructing a new stormwater management facility, and in many cases less expensive than retrofitting existing facilities.

This presentation will cover the design and nutrient reduction credit calculation of a stream restoration project being completed for Chesapeake Bay TMDL compliance. It will also compare the nutrient reduction cost effectiveness of this project with two other more traditional stormwater treatment facility projects. The presentation will highlight how choosing to restore a stream reach that has an urbanized watershed and is highly incised may be more challenging, but can be very cost effective for TMDL compliance.

About the Speaker: Daren Pait is a surface water engineer at Kimley-Horn and Associates with 16 years of design experience. His background includes the design of a range of ecosystem restoration and water quality improvement projects consisting of stream restoration, wetland restoration, stormwater wetland design, lake retrofit design and wet pond retrofits. He also specializes in the development of watershed management plans that utilize SWMM hydraulic modeling to identify and prioritize drainage improvement projects as well as identify water quality improvement opportunities for municipalities.

Partnerships in Action: Working collaboratively to develop, promote, and expand economically, scientifically, and socially sound ecological restoration

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Co-Author: Chris Tomsic, Ecosystem Services, chris@ecosystemservices.us

Abstract: Business, environmental and social interests overlap in ecological restoration projects. This overlap coupled with the intractable nature of today's restoration challenges, make collaboration critical to ensure the highest impact of restoration projects.

Ecological restoration projects often suffer due to disciplinary and sector isolation. Though this is widely understood by academics and practitioners, there has been little effort to systemically address the approach for accomplishing ecological restoration. Some of the challenges typically encountered by the restoration community include determining functional design alternatives, long-term project performance, sufficient monitoring, social and educational engagement, and funding at every level of project development.

By cultivating partnerships that coordinate diverse stakeholders, collaborative projects are capable of jointly identifying alternatives that will improve both short and long-term project performance, credibility, capacity and efficiency. Partnerships leverage the unique skills and capabilities of team members to accelerate innovation and achieve faster, more cost effective solutions. Additionally, approaching projects collaboratively can result in localized solutions that enhance long-term success through community capacity building and buy-in.

Partnerships are formed in different ways for different reasons. Understanding the differences in stakeholder incentives, biases, and organizational cultures is essential to creating cohesive teams. Identifying clear roles and responsibilities of partners without resorting to individualized business-as-usual is critical to developing successful partnerships.

Private sector consulting firms can be a critical contributor and partner in the collaboration movement. Private firms offer the technological expertise, research and development capacity to drive innovations and enable market-based solutions.

This presentation highlights some of our most innovative partnerships as a platform for the discussion. Using case study examples from stream restoration, rain garden installation, and watershed planning projects, we will explore effective partnerships, how they are created, and their benefits and challenges. We'll also explore lessons learned, and discuss ways to make partnering more efficient and effective.

About the Speaker: Annemarie is an environmental scientist with a focus in biological, regulatory, and GIS services. She has worked on a variety of projects ranging from infrastructure

projects that included urban stormwater management, and flood control projects, to ecologically-focused projects, which included nutrient bank establishment, habitat enhancement, and stream and wetland restoration.

Much of Annemarie's motivation and passion for her discipline comes from observing the need for preservation and the ability of environmentally sound project management to inform sustainable development practices. It is her understanding of the connection between the preservation of ecosystem services and the promotion of security, poverty reduction, and sustainable livelihoods that energizes her work.

Education: M.S. Environmental Science and Policy, Johns Hopkins University, Baltimore, MD
B.A. Major Government/Minor Environmental Science, College of William & Mary, Williamsburg, VA

Recruiting volunteer labor in maintaining restoration project buffers long-term

Callie Moore
Hiwassee River Watershed Coalition
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Abstract: The Hiwassee River Watershed Coalition manages 98 acres of riparian buffers associated with 27 individual restoration projects along nearly 10 miles of stream in the upper Hiwassee River watershed. In-stream restoration structures aren't permanent. Their life expectancy is only 30-50 years – long enough for native trees and shrubs in 50-100 feet strips along the stream or river to mature and function. Arguably the greatest challenge to resource agencies who are conducting stream restoration work is how to insure a mature, healthy riparian buffer exists in 30-50 years and in perpetuity. There is beaver and flood damage that probably happens everywhere, but here in the Southeast, a major threat to buffer establishment and function is nonnative invasive plants. HRWC has multiple programs to maximize use of volunteer labor in maintaining riparian buffers to insure project success. The HRWC Restoration Program logged 2,219 volunteer hours in 2015 valued at more than $47,000! More than half of this time was contributed by students from five universities and the local early college high school. This presentation will reveal many of our secrets for getting the work done cost-effectively and efficiently and share success stories related to individual restoration projects.

About the Speaker: Ms. Moore became HRWC's first full-time executive director in January 2003. She has a Master's Degree in Water Resources from Indiana University and is also a graduate of Western Carolina University's Environmental Health Program. Before coming to work for HRWC, she worked for four years as a river basin planner for the NCDENR, Division of Water Quality, during which time she was assigned to several river basins including the Hiwassee, Little Tennessee, and Savannah. Other previous work experience includes water quality monitoring, sediment/erosion control compliance inspections, and environmental education for the Tennessee Dept. of Environment & Conservation and the Tennessee Valley Authority. Ms. Moore recently completed a three year term on the Z. Smith Reynolds Foundation's Community Leadership Council and she is a 2009 graduate of the Institute for Georgia Environmental Leadership. Callie and her husband, Philip live on a farm that's been in Philip's family for seven generations in the Tusquitee Community of Clay County, NC.

Public Perception of Stream Restoration: Results of a Web-based Survey

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Abstract: The value of stream restoration design in terms of direct ecological uplift has been brought into focus through several easily understood presentation methods, such as the functional uplift pyramid. However, the public's true understanding and opinion regarding stream restoration is nebulous and often anecdotal based on a few or perhaps one "good" or "bad" project. This presentation will detail the findings of a web-based public survey regarding the public's understanding of streams and restoration efforts, stratified by parameters such as participant age, location and level of education. The survey (for the most part: multiple choice and yes/no questions) was developed to gage the public's opinion of what stream restoration is, what people think about the work being done and about funds being spent on stream work. The questions are general and meant for a broad audience (school aged children and up).

About the Speaker: Tim Schueler is a graduate of Virginia Tech and professional engineer with 28 years of stream restoration engineering and design experience. He has evaluated, designed, constructed and monitored over 14 miles of stream restoration projects in nine states. Tim has prepared stream mitigation bank projects, habitat functional uplift sites, erosion control stream stabilization projects and riparian habitat creation and enhancement zones.

Recreational Value of Riparian Vegetation in Public Green Spaces, Sydney, Australia

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Abstract: The Georges River and Cooks River are the two longest rivers in Sydney, Australia. Today, the areas along the rivers are major suburbs of Sydney with dense housing and retail and commercial development. Many of the waterways in river catchments have been piped and lined with concrete channels and rocks. Native vegetation has been removed and replaced with grass.

Local councils and other nongovernmental organizations, are interested in restoring the two river catchments and they would like to know how much people in local communities' value improvements in the river ecosystems. We obtain this information by estimating a random utility model that investigates the value of recreation activities along the waterways in the river catchments.

The basic idea for this method is that people make tradeoffs between recreation site quality and the cost of travel to the site, and choose the site that provides the best balance between desired quality and the cost of access. The money and time costs of travel serve act as implicit prices of recreation activities. The waterway attributes of interest in this study include native vegetation and park characteristics. An internet survey instrument has been designed and administered to samples of council residents living in southern Sydney to collect visitation data for parks along the waterways. This trip data is then merged with GIS data on park characteristics and waterway vegetation data for the estimation of the model.

Our results show that people prefer good riparian vegetation to no vegetation and are willing to pay an average of 3.51 AUD to improve no-vegetation to good vegetation per trip. For people who say riparian vegetation is important when they choose where to recreate, they prefer having either moderate vegetation or good vegetation to no-vegetation and are willing to pay 3.69 and 5.65 AUD per trip respectively to have them.

About the Speaker: Weibin Xu is a Fourth-year PhD Candidate of Economics at Virginia Tech University. His research include environmental economics and applied econometrics. His PhD dissertation focuses on using the random utility model to value the benefits of riparian vegetation in waterways in urban Sydney Australia. He has also worked on projects in the area of clean energy, horticulture and marine resources.

Correcting the Past

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Co-Author: Jason Claudio-Diaz

Abstract: "Correcting the Past" (Rebuilding McDowell Creek to today's standards)

Mecklenburg County has implemented several projects in the McDowell Creek Watershed through its capital improvement program. This has included over 8 miles of stream restoration and multiple Best Management Practices to improve the overall water quality and stability of the watershed draining to Mountain Island Lake, Charlotte's major drinking water supply to over 800,000 residents. This presentation will detail the challenges in restoring the main stem of McDowell Creek. This project was unique in how the approach was taken to undo a past fix form dredging in 1927. This discussion will focus on high level challenges associated with working in active neighborhoods, utilities, park/recreation, mitigation, and overall public perception to achieve a "win/win" for both water quality and public tax payers.

http://charmeck.org/stormwater/Projects/Pages/McDowellCreek.aspx

About the Speaker: David Woodie, PE, CPSWQ, currently serves as the Storm Water Services Project Manager for Charlotte/Mecklenburg County Government of Charlotte, NC. David has over 20 years of professional experience in construction, survey, water resources, bridge/hydraulic design, bmp design, and both bmp/stream construction. Working through private sector, State and Local Government, David has constructed major highway projects, 140+ Best Management Practices across the state of North Carolina as well as implemented over 12 miles of stream restoration in Mecklenburg County. David is a Professional Engineer and Certified Profession in Storm Water Quality.

Jason Claudio-Diaz, PE, CFM, currently serves with Kimley Horn and Associates, Inc. He has 12 years of experience managing and designing surface water projects. Jason is a lead designer on stream restoration projects and has successfully planned, designed, and implemented over 30 miles of stream projects. He has worked in 8 states on small and large systems, in rural, urban, and suburban watersheds for both mitigation and non-mitigation projects. Jason specializes in using natural channel design techniques for stream stabilization/enhancement and water quality improvements in urban and sub-urban watersheds. Jason also specializes in H&H modeling and culvert/closed system drainage design.

A Function-Based Approach to Stream Mitigation Policy

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Abstract: State and Federal mitigation guidelines, including Section 404 of the Clean Water Act, require compensatory mitigation for unavoidable impacts to natural resources. A fundamental principle of the mitigation hierarchy is to prevent a net loss to aquatic resources and ensure that completed mitigation projects measurably replace lost aquatic function. A common challenge facing regulated industries, policy makers, and mitigation providers is quantifying the net gain, or the functional-lift, resulting from restoration projects. With the goal of improving compensatory stream mitigation policy and outcomes, Environmental Defense Fund and Stream Mechanics developed the Functional Lift Quantification Tool (QT) for use by state and federal agencies. To quantify the functional lift of a mitigation project, our tool utilizes the five functional categories published in the Stream Functions Pyramid Framework (hydrology, hydraulics, geomorphology, physicochemical and biology) and related function-based parameters (e.g. floodplain connectivity, riparian vegetation, bed form diversity, organic carbon, and macroinvertebrates) to compare a degraded stream's existing condition with a restored stream's proposed condition. Users input scores for each of the parameters based off of a site's existing and proposed condition, and the QT provides users with a numerical output scored as Not Functioning, Functioning-At-Risk, or Functioning. Practical applications of the QT include assisting practitioners with site selection by determining if a proposed project has sufficient lift and quality to be considered for a stream restoration or mitigation project. The QT is currently undergoing pilot testing and this session will provide an overview of the tool, policy applications, and next steps with an eye toward ensuring rigorous, science-based stream mitigation policy.

About the Speaker: Paxton Ramsdell serves as the Southeast Habitat Markets Analyst on EDF's Ecosystems Team. Paxton is based in EDF's Raleigh office and is focused on driving policy adoption of a function-based stream mitigation tool. Paxton is also working to identify opportunities to establish Habitat Exchanges in the southeast for the benefit of at-risk terrestrial and aquatic species. Paxton previous worked with World Wildlife Fund, The Nature Conservancy and the Brandywine Conservancy. Paxton received his bachelors degree in Government and Environmental Studies from Hamilton College, and his master's degree in Forest Resources and Environmental Conservation from Virginia Tech.

Stream Lift Quantification Tool Case Studies

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Abstract: The Functional Lift Quantification Tool for Stream Restoration Projects in North Carolina has recently been released by Environmental Defense Fund and Stream Mechanics. The purpose of the tool is to improve the practice of stream restoration by quantifying the functional difference between degraded and restored stream conditions. Based on the Stream Functions Pyramid, the tool assesses function-based parameters within the hydrology, hydraulic, geomorphology, physicochemical and biology functional categories. Actual stream restoration projects have been entered into the tool as case studies in order to determine if there is a difference between projects categorized as Restoration, Enhancement 1, and Enhancement 2 using the Wilmington Corps District's stream mitigation protocol. In addition, projects categorized as a Rosgen Priority 1, 2, or 3 approach were evaluated to determine if higher-level priorities scored better than lower-levels. In addition to the case studies, a mock scenario was created as a simple sensitivity analysis to show how the tool responds as functional categories are added, and with the addition of stormwater Best Management Practices to treat lateral or upstream runoff. The tool is currently being used by the NC Division of Mitigation Services and various stream practitioners and agencies across NC and the U.S.

About the Speaker: Cidney Jones is a Water Resource Engineer working for Ecosystem Planning and Restoration where she assists in designing stream restoration projects and has been assisting in the development of the Quantification Tool. She received her undergrad from Harvey Mudd College in California and performed her masters work with Dr. Peggy Johnson at Penn State.

Developing a Large Woody Debris Performance Standard for Stream Restoration Projects

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Abstract: Large woody debris (LWD) provides a variety of critical functions including substrate for aquatic organisms, heterogeneity of bed forms, bed material sorting, flow resistance, and more. A LWD piece is defined here as non-living organic matter over 1 m (3.28 ft.) in length with a large end diameter of at least 10 cm (3.96 in). The accumulation of three or more LWD pieces in contact with one another is a LWD debris jam. Research has shown that most of our streams in the Southeast were wood dominated prior to European settlement; however, methodologies for assessing LWD are more common in the western United States.

This presentation demonstrates how a LWD assessment method developed by the US Forest Service has been applied to eastern U.S. streams. The assessment method is called the Large Woody Debris Index (LWDI) and it is being used in the Stream Functional Lift Quantification Tool (QT) to calculate the LWD scores before and after stream restoration. The QT along with the LWDI is being used by the NC Division of Mitigation Services to show functional lift in stream restoration projects across NC. Draft performance standards and data from a variety of eastern streams will be presented.

About the Speaker: Thomas serves as Senior Environmental Scientist and Project Manager for EPR in their Raleigh, NC office. With over 20 years of experience with forestry and natural resource investigations, he has been involved with numerous projects across the Southeast during his career. His expertise includes stream assessment surveys, reforestation, non-native invasive species management, stream and wetland inventories, wetland design, protected species surveys and the use of GIS/GPS. Currently, he is involved with the development of the LWDI protocols for the Stream Functional Lift Quantification Tool (QT). Thomas received both his B.S and M.S. degrees in Forestry from NC State University.

Cat Creek Stream and Wetland Restoration - A Functional Evaluation in Retrospective

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Abstract: Within the last few years the USFWS has been developing tools such as the stream functions pyramid (Harmen et. al., 2012) to describe existing stream functions and to quantify the potential uplift that could occur from a restoration effort. The Cat Creek stream and wetland site was first identified by NCDOT in 2002 as a potential stream restoration site. At that time few tools were available to evaluate the functional uplift of a stream restoration project. While at the time the stream was considered a good candidate for restoration there were no quantifiable data to support the decision. Due to a number of factors the detailed design was completed in 2008. Construction was completed in 2010 and the project was closed out in2015 after 5 years of monitoring.

Utilizing the recently developed Functional Lift Quantification Tool (Harmon and Jones, 2016), the pre-restoration and post-restoration functions of the stream were quantified to document the functional uplift of the restoration project and to evaluate whether it was a "worthwhile" project. At the time of finalizing the restoration design there were extensive discussions at to the need for restoration activities on the lower reaches of the project. While ultimately minimal activity occurred on the lower reach, use of the Functional Lift Quantification tool would have been useful to assist in the decision making process. Additionally, while a number of goals were stated in the Restoration Plan, the Functional Lift Quantification tool can provide insight as to whether those goals could have been better defined and if they were achieved.

About the Speaker: Ron Johnson is a Senior Biologist at AECOM. He has over 28 years of experience in natural resources consulting and has been working on stream restoration projects for over 15 years throughout NC and the east coast.

Stream Restoration as Part of a Comprehensive Watershed Restoration Framework to Meet Water Quality Objectives

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Abstract: Stream restoration has become an increasingly popular watershed management practice, particularly for meeting water quality objectives such as complying with total maximum daily loads (TMDLs). Over the last few decades, new techniques have been pioneered to restore urban streams using diverse approaches, such as natural channel design, regenerative stormwater conveyance, and removal of legacy sediment. The proliferation of stream restoration projects has raised questions regarding the effectiveness of stream restoration in meeting overall watershed and project-specific goals. It is important to know why the project is being completed and what techniques are best suited, if a project is to be successful. This presentation will provide an overview of how stream restoration is integrated into a comprehensive watershed restoration framework from the Center for Watershed's perspective as the Chesapeake Bay Program Sediment Reduction and Stream Corridor Restoration Coordinator. Tools such as the Impervious Cover Model and functional assessments can be used to help diagnose the severity of stream impacts and set realistic goals and objectives for stream restoration. In addition, we will explore the use of stream restoration as part of an overall watershed strategy to meet nutrient and sediment load reduction targets for complying with total maximum daily loads using recommendations from the Chesapeake Bay Program Stream Restoration Expert Panel as an example. These recommendations include crediting protocols based on the reduction in stream bank erosion rates, denitrification during baseflow conditions, and nutrient and sediment reduction through floodplain reconnection.

About the Speakers: Lisa Fraley-McNeal, Research Specialist, has over 10 years of experience in urban watershed and stormwater management. Her areas of expertise include GIS and field methods for watershed assessment, watershed planning, and applied research on topics related to watersheds and stormwater. She served as one of the Sediment and Stream Corridor Restoration Coordinators for the Chesapeake Bay Program and helped with the development of the Stream Restoration Expert Panel recommendations. Lisa's interests include fluvial geomorphology, urban hydrology, and sedimentology. She has a B.S. degree in Geography and Environmental Systems, with a writing minor and cartography certificate from the University of Maryland,

Baltimore County. Lisa also has a M.S. degree from the University of Maryland, Baltimore County in Marine and Estuarine Environmental Science.

Bill Stack, Deputy Director of Programs, is a professional engineer who has worked in the environmental restoration field for over 38 years. He joined the Center for Watershed Protection in 2010 as the Deputy Director of Programs and helped lead the Center's effort in developing Stream Restoration Crediting Protocols for the Chesapeake Bay Program. Prior to coming to work with the CWP, Mr. Stack spent 30 years working for the Baltimore City Department of Public Works where he retired as Chief of the Surface Water Management Division. One of his responsibilities while at the City included the Municipal Separate Storm Sewer System Permit. Under this program, Mr. Stack was responsible for implementing 6 stream restoration projects(approximately 3 miles in total) with several more under design. Mr. Stack also co-chaired a work group under the auspices of the Maryland Water Monitoring Council and Maryland Stream Restoration Association to address the issue of quantifying the benefits of stream restoration through collaborative monitoring approaches.

Identifying and Prioritizing Stream Restoration and Stormwater Control Measure Projects in the City of Durham Little Lick Creek Watershed Improvement Plan

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Co-Author: Sandra Wilbur, City of Durham Stormwater and GIS Services Division

Abstract: Wildlands Engineering, Inc. partnered with the City of Durham Stormwater and GIS Services Division to prepare the Little Lick Creek Watershed Improvement Plan. The plan was initiated to address degraded water quality and aquatic habitat conditions in Little Lick Creek, and to address state water quality regulations for Falls Lake. A project goal was to develop a database of prioritized potential stream restoration, stormwater control measure (SCM) retrofit, and new SCM projects the City could implement to meet the Falls Lake nutrient reduction goals. To develop the project database 97 stream reaches (24.7 miles), 52 existing SCMs, and 95 locations for potential SCM retrofits were evaluated. Stream evaluations included recordation of physical measurements, observed water quality problems, evaluation of restoration potential, and RSAT, BEHI and NBS evaluations. Existing SCM evaluations included recordation of functionality, physical measurements, and potential retrofit opportunities to enhance nutrient retention and removal. Potential new SCM evaluations included evaluation of site accessibility and quantity of runoff that could be treated. Nitrogen, phosphorus, total suspended solids, and fecal coliform reduction amounts were applied to all potential projects. For stream projects, the Chesapeake Bay protocols along with the development of a localized sediment erosion rate curve for Durham was used as a guideline for calculations. Nutrient reduction rates for SCMs were calculated using the Jordan Lake/Falls Lake tool. Project costs were applied to all stream and stormwater projects. The final database was developed using a ranking system that took into account the unit cost of nutrient removed, accessibility of the project, aquatic habitat uplift, use as an educational outreach project, and several additional metrics. This talk focuses on the development and execution of processes to compare stream restoration and SCM projects for their potential implementation as watershed improvement projects.

About the Speaker: Angela Allen is a water resources engineer and project manager in Wildlands Engineering's Raleigh office. She has twelve years of experience in stream and wetland restoration design, stormwater control measure design, and water quality analysis and modeling. She has a Bachelor's Degree and Master's degree in Biological Systems Engineering from Virginia Tech and NC State, respectively. Wildlands Engineering specializes in water resources engineering and planning with a particular focus on innovative engineering for ecosystem renewal.

The Nature Conservancy's Watershed-Based Site Selection Approach: Endeavoring to Improve Results and Increase Benefits

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Abstract: This presentation will showcase the watershed-based site selection process developed by The Nature Conservancy (TNC) in Ohio for their state-wide Stream and Wetland In-Lieu Fee Mitigation Program.

The 2008 Mitigation Rule requires the use of "a watershed approach to establish compensatory mitigation requirements to the extent appropriate and practicable." The rational for this focus is that a watershed approach allows decisions to be made in the context of a science-based analysis of watershed needs, achieve broader conservation outcomes, and help improve efficiency. The success of a stream restoration project often depends as much on its watershed context as it does on site conditions or the quality of the restoration work itself. Without a watershed approach, projects are often selected primarily based on costs, availability of land, and technical feasibility - criteria that are important but which may lead to projects with fewer benefits and less success.

In order to achieve a watershed approach for the Ohio In-Lieu Fee Program, TNC developed a site evaluation and selection process that to the highest extent possible maximizes the conservation benefits and meets the specific needs of the watershed. In this presentation, Schenk will explain the approach TNC has developed for the Ohio program and how it is being utilized to align the work, energy, and projects which add up to more than the sum of their parts.

About the Speaker: Devin Schenk is the Mitigation Program Manager for The Nature Conservancy (TNC), where he is responsible for running TNC's state-wide Stream and Wetland In-Lieu Fee Mitigation Program. Devin has worked in the field of stream and wetland mitigation for over 16 years in California, Kentucky, and Ohio. Devin received his B.S. from the University of Cincinnati, Masters in Environmental Sciences from Miami University of Ohio, and Juris Doctorate from Northern Kentucky University's Salmon P. Chase College of Law. He is a member of the Kentucky Bar Association.

Rehab is Not Just for Celebrities and Bad Knees. Our Urban Waterways Need Some Too.

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Abstract: Many have proclaimed that urban stream restoration is "impossible" or "doesn't do jack." Is urban stream restoration impossible? Well, yes—if you define restoration as bringing back an ecologic condition prior to anthropogenic impacts. However, that is the wrong way to look at it. Urban stream project discussions need to focus on setting goals and objectives around rehabilitating stream functions through sound design and complementary watershed management. Say a given watershed is representative of the human body. In this case, urban waterways would represent a part of it. We need to think of how we can rehabilitate the part (i.e., restore this part of the watershed to a useful place) and how that rehabilitation fits into the body's overall health (e.g., the larger watershed's health). As designers, it is our responsibility to not only understand what is achievable based on available science and project-specific constraints, but also effectively communicate this information.

This presentation focuses on the typical stream functions we can rehabilitate in urban systems and the best way to do so, how to connect stream rehabilitation with watershed management, and, just as importantly, how to effectively communicate these processes. Urban stream restoration can do "jack"—it just depends on how you define "jack."

About the Speaker: Will Wilhelm is a water resource professional who manages numerous watershed projects involving natural channel designs and best management practices for water quality and quantity. He is one of the driving forces behind Kimley-Horn's watershed and natural systems practices. Mr. Wilhelm has been involved in all aspects of urban and rural watershed and stormwater management projects—including master planning, site feasibility, permitting, public involvement, modeling, design, construction management, and monitoring. He has been involved in the design of more than 200,000 linear feet of completed stream rehabilitation projects. Mr. Wilhelm is a registered professional engineer in North Carolina and Tennessee, a certified floodplain manager, and a certified professional in erosion and sediment control. He holds Bachelor of Science degrees in both civil and environmental engineering from North Carolina State University.

Watershed Assessment to Identify Stream Restoration and Stormwater Management Opportunities in Morrisville, NC

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Abstract: The Town of Morrisville initiated a comprehensive watershed assessment in 2014 to identify stream restoration and stormwater management opportunities within the Town's seven square miles of jurisdiction. The assessment includes a GIS analysis of streams, stormwater outfalls, and land uses in addition to a field assessment of stream conditions. The GIS database includes the Town's stormwater layers along with topography, hydrology, land use, and soils information. ArcView Collector is used on IPads to input field observations to supplement this database. The field team consisting of an engineer familiar with fluvial geomorphology and a scientist familiar with riparian ecology walks all stream reaches to evaluate condition and take photographs. Streams are characterized for geomorphic stability, erosion, incision, substrate, habitats, and riparian vegetation. Restoration opportunities are noted, especially where threats to infrastructure are imminent. Stormwater outfalls are evaluated for stability and potential illicit discharge/pollution problems. Stormwater control measure (SCM) retrofit opportunities are identified based on feasibility and need. Follow up grant applications have been submitted to implement high-priority projects identified in this watershed assessment. The project is a valuable tool/component of the Town's stormwater program to support successful watershed protection.

About the Speaker: Amber Coleman is a licensed soil scientist and professional wetland scientist for Stantec in their Raleigh, NC office. She has been working in the private sector for more than 16 years on stream and wetland restoration projects with an emphasis on natural resource analysis, mitigation plan development, vegetation design, regulatory coordination and post-construction monitoring. Ms. Coleman received a BS in Environmental Science and an MS in Soil Science both from Virginia Tech. In her spare time she enjoys drawing nature-related art, including hellbenders! Ms. Coleman is the winner of the 2016 EcoStream Conference t-shirt design contest, and her hellbender drawing is featured on the cover of this program as well as the EcoStream t-shirts.

Benthic Macroinvertebrate Habitat Enhancement and Relocation: Smith Creek, NC

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Co-Author: Holly Miller, Town of Wake Forest

Abstract: In 2008, Smith Creek was added to the 303(d) impaired waters list because of its "Fair" benthic macroinvertebrate sampling results. In 2013, WK Dickson began work on the Town of Wake Forest's 319-funded Smith Creek Watershed Management Plan (WMP), which included a detailed evaluation of water quality and aquatic habitat conditions.

Three years of benthic sampling at three sites began in July 2013. To better characterize watershed-wide conditions, six additional sites were sampled in 2014. One site's results confirmed a highly diverse benthic population, indicative of nearly excellent water quality conditions.

Community involvement was emphasized from the WMP's inception. In the summer and fall of 2014, several benthic macroinvertebrate-focused events were held. After discussion of benthos' lifecycles and habitats, as well as their role in water quality monitoring, participants collected and identified specimens from the creek. The events' final components focused on the physical enhancement of benthic habitats within the creek.

Later in the fall of 2014, populations were collected from the reference reach and transplanted into the enhanced aquatic habitats. While not resulting in significant increases in EPT or overall taxa richness, several species that are highly intolerant of poor water quality conditions, and had not been found at the site during the previous two years' sampling efforts, were identified following the July 2015 sampling. While these data do not justify de-listing, the ongoing survival of intolerant species is likely to.

The project was selected for an ACEC 2016 Engineering Excellence Award.

About the Speaker: Mr. Marotti has 25 years' experience in the application of environmental sciences to achieve natural resource restoration, conservation, management, and permitting goals. He has identified, proposed, negotiated, won, and managed a wide variety of wetland, stream, riparian buffer, and upland restoration and reclamation projects on private and governmentally owned properties in the southern Appalachians (West Virginia, North Carolina, South Carolina, and Gerogia), the Rockies (Montana, Wyoming, Colorado, Utah, Nevada and New Mexico), the Andes (Bolivia, Chile, Peru, and Argentina), the Piedmont, the Sandhills, the Coastal Plain, the Great Plains, the Colorado Plateau, and the Basin and Range. In addition to Mr. Marotti's restoration experience, he has completed hundreds of public and private

environmental compliance and permitting projects, including: NEPA and SEPA EAs and EISs, Individual and nationwide 404/401 permits, NCDENR water quality and riparian buffer variances (major and minor), Endangered Species Act Section 7 and 10 impact permits and conservation plans, and protected species relocation plans.

Innovative Approaches to Improve Macrobenthic Invertebrate Communities Through Stream Restoration

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Abstract: There is increasing interest to improve macrobenthic invertebrate communities as a result of stream restoration projects. Compensatory mitigation projects often require the monitoring of macrobenthic populations for several years after the completion of restoration work, sometimes with success criteria tied to the results. Macrobenthic communities are also monitored as an indicator of water quality under TMDL programs and EPA's Stormwater Phase II rules. Whereas stream restoration projects have traditionally focused on stream stability, with a "if you build it, they will come" mentality, practitioners are increasingly being asked to consider higher functions and to specifically improve macrobenthic communities and biological functions.

This presentation will focus on stream restoration efforts that are specifically designed and implemented to improve macrobenthic invertebrate communities and populations. The presentation will focus on two aspects of this work: 1) the design and installation of innovative in-stream structures that provide appropriate habitat for macrobenthics following restoration, and 2) techniques to jump-start the colonization process after restoration and promote macrobenthic communities into the future. Example projects will be discussed, along with pre- and post-monitoring data that document changes in macrobenthic communities as a result of the presented methods.

About the Speaker: Kevin serves as Principal Engineer for EPR, and also serves as their Raleigh Office Manager. As a stream restoration specialist, Kevin has served as the Project Engineer/Engineer of Record for over 130 stream restoration projects, totaling to over 100 miles of stream restoration design.

Patrick Barber is the Owner and Senior Consultant at Acer Environmental, LLC, an environmental consulting firm based in Atlanta, GA. Pat's areas of expertise include permitting of large, complex environmental projects, and conducting research into restoring habitat and food sources for benthic macroinvertebrates. Pat works with stream designers and engineers on various techniques to increase organics and detritus in stream systems so that macroinvertebrates can thrive in a stream system after a restoration or loss of habitat.

Evaluation of the Relationship Between Stream Habitat Quality and Species Traits in Piedmont Streams in North Carolina

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Abstract: Stream habitat quality and benthic macroinvertebrate community diversity are negatively impacted by urbanization. As Percent Impervious Cover (%IC) increases with development, stream channels are degraded by the increasing storm water runoff volume and intensity. Watershed managers respond to urban stream degradation by repairing degraded streams using stream restoration techniques; however most natural channel design approaches do not result in an uplift of the benthic macroinvertebrate community. To better inform restoration design and evaluation, we investigated the relationship between stream habitat quality and benthic macroinvertebrate community diversity and function by evaluating 30 streams in the Piedmont, North Carolina spanning a gradient of good to poor habitat quality. We used the Mecklenburg Stream Habitat Assessment Protocol (MHAP) to assess stream habitat quality at each site to quantify physical parameters, including stream flow, depth, substrate consistency, canopy cover, stream width and habitat diversity. We sampled the benthic macroinvertebrate community in these streams using the Standard Bioassessment Sampling Method (NC Division of Water Biological Assessment Branch). In the 10 streams with Good MHAP scores, we collected benthic macroinvertebrates from 8 microhabitats, including riffles, root wads, and sandy areas to correlate species and species ecological traits such as functional feeding groups, thermal preferences and habit preferences with each microhabitat. We found that EPT Taxa Richness is generally 10 or more when the MHAP score is greater than 110 which corresponds to the Partially Supporting use category. The EPT Shredder and Predator Trophic Groups are usually not present when the IC is greater than 10%. By correlating the species traits with specific microhabitats we can better evaluate the success of stream restorations in restoring stream function and in stimulating benthic macroinvertebrate community recovery.

About the Speaker: Anthony Roux is a Senior Environmental Specialist in the Water Quality Program of the Mecklenburg County Land Use and Environmental Services Agency and a Ph.D. student in the Infrastructure and Environmental Systems Program at the University of North Carolina at Charlotte. He has worked at MCWQP for 31 years serving as the supervisor of the Mecklenburg County State Certified Biological Laboratory for the past 22 years coordinating the stream bioassessment program (fish, benthic macroinvertebrate and algae). Mr. Roux has worked with the Charlotte-Mecklenburg Storm Water Services to evaluate the various stream restoration projects in Charlotte and Mecklenburg County. Mr. Roux is currently pursuing a Ph.D. in

Environmental Engineering at UNC Charlotte studying the impact of stream restoration projects on stream benthic macroinvertebrate communities. He has a B.S. in Biological Life Sciences, a B.S. in Zoology, and a M.S. in Zoology from North Carolina State University and a M.S. in Aquatic Ecology from the University of Notre Dame.

Pre-restoration Monitoring of a Forested Urban Watershed Provides Knowledge of How Urban Streams Function

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Abstract: Urbanization has predictable impacts on local streams including altered hydrology, increased nutrients and contaminants, and decreased biodiversity. In the Piedmont of North Carolina, continuing challenges are identifying the relative importance of different stressors contributing to stream degradation and identifying reference streams where we can quantify the functions we strive to return through restoration. The Reedy Creek (RC) Restoration Study in Charlotte, NC provides a unique opportunity not only to quantify the impacts of stream restoration and recovery but also to provide a rich data set of how land use affects urban streams in a system with a predominantly intact forested watershed. We have collect 3 years of watershed data quantifying organic matter and sediment, macroinvertebrate diversity and function, baseflow water chemistry, and groundwater-surface water interactions at 10 sites in the watershed. For this presentation we will summarize the seasonal patterns of all parameters with an emphasis on macroinvertebrate diversity and function over the study period. At all locations stream depth showed a consistent pattern of rapid response to precipitation with relatively consistent baseflow. Groundwater depths in the riparian well closest to the stream showed a distinct seasonal pattern reflective of falling water levels during the growing season attributed to evapotranspiration. Differences in water chemistry among the sites were observed with higher nitrate and phosphate concentrations in the sub-watershed with agricultural activities in the headwaters. High quality macroinvertebrate communities were identified in sub-watersheds of the Reedy Creek Watershed that appear to be linked to sources of organic matter. Overall we 1) identified macroinvertebrate species that were not common in other local urban watersheds, 2) quantified strong seasonal differences in macroinvertebrate communities, and 3) demonstrated differences in communities related to land use. Overall, these data provide an understanding of the pre-restoration condition and information on how unimpacted urban streams function.

About the Speaker: Dr. Sandra M. Clinton is a Research Assistant Professor in the Department of Geography and Earth Sciences where her research focuses on the ecology of freshwater aquatic systems. She has over a decade of research experience on a diversity of ecosystems including Boreal Shield lakes, desert streams, floodplain rivers, urban streams, and managed systems such as wastewater treatment facilities. Dr. Clinton's current research is focused on understanding how urbanization impacts stream ecosystem structure and function and using this knowledge to improve restoration practices.

Comparison of 2D Modeling Approaches

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Abstract: One dimensional hydraulic modeling has long been the standard of care in evaluating the hydraulic performance of proposed stream restoration designs. The U.S. Army Corps of Engineers Hydrologic Engineering Center, River Analysis System (HEC-RAS) software is the most widely accepted tool for meeting this end. Some designers have been incorporating two-dimensional analyses since the availability of River2D in the early 2000s. River2D is a depth averaged finite element hydrodynamic model that was originally developed for the purpose of evaluating fish habitat at the University of Alberta, Canada. With the release of HEC-RAS V5, 2D modeling is likely to represent the new standard of care in stream restoration design. The new V5 incorporates an implicit finite volume hydrodynamic solver that may be linked to one-dimensional elements. It also includes uncertainty analysis capabilities. This presentation will review a comparative analysis of results from the application of HEC-RAS V4 one-dimensional modeling, River2D, and HEC-RAS V5 Beta two-dimensional modeling when applied to the proposed design of the same stream restoration project. The results of each of these analyses will also be compared against observations of damage to the constructed stream restoration design resulting from a major storm event. In addition to a comparison of the results, the implications of the differing calculation approaches and the differences in the results for stream restoration design will be addressed.

About the Speaker: Ken Barry, PE, D.WRE is a Technical Principal for S&ME, Inc. His practice there is focused on water resources. Ken has a BSCE from Tennessee Tech and an MS in Environmental Systems Engineering from Clemson.

A Live Demonstration of 3D Stream Restoration Design Using AutoCAD® Civil 3D® 2016 Corridors

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Abstract: The complexity of multifaceted streams presents a challenge for three-dimensional grading plans and hydraulic modeling. With the development of customized subassemblies in AutoCAD® Civil 3D®, corridors surfaces can be created to produce three-dimensional features such as riffles, runs, pools, glides, point bars, inn-berms, and scour pools. Not only does this style of design create the detail that is attractive for natural channel design, but it also dynamically and inherently links the three components (pattern, profile, and dimension) of a stream allowing a designer to make iterative changes with instantaneous and accurate three-dimensional updates. A workflow model was developed by Civil & Environmental Consultants, Inc. to provide optimization and balancing of earthwork volumes, accurate grading plans and quantities, precision construction grades, and cost savings during design and construction. Additionally, customized tools and processes have been developed to provide users with the capability to complete accurate, early stage design decisions with a minimal amount of training/expertise in AutoCAD and Civil 3D. This presentation will include a live demonstration of a natural stream design using corridors in AutoCAD® Civil 3D® 2016 to produce the bankfull channel and associated floodplain. This demonstration will not cover the necessary steps required to develop geomorphic, hydrologic, and hydraulic data for a natural stream design.

About the Speaker: Nathan (Nate) Ober is the ecosystem restoration practice lead and geomorphologist at Civil & Environmental Consultants, Inc. As a geomorphologist, Nate has managed and designed 50+ miles of stream restoration projects, drawing from more than 14 years of experience in fluvial geomorphology, natural channel design, construction management, and post-restoration monitoring.

Integrating Light Distance And Ranging (LiDAR) Elevation Data into Jurisdictional Determinations and Conservation Easement Design

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Abstract: Jurisdictional Determinations are an integral part of any mitigation site, regardless of whether it will be developed through mitigation bank, lieu fee, or permittee-responsible sponsorship. In this presentation, we describe the integration of LiDAR to enable phased mitigation planning for a 5,055 acre tract of land being developed as a stream and wetland preservation tract. This large, undeveloped tract of land presented numerous challenges to fully develop into a mitigation site. Services provided included the delineation of waters of the U.S., vegetation community assessment and mapping, and federally protected species surveys. During early project planning, stream resource estimates ranged from 100,000 to over 300,000 linear feet of stream depending on the source of stream data that was used. While the project progressed into the field delineation of resources, there was a release of publicly available LiDAR-based elevation data that provided comprehensive, high quality elevation data. These data allowed Atkins to improve the stream network estimates by computer modeling. By the completion of the jurisdictional determination process, Atkins had mapped 210,523 linear feet of stream using LiDAR data and field confirmation of headwater initiation points and stream flow transition points. This approach received praise from the U.S. Army Corps of Engineers for the innovation used to map waters of the US at a landscape scale. When compared to a ground survey by a licensed surveyor, the stream network was found to have mapping-grade accuracy, which was appropriate resolution for permitting and conservation easement design. Using this case study as the primary example, additional ideas for integrating new data and technologies into conservation easement design will be explored during this presentation.

About the Speaker: Matt Cusack is a senior scientist with over 18 years of experience in project management and technical performance associated with environmental consulting. Mr. Cusack's project history demonstrates the strengths he can bring to his clients and their project needs. He has supported and overseen multiple environmental permits ranging from large-scale individual permits for new build nuclear power stations to smaller, more nuanced coastal permitting for an innovative floodwater storage system for a small coastal community in North Carolina. Mr. Cusack's ability to work with diverse local and Federal regulatory agencies has been recognized by two separate awards (FHWA 2011 Award for Environmental Excellence and USACE Commander's Award for Public Service in 2009), which were given for working on complex interagency teams in developing a rapid functional assessment for wetlands. Mr. Cusack focuses on keeping projects on schedule, and succeeds through building relationships and partnerships with the agencies that provide tangible benefits to the project and to his client's future endeavors.

Comparison and Use of Aerial and Terrestrial LiDAR for Stream Restoration

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Abstract: LiDAR (Light Detection and Ranging) is an effective, efficient, and economical remote sensing method for stream restoration. Aerial and terrestrial LiDAR can be used in combination to create high resolution Digital Elevation Models (DEMs) for stream restoration project sites. Aerial LiDAR is ideal for identifying surface features such as headwater streams, skid roads, trails, landslides, and anthropogenic disturbances that cannot be identified with 3.0 and 10.0 meter DEMs, or topographic maps. Aerial LiDAR is used to create high resolution field maps to target specific areas of interest within a watershed, and is a valuable time-management tool for planning field assessment of a project site. Terrestrial LiDAR DEMs and spatial data models created with a 3D laser scanner create a point cloud with greater local precision than aerial LiDAR. The stream laser scan survey requires augmentation with underwater shots to create a seamless surface for topographic and geomorphic surveys of larger streams and rivers. Laser scanning rapidly captures detailed bank profiles for quick and accurate BEHI calculations, precise topographic surveys, vegetation identification, detailed cross sections, and exact locations and size of in-stream structures. Terrestrial LiDAR is ideal for stream and floodplain designs. 3D scanning also produces as-built surveys including 3D True Views of imagery draped over point clouds. These LIDAR based capabilities aid in detailed remote stream analysis thereby reducing project costs.

About the Speaker: Marla Denicola is a staff scientist at Civil & Environmental Consultants, Inc. in Bridgeport, West Virginia. She is experienced in the restoration of streams located on mined landscapes in West Virginia and the analysis of topography using LiDAR. She attended West Virginia University, and has a B.S. degree in Geology, and will finish her M.S. degree in Geology with an emphasis on Geomorphology and Remote Sensing in August 2016.

Greenhouse Gas Emissions Across a Stream-Riparian-Upland Gradient: What Does This Mean for Floodplain Restoration?

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Abstract: Reconnecting floodplains with their adjacent stream is a restoration approach that serves to diminish the downstream flood pulse and promote floodplain ecosystem services. For example, denitrification is one beneficial biological process that removes excess nitrate resulting in lower downstream nutrient fluxes. However, floodplain reconnection may also promote other redox processes that increase greenhouse gas emissions. Although denitrification results in N2 production, in-complete denitrification produced N2O, a potent greenhouse gas. Prolonged wet conditions are known to produce CH4, another potent greenhouse gas. Our objective in this study was to quantify greenhouse gas fluxes across a stream-floodplain-upland continuum over a year. We have measured in-situ fluxes of CO2, N2O, and CH4 fluxes biweekly for 12-months, in addition to other environmental/physical variables. Our results indicate predictable patterns of CO2 and CH4 in response to temperature and soil moisture, whereas N2O fluxes were relatively insignificant. Our results will provide insight into considering design aspects that maximize nutrient removal but minimize the production of CH4 and N2O.

About the Speaker: Durelle Scott is an Associate Professor in the department of Biological Systems Engineering at Virginia Tech. His research focus focusses on ecosystem services within aquatic and riparian system. His work includes: metal cycling in acid mine drainage streams, stream restoration in small streams and floodplains, large river-floodplain hydrology/biogeochemistry in the Southeastern US and coastal glacier streams in Alaska, and water-quality throughout the US stream network.

Effects of In-stream Structures and Floodplain Restoration on Removal of Excess Nutrients

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Abstract: Watershed water quality mitigation efforts such the Chesapeake Bay and Neuse River Estuary TMDLs have increased interest in conducting stream restoration to improve water quality. Enhancing hyporheic and floodplain exchange can remove excess nutrients, but their effects have not been fully quantified. Recent field and modeling studies at Virginia Tech indicate that sufficient exchange with the off-channel zone must be balanced against sufficient residence times in the off-channel zone. Hyporheic exchange and associate nitrate removal was strongly limited by hydraulic conductivity of sediments, and by the fraction of the year when hydraulic conditions are favorable to inducing exchange. Employing common in-stream structures such as cross vanes to increase hyporheic exchange was limited by the density of structures that are possible given constraints of channel slope. By contrast, enhancing floodplain nitrate removal was limited by short residence times within the floodplain and again, the fraction of the year when the floodplain was hydraulically engaged. For both hyporheic and floodplain enhancement, the cumulative removal of excess nitrate was minimal when implemented in reach lengths typical of stream restoration projects. Conversely, restoration of long lengths of stream (multiple km) was necessary to have a substantial effect on excess nitrate. Furthermore, floodplains were found to be sources of nutrients in some cases. In summary, our results suggest that stream restoration efforts to enhance hyporheic or floodplain exchange can improve water quality, but may require substantial investment of resources to restore longer lengths of stream than is typical practice.

About the Speaker: Erich Hester is an Associate Professor in the Department of Civil and Environmental Engineering at Virginia Tech, in Blacksburg VA. He teaches classes in the areas of water resources engineering, environmental hydraulics, and hydraulic structures. His research focuses on how water moves through stream, river, wetland, and groundwater systems, and how these systems interact. He studies how pollutants migrate through these systems, where pollutant attenuation by natural processes occurs, and how such attenuation can be enhanced by human actions including stream and river restoration. He has 8 years' experience in the private sector in stream and river restoration, wetland restoration, stormwater management, and pollutant mitigation. He is a professional engineer in Virginia and Washington State.

Protecting Coastal Streams: the Wilmington Experience

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Abstract: Wilmington is the largest coastal city in North Carolina. As such, it has experienced rapid urban development in the past several decades which has led to significant non-point source pollution of urban streams, tidal creeks, sounds and urban lakes. A number of best management practices (BMPs) have been used over the years to protect water quality with varying results. A comparative study of wet detention ponds found that an enhanced length to width ratio coupled with significant rooted vegetation was the most effective design for nutrient and fecal bacteria removal. Constructed wetlands have had mixed results in Wilmington. A large regional constructed wetland was highly effective in reducing fecal bacteria, nutrients and TSS while results from small constructed wetlands showed reduced efficacy, or no significant removal. Important pollutant removal mechanisms quantified from stormwater wetlands include plant species-specific denitrification, and removal of fecal microbes through micro-zooplankton grazing. Coastal areas have primarily sandy soils, which can be used to advantage in stormwater treatment. Large-scale infiltration devices can greatly reduce fecal coliform and TSS loading to coastal water bodies, and rain gardens, small-scale curb cuts and infiltration swales collectively can significantly reduce and improve stormwater runoff and pollutant loading. While engineering such treatment during area development is the ideal means to control stormwater pollution, retrofitting runoff-prone areas has been demonstrated to be highly effective as well.

About the Speaker: Dr. Michael Mallin is Research Professor at the UNC Wilmington Center for Marine Sciences. He holds an M.S. in limnology and a Ph.D. in marine and estuarine ecology, and he is an Aldo Leopold Environmental Leadership Fellow and an elected Fellow of the American Association for the Advancement of Science. His research has focused on sources and vectors driving the pollution of fresh, estuarine and coastal marine waters, especially nutrients, algal blooms, hypoxia and fecal microbial pollution. He has an especial interest in solution-oriented research to protect waterways.

Nitrogen Absorption Rates by Plants and Sessile Animals: Restoring and Maintaining Stream/Estuary Waters

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Abstract: Waterways including streams, rivers and bayous typically drain to coastal zones. These rich areas of mixing are estuaries and contain great biodiversity, immense productivity, but also serious environmental challenges as well as challenges from land subsidence, sea level changes and coastal storms. Coastal bioengineered structures have been designed and built to encourage native species such as the Eastern Oysters Crassostrea virginica to grow. Three dimensional engineered structures can then grow into robust areas of life which can dramatically reduce wave energy and encourage native plant growth, such as Spartina alterniflora. These plants and animals can store nitrogen, carbon and other nutrients, while also absorbing excess nutrients and, can potentially positively impact entire coastal zones to enhance life. This study calculates that these bioabsorbers can dramatically enhance water quality in estuary and coastal zones. Carbon payback rates have been calculated at 6 months to 2 years for some emplaced structures; Nitrogen absorption rates may be able to significantly impact hypoxic coastal zones when fully emplaced. Calculations suggest that extensive use of these techniques could potentially offset an entire state's carbon emissions under optimal conditions. Further study will focus on optimal techniques to use native species to restore and enhance habitat in a sustainable fashion.

About the Speaker: Steven Hall received the PhD from Cornell University, degrees and training from UC Davis, SUNY Buffalo and McGill University and has been a professor at LSU and the LSU AgCenter since 2000. He has also served on the faculty at the Au Sable Institute. His focus is on the interface between water, agriculture and the environment. Among focal areas are sustainable aquacultural engineering and coastal bioengineering.

Stream Rehabilitation for Biodiversity Hotspots in Face of Climate Changes

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Abstract: Stream mapping, hydrological and biodiversity baseline studies have been carried out in more than 20 forest streams in Singapore, and most of which are found in Bukit Timah Nature Reserve (BTNR), Central Catchment Nature Reserve (CCNR), providing significant ecological function and services supporting a wide range of native fauna and flora through their in-stream habitats, riparian and stream corridor vegetation. Most of these streams are experiencing ecological stresses caused by both natural and human induced disturbances. Preventing further degradation and loss of these stream habitats will avoid catastrophic effects on Singapore's native aquatic fauna and flora as well as many other groups of animals that are associated with these habitats. Resilient, mitigation and intervention measures are required to address the current problems, to halt or reverse the trends so that biodiversity conservation and ecosystem services of streams can be sustained in the long term. A stream restoration project was initiated recently to apply a multi-disciplinary approach to understand the hydrological processes, biodiversity characteristics and ecological functions of streams in Singapore's biodiversity hotspot areas, to analyze the stresses and disturbances that all these streams are currently experiencing, taking into account of the extreme scenarios of climate change effects, and to address the problems at ecosystem level. Conservation strategy and action plan for the biodiversity conservation in streams of Singapore will also be discussed.

About the Speaker: Dr. Cai Yixiong is an established freshwater shrimp taxonomist, and his current research focus on the conservation of freshwater biodiversity, with a particular interest in the ecological and hydrological functions of tropical freshwater habitats.

Hatchery Creek Stream Restoration Project – Monitoring Protocols to Evaluate Impact of Project on Various Trout Life Stages

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Abstract: The Hatchery Creek Stream Restoration project is a unique opportunity to utilize the latest stream restoration techniques to maximize trout habitat, create recreational opportunities for the citizens of Kentucky, and provide mitigation credits. The project is located immediately downstream of the Wolf Creek Dam US Fish & Wildlife National Trout Hatchery near Lake Cumberland in Jamestown, Kentucky. The project was completed in 2015 and extended an existing 400 foot long channel, which is the outflow from the trout hatchery to create approximately 6,000 feet of trout stream habitat. In an effort to maximize habitat and recreational opportunities, the project was designed to provide a variety of habitat for all life stages of trout and included a variety of stream types including A, B, C and DA channels. This project has several unique aspects, which are not typical to natural channel design projects in the southeast, including a constant flow of approximately 35 cfs, which is approximately 70% of the upstream bankfull flow, limited sediment supply, and the need to maintain imported spawning gravels.

Flows were released into the channel in November, 2015 and the project is currently being monitored to confirm usage for the various life stages of trout including spawning. The project also included an artificial upwelling device to help minimize settling out of fines and to promote upwelling in the newly constructed stream. This talk will provide a brief overview of the project and will focus on the techniques being utilized to monitor the site. This includes review of the site to confirm the presence of redds, macroinvertebrate sampling, collection of wood loading data, fish shocking/sampling, and the use of snorkeling surveys to confirm habitat usage. The results of the monitoring to date will also be presented.

About the Speaker: Oakes Routt, PE is an Associate at Stantec's Louisville, KY office with 9 years of experience in watershed assessments, stream restoration design and construction, and dam removal. Oakes earned both Bachelors and Master's Degrees in Biosystems and Agricultural Engineering from the University of Kentucky.

Stream and Wetland Restoration at Rendezvous Mountain State Forest and Grassy Creek

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Abstract: Implementation and monitoring of two mountain stream habitat restoration projects will be described. The Purlear Creek project on the Rendezvous Mountain State Forest property in northwestern North Carolina began in 2005 with the goals of improving water quality and habitat, specifically for native brook trout. The project included channel realignment and floodplain reconnection for 4,000 linear feet of streams, restoration of a 1-acre wetland by ditch-plugging, and establishment of 30 acres of native riparian forest. Stream designs were based on local reference streams to restore natural physical and ecological stream functions. During construction and planting, educational workshops were conducted to teach contractors, consultants, and agency representatives about natural stream restoration techniques. Over the past decade, monitoring and adaptive management have been used to document conditions and optimize stream health. The primary management needs have been related to tree re-planting and invasive plant removal. Monitoring results indicate that the stream system is stable with a growing diverse plant and animal community. Ongoing benthic macroinvertebrate studies indicate rapid reestablishment of stable populations. The NC Wildlife Resources Commission will implement a re-introduction of native brook trout to this restored ecosystem in 2016.

Grassy Creek is a tributary to the North Toe River in northwestern North Carolina with water quality and habitat impairments due to sediment, stormwater runoff, and loss of riparian buffer. A 3,000-ft segment of Grassy Creek in Spruce Pine, NC, was restored in 2015-2016 with the goals of improving water quality and habitats, specifically for the Significantly Rare hellbender and other aquatic fauna, including trout. Ecosystem restoration components include: (1) stream channel realignment and floodplain re-connection to provide natural equilibrium bankfull morphology; (2) in-stream structures including log and rock vanes for habitat enhancement and erosion reduction; (3) streambank wood toe revetments to reduce erosion in meander bends and support habitats; (4) planting native riparian vegetation and removal of invasive plants; and (5) installation of constructed stormwater wetlands to collect and treat runoff from adjacent impervious surfaces. During construction and planting, educational workshops were conducted to teach contractors, consultants, and agency representatives about natural stream restoration techniques. A nature trail was installed parallel to the restored stream reach with signs to educate the public about water quality, hellbender habitat, and stormwater control. Project success is being monitored using water quality samples and biological community assessments of fish,

macroinvertebrates, and hellbenders. Results to date indicate that the stream system is stable with a growing diverse plant and animal community. This presentation will highlight lessons learned during and following project implementation while highlighting the need for long-term monitoring studies to evaluate ecosystem restoration performance.

About the Speaker: Dr. Jennings is a professional engineer with 30 years of experience in water resources engineering, ecosystem restoration, and watershed management. He holds B.S. and M.S. degrees in engineering from The Pennsylvania State University and a Ph.D. in engineering from the University of Nebraska. Dr. Jennings retired as Professor Emeritus at North Carolina State University after teaching for 23 years. He has taught many courses and conducted research on stream restoration and ecological engineering and was co-founder of the NCSU Stream Restoration Program. He has published 120 technical papers and provided technical consulting to government agencies, non-profit organizations, and landowners on more than 150 stream restoration and watershed management projects throughout the USA.

Using Stream Restoration for Pollution Reduction: Elm Fork and Minor Creek Stream Restoration Case Study

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Abstract: Sediment is the number one pollutant in Kentucky streams. Excess sediment impairs habitat and water quality, and also carries nutrients into the stream. Nutrients such as phosphorus and nitrogen are the third leading cause of impairment in Kentucky streams. Often, excess sediment loads are caused by the erosion of unstable banks and channels. The proper restoration of eroding streams can dramatically reduce sedimentation of a system as well as reduce the concentration of phosphorus and nitrogen.

The Elm Fork and Minors Creek Stream Restoration project is a good example of how stream restoration can be used to reduce pollution in streams. The project, located on the Kleber Wildlife Management Area (WMA) property in Owen County Kentucky, incorporated Priority I and II restoration techniques and included a variety of riffle forms, various native substrates, deep pool habitat, groundwater dams, and oxbow wetlands/depression areas. The restored stream reaches were designed to be self-sustaining with minimal erosion as well as provide an array of ecological benefits including varying flow velocities and depths, various substrates, native vegetation, and strong groundwater interaction. Root wads and woody debris generated from construction were utilized for in-stream structures to hold grade, reduce erosion, provide natural habitat features and varied substrates in the channel. The rock used in the constructed riffles consisted of native material harvested on site or mined on an adjacent property. The result is a fully functioning system of diverse riffle and pool features that support and enhance the stream both ecologically and hydraulically. Significant improvement in sediment impairment compared to the pre-construction conditions was observed within the first year following the restoration. Progress will continue to be monitored as vegetation on the banks and riparian area matures. The project was funded with in-lieu fees managed by the Kentucky Dept. of Fish and Wildlife Resources.

About the Speaker: Wanda Lawson P.E. is a Stream Restoration Designer and Project Manager with Stantec. She has been working on stream restoration projects for over 12 years in Kentucky and across the United States. As a Stream Restoration Engineer, Mrs. Lawson has assessed over 55 miles of streams in Kentucky and across the U.S. as well as presented stream restoration techniques to several collegiate level classes and interest groups. Mrs. Lawson obtained her Bachelor of Science in Biosystems and Agricultural Engineering from the University of Kentucky.

Power Dam - Linking Dam Removal and Sediment Transport Modeling with Downstream Restoration

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Co-Authors: William Tanger, Friends of the Rivers of Virginia; Will Smith, Us Fish and Wildlife Service; David Byrd, Us Fish and Wildlife Service

Abstract: The Power Dam in near Rocky Mount, Virginia is over 100 years old. A multi-year initiative to tear down the dam and restore connectivity to over 75 miles of river is nearing its successful completion. A final phase of the planning involved a detailed sediment modeling effort to predict the fate of the nearly 400,000 CY of trapped sand behind the dam. Although the results showed both short and long term effects, presenting the data in the context of downstream river evolution was an important part of the decision making process. Framing the project with a restoration perspective provided agencies a more complete view and allowed designers to make adjustments that would improve recovery trajectories and make the work more efficient. Discussion of this project may help with developing modeling plans, interpreting results, and add to the conversation about the outcomes of dam removals.

About the Speaker: Kris Bass is ecological engineer and the owner of Kris Bass Engineering. He provides design and modeling services for restoration projects of all kinds.

Considerations for Dam Removal and Aquatic Organism Passage Projects

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Abstract: This presentation will look at design and construction challenges and solutions for dam removal and passage-focused culvert design (upgrade) and removal projects. Design and construction issues will be explored drawing on a handful of example projects in Western North Carolina at various stages of design and construction, including the Cane River Dam removal site which is one of the conference tour destinations. Issues incorporated into the presentation will be habitat and barrier removal considerations, site access and footprint minimization factors, use of on-site material, and other challenges. Stream simulation, a US Forest Service method for culvert design focused on passage, will be part of the discussion, and project design and implementation examples will be included.

About the Speaker: With 12 years of experience, Jake is a project manager and designer of stream and wetland restoration, stormwater, and aquatic passage projects for Wildlands Engineering in Asheville, NC. He is currently involved in implementing a number of fish and AOP projects on public and private lands in Western North Carolina. Wildlands Engineering specializes in water resources engineering and planning with a particular focus on innovative engineering for ecosystem renewal.

Dam Removal: Turning Restoration Goals into a Successful Project.

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Abstract: Each year, small dams in the U.S. fail due to a combination of degrading infrastructure and extreme precipitation, causing significant impacts to life, property and natural resources. Most of these dams no longer serve their intended purpose (e.g. water power for mills, flood mitigation, power generation) and as the functional life of these dams is exceeded, owners must consider removal as a viable option to mitigate risks associated with the aging infrastructure. At the same time, many communities and government agencies are interested in funding dam removal to restore fish passage for impacted migratory species. Effective dam removal requires an understanding of river science, engineering, and ecology, in addition to understanding and problem solving multiple objectives and concerns in the political spectrum. This presentation is a primer outlining the many steps needed to take a dam removal project from start to finish. The presentation will focus on the core elements of a dam removal project, including: data collection and survey, hydrology and hydraulics, sediment management, infrastructure protection and demolition, threatened and endangered species protection and cultural resource considerations. Specific project sites will be featured, drawing on experiences from the 70+ dam removal projects completed by Inter-Fluve, Inc.

About the Speaker: Kristen grew up in the coastal Delaware community of Rehoboth Beach where an early interest in preserving land and water collided with her ambitious interests in science and math. She followed those passions to the University of Delaware, where she completed her degree in Civil Engineering. After completing her masters in Civil and Environmental Engineering at the University of Virginia, she went on to earn her PhD. Her dissertation research employed a laboratory flume to identify the impact that various flow regimes, sediment compositions, and removal techniques had on the downstream sediment deposition patterns following dam removal. Following graduation in 2013, Kristen joined Inter-Fluve's (IFI) Cambridge, MA office and recently relocated to Durham, NC where she continues to work on IFI projects nationwide. She is actively involved in several dam removal projects, multiple cranberry bog restorations and habitat restoration projects. Her role varies daily, but includes geomorphic assessments, total station and RTK surveying, hydrologic and hydraulic modeling, project design, permitting and construction oversight.

Use of Telemetry, Genetics, and Isotope Analysis to Characterize Brook Trout Response to Culvert Replacement in an Appalachian Watershed

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Abstract: Culvert replacement projects have the potential to benefit brook trout populations by reconnecting important complementary and supplementary habitats within fragmented watersheds. However, quantifying ecological response to culvert replacement is difficult and monitoring projects are rare. The overall objective of this study was to characterize brook trout response to replacement of 3 impassible culverts within a high elevation Appalachian watershed. We utilized a combination of radio telemetry (summer 2015) and genetic (spring 2011-15) and isotopic analyses (fall 2014) to quantify benefits of reconnecting spawning habitats (i.e., tributaries) with supplementary foraging habitats (i.e., larger main-stem reaches). Radio telemetry demonstrated extensive movement (up to 8.21 km) of brook trout between main-stem and tributary habitats distributed at the watershed-scale. We found no genetic evidence of individuals moving into the three study streams prior to culvert replacement. However, genetics suggested substantial movement (up to 22% of individuals) into two of the three streams following restoration. Analysis of C and N isotopes suggest widespread (up to 50% of individuals) use of the main-stem as supplementary foraging habitat prior to spawning migration into two of the three previously isolated tributaries. Our results demonstrate individual- and metapopulation-level benefits of reconnecting spawning (tributary) and foraging (main-stem) habitats. This study confirms the importance of watershed-scale dispersal within native brook trout populations and suggests large-scale culvert replacement projects should be a major focus of brook trout restoration efforts throughout their native range.

About the Speaker: Eric Merriam received a B.S. in Biology from Marshall University in 2007 and a M.S. in Wildlife and Fisheries Resources from West Virginia University in 2009. He earned a Ph.D. in Forest Resource Science from West Virginia University in 2015, where his research largely focused on modeling aquatic ecosystem response to mountaintop removal and valley fill mining in the central Appalachian region. He is currently a post-doctoral research assistant at West Virginia University. His current research focuses on managing brook trout under uncertain future conditions, and includes efforts to: characterize population response to watershed-scale restoration activities, quantify changes in distribution as a result of unconventional oil and gas development, and predict habitat loss under future climate scenarios.

Todd Petty is a Professor of Aquatic Sciences at West Virginia University and serves as Associate Dean of Academic Administration in the Davis College of Agriculture, Natural Resources & Design. He earned a bachelor's degree in Biology from the University of Virginia

(1990), and an M.S. and Ph.D. in Forest Resources and Ecology from the University of Georgia (1994, 1998). After a one-year post-doctoral fellowship, he joined the WVU faculty in 2000, where he teaches courses in river ecology, watershed restoration, and vertebrate population dynamics. Dr. Petty studies watershed scale processes influencing water quality and stream fish and invertebrate assemblages. Through this research, Dr. Petty's lab has developed an analytical process used to target high priority areas for protection and restoration of aquatic diversity. Statistical tools and data are now available through an on-line analytical system at www.fishhabitattool.org. This research is being applied to efficient restoration of fisheries throughout the Great Plains, Lake Superior, the Ohio River basin, and the Chesapeake Bay watershed. Dr. Petty's research has been funded in recent years by the USEPA, the USFWS, USGS, the WV Department of Environmental Protection, the North Atlantic Land Conservation Consortium, and the National Science Foundation.

SPECIAL SESSION:

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Abstract: The Watershed Resources Registry (WRR) is an interactive GIS-based screening tool, a product of the Green Highways Partnership and Maryland State Highway Administration's Route 301 Project, created to improve resource planning and mitigation decision-making using a watershed approach, by integrating regulatory and non-regulatory programs. Historically, program management decisions have been constrained by the "stovepipe" or programmatic nature of the agencies' legislation. This narrow approach, while useful for specific resource protection, impedes broad-based collaborative planning and application of environmental programs. The element that makes the WRR unlike many other mapping and targeting tools is the level of agency collaboration and program integration.

As a result, a Technical Action Committee (TAC), consisting of staff from partner agencies including: U.S. Environmental Protection Agency (EPA), Region 3; U.S. Army Corps of Engineers (Corps), Baltimore District; Maryland Department of the Environment (MDE); State Highway Administration (SHA); U.S. Fish and Wildlife Service (FWS); Maryland Environmental Services (MES); Maryland Department of Natural Resources (DNR); and the U.S. Federal Highway Administration (FHW A), collaboratively strategized the development, progress, and future of the WRR, and uses it as a vehicle to discuss how to reduce cost and maximize environmental benefit.

The WRR was designed to address priority resources goals, identify watershed needs, and to facilitate the integration of multiple local, state, and federal environmental program goals at a watershed level (CWA 319, 401, 402, 404, 303(d), Green Print, Rural Legacy, NEPA, TMDL Implementation, stormwater management, etc.). Using available data from various organizations, the WRR reveals a comprehensive picture of watershed conditions and identifies opportunities for aquatic and terrestrial creation, restoration, enhancement and preservation. The WRR currently identifies ecological opportunity areas throughout the state of Maryland and scores each opportunity area with a score from one to five stars (five stars indicating the greatest ecological value). These scores are based upon eight suitability analyses for both preservation and restoration opportunities for: Wetlands, Uplands, Riparian corridors, and Stormwater areas. The TAC is also currently working on the development of a suitability analysis for Stream Stability to be incorporated into the registry.

The WRR is currently available to the general public for the state of Maryland via the Watershed Resources Registry Outreach Website and Web Application found at http://www.watershedresourcesregistry.com/. It is currently being used by the partner agencies as well as other agencies that have recently become familiar with the WRR. Agencies are currently using it for an array of activities such as: targeting strategies for TMDL implementation and CW A §404 NEPA related projects, targeting ecological oppo11unities for preservation and restoration, and in support of MD E's In-Lieu Fee program for tidal and non-tidal wetland permitting activities, among other things. Additionally, the EPA uses the WRR to gather information prior to conducting site visits and to provide supportive materials for briefings and other projects.

As a result of overwhelming interest in the WRR following a national workshop, EPA Region 3; the Corps, Philadelphia District; Delaware Department of Natural Resources & Environmental Control (DNREC), Delaware Department of Transportation (DelDOT) and MES are currently developing a WRR Delaware and Pennsylvania. Using a "skeletal" prototype solely consisting of national and federal data layers, and the Delaware and Pennsylvania TAC is determining which specific state and/or local data layers would be the most beneficial for state specific goals.

About the Speakers:

Ralph Spagnolo is the Watershed Restoration Program Manager for the Water Protection Division of the U.S. Environmental Protection Agency. Ralph promotes the integration of regulatory and non-regulatory Sections of the Clean Water Act using the watershed approach. Ralph is the EPA lead for the implementation of the WRR in Region III. He coordinates state and local governments, the private sector and watershed organizations with federal water programs. Mr. Spagnolo serves as the national representative for EPA on the National Technical Committee for Hydric Soils and the Wetland Delineation Manual. He also is an adjunct professor at Cabrini College in Pennsylvania.

Michael Herzberger is a GIS Manager for the Maryland Environmental Service, an independent State Agency created to protect the State's air, land and water resources. Mr. Herzberger is responsible for oversight of various GIS-based services for numerous entities within the public sector. Michael has a B.S. in Geography and Environmental Planning and a minor in GIS from Towson University located in Baltimore, Maryland (2005).

Riparian Habitat Quality Assessment Following Stream Restoration

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Abstract: Monitoring programs should be created in conjunction with the implementation of restoration procedures to assess water quality and ensure that restoration goals are met. In areas where excessive sedimentation or erosion are primary factors for restoration, stream morphology and erosion controls, including riparian vegetation, should be included in the monitoring program. Currently, in the southeastern United States, a model has not yet been calibrated to assess riparian habitat condition. Existing models determine stream quality using primarily invertebrate proxies such as the index of biological integrity but these do not assess the riparian habitat condition directly. Some of these models are calibrated for areas of gravel bottom streams or in areas of different macroinvertebrate assemblages. Due to this lack of calibrated habitat assessment models a rapid monitoring protocol was developed to determine habitat quality in areas impacted by stream restoration using vegetation proxies. This monitoring protocol uses an index calibrated for sand bed streams, which are prolific in the southeastern United States.

The index is based on observable factors including channel entrenchment and vegetative diversity and structure. This rapid monitoring protocol relates changes in downstream channel morphology to vegetative assemblage based on established relationships in the literature. It was tested in two highly impaired urban systems (determined through hazard assessment) in the D'Olive watershed in southeastern Alabama, at varying temporal scales post-restoration. These systems are within the network of tributaries providing excessive sediment deposition into Mobile Bay, which necessitated the need for channel restoration. This protocol was created for use specifically in riparian habitats as a rapid assessment method in stream restoration monitoring but can be used to determine habitat quality in other riparian habitats.

About the Speaker: Michele Goodfellow is currently a Master's Candidate at the University of West Florida. She graduated from the University of Florida with a BS in Forest Resources and Conservation and a BA in Spanish in December of 2013.

Meeting Vegetation Success Criteria: Should we "hedge" our bets with supplemental plantings?

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Abstract: Conditions on newly built stream and wetland mitigation sites can be hard on bare root nursery stock. It is tempting to beef up planted stems as their numbers drop in the first few years of monitoring. But how do you know if your project is on a trajectory toward meeting vegetation success criteria at closeout? This presentation examines growth and survival rates from thousands of individual planted stems as well as their resilience under stress. We hone in on the most important factors contributing to vegetation success in order to make better informed decisions when it comes to initial and supplemental planting density, species composition, or whether to do supplemental planting at all. We will also discuss how control of invasive vegetation, soil amendments, and other management activities contribute to project success.

About the Speaker: Alea Tuttle currently serves as an Environmental Scientist for Wildlands Engineering's Charlotte, NC, office. She has over five years of professional experience in the field of riparian and stream ecology. She specializes in existing conditions assessment and post-construction monitoring of stream restoration and enhancement work for mitigation credit. Ms. Tuttle holds a bachelor's degree in Environmental Science from the University of Vermont and a master's in Earth Sciences at the University of North Carolina, Charlotte. She is certified as a Professional Wetland Scientist. Wildlands Engineering specializes in stream and wetland restoration with a particular focus on innovative engineering for ecosystem renewal.

Kirsten Gimbert currently serves as an Environmental Scientist in charge of the post-construction monitoring program for Wildlands Engineering's Charlotte, NC office. She has 11 years of professional experience in stream restoration and watershed assessments. Her duties include monitoring/assessments, design, construction oversight, geographic information systems (GIS) mapping, and project management for ecological restoration projects. Her project experience includes stream restoration monitoring and design, water quality monitoring, construction management and document production, sediment transport sampling and analysis, stormwater BMP/LID monitoring and design, watershed and habitat assessments, and sediment and erosion control monitoring and inspections. Ms. Gimbert holds a bachelor's degree in Earth Sciences from State University of New York at Fredonia, and a master's in Forestry and Natural Resources from Clemson University.

Vegetation in NC Wetlands: What we hope to learn about anthropogenic environmental changes through long-term monitoring

Karen Hall
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Abstract: North Carolina's Wetland Monitoring Network has been established by the NC Division of Water Resources through various grants and programs over the past few years. NCSU received funding from the US EPA to continue long-term monitoring at 16 of the sites within the network. This project is needed to collect, analyze, and archive data on the condition, functions, and services provided by wetlands within the Piedmont and Coastal Plain of NC. Data collected from the NC Wetland Monitoring Network as well as establishment of a wetlands databank will help document and evaluate changes in wetland condition and functions over time. NCSU has resampled these sites to establish a consistent baseline for sampled wetland parameters, including vegetation. This presentation will discuss vegetation parameters and baseline data collected during the 2015 field season.

About the Speaker: Karen Hall is an Extension Assistant Professor at NCSU in the Biological and Agricultural Engineering Department. She received a BS degree in biology from UNC-Chapel Hill and MS and PhD degrees in forestry and environmental resources from NCSU. Dr. Hall has worked for the NC Cooperative Extension since 2000 with expertise in riparian vegetation and management.

Productive Food Forest Systems for Riparian Buffers

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Abstract: Permaculture generally refers to a design approach that takes a holistic system view, observes the interrelationships of different parts and mimics sustainable natural systems. Whereas many sustainable design approaches often emphasize the mitigation of human impacts, permaculture emphasizes regenerative design and seeks ways to positively integrate humans within ecosystems. At its best, permaculture design solves multiple interrelated problems systemically by mimicking biological patterns. For instance, water quality degradation, topsoil loss, habitat destruction, carbon sequestration, and a vulnerable food supply may all be addressed with a single permaculture strategy for land management.

Food forests are a permaculture strategy for creating low-maintenance, sustainable local food systems that mimic woodland ecosystems while also producing yields directly useful to humans. These yields are achieved by incorporating fruit and nut trees, berry shrubs, perennial vegetables, and other plants and fungi which can be used for food, medicine and other human needs. This approach to producing perennial food crops within a forest system has a long history in tropical regions with recent applications adapted to temperate regions.

Riparian buffers for stream restoration may present a significant opportunity for a food forest strategy - one that provides the hydro-ecological function of a restored stream buffer, but goes beyond to provide additional ecosystem services, including food production. Because of the yields directly beneficial to property owners, food forest applications may also facilitate the acceptance, adoption and maintenance of stream buffers, particularly in urbanized areas.

This presentation will provide an overview of food forest systems and focus on their application within riparian buffers. Key concepts of food forest systems including forest layers and plant guilds will be discussed. Examples of several small-scale experimental food forest systems within riparian corridors in Western North Carolina will also be presented along with recommendations for future research.

About the Speaker: Tim Ormond, P.E. is an Asheville-based environmental and water resources engineer with over two decades of applied engineering and research experience. He holds a B.S. degree in civil and environmental engineering and an M.S. degree in civil and water resources engineering. In 2009, Tim founded HydroCycle Engineering, a consulting firm which focuses on sustainable and regenerative design that is mindful of the interconnections of the water cycle, ecosystems, and people.

Holistic Stormwater Management Partnered with In-Stream Restoration to Reestablish Stream Integrity

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Abstract: Active mass wasting on a 4,500-ft reach of Horsebranch Creek is a major sediment source to Banklick Creek in Northern Kentucky—a sediment-impaired water on the 303(d) list. The instability not only impairs stream habitat but also jeopardizes the stability of the arterial access to the local hospital and several utilities. In addition to possible historic channelization during construction of the roadway, a holistic analysis of the ~800-acre watershed identified the lack of adequately designed detention facilities as one of the key drivers of streambed erosion, downcutting, and subsequent bank failure via mass wasting. For example, of the 166 acres of impervious area in the watershed, only 40% is currently routed through detention facilities. Furthermore, the conventional detention designs do little to mitigate the erosive power of the urban flow regime, with ~80% more sediment transport capacity than the predeveloped flow regime for a 2-year event. However, a combination of detention basin retrofits and strategic new storage were able to reduce the sediment transport capacity to within ~30% of the predeveloped regime. These flow regime improvements could promote the gradual transition from a degradational trajectory toward a recovered equilibrium, along with the restoration of a more natural disturbance regime for benthic macroinvertebrates. In-stream restoration measures were also identified to accelerate the recovery of equilibrium and restore some of the most geotechnically unstable banks in strategic areas. The coupled stormwater and stream restoration approach will facilitate a more holistic restoration of the stream system by addressing numerous drivers of ecosystem degradation. The approach also created greater appeal to the public and other stakeholders (e.g. the hospital, utilities, watershed groups etc.) creating greater possible watershed partners to support implementation.

About the Speaker: Kurt Cooper, P.E., LEED AP, has an M.S. in Civil Engineering with a focus in Hydraulic Engineering, Stream Restoration and River Mechanics from Colorado State University. He has ten years of professional experience in stream restoration and stormwater management. As a Design Engineer at Sustainable Streams, Mr. Cooper leads field activities and serves as the lead stream restoration designer.

Nora Korth, P.E. is also a Design Engineer at Sustainable Streams with six years of experience across many stormwater-related topics. She has a B.S. in Environmental Engineering and leads stormwater modeling for the firm.

Automated Geospatial Model Development for Stream Bank Erosion Spatial Vulnerability Determination for Coastal and Upland Streams

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Abstract: Remote prediction of spatial vulnerability due to stream bank erosion, one of the four types of water erosion, is yet to be ascertained accurately. Universal Soil Loss Equation (USLE) or RUSLE models are able to quantify the erosion rate on spatial basis very precisely but not able to locate the vulnerable locations of the stream for stream bank erosion. Geomorphological characteristics of the stream valley and the watershed such as overbank floodplain level, drainage area, stream channel capacity, channel slope, and soils are some of the factors that influence the frequency, duration, and intensity of flooding and subsequent soil erosion on the channel banks. Riparian areas along the stream banks also support soil stabilization along the stream reducing stream bank erosion. Studies of inexpensive and efficient use of geospatial technology (GIS, remote sensing, and GPS) to predict spatial vulnerable locations of stream bank erosion are rare. The goal of our study is to develop an automated geospatial model in ArcGIS ModelBuilder using spatial data like landuse, Digital Elevation Models (DEM), soil, and design flood discharges of various frequencies to determine vulnerable spatial locations on the streams of interest. A model was developed for an inland stream with undulated landscape in Northeast Georgia, USA and another model was developed for a low-gradient coastal stream in eastern South Carolina, USA. Both model results were ground-truthed and accuracy assessment was completed on it. The results were very accurate with more than 80% overall accuracy obtained for the NE Georgia stream bank erosion prediction vulnerability location determination. Light Detection and Ranging (LiDAR) has become an increasingly useful tool not only for land-use and classification, but also for monitoring gullies to obtain very detailed topographic information. DEMs were created with LiDAR data (30 cm) for both sites. High resolution multispectral imagery (Y2015 -1m NAIP Imagery for SC and 0.15 m orthoimagery for NE Georgia) was obtained and classified to obtain the landuse features of the study watershed that embedded the streams. The same classified landuse raster provided the accurate riparian cover along the stream. High resolution SSURGO soil data was processed and used for the model

development. Slope map was created from the DEM and classified into different class ranges based on the stream bank erosion vulnerability range. These ranges were ascertained based on literature review and our own knowledge of the landscape dynamics. Soils of the study watersheds were reclassified to flood frequency, hydrologic group, soil erodibility (K-factor) rasters. Weighted Sum tool of ArcGIS was introduced in the model to provide specific weightage to individual stream bank erosion vulnerability parameters discussed above. The weight scale was developed with expert knowledge and group scoring. The resultant raster was overlayed with weight based riparian zone rasters and the slope rasters along the stream (1 ft) as the riparian zone cover and the topographic slope adjacent to the stream bank has higher impact for stream bank erosion. The final weighted summed raster was clipped to 1 m buffered stream polygon and classified into five different classes (Very Low – Very High) of vulnerability to erosion along the stream. As mentioned above in-field ground-truthing were completed and accuracy assessment matrixes were developed. This automated geospatial model can be replicated to determine the highest vulnerable spots for stream bank erosion and provide decision support for its control, which in turn improve stream water quality.

About the Speaker: Trae Timmerman is a student and undergraduate research assistant at the University of North Georgia's Institute for Environmental Spatial Analysis whose primary focus has been on GIS and remote sensing based coursework, with additional experience in environmental studies and environmental sciences. He is passionate about natural resource conservation, and would like to apply the skills that he has gained during undergraduate study to assist and improve decision support in regards to environmental conservation using geospatial technologies.

Process-Based Restoration of Streambed Sediment Disturbance Regime

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Abstract: Current stream restoration practices typically attempt to address impairments to geomorphic stability, water quality, and aquatic habitat at the reach scale. There has been increased interest in considering stream functions for stream restoration projects. This is primarily driven by focus on ecological standards for determining successful stream restoration and the relative importance of stream processes compared to channel form. Stream functions are also a key component of the 2008 Final Compensatory Mitigation Rule.

In Process-based Principles for Restoring River Ecosystems, Beechie et al. (2010) describe process-based restoration as reestablishing normative rates and magnitudes of physical, chemical, and biological processes that create and sustain river and floodplain ecosystems. The process-based restoration approach consists of four principles, including (1) target root causes of habitat and ecosystem change, (2) tailor restoration to local potential, (3) match the scale of restoration to the scale of the problem, and (4) be explicit about expected outcomes. In order to address the four principles of process-based restoration, restoration scientists and engineers need to have an understanding of (1) existing conditions and trajectories of stream functions, (2) normative rates and magnitudes that should be targeted, and (3) tools available to make quantitative predictions of possible outcomes due to restoration.

The magnitude and frequency of streambed sediment disturbance is important in shaping biotic communities within a given stream reach. This presentation focuses on the disturbance regime of streambed sediment to illustrate the application of process-based restoration. Using the appropriate tools and analyses is imperative for understanding the existing conditions and trajectories of the streambed sediment disturbance regime and to estimate possible outcomes due to restoration. Knowing normative rates and magnitudes of streambed sediment disturbance is important to guide and quantitatively test the possible outcomes of proposed restoration. Potential target values of streambed sediment disturbance will also be discussed.

About the Speaker: Mike has over 15 years experience working on projects involving stream restoration, stream bioassessment, and watershed management. Key interests include detailed sediment transport analyses including transport sampling, transport formula calibration, effective discharge calculation, and capacity-supply assessment to examine sediment transport continuity. Experience with sediment transport modeling includes bed load and suspended load transport.

Streambank erosion model for the northern Gulf of Mexico coastal plain.

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Abstract: Predictive field-based models have been developed to identify streams that can be expected to experience rapid erosion and are in need of restoration. One of the most widely applied models, the Bank Assessment for Non-point Source Consequences of Sediment (BANCS) model, correlates observed rates of streambank erosion with near-bank stress and bank erodibility. The BANCS model is region specific and has to be calibrated in every hydrophysiographic region. Our study calibrated the BANCS model for the northern Gulf of Mexico coastal plain and evaluated if the model could be made more robust. The study was carried out at 75 sites in the Florida Panhandle, South Alabama, and South Georgia. We applied the standard BANCS methods but because other studies found the BANCS vegetation factor to be inadequate we additionally determined root density and tree biomass. Root density was determined with a new point intercept probing method and tree biomass was determined with a distance weighted approach to traditional forestry surveying protocols and allometric equations. The average measured bank erosion rate during the first year of the project was 6 cm/yr but showed considerable variability in year two. Prediction of measured bank erosion rates with the standard BANCS model yielded low R2 values, indicating that the standard model should be improved. Even though we demonstrated that our root probing method accurately estimated root density, it was not a good predictor of measured bank erosion rates. Tree biomass was a good predictor of measured bank erosion rates ($R2=0.6$, $p<0.01$) and thus is suitable for improvement of the BANCS model. Our study indicates that the standard BANCS approach is not optimal for the Gulf of Mexico coastal plain and that our objective method to determine tree biomass is a promising alternative to the traditional visual estimates of the standard BANCS model.

About the Speaker: Mitchell McMillan graduated from the University of Alabama in 2012 with a B.S. in Geology and worked as a geologist for Longleaf Energy Group. Mitchell is currently pursuing a M.S. in Environmental Science at the University of West Florida, where his work focuses on understanding the physical and environmental controls on streambank erosion and representing them in predictive models that can be used by applied scientists. This work has been supported by the U.S. Fish and Wildlife Service, the Geological Society of America, and the Gulf Coast Association of Geological Societies.

SPECIAL SESSION:

Using Stream Restoration on UGA's Campus as a Focus for Engaging all Three Land Grant Missions in Sustainability

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Watershed UGA is a vision and framework for using campus watersheds as real world examples to advance campus sustainability through teaching, research, public service and outreach. We are engaging thousands of university students in campus water quality issues, while stimulating collaboration across disciplines in unparalleled ways, and forging partnerships with a variety of community organizations essential to the protection of our water resources. The restoration of campus streams and lakes has become a university-wide priority and generated buy-in from University administrators and facilities managers. Our main sources of impairment are leaking sewer lines, stormwater runoff, pet waste, and the proliferation of invasive species in stream corridors. Past land uses has left many streams in need of day-lighting; currently they are buried under roads and buildings and largely forgotten. Watershed UGA has initiated a paradigm shift in the University's approach to environmental stewardship and sustainability.
As we enter into our second year, Watershed UGA is being taught in at least fifty-six classes, reaching thousands of students in classrooms across thirteen colleges on campus. Courses as diverse as engineering, law, the biological and physical sciences, technology, English composition, and the arts are included. Our classroom modules are effective with significant increases in knowledge documented in post-test assessments. Using Watershed UGA as the centerpiece, faculty submitted proposals totaling over $2.5 million to support undergraduate and graduate research; funding sources include the National Science Foundation and the National Endowment for the Arts. Two foundations awarded funds for the restoration of Lake Herrick, which was closed to swimming as the result of poor water quality in 2002. A committee of faculty, staff, and students are developing a restoration plan to guide the expenditure of these funds. A major component of the project is to use the arts, signage and vegetative plantings to show where streams flow under buildings, parking lots and roads.

Laurie Fowler will provide "An Overview of Watershed UGA" to address establishment of program, essential elements, key partners, funding and long-term sustainability of the program. James Wood will discuss his "Urban Ecology STEM Course", a newly-established course that engages undergrads in urban ecology issues including stream impairment and invasive species and habitat conservation in urban areas. Jon Calabria will discuss "Engaging Students in the Development and Implementation of a 9-Key Element Watershed Restoration Plan". He will

describe how students from multiple disciplines identified the impairments of campus watersheds and current and planned restoration efforts, including a possible new graduate degree program in restoration ecology co-sponsored by the College of Environment and Design and the Odum School of Ecology.

About the Speakers:

Laurie Fowler, an environmental attorney, is the Director for Policy of the UGA River Basin Center (www.rivercenter.uga.edu) where her current research interests include transboundary management of water resources, payment for ecosystem services, land planning/conservation to protect water resources and the pedagogy of sustainability science and experiential learning. Laurie teaches experiential service learning courses that allow graduate students to work across disciplines, applying policy, design and ecological principles to manage and protect water and other natural resources for diverse stakeholder clients at the federal, state and local level. She currently leads a team of 70 faculty and administrator in developing and implementing Watershed UGA, using the restoration of UGA's campus streams and lakes as a living laboratory to promote sustainability across the three missions of the land-grant university: teaching, research and public service and outreach, as well as facilities/ground management. She earned her LL.M. degree from the University of Washington, her J.D. degree from the University of Georgia and her B.A. degree from the University of the South.

James Wood is a PhD candidate working with the River Basin Center in Odum School of Ecology at the University of Georgia. His research focuses on freshwater and plant ecology and the impacts of urbanization on lotic systems. In spring 2016 he designed and taught an undergraduate service-learning course on urban landscape ecology, which explored the many impacts of urbanization on wildlife, biodiversity and ecosystem health. This writing intensive course provided students with both broad and local perspectives of ecology by integrating core ecological principles with hands-on service-learning experiences in the community.

Dr. Calabria, a licensed landscape architect, has worked on many conservation, restoration and development projects that improved environmental quality within the human context. He brings these experiences to the classroom and studio to engage students in the art and science of landscape architecture and was recognized as one of UGA's creative teachers for experiential learning. His research includes the amelioration of land use impacts on receiving waters and understanding peoples' perceptions and attitudes toward water resources.

SPECIAL SESSION:

Leave it to Beavers: Natural Systems Restorations in Urban Environments

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In 2002, a developer illegally rerouted a stream to drain a wetland in an urban area of Atlanta, GA, USA that ultimately drains into a major tributary of the Chattahoochee River. Many restoration alternatives were considered, until the arrival of beavers a few years later began to transform the site, possibly beginning the recovery of the stream-wetland system. Beginning in 2014, we have monitored beaver activity and physical, chemical, and biological data at the site, looking for indications of recovery of the ecosystem. Strong positive trends in groundwater levels in the wetland have been seen. Downstream reductions in nitrogen and fecal coliform concentrations have already been seen at times, indicating improvements in water quality. However, the site remains a net exporter of sediment to the watershed, likely due to high erosion rates on the constructed channel, which is part of the natural process of beaver wetland formation. We have also been exploring beaver dam analogs (BDAs) to support the beavers' efforts and to possibly provide similar ecological benefits in systems without beavers. We propose that rather than being treated as impediments to stream restoration that must be removed from a restoration site, beavers can be vital allies in the restoration of stream ecosystem functioning without the high costs and impacts of major restoration projects.

About the Speakers:

Nancy Jones is the Founder and Executive Director of Blue Heron Nature Preserve, a 30 acre green space in Atlanta. She is a graduate of the University of the South in Sewanee, Tennessee and currently lives in Atlanta. She is an artist, teacher, activist and environmentalist and cares deeply about nature. She has been honored for her work by Common Cause of Georgia, the EPA, the Buckhead Heritage Society and the North Buckhead Civic Association.

Kevin McCauley is the Project and Operations Director at Blue Heron Nature Preserve and has been an activist in Atlanta ever since returning there with his family 20 years ago. He established the first organic, community garden in North Atlanta and a bee apiary at Blue Heron. As Project and Operations Director he is responsible for managing the 30 acre Preserve and office building including work on capital projects, grant writing and implementing and volunteer outreach. He is passionate about the idea of reclaiming nature and reestablishing natural processes in an urban environment where the impact is multiplied because it's where people live, work and play.

Elizabeth Sudduth, Ph.D. is an Assistant Professor of Biology at Georgia Gwinnett College in Lawrenceville, GA. Her research focuses on the benefits and impacts of modern stream management and restoration practices, particularly in urban streams in the southeast. At GGC, she teaches in the Biology and Environmental Science majors and mentors undergraduate researchers interested in urban freshwater science, conservation biology, and restoration.

Amber Hughes is a 2016 graduate of Georgia State University with a degree in Environmental Science. She has interned at Blue Heron Nature Preserve for 18 months, assisting with GIS mapping, water monitoring and helped install the first Beaver Dam Analog at the Preserve.

Lessons Learned in the Design, Construction, and Monitoring of a Large-Scale RSC

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Abstract: Charlotte-Mecklenburg Storm Water Services (CMSWS) has implemented an innovative Regenerative Stormwater Conveyance (RSC) project to remediate a large and severely eroded gully. This project is unique in its scale, its location within an urban watershed and residential setting, and the fact that it was designed and constructed to allow for water quality and hydrology monitoring. This project encountered multiple obstacles during construction, including inclement weather, inadequate erosion control, scour, persistent standing water and citizen concerns. These obstacles were overcome using adaptive management practices and multiple on-the-fly retrofits. Ultimately, this project was completed and is generating monitoring data that will be used to evaluate its efficacy as a SCM within Charlotte. This presentation provides a comprehensive and highly illustrative case study of multiple facets of RSC implementation and performance.

About the Speaker: Isaac Hinson is the Watershed Restoration and 404 Permitting Supervisor for Charlotte-Mecklenburg Storm Water Services. He has over 10 years of experience in municipal government and specializes in water resources, stream/wetland restoration, 401/404 permitting, water quality monitoring, and SCM inspection and maintenance. Isaac is a certified Professional Wetland Scientist. He holds a B.S. in Biology from the University of North Carolina at Charlotte and a M.S. in Biology from Winthrop University

When Stream Restoration Meets Mastodon

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Abstract: Jordan Branch/Spencer Creek, located within a residential neighborhood and downstream from a golf course, was selected for restoration and enhancement by the City of Franklin following numerous requests from local residents. The purpose of the project is to create improvements to the stream that would have measurable positive impacts and protect properties and houses. Franklin has had complaints for several years regarding the severely entrenched and eroding, undercut banks of Jordan Branch/Spencer Creek which flows behind several houses. Large trees have fallen and many could fall on or very near houses uprooting large portions of back yards. Stormwater channels designed to convey flow from the subdivision streets to the stream are likewise actively head-cutting and encroaching on back yards.

A feasibility study was prepared and restoration options considered. Upon completion of the feasibility study which included a literature review of previous archaeological explorations, the project team better understood the site's significant prehistoric archaeological resources, including the remains of American mastodons, prehistoric stone tools and other evidence that mastodons were butchered by humans. The Tennessee Department of Archaeology conducted an excavation of a mastodon and associated prehistoric tools in 2010. Other previous archaeological excavations were conducted in the 1970s and 1990s, both recovered mastodon remains. Because of the sensitive and rare nature of these resources, agency coordination was performed. Evidence indicates that the resources are between eight and twelve feet below the current ground surface.

Restoration options are being considered that would require excavation no deeper than approximately five feet above the bottom of the stream and involve sloping the banks and providing stabilization measures and grade control. This approach is being coordinated with the agencies to keep the excavation outside of the layer where the findings have occurred.

About the Speaker: Jeff Duke is an ecologist with over 26 years' experience managing and performing ecological and ecosystem restoration projects. He has experience in the regulatory permitting and compliance arena dealing with §404/401 of the Clean Water Act. His areas of expertise include ecosystem restoration, wetland ecology and delineation, mitigation banking, and ecological assessments. He has a Master of Science degree from the University of Alabama in Aquatic Ecology.

Root Step / Pool Channels: Biologically Controlled, Steep Coastal Plain Channels

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Abstract: In many regulatory programs and stream evaluation protocols, coastal plain streams are almost always assumed to be low gradient systems, often heavily meandering, with a riffle/pool or glide/pool bed form. But in the Coastal Plain of Virginia, there are often high scarps that drain to tidal waters through very steep headwater channels (5-10+% slope). Many of these systems have been impacted by altered watershed hydrology and direct discharge of stormwater at the head of the channel. In most of the channels the original bed forms have been obliterated, resulting in severe incision and increased sediment loads into tidal waters.

Recent work on Fort Belvoir, Virginia has identified headwater streams that still have their historical bed form. These steep channels have the geomorphic characteristics of a classic Step/Pool channel: steep slopes (>5%), low sinuosity, vertical energy dissipation, and minimal floodplain. However, unlike their mountainous, geologically controlled cousins, these channels are Biologically Controlled Step Pool Systems. Steps are created by mature tree roots spanning the entire channel width, with dense mats of root hairs lining the step and extending into the pool. These watersheds are sandy with very high infiltration rates, converting precipitation into groundwater which is discharged to the channels creating a perennial base flow. Watershed development reduces infiltration and groundwater discharge, increases surface runoff, resulting in pool scour, and ultimately root step failure.

Stabilization of steep coastal plain streams could be achieved through installation of stone steps and larger bed material sufficient to resist the altered watershed hydrology. But true restoration of root step/ pools faces many challenges. Restoration of watershed hydrology is typically unattainable, so a hybrid approach to channel design is proposed to improve hydrology and channel resistance, while setting the stage for long-term root step development.

About the Speaker: Mr. Siegfried has 30 years of experience with water quality, environmental planning and design in the Mid-Atlantic region, with the last 20 years focused on wetland and stream restoration. In addition to designing projects for federal, state and local clients, he has co-authored state guidance and taught graduate level courses in stream restoration.

Headwaters, Hatfields, and Hollows: Stream restoration in the West Virginia Coalfields

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Abstract: Ecosystem Investment Partners, Inc. (EIP) has teamed with Civil & Environmental Consultants, Inc. (CEC) and the Canaan Valley Institute (CVI) in the restoration and creation of over 65,000 feet of headwater streams in the Coalfields region of southern West Virginia. Upon completion, this project will represent the largest stream mitigation bank in the state. The purpose of this presentation is to discuss the techniques EIP and its partners have taken to accomplish watershed-scale restoration in the heavily impacted landscapes of the southern Appalachians. Stream restoration in this region requires novel approaches to the design and construction of functioning, ecologically-sound lotic systems. Site constraints in the Coalfields are not limited to narrow valleys and steep topography: legacy mining impacts present a unique set of challenges to the stream designer. Those impacts which have presented the greatest challenges to our restoration work in southern West Virginia are associated with surface mining, specifically in the form of valley fills and highwall benches. These landscape-level alterations, combined with the potential for contamination from relic underground mines or buried mine spoils, contribute to the challenges of stream restoration in this region. It is our hope that this project will demonstrate new and advanced approaches for achieving sound headwaters restoration in the challenging terrain of the southern Coalfields.

About the Speaker: Ian Turner is a project manager with Civil and Environmental Consultants, Inc. in Bridgeport, WV. He works primarily on mining-related stream restoration projects in West Virginia and Pennsylvania. Mr. Turner holds a B.S. in Natural Resources from Sewanee: the University of the South and a M.S. in Soil Science from Auburn University.

How Can One Little Creek Cause So Much Trouble? Overcoming Boundary Lines, Budget Constraints and Other Issues During An Urban Stream Restoration

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Co-Author: Dr. Eve Brantley, Auburn University ACES Water Resources

Abstract: The Mill Creek Restoration Project is a multi-year, multi-agency collaborative effort towards the removal of Mill Creek from the CWA S. 303(d) List of Impaired Waters.

The Mill Creek Watershed in Alabama is comprised of Mill Creek and Holland Creek and drains an area of approximately 25 square miles. The headwaters of Mill Creek originate within the City of Smiths Station (Lee County) and then flow through an increasingly urbanized area of Phenix City (Russell County) where it finally discharges into the Chattahoochee River at the Alabama-Georgia state line. Mill Creek in its entirety (9.93 linear miles) is impaired by low dissolved oxygen developing from organic enrichment triggered by urban development. Much of the watershed is increasingly urbanizing which results in recurrent flashy stormwater runoff flows in the creek; thus, contributing to eroding streambanks, lack of floodplain connection, minimal native riparian vegetation, invasive species, and aggraded stream channels. Completion of this project results in the implementation of sevral stream projects, BMPs including LID/green infrastructure practices, water quality community outreach and education workshops as well as water quality education and training of over 2,000 elementary school children and 60 teachers from over 20 schools and 3 universities. Implementation of this project is dependent on the collaborative efforts of its partners. Partners include ADEM, EPA, NFWF, ACES, City of Phenix City, City of Smiths Station, Chattahoochee-Chipola CWP, Lee and Russell County Commissions, Smiths Water and Sewer Authority, AWW, Phenix City Beautiful, Consolidated Resources, Phenix City Public Schools, and Lee County Board of Education.

About the Speaker: Alex James works for the Alabama Cooperative Extension System at Auburn University where she is responsible for managing S.319 Grant Projects. Has worked in this position since graduating from Auburn University in 2014 with a MS in Agronomy and Soils. BS also from Auburn University in Environmental Sciences.

Multiple Elements/Multiple Benefits – East Jesters Creek Phase 5

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Abstract: Clayton County Water Authority (CCWA) recently completed the final phase of a 10,000 linear foot stream restoration project along East Jesters Creek. CCWA, along with the City of Morrow and USEPA, has created a multi-use recreation, stormwater treatment, wetland enhancement, and stormwater treatment project. Project elements include retro-fitting an existing stormwater pond, building a new stormwater pond, building a new wetland enhancement area, stream restoration, sanitary sewer line replacement, catch basin filtering devices, greenspace acquisition and grading for a recreation trail. This presentation will discuss the project background and funding, project elements, and estimated water quality improvement. The project was partially funded by a USEPA 319(h) grant.

About the Speaker: Ms. Mattfield is a Supervising Water Resources Engineer in Brown and Caldwell's Milwaukee, Wisconsin office. She has over 24 years of experience in performing water resources studies, including stream restoration designs, stream identifications and restoration assessments, watershed planning and stormwater drainage design. Kelly holds a B.S. degree in Geological Engineering from the University of Wisconsin.

New Belgium Brewery: Brownfields to Green Infrastructure

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Abstract: New Belgium Brewing Company has recently built a brewery on a Brownfield site along the French Broad River in Asheville. A focus on sustainable development including low impact development has been a guiding force for the redevelopment of the site. During the planning and design phases, emphasis was placed on creating a Leadership in Energy and Environmental Design (LEED) certified project and providing design solutions to avoid impacts to natural systems. A partnership between New Belgium Brewery and the City of Asheville fostered a holistic approach to redeveloping the site with sustainable improvements such as multimodal transportation, including a complete streets design approach, stormwater improvements and a greenway in the floodplain.

This presentation will focus on the implementation of the key aspects of this project that make it a model development including stormwater improvements, stream restoration, phytoremediation plantings, and a greenway along the French Broad River. Innovative elements such as “green streets” and the integration of stormwater best management practices such as water quality swales, bioretention areas, and a constructed wetland throughout the site will be presented. This will also include a discussion around the restoration of an urban stream. The design and planning process will be discussed in addition to examples of how the design professionals adapted low impact principles to the challenges of the site.

About the Speakers: David Tuch is a the president and principal partner of Equinox. He holds degrees in Horticulture, Landscape Architecture, and Conservation Ecology & Sustainable Development. David began his professional career working for a multidisciplinary firm in Portland, Oregon, within a context of progressive ecological design and planning. He helped lead-up the environmental arm of a landscape architecture and engineering firm in Charlotte NC before helping build Equinox into a leading environmental planning and design firm in Asheville. He planned the first conversation subdivision in Buncombe County, has a featured project in the North Carolina Low Impact Development Guidebook, and has managed several award winning projects. David’s focus over the years has been on sustainable design, greenway planning and design, stormwater design, ecological restoration, and climate change. As an expert

in the field of sustainable design and planning, he has given presentations throughout the southeast and authored published papers and numerous articles.

Grant Ginn, P.E. of Wolf Creek Engineering, has over twenty-five years of experience in the hydrologic and hydraulic design of streams, wetlands, bridges and other transportation and industrial facilities. Over the course of his career Mr. Ginn has designed and analyzed over 200,000 feet of stream projects, including over 152,000 feet of stream restoration since founding Wolf Creek Engineering. His experience includes a variety of civil projects, bridge replacements, wetland design, scour evaluation studies, stream restoration design, urban and rural roadways, stormwater management plans, site utilities, and site drainage projects. His experience on these projects has included natural channel design, open channel hydraulics, bridge hydraulics, sediment transport analysis, stream classification, storm sewer design, erosion control, culvert design, detention basin design, hydraulic routing analysis, BMP design, and flood analysis.

Athletes and Infrastructure: Parkerson Mill Creek Urban Stream Enhancements

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Abstract: Parkerson Mill Creek is located in east Alabama and flows through the City of Auburn, Auburn University's campus (AU), and Lee County before joining Chewacla Creek. The stream's watershed is 2,420 ha and is predominately urban and suburban land use, especially in the headwaters. Past stream management impacts (piping, channelization) and current impacts (stormwater management, floodplain encroachment) contribute to stream instability, incision, and poor water quality. Streambank erosion is a priority in the Parkerson Mill Creek Watershed Plan. Stakeholders work together to improve the stream through planning, education, and project implementation.

This presentation outlines two projects on Parkerson Mill Creek that address infrastructure protection and stream enhancement: 1) The high visibility Wellness Kitchen stream project was constructed in 2014 with funding from AU Athletics, AU, and a Section 319 Alabama Department of Environmental Management Grant administered by the Alabama Cooperative Extension System (ACES). Goals of the Wellness Kitchen project were to improve water quality, habitat quality, and aesthetics. The 105 m project was constrained by parking lots and buildings. It incorporated energy stilling basins, boulder cross vanes, floodplain where possible, and native plants. This project is used for public awareness and education. 2) The City of Auburn enhanced 60 m of Parkerson Mill Creek at the Turf Research Unit in 2015 for infrastructure protection. AU, ACES and the City developed vegetation and monitoring plans. Project elements include boulder vanes, log vanes, maximized floodplain, and native vegetation. The Turf Grass Unit project is not as accessible as the Wellness Kitchen project; however, students and faculty are participating in interdisciplinary research and education. Research and monitoring data will be presented.

About the Speaker: Eve Brantley is an Associate Professor with the Auburn University Department of Crop, Soil and Environmental Sciences. She also serves as the Alabama Cooperative Extension System Water Resources Specialist. Eve has worked as a local watershed coordinator, facilitator for the Coastal Alabama Clean Water Partnership, and coordinator of a state citizen water-monitoring program. Her degrees are from Berry College, Clemson University, and Auburn University.

Pipeline Stream Crossing Exposure Repair, A More Sustainable Approach

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Abstract: Underground pipeline utilities navigate stream valleys throughout the country. Natural and impaired stream migration can eventually expose high value infrastructure, including high pressure natural gas pipelines. Traditional repair approaches include dumped rock over the exposed pipeline every few years or a relocation/rebury of the pipeline. The former solution can be very short term and potentially increase the impaired condition of the stream, the later solution can be very expensive and impactful on the utility customers served due to lengthy required outages.

This presentation will highlight several successful utility stream crossing repairs in Ohio River Valley Tributaries utilizing natural channel/bioengineering design techniques. Each crossing and stream reach of interest is unique and warrants the linking of restoration goals to functional improvement. Restoration goals include, streambank stability, reducing sediment supply and land loss, improve visual values, creating a cost-effective naturally stable stream reach able to be self-maintaining and withstand floods. Rosgen Stream Types B, C, and F have been addressed with Priority Type 1 and 2 Restoration within constrained utility corridors and drainage areas ranging from 0.05 to 25 sq. miles. Stream Hydraulics were analyzed for pre and post project velocity, shear stress, and stream power for a series of stage and discharges. The restorations utilized boulder vanes, hooks, and step type in-stream structures for protection of the pipeline, new channel protection prior to riparian vegetation establishment, grade control, stable flow diversions, and near bank shear stress reduction. Most projects include long-term permit monitoring and a few examples are now several years old and performing well within the established restoration goals. The goal of the presentation is to discuss experience gained and lessons learned during design and construction of utility crossing stream exposure repairs to promote the science and engineering of the solutions.

About the Speaker: Matt Gramza, P.E., CFM, is a Water Resources Engineer and Senior Project Manager with Civil & Environmental Consultants, Inc. in Cincinnati, Ohio. He has more than 18 years of diverse consulting experience in the water resources practice. His project experience includes stream restoration assessment, analysis, design, and construction administration, advanced stormwater management, floodplain management, riverine hydrologic and hydraulic analysis, dam safety engineering and compliance and utility design in the public and private sectors. He has a B.S. in Civil Engineering from the University of Cincinnati, holds professional engineering licensure in several states and is a Certified Floodplain Manager with the Association of State Floodplain Managers.

Improved Innovative Stream Bank Restoration Techniques

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Abstract: Ecologically safe stream restoration techniques are getting popular year after year. Over the past 25 years, the use of Coconut fiber (coir) products in stream bank restorations has increased significantly. Coconut fiber is a strong, durable, and renewable natural resource. Two coir products commonly used in stream bank restorations are coir log and coir block. Until now, planting of live plants and plant cutting were done in between layers of the product. Also there is no possibility to plant in between layers after installation. This presentation will show improvements of these two products which will allow for planting through the coir fiber mass. The planting can be done during or after construction. This new feature is a series of invisible pre-formed holes in the product. These pre-formed holes plugged with removable coir fiber plugs can be used for planting through the product or for anchoring the product.

About the Speaker: Udare Santha is an Industrial Engineer graduated from Georgia Tech.

The use of compost based structural BMP to Stabilize Stream Channels

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Abstract: Presently stream channel bank restoration efforts utilize varying degrees of hard structural components such as Rip Rap, wire baskets, or combinations of both. Although these structures provide the needed structural stabilization they provide little environmental benefit or enhancement beyond sediment reduction. Often attempts are made to add green features with plants that are in many cases no-native to the particular setting. Filtrexx Systems utilize existing MSE technology combining a proven compost growing system with commonly used grids and anchors to provide a natural based living system that provides both naturalized stabilization system with unique opportunity to utilize a large slate of native plants to naturalize the restoration effort. This presentation will focus on a project completed in the spring of 2015 in Columbia South Carolina that survived a single storm event estimated to be on the magnitude of 500 t0 1000 year event.

About the Speaker: Jeff Opel has 20 years experience working for Soil Conservation Districts In Maryland working on innovative projects in the sediment and stormwater field. Received an award for an innovative stream restoration project. For the past 5 years I have utilized Filtrexx restoration systems as both an installer and a Technical sales Representative in the Mid-Atlantic region.

Hands-On Stream Repair Workshops for Homeowners

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Abstract: With built-upon-areas increasing streambank erosion is a very common problem for property owners bordering streams in residential areas. Traditional methods of streambank stabilization (walls, rip rap, gabion baskets) are failure prone and cost prohibitive.

Since 2012 Cooperative Extension has delivered 10 'Backyard Stream Repair' workshops across the state. Participants include state/local government employees (environmental divisions, parks and recreation, planning and Army Corps of Engineers), environmental groups, homeowners, property managers, HOAs, landscapers, and nursery owners.

Workshop evaluations indicate 90% of participants plan to use workshop ideas to protect client/personal property. 8% planned to use information to educate citizens in their community. One participant said: "With the knowledge gained I feel I can talk with homeowners whose properties back up to eroding streambanks about what they can do, and save both the bank and their backyards." Workshop participants learn small-scale solutions, permit requirements, and how to properly seed, mat, and plant a bank. Behavior changes include giving up water access and altered ideas of aesthetics. In return landowners get peace of mind (ex. stable banks, mower won't fall in creek, etc.) and reduced sediment for downstream neighbors. Workshops and survey participants have stabilized 3163 linear ft which will annually save and reduce 194 tons of soil, 223 lbs phosphorus and 445 lbs nitrogen (future savings: $79,075). A resource guide, "Small-scale Solutions to Eroding Streambanks" was created to compliment the workshop. Over 600 copies have been distributed, 5 municipalities and the NC Forest Service have added as an online resource, and the University of Kentucky is interested in a KY version. Two representatives from the Army Corp of Engineers and NC Department of Environmental Quality use the guide to advise stream owners.

About the Speaker: Mitch Woodward is the Area Specialized Agent for Watershed and Water Quality with the NC Cooperative Extension, Wake County Center. Mitch has over 35 years of water quality protection experience. He has worked on non-point source water quality issues for the DuPont Company, University of Maryland, Penn State University, and the United States Department of Agriculture. Mitch has been area specialized agent – watersheds and water quality for North Carolina Cooperative Extension for the past 19 years, delivering 20-25 educational workshops annually on stream repair, low impact development, urban stormwater management practices and water quality protection issues. Mitch has designed, installed, and assisted others in installing over 250 urban stormwater control systems in NC, GA, SC, OR, and AL including innovative water harvesting, bioretention, stream repair, and residential raingardens.

Engineers and Biologists: It Takes A Village

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Abstract: Mecklenburg County Storm Water Services has constructed over 17 miles of stream restoration projects over the last 15 years through the County's capital improvement program. The overall goal has been to improve water quality and habitat. However, determining whether those stream restoration projects are "successful" is sometimes a difficult task. Factors that make a successful project are often in the eye of the beholder. Possible evaluation criteria can vary widely from aesthetic value to benthic macroinvertebrate data. The criteria can be quantitative or qualitative. Over the years, the science behind stream restoration has greatly improved and in turn, so should the County's capital improvement program. This presentation will detail the history of the program, the challenges in defining specific goals for stream restoration projects and the direction for the future of the capital improvement program.

About the Speaker: Crystal Taylor, PE, CFM, currently serves as a Lead Project Manager, Charlotte-Mecklenburg Storm Water Services for the Engineering & Mitigation Program. Crystal has over 15 years of professional experience in construction, water resources, BMPs and stream restoration. More recently, Crystal manages a team of project managers that implement storm water/stream restoration CIP projects. Crystal is a NC Professional Engineer and Certified Floodplain Manager.

Olivia Edwards is an Environmental Supervisor with Charlotte-Mecklenburg Storm Water Services. She manages a team that is responsible for protecting and restoring the usability of Mecklenburg County surface waters through surface water quality monitoring activities. She has 14 years of experience in the field of watershed protection and surface water quality monitoring. Edwards has a BS in Biology from the University of North Carolina at Charlotte and a MS in Environmental Assessment from North Carolina State University.

Simultaneously improving drainage and water quality by restoring streams, wetlands, and tidal marsh in Wilmington NC

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Abstract: Two of the primary purposes of the City of Wilmington's Wisteria/Clearbrook Drainage Improvement Project are to improve drainage and water quality issues along a mostly residential corridor of an unnamed tributary to Hewletts Creek (WS II, HQW) in Wilmington, North Carolina. A previous study recommended that that the tributary itself would require extensive widening to address flooding issues; however, by using a dynamic hydraulic model (unsteady state HEC RAS), it was established that the more natural, higher ecologically functioning reaches did not need to be altered if combined with the removal of historic wetland/tidal marsh fill and the use natural systems design techniques for the ditched reaches in conjunction with the replacement of undersized road culverts. The first of two stages of construction (roughly the lower half of the project) was completed in March 2016. The first stage includes: removal of fill from three residential lots, reestablishing wetlands - including a tidal marsh system, restoration of stream reaches using natural channel design techniques, and replacement of 7 road culvert systems. After construction striped mullet (Mugil cephalus) were observed accessing the tributary as far as 1/3 of a mile upstream of Patricia Drive where they had not been observed previously. The presentation will focus on the use of the natural systems design techniques not only to restore lost habitat and other ecological functions, but also to serve as storage for flood waters.

About the Speaker: Todd St. John, P.E., LEED AP, is a project manager/engineer with Kimley-Horn and Associates, Inc. in Raleigh, NC. For the past 12 years, he has been responsible for designing and implementing stormwater, stream, wetland, and other natural system restorations as well as coordinating environmental permitting. Previously, Todd spent 9 years with the NCDWQ (now Division of Water Resources developing stormwater and natural system design policies and reviewing stormwater management and natural systems design plans. He has a Master of Science degree in Civil Engineering from NC State University and a Bachelor of Arts degree in Environmental Science from the University of Virginia.

Restored water quality and habitat functions by use of created floodplain sloughs along South Buffalo Creek in Greensboro, NC

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Abstract: The first three phases of the South Buffalo Creek Water Quality and Habitat Improvement Project have now been completed. The project included restoration of four deeply incised side tributary systems to South Buffalo Creek using a variety of natural channel design techniques. Additionally, along the main stem of South Buffalo Creek, soil lifts and brush mattresses were used to stabilize highly eroding banks, and log and boulder vanes (some with integrated boulder clusters) were established to improve stream habitat. The project also included the extensive use of floodplain sloughs —a side channel with an invert elevation between the stream invert elevation and the bankfull elevation—to improve stream, riparian, and wetland functions without wholesale relocation of the stream or reshaping of South Buffalo Creek's banks. Sloughs can provide flood storage, a strong diversity habitat features, and pollutant removal characteristics. Greensboro has also established other water quality and habitat improvement measures in the watershed, including other stream restoration projects, stream buffer reforestation, and a unique stormwater wetland. The three phases of the subject project were constructed between the summer of 2013 and spring of 2016 by three separate contractors. The results of these improvements are provided with this presentation.

About the Speaker: David Phlegar, CPSWQ, is the Stormwater Manager for the City of Greensboro Water Resources Department. For the past 17 years, he has been responsible for implementing the City's NPDES MS4 permit requirements, water quality and capital project planning and project management, and overall management of an annual $10M stormwater utility. Previously, David worked for five years for the U.S. and NC Forest Service and spent one season as a "Hotshot" firefighter. He has a Bachelor's degree in Natural Resources Management from Western Carolina University.

Restoring Alabama's Coast- Case Study on Natural Channel Design for Applied Shear Stress, 2-Dimensional Modeling and Project Implementation

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Co-Author: William McLemore, Goodwyn, Mills and Cawood, Inc.; David Bidelspach, 5 Smooth Stones Restoration, PLLC; Michael Geenen, Watershed Restoration, PLLC; John Curry, Hydro Engineering Solutions a Division of Trimble

Abstract: Coastal Alabama is a vital part of the economics and beauty of the state. Many coastal areas are vital to marine and terrestrial wildlife that play a pivotal role in the overall health of the environment. These areas have been impacted by both natural and man-made disasters putting the ecosystem at risk along the Alabama Coast. A crucial portion of the overall health of the ecosystem is sediment supply from the various streams and rivers to Mobile Bay. Sediment delivery to the bay has increased due to watershed impacts associated with land development increased storm activity and intensity. Numerous watersheds surrounding the bay have been studied and recognized as problem areas for sediment supply. The D'Olive Creek watershed has been identified as a watershed with increased sediment supply and drains part of the eastern shore of Mobile Bay, including parts of the cities of Spanish Fort and Daphne. The watershed is in transition from forested, agricultural, and residential land uses to residential and commercial development. The changes in land-use and impervious surfaces have impacted water quality and habitat in the watershed and Mobile Bay. Increased runoff has influenced erosion and stream channel degradation which has resulted in extensive sediment loads and destroyed habitat. Using methods associated with natural channel restoration design, the design team has developed plans for restoring approximately 4,100 linear feet of stream that drains directly to Mobile Bay. The streams' ability to access its floodplain and withstand applied shear stress to the floodplain was also assessed. The purpose of the current design is to address the stability and departure of the creek and the accelerated bank erosion that has occurred along this reach of D'Olive Creek and Tiawasee Creek. Through 2-Dimensional hydraulic modeling, the design team evaluated the applied shear stress, velocity, and scour. The design proposes to restore and stabilize the channel through natural channel restoration and best engineering practices. This objective will be met through the design and construction of proper channel dimension, layout, and profile based on reference reach data and instream stabilizing structures. The design will also mitigate sediment deposition downstream through channel stabilization and native vegetation installation. With the successful implementation of the D'Olive Creek and Tiawasee Creek stream restoration plans, the design team hopes the project may be used as an example for addressing similar stream impairments within the Mobile Bay watershed.

About the Speaker: Justin is a Project Manager in GMC's Environmental Department with six years of experience in stream and wetland delineations, stream and watershed assessment, natural channel design, urban stream stabilization, flood modeling for CLOMRs, LOMRs and No-Rise Certifications, hydrologic assessments, construction management, Phase I Environmental Site Assessments, construction stormwater permitting and inspections, erosion control plans and construction best management practices plans. Throughout his career he has had the opportunity to manage ecosystem restoration efforts on a variety of habitats throughout the state of Alabama. Justin earned a Bachelor's Degree in Biosystems Engineering from Auburn University. He is a member of the American Society of Agricultural and Biological Engineers, the American Ecological Engineering Society, Association of State Floodplain Managers and the Alabama Association of Floodplain Managers.

Justin believes in sharing his knowledge and experience openly within the industry to develop relationships that will help build a stronger engineering and scientific community.

Compensatory Mitigation Performance Evaluation

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Co-Authors: Joseph Morgan and Palmer Hough

Abstract: Compensatory mitigation, or the restoration, establishment, enhancement and/or preservation of aquatic resources meant to offset losses permitted under §404 of the Clean Water Act, has been the subject of numerous disputes surrounding its ecological value and administrative oversight. To address some of these concerns, the U.S. Army Corps of Engineers and the U.S. Environmental Protection Agency jointly issued regulations in 2008 revising and clarifying standards for compensation projects, known collectively as the Mitigation Rule. The Mitigation Rule has driven significant changes in the character of compensatory mitigation, including pronounced growth in the mitigation banking industry. In light of these changes, evaluating both ecological and administrative performance of compensatory mitigation programs continues to be essential to ensuring that the important functions and services provided by impacted aquatic ecosystems are effectively replaced. In a review of studies evaluating compensatory mitigation performance in the last 15 years, trends show an overall decline in evaluations, especially in the years since the 2008 Mitigation Rule. This has impeded efforts to assess the performance of mitigation programs: compensatory mitigation performance has not been evaluated for very large portions of the US, the ecological benefits of different compensation mechanisms (i.e. mitigation banks, in-lieu fee programs, and permittee-responsible projects) remain largely uninvestigated, and relatively few studies of compensation for streams have taken place despite the growing importance of this area. In addition, study design is inconsistent, making comparisons across time and space difficult. We recommend a long-term approach to mitigation to include selecting a standardized study design, organizing project files in a geospatial database, and regular self-auditing for governments to assess the performance of mitigation programs on a recurring basis.

About the Speaker: Brian has worked at EPA since 2004, primarily in Clean Water Act Section 404 regulatory program for the discharge of dredge and fill material in waters of the United States. He has also worked in EPA Region 4 in Atlanta and for the Portland District of the US Army Corps of Engineers. He currently works on program tracking and reporting, stream assessment and compensatory mitigation, and surface coal mining in Appalachia among other issues. Brian received a B.S. from the University of New Hampshire, a M.E.M. from Duke University and is a certified Project Management Professional.

Tennessee, North Carolina, and South Carolina: How Many Credits Would Your Stream Mitigation Project Generate?

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Abstract: Stream mitigation has become a routine unavoidable requirement from Federal and State permitting agencies for impacts to our water resources. This has placed intense focus on stream restoration practices as the most common practice for mitigation. As it is written, the Federal regulations have left it up to each region or district to establish stream mitigation requirements. These regulations have created a wide range of assessments and procedures for mitigating the impacts.

This presentation will briefly attempt explaining the regulatory stream mitigation guidelines for, Tennessee, North Carolina, and South Carolina. In addition, the presentation will do a credit and cost comparison for two hypothetical projects for each State's current in-lieu fee providers and will assess the projects to see how each State tallies potential mitigation credits. Results from previous presentations will also be shown for comparison (Kentucky, Ohio, West Virginia, and Virginia).

About the Speaker: Joshua White is a geomorphologist based in Columbus, Ohio for Civil & Environmental Consultants, Inc. (CEC). He received a M.S. in Geomorphology from West Virginia University and a B.S. in Geology from Northern Kentucky University. Josh worked in ecological restoration for a decade in North Carolina before moving back closer to home. Josh fell in love with rocks and streams at an early age on his parent's farm in Kentucky. Josh's first experience with stream design; as a child; was stacking stones in the creeks. His education continued as he rode his horse around his home state – noticing differences within the landscapes and wondering about the types of processes that had sculpted them. Josh later found out that he could make a career out of restoring streams. He is a professionally licensed geologist, professionally licensed engineer, certified floodplain manager, and certified professional of erosion and sediment control and for the past twelve years has worked in all aspects of ecological restoration.

Stream Mitigation in North Carolina, a Regulatory Perspective

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Abstract: The practice (and art) of stream restoration in NC has evolved greatly over the last 18 years. Greater collaboration amongst the regulatory agencies, providers, and the academic community has greatly increased the knowledge-base of the restoration or enhancement practices that are appropriate for a given stream and watershed condition. Despite these advancements, we see projects that do not meet expected performance metrics; hence risk management and expectation management are still critical components of a successful stream restoration or enhancement project. The Wilmington District has recently revised its stream monitoring protocols which should improve the measurement of functional outcomes associated with these projects. Scrutiny of stream mitigation proposals and whether the stated biological benefits are attainable given the underlying factors that were causing the apparent loss of stream function in the first place are still factors of debate.

About the Speaker: Scott McLendon is the Chief of the Regulatory Division, Wilmington District. He has worked in the Regulatory Division for 25-years as a Project Manager, Chief of the Asheville Field Office, Team Leader for the NC Department of Transportation, and as Assistant Chief for the Regulatory Division. He participated in the development of the North Carolina Wetland Restoration Program in the late 1990's and later served as the District's primary point of contact for the Ecosystem Enhancement Program. He received a BS in Biology from Virginia Tech in 1983 and an MS in Environmental Biology from George Mason University in 1989.

Poster Presentation Abstracts

Stormwater management as a prescription for "urban stream syndrome"

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Abstract: While "urban stream syndrome" is recognized as a real phenomenon, research demonstrates that characterizing which causes link to what effects is highly complex and context dependent. What has become increasingly clear, however, is that stormwater runoff is a key agent in altering stream dynamics in most urban settings. More specifically, thermal pollution and high salt levels are two negative consequences of urbanization and subsequent runoff. When runoff is a root cause of reduced stream quality, in-stream restoration efforts are likely to be ineffective in improving conditions. Rather, watershed scale measures are required. With a decade of monitoring data from Boone Creek, a headwaters tributary of the New River in Watauga County, this study assesses the frequency and severity of temperature surges and salt concentrations. The results show frequent temperature surges exceeding 20˚C, which has serious implications for aquatic life. The results also show more than 35 days exceeding EPA recommended salinity levels at the chronic level (230mg/L) and more than 8 days at acute salinity levels (860mg/L). The project modeled groundwater-surface water interactions and demonstrated a long-term additive effect as high salinity water is driven into the aquifer during storm events. To assess the potential affect of stormwater management practices, the model was run with reduced salt as an input and with reduced impervious surface to simulate stormwater retention. The results demonstrate that modest stormwater management practices have the potential to greatly reduce salt concentrations and simultaneously reduce thermal pollution. There are numerous policy implications from our findings, including giving town planners/managers options for addressing the long-term consequences of urbanization.

About the Presenter: Kristan Cockerill has more than 15 years experience working to understand how cultural and scientific information influence water policy and management. Her work has included assessing media coverage and public attitudes about water-related issues; developing collaborative models for water management; and assessing stream restoration projects. She has taught a broad suite of interdisciplinary courses at Appalachian State University, Columbia University's Biosphere 2 Center in Arizona, and the University of New Mexico.

Brandenbark™: Mitigation/Management Tool for Projects Involving Bark Roosting Bats

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Abstract: Habitat loss is a major threat to tree roosting bat species, and often developers are required to mitigate in some way for these impacts. However, available mitigation strategies are scarce, typically ineffective, often poorly researched, and can be cost prohibitive. To address these issues, we developed and tested BrandenBark™, an artificial roost structure specifically designed to mimic the natural habitat of bark roosting bats. Research efforts occurred within a known Indiana bat (Myotis sodalis) maternity colony at Fort Knox in northcentral Kentucky during the summers of 2009-2014. Twenty-one BrandenBark™ structures were placed in locations typical for Indiana bat primary roost trees and a combination of guano checks, exit counts, mist netting and radio tracking was used to determine bat usage. During the project, BrandenBark™ structures were selected by Indiana bats regularly with 76.4% (146 of 191) of roost visits documenting occupation. In addition, 120 emergence counts resulted in an average of 81.3±7.1 bats per roost with a high count of 451 bats. Mist netting efforts confirmed six bat species utilizing the BrandenBark™ structures and radio tracking resulted in documentation of Indiana bat use of 12 BrandenBark™ structures for a total of 149 bat days. Temperature comparisons between BrandenBark™ and natural bark roosts indicate that BrandenBark™ roosts are slightly warmer ($\bar{X}$ = 24.6±7.2 [SD]°C) than natural bark roosts ($\bar{X}$= 23.1±6.5°C). Temperature differences between BrandenBark™ and ambient air ($\bar{X}$ = 2.1±2.7°C) are less variable than those between natural bark and ambient ($\bar{X}$ = 3.9±4.0°C), possibly indicating a more stable thermal environment. Since proving its effectiveness for Indiana bats, BrandenBark™ has become an immediate long term solution to habitat loss caused by development, restoration, etc. In addition, BrandenBark™ is an ideal addition to stream and wetland projects, and with recent bat listings has the potential to be used in species specific mitigation banks.

About the Presenter: Alexi Dart-Padover is a biologist at Copperhead Environmental Consulting in Kentucky where he participates in bat, freshwater mussel and plant surveys and GIS analysis. He is interested in conservation biology and has worked with rare serpentine plant communities in California, threatened shorebirds in Florida, mixed species bird flocks in the Peruvian Amazon, and did his Master's thesis on the management of an endangered plant at Eastern Kentucky University.

Using Photogrammetry to Document Stream Topography

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Abstract: Bank erosion occurs in many impaired streams. Stream topography measurements over time are necessary to quantify stream bank erosion. Our goals are to evaluate topographic survey methods for costs, effort, and accuracy, to develop a stream geometry monitoring method based on photogrammetry, and to verify as-built restoration geomorphology with designed stream geometry.

As photogrammetry is based on images, the quality of the images, the number of images from different angles as well as vegetation affect the accuracy of this method. We studied these effects in the lab and in the field. Volume models from a small box were evaluated in the lab. Treatments included two cameras (Samsung Galaxy S4 cell phone and Nikon D90 DSLR), camera angles (15-60 degrees), and vegetation cover with broom sedge (Andropogon virginicus L. with 5, 10, 20, and 30% surface cover). A volume model was considered as accurate when it matched at least 99% of the small box volume.

Without vegetation, 18 photos from the cell phone and 12 photos from the DSLR camera are necessary to create an accurate volume model while with 5% vegetation cover, 24 and 18 photos were necessary from cell phone and DSLR cameras, respectively. Overall fewer images are necessary when using loss-less images from the DSLR camera. However, high quality and loss-less images also require more disk space. In the field, truncated pyramids with edge lengths of 1 and 3m were covered with soil as well as straw and planted with cereal rye (Secale cereal L.). Volume models of bare soil, straw cover, and vegetation at different growth stages will be evaluated this spring.

About the Presenter: Caleb Duke is a graduate research assistant at Auburn University, in the Crop, Soil and Environmental Sciences Department. He received my undergraduate degree from The University of Tennessee at Martin, in Natural Resources Management, concentration of Fisheries. Throughout the past several years, Caleb has interned at an Environmental Consultant firm, where he worked as a field ecologist, assisting with stream, wetland and ecological surveys. Caleb's goal in graduate school is to gain a greater knowledge of stream ecology and to hopefully provide a new method for monitoring stream restoration.

Large scale dispersal of brook trout in a restored central Appalachian watershed

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Abstract: In-stream structures have been used in stream restoration designs for decades. Their relative simplicity of design and less-expensive construction make these structure types preferable to other stream restoration techniques with the main goal of bank erosion control. In addition, in-stream structures have potential benefits above and beyond erosion control, especially in creation of aquatic habitat through the formation of diverse flows and scour pools. However, the placement of these structures within the stream flow itself can lead to a greater incidence of failure than is seen with other erosion control methods, as they are directly susceptible to the effects of bed and bank scour and high flow events. A wealth of information and guidance exists concerning the design of in-stream structures, but at present this knowledge is scattered throughout various different sources. Government-issued design guidance often exists separately at multiple levels (federal, state, and local), and is created with different interests and emphases in mind, from engineering to ecological perspectives. Professionals have conducted specific related scholarly research as well as site evaluations and monitoring. An invaluable wealth of knowledge also lies in the experience of stream restoration practitioners. The purpose of this study is to synthesize and evaluate the similarities and contradictions between the recommendations available from publically available design guidance and peer-reviewed research literature to develop a summary of the best possible design solutions for the following in-stream structures: rock and log single-arm vanes, j-hook vanes, cross vanes, and w-weirs.

About the Presenter: Ben Harris is a graduate student at West Virginia University with a research focus on the movement response of fish to restoration events. Ben received his Bachelors of Science degree in Fisheries Biology from Humboldt State University and also earned a Graduate Certificate in Fisheries Management from Oregon State University. He has worked with state and federal fisheries management agencies across the country, including the California Dept. of Fish & Wildlife, Pacific States Marine Fisheries Commission and the National Marine Fisheries Service. His current project is in collaboration with the West Virginia Division of Natural Resources, and uses radio telemetry to study Brook and Brown trout movement in restored headwater sections of Appalachian river systems.

Design Guidance Synthesis and Summary for In-Stream Structures

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Abstract: The practice of conveying urban runoff to concentrated outfall locations frequently leads to stream bank erosion and head cut formation. Installed in an eroded channel, regenerative stormwater conveyance (RSC) is a grade-control and retention practice that uses a series of pools riffles with an underlying media layer. As a recently developed practice, RSC performance evaluations are needed to improve design and guide regulatory accreditation. An eroded channel with a 10% overall slope was stabilized with a RSC and monitored for a 14-month period. Hydrologic mitigation was achieved only for storms less than 12.7 mm, 8% volume retention and 49% peak flow reduction. An undersized system, 6-mm event storage, and groundwater intrusion led to minimal hydrologic benefit. A substantial 49% of inflow volume was converted to media flow at the second pool but reemerged as surface flow downstream where groundwater intrusion was evident. Storm event mean concentrations were reduced for most analytes but removal was minimal: 17% TSS, 17% TP, and 3% TN. Significant reductions only occurred between the upstream and second cell, indicating minimal water quality benefit of the downstream wetter pools. Comparisons between inter-event grab samples and storm event outflow concentrations indicate nitrogen export during inter-event periods, 47% increase in TN. Groundwater inflow led to an anaerobic inter-event system with evidence of denitrification, 81% decrease in NO2,3-N, but also mineralization, 390% increase in TAN. Due to inter-event export, mass loading of nitrogen increased. The head cut was successfully stabilized and no major structural failure was observed during the monitoring period. Maintenance concerns were evident including filling of pools, bank slumping, and media washout. Findings indicate hydrologic and water quality benefits only in the cells not affected by groundwater intrusion. Future implementations of RSC are encouraged to closely examine water table elevations and sizing criteria.

About the Presenter: Lizzie Hickman is currently a Master's Student and Graduate Research Assistant in the Biological Systems Engineering department at Virginia Tech. She graduated in May 2015 with a Bachelor's of Science in Biosystems Engineering with an emphasis in Environment and Natural Resources from Oklahoma State University. She was heavily involved at undergraduate research during her time at OSU, mainly in the areas of stormwater quality and Low Impact Development, particularly bioretention, and her senior design project concerned streambank stability structures used in natural stream restoration. She is currently pursuing a Master's of Science in Biological Systems Engineering with an emphasis in Watershed Science and Engineering from Virginia Tech, studying under Dr. Tess Thompson. Her area of thesis research is improving the success of vane-type in-stream structures used in stream restoration.

Watershed-scale brook trout restoration efforts within a high-elevation Appalachian stream network

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Abstract: Brook trout *Salvelinus fontinalis* are experiencing population declines throughout their native range largely as a result of habitat loss and fragmentation. Consequently, habitat restoration efforts have become a priority of many management agencies. Herein, we detail a $9 million watershed-scale restoration effort specifically designed to address multiple factors limiting a brook trout metapopulation within the Upper Shavers Fork watershed, West Virginia. Initially, water chemistry degradation associated with acid precipitation (i.e., low pH and associated increased toxic metals) was identified as the primary factor limiting successful reproduction. We began strategically treating several locations within the Upper Shavers Fork watershed with limestone sand in 2007, successfully alleviating the effects of acid precipitation and promoting successful reproduction within these systems. We then identified culverts isolating three key spawning tributaries and preventing dispersal between spawning areas (i.e., isolated tributaries) and supplementary foraging habitats within the Shavers Fork main stem. A total of $850,000 was spent to replace existing culverts with embedded and HDPE baffled culverts in 2011 and 2012. Finally, we designed and implemented 4 miles of instream habitat restoration within the Shavers Fork main stem 2012 and 2013. We used natural channel design to create structures (e.g., J-hooks) and habitats (e.g., woody debris placement and riffle construction) in an effort to promote main stem use and increase overall brook trout productivity by improving physical habitat structure and decreasing in-stream temperatures. Initial monitoring data (presented at this conference) suggest brook trout are responding to the described restoration. Restoration efforts that integrate multiple actions to achieve watershed-scale goals will likely result in the greatest benefits to aquatic systems across the U.S.

Hydrologic and Water Quality Performance of Regenerative Stormwater Conveyance Installed to Stabilize an Eroded Outfall in Durham, NC

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Abstract: The practice of conveying urban runoff to concentrated outfall locations frequently leads to stream bank erosion and head cut formation. Installed in an eroded channel, regenerative stormwater conveyance (RSC) is a grade-control and retention practice that uses a series of pools riffles with an underlying media layer. As a recently developed practice, RSC performance evaluations are needed to improve design and guide regulatory accreditation. An eroded channel with a 10% overall slope was stabilized with a RSC and monitored for a 14-month period. Hydrologic mitigation was achieved only for storms less than 12.7 mm, 8% volume retention and 49% peak flow reduction. An undersized system, 6-mm event storage, and groundwater intrusion led to minimal hydrologic benefit. A substantial 49% of inflow volume was converted to media flow at the second pool but reemerged as surface flow downstream where groundwater intrusion was evident. Storm event mean concentrations were reduced for most analytes but removal was minimal: 17% TSS, 17% TP, and 3% TN. Significant reductions only occurred between the upstream and second cell, indicating minimal water quality benefit of the downstream wetter pools. Comparisons between inter-event grab samples and storm event outflow concentrations indicate nitrogen export during inter-event periods, 47% increase in TN. Groundwater inflow led to an anaerobic inter-event system with evidence of denitrification, 81% decrease in NO2,3-N, but also mineralization, 390% increase in TAN. Due to inter-event export, mass loading of nitrogen increased. The head cut was successfully stabilized and no major structural failure was observed during the monitoring period. Maintenance concerns were evident including filling of pools, bank slumping, and media washout. Findings indicate hydrologic and water quality benefits only in the cells not affected by groundwater intrusion. Future implementations of RSC are encouraged to closely examine water table elevations and sizing criteria.

About the Presenter: Kevin Koryto is a graduate research assistant at North Carolina State University with the Stormwater Research Group. Kevin has spent the past two years studying regenerative stormwater conveyance, an innovative practice that links the fields of stormwater management and stream restoration. Prior to coming to NC State, Kevin served as a Peace Corps volunteer in Lesotho teaching high school math. Eager for outdoor exploration, he is excited to check out the Asheville area

Nitrogen and phosphorus removal in ecological drainage ditch used to treat domestic sewage in a small catchment of the upper Yangtze River

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Abstract: Over-fertilization of agricultural land has resulted in large loss of N and P from land to the aquatic ecosystem in china and many developed countries worldwide. Nutrient losses from agricultural fields have impaired the use of water for drinking, industry, agriculture, recreation, and other purposes. Maximizing ecological drainage ditches are being closely assessed to capture pollutants and mitigate harmful side effect in rivers. Mesocosm (consisted of 140 drums, 104 L) and eco ditch experiments were conducted to analyze the efficiency of N and P removal by ditch plants. The eco-ditch was designed and constructed in the downstream section of the catchment in 2009 for in situ treatment of residential sewage. Water discharge was monitored at the outlet of eco ditch. The current work was conducted to assess the water quality of a constructed vegetated ditch (300 m long and 2.4 m wide). Inlet concentrations during the study period (January- December, 2015) ranged from 65.14 to 180.2 mg/L for TN and 2.5 to 5.42 mg/L for TP. The removal efficiencies of TP and TN from the eco-ditches reached up to 68% and 74%, respectively. The results of mesocosm experiment indicated that the removal efficiencies of TN, TP and NH4 -N from the drums reached up to 72%- 99.4%, 64%- 98.7 %, and 75%-100%, respectively. The mesocosm system allowed the complete removal of all NO3-N applied. 73-95% of increase in plant biomass at the end of the experiment was observed. The plant uptake and sediment N/P accumulation accounted for 17.9- 42.2% and 18.0 -43.8% of the initial TP and TN load, respectively. Results of this work can also be used to model future design specifications eco-ditch mitigation. Furthermore, the outcomes from this research indicate that eco-ditch can be effective at mitigating transport of untreated sewage water in-situ.

About the Presenter: Mathieu Nsenga Kumwimba is a junior researcher in environmental science at Chinese Academy of Sciences. His research interests lie in the field of environmental pollution mechanism and remediation, nonpoint source pollution and its control along the Yangtze River, accelerated water quality of aquatic environments (such as ditches, wetlands, streams, river basins and lakes) in field experiments, mescosms and the laboratory; functions and values of aquatic environments, assessment, monitoring, restoration and biodiversity.He conducted studies on strategic prevention of water, food and soil pollution in China and have participated in field research including Environmental Impact Assessment of coal mining and washing and chemical industries. Also, in many water and sanitation trainings, wastewater treatments trainings etc. I am currently working on nonpoint source pollutants (N, P, C, sediment and heavy metals) control along Yangtze River, China. I am experienced with statistical methods and multivariate analyses.

New Stormwater Management Metrics for North and South Carolina to Address Receiving Stream Geomorphology: Proposed Methods and Anticipated Results

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Abstract: The question of how to best manage the altered hydrology, geomorphology, and ecology of urban streams remains a focus of much research and debate. Particularly in urban watersheds where stormwater quantity and quality issues are poorly managed, many conventional reach-scale stream restoration practices seem to be ineffective because the watershed impacts are just to great. Those same impacted urban watersheds are also the homes of beavers, who have their own approaches to engineering urban streams. To better understand the potential benefits of beavers in a range or urban systems, we will be studying several sites in Atlanta where beavers are active, examining the hydrologic and water quality benefits of beavers at these sites. We will also install beaver dam analogs (BDAs) at similar sites in Atlanta, to see if these benefits of beaver dams can be achieved in urban sites where beavers are not currently active.

About the Presenter: Charlie Stillwell is a third year PhD student at North Carolina State University under the guidance of Dr. Bill Hunt. Charlie's research interests include the evaluation of low impact development (LID) performance and designing stormwater management targets that directly consider a receiving stream's stability and natural flow regime. Prior to graduate school, Charlie received his BS in Civil Engineering at Drexel University and assisted in Dr. Montalto's Sustainable Water Resources Engineering group. Charlie has also completed internships at URS Corp, Nave Newell Inc., and the Philadelphia Water Department, where he was first introduced to green infrastructure and watershed management.

Brook trout response to habitat enhancement construction in an Appalachian river main stem

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Abstract: Brook trout Salvelinus fontinalis have experienced significant population declines throughout much of their native range, largely due to habitat loss. Increasing effort has been put toward restoring and preserving existing brook trout habitat in the face of continued loss under uncertain future conditions (e.g., climate change). The overall goal of this study was to monitor and assess ecological response to a multi-scale restoration project designed to improve brook trout habitat on the Shavers Fork, West Virginia. We first quantified changes in densities of brook trout and two competing trout species (brown trout Salmo trutta and rainbow trout Oncorhynchus mykiss) at the channel unit scale and relate observed distribution patterns to channel unit-specific habitat characteristics (depth, average velocity, and distance to fish cover). We then conducted snorkeling surveys to quantify microhabitat use by brook, brown, and rainbow trout in restored and natural habitats. Prior to restoration, brook trout were most dense in riffles, while brown and rainbow trout were most dense in natural pools. Following restoration, all 3 species occupied constructed pool habitats. However, brook trout consistently occupied constructed habitats at densities 4.5× those of competing species. At the channel unit scale, brook trout densities significantly correlated to greater amounts of cover, and were negatively correlated to increasing depth. No significant relationships were found between habitat variables and brown trout and rainbow trout densities at the channel unit scale. At the microhabitat scale, brook trout consistently occupied shallower habitats with higher average and fastest velocities, while brown and rainbow trout occupied deeper, slower moving locations within pools. All three species were consistently found near cover, but large brown trout dominated cover in the deepest sections of both natural and constructed habitats. Future brook trout habitat restoration projects should aim to increase habitat complexity to facilitate minimum competition for limited space.

About the Presenters: Cory Trego graduated from Lycoming College in Williamsport, Pennsylvania in May 2014 with a BS in biology. While there, he spent a semester interning with the PA DEP and two summers working with the Clean Water Institute assisting with the Pennsylvania Boat Commission's Unassessed Waters Initiative and helping farmers manage nutrient runoff in the Susquehanna River watershed. After graduation, he worked for Penn State University monitoring the effects of hibernaculum destruction on the movements and persistence of timber rattlesnake populations before enrolling at West Virginia University as a master's

student working under Todd Petty. He is currently finishing his research at WVU and recently began working with Trout Unlimited as a Conservation Planner.

Eric Merriam received a B.S. in Biology from Marshall University in 2007 and a M.S. in Wildlife and Fisheries Resources from West Virginia University in 2009. He earned a Ph.D. in Forest Resource Science from West Virginia University in 2015, where his research largely focused on modeling aquatic ecosystem response to mountaintop removal and valley fill mining in the central Appalachian region. He is currently a post-doctoral research assistant at West Virginia University. His current research focuses on managing brook trout under uncertain future conditions, and includes efforts to: characterize population response to watershed-scale restoration activities, quantify changes in distribution as a result of unconventional oil and gas development, and predict habitat loss under future climate scenarios.

Effects of Agricultural Restoration Practices on Stream Health in the Shenandoah Valley, Virginia

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Abstract: The Shenandoah Valley encompasses some of the highest agricultural producing regions in Virginia, many of which are large contributors of nutrients and sediment. The Conservation Reserve Enhancement Program (CREP) assists landowners in the installation of riparian restoration projects in which cattle are fenced out or a riparian buffer is planted. We examined the temporal effects of riparian restoration and the impact of upstream landuse on water quality for eleven farms participating in the CREP program for various times (from 1 to 14 years). We hypothesized that the length of time that the CREP program has been established would have a positive effect on the water quality of a stream. Water quality was quantified by measuring benthic macroinvertebrate assemblages using the Hilsenhoff Biotic Index (HBI), Virginia Stream Condition Index (VA-SCI), Shannon Diversity Index, and total abundance. GIS analysis was also employed to calculate upstream land use and stream channel characteristics: land use, canopy cover, slope, impervious surface, relief, road density, and watershed area were assessed for the watersheds and 100-meter stream buffers at each sampling site. Single variable and multiple linear regressions were performed separately within the watershed and buffer zones. While no single variable showed a significant relationship, the time since restoration and the percentage of upstream forested land use predicted HBI values, both in the watershed ($p = 0.005$, $R2 = 0.668$) and in the buffer zone ($p < 0.001$, $R2 = 0.766$). VA-SCI was predicted by time since restoration and upstream impervious surface in the buffer zone only ($p = 0.025$, $R2 = 0.501$). These data show that CREP efforts are having a positive effect on water quality, although upstream land use is also an important factor.

About the Presenter: Bruce Wiggins is a Professor of Biology at James Madison University, and teaches courses in Ecology and Evolution, Environmental Toxicology, and GIS. He is interested in water quality, and how it is affected by the surrounding landscape and upstream land use. His lab is investigating how streambank restoration practices (such as tree plantings and cattle exclusion) in agricultural areas affect the community structure of benthic macroinvertebrates, with the goal of determining how well the various types of restoration practices are working.

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