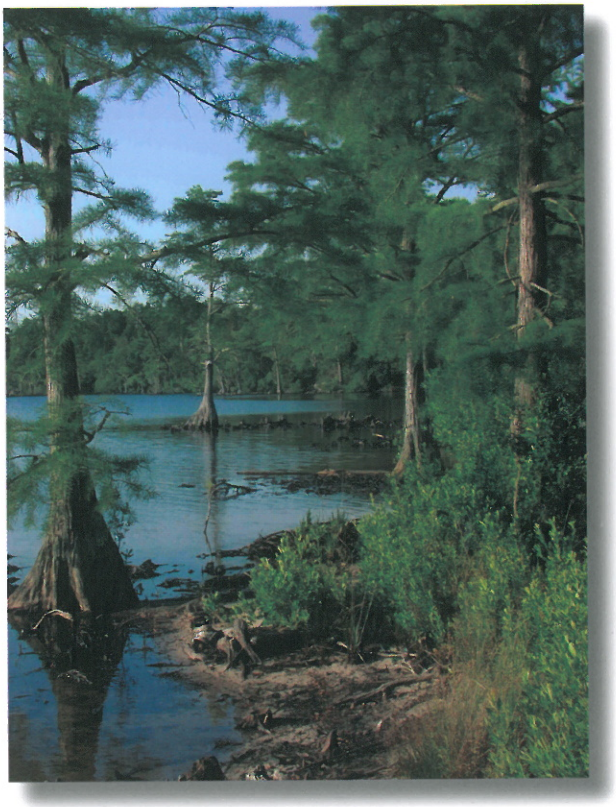
NC STATE UNIVERSITY Stream Restoration Program

NCSU-SRP Biennial Stream Restoration Conference

# Stream Restoration in the Southeast: Innovations for Ecology



NC STATE UNIVERSITY Bio&Ag ENGINEERING Stream Restoration Program

Sea Grant North Carolina

NC State University A&T State University COOPERATIVE EXTENSION Empowering People · Providing Solutions

Applying knowledge to improve water quality
Southern Regional Water Program
A Partnership of USDA NIFA & Land Grant Colleges and Universities

October 15-18, 2012
Hilton Wilmington Riverside
Wilmington, North Carolina

Hosted by
NC State University Stream Restoration Program
NC Sea Grant
NCSU Department of Biological & Agricultural Engineering,
North Carolina Cooperative Extension Service
USDA NIFA Southern Regional Water Program

*www.ncsu.edu/srp/conference/*

# Conference Agenda and Abstracts

## Stream Restoration in the Southeast: Innovations for Ecology

October 15-18, 2012
Hilton Wilmington Riverside, Wilmington, North Carolina

## Conference Hosts

North Carolina State University Stream Restoration Program
North Carolina Sea Grant
NCSU Department of Biological and Agricultural Engineering
North Carolina Cooperative Extension
USDA NIFA Southern Regional Water Program

## Conference Partners

Alabama Cooperative Extension System

Auburn University

Carolina Vegetation Survey

City of Wilmington Stormwater Services

Duke University-Nicholas School of the Environment

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NC Coastal Federation

NC Ecosystem Enhancement Program

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NC State University Department of Plant Biology

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Southwest Florida Water Management District

UNC-Charlotte, Department of Geography & Earth Sciences

University of Georgia

University of Kentucky, Department of Biosystems & Agricultural Engineering

University of North Carolina – Wilmington

US Environmental Protection Agency, Region IV

**Website**: http://www.ncsu.edu/srp/conference/

# About the Conference

*Welcome to the 2012 Southeast Stream Restoration Conference in Wilmington, NC. This is the 10th conference on this topic since 1998 and the second time we have convened in Wilmington. This conference includes more than 300 attendees representing 20 states and 100 affiliations. The goal is to provide a forum for sharing ideas, information, and experiences among natural resource professionals in the public and private sectors in order to improve the science and practice of stream restoration.*

*The conference focus this year is 'Innovations for Ecology'. The opening general session features a diverse group of invited speakers with expertise in biological monitoring, nutrient cycling, ecological function assessment, habitat improvement, and ecology-based restoration. This year we have included a closing general session that will present a diverse array of perspectives and information on stream mitigation programs and projects. We encourage you to take advantage of the opportunities to network with all the presenters on these and other important restoration issues.*

*We thank the conference sponsors and exhibitors who are listed in the program. More than 35 companies, nonprofit organizations, and government agencies involved in all aspects of ecosystem restoration are providing sponsor support and exhibits throughout the conference.*

*Planning is already underway for our next biennial conference. Details are coming soon for our next conference in 2014! We ask that you please complete the conference evaluation forms and turn those in before you leave to help improve our next event and future educational programs. Enjoy your time in Wilmington!*

*2012 Southeast Regional Stream Restoration Conference Coordinators:*

*Barbara Doll, Greg Jennings, Karen Hall, Cathy Smith, and Christina Shepard*

We gratefully acknowledge our Conference Sponsors!

## *Bedrock Sponsors*

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*NOTES:*

# 2012 Southeast Regional Stream Restoration Conference

## Monday Evening, October 15, 2012, 5:30 – 9:30pm

**Please join us for a reception at Reel Café,**
**compliments of our Bedrock Sponsor, River Works!**

(From the Hilton, walk south on N. Water St.; turn left onto Market St., then right onto S. Front St.)


## Wednesday Evening, October 17, 2012, 5:30 – 9:30pm

**Dinner Cruise onboard the Henrietta III**
**Thanks to our Mayfly Sponsor, Environmental Banc & Exchange!**

***(You must have a ticket to board.)***

# AGENDA

**DAY 1 – Monday, October 15, 2012**

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| **10:30 am** | **Pre-Registration** |
| **1:00-5:00pm**<br><br>*Carolina Room: 2nd Floor, Lobby Level*<br><br>*Azalea Room: 1st Fl., Lower Lobby*<br><br>*Bellamy and Dudley Rooms: 3rd Floor* | **Pre-conference workshops**<br>**#1** Introduction to Stream Project: Decision Analysis and Design Guidance for Stream Restoration *(Carolina Room)*<br><br>**#2** Working with Stream Functions *(Azalea Room)*<br><br>**#3** Managing Invasive Plant Species in the Coastal Southeast *(Bellamy Room)*<br><br>**#4** Speaking of Science --- how to avoid the snares and sand traps of public speaking *(Dudley Room)* |
| **5:00-9:30pm** | **Reel Cafe - Sponsored Reception - compliments of our Bedrock Sponsor, River Works!**<br>100 S. Front St. (From the Hilton, walk south on N. Water St.; turn left onto Market St., then right onto S. Front St.) |

**DAY 2 – Tuesday, October 16, 7:30am *(Cont. breakfast sponsored by Mayfly Sponsors)***

**8:20am-12:10pm General Sessions** – *pp. 17-24*

*Moderator: Karen Hall, NC State University* *Grand Ballroom, Lower Lobby Level*

*Michael Barbour*, Tetra Tech – The relationship of biological monitoring to ecological restoration and ecological recovery

*Sara McMillan*, UNC-Charlotte – Nutrient cycling in urban streams

*Barbara Doll*, NC State University – Build it and they will come?

*Break: 10:10am*

*Richard Starr*, U.S. Fish & Wildlife Service – Innovations for achieving ecological goals in stream restoration: US FWS perspective

*Brian Helms*, Auburn University – The elements of a perfect stream: critical needs for a positive biological response to restoration

*Dave Rosgen*, Wildland Hydrology Consultants – Innovative approaches for improving habitat in stream restoration projects

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| **12:10-1:10pm** | **Lunch Sponsored by Stonefly Sponsors Wildland Engineering & Stantec** |

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| Tuesday, 1:10-2:50pm<br><br>*Azalea Ballroom* | **Concurrent Session 1**<br>**A. Perspectives and Reflections – pp. 25-29**<br>*Moderator: Beth McGee, NC Clean Water Management Trust Fund*<br><br>Evolving Stream Design Practices with a Focus on Ecological Uplift<br>*John Hutton, Wildlands Engineering, Inc.*<br><br>It doesn't have to look constructed: River restoration in a time of increased popularity and limited budgets<br>*Nick Nelson, Inter-Fluve, Inc.*<br><br>One size fits all stream restoration?<br>*Vince Sortman, Biohabitats*<br><br>Achieving "function" without "form" in urban streams<br>*Todd St. John, Kimley-Horn and Associates, Inc.*<br><br>Stream Restoration in Canada - the State of the Union (or perhaps confederation)<br>*Heather Amirault, Stantec Consulting, Inc.* |
| *Camelia/Dogwood Ballrooms* | **B. Stormwater Management Benefits to Stream Restoration – pp. 30-34**<br>*Moderator: Mitch Woodward, NC Cooperative Extension*<br><br>Regenerative stormwater conveyance-update on performance<br>*Kevin Nunnery, Biohabitats, Inc.*<br><br>Reacting to unexpected groundwater influence and reaping the benefits: Innovative field engineering on a a pocket wetland<br>*Jill Davenport, CH2M HILL*<br><br>Stream restoration as a tool for storm water managers<br>*Will Wilhelm, Kimley-Horn and Associates, Inc.*<br><br>High pollutant removal efficacy of a large constructed wetland leads to receiving stream improvements<br>*Michael Mallin, University of North Carolina, Wilmington*<br><br>Anaerobic ammonium oxidation and denitrification in a constructed stormwater wetland<br>*Bongkeun Song, University of North Carolina, Wilmington* |

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| *Tuesday, cont'd*<br>*1:10-2:50pm*<br><br>*Magnolia Ballroom* | C. Prioritizing Habitat Enhancement from the Benthos Up – pp. 35-39<br>*Moderator: Dave Penrose, Watershed Science*<br><br>Designing freshwater mussel habitat following dam removal: Two case studies<br>*Scott Peyton, Stantec Consulting, Inc.*<br><br>Restoration of a southern Appalachian bog: Restoring habitat for a critically endangered plant in North Carolina<br>*Megan Mailloux and Christopher Engle, P.E., Wolf Creek Engineering, PLLC*<br><br>Effects of streambank stabilization on aquatic biodiversity in Oklahoma's Illinois River Watershed<br>*Gina Levesque, Oklahoma Conservation Commission*<br><br>Threatened and endangered fish species responses to Racoon Creek stream restoration<br>*Steven Glickauf, Corblu Ecology, LLC*<br><br>Constructed log jams for fisheries habitat improvement<br>*Micky Clemmons, Michael Baker Engineering, Inc.* |
| 2:50-3:20 | Break Sponsored by Caddisfly Sponsors |
| Tuesday,<br>3:20-5:00pm<br><br>*Azalea* | Concurrent Session 2<br>A. Designing with a Deluxe Toolkit – pp. 40-44<br>*Moderator: Jason Doll, Moffatt & Nichol*<br><br>Design Challenges & Intervention design approaches for valleys impacted by legacy sediments<br>*Drew Altland, Cardno ENTRIX*<br><br>Latest advances to the RIVERMorph software<br>*George Athanasakes, Stantec Consulting Services, Inc.*<br><br>Building a conceptual model of Piedmont streams<br>*S. Kyle McKay, Environmental Laboratory, U.S. Army Corps of Engineers*<br><br>Re-evaluating hydraulic geometry<br>*Grant Ginn, Wolf Creek Engineering*<br><br>Can over-planting of constructed stream banks instigate channel incision?<br>*Zachary Mondry, NC Ecosystem Enhancement Program* |

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| *Tuesday cont'd*<br>*3:20-5:00pm*<br><br>*Camelia/Dogwood* | **B. Monitoring for Ecological Recovery: Field of Dreams? – pp. 45-49**<br>*Moderator: Eric Kulz, NCDENR – Division of Water Quality*<br><br>Support for family level benthic macroinvertebrates for rapid bioassessment<br>*Jon Calabria, The University of Georgia*<br><br>Monitoring effects of watershed improvement projects on macroinvertebrate communities and Total Suspended Sediments in Gwinnett County, GA<br>*Kevin Middlebrooks, CH2M HILL*<br><br>James River Continuum<br>*Ben Leatherland, Hurt and Proffitt Engineering*<br><br>Water quality monitoring data to demonstrate compliance with EPA 319 grant criteria for 1,700 feet of a G5 stream restoration in the headwaters of the McDowell watershed in Cornelius, NC<br>*Tim Schueler, Hazen and Sawyer*; *David Woodie, Charlotte/Mecklenburg Stormwater Services*<br><br>Assessing conductivity sensor performance: A laboratory and field study<br>*Carmen Agouridis, University of Kentucky* |
| *Magnolia* | **C. Thinking Outside the Trapezoid – pp. 50-55**<br>*Moderator: Wendy Patoprsty, NC Cooperative Extension*<br><br>Rapid barrier assessment methodology for fish habitat connectivitiy in watersheds of the Piedmont and upper Coastal Plain Physiographic Province<br>*Chris Sheats, The Catena Group*<br><br>Innovative planning to construcion in urbanized environment<br>*Ben Soleimani, USACE*<br><br>Large, woody material: Science, policy, and best management practices for Florida streams<br>*Anna Linhoss, University of Florida*<br><br>Incorporating large woody debris into urban stream restoration - A case study of the design of the northwest branch of the Anacostia River<br>*David Griffin, McCormick Taylor, Inc.*<br><br>Oxbows: From surplus companion value to sustained individual value (Opportunity meets necessity)<br>*Mike Adams, Stantec Consulting* |

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| Tuesday<br>5:00-7:00pm | Poster Presentations and Reception Sponsored by Stonefly Sponsor, WK Dickson |
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| DAY 3, Wednesday, Oct. 17, 7:15am *(Cont. breakfast sponsored by **Mayfly** Sponsors)* | |
| 8:20-10:00am<br><br><br><br>*Azalea* | Concurrent Session 3<br>A. Design Tools – pp. 56-61<br>*Moderator: Kris Bass, NC State University*<br><br>Efficiently creating 3D stream designs with AutoCAD<br>*Michael Aust, Timmons Group*<br><br>Utilizing automation to improve design efficiency and plan quality for stream restoration projects<br>*Michael Marsala, Wetland Studies and Solutions, Inc.*<br><br>Urban stream restoration design utilizing a threshold channel approach<br>*Ken Barry, S&ME, Inc.*<br><br>Use of GIS and WATER to identify and delineate stream types in eastern Kentucky<br>*Jonathan Villines, University of Kentucky*<br><br>GIS based asset verification: Understanding data accuracy<br>*Colleen Kiley, NC Ecosystem Enhancement Program* |

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| *Wednesday cont'd*<br>*8:20-10:00am*<br><br>*Camelia/Dogwood* | B. Monitoring: Beyond Data, What Does it Mean? – pp. 62-67<br>*Moderator: Dani Wise Johnson, North State Environmental*<br><br>Revisiting reference reaches<br>*Kevin Tweedy, Michael Baker Corporation*<br><br>Lessons learned: Erosion monitoring in Gwinnett County, GA<br>*Andrea Althoff, Brown and Caldwell*<br><br>Five years of stream restoration monitoring data demonstrate successful conversion of rip rap lined trapezoidal channel to diverse stream and wetland habitat<br>*Eileen Straughan, Straughan Environmental, Inc.*<br><br>Using the "kitchen sink" approach for restoration monitoring in Red Hill Branch<br>*Elizabeth Franks, Versar, Inc.*<br><br>An examination of no net loss and the spatial relationship between approved impacts and compensatory mitigation for streams, riparian buffers and wetlands in North Carolina<br>*John Dorney, Atkins North America* |
| *8:20-10:00am*<br><br>*Magnolia* | C. Vegetation: Getting to the Root – pp. 69-73<br>*Moderator: Wendi Hartup, NC Cooperative Extension*<br><br>Comparison of biomass and survival of four native live stake species: black willow (*Salix nigra*), silky willow (*Salix sericea*), silky dogwood (*Cornus amomum*), and Virginia sweetspire (*Itea virginica*)<br>*Eve Brantley, Auburn University*<br><br>The interactive effects of growing season flood duration and timing on bottomland hardwood tree species regeneration patterns<br>*Jacqueline White, University of North Carolina at Chapel Hill*<br><br>Analysis of planted vegetation in riparian zones of priority I and priority II EEP stream restoration projects: A comparison of success and growth trends<br>*Melonie Allen, NC Ecosystem Enhancement Program*<br><br>Controlling Microstegium vimineum on stream restoration sites: Experimental field trials with aquatic-use herbicides<br>*Karen Hall, North Carolina State University*<br><br>A tool for predicting restoration target vegetation from environmental variables using a large reference dataset<br>*Michael Lee, University of North Carolina at Chapel Hill* |

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| 10:00 – 10:20 | Break Sponsored by Caddisfly Sponsors |
| Wednesday, 10:20-12:00<br><br>*Azalea* | **Concurrent Session 4**<br>**A. Urban Case Studies: Making the Most of Difficult Settings – pp. 74-79**<br>*Moderator: Daniel Ingram, W.K. Dickson*<br><br>Newland by-pass channel and downtown floodplain improvement project<br>*David Kiker, WK Dickson*<br><br>Davie Park stream restoration<br>*Dasa Crowell, HDR Engineering, Inc.*<br><br>Case studies in urban stream restoration in Chapel Hill and Carrboro, North Carolina<br>*Zan Price, NC State University*<br><br>West Sides Creeks Ecosystem Restoration Project<br>*LeeAnne Lutz, San Antonio River Authority*<br><br>Drops in the bucket... half empty or half full? A watershed approach to environmental restoration on Little Sugar Creek<br>*David Woodie, Charlotte-Mecklenburg Stormwater Services; Emily Reinicker, Wildlands Engineering, Inc.* |
| *Camelia/Dogwood* | **B. Professional Responsibility and Liability – pp. 81-85**<br>*Moderator: Tara Allden, Restoration Systems*<br><br>1994-2012: A Historical Risk Perspective:<br>Who should accept the risk when significant design changes are made in the field to increase ecosystem benefit; the designer, the contractor, the owner, or the insurance company?<br>*Wes Newell, Backwater Environmental*<br><br>Restoration planting success: An EEP methodology to evaluate vegetation warranties<br>*Jessica Kemp, NC Ecosystem Enhancement Program*<br><br>What level of risk are we prepared to accept for a stream restoration design?<br>*Brad Fairley, Stantec Consulting Services, Inc.*<br><br>Legal considerations for stream restoration<br>*Jay Wilkerson, Conner Gwyn Schenck, PLLC*<br><br>Are we certifiable?<br>*Peter Wilcock, Johns Hopkins University* |

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| *Wednesday cont'd*<br>*10:20am-12:00pm*<br><br>*Magnolia* | C. Case Studies: Focus on Habitats – pp. 86-90<br>*Moderator: Bill Swartley, NC Forest Service*<br><br>Beaver Creek: A focus on trout reproduction<br>*Dani Wise Johnson, North State Environmental*<br><br>Mechumps Creek Corridor Restoration Project, Ashland, Virgina<br>*Josh Running, Williamsburg Environmental Group, Inc.*<br><br>Stream restoration in Dupont State forest, North Carolina<br>*Jason Zink, North Carolina State University*<br><br>Chadrick Creek Restoration: Daylighting a NC fisheries<br>*Darrell Westmoreland, North State Environmental*<br><br>Restoration in the Park<br>*Reid Cook, Angler Environmental* |
| 12:00-1:00pm | Lunch Sponsored by Stonefly Sponsors Michael Baker Corp. and Stream Mechanics |
| Wednesday, 1:00-2:20pm<br><br>*Azalea* | Concurrent Session 5<br>A. Mitigation Drivers and Passengers – pp. 91-96<br>*Moderator: Norton Webster, EBX*<br><br>Liability risks and challenges for contractors<br>*Sean Connolly, South Carolina Department of Transportation*<br><br>North Carolina, Kentucky, and Virginia: How many credits would your stream mitigation project generate<br>*Joshua White, Michael Baker Engineering*<br><br>Turning liabilities into assets: Municipal stream and wetland restoration<br>*Ward Marotti, WK Dickson & Co., Inc.*<br><br>Where mitigation hits the road: Successful project closeout from the perspective of both the mitigation user and mitigation provider<br>*Tim Baumgartner, NC Ecosystem Enhancement Program, Scott Hunt, Michael Baker Engineering* |

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| *Wednesday cont'd*<br>*1:00-2:20pm*<br><br>*Camelia/Dogwood* | **B. Coastal Restoration: Down by the Sea – pp. 97-100**<br>*Moderator: Robert Evans, NC State University*<br><br>Lux Farms Hydrologic Restoration Project: An innovative partnership for agriculture and water quality at the end of the world, North Carolina...<br>*Kris Bass, NC State University*<br><br>Benefits of a hydrobiogeomorphic, multi-scale approach to stream classification in a sandy coastal plain<br>*John Kiefer, AMEC Environment and Infrastructure*<br><br>Techniques for restoration of headwaters streams in the inner coastal plain<br>*Jeff Keaton, Wildlands Engineering, Inc.*<br><br>Overview of Wilmington's stormwater program and the role of stream restoration<br>*David Mayes, City of Wilmington* |
| *Magnolia* | **C. Educating to Make a Difference – pp. 101-105**<br>*Moderator: Eve Brantley, Auburn University*<br><br>Starting a backyard buffer program in your community<br>*Wendi Hartup, North Carolina Cooperative Extension*<br><br>The impact of streambank stabilization on recreation and challenges with education and outreach<br>*Jeri Fleming, Oklahoma State University*<br><br>Boater habitat: The recreational and ecological enhancements on the Little Coal River, West Virginia<br>*Nathan Ober, Stantec Consulting Services, Inc.*<br><br>The wonders of wetlands: Exposing youth and adults to the benefits and life of community constructed wetlands<br>*Wendy Patoprysty, North Carolina Cooperative Extension* |
| 2:20-2:40pm | Break Sponsored by Caddisfly Sponsors |
| Wednesday,<br>2:40-4:40pm<br><br>*Grand Ballrooms* | **General Session**<br>**A. Directions and Challenges – pp. 106-113**<br>*Moderator: Barbara Doll, NC Sea Grant*<br><br>Federal perspectives on stream mitigation<br>*Brian Topping, US EPA*<br><br>State perspectives on stream mitigation<br>*Scott McClendon, US Army Corps of Engineers* |

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| | Focusing mitigation procurement to improve mitigation outcomes<br>*Michael Ellison, NC Ecosystem Enhancement Program*<br><br>Mitigation banking perspectives on stream restoration<br>*Tara Disy Allden, Restoration Systems*<br><br>Innovative approaches to stream assessment and restoration<br>*Will Harman, Stream Mechanics*<br><br>An examination of no net loss and the spatial relationship between approved impacts and compensatory mitigation for streams, riparian buffers and wetlands in North Carolina<br>*John Dorney, Atkins North America* |
| 5:00 pm | Adjourn |
| 5:30 – 8 pm | Sponsored Dinner Cruise onboard the Henrietta III - Special thanks to our Mayfly Sponsor, EBX! |
| | |
| DAY 4, Thursday, October 18 | |
| 8:00am<br><br>*Buses leaves at 8am for Tour 1; and 8:30am for Tour 2.* | Stream Tours: ***(breakfast-to-go provided for tour participants only, sponsored by Mayfly Sponsors)***<br><br>Stream Tour 1: Rural Coastal Plain Stream Restoration Projects (lunch included). Tour duration: 8:00am – 3:00pm<br><br>Stream Tour 2: Urban Coastal Restoration Projects<br>Tour duration: 8:30am – 12:00pm<br><br>Please meet in the hotel lobby between 7:45 and 8 a.m. |

Please see our list of Poster Presentations on pp. 115-127
and our Exhibitor contact information on pp. 129-131.

CONTINUING EDUCATION CREDITS

13 professional development hours (PDHs) for professional engineers are approved by the NC Board of Examiners for Professional Engineers and Land Surveyors for the main conference (Tues - Wed), plus 3 PDHs for each of Pre-conference workshops #1 and #2 and each of the fieldtrips.
10 CEUs for Landscape Architects are approved by the NC Board of Landscape Architects, Course # 8953; and Workshop # 3 has also been approved for 3.5 CEUs, Course # 8955.
Other professionals may appeal to their respective boards to obtain professional education credits.

# The Relationship of Biological Monitoring to Ecological Restoration and Ecological Recovery

**Michael T. Barbour**

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*Abstract*: Effective watershed management is a combination of restoration and protection. Using a management framework based on biological response to stressors, restoration can be defined as the reduction, control, or elimination of stressors and the sources that produce them; protection is the prevention of new stressor sources from becoming established in the watershed. Biological monitoring using appropriately-calibrated indicators of stressor response (such as fish and benthic macroinvertebrate indexes of biological integrity) provides the most direct and accurate approach for assessing watershed conditions for ecological health, both for protection and for recovery after restoration activities. Stressor indicators are used to help explain causes of degraded biological indicators, and stressor sources information, associated with different kinds of land use and land cover activities, from urban to agricultural to relatively natural help target restoration or remediation activities. Different spatial and temporal scales for monitoring are necessary for evaluating the effectiveness of 1) stressor control strategies and 2) overall watershed management. Thus, effective decision-making is adaptive, influenced by scientific information provided by biological condition indicators, and focused on stressor source elimination or mediation.

*About the Speaker*: **Dr. Michael T. Barbour** is Vice President of Tetra Tech (Tt), Inc., an environmental consulting firm, and is Director of Tt's Center for Ecological Sciences in Owings Mills, Maryland. His PhD is in Marine, Estuarine, and Environmental Science from the University of Maryland. Dr. Barbour serves in a technical capacity to the U.S. Environmental Protection Agency in the development of technical guidance for ecological assessment strategies of water resources. In addition, Dr. Barbour works internationally, and has participated as a Visiting Scientist in nearly a dozen countries. He has been an invited speaker for innumerable conferences and symposia, facilitated more than 80 workshops, and published over 20 peer-reviewed government guidance reports, and 50 scientific papers including his newest book, *Wading for Bugs: Exploring Streams with the Experts*. Dr. Barbour was given professional recognition awards from both the Southeastern (U.S.) Water Pollution Biologists Association and the Environment Agency of Great Britain, and has recently received the Distinguished Service Award from the Society of Freshwater Science. He has used his professional experience and interests as the basis for writing novels that focus on key environmental issues. Dr. Barbour has two novels, *The Kenai Catastrophe* and *Blue Water, Blue Island,* and two children's books, *Caitlyn and Craig the Crayfish* and *Douglas Visits the Seashore.*

# Coupled carbon and nutrient cycling: trajectories for restoration success

**Sara K. McMillan, PhD, PE**

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*Abstract*: Headwater streams have been identified as hot spots of biological activity and play a disproportionately large role in nutrient retention. This role is attributed to the high proportion of stream water in contact with biologically active streambed sediments and the total number of river miles associated with small streams at the watershed scale. However, extrapolation of these attributes to restored headwater streams is uncertain. Altered hydrology and increased nutrient loads in urban and agricultural areas have led to degraded streams and increased nutrient transport. In addition, degradation of riparian forests (either prior to or during construction) can greatly affect nutrient transformations via disruption of organic matter inputs, decreased shading and alterations of instream water chemistry. The primary goals of stream restoration are often to reduce flooding and decrease sediment loss, however changes to the physical structure of the stream system can also impact nutrient retention. While considerable research is still needed, results from studies across scales in the Eastern US offer considerable insights into the potential for restoration to affect nutrient retention. Generally, greater retention of nutrients has been observed in newly restored streams and is largely attributed to dramatic changes in carbon supply and temperature. Newly restored streams with herbaceous riparian vegetation and minimal shading exhibited high standing stocks of algal biomass which remove nutrients from the water column. The long term result is an increase in organic nutrients as algal biomass senesces, potentially transferring nutrient enrichment downstream. However, newly restored streams also tend to exhibit higher rates of denitrification in streambed and bank sediments which may be fueled by this highly bioavailable carbon. Long term research is still needed to understand how these shifts in carbon supply as a stream restoration project matures affect biogeochemical processes and thereby overall water quality.

*About the Speaker*: **Sara McMillan** is Assistant Professor of Civil Engineering Technology at University of North Carolina at Charlotte. Together with Sandra Clinton (Dept of Biology, UNCC) she leads the Ecology and Biogeochemistry of Watershed research group. Her study focus is biogeochemistry and water quality of aquatic ecosystems with an emphasis on the interactions between hydrology and nutrient and carbon transformations. And her research centers on the sustainability of healthy ecosystems and restoring ecosystem functions of streams and wetlands.

# Build it and they will come?

**Barbara A. Doll, PE**

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barbara_doll@ncsu.edu

*Abstract*: Macroinvertebrate communities were sampled in 85 North Carolina restored streams in 2006-2012, and resulting metrics were correlated with two new stream assessments (Eco-Geomorphological Assessment (EGA) and Stream Performance Assessment (SPA)). At 65 of these streams, three existing stream assessments were also applied, including USEPA Rapid Bioassessment Protocol (Barbour et al., 1999), USDA Stream Visual Assessment Protocol (USDA, 2000), and Riparian Channel and Environmental Inventory (Peterson, 1992). Regression analyses indicated weak correlations between stream assessment scores and macroinvertebrate metrics. Correlations were improved by applying principal component analysis (PCA) to the stream assessment variables along with multivariate linear regression to correlate principal components to macroinvertebrate metrics. To further explain variability, watershed conditions (size, slope, land use) were determined from GIS analysis of 65 restored streams. PCA of stream assessment score variables combined with watershed conditions improved correlations for multivariate linear regressions for most stream assessments and macroinvertebrate metrics. In contrast, the age of restoration was not significant relative to macroinvertebrate metrics and did not show interaction with EGA score relative to macroinvertebrate metrics.

The SPA method was applied to a larger data set of 156 streams that represent a wide range of eco-geomorphological conditions from high-quality, stable reference streams to highly unstable or degraded streams. PCA was conducted on this larger dataset of restored and un-restored streams. Three-dimensional graphical comparison of the stream scores for the top three Principal Components revealed segregation between degraded and reference quality streams. In addition, restored streams grouped closely with the reference streams rather than the degraded streams.

This presentation will outline the objectives and outcomes of this research study.

*About the Speaker*: **Barbara Doll** is a licensed professional engineer who joined Sea Grant in 1992 as a water quality specialist. Sea Grant is a federal/state program that promotes the wise use of coastal resources. Based at NC State University, much of Barbara's current work is focused on repairing degraded stream systems and reducing the impacts of stormwater runoff and nonpoint source pollution. She specializes in urban stream restoration, and is responsible for leading a multi-million dollar, three-phase project to restore Rocky Branch, a creek that runs a mile through the North Carolina State University campus and is a tributary to the Neuse River.

# Innovations for achieving ecological goals in stream restoration: USFWS perspective

**Richard Starr**

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*Abstract:* The mission of the Service is to work with others to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The Service must demonstrate a link between their restoration activities and benefits to species populations. The Service has recently developed a few tools that relate stream physical functions to stream biological functions. Additionally these tools can be used to describe how restoration activities influence stream functions and what potential functional lift can be achieve. This presentation will presents these tools and how they are being used by the Service as well as other resource agencies.

*About the Speaker:* **Richard Starr** is Chief of the Habitat Restoration Division within the U.S. Fish and Wildlife Service –Chesapeake Bay Field Office, Annapolis, Maryland. The division promotes watershed and function–based assessments and natural stream restoration methodologies and has three focus areas: training and education, technical assistance, and demonstration projects. Richard has over 20 years experience and has conducted numerous geomorphic watershed and stream assessments; implemented stream restoration and fish passage projects; developed a variety of stream assessment protocols and tools; produced numerous technical and planning documents, and developed and delivered training courses on stream protection, assessment, and restoration.

# Elements of *ideal* stream condition: critical needs for a positive biological response to restoration

**Brian Helms, PhD**

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*Abstract*: Geomorphologists, engineers, chemists, biologists, and the public often view streams and their restoration in very different ways. This disparity often can lead to misunderstandings in determining causes of stream degradation as well as proximate and long-term restoration goals. Thus it is important for all partners in a restoration project to understand the contrasting perspectives of how a stream "works". Here I explore elements of idealized stream conditions from the perspective of an aquatic ecologist. Although individual system components can be highly localized, hydraulically and hydrologically conducive conditions as well as lateral and longitudinal connectivity, elements largely influenced by watershed-level processes, are of utmost importance in maintaining, through successive hierarchical steps, a diversity of *functional* habitats occurring at relatively fine scales. Such functional habitats, including riffles, pools, debris dams, undercut banks, etc., serve as refuge, reproduction, and recruitment resources for aquatic biota and are the ultimate source for critical stream ecosystem function. Thus from an ecological perspective, understanding the critical habitats of a viable stream ecosystem, and the hierarchy of influences, is critical in defining and achieving attainable restoration goals.

*About the Speaker*: **Brian Helms** is the Invertebrate Collections Manager at the Auburn University Museum of Natural History in Auburn, Alabama. An astacologist and stream ecologist by training, Brian is actively involved in crayfish conservation efforts and has conducted and directed research on influences of anthropogenic disturbance on biota in Alabama, Georgia, and North Carolina streams. Brian promotes understanding critical habitat and ecological associations as a means of preserving and restoring aquatic biodiversity through research, mentorship, outreach, and teaching. His current research includes developing ecological endpoints for regional geomorphic curves in streams of Alabama and western North Carolina.

# Incorporating Ecological Criteria on a Large Scale Restoration Using the Natural Channel Design Approach

**Dave Rosgen, Ph.D., P.H.**

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*Abstract*: A large scale restoration project was designed and implemented in Central Idaho that incorporated multiple ecological objectives utilizing the Natural Channel Design approach. Ecological criteria were established based on a limiting factor analysis for various organisms and their habitats, including large mammals, eagles, heron, waterfowl, songbirds and aquatic organisms. The watershed assessment also documented the major causes of river and riparian impairment. Land uses related to heavy long-term, season-long livestock grazing, poor irrigation practices, and direct channel impacts were responsible for the loss of physical and biological function.

The multiple objectives were to offset the limiting factors identified in the assessment phase; redirect land use practices to take care of the cause of impairment; reduce excess sediment from streambank erosion for both large and small streams; reduce water temperature; and convert the irrigation system from surfacing flooding to subterranean. Thirteen miles of stream channels were constructed on a previously abandoned surface to reconnect floodplains and to regain an instream flow regime with a new water management plan. Oxbow lakes, emergent wetlands and off-channel food plots were created, and the toe wood structure was implemented on newly constructed channels and for portions of the braided Big Wood River. Overall, a great diversity of habitats were created for mammals, birds, and aquatics, including adult, rearing, reproduction, food chains, and low flow, high flow and winter refugia. Invasive species were eliminated and native riparian vegetation was re-established on previously overgrazed lands including compatible overstory and understory species.

Pre-calibration, active construction and post-restoration monitoring was conducted for streamflows, water temperature, ground water levels, turbidity, fish populations, food chains, and for nesting eagles and herons. Monitoring will continue for several years to determine restoration effectiveness.

*About the Speaker:* **Dave Rosgen** is the owner of Wildland Hydrology Consultants, a fluvial geomorphology training and design firm located in Fort Collins, Colorado. Dave has 48 years of experience in stream morphology, restoration, sedimentology, stream classification development and applications, grazing and riparian systems management, cumulative water resource impact

assessment and modeling, and fish habitat enhancement. He has assessed, designed, constructed and monitored hundreds of large scale river restoration projects since 1968. Dave also conducts short courses for government agency personnel, universities, and consulting firms in watershed management, river morphology, river stability assessment, restoration and applications. He plans to complete a book on restoration this year.

# Evolving Stream Design Practices with a Focus on Ecological Uplift


## John Hutton

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*Abstract:* This presentation will provide a broad overview of the evolution of stream engineering and restoration practices from the pre-restoration era, to the early days of designs focused only on stability, and into the current period characterized by a greater focus on native materials and ecologically based designs. Stream restoration practices have evolved because project goals have become more specific, regulatory requirements and guidance have expanded, and practitioners have gained years of valuable experience. The majority of stream engineering occurring prior to the 1990's consisted of channelization and hard bank stabilization to promote flood control and hydrologic alteration but contributed to poor water quality and destroyed habitat. In the 1990's and 2000's, the number of restoration projects greatly increased but technical resources were limited and a simplistic approach to restoration was the norm. These designs focused on creating highly sinuous, yet uniform channels with large boulder structures and bioengineering to improve stability and habitat. As the practice of restoration matures, stakeholders expect projects to provide more measurable ecological benefits. Practitioners are digging deeper into the hydrologic, geologic, and biological sciences, focusing on site specific natural processes, and creating designs that are appropriate for the surrounding landscape and ecology. Current restoration practices include everything from rigorous methods of analyzing and measuring site hydrology, to improved in-stream structures and habitat features, to better management of riparian plants for reduced mortality.


*About the speaker:* **John Hutton** is Vice President of Mitigation Services for Wildlands Engineering and manages the Raleigh office. He has over twelve years of experience in in the assessment and restoration of streams and wetlands. He has a master's degree in Ecology from Old Dominion University. Wildlands Engineering specializes in stream and wetland restoration with a particular focus on innovative engineering for ecosystem renewal.

# It doesn't have to look constructed: River restoration in a time of increased popularity and limited budgets

**Nick Nelson**

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*Abstract*: River restoration is an expanding field in many regions of the country. An ever increasing number of agencies and organizations are taking an interest in restoration and the general public is becoming more accustomed to hearing about dam removals, improving fish passage, and restoring waterways. Funding, however, has not necessarily kept pace with the increased number of proposed restoration projects. In this period of funding shortfalls, cutbacks, and layoffs, resource managers are tasked with improving stream functionality and habitat with minimal resources. They must decide which projects can provide the most benefit per dollar spent. While the limited funding can produce design plansets and constructed projects, this does not necessarily mean that habitat has been improved significantly or 'natural' stream and floodplain functionality restored. Dams can be removed without providing improved habitat. Stream stabilization and habitat structures can be built that may do more long-term harm than good. Many completed projects look engineered and constructed, rather than blending into the landscape. If designed and constructed properly, however, the functionality of rivers and floodplains can be restored and provide improved aquatic and riparian habitat without appearing to be man-made. This presentation discusses the challenges of river restoration with limited budgets and the importance of properly designed in-stream and out-of-channel geomorphic and habitat features.

*About the speaker*: **Nick Nelson** is a fluvial geomorphologist and manages Inter-Fluve's New England office located in Cambridge, MA. Nick is currently involved with all phases of more than a dozen river restoration and dam removal projects in New England and around the country. His work with Inter-Fluve has focused on dam removal and channel restoration/rehabilitation planning and design, geomorphic and habitat assessments, and GIS and hydraulic analyses. Nick has a B.S. degree in geology from Williams College and an M.S. degree in watershed sciences with a focus on fluvial geomorphology from Utah State University.

# One size fits all stream restoration?


## Vince Sortman

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*Abstract:* The North Carolina Ecological Enhancement Program (EEP) recognizes the great diversity of unstable stream channels and utilizes a vetting process to determine the most cost efficient level of restoration to obtain mitigation credits based on the severity of disturbance of the channel and site constraints.

Two recent stream projects are excellent examples of selecting the best restoration options for the stream. Both streams classified as Rosgen "C" channels and both have similar sized drainage areas, but Greenbrier Creek had been channelized for agricultural purposed while Glade Creek had been destabilized due to land use changes in the watershed.

The straightening of Greenbrier Creek had occurred nearly 100 years ago and now native mature trees were growing along its banks. The large trees constituted a strong site constraint that led EEP to select Enhancement of the creek rather than full restoration which would have included channel realignment and necessitated removing many of the mature trees. We utilized an innovative riffle weir structure to modify the channel profile (more pronounced riffles and deeper pools) and at the same time raise the channel invert to reconnect the stream to its floodplain. Raising the invert also meant less grading to modify the cross section which allowed us to save the mature trees.

Glade Creek's watershed has experienced several phases of silvaculture over the past 200 years. While Glade Creek flows through a narrow riparian forest, the age range of the trees did not constitute a strong constraint and the severity of the instability required full restoration. The channel realignment was designed to minimize large tree removal and those trees that could not be avoided were utilized in the restoration as rootwads and log vanes. The invert of Glade Creek was raised in two locations to minimize floodplain grading and thus tree removal.


*About the speaker:* **Vince Sortman** is a fluvial geomorphologist at Biohabitats. He has been designing and constructing stream restoration projects for over 25 years. He has an MS degree in geology from Colorado State University.

# Achieving “function” without “form” in urban streams

**Todd St. John, P.E., LEED AP**

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*Abstract:* Replacing stream function versus stream form is a topic of particular relevance for urban stream systems where functional degradations cannot always be addressed fully through the restoration of a stream’s dimension, pattern, and profile. For certain urban systems, the creation of a floodplain slough—a side channel that has an invert elevation between the stream invert elevation and the bankfull elevation—can be used to improve stream and riparian functions without wholesale relocation of the stream or reshaping of its banks. This technique can be particularly effective for some large, flashy, urban systems where the risks of providing such adjustments could potentially outweigh the benefits that would be achieved. Many large stream systems in North Carolina’s coastal plain and piedmont regions already have such slough systems in their flood plains. Some of these systems formed naturally, and some were created when the historic channel was abandoned by channelization practices. In any event, sloughs can provide flood storage, diverse habitat for certain species, and pollutant removal characteristics. One such slough system was created along Stoney Creek in Goldsboro, and another is proposed for South Buffalo Creek in Greensboro. This presentation will discuss and compare both projects.

*About the Speaker:* **Todd St. John** is a project manager/engineer with Kimley-Horn and Associates, Inc. in Raleigh, NC. For the past eight years, he has been responsible for designing stormwater, stream, wetland, and other natural systems as well as coordinating environmental permitting. Previously, he spent nine years with the NC Division of Water Quality creating the policies he still has to live by. 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 (making him a closet ecologist).

# Stream Restoration in Canada – the State of the Union (or perhaps confederation)


## Heather Amirault

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*Abstract*: In Canada, a complex regulatory environment has resulted in a much slower process of development for regulations and technical approaches to stream restoration. Each project can fall under the jurisdiction of multiple approval agencies including federal, provincial, and local authorities. These regulators set requirements for such things as water takings / diversions, an absolute restriction on working in the wet, and fisheries timing windows that severely restrict the construction season. The primary driving force behind stream restoration is the Federal Fisheries Act, which requires "no net loss" of fish habitat. This clause requires significant efforts at avoidance and minimization and then ultimately compensation. At present, regulators require that the compensation be located at the point of impact. This has resulted in a series of small projects with limited ecological improvement within the affected stream systems.

Recently, many regulatory authorities have begun to question the value of this fragmented approach and started looking for alternatives. With a much less severe economic downturn and development pressures mounting from more than 5 million people located in the Greater Toronto Area, regulators are considering mitigation banking or in-lieu fee programs. To date, pilot programs for wetland impacts have been established but there is nothing on the horizon for streams. Lessons learned from similar programs in the US may prove beneficial to advancing Canadian regulations.


*About the speaker*: **Heather Amirault** is a stream restoration engineer with Stantec Consulting Ltd. located in southern Ontario. She is working on projects throughout the US and Canada developing skills and experience that can be applied as the market for stream restoration develops in Canada.

# Regenerative stormwater conveyance-update on performance


## Kevin Nunnery

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*Abstract*: The degrading effects of urban stormwater runoff on water quality, stream channel geometry, aquatic ecology and riparian habitat form and function are widely recognized. Regenerative stormwater conveyance (RSC) systems were developed in the Chesapeake Bay region to address negative aspects of stormwater runoff. Where feasible, RSC's generally consist of open-channel, sand seepage filtering systems that utilize a series of shallow aquatic pools, riffle weir grade controls, underlying carbon-rich sand substrate and native vegetation to treat and safely detain and convey storm flow, and convert stormwater to groundwater through infiltration. Research is currently being conducted on RSC function in Maryland and North Carolina. Monitoring work conducted by the University of Maryland demonstrates storm water quantity benefits (e.g., reduction in peak discharge and increased Time of Concentration), as well as water quality benefits (e.g., reduction of Total Suspended Sediments and Total Nitrogen). In July 2012 North Carolina State University (NCSU) began conducting hydrologic research on a local RSC, investigating the water balance for the system. Additionally, NCSU conducted an ecosystem assessment on a chronosequence of sites in both NC and MD, which is suggestive of several additional ecosystem benefits that RSC systems offer as compared to conventional stormwater systems. Guidance for treatment of stormwater with RSC's has been issued by the State of Maryland in a July 2011 Draft document titled "*Accounting for Stormwater Wasteload Allocations and Impervious Acres Treated: Guidance for NPDES Stormwater Permits*" where this approach was adopted as a best management practice with TSS, TP, and TN removal efficiencies of 90%, 60%, and 50%, respectively.


*About the Speakers:* **Kevin Nunnery** has been a Senior Ecologist at Biohabitats, Inc. for over 7 years, working on a variety of stream and stormwater projects. Biohabitats has been active in stormwater best management practice design and implementation for over 25 years and in stream restoration design and construction for over 23 years.

**Adrienne Cizek** is a PhD student in the Biological and Agricultural Engineering Department at North Carolina State University under the guidance of Bill Hunt. Her research focuses on the function and ecosystem services provided by RSC, particularly in North Carolina. Ms. Cizek received her B.S. from the University of Wisconsin – Madison and her M.S.E.E. from UNC at Chapel Hill.

# Reacting to unexpected groundwater influence and reaping the benefits: Innovative field engineering on a pocket wetland

**Jill Davenport, P.E.**

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*Co-authors*: Jarrod Karl, Monica Kruckow, Charlotte-Mecklenburg Storm Water Services

*Abstract:* As part of the Edwards Branch Watershed Improvement mitigation project for Charlotte-Mecklenburg Storm Water Services in Charlotte, North Carolina, a pocket wetland headwater BMP was constructed in 2011 upstream of a preservation stream and wetlands on Evergreen Tributary. The project goal was to attenuate flow and provide pretreatment before the flow entered the preservation stream and wetlands. This presentation highlights the innovative field designs during construction to address unexpected complications with groundwater influx using a "burrito-wrap" French drain under a replacement culvert and coir fiber plant beds installed on top of unexpected newly exposed wetland soils. Results of the pocket wetland completion included enhanced hydration of the preservation wetlands through the ground and surface water reconnection and greater success than anticipated with the vegetation due to the groundwater-influenced and stable normal pool, constructed plant beds, and volunteer wetland species.

*About the Speaker:* **Jill Davenport** is a Water Resources Engineer in the Charlotte Office of CH2MHILL. Jill is a design manager specializing in stream restoration and best management practice site evaluation, concepts, design, construction, and monitoring. During her 10 years at CH2M HILL, Jill has been involved in over 20 stream restoration, enhancement, and bank stabilization projects, focused in the eastern United States. She has a B.S. degree in Biological Engineering from North Carolina State University.

# Stream Restoration as a Tool for Storm Water Managers
## A Case Study: McDowell Creek Watershed Management Plan and Restoration Efforts—Over a Decade of Data

**Will Wilhelm, P.E., CFM, CPESC**

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*Abstract*: Stream restoration has been used across the southeastern U.S. to address a wide variety of problems. Historically in the region, mitigation was the impetus for many of the implemented projects. Yet recent research and policy have recognized the benefits of stream restoration not only for ecological habitat improvements, but also for pollutant loading reduction. As a result, stream restoration is becoming a popular tool among municipal storm water managers. Managers are finding that stream restoration can be used as a cost-effective BMP retrofit for NPDES MS4 permit compliance, TMDL requirements, and water quality criteria in addition to satisfying mitigation needs.

This presentation will summarize recent policy and published data relative to NPDES MS4, TMDLs, and water quality criteria. It also will cite a decade of data in the McDowell Creek Watershed in Mecklenburg County, North Carolina, as a case study regarding the effectiveness of stream restoration as a BMP. This presentation will help storm water managers and practitioners have a better context for the potential pollutant loading reductions possible in a large watershed with focused implementation of stream restoration projects on a reach scale.

*About the Speaker*: **Will Wilhelm** is a water resource professional who manages numerous watershed projects involving best management practices for water quality and quantity and natural channel designs. Mr. Wilhelm is one of the driving forces behind Kimley-Horn's watershed restoration and natural systems practices. He 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. Mr. Wilhelm is register professional engineer in North Carolina and Tennessee, a certified floodplain manager, and certified professional in erosion and sediment control. Mr. Wilhelm holds bachelors of sciences in civil engineering and environmental engineering from North Carolina State University.

# High Pollutant Removal Efficacy of a Large Constructed Wetland Leads to Receiving Stream Improvements

**Michael A. Mallin, Ph.D.**

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*Co-Authors*: Janie A. McAuliffe and Matthew R. McIver, UNC Wilmington
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*Abstract:* Hewletts Creek, in Wilmington, North Carolina, USA drains a large (7,436 acre) suburban watershed and as such is impacted by high fecal bacteria loads and periodic algal blooms from nutrient loading. During 2007 a 7.6 acre wetland was constructed to treat stormwater runoff from a 589 acre watershed within the Hewletts Creek drainage. A rain event sampling program was carried out in 2009-2010 to evaluate the efficacy of the wetland in reducing pollutant loads (fecal bacteria, nutrients, suspended solids and metals) from the stormwater runoff passing through the wetland. During the eight storms sampled, the wetland served to greatly moderate the hydrograph, retaining and/or removing 50-75% of the inflowing stormwater volume within the wetland. High removal rates of fecal coliform bacteria were achieved (based on "first flush"), with an average load reduction of 99% and overall concentration reduction of > 90%. Particularly high (>90%) load reductions of ammonium and orthophosphate loads also occurred, and lesser but still substantial reductions of total phosphorus (89%) and TSS loads (88%) were achieved. Removal of nitrate was seasonally dependent, with lower removal occurring in cold weather and high percentage (90%+) nitrate load removal occurring in the growing season when water temperatures exceeded 15$^{o}$C. Long-term before-and-after sampling in downstream Hewletts Creek proper showed that, following wetland construction, statistically-significant average decreases of 43% for nitrate, 72% for ammonium and 59% for fecal coliform bacteria were realized. Since the principal source of impairment in Hewletts Creek is fecal bacteria contamination, and a secondary source is algal blooms (limited by nitrogen in this system), this constructed wetland appears to be very successful in reducing both concentrations and loads of polluting substances to the receiving waters.

*About the Speaker*: **Michael A. Mallin** is Research Professor at the UNC Wilmington Center for Marine Science, where he is the science coordinator for the Lower Cape Fear River Program and the Wilmington Watersheds Program. He teaches graduate courses in River Ecology and Estuarine Biology. His research interests include impacts of land use on freshwater, estuarine, and marine water quality, pollutant mitigation, tidal creek ecology, blackwater stream studies and effects of major storms on the environment. He holds a B.S. in Botany from Ohio University, an M.S. in Limnology from the University of Florida, and a Ph.D. in Marine and Estuarine Ecology from the University of North Carolina Chapel Hill. He is a Fellow of the American Association for the Advancement of Science, an Aldo Leopold Environmental Leadership Fellow, and has served as President of the Southeastern Estuarine Research Society.

# Anaerobic ammonium oxidation and denitrification in a constructed stormwater wetland

**Bongkeun Song, Ph.D.**

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*Abstract*: Agricultural runoff and precipitation have contributed to increased nitrogen loading in freshwater ecosystems. Stormwater wetlands have been constructed and used to diminish excess nitrogen loading in rivers and estuaries. However, the microbial processes, denitrification and anaerobic ammonium oxidation (anammox), involved in N removal have not been fully examined in constructed wetlands. In order to assess the efficiency and factors influencing microbial nitrogen removal in stormwater wetlands, molecular and stable isotope analyses of anammox and denitrifying communities were conducted with the sediment samples collected from the JEL Wade wetland in Wilmington, NC. Water quality parameters were monitored with surface water samples, while the abundance and activity of anammox and denitrifying communities were measured using quantitative PCR and $^{15}N$ tracer incubation experiments, respectively. Anammox and denitrifying communities in bare and rhizospheric sediments were compared with the samples collected in the summer and fall of 2011. Denitrification was found to be the dominant N removal pathway, contributing up to 71% of the $N_2$ production in the bare sediments and 78% in the rhizosphere. The activity and abundance of both anammox and denitrification were found to be higher in the rhizosphere compared to the bare sediment. Denitrification and anammox activities were much higher in the summer than in the fall. These results indicate wetland plants play a significant role in enhancing sedimentary N removal processes. Further, this study has elucidated a significant seasonal aspect to optimal N removal in constructed wetlands, potentially due to temperature changes, dissolved oxygen differences, plant senescence and decomposition.

*About the Speaker*: **Bongkeun Song** is an Associate Professor in the Department of Biology and Marine Biology Center for Marine Sciences, University of North Carolina Wilmington.
EDUCATION: 2000 - 2004 Postdoctoral Training, Molecular Microbial Ecology, Princeton University, New Jersey. 2000 Ph.D., Environmental Science, Rutgers the State University of New Jersey, New Brunswick, New Jersey. 1997 M. S., Environmental Science, Rutgers the State University of New Jersey, New Brunswick, New Jersey. 1994 B. S., Agriculture Biology, Dongguk University, Seoul, Korea. PROFESSIONAL EXPERIENCE: 2010 – Present Associate Professor, Department of Biology and Marine Biology, University of North Carolina Wilmington. 2004 - 2010 Assistant Professor, Department of Biology and Marine Biology, University of North Carolina Wilmington. 2000 - 2004 Research Associate, Department of Geosciences, Princeton University. 1996 - 2000 Graduate Research Assistant, Department of Environmental Science, Rutgers the State University of New Jersey, New Brunswick, New Jersey.

# Designing freshwater mussel habitat following dam removal: Two case studies


## Scott D. Peyton

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*Abstract*: Dam removal projects have become an increasingly popular way to restore riverine ecosystems and their functions. Many dam removal projects focus on fish passage and water quality, geomorphic, and recreational benefits as project goals. This presentation will focus on benefits to freshwater mussel communities as they pertain to dam removal and river restoration projects. Strayer (2008) discusses several habitat requirements for mussels, but the study of designing suitable habitats is still in its infancy. The authors will discuss some known mussel habitat design considerations including channel hydraulics and dimensions, structure types, and construction sequencing and timing. The authors will demonstrate the application of natural channel design for mussel benefit and also show 1D and 2D hydraulic modeling results of two dam removal projects. Potential fish host habitat design considerations will also be discussed.


*About the Speaker:* **Mr. Peyton** is a project manager and water resources engineer who specializes in ecosystem restoration projects. He has worked on over 40 miles of stream assessment and restoration and a dozen dam removal projects in the past 10 years. He has extensive experience in all phases of restoration projects including project funding, conceptual level planning, preliminary and final design, permitting, assistance during construction, and post construction monitoring. Mr. Peyton also has experience in hydrologic and hydraulic modeling, performing floodplain analysis and delineation, water quality studies, and a variety of storm water and water resources projects including watershed management and planning.

# Restoration of a Southern Appalachian Bog: Restoring habitat for a critically endangered plant in North Carolina

**Megan Mailloux and Christopher Engle, P.E.**

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*Abstract*: Wolf Creek Engineering provided site analysis, design, plan preparation, and construction oversight for the restoration of Ochlawaha Bog, which included 1092 LF of stream and 6 acres of wetland restoration in Henderson County, NC. Project partners included the NC Plant Conservation Program, U.S. Fish and Wildlife Service, Natural Resources Conservation Service, EPA, Clean Water Management Trust Fund, Western North Carolina Alliance, NC DENR, and the Carolina Mountain Land Conservancy. Southern Appalachian mountain bog habitats are extremely rare, and most in the region have been degraded by agricultural practices and development. This project restored a swamp forest bog complex which is aiding in the recovery of bunched arrowhead (*Sagittaria fasciculata*), a critically endangered plant known from only two counties. Prior to restoration, the site consisted of a degraded swamp forest bog complex and adjacent agricultural field. The hydrology at the site was substantially impacted by a channelized stream and ditch, which emptied into Mud Creek, an incised stream. The design approach included the utilization innovative techniques to raise the streambed profile and reconnect hydrology to support the degraded wetland habitat. This restoration project is providing a showcase example of successful mountain bog restoration to agencies, conservation groups, and universities, and will help guide restoration and protection efforts of similar habitats in the future.

*About the Speakers:* **Megan Mailloux** is a Project Designer at Wolf Creek Engineering, PLLC. She served as the project manager for the Ochlawaha Bog Restoration Project for Carolina Mountain Land Conservancy. Ms. Mailloux has a Master's degree in Landscape Architecture from the University of Georgia and has had several years of experience working in environmental conservation and restoration.

**Christopher Engle, P.E.** is a Project Engineer at Wolf Creek Engineering, PLLC and he served as the lead designer for the Ochlawaha Bog Restoration Project. Mr. Engle is graduate of North Carolina State University where he focused on geotechnical engineering and has worked with Wolf Creek for over six years.

# Effects of Streambank Stabilization on Aquatic Biodiversity in Oklahoma's Illinois River Watershed


## Gina Crowder Levesque

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*Abstract*: The Illinois is designated an Oklahoma Scenic River and enjoyed by many for recreational purposes. It originates in Northwest Arkansas and runs along the Eastern edge of Oklahoma to Lake Tenkiller. Due to water quality impairments, including sedimentation, it is ranked as a high priority watershed. With the predominant soil type being Clarksville stony silt loam, which is categorized as highly erodible land, many areas suffer from significant bank erosion. As sediment increases water turbidity, quality habitat and biodiversity decline. Money available for streambank restoration work is inversely proportional to the great need. Although programs such as the Conservation Reserve Enhancement Program and 319 are available to landowners in the watershed, they are best used as insurance against erosion of a healthy streambanks, not a fix to those currently sloughing away. Funding became available to the Oklahoma Conservation Commission for streambank stabilization in this watershed and work was finished in 2012. Twelve sites were selected based on several variables. Prior to construction activities, habitat and fish surveys were completed on each site. (Historical data was even available for a few sites dating back five years.) One aspect that will be taken into account when evaluating the success of this restoration work will be any detectable change in aquatic biodiversity both in numbers and species composition. This presentation will discuss historical and pre-construction community compositions, methods of wildlife habitat creation during construction, and expected outcomes.


*About the Speaker*: **Gina Levesque** is the Oklahoma Conservation Commission's (OCC) Coordinator for the Conservation Reserve Enhancement Program (CREP) in Oklahoma as well as OCC's Project Manager for the Illinois River Streambank Stabilization Project. She has a B.S. degree in Biology from Purdue University and a M.S. degree in Zoology from the University of Arkansas with an emphasis on conservation biology/restoration ecology.

# Threatened and Endangered Fish Species Responses to Raccoon Creek Stream Restoration

**Steven Glickauf**

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*Co-authors*: Kathleen Owens, The Nature Conservancy; Anita Goetz, U.S. Fish and Wildlife Service; Brett Albanese, PhD, Georgia Department of Natural Resources, Nongame Conservation Section

*Abstract*: Raccoon Creek is one of The Nature Conservancy's (TNC) high priority watersheds in the greater Etowah River Basin because it is the only known habitat for the federally endangered Etowah darter downstream of Lake Allatoona and supports one of the largest populations of the federally threatened Cherokee darter in the species' genetically-distinct lower evolutionary species unit. The Raccoon Creek stream restoration project consists of improving aquatic habitat for the Etowah and Cherokee Darters through the restoration, enhancement and stabilization of approximately 6,441 feet of channel. This portion of Raccoon Creek flows between two road crossings and under Georgia Power 500kV lines all of which have caused fish passage restrictions, riparian buffer damage and alteration, channelization, eroding streambanks, and a lack of large woody debris and other organic material. The long term goals of the project are to protect and enhance wildlife habitat, reduce streambank erosion and sedimentation, and improve stream stability through the use of natural channel design and bioengineering.

The first phase of the project, which was designed in 2010 and constructed in the winter of 2011, consisted construction of approximately 1,000 feet of Raccoon Creek and riparian buffer planting for approximately 3,100 feet of Raccoon Creek. The design approach created native fish habitat, reduced streambank erosion, and improved water quality and stream stability through the use of natural channel design techniques and bioengineering. Post restoration fish sampling of the reaches shows that the stream restoration had no negative effect on the existing populations of Etowah and Cherokee Darters. Post restoration sampling showed an increase in abundance in each of these species. Results of the sampling will be discussed during this presentation. The second phase is currently in design with construction slated for the winter of 2012/2013.

*About the Speaker*: **Steve Glickauf** presently serves as a Senior Project Manager for Corblu Ecology, LLC in Lawrenceville, Georgia. He specializes in stream restoration from endangered species habitat to mitigation banking development, permitting and management. He has a B.S degree in Natural Resources Ecosystem Assessment from NCSU and a M.S. degree in Forest Ecology from Southern Illinois University.

# Constructed Log Jams for Fisheries Habitat Improvement


## Micky Clemmons

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*Co-author*: Ms.Callie Moore, Hiwassee River Watershed Coalition



*Abstract*: During 2006, Baker Engineering was contracted by the Hiwassee River Watershed Coalition (HRWC) to conduct a stream restoration project along 5,200 LF of the Valley River near Marble in Cherokee County, North Carolina. This work consisted of repairing eroding banks where old log revetments were failing, connecting the river to the floodplain, protecting highly erodible areas by redirecting flow with vanes and improving fisheries habitat with woody debris and boulder placement. This reach of the Valley River is known to support the undescribed, endemic Sicklefin Redhorse sucker, as well as at least 33 other fish species. We were particularly interested in providing habitat improvements that would benefit the Sicklefin. The HRWC was interested in improving the available habitat from woody debris and requested that Baker plan improvements that could be construct during our project.

To meet this objective we planned and constructed three log jams that were built similarly to rootwad revetments. Trees with a diameter of 12-20 inches at breast height, 30-40 foot trunks and with attached rootwads were obtained on site. The location for the log jams was determined by the presence of existing deposited wood along the bank, to ensure that it was a depositional area were velocities would be minimal and the potential for washout minimized. A 15-20 foot length of the tree trunk was buried in the bank and anchored with shorter logs and boulders. The rootwad end was laid in the stream with 15-20 feet extending beyond the bank. Each tree was placed so that it intertwined with other shorter logs that were oriented with the flow, forming a mass of logs that were anchored in the bank, overlapping logs where pined with rebar and the upstream logs were weighted with boulders. The construction sequence will be described. After six years these log jams continue to provide habitat and observations by NCWRC biologists indicate that they have noted more and larger sunfish in the vicinity of these structures. However, so few Sicklefin Redhorse suckers are sampled throughout the entire reach that it is impossible to associated benefits for this species with these structures.


*About the Speaker*: **Micky Clemmons** is a Senior Environmental Scientist and Office Principal with Michael Baker Engineering in their Asheville Office. His responsibilities include office administration, marketing, stream restoration design and project management. Prior to joining Baker, Mr. Clemmons worked for 18 years with the North Carolina Wildlife Resources Commission (WRC) as a Fisheries Biologist and was the WRC's first Stream Restoration Coordinator. He has a B.S. degree in Marine Biology from UNC-Wilmington and an M.S. degree in Biology from Western Carolina University.

# Design Challenges & Intervention Design Approaches for Valleys Impacted by Legacy Sediments

**Drew A. Altland, P.E.**

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*Abstract*: Pervasive valley bottom damming for water power, upland soil erosion due to land-use changes, and floodplain sedimentation under extreme backwater conditions during the post-settlement era in the Eastern USA have led to widespread stream and floodplain impacts. Stream channel straightening and relocation were also widespread during this era. More recently, dam breaching, stream incision and widening, infrastructure building, stream piping, watershed urbanization, and sediment re-suspension have further altered in-stream and floodplain functions from the pre-settlement form. Given this history of impact, this presentation will illustrate common post-settlement valley bottom conditions routinely observed in Eastern USA watersheds and contrast these conditions with the pre-settlement valley form and function. The common post-settlement valley conditions will be explained using case studies to effectively describe the altered stream and floodplain conditions and associated restoration design challenges of each. The legacy sediment impact case studies will include the following: 1) a dam in-place, 2) dam breach conditions with partial channel incision into legacy sediments, 3) dam breach conditions with full channel incision exposing the pre-settlement floodplain soil layer, and 4) a stream relocated into its valley wall. The presentation will introduce intervention design approaches including the anticipated ecological and water quality benefits and long-term sustainability potential of each approach for valleys that have been impacted by legacy sediments.

*About the speaker*: **Drew Altland** is a Senior Consultant with Cardno ENTRIX and a professional engineer with 19 years of experience in the Eastern USA. He specializes in water resources engineering providing stream and wetland assessment and restoration design, watershed and floodplain studies, historic and modern valley impact investigations, hydrologic, hydraulic and sediment transport analysis, stormwater BMP design, environmental permitting, and construction management services. He has a B.S. degree in Civil Engineering with a water resources focus from the Pennsylvania State University and is a registered professional engineer in NC, MD, DE and PA.

# Latest Advances to the RIVERMorph Software


## J. George Athanasakes, P.E.

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*Abstract*: The RIVERMorph Stream Restoration software was developed to greatly simplify the assessment, design and monitoring of natural rivers. The software was originally developed 10 years ago and has had numerous updates over the years including the recent release of Version 5. RIVERMorph contains a number of tools to assist with the *WARSSS* (Watershed Assessment of River Stability and Sediment Supply) process including stream classification, development of dimensionless ratios, gage analyses, and Bank Erosion Hazard Index (BEHI), to name a few. RIVERMorph also contains a Natural Channel Design module and includes competency and capacity sediment transport calculations. Sediment transport capacity tools include the FLOWSED/POWERSED model developed by Dave Rosgen, which allow users to quickly download gage data, develop flow duration curves, develop sediment rating curves and calculate sediment transport capacity.

Version 5 of the software contains a number of new modules including a velocity/discharge module, a competency module, updated dimensionless ratios module including inner berm dimensionless ratios, as well as a new assessment module which contains all of Dave Rosgen's WARSSS assessment forms. A new tool has also been developed which allows the user to develop cross sections having the same hydraulic geometry of a reference cross section. These new modules allow for a more thorough geomorphic assessment and easy reporting of the collected data. In this presentation, a broad overview of the software will be given and the use of the new tools available within RIVERMorph will be demonstrated.


*About the speaker*: **George Athanasakes** has a broad range of experience in Ecological Restoration including the use of natural channel design, stream and wetland restoration, watershed master planning and dam removal. For over 20 years, George has served as Project Manager on numerous stream restoration projects throughout the United States. George also led the development of the RIVERMorph Stream Restoration Software and is responsible for software content, new releases and training. George serves as the Ecosystem Restoration Services Leader for Stantec and is responsible for leading Ecosystem Restoration for the firm throughout the United States. George holds Bachelor's of Science and Master's of Engineering Degrees from the University of Louisville. He is also a Registered Professional Engineer in several states.

# Building a conceptual model of Piedmont streams

**S. Kyle McKay and Bruce A. Pruitt**

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*Abstract*: Under rapid land use change, high demand on freshwater ecosystem services, and a growing appreciation for the value of functioning ecosystems, the Appalachian Piedmont has developed a multi-million dollar stream restoration industry. A comprehensive understanding of ecosystem structure, function, and process is necessary to effectively plan, design, monitor, and adaptively manage these projects. Furthermore, funding agencies must justify their restoration investments in terms of environmental benefits and ecosystem services provided by a single project as well as a suite of projects. To this end, this presentation proposes a Piedmont stream conceptual model mapping common system drivers and stressors to the ecosystem services they affect. This qualitative, descriptive model was developed primarily to assist practitioners in setting restoration objectives, identifying stream functions influencing those objectives, and linking anthropogenic impacts to functionality.

*About the Speaker*: **Mr. McKay** is a research civil engineer with the U.S. Army Engineer Research and Development Center (ERDC) Environmental Laboratory. Mr. McKay holds a B.S. in environmental engineering from Colorado State University and an M.S. from the University of Illinois Urbana-Champaign in civil engineering. He is currently pursuing a Ph.D. in the Odum School of Ecology at the University of Georgia, where his dissertation focuses on managing water for ecological objectives. Mr. McKay's research with the Corps focuses broadly on examining physical processes and ecological outcomes with specific applications to: quantifying the benefits of ecosystem restoration projects, environmental flow management, and vegetation-flow interaction.

# Re-evaluating Hydraulic Geometry


## Grant Ginn, PE

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*Abstract:* Hydraulic geometry relationships based on regional curves and local watershed curves are often used in the initial determination of the design channel dimensions. The four typical relationships developed are bankfull discharge, bankfull cross sectional area, mean depth and bankfull width plotted against watershed area with the bankfull cross sectional area curve being the relationship that is most often used for establishing the channel dimensions. Certain assumptions are inherently associated with using cross sectional area as the dominant factor for determining the design channel dimensions, some of which can adversely affect the hydraulic performance of the channel. Since the hydraulic geometry of a channel consists of more than just its cross sectional area it is worthwhile to consider each of a channel's dimensions and what role they play in stability, sediment transport and habitat of the stream. How do the width/depth ratio, bed width, mean depth, maximum depth, bank slope, toe slope, thalweg width, and inner berm affect how a stream performs under different flow conditions?

Developing the design dimensions of a channel often requires establishing a higher priority for some dimensions while allowing other dimensions to be adjusted in order to achieve the desired cross sectional area or width/depth ratio. The design process does not always clearly identify what the hierarchy should be for the channel dimensions or what the assumptions are for giving preference to certain dimensions. In order to better understand the implications of the design process this presentation will first map out the design dimension hierarchy that is commonly used in the natural channel design method, challenge some of the assumptions of this hierarchy and then propose an alternative way of looking at hydraulic geometry and how it can be incorporated into the design.


*About the Speaker:* **Grant Ginn**, PE is the founder and president of Wolf Creek Engineering located in Asheville, North Carolina which specializes in stream and wetland restoration. Grant has twenty-four years of experience in the morphologic, hydrologic and hydraulic design of streams and wetlands associated with restoration, mitigation, remediation and infrastructure projects.

# Can Over-Planting of Constructed Stream Banks Instigate Channel Incision?


## Zackary Mondry

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*Abstract*: The North Carolina Ecosystem Enhancement Program (EEP) has implemented stream restoration projects statewide for approximately ten years. These projects result in newly-constructed stream banks that are extensively matted and planted with woody species. Typically, live stakes are installed on sloping banks from the low-water surface elevation to the tops of banks. This practice does not replicate a common natural condition, i.e. dense woody vegetation does not usually persist on the entire bank face along stable streams in the Southeast. Annual post-construction stream monitoring of numerous projects describes sediment accretion on floodplains and banks such that both bank heights and bank angles are increased. As channels narrow and deepen we expect a corresponding increase in bed shear stress at geomorphically effective flows. Increased bed stress can in turn impact channel bed morphology and function by potentially de-stabilizing restored riffles and impacting engineered grade control structures.

SWe hypothesize that densely vegetated stream banks can result in sediment trapping that significantly alters at-a-station hydraulic geometry. We also expect the changes in cross section to be correlated with channel bed adjustments. We examine data from project designs, as-built surveys, and corresponding post-construction monitoring that illustrate dense planting of project banks (and even point bars) with subsequent sediment accretion. We then attempt to link channel narrowing and deepening to impacted bed morphology with case examples.


*About the Speaker*: **Zack Mondry** is a professional hydrologist and a geomorphology and surface water specialist for the NC Ecosystem Enhancement Program. He manages stream and vegetation success monitoring on restoration projects across the state, and provides technical assistance on watershed assessment, site selection, and design review. He previously worked as a hydrologist for the US Forest Service in Arizona and California and received a B.S. in Geology from Oregon State University and an M.S. in Geology from Humboldt State University. In his spare time he enjoys keeping his nine month old son from destroying the upright bass, mandolin, and guitar at home.

# Support for Family Level Benthic Macroinvertebrates for Rapid Bioassement

**Jon Calabria, Ph.D., RLA**

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*Abstract*: Bioassesment techniques characterize water quality by examining benthic macroinvertebrates found in surface water systems. Several methods may reliably predict water quality. Some of these methods classify stream health based on identification to either family or species level. While family level identification is more quickly obtained and offers a coarse prediction of water quality, species level identification takes more time and additional effort to determine water quality. This study examines correlations between family and species level identification when predicting water quality in the mountains of North Carolina. This information is useful for prioritizing enhancement and restoration efforts.

*About the Speaker:* **Jon Calabria** is a landscape architect and Assistant Professor in the College of Environment and Design at the University of Georgia. Dr. Calabria teaches undergraduate and graduate students about Green Infrastructure, ecological restoration, professional practice and construction techniques. He has landscape architecture degrees from UGA and Clemson and a PhD in Wildlife and Fisheries Biology from Clemson.

# Monitoring Effects of Watershed Improvement Projects on Macroinvertebrate Communities and Total Suspended Sediments in Gwinnett County, GA


## Kevin Middlebrooks

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*Co-author(s):* Pete Wright, Gwinnett County Department of Water Resources



*Abstract:* As part of Gwinnett County's Watershed Improvement Program, the County has been implementing a combination of stream restoration and stormwater best management practices with the goal to reduce total suspended sediments and improve aquatic habitat in the affected areas. To date, nearly 36 projects restoring approximately 4 miles of stream have been implemented.

As Gwinnett County continues its implementation of a Watershed Improvement Program, the need to continually improve restoration methods and achieve greater success related to reduced sedimentation and improved aquatic habitat has been established as a goal. To achieve this goal, the County has instituted standard monitoring procedures to determine the overall effectiveness and success of the watershed improvement projects, as well as potential maintenance issues. Monitoring efforts were designed to determine the improvements in vegetation, stream stability and geomorphology, sedimentation reduction, peak flow reduction, aquatic biological communities, and community acceptance of the project.

Gwinnett County tracks changes in watershed conditions through a long-term monitoring program as well as site specific monitoring data at implementation sites. As a part of the long-term monitoring, 33 monitoring stations are located throughout the County. Monitoring stations are representative of various land uses, restoration projects, and impaired stream segments and evaluated for trend analysis to identify localized and more widespread watershed successes and areas for improvement. Based on monitoring results, projects appear to sustain an improved overall condition with reduced sedimentation and improved aquatic biological communities. Monitoring results from 2 stream restoration case studies and county-wide monitoring stations will be presented and related to the County's specific techniques and approaches to watershed improvement.


*About the speaker:* **Kevin Middlebrooks** is a biologist at CH2M HILL with over 7 years of experience in natural resource consulting focusing primarily on stream restoration, mitigation banking, and Clean Water Act section 404 and 401 permitting. Middlebrooks has designed and constructed over 10 miles of stream in the Piedmont Southeast in both urban and rural environments. Middlebrooks graduated from the University of Georgia with a dual major in Wildlife Biology and Forest Environmental Resources. During his final years at UGA, Kevin served as an intern with the USFWS, Ecological Services Division where he gained his first stream assessment experience working on the Etowah Habitat Conservation Plan.

# A Day in the Life of the River


## Ben Leatherland, PWD, PWS, CPESC

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*Abstract*: This presentation will discuss observations along 240 miles of the James River as it flows through the heart of Virginia. This river drains approximately 25% of the entire state, and has been an integral part of Virginia history, from its earliest use by Native Americans, through the batteau era, to canal boats, and later railroads. The project involves river observations and water quality collections approximately every three miles along the 240 mile length of the river in two days (80 samples). The purpose of this research is to help quantify changes in temperature, nitrate/nitrite/phosphate concentrations, pH, and total dissolved solids/salinity through the river in a short time period (essentially a 'snapshot' of the James River at baseflow). The goal will be a better understanding of background water chemistry along the river continuum (including impoundments, agricultural lands, and urbanized areas). It is anticipated that the collected data may be useful for comparison to annual stormwater sampling results from a wide variety of regulated dischargers. The James River itself is typically divided into three sections, based primarily on geographic position in the landscape. The Upper James River is scenic, mountainous, and largely undeveloped. The Middle James River passes through the agricultural heartland of central Virginia. The Lower James River is characterized by barge/shipping traffic through the Port of Richmond and the Chesapeake Bay. The river's extensive watershed and west-to-east alignment provides an ideal opportunity to assess water quality characteristics in these three very different landscapes along an Atlantic slope river in the eastern U.S.


*About the Speaker*: **Ben Leatherland** is a senior environmental scientist with Hurt and Proffitt Engineering in Lynchburg, Virginia. He has over 12 years experience playing outside in the water and mud (also known as natural resource management). He attended UNC Charlotte for his undergraduate and graduate work years ago, and now lives in the beautiful mountainous Roanoke River valley of western Virginia. He is currently registered as a Virginia Professional Wetland Delineator, a Virginia Combined Erosion and Sediment Control Administrator, a Professional Wetland Scientist, and a Certified Professional in Erosion and Sediment Control.

# Water quality monitoring data to demonstrate compliance with EPA 319 grant criteria for 1,700 feet of a G5 stream restoration in the headwaters of the McDowell watershed in Cornelius, NC

**Tim Schueler, PE**

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*Abstract:* A 1,700 linear foot stream restoration project was completed in 2010 near the town of Cornelius, North Carolina as part of a partnership between Mecklenburg County and the Town of Cornelius. This project is one of several projects completed or under design within the headwaters of the McDowell watershed (approximately 30 square miles total). The main goal of the *Upper McDowell Stream Restoration and Best Management Practice (BMP) Project* was to improve water quality via reduction of sediment input from eroding banks for this portion of the overall McDowell watershed (approximately 0.41square miles of urbanized drainage through a series of severely eroded G5 streams). Other goals included riparian and wetland habitat creation and stormwater management via installation of a bioretention facility. Project success or failure was to be established by comparison of pre and post project in-stream water quality parameters (e.g., turbidity), benthic assessment and Mecklenburg Habitat Assessment Protocol (MHAP) evaluations at five separate locations as well as an EPA Bank Assessment for Non-point source Consequences of Sediment (BANCS) evaluation. This presentation will discuss the project design decisions, construction management and pre/post-construction water quality monitoring results for this project. Water quality improvement was marked and the project improved benthic counts quickly (within the first year) without demonstrating the post-construction macrobenthic negative impact typically associated with stream restoration work. The project MHAP scores improved from an 'impaired/severely degraded' status to a 'partially supporting' status within a year of project completion.

*About the speaker:* **Tim Schueler** is an Associate at the Raleigh, NC office of Hazen and Sawyer where he provides project management, evaluation, design and construction supervision for stream restoration, utility crossing and stormwater projects. Mr. Schueler has a B.S. in Civil Engineering from Virginia Polytechnic and State University and has been working in his field for 24 years.

# Assessing Conductivity Sensor Performance: A Laboratory and Field Study

**Carmen Agouridis, Ph.D.**

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*Abstract*: Water quality characteristics fluctuate in response to changes in environmental factors such as precipitation, land use, time of day (diurnal), and season or climate. In order to adequately account for these variations in water quality, continuous water quality monitoring sensors are needed. Such high frequency in-situ monitoring is best suited for capturing cyclical trends associated with seasons or diurnal fluctuations as well as rapid changes associated with storm events. But which continuous monitoring sensor to select becomes an important question. Studies on soil moisture sensors have shown large variations in performance. Is this the case for water quality sensors, and in particular specific conductivity sensors? In the Appalachian region, specific conductivity ($EC_{25^oC}$) is of most interest because elevated conductivity levels have been linked to declines in EPT taxa. Because of this, the U.S. Environmental Protection Agency (USEPA) issued guidance stating that waters discharged from mine sites in this region should have $EC_{25^oC}$ levels less than 300-500 µS $cm^{-1}$. This guidance has implications not only for mining but also for stream restoration projects, which are conducted in the region especially if done for mitigation. Thus, being able to accurately determine the $EC_{25^oC}$ levels has significant implications, especially as $EC_{25^oC}$ levels approach this designated threshold. As such, four commercially available continuous recording conductivity sensors were compared in in the laboratory as well as in the field in stream reaches with low to high $EC_{25^oC}$ levels. Laboratory results showed that 1) sensor over- and under-estimation typically ranged from 10-150 µS $cm^{-1}$, and 2) at least one sensor within each sensor type performed quite differently than the others of the same type. Field results indicated that fouling, even within days, significantly interfered with performance at high conductivity levels. The mixed chemistry of high conductivity waters means that sensor ruggedness is a critical factor.

*About the speaker*: **Dr. Agouridis**, Assistant Professor of Biosystems and Agricultural Engineering, focuses on ecosystem restoration for streams impacted by mining, urban or agricultural activities; riparian zone management; and mined land reclamation. She also examines the use of green infrastructure to improve stormwater management and the use of geospatial analysis to identify headwater stream types and environmental impacts from grazing livestock.

# Rapid Barrier Assessment Methodology for Fish Habitat Connectivity in Watersheds of the Piedmont and Upper Coastal Plain Physiographic Province


## Chris Sheats

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*Abstract*: The Catena Group developed a rapid barrier assessment (RBA) methodology to identify barriers to fish migration in watersheds of the Piedmont and Upper Coastal Plain Physiographic Provinces in conjunction with a stream restoration project. When evaluating potential fish habitat connectivity, the first step is to identify target species (e.g. American Shad) and the life histories, habitat requirements, and swimming abilities. This information is essential to identify and evaluate the passage barriers. Each barrier is then assigned a level of severity based on a scoring algorithm, which is used to prioritize the barrier removal for future planning of the target watershed. Identifying barriers within a watershed is an important component for predicting the ecological uplift that can be expected from any restoration project.

This RBA methodology was employed in conjunction with American Rivers removal of the Steeles Mill Dam on Hitchcock Creek near Cordova, North Carolina, a project funded by the National Oceanic and Atmospheric Association. The Catena Group developed two assessment field sheets, one for stream barriers/dams and one for road crossings, to evaluate a portion of the Hitchcock Creek watershed. Twenty two stream road crossings and five stream barriers/dams were assessed, of which eight features were determined as "Not a Barrier". Fourteen additional stream road crossings were identified as bridges which were not barriers to fish movement. Feature assessment data, spatial determination, and feasibility considerations will be considered during the prioritization component of the RBA. This data will be provided to State, County, and local governments for consideration in future planning and development within the watershed in order to improve aquatic wildlife habitat connectivity.


*About the presenter*: **Chris Sheats** is an environmental biologist for The Catena Group. He has worked for The Catena Group for seven years and has over 12 years of environmental experience working in North Carolina and the southeastern United States. He has a B.S. in Botany from North Carolina State University.

# Innovative Planning to Construction in Urbanized Environment

## Paint Branch fish passage / Stream Restoration
## College Park, Maryland


## Ben Soleimani

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*Abstract:* The project consists of approximately 5,000 LF of restoration using the Natural Channel Design approach to create a channel dimension, pattern and profile appropriate for the current hydrologic regime. In-stream structures (cross-vanes, log-vanes, deflectors and J-hooks) were used to provide grade control, properly convey the water, and improve habitat. Additionally, an existing fish passage blockage at an exposed 48" sanitary sewer line was removed through raising the channel bed with a series of nested cross vanes. This removal connected over 6 miles of potential spawning habitat for "river" herring and allows migration for other anadromous and catadromous fish species.

Due to the large-grained channel bed material which quickly settles out of the water column, the channel construction was completed in the wet. Therefore, no in-stream flow diversions were proposed. This process was used with great success in a localized section within this reach during construction of a cross vane and J-hook vane to stabilize a pedestrian bridge. A technical presentation also was needed to obtain the sediment erosion control permit.


*About the Speaker*: **Ben Soleimani** has over 28 years of experience dealing with streams and stream crossings. He was a technical track manger with Maryland State Highway Administration and joined U.S. Army Corps of Engineer in 2002. His diverse educational background and work experience make him a very effective engineer, able to deal with complex stream restoration designs challenges, especially in highly urbanized setting. Ben attended Catholic University of America for both B.S. and M.S. and had six courses with Dave Rosgen.

# Large Woody Material: Science, Policy, And Best Management Practices For Florida Streams

**Anna Cathey Linhoss, Ph.D.**

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*Abstract*: Anthropogenic activities have altered streams and rivers throughout Florida. Silvicultural practices, deadhead logging, road and bridge maintenance, desnagging for navigation and flood control, and the clearing of riparian buffers for development have all impacted Florida's streams and rivers through the loss of woody material. Repercussions from these impacts include changes to sedimentation patterns and stream morphology, erosion of banks and bars, and the consequent loss of habitat structure and diversity. The loss of large woody material (LWM) presents far-reaching impacts on the hydrology, ecology, and water quality of southeastern coastal plain streams. Federal and state law regulating the removal and/or reintroduction of LWM remains murky. Current decision-making does not adequately account for LWM's importance to Florida streams. Moreover, in many cases, the law appears to treat the removal of LWM more favorably than it does its reintroduction. We conclude that use of Best Management Practices associated with current statutory exemptions and categorical permits, as well as stakeholder education, offers the greatest promise of reducing the adverse impacts that the historic loss of LWM has had on coastal plain streams in Florida. Specific challenges include working with regionally appropriate techniques, balancing safety and accessibility with natural processes, and allowing for uncertainties.

*About the Speaker*: **Dr. Anna Cathey Linhoss** is a Postdoctoral Associate in the Biological and Agricultural Engineering Department at the University of Florida. She has her Ph.D. from the University of Florida and her M.S. from the University of Georgia, both in the field of in Biological and Agricultural Engineering. She has also worked as a consultant for Buck Engineering in North Carolina in the field of stream restoration.

**Incorporating Large Woody Debris into Urban Stream Restoration – A Case Study of the Design of the Northwest Branch of the Anacostia River**


## Scott Lowe and Dave Griffin

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Multiple challenges arise in restoring incised channels in urban watersheds. Design approaches are often oriented to grade a floodplain to a bankfull elevation, to raise the channel bed to allow floodplain inundation at more frequent flows, or to stabilize the channel in place with large stone structures. These strategies are often limited by prohibitive costs, result in impacts to adjacent resources or produce limited ecological benefits. Therefore an alternative restoration strategy was proposed by the Maryland State Highway Administration for an urban stream restoration project in the Washington DC suburbs. Construction was recently completed in Spring 2012. During the Preliminary Site Assessment it appeared that the accumulation of large woody debris (LWD) had a significant influence on channel dimension, plan and profile geometry.

Recent studies have indicated that LWD has a tremendous effect on channel processes and morphology and can serve as a principle in-channel roughness element (Abbe et al 2005). Therefore, the design strategy focused on evaluating the relationship between bed structure, channel shape and large woody debris influence. The addition of wood structures was predicted to have a significant effect on channel roughness and bed stability: increasing floodplain connectivity and improving/diversifying in-stream habitat. An inventory of existing LWD accumulations at the study and several reference sites was completed to establish a classification system which was subsequently used in the design development of in-stream structures. The implementation strategy focused on reducing erosion, stabilizing localized vertical degradation and increasing channel roughness through the addition of six types of LWD structures (based on natural analogs) designed using Engineered Log Jam (ELJ) methodologies. In the years following construction, observations of structure function and channel response is compared to predicted responses. Suggestions of improvements in the application of design and construction for future ELJ features in similar environments will be presented.

*About the Speakers:* **David Griffin** is currently serving as Regional Manager for McCormick Taylor in Charleston, SC. He has focused on geomorphology and the restoration of stream systems and has been conducting stream assessments and restoration design in the mid-Atlantic since 1987, including restoration efforts in MD, DE, PA, NJ, VA, and NC. Dave currently manages multiple open-end contracts for stream restoration, wetland mitigation design, natural resource assessment and permitting and is assisting on additional stream restoration projects in VA, PA, and DE.

**Scott Lowe** has experience in fluvial geomorphology, stream assessments, monitoring, sediment transport, fish passage assessment and design, bioengineering and bank stabilization design, stream restoration design, and construction management services. Scott has served as restoration designer or construction manager on over 120,000 linear feet of streams in the Mid-Atlantic and as project manager, designated specialist or principal designer on several large scale stream restoration projects including the Northwest Branch of the Anacostia River (site NW160/170), the PB-85 Stream Restoration Project, the SF220 Stream Mitigation Project and the Woodrow Wilson Bridge Fish Passage mitigation project.

# Oxbows: From surplus companion value to sustained individual value (Opportunity meets Necessity)

**Mike Adams, P.E.**

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*Abstract*: Working for the Tennessee Stream Mitigation Program, Stantec and Jen-Hill worked together on the Middle Fork Stream Restoration Project to expand the ecological footprint of a restoration project in Western Tennessee by incorporating a variety of oxbow ponds and ephemeral pools. The oxbows were designed and constructed in a manner that provided an array of ecological opportunities including variable depths, hydrologic regimes (ephemeral, intermittent and ephemeral), vegetation, woody debris and substrates. The project, located in Huron, TN., is primarily a Priority 1 design and included, among the oxbows, a 0.5 ac pond designed to intercept sub-surface drainage tiles installed sometime prior to 1985 to convert wetlands to farmable land. The balance of the oxbows were created using landform grading techniques because the combination of hydrology and sandy silty soils made it difficult, and in some areas almost impossible, to fill areas of the old channel and floodplain. The oxbows hold water and slow down storm water flowing down slopes adjacent to the stream, especially through sand and silt layers, that can cause erosion and slope instability. In other areas, oxbow swales, tied to a network of oxbow lakes, were created to accept storm water runoff from the slopes and maintain existing springs and seeps. The networks facilitate the controlled runoff of storm water and the woody debris creates natural check dam type structures. Excess root wads generated from in-stream structure construction were used to ecologically augment the oxbows. The depth was varied and where trees were present, they were incorporated in the design. The result is a functioning system of oxbows that support and enhance the natural channel design.

*About the Speaker:* **Mike Adams,** P.E., is a Senior Stream Restoration Designer with Stantec who has been working on stream restoration projects for over 11 years across the United States. Mr. Adams holds a degree in History from Vanderbilt University and Engineering degrees from the University of Kentucky. **Gary Moody** is a Sr. Scientist, Consultant, and stream contractor with Jen-Hill and WISE Hydrology in Hendersonville TN. Both have teamed on other stream projects including Kyles Ford TN. on the Clinch River.

# Efficiently Creating 3D Stream Designs with AutoCAD


## Michael Aust

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*Abstract:* With the increasing complexity of stream restoration and the greater need for accuracy in developing construction plans for contractors and reviewing agencies, Timmons Group has developed procedures that fully utilize Autodesk's Infrastructure Design Suite. These methods allow designers to efficiently create construction plans, thereby reducing time spent on drafting the plans and more time spent on the design itself.

With Autodesk's products, Timmons Group can create accurate 3D models that dynamically update with design changes. If needed, realistic renderings can also be created for clients and reviewing agencies to facilitate visualization of the design intent.

The Varina Stream Mitigation Bank project, located on 182 acres of farmland in Henrico County, Virginia, was utilized as a case study in these design approaches. The software allowed our design team to efficiently and accurately design over 10,000 linear feet of stream channel. Discussion of how the software products were utilized to implement the design will be discussed during the presentation.


*About the speaker:* **Michael Aust** is a Project Engineer at Timmons Group specializing in natural stream channel design and has a passion for design software.

# Utilizing Automation to Improve Design Efficiency and Plan Quality for Stream Restoration Projects

**Michael S. Marsala, P.E., C.F.M.**

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*Abstract*: The ultimate success of a stream restoration project, particularly in public bid projects, relies heavily on the level of detail in the design, the quality of the plan set, and the ability of a contractor to bring the intended design to fruition. Without an adequately detailed design or plan set, comprehension of the design by the contractor may be compromised and can result in the construction of an inferior product. The key is in the detail…detail in the design process, detail in the modeling process, and understandable detail in the construction drawings. But how do we get this level of detail in an efficient manner? The answer is automation. This presentation will focus on the need for design automation, utilizing StreamNCD as a case study – a proprietary software bundle (not commercially available at this time) which allows designers to achieve this desired level of detail with state of the art technology and groundbreaking efficiency.

In most industries, and particularly in these recent economic times, streamlining specific time consuming development tasks is clearly essential to improving efficiency. Engineering software is continually advanced to keep up with the need for more efficient processes as well as for reducing the potential for errors from manually performed operations. To date, stream restoration software is generally comprised of assessment tools, with extremely limited capability for aiding the engineer or designer in the development of a detailed design or set of construction drawings. For years, the lack of such detail in both design and construction plans has undoubtedly contributed to miscommunication in the field and, ultimately, to an inferior product that was not intended. Stream restoration professionals understand that better communication in the field is key to producing a better final product and that better communication begins with a more detailed design and a more accurate set of plans. Without sufficient stream restoration software, such detailed plans are extremely tedious to produce, if not economically infeasible. StreamNCD has been developed to address this issue.

StreamNCD is a stream restoration software package that runs inside the AutoDesk Civil 3D environment providing key automation tools for improving efficiency in the design process, allowing the development of a highly detailed design corridor, enabling efficient processing of extremely detailed 3D corridor data in HEC-RAS, and aiding in the development of essential construction plan components necessary for an improved level of comprehension by the contractor. The efficiency achieved by utilizing such automation allows the designer to focus more on the design or even on various design alternatives rather than spending valuable time on tedious manually preformed drafting and design tasks. Automation of the key design, modeling, and plan development processes reduces potential for errors. The final result of detailed construction drawings reduces ambiguity with contractors. In summary, StreamNCD can help improve efficiency, increase the quality of the plan set, improve the level of comprehension with

local reviewers, the contractors, and the public, and ultimately increase the likelihood of a successful stream restoration project.

*About the Speaker*: **Mr. Marsala** has a Bachelors of Science degree in civil engineering from the University of Maryland with a concentration in construction management. As a civil engineer, he has more than seventeen years of experience working as a design engineer and project manager on various land development, environmental, and water resources related projects. He is a Certified Floodplain Manager and a member of the Association of State Floodplain Managers and the American Society of Civil Engineers. Currently he is the Director of Floodplain Management and Dam Safety at Wetland Studies and Solutions, Inc. Since joining WSSI in March of 2004, he has worked primarily on stream assessment/stabilization/restoration, stormwater management, dam safety, and floodplain management projects. He has coordinated a team of civil and biological engineers, computer programmers and CAD specialists through the development of StreamNCD and has provided training and design support for the use of this program on 50,000+/- linear feet of restored streams.

# Urban stream restoration design utilizing a threshold channel approach

**William K. Barry, PE, D. WRE**

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*Abstract:* Stream restoration in urban areas is difficult due to many constraints including roads, buildings, flood regulations, utility infrastructure and multiple landowners. Efforts are underway to perform stream restoration within the Genetta Ditch watershed in Montgomery, Alabama. The watershed is comprised of moderate to high density residential areas, commercial areas, and parks, with some wooded areas in its downstream portions. Genetta Ditch is culverted for the upper half of its approximately four mile length. Downstream of this is an approximately 3,000 foot trapezoidal concrete channel that is parallel to, and within the right of way of, Interstate 65 with the balance of its length being an earthen channel that was straightened soon after World War II. The current design project addresses the naturalization of the trapezoidal concrete lined portion of the channel. The software *River2D* is being used to aid in the design of a threshold channel in an effort to enhance habitat as much as possible given the physical constraints present. The evaluation of design options and approaches will be discussed along with specific goals and challenges of the project.

*About the Speaker:* **William K. (Ken) Barry**, P.E., D. WRE is a Technical Principal for S&ME, Inc. During his nine years with S&ME, he has primarily worked on stream restoration, wetland mitigation, flood modeling, and erosion and sediment control projects. Prior to S&ME, Mr. Barry had 19 years of broad experience in civil engineering and construction including being the Project Engineer for the cleanup and restoration of 4 km of East Branch of Greenlaw Brook at the former Loring Air Force Base in Limestone, Maine. He is a graduate of Tennessee Technological University (BS Civil Engineering) and Clemson University (MS Environmental Systems Engineering).

# Use of GIS and WATER to Identify and Delineate Stream Types in Eastern Kentucky

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*Co-authors*: Carmen Agouridis, Tanja Williamson, Teri Dowdy, Richard Warner, and Chris Barton

*Abstract*: A Cumulative Hydrologic Impact Assessment (CHIA) is an analysis of the combined effects of one or more human activities (e.g. urbanization, silviculture, or mining) on the environment. While an activity may independently be insignificant, when combined with one or more additional sources, the cumulative impact can result in significant environmental degradation. Such information is needed to make informed decisions regarding project procession. To conduct these CHIAs, knowledge of the extent of ephemeral, intermittent and perennial streams within a large watershed (e.g. tens of thousands of acres) is required. However, field reconnaissance alone is not practical due to the large time and expense inputs such as effort would entail. Geographical information systems (GIS) in combination with the Water Availability Tool for Environmental Resources (WATER), which was developed by the U.S. Geological Survey offers a means of developing a standardized protocol for using detailed spatial information to remotely delineate stream types in the Appalachian region. GIS and WATER models were developed and validated using point-of-origin data collected in eastern Kentucky. It is anticipated that such a protocol would aide regulatory agencies and other stakeholders in assessing the likely effects of anthropogenic activities on the environment.

*About the Speaker*: **Jonathan Villines** is a Graduate Research Assistant in the department of Biosystems and Agricultural Engineering. He anticipates graduating with a M.S. in December 2012. He obtained his B.A. in Urban Studies from Brown University.

# GIS Based Asset Verification: Understanding Data Accuracy


## Colleen Kiley, GISP

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*Abstract*: Asset verification using GIS methods can be a tricky business. The GIS analyst must understand the accuracy of the GIS, CAD, or GPS data used, the regulations that govern the calculation of assets, how assets are measured or defined in the field, and inherent gaps in spatial data. Ideally, a GIS based asset verification will produce a record of assets that matches the initial field based assessment or survey. In reality, quality of spatial data can greatly influence the number of assets measured through GIS analysis.

The GIS analyst uses many sources of spatial data to compute mitigation assets. Each source has an accuracy, that when combined with other data layers, may decrease the overall accuracy of the results. While on the surface, this statement may seem like it throws GIS analysis into doubt; it is in fact, a strong reminder to mitigation professionals that our world is not black and white. GIS may not be able to measure the difference between a 49 foot wide buffer and a 51 foot wide buffer, and even field measurement may fall prey to the same accuracy problems depending on the method used to measure the distance. Understanding the accuracy of the most commonly used data, GIS methodology, field measurements, and our true ability to calculate credits may help guide us in determining the finalized credits produced by the site.


*About the Speaker*: **Colleen Kiley**, GISP is a GIS Analyst with over 15 years experience in GIS and Water Resource Management. She has degrees in Geology and Coastal Zone

# Revisiting Reference Reaches


## Kevin Tweedy, PE

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*Abstract*: A "reference reach" is a section of a natural stream that represents a stable, highly functioning system. Reference reaches are a fundamental tenant of most natural channel design (NCD) techniques. Quantitative data collected from reference reaches regarding channel dimension, pattern, profile, substrate and habitats are used to guide the development of restoration design criteria, with the expectation that the restored systems will then mimic the functions of the natural reference. There has been considerable discussion over the years regarding the appropriateness of using reference reach data for restoration design, and the limitations of such data. However, as constructed restoration projects have aged, there has been little use of reference reach data in evaluating restoration success, especially from the standpoint of channel stability.

Within the Wilmington District Corps of Engineers, the primary success criteria used to evaluate stream mitigation projects involve assessing the stability of the channel after 5 to 7 years of post-construction monitoring. Restored/enhanced streams are expected to be stable at the end of their monitoring period, with no areas of active erosion or channel degradation. As more and more stream mitigation sites have reached the end of their required monitoring in recent years, a common question has arisen: "how stable is stable enough?"

In this presentation, we will focus on documenting typical ranges of stability/instability on reference reaches that have been used previously for developing design criteria. Reference sites will be revisited to quantitatively measure areas of erosion and instability, in order to document the range of conditions that can be expected from natural reference systems. Average erosion rates (tons/year) will also be estimated using the Rosgen BEHI/Near Bank Stress method. This information should prove helpful to practitioners and regulatory agencies when assessing the performance of stream restoration/mitigation sites, by comparing the stability of the restored streams to the range of conditions documented from "stable" reference sites.


*About the Speaker*: **Mr. Tweedy** serves as a Senior Water Resources Engineer for the Cary, NC office of Baker Engineering, and also as Baker's Technical Service Manager for Ecosystem Restoration. He has worked for the past 13 years with environmental restoration projects that focus primarily on the design of stream and wetland systems, with emphasis on the restoration of site hydrology and habitat functions. In his current role, he assists Ecosystem Restoration staff in Baker offices with project delivery, business development, and staff development across the company. He has a MS in Biological and Agricultural Engineering from North Carolina State University and a BS in Agricultural Engineering from Virginia Tech.

# Lessons Learned: Erosion Monitoring in Gwinnett County, GA

**Andrea Althoff**

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*Abstract*: Gwinnett County is located approximately 30 miles northeast of Atlanta in the urbanized Piedmont region of northern Georgia. The County has experienced increased stream erosion and sedimentation problems, which may be attributed to rapid urbanization of the area.

Brown and Caldwell has conducted streambank erosion monitoring at 50 sites within Gwinnett County, GA since 2005. The 50 sites include tributaries of varying watershed size within the Chattahoochee River Basin. Monitoring began as part of the County's overall watershed improvement program which has a goal of developing and evaluating projects that will reduce sediment load within the watershed and with the streams, enhance the aquatic integrity of receiving streams, and be a community amenity for the County citizens.

Multiple methods have been used to calculated bank erosion, and two methods have been used during repeated years. First, bank pins have been inserted into the banks each year. The pins were measured for coverage or exposure. Laboratory analyses of soil samples collected at each monitoring station were used to calculate bulk density at each site. Second, bank profile measurements were taken in years 2011 and 2012 to measure actual gain and loss of the bank along the profile. During the last annual monitoring year in 2011, the annual rainfall was average, and the comparison between the bank pin and profile production rates were very similar.

The focus of this presentation will cover lessons learned during field work performance as well as recommendations on how to efficiently yet effectively collect bank erosion data. Throughout the past seven years of monitoring, methodology has changed and has been tailored to more accurately acquire the specific information that is desired for the study. In addition, thoughts on how rainfall and other watershed parameters affect results will be discussed.

*About the Speaker*: **Andrea Althoff** has been a Watershed Scientist with Brown and Caldwell since January 2012. She has 5 years of professional water resource experience, including wetland and streambank mitigation, field analysis of streams and watersheds, and water quality sampling. Her foundation is in geomorphology, hydrology, natural resource management, and GIS. Ms. Althoff previously worked for the USGS on the EPD statewide water sampling project and Foxwater, LLC where she worked on all aspects of streambank mitigation. She studied hydrology and fluvial geomorphology at the University of Georgia where she earned both bachelors and masters degrees.

# Five years of stream restoration monitoring data demonstrate successful conversion of rip rap lined trapezoidal channel to diverse stream and wetland habitat.

**Eileen K. Straughan**

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*Abstract*: The Western Tributary of Church Creek in Annapolis, Maryland was restored to a normal riffle pool sequence meandering channel with connection to floodplain wetlands. The project was performed as mitigation for unavoidable stream impacts associated with culvert crossings of headwater tributaries for the construction of extension of Admiral Cochrane Drive to Maryland Route 2 in Annapolis. The tributary had been disturbed previously by channelization, straightening and the placement of rip rap along its entire length. A natural channel design approach was implemented to restore a natural meander pattern and stream profile. Log cross vanes and j vanes were used as structure to form the pattern, and the design incorporated a flood plain bench at the elevation of the bank full discharge. Materials disposal costs were reduced by innovatively reusing the rip rap that formerly lined the channel. The rip rap was wrapped in filter fabric to form the supporting footer logs installed across the stream invert elevation to support the log vane structures. Five years of photographic, biological and geomorphic assessment data indicate that the habitat restoration achieved its design objectives. Water quality data indicate pollutant sources in contributing watershed pose challenges to future ecological lift in species diversity.

*About the Speaker:* **Eileen Straughan** is founder and president of Straughan Environmental, a Maryland-based firm providing sustainable environmental planning, analysis and design services. She is a multi-disciplinary environmental scientist with 30 years' experience in environmental permitting, guiding infrastructure projects to avoid and minimize impacts to resources, and designing restorative mitigation for unavoidable impacts. She has significant experience in stream restoration design and is expert in erosion control, avoidance and minimization of wetland impacts, stream diversions, natural channel design, and mitigation site monitoring plans.

# Using the "Kitchen-Sink" Approach for Restoration Monitoring in Red Hill Branch


## Elizabeth Franks

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*Abstract*: Howard County, Maryland, in cooperation with the Columbia Association, received grant monies through the Chesapeake and Atlantic Coastal Bays Trust Fund for restoration in the Little Patuxent Watershed. In 2009, the Red Hill Branch subwatershed was identified as a priority for restoration in the Upper Little Patuxent River Watershed Management Plan. The Trust Fund program requires evaluation of effectiveness of the implemented restoration projects, and tracking of progress toward meeting overall watershed restoration goals. Therefore, a monitoring program was initiated in 2009 for the Red Hill subwatershed. Between 2010-2012, a stormwater management facility retrofit and a stream restoration project were designed and constructed within the subwatershed. Pre- and post-restoration monitoring is intended to demonstrate the effectiveness of retrofits in reducing loading of primary pollutants and to evaluate success of restoration efforts at the subwatershed scale. Monitoring protocols were developed to evaluate existing conditions of channel geometry and sediment load, macroinvertebrate and fish colonization, and water quality conditions, and to detect changes over time owing to restoration activities. This presentation will focus on the multi-faceted stream monitoring being conducted, highlighting results of two years of pre- and one year of post-restoration monitoring. Geomorphic assessment techniques include annual surveys of permanently-monumented cross-sections, longitudinal profile surveys, particle size analyses, substrate facies mapping, bulk-bar sieve analyses, and assessment of bank pins and scour chains. Ecological assessment includes benthic macroinvertebrate and fish sampling and evaluation of physical habitat. Sediment transport is monitored through the use of siphon samplers and pit trap samplers. Finally, water quality is assessed through dry-weather (base-flow) and wet-weather (storm-flow) monitoring. By incorporating so many types of assessments into one monitoring effort, we hope to identify the most efficient suite of parameters to detect changes in stream and ecological condition that might be overlooked using fewer monitoring techniques.


*About the speaker*: **Elizabeth Franks** is an Environmental Analyst and Project Manager in Versar's Ecological Sciences and Applications office in Columbia, MD. She has more than thirteen years of experience performing field assessments and analyses of aquatic ecological data. Prior to joining Versar, Beth worked as a Coastal Ecologist in Richmond, VA for the Virginia Department of Conservation and Recreation through Virginia Commonwealth University for three years. She received a Master's Degree from Virginia Tech in 2001, and received her undergraduate degree in Biology from the University of Maryland at College Park in 1999.

# An Examination of No Net Loss and the Spatial Relationship Between Approved Impacts and Compensatory Mitigation for Streams, Riparian Buffers and Wetlands in North Carolina

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*Abstract*: This project examined the landscape-scale relocation of wetland, stream and buffer resources in North Carolina resulting from the 401 Certification and Riparian Buffer Protection regulatory programs from July 1, 2005 through June 30, 2010. Impact and compensatory mitigation values were calculated on an eight-digit hydrologic unit (known as cataloging units) basis to examine achievement of No Net Loss of aquatic resources. When taking overall regulatory success into account, wetland and buffer mitigation (the latter only in basins with riparian buffer rules) outpaced impacts statewide but individual cataloging units displayed a range of losses and gains. The overall regulatory success for streams suggested an overall, statewide net loss, likely due to lower mitigation ratios, regulatory mitigation thresholds, use of stream preservation and the lack of regulatory requirements by the state for mitigation of intermittent stream impacts during most of the study timeframe. Impact and mitigation locations were classified as urban versus rural based on NC Gap Analysis Project data. Relocation of aquatic resources (streams, wetlands and riparian buffers) from urban to rural locations was observed in most cataloging units. Project results may have policy implications as natural resource and regulatory agencies consider the ecological implications of the spatial shifting of aquatic resources due to permitting and mitigation of impacts to the state's wetlands, streams and riparian buffers.

*About the Speaker*: **Mr. Dorney** has been employed by Atkins Global since October 2011 after working with the Water Quality Section of the N.C. Division of Water Quality for about twenty nine years. At Atkins, he is responsible for administering a contract with the US EPA for Clean Water Act assistance as well as being involved in stream and wetland functional assessment. When Mr. Dorney started at the Division of Water Quality, he spent three years working on water quality standards. After that he was the supervisor of the Special Projects Group in Water Quality Planning for three additional years. From 1990 to 2004, Mr. Dorney was been responsible for the 401 Water Quality Certification Program and was supervisor of the Wetlands/401 Unit that is responsible for regulatory review of development projects to ensure compliance with the state's wetland and buffer regulations. From 2004 to 2011, Mr. Dorney was in charge of the Wetlands Program Development Unit which is responsible for developing and implementing new or modified wetland regulatory policies including developing policy for

cumulative and indirect impact as well as FERC permitting and watershed monitoring. Previously Mr. Dorney worked for environmental consulting firms in Wisconsin and Ontario, for local governments and a Native American tribe doing land use and recreational planning and at a research lab at NCSU.

Mr. Dorney has a B.S. degree in Biology, a M.S. degree in Botany and a M.S. degree in Civil Engineering. Mr. Dorney has prepared numerous government agency reports and has published scientific articles concerning wetlands and water quality. In addition he has been an expert witness for wetlands and water quality for several court cases. He has also done numerous presentations on water quality issues and wetland/buffer regulations for various groups.

# Comparison of biomass and survival of four native live stake species: black willow (*Salix nigra*), silky willow (*Salix sericea*), silky dogwood (*Cornus amomum*), and Virginia sweetspire (*Itea virginica*)

**Eve Brantley, Ph.D.**

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A comparison among live stakes of the native species black willow (*Salix nigra*), silky willow (*Salix sericea*), silky dogwood (*Cornus amomum*), and Virginia sweetspire (*Itea virginica*) was conducted to investigate the effect of soaking in water prior to installation, to evaluate biomass differences among species, and to observe differences in survival attributed to season of harvest. The experiment was conducted at Auburn University Paterson Horticulture Greenhouse complex in Auburn, Alabama in 2010 and 2011. All four species became established and survived when harvested in the dormant season. Silky dogwood had greater belowground biomass after nine months compared to the other species and silky dogwood, Virginia sweetspire, and silky willow had greater root / shoot ratios than black willow after nine months. Soaking in water for 48-hours prior to installation did not consistently result in significantly greater biomass or survival of live stakes harvested in the dormant season compared with stakes that were not soaked. This is likely due to the irrigation all live stakes received after installation highlighting the importance of insuring live stakes are not allowed to dry out before installation. Harvesting live stakes during the growing season is not recommended due to high mortality rates when compared with live stakes harvested in the dormant season. Results of this study suggest the use of silky dogwood, Virginia sweetspire, and silky willow as live stakes in stream enhancement and restoration projects are a viable alternative to increase riparian vegetation diversity.

*About the speaker*: **Eve Brantley** is an Assistant Professor with the Auburn University Department of Agronomy and Soils and the Alabama Cooperative Extension System Water Resource Specialist. She has worked on watershed management and education at several scales including a local watershed coordinator, coastal Extension agent, and regional leader of the USDA Southern Region Watershed Education and Restoration Team.

# The interactive effects of growing season flood duration and timing on bottomland hardwood tree species regeneration patterns

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*Abstract*: Most large rivers in the Southeast are regulated by dams that alter the frequency, duration, and timing of floods. Because bottomland hardwood tree species' distributions are determined primarily by their tolerance to flooding, river regulation can result in shifts in composition, structure, and diversity of vegetation on the floodplain in part by inhibiting or enhancing regeneration. Previous studies have linked the regeneration strategy of bottomland species to the duration and frequency of floods. However in a recent meta-analysis, Latzel et al (2011) noted only a few studies of a limited number of species that have assessed the effects of flood timing on regeneration. To investigate the spatial and temporal effect of flooding on bottomland hardwood regeneration, we biannually monitored seedlings of bottomland tree species across floodplain gradient on the lower Roanoke River in 118 permanent plots from 2007-2011. We characterized the flooding regime each year at each plot using well data and a hydrologic model. Overall there was an interaction between flood timing, duration, and regeneration patterns. Long duration floods late in the growing season were associated with reduced germination, recruitment, and survivorship. Early, long duration floods and late, short floods resulted in higher germination rates, but only later floods were followed by higher recruitment the next season. There were important difference between species, age class, and position along the floodplain gradient. These results illustrate the influence of flood timing and duration on regeneration patterns, knowledge critical for adaptive management of flows.

*About the Speaker:* **Jacqueline White** is a PhD candidate in the Curriculum for the Environment and Ecology at the University of North Carolina at Chapel Hill. She has worked in the field of Riparian Ecology for 10 years in both the Southwest and Southeast studying the effects of altered hydrology on riparian plant communities. Currently, she is assessing the impact of hydropeaking on bottomland hardwood tree seedling regeneration on the lower Roanoke River as a part of the Federal Energy Regulatory Commission's dam re-licensing process for Roanoke Rapid Dam. She earned her B.S. in Environmental Studies from the University of North Carolina at Asheville and her M.S. in Plant Biology from Arizona State University.

# Analysis of Planted Vegetation in Riparian Zones of Priority I and Priority II EEP Stream Restoration Projects: Comparison of Success and Growth Trends

**Melonie Allen**

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*Abstract:* Establishment of riparian zone vegetation is a key component of a successful stream restoration project. The 2003 USACE Stream Mitigation Guidelines (USACE SMG) established riparian zone vegetation success criteria based on stem densities; requiring a minimum of 320 planted stems/acre in year 3 and 260 stems/acre in year 5 post-construction. The 2011 Ecosystem Enhancement Program Monitoring Requirements and Performance Standards for Steam and Wetland Mitigation further refined vegetation success criteria through the introduction of performance standards for average height of planted stems in year 7 post-construction. Minimum average heights of 10 ft. for the Coastal Plain and Piedmont, and 8 ft. in the Mountain physiographic zone are currently required to meet vegetation success standards. Soil conditions such as texture, structure, and fertility are important factors which affect vegetation establishment. A design option often applied to constrained incised streams, Priority II stream restoration creates a floodplain by excavating bankfull benches along the new channel without elevating the stream bed to its historic location. The grading associated with the creation of the new floodplain on Priority II projects may result in riparian areas with disturbed lower fertility soils as compared to nutrient rich alluvial soils on natural undisturbed floodplains. Consequently, planted riparian vegetation on priority II stream restoration sites may exhibit lower vigor and higher mortality rates resulting is sites less likely to meet established vegetation success criteria. This analysis will quantify and compare average planted density, and characterize growth trends, on EEP priority I and Priority II stream restoration projects.

*About the Speaker:* **Melonie Allen** is a Science & Analysis staff member at the NC Ecosystem Enhancement Program (EEP). She has worked at EEP for nine years serving as a Project Manager for seven years prior to joining the Science & Analysis unit. She has B.S. degrees in Biology and Environmental Science from Salisbury University and University of Maryland Eastern Shore and a M.S degree in Natural Resource Management from North Carolina State University.

# Controlling *Microstegium vimineum* on Stream Restoration Sites: Experimental Field Trials with Aquatic-Use Herbicides

**Karen Hall, Ph.D.**

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*Abstract***:** Preemergence (PRE) and postemergence (POST) herbicides registered for aquatic use were evaluated for control of *Microstegium vimineum* on two separate stream and riparian restoration sites in the Piedmont and Upper Coastal Plain regions of North Carolina. Each restoration site was a Priority 1 stream restoration project that had become infested with the exotic plant post-construction. *M. vimineum* is an invasive, nonnative grass introduced from Asia that has now spread throughout riparian areas of the eastern United States. This study provides results from different herbicides applied PRE and POST at different rates within a field setting. Bispyribac, flumioxazin, fluridone, imazamox, imazapyr, and penoxsulam were applied at one or two different rates in both PRE and POST trials. Additionally, carfentrazone was applied to PRE trials and diquat and glyphosate were applied to POST trials. Data analyses show that full and half rates of flumioxazin, fluridone, imazamox, and imazapyr applied both PRE and POST provided significant control of *M.vimineum* both 6 weeks after treatment (WAT) and 30 WAT. Results from these field trials will allow practitioners to incorporate additional weed control methods in vegetation management plans involving riparian sites plagued with *M. vimineum*.

*About the Speaker*: **Karen Hall** is an Extension Associate at NCSU in the Biological and Agricultural Engineering Department. She received a B.S. degree in Biology from UNC-Chapel Hill, and M.S. and Ph.D. degrees in Forestry and Environmental Resources from NCSU. Dr. Hall has worked for Cooperative Extension since 2000 with expertise in riparian vegetation restoration and management.

# A Tool for Predicting Restoration Target Vegetation from Environmental Variables Using a Large Reference Dataset

**Michael T. Lee**

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*Co-author*: Robert K. Peet, University of North Carolina

*Abstract*: We extracted about 300 discrete vegetation types for riparian and wetland vegetation types in North and South Carolina, represented by 1,300 plots from the Carolina Vegetation Survey. We developed a software tool that summarizes the environmental variables from the plots for each type to create environmental summaries for each restoration target. Some of the environmental variables included were soil series, river basin, floodplain width, geomorphology, topographic position, hydrologic regime, latitude, longitude, elevation, slope, and aspect. The tool then compares environmental data from individual restoration sites to the target summaries and uses numerical analysis to select the most similar vegetation types for each site. Lastly, the tool creates a planting list for each restoration site, reporting the species found most commonly for the restoration target.

*About the Speaker*: **Michael Lee** is the database administrator and developer for the Carolina Vegetation Survey in the research group of Robert Peet at the University of North Carolina at Chapel Hill. He has developed and maintained a number of ecological databases and tools, including serving as the project manager for the online plots database VegBank (vegbank.org), the Carolina Vegetation Survey's database system, the NC Ecosystem Enhancement Program's (EEP) vegetation database, the species distribution database for the Herbarium at the University of North Carolina, and the National Park Service Cumberland-Piedmont Network (CUPN) long-term monitoring database. He has a B.S. in Biology from UNC-Chapel Hill.

# Newland By-Pass Channel and Downtown Floodplain Improvement Project Town of Newland, NC


## David Kiker

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*Abstract*: In September 2004, remnants of Tropical Storm Frances and Hurricane Ivan caused severe flooding in western North Carolina. One community that experienced some of the worst flooding was the Town of Newland. As many as thirty-five (35) businesses and six (6) residential structures experienced flooding. Additionally, numerous roads in the downtown area overtopped. As a result of the severe flooding experienced in this area, the State of North Carolina through Senate Bill 7 developed a planning level report which identified a series of projects intended to alleviate future flooding. One of these projects is the Newland By-Pass and Downtown Floodplain Improvement Project. The presentation will cover history of flooding in Newland along with the following items:

- Design of the by-pass channel constructed in Phase 1 of the project. The iterative approach to optimizing the flood reduction benefits of the by-pass channel will be discussed along with steps to design a stable channel.
- Design of the downtown floodplain improvements constructed in Phase 1 of the project. The steps taken to set the height and width of the floodplain benches will be covered along with the overall flood reduction benefits of the project.
- Design of the concrete and geogrid walls along with efforts to improve water quality, improve trout habitat and revitalize the downtown business area by connecting two of the Town's parks.
- How flood reduction and stream restoration can complement each other.
- Permitting and how it affected the final design of the project.


*About the Speaker*: **Mr. David Kiker** is Technical Manager in the Water Resources Department of the Raleigh office of WK Dickson. David has over 25 years of experience in water resources management with particular emphasis in computer simulations of watershed hydrology, channel hydraulics, and stream restoration. He has prepared stream restoration and stabilization designs in Virginia, North Carolina, and South Carolina on a variety of flood control and water quality projects including NCDOT roadway projects, stormwater BMPs, stream restoration, basin master plans, FEMA submittals and capital improvement projects. Designs have incorporated innovative measures to meet channel stability and habitat objectives along with water quality improvement goals and FEMA compliance. In addition, Mr. Kiker has extensive experience with securing permitting for Federal and State environmental agencies including NCDWQ, USACE and FEMA.

# Davie Park Stream Restoration

***Lift and Shift with a Twist***


## Dasa Crowell, PE & Eric Mularski, PWS

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*Abstract:* A stream mitigation project to offset Foxhole Landfill Expansion impacts was completed in fall 2010 on an Unnamed Tributary to Fourmile Creek located within the property of the Davie Park, in Mecklenburg County off of Highway 51 near Rea Road. The first year monitoring was completed in December 2011. This stream design utilized unique concepts to promote groundwater recharge and bring base flow back into the stream, while shifting and lifting the alignment, all the while preserving a heavily wooded area. Design concepts, construction methods and lessons learned from implementation, and monitoring results will be discussed during presentation.


The approximately 1,500/ long project reach was incised and degraded with severely oversized cross section, major headcuts, sink holes, undermining trees, and eroding soils. The stream was deeply incised without connection to its floodplain, which was progressively detrimental to the yet surviving wetlands in the basin headwaters.

The focus of the project was to restore the stream, create and preserve wetlands, prevent creation of gullies and sinkholes, conserve and enhance existing vegetative communities and habitat, improve aesthetics for park visitors while preserving a conservation easement according to the USACE requirements.

*About the Speakers:* **Dasa Crowell** is a registered professional engineer in NC and has been in consulting engineering for 14 years. Her focus is water resources, hydrology/hydraulic modeling. Her experience includes watershed planning, feasibility studies, CIP and stream restoration design and construction administration. She is Rosgen IV certified. She graduated from Slovak Technical University in Bratislava with MSCE and University of North Carolina in Charlotte with MSCE.

**Eric Mularski** is an environmental scientist and has been in consulting engineering for 9 years. His experience includes stream and wetland delineation, biological monitoring for stream and wetland mitigation projects, Section 404/401 permitting, and stream restoration design and construction administration. He is Rosgen II certified. He is a graduate of Eastern Washington University with BS in Biology.

# Case studies in urban stream restoration in Chapel Hill and Carrboro, North Carolina


## Zan Price, PE

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*Co-authors*: Greg Jennings, PhD, PE, Mike Shaffer PE, Jason Zink, PhD, PE, NCSU Stream Restoration Program



*Abstract:* The Town of Carrboro and Chapel Hill (Towns) recently received an EPA 319 grant to complete watershed restoration practices in the Bolin Creek watershed. The Towns contracted with the North Carolina State University (NCSU) Department of Biological and Agricultural Engineering to provide technical assistance and oversight for the projects.

One component of the grant was to complete two small stream restoration projects. The first project called Dry Gulch was located in a wooded residential area in Carrboro. The second project called Trinity Court was located between an apartment complex and public park in Chapel Hill. Both projects contained steep and eroding streambanks and experienced flashy hydrology due to the urban nature of the watershed. The goals of both projects were to reduce streambank erosion, improve floodplain connectivity, remove invasive vegetation, and enhance the riparian buffer by planting native riparian plants. Design and permitting occurred in 2011 and construction was completed in spring 2012.

The restoration approach for the Dry Gulch project was to relocate the stream away from a steep and eroding streambank and away from a sewer line. A series of boulder steps and j-hooks were installed to help reduce streambank erosion and to enhance riffle and pool habitats.

The approach for the Trinity Court site was to install multiple boulder steps to help raise the existing streambed elevation. This reach was a steep (8 – 10%) stormwater driven ephemeral channel. For the most incised portions of the channel, an engineered sandy media was used to raise the channel bed and support surface stormwater to shallow groundwater flow. Restoration techniques and lessons learned from both projects will be discussed during this presentation.


*About the Speaker:* **Zan Price** is an Extension Associate and member of the Stream Restoration Program in the Biological and Agricultural Engineering Department at NCSU. He is stationed in Asheville, NC and has worked for NCSU for over six years as an engineer specializing in stream restoration and stormwater management BMPs design and monitoring. Additionally, Mr. Price helps coordinate and teach River Course stream restoration workshops throughout the year. He has a B.A. degree in Psychology from UNC-Chapel Hill and an M.S. degree in Civil Engineering from North Carolina State University.

# Chadrick Creek Restoration: Day lighting a NC fisheries


## Darrell Westmoreland

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*Abstract*: Chadrick Creek stream restoration included day lighting of over 900 feet of trout stream near Devotion, NC. The project was designed by Wolf Creek Engineering, Clear Creek Consulting, and Wildlands Hydrology. Installation was completed during a Rosgen Level IV training class. Chadrick Creek is a tributary to the Mitchel River and in the past was critical for habit and spawning for native brook trout in the headwaters of the Mitchell River. During the 1960's a recreational public trout fishing pond was built at the end of Chadrick Creek and the stream was diverted into the pond and existing channel piped to allow more parking for the public. Innovative structures were installed to maximize the trout habitat and achieve excellent fisheries throughout the project reach. This presentation provides the contractor's perspective on implementation and discussion of field based decisions used to enhance the design.


*About the Speaker:* **Mr. Westmoreland** is a 1991 graduate of NC State University in Raleigh, with a degree in Agricultural and Biological Engineering, with an Environmental Concentration. He worked for NC-DENR, Land Quality Section of the Winston-Salem Regional office for 3 years. His responsibilities included inspection and review of erosion control plans, dam inspection and mine inspections. Seeing a vital need for education in the field of stream restoration and wetlands mitigation, he has completed the Rosgen Courses Level V with Dave Rosgen in Colorado. He has attended The Natural Rivers Mechanisms Morphology & Management Course by Dr. Richard Hey. Additionally, he has completed the Geomorphic Stream Assessment: Principals & Field Techniques by Rocky Powell of Clear Creek Consulting, and has worked with him one-on-one completing three stream restoration projects in NC. He has sixteen years of business experience and project management in the field of erosion control. Darrell has received recognition for his competency and timely completion of the many projects he has undertaken for state, federal and private organizations in the field of stream restoration. He has had years of experience in the installation of erosion control methods such as Type A, B, Sediment Basins, Sediment Traps, Rock Silt Check dams, Slope Drains, Silt Fencing Diversion Berms, Silt Ditches, Flock Log and Polymer Applications as well as the use of numerous types of matting and slope stabilization development. He is experienced in storm water management, energy dissipaters and storm drain systems. He has installed numerous bio-retention cells and provides consultation for the same. He has overseen the installation of over 517,000 linear feet of stream restoration and 477 acres of Wetlands mitigation and restoration. In day to day operations he is responsible for all field operations, stream restoration and wetlands mitigation, job estimating, equipment scheduling and maintenance, and management of all field personnel.

# Drops in the Bucket… Half Empty or Half Full?
# A Watershed Approach to Environmental Restoration on Little Sugar Creek


## David A. Woodie, PE, CPSWQ

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*Co-author:* Emily G. Reinicker, PE, CFM, Wildlands Engineering, Inc., Charlotte, NC



*Abstract:* For more than ten years, Mecklenburg County has worked to enhance or restore more than 22,000 linear feet in eight project segments along Little Sugar Creek. How did this process begin? What were the goals of each project? How has each of these drops in the bucket contributed to a holistic urban watershed restoration approach?

This presentation will summarize the early planning process for environmental restoration work in the Little Sugar Creek watershed. A brief overview of the funding, stakeholder partnerships, design focus, and outcomes will be provided for each of eight sites constructed between 2002 and 2012. The sites include:

- Hidden Valley Ecological Park
- Freedom Park Mitigation Project
- Westfield Environmental Restoration
- Midtown Reach of the Little Sugar Creek Greenway
- Kings Drive Reach of the Little Sugar Creek Greenway
- Elizabeth Reach of the Little Sugar Creek Greenway
- Cullman Avenue Water Quality Enhancement Program

A monitoring program is in place for the Little Sugar Creek watershed to continuously track project success. Early data indicate that among other improvements, significant increases in habitat value have been observed along Little Sugar Creek. These results are supported by the recent inhabitation of Little Sugar Creek by the Tessellated darter (*Etheostoma olmstedi*) and the Piedmont darter (*Percina crassa*), which have been absent since fish population studies began in the 1950's. The Piedmont darter is rated pollution intolerant by the NC Division of Water Quality, and so its presence in Little Sugar Creek is a great success for urban stream and watershed restoration (*Mecklenburg County State of the Environment Report*, 2010).


*About the Speakers:* **David Woodie** serves as the Storm Water Services Project Manager and Land Development Supervisor for the North Mecklenburg Towns under Mecklenburg County Government of Charlotte, NC. He has over 19 years of professional experience in both construction, survey, water resources, bridge/hydraulic design, BMP design, and both BMP and stream construction. Working through private sector, state and local government, David has constructed major highway projects, over 140 BMPs across the state of North Carolina as well as implemented over 10 miles of stream restoration in Mecklenburg County. David is a Professional Engineer and Certified Professional in Storm Water Quality.

**Emily Reinicker** currently serves as a water resources engineer for Wildlands Engineering's Charlotte, NC, office. She has 13 years of professional experience in water resources and civil engineering, including hydrologic and hydraulic modeling, natural channel design, watershed analysis and storm water management. She specializes in the design of stream restoration and enhancement work in urban and rural settings of NC. Emily holds a biosystems engineering degree from Clemson University and is a registered Professional Engineer and Certified Floodplain Manager in NC. Wildlands Engineering specializes in stream and wetland restoration with a particular focus on innovative engineering for ecosystem renewal.

# 1994-2012: A Historical Risk Perspective
## Who should accept the risk when significant design changes are made in the field to increase ecosystem benefit; the designer, the contractor, the owner, or the insurance company?

**Wes Newell**

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*Abstract:* Stream construction drawings have frequently been modified in the field during construction to increase ecosystem benefit, including changes to habitat, floodplain, pattern, dimension, and profile attributes. Most often, everyone on the project team runs in fear of the liability (and potential extra paper work) issues associated with these beneficial changes. Due to industry evolution, the frequency and scope of these beneficial changes has been steadily decreasing in North Carolina over the years.

Unlike highly structural construction projects such as buildings and highways, stream and floodplain projects are not best served by strict engineering and legal practices intended to protect human populations. However, this paradigm exists in stream restoration anyway, largely as a result of human nature. Since 1994, North Carolina has slowly continued to become more entrenched in the "stream = highway" paradigm, caused in part by a legal perception of liability in the industry. Potential causes of this trend will be presented including case studies involving the N.C. Department of Transportation (1994), N.C. Global TransPark (1998), Mitigation Banking Firms (2001), Nonprofit Environmental Organizations (2005), and the N.C. Ecosystem Enhancement Program (present day). As the industry has matured in North Carolina, risk and liability has slowly shifted from the owner, to the contractor, to the insurance company, and now to the designer, who is really running scared.

*About the Speaker:* **Wes Newell** worked with U.S.A.I.D. in Zaire, Africa from 1987-1990, focused upon aquaculture, wetland land use, and classification. In 1992, Mr. Newell earned a masters degree in Landscape Ecosystem Classification (LEC) at Clemson and began a career in stream and wetland mitigation. Mr. Newell continues to be involved in the design, construction, and monitoring of stream and wetland sites in the Southeast, including data collection on trends in the mitigation industry. Mr. Newell currently serves as president of Backwater Environmental, a design-build and construction firm that specializes in environmental restoration.

# Restoration Planting Success:
# An EEP Methodology to Evaluate Vegetation Warranties


## Jessica Kemp

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*Abstract*: Plant establishment and growth is a critical component to ecological restoration and mitigation. A majority of North Carolina Ecosystem Enhancement Program (EEP) projects are planted by a sub-contractor hired by the General Contractor. These contracts typically have a one-year 80% vegetation survival warranty that begins once construction is accepted as complete. Since 2009 a total of 30 sites have been assessed for warranty compliance using a standardized methodology. Approximately 75% of the sites did not meet warranty requirements. To date nearly 70,000 bare roots and 70 specimen trees have been replanted statewide as per contract warranty requirements. Vegetation assessment methodology, results and future planting strategies will be discussed.


*About the Speaker:* **Jessica Kemp** has overseen stream, wetland and buffer restoration projects for the NCDENR Ecosystem Enhancement Program since 2006. Prior to working in North Carolina, she worked on costal habitat restoration initiatives for 5 years in Florida. She holds a B.A. in Environmental Science from Stetson University and graduate work in Conservation Biology from KSU and Duke University Marine Laboratory.

# What level of risk are we prepared to accept for a stream restoration design?


## Brad Fairley

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*Abstract*: Failures on stream restoration projects generally lead to a lot of finger pointing. The owner points to the designer. The designer points to the contractor or states that the project was not designed to withstand a storm of that specific magnitude. In most cases, expectations by project partners were not effectively communicated. For instance, the owner and the designer probably did not have had any discussion about trading off the cost of design and construction against the risk of failure. That is, no one asked nor answered the question as to what level of risk was to be assumed by which partner for the particular stream restoration project. These are important questions to consider, discuss, and document from the outset.

It is time for owners and designers to have an explicit discussion and reach agreement about balancing cost and risk for each project. What is the cost of designing and constructing a channel that will handle a 100-year event within the first 5 years? And perhaps more importantly, does it make sense? If the stream project is located in a pasture (i.e., low risk), then designing the project to accommodate the 100-year peak flow event may not make economic sense. If the stream project is located in an urban area with infrastructure and public safety at risk, it may well make more sense to design the project to accommodate a 100-year event. In either case, documenting agreement on level of risk from the outset could help head off a lot of potential problems.

With eight miles of channel and 72 individual reaches, the Big Harris project provides an excellent opportunity to apply this idea. Stantec will propose specific design events for each of the 72 reaches to NCEEP. The two parties will discuss and agree on specific design event for each of the 72 reaches. It is our hope that this process will provide a higher degree of protection for both the owner and the designer.


*About the speaker:* **Brad Fairley** is the Managing Principal of Stantec's Environmental Group in NC, SC and GA. He has led the group for more than 10 years and is responsible for managing stream restoration projects in the US Southeast and beyond. Brad holds a Bachelor's Degree in Biology and a Master's Degree in Watershed Planning.

# Legal considerations for stream restoration


## Jay Wilkerson

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*Abstract*: Existing construction law arose out of traditional building projects where the designer prepared the plans, contractors submitted bids and the owner selected the lowest responsible bidder to perform the work. The contractor was required to build only the structures on the plans and any unauthorized deviation from the project design was a breach of the contract. The project designer was responsible for the sufficiency of the design and warranted that the project could be built according to the project plans. The owner's main responsibility was to write the checks. To address latent site conditions or events that unexpectedly occurred during construction, the parties' contracts established elaborate procedures for changing the design. Disputes over responsibility for delays and defects were, and are, routine between the designer and contractor.

This traditional legal framework does not address the design, construction and warranty issues that come up in stream restoration contracts. This presentation will address the existing state of designer liability, warranties and contractual performance and how these traditional legal concepts apply to current stream restoration projects. This presentation will also address risk management strategies and project delivery systems that resolve some of the inherent conflicts that arise on any construction project.


*About the Speaker:* **Jay Wilkerson** has been in private practice as a construction lawyer since 1992 representing contractors and subcontractors in disputes arising out of public and private construction projects. The majority of his practice involves litigation, arbitration and mediation of construction disputes. He is a graduate of the University of North Carolina at Chapel Hill and the University of North Carolina School of Law.

# Are we certifiable?

**Peter R. Wilcock, Ph.D.**

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*Co-Author*: Sue L. Niezgoda, Dept. of Civil Engineering, Gonzaga University, Spokane, WA

*Abstract*: Should stream restoration professionals by registered? Certified? What is the body of knowledge that defines the practice? Should competence be evaluated and how would this be done? And by whom? Many projects require the stamp of a PE. Are professional engineering standards sufficient to ensure that stream restoration projects are appropriately specified, well designed, and adequately installed? Can standards of practice be defined that encompass the scope of responsible design methods? Issues of responsibility and liability make these questions intensely relevant to engineers, but they also help to define the state of the practice. We report on the progress of ASCE subcommittees whose charge is to provide practitioners with clear guiding principles and to develop learning objectives for stream restoration education. Such efforts help define the body of knowledge for stream restoration practice, which can be a prelude to establishing a National Certification in Stream Restoration. Good idea or bad? We report on initial findings of the committees and pose broader questions regarding the pros and cons of certification, licensure, liability, and the development of a sound stream restoration practice.

*About the Speaker*: **Peter R. Wilcock** is a Professor and Associate Chair at the Dept. of Geography & Environmental Engineering, 310 Ames Hall Johns Hopkins University and 3400 N. Charles St. Baltimore MD 21218.

# Beaver Creek: A Focus on Trout Reproduction


## Dani W. Johnson

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*Abstract*: Beaver Creek is a spring fed stream in the Shenandoah Valley of Virginia and has been impacted by agriculture, including livestock in the channel for decades. This project, spearheaded by Trout Unlimited and other partnerships, has resulted in a stable, well-functioning channel that supports trout reproduction as proven by the latest fish sampling results. This presentation is a collaboration with TU, the designer, and contractor to provide information on an example of achieving maximum habitat and water quality improvements despite tight budgets and a limited project length.


*About the Speaker*: **Dani W. Johnson** is a hydrologist and owner of Blueline Environmental, based out of Pittsboro, NC. Her primary focus is water resource related projects including watershed assessment, stream restoration design, innovative stormwater management practices, and incorporation of natural resources into large-scale master planning efforts.

# Mechumps Creek Corridor Restoration Project, Ashland, Virginia


## Josh Running

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*Abstract:* For the past decade, students at Randolph-Macon College (R-MC) have studied the Mechumps Creek Watershed. Located in the Town of Ashland, Virginia, its headwaters are surrounded by approximately 820 acres of highly urbanized land. Classroom studies have focused on biological and chemical monitoring, and produced trend analysis data to evaluate impacts from non-point source runoff. Study results show declining productivity within the ecosystem, high bacteria and sediment loads, and poor overall water quality.

In 2007, R-MC and Williamsburg Environmental Group, Inc. (WEG) partnered to further evaluate the sources of impairment affecting Mechumps Creek and improvement options. Funding was then secured via student presentations to the Ashland Town Council and two National Fish and Wildlife Foundation grants. Town and grant monies totaled $245,000.

In the summer of 2010, WEG completed a natural channel design for 1,200 linear feet – the first Phase of the three Phase project. Construction was completed in November 2010. Over 30 volunteers from R-MC, the Town, WEG, and the local community assisted with planting activities. First Year data results showed a 35% increase in fish population among 14 species and an active yet stable dimension, pattern and profile. Students from RM-C will continue their studies for an additional 10 years, including physical, biological, and chemical monitoring on the restored section of stream. Year two monitoring will be completed this fall.

The Project was awarded a technical assistance grant for Phase 2 in June 2012 with design set to begin this fall.


*About the speaker:* **Josh Running** is a Senior Environmental Planner on Williamsburg Environmental Group's (WEG) Stream Team, and has worked with WEG for over 11 years. He received his B.S. from the University of Wisconsin-Stevens Point, with a major in Watershed Management and a minor in Soil Science. His current responsibilities pertain to the design, construction, and monitoring of stream restoration projects associated with a wide variety of private and public clientele.

# Stream Restoration in Dupont State Forest, North Carolina

**Jason Zink, Ph.D., P.E.**

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*Co-authors:* Greg Jennings, Zan Price

*Abstract:* Prior to becoming part of Dupont State Forest, the Little River watershed, including Reasonover Creek, experienced impacts from floods, logging, agriculture, impoundments, and road construction. Reasonover Creek, downstream of Lake Julia, was unstable with severe bank erosion and excessive in-stream sediment, resulting in poor habitat for fish and aquatic invertebrates.

The North Carolina State University (NCSU) Department of Biological and Agricultural Engineering worked with the North Carolina Division of Forest Resources (DFR) to complete a stream restoration demonstration and education project on Reasonover Creek at Dupont State Forest in Transylvania County, North Carolina. The purpose was to design and implement a natural channel design project to achieve the highest water quality and habitat potential for Reasonover Creek, while providing opportunities for ongoing education, training, and research. Approximately 600 linear feet of degraded stream were restored using natural stream channel design and construction techniques, including channel realignment, floodplain grading, in-stream boulder and log structures, constructed riffles, brush toes, and planting native riparian vegetation. Project design and permitting occurred in 2009 and 2010, with construction in 2011.

Restoration techniques used in this project have been demonstrated using workshops and "hands-on" education and training. During construction, a workshop was held at the site for 30 engineers, contractors, and regulators. Since project completion, three tours have been conducted for 80 resource management professionals. Additional site tours and the placement of interpretive signs for recreational visitors are both anticipated. The site now serves as a demonstration, education, and research project to demonstrate best management practices for restoring natural stream functions in impaired watersheds.

*About the Speaker*: **Jason Zink** has worked for the Biological and Agricultural Engineering Department at North Carolina State University since 2005. He holds doctoral and masters degrees from NCSU, and is a registered Professional Engineer. Dr. Zink conducts research in the fields of stream restoration and stormwater management, particularly in western North Carolina.

# West Sides Creeks Ecosystem Restoration Project


## LeeAnne Lutz, P.E. (SARA)

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*Co-presenter*: Tami Norton, P.E., CFM, Michael Baker Jr., Inc.



*Abstract*: The San Antonio River Authority (SARA) and the USACE are conducting an Ecosystem Restoration feasibility study for 14 miles of previously channelized flood control channels within a highly urbanized watershed. This project is part of the Corp's Pilot Program and is one of four projects under consideration in the nation. The primary goals of the project are to resort habitat for aquatic and riparian dependent migratory and native bird species by establishing native vegetation community and a sustainable riverine environment. SARA is assisting the USACE with the preliminary channel design based on natural channel design principles. Natural channel design is a relatively new concept to the San Antonio region. The urban nature of the watershed and the highly confined flood corridors present challenges to providing the ecosystem frame work needed to meet the goals of the project. This presentation will present the challenges of using natural channel design in an urban stream system and coordinating with the USACE to develop a channel design that meets project goals and criteria.


*About the Speaker:* **LeeAnne Lutz** is a Stream Restoration Specialist at the San Antonio River Authority. She is a Civil Engineer with 10 years of experience in hydrologic and hydraulic modeling experience.

# Restoration in the Park


## Reid Cook

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*Abstract*: In 2008 Angler Environmental entered into a unique public/private partnership with the Prince William County Park Authority (PA) to complete stream mitigation on PA owned property. This multi-phased collaboration will result in the protection and/or restoration of approximately 116,000 linear feet of stream channel within county parks.

The first phase of the project was completed at Locust Shade Park in 2012 and was the largest stream restoration project ever completed in Prince William County. The size, scope, and location of this project presented unique challenges as well as significant ecological and stake holder benefits.


*About the speaker*: **Reid Cook** is the Stream Restoration Manager at Angler Environmental and has 11 years' experience in passive and active stream restoration. Mr. Cook has completed over 10 miles of stream restoration design and construction management in all different stream types and a wide range of physiographic provinces. His team is responsible for feasibility, geomorphic assessment and survey, restoration design, construction management, and post-construction monitoring of all stream mitigation projects.

# SCDOT Full Delivery Process and Future of SCDOT Mitigation


## Sean Connolly

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*Abstract*: The South Carolina Department of Transportation (SCDOT) currently mitigates for unavoidable impacts associated with its infrastructure projects on a project-specific and permittee-responsible basis, while operating several mitigation banks throughout South Carolina. However, the SCDOT's mitigation banks and private mitigation banks are not sufficient to meet the forecasted needs of upcoming transportation projects in the State. Because of the mitigation deficit, SCDOT is considering new mitigation initiatives to meet their demand in the coming years. These initiatives, though not new to other states, include utilizing GIS to forecast impacts and mitigation credit demand and Request for Proposals (RFPs) for "Full Delivery" mitigation. The SCDOT is also considering development of an In-Lieu-Fee Program that allows for use of mitigation banks first, followed by a contingency to develop "Full Delivery" projects. As part of the In-Lieu-Fee Program, the SCDOT would partner with land managers to determine if there are restoration opportunities on preserved lands that could generate credits.

To facilitate environmental permitting and project schedules, the SCDOT developed an RFP to identify mitigation for five transportation projects funded by Florence County's One-Cent Local Option Sales Tax. The RFP process was faced with a unique challenge to mitigate for impacts to streams and wetlands in two 8-digit Hydrologic Unit Codes and ecoregions. Since no mitigation banks operate within these watersheds, the RFP was designed to identify a suitable permittee-responsible mitigation site. The SCDOT used guidance from the North Carolina Ecosystem Enhancement Program and federal and state agencies to draft the RFP. Tidewater Environmental Services Inc. was contracted to assist in the RFP development and review of proposed mitigation sites. In October 2011, the SCDOT issued one of the largest requests for compensatory mitigation in the State's history. Nine sites were submitted and one site was selected to meet the objectives of the RFP.

*About the speaker*: **Sean Connolly**, South Carolina Department of Transportation (SCDOT) Environmental Permitting Division Manager. He earned a Bachelor of Science in Biology and Chemistry from Armstrong Atlantic State University and a Masters Degree in Environmental Resource Management from the University of South Carolina. Sean has over 14 years of experience working with natural resource mitigation and environmental regulatory. His current position is with SCDOT were he oversees the statewide mitigation program, oversees all Federal and State permit acquisition, and assist with any other environmental concerns that may arise during project's lifespan.

# North Carolina, Kentucky, and Virginia: How Many Credits Would Your Stream Mitigation Project Generate?

**Joshua White, PG, PE, CFM**

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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 North Carolina's Wilmington District, Kentucky's Louisville District, and Virginia's Norfolk District. In addition, the presentation will do a credit and cost comparison for two hypothetical projects for each District's current in-lieu fee providers and will assess the projects to see how each District talleys potential mitigation credits.

*About the Speaker*: **Joshua White** is a geomorphologist with Michael Baker Engineering, based in Cary, North Carolina. He received a M.S. in Geomorphology from West Virginia University and a B.S. in Geology from Northern Kentucky University. 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 piling 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, and a certified floodplain manager in North Carolina and for the past eight years has worked for Michael Baker Engineering in all aspects of ecological restoration.

# Turning Liabilities into Assets: Municipal Stream and Wetland Restoration

**Ward Marotti**

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*Abstract*: Most municipalities and counties own and manage lands that contain significant hidden value. Since the US Army Corps of Engineers/Environmental Protection Agency's 2008 Mitigation Rule became effective, projects with stream and wetland impacts that require compensatory mitigation must first look to mitigation banks, before using In Lieu Fee programs or permittee responsible restoration. Portions of many properties owned by local governments, and often managed by parks and recreation departments, have streams and wetlands that can be restored and/or protected. These resources can be sold on the open market, used to offset impacts from internal projects, or offered as parts of incentive packages to attract development. In addition to municipalities organizing and executing these projects internally, private mitigation providers are often eager to purchase conservation easements and perform restoration and/or enhancement. Pursuant to NC Session Law 2011-343 and the subsequent update of NC General Statute § 143-214.11, only an "Existing local compensatory mitigation bank" can offer mitigation credits to the North Carolina Ecosystem Enhancement Program.

*About the speaker*: **Ward Marotti** is a Senior Scientist/Project Manager in WK Dickson's Watershed Sciences Department. He has over 20 years' experience in the application of environmental sciences to achieve natural resource restoration, conservation, management, and permitting. His wide-ranging experience in restoration of mountain ecosystems has spanned the southern Appalachians, the Rockies (Montana to New Mexico), and the Andes (Bolivia, Chile, Peru, and Argentina). He has also restored and reclaimed aquatic and terrestrial ecosystems in many other physiographic provinces, including: the southern Piedmont and Coastal Plain, the Great Plains, the Colorado Plateau, and the Basin and Range.

# Where Mitigation Hits the Road: Successful Project Closeout from the Perspective of both the Mitigation User and Mitigation Provider

**Tim Baumgartner**

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Scott Hunt, Senior Water Resources Engineer, Michael Baker Engineering, Inc., wshunt@mbakercorp.com

*Abstract*: So much discussion occurs within the restoration community and regulatory agencies concerning how to implement mitigation projects to effectively provide targeted functions and assets. Coordination efforts at all levels are often dominated by such technical discussions. However, what is less often discussed is the final result of the mitigation work: successful regulatory project closeout. A successful regulatory project closeout is the culmination of planning, design, implementation, and monitoring that yields both functional uplift and positive financial results.

The North Carolina Ecosystem Enhancement Program's (NCEEP) regulatory closeout process is a cooperative effort between the NCEEP, the mitigation provider, and the regulatory agencies. Each partner has different roles and responsibilities throughout the process, but each is seeking a common outcome: the successful, final release and realization of mitigation assets. Michael Baker Engineering, Inc. (Baker) is one of several firms that have partnered with NCEEP since its inception to successfully implement and close out mitigation projects.

In this presentation the authors will provide experience-based perspectives of the project closeout process from both the mitigation user (NCEEP) and a mitigation provider (Baker). Experiences shared will include the key aspects of the closeout process: process integrity, adapting to evolving practices, regulatory expectations, asset risk, and contractual obligations. Lessons learned regarding the closeout timeline and actions required to ensure the process is smooth and without contingency will also be discussed.

*About the speakers*: **Tim Baumgartner** has been with the Ecosystem Enhancement Program (EEP) for approximately 5 years and worked primarily with the Full Delivery Program inside EEP. Within the past year, Tim's position has shifted focus to project closeout. Closeout is the culmination of all aspects of the project into a realization of project assets. Prior to working at

EEP, Tim was employed with several private consulting companies managing full delivery and banking projects.

**Scott Hunt**, Senior Water Resources Engineer, Michael Baker Engineering, Inc., Mr. Hunt is an accomplished natural resources engineer with more than 20 years of civil engineering experience, specializing in stream, wetland, and habitat restoration, conservation and stewardship. An avid, conservation-minded outdoorsman with passionate vision and a genuine desire to strike a balance between sound engineering principles and environmental stewardship in order to promote and implement improvements to the conservation of our natural resources. Mr. Hunt works for Michael Baker Engineering, Inc., managing the Ecosystem Restoration Group in the Cary, North Carolina Office.

# Lux Farms Hydrologic Restoration Project: An innovative partnership for agriculture and water quality at the end of the world, North Carolina…

**Kris Bass, PE**

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*Co-Authors*: Michael Burchell, George Chescheir, Tiffany Messer: NC State University Biological and Agricultural Engineering. Erin Fleckenstein, Todd Miller: North Carolina Coastal Federation. Wilson Daughtry: Lux Farms. Bill Edwards, Jonathan Hinkle: USDA Natural Resources Conservation Service

*Abstract:* Hyde county is a remote area in the tidewater region of NC that known for agriculture and Lake Mattamuskeet. The majority of the county is at or below sea level, and drainage and water levels are a prominent part of the daily discussion. Residents are intimately connected to environmental issues such as climate change and environmental issues such as water quality. The need for action, combined with a collaborative vision has resulted in a unique partnership of farmers with several federal and state programs, universities, and non-profit environmental groups. Together, they have initiated a first of its kind restoration project that strives to make wetlands and farming a cooperative effort. The completed project will serve as an example of how agricultural and environmental goals can be accomplished by leveraging partnerships and the resources of multiple groups.

The project involves the restoration of over 4,000 acres of previously drained wetlands using an approach that will restore both local and watershed level hydrologic regimes. The system will also benefit agricultural operations by installing new pumps and boundaries that will improve protection from climate change. Modeling and initial research efforts at NC State University have shown that the project could dramatically improve water quality, substantially reduce freshwater flows into sensitive estuarine areas, and efficiently restore an enormous wetland area. The measurement of other ecosystem impacts is a planned part of future research. The project is in its first stages of construction and is an initial part of an even larger cooperative effort throughout the county.

*About the Speaker*: **Kris Bass** is part of the NCSU Water Quality Group. He and his co-authors hope to promote expanded approaches to water quality issues in NC and at the coast. Kris is currently offering cut-rate deals on his annual Coastal Restoration Tour, which he organizes each May. Stick around with a question or comment to take advantage of this special offer!

# Benefits of a hydrobiogeomorphic, multi-scale approach to stream classification in a sandy coastal plain

**John Kiefer, Ph.D., P.E., P.W.S.**

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*Co-authors*: Joann Mossa &William Wise, University of Florida: Tom Crisman, University of South Florida

*Abstract*: More than 100 readily-measurable variables known to be associated with stream functions related to hydrology, geomorphology and biology were used to derive a classification system for peninsular Florida streams. In addition to being multi-disciplinary, variables also encompassed a variety of scales, ranging from the watershed down to small in-stream habitat patches. This approach led to the identification and characterization of 15 natural kinds of streams on the peninsula. Each type was hierarchically classified first by their dominant watershed media (sand, limestone, swamps), and then along gradients of watershed size and valley slope. These factors were strongly associated with thresholds in the presence or absence of various alluvial and biogenic habitat features in the bankfull channel and floodplain. This approach provides a synthesis that clearly demonstrates how streams belong to their watersheds and it improved understanding of Florida streams in ways that single-discipline or reach-scale classification failed to discriminate. The classification subsequently provided value as a stratifying variable to improve studies related to nutrient enrichment sensitivity, biological integrity indices, and environmental flows. It also has provided excellence guidance for natural channel design in rural and mining areas.

*About the Speaker:* **John Kiefer** is a Principal Water Resources Engineer at AMEC. He has 21 years experience planning and designing aquatic ecosystem restoration projects and has professionally examined 100's of streams from Venezuela to Michigan. He has a Ph.D in Environmental Engineer Sciences from the University of Florida and is a registered Professional Engineer and certified Professional Wetland Scientist.

# Techniques for Restoration of Headwaters Streams in the Inner Coastal Plain

**Jeff Keaton, P.E.**

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*Abstract:* Many stream and wetland mitigation projects in North Carolina are developed on sites in the Coastal Plain. The physiography of the Coastal Plain is distinct from other regions of the state and can be further divided into "inner" and "outer" physiographic zones. The inner Coastal Plain is somewhat higher and drier than the outer zone and gradients of headwaters streams are more variable. Streams in this region are often quite different in form and function than those located in other parts of the state. Common restoration techniques used in other regions may not be appropriate in the inner Coastal Plain, especially on headwaters systems. However, limited guidance is available to practitioners working in this region and designers must rely on their own intuition and be willing to explore new techniques. An example headwaters restoration project located in the inner Coastal Plain of North Carolina will be presented. Discussion of the project will include assessment of jurisdictionality, identification of appropriate references in similar physiographic settings, and design analyses. The project design was based on discharge monitoring and design discharge formulation, sediment transport modeling, and using an appropriate reference system as a model for restoring a landscape of headwaters, wetlands, and receiving streams. Resulting design concepts will be presented.

*About the Speaker:* **Jeff Keaton** is a senior water resources engineer in Wildlands Engineering's Raleigh office. He has over twelve years of experience in stream and wetland mitigation, watershed planning, stormwater infrastructure design, and water quality analysis and modeling. He has a master's degree in Civil Engineering from UNC-Charlotte and is a registered professional engineer. Wildlands Engineering specializes in stream and wetland restoration with a particular focus on innovative engineering for ecosystem renewal.

# Adventures in Stream Restoration Projects – Perspective from the City of Wilmington

**David B. Mayes, P.E.**

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*Abstract*: The City of Wilmington has made substantial progress through capital drainage improvements to the public drainage system since a stormwater utility was put in place in 1998. Six of those capital improvement projects involved a segment of the drainage system that was identified as a regulated stream and thus required a high level of regulatory oversight in obtaining permission to make improvements. Through consulting assistance, the City has used stream restoration and other natural stabilization techniques that recognize the environmental sensitivity of these water resources. This presentation will compare these projects and review the positive benefits for the City, our water resources and the public.

*About the Speaker:* **David Mayes** is a licensed Professional Engineer and the Stormwater Services Manager for the City of Wilmington. He has worked at the City of Wilmington for 17 years all of which have been involved with stormwater management. He has managed over 25 capital drainage improvement projects for the City. Currently, he manages a 59 person division within the Public Services Department that is responsible for maintenance of the public drainage system, compliance with NPDES permitting requirements, outreach and education to citizens on water quality issues and other related stormwater issues.

# Starting a Backyard Buffer Program in Your Community


## Wendi Hartup

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*Co-author*: Wendy Patoprsty, Natural Resources Extension Agent, NCCE – Watauga County Center



*Abstract*: North Carolina is a water-rich state filled with thousands of miles of streams. Streamside forests naturally store floodwater and sediment, provide habitat and food for wildlife, regulate water temperatures for aquatic species, stabilize soil on streambanks and act as crucial buffers by filtering out pollutants. However, many miles of streambank have been cleared and are eroding. There have been many efforts in the past to train, educate, and deliver educational materials about river protection to landowners. While this type of programming continues to be important, the next step is to help landowners implement "on the ground" projects that will enhance and protect the riparian ecosystem. The Backyard Buffer Program was developed as a resource for stream owners to learn why and how to install plants, participate in a demonstration project, and take action on their own property by installing livestakes. Livestakes are cuttings of certain native shrubs found along creek banks that have extensive root systems thus sufficiently holding soil in place while creating riparian habitat. Livestaking is a cost effective method of stabilizing creek banks. Since 2011 a total of 285 participants received livestakes (silky dogwood, silky willow, elderberry, buttonbush and ninebark). Each livestake was to be planted one to three feet apart and may grow up to 15 feet tall. The 7,000 livestakes planted will buffer 2.25 miles of streambank. Twenty-four survey respondents stated that they had shared the Backyard Buffer information with over 80 others. One attendee stated, "The program opened my eyes to how to properly care for my creek." This presentation will highlight several methods for starting your own Backyard Buffer Program.


*About the Speakers*: **Wendi Hartup** and **Wendy Patoprsty** have worked for NCCE for 7 and 11 years, respectively. Both provide public education opportunities in the areas of stormwater management practices, erosion issues and stream ecology as well as implementing on-the-ground demonstration projects such as rain gardens and streambank stabilization. Their strengths lie in bringing communities together with a common goal of improving the environment and determining solutions to common erosion problems. Ms. Hartup has a B.S. degree in Marine Biology from Troy State University and an M.S. in Fisheries Conservation from Auburn University. Ms. Patoprsty has a B.S. in Horticulture from the University of Georgia and is working on her M.S. in Geography and Planning from Appalachian State University.

# The impact of streambank stabilization on recreation and challenges with education and outreach

**Jeri Fleming, Esq.**

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*Abstract*: Twelve sites in a high priority watershed in Oklahoma were restored/enhanced using natural stream restoration techniques. The projects were located within the Illinois River watershed which has been the subject of litigation between Oklahoma and Arkansas, and several chicken integrators. Much of the litigation concerns the amount of phosphorous discharged, or flowing into the river from either sewage treatment plants or farm runoff with high phosphorous loads as a result of application of chicken litter and limited riparian buffers. Oklahoma has set a .037mg/L phosphorus limit and Oklahoma and Arkansas have spent millions of dollars to improve the water quality. However, erosion is also a major contributor to decreasing water quality and siltation of Lake Tenkiller which is fed by the streams in the watershed. Because the Illinois River is visited by over 500,000 people annually and is one of six scenic rivers, improving water quality is an ongoing process. Six of the twelve sites targeted for improvement were either public access sites on the Illinois River, or city parks on a tributary of the river. These sites were all less than 500 feet in length but the impact made to the water quality, habitat and the community will continue to improve over the next several years. One component of the project was education and outreach; the goal being the more people understand the benefits of natural stream restoration, the more willing they may be to fund it. This presentation will discuss the impact the streambank improvements and in stream structures have had on visitors to the sites and what economic value the public places on improved streambank conditions. Further, this presentation will discuss public outreach and education as it relates to streambank restoration.

*About the Speaker*: **Jeri Fleming** is a Program Manager in Biosystems and Agricultural Engineering at Oklahoma State University. She oversees most aspects of the Illinois River Streambank Stabilization project. Ms. Fleming was also involved in the development of Oklahoma's comprehensive water plan that was completed in 2011. She has a B.A. in Mass Communications/Public Relations from Northeastern State University and a J.D. from the University of Tulsa College of Law.

# Boater Habitat: The Recreational and Ecological Enhancements on the Little Coal River, West Virginia

**Nathan Ober**

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*Co-Speakers:* Darrell Westmoreland (North State Environmental, Inc.)

*Abstract:* The West Virginia Department of Environmental Protection has identified the Little Coal River in southern West Virginia as a primary location for off-site stream mitigation to compensate for coal mining and industrial stream impacts. To date multiple sections of this river have been enhanced with in-stream boulder structures and large woody debris to produce ecological and recreational improvements. Enhancement design and in-stream construction techniques have been and will continue to be implemented to produce approximately 20 miles of river mitigation by the conclusion of the year 2013. In addition to geomorphic design, aquatic surveys and studies have been completed to establish design criteria and baselines for monitoring the ecological lift potential.

The Little Coal River watershed is a recreational destination for outdoorsman including fisherman and non-motorized boaters. The local watershed association called the Coal River Group estimates that 10,000 people paddle the Little and Big Coal River every year. Plyler (2006) conducted an accident study for non-motorized boaters across the United States and found that 31.4 million people participated in boating activities in the year 1999. With this immense interest in rivers it would be beneficial to incorporate the recreational benefits of the boater with the selection of fluvial hydraulics conducive to the needs of the boater and the environment. Access and navigation are examples of river enhancements that can benefit the community while providing ecological benefit. This dual presentation will provide insight of the designer and contractor to introduce the concept of in-stream enhancement in a large river system.

*About the Speakers:* **Nathan Ober** is a Geomorphologist with over 9 years of detailed experience and training in fluvial geomorphology, stream restoration, stream mitigation, and coal mine remediation. Following his graduation from West Virginia University, Mr. Ober worked for five years in Southwestern Pennsylvania and West Virginia where he provided environmental and geotechnical consulting for mining and industrial clients. Since 2008, Mr. Ober has served as a Geomorphologist and Project Manager in ecosystem restoration providing technical

expertise in stream assessment, natural stream design, and construction management for stream restoration projects in the Southeast and Mid-Atlantic United States.

**Darrell Westmoreland** is the Founder and Vice President of North State Environmental, Inc. Following his graduation from NC State University with a degree in Agricultural and Biological Engineering with an Environmental concentration he worked for NC-DENR, Land Quality Section of the Winston-Salem Regional office for 3 years. In 1994, Darrell and his wife Stephanie, started North State Environmental, Inc. Since then, Darrell has received recognition for his competency and timely completion of the many projects he has undertaken for state, federal and private organizations in the field of stream restoration. These projects provided the installation of a variety of erosion control methods, storm water management, energy dissipaters and storm drain systems. Darrell has overseen the installation of over 275,000 linear feet of stream restoration and more than 420 acres of Wetlands mitigation and restoration.

# The wonders of wetlands: Exposing youth and adults to the benefits and life of community constructed wetlands


## Wendy Patoprsty

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*Abstract*: It's been 4 years since the 1.4-acre stormwater wetland was constructed along the greenway trail in Boone. Within these 4 years volunteers and town employees have planted hundreds of native plants that are now thriving and providing water treatment and habitat for wildlife. Designed by NCSU Biological and Agriculture Department, the wetland has become an urban park for the community to enjoy, both human and wild. As passive recreation, the trail around the wetland provides a great view to observe what's going on in the wetland throughout the seasons. Local Extension Agent utilizes the wetland for instructional tours, labs, and educational events throughout the year for groups from elementary school to senior citizens. Utilizing all kinds of hands on activities, participants experience the plants, birds, and soils while learning how the wetland contributes to the overall health of the New River. This presentation will provide resources and ideas on how to get the community engaged in wetland conservation and education.


*About the Speaker*: **Wendy Patoprsty** is a Natural Resource Extension Agent based in Watauga County, North Carolina. She moved to Watauga County in 2000 after receiving a Bachelor of Science in Agricultural Sciences from the University of Georgia. She started with Extension in 2001 as a grant funded Water Quality Technician and was hired as a Natural Resources Extension Agent in 2003. In October 2008, NC A&T State University hired Wendy as a Natural Resource Extension Agent. In this position Wendy collaborates with community development projects, stormwater projects, and community environmental education.

# Federal Perspectives on Stream Mitigation

**Brian Topping**

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*Abstract:* A discussion of recent efforts to improve the understanding, evaluation and practice of stream mitigation, and a brief exploration of what is on the horizon. Early efforts have focused on cataloguing the state of the science and practice of stream mitigation through the development compendiums of assessment methods in 2004 and 2010. EPA has also invested significantly over the past decade in the development of trainings and tools including the Natural Channel Design Review Checklist and the Functional-Based Framework for Stream Assessment and Restoration Projects. As the science and understanding of stream restoration have advanced, so has our focus, expanding from design and installation to measuring changes in stream condition and function.

*About the Speaker*: **Brian Topping** has worked at EPA Headquarters since 2004 on Clean Water Act section 404 and 401 programs. Currently Brian focuses on stream mitigation, surface coal mining in Appalachia, wetland delineation, and general regulatory program operations and data management. Brian also has experience working EPA's Region 4 office in Atlanta and the Portland District U.S. Army Corps of Engineers. Brian holds a Masters degree in Environmental Management from Duke University and a Bachelor of Science in Environmental Science-Wetland Ecology from the University of New Hampshire.

# State Perspectives on Stream Mitigation

**Scott McLendon**

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*Abstract:* The practice of stream restoration in NC has evolved greatly over the last 15 years. This evolution has been in response to changing regulatory requirements promulgated first by the NC Division of Water Quality and then by the US Army Corps of Engineers as well as a greater understanding of how stream restoration practices effect improvements to stream function. In response to the need for more predictability with stream mitigation credit, in 2003 the Wilmington District finalized its Stream Mitigation Guidelines which linked credit generation to the type of restoration or enhancement project that was proposed. In the ensuing years there has been increased scrutiny of, and debate over, stream mitigation proposals and whether the stated biological benefits were attainable given the underlying factors that were causing the apparent loss of stream function. Despite the improvements that have been made in the practice of stream restoration, there is criticism that functional success is still being tied too closely to construction success. The Wilmington District is looking harder at watershed condition as it relates to the potential to improve stream function and would like to move towards performance standards that reflect biological improvement.

*About the Speaker*: **Scott McLendon** is the Chief of the Regulatory Division, Wilmington District. He has worked in the Regulatory Division for 22-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 received a BS in Biology from Virginia Tech in 1983 and an MS in Environmental Biology from George Mason University in 1989.

# Focusing Mitigation Procurement To Improve Functional Outcomes In North Carolina


## Michael Ellison

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*Abstract*: The North Carolina Ecosystem Enhancement Program (NC EEP) provides compensatory mitigation for unavoidable impacts to waters and wetlands regulated under Sections 401 and 404 of the Clean Water Act. Over the past ten years, NC EEP has delivered over 600 projects to generate four types of mitigation credits: stream, wetland, riparian buffer, and nutrient offset. Historically, mitigation projects have been identified within a watershed planning framework that seeks to concentrate projects based on needs and opportunities identified at various spatial scales.

NC EEP now seeks to improve ecological outcomes through increased emphasis on water quality and local hydrology through modifications to its watershed planning processes. Rather than an extensive project atlas that describes discrete stream and wetland project opportunities, the functional watershed plan will match suites of watershed improvement practices with impaired conditions in close proximity to high-value resources. The idea is to provide the toolbox and describe type localities where applying specific groups of tools should be expected to optimize functional uplift. A unique feature of the new approach is that it can be applied rapidly for single procurements of large mitigation needs where sufficient data already exist, or integrated into a more deliberative planning effort. This approach also appears more compatible with operational priorities revised in 2011 to increase "full-delivery" mitigation procurement and mitigation bank credit purchases.

Regulatory buy-in is critical to the success of this revised planning approach. To date, the Interagency Review Team and the USACE have been amenable to trial applications, but broader application will reliable credit structures for non-traditional mitigation practices.


*About the Speaker*: **Michael Ellison** has over twenty-five years of experience in the analysis, restoration and management of disturbed landscapes. As a consultant and contractor he has completed over 250 stream and wetland restoration projects, and restored over 30,000 acres of forest and prairie habitat throughout the United States. Mr. Ellison has a BS in Geology degree from the University of Alabama and has completed graduate coursework at NC State University. For the past two years he has served as the Deputy Director of Operations for the North Carolina Ecosystem Enhancement Program.

# Focusing mitigation procurement to improve mitigation outcomes


## Tara Disy Allden

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*Abstract:* Mitigation banking is the statutorily preferred method of delivering compensatory mitigation throughout the U.S. The mitigation entrepreneurs who began in the 1990s have led the way to development of an industry that is proficient in the entire mitigation process – from site selection and implementation to monitoring and closeout and long term stewardship. In addition, professional, commercial mitigation providers understand and effectively navigate the inherent market, regulatory and financial risk associated with all mitigation projects. This presentation will provide a brief overview of the components of a stream mitigation bank, using the federal rule as the backdrop, an in depth look at risk, and a discussion of the relative benefits of mitigation delivery methods (mitigation banks, in lieu fee and project specific).


*About the Speaker*: **Tara Disy Allden** is the Regulatory Manager at Restoration Systems, LLC, a restoration and mitigation banking company that restores and protects land and water by purchasing a permanent conservation easement or fee-simple interest from property owners, and physically restoring the waterways, trees and vegetation to exceed current function and duplicate historic condition as closely as possible. Tara has worked in the water quality field since graduating from the University of Florida College of Journalism and Communications. In 1991, Tara became an editorial assistant in Agricultural Communications at N.C. State soon moving on to manage the communications program for the Water Quality Initiative of the North Carolina Cooperative Extension Service. Since that time, Tara has received her M.S. in Ecology (with a focus on Soil Science) from N.C. State and a law degree from the University of South Carolina and worked as a consulting biologist at Kimley-Horn and Associates and as the Southeast Regional Manager for Environmental Banc and Exchange prior to joining Restoration Systems in 2006. Restoration Systems currently has more than 40 sites and banks underway or completed in ten states. Tara is licensed to practice law in the State of South Carolina and is on the board of the North Carolina Environmental Restoration Association and active in the National Mitigation Banking Association.

# Innovative Approaches to Stream Assessment and Restoration

**Will Harman, PG**

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*Abstract*: There have been significant improvements to stream assessment and restoration since the first Southeastern Stream Restoration Conference in 1998. This was evident at the 2010 conference where presenters provided results from long-term monitoring studies showing the benefits—and failures—of stream restoration projects. This was a striking difference to the 1996 conference where presenters focused on designs and predictions about what *would* happen, since very few projects had actually been constructed. Fourteen years later, the academic and practitioner communities are producing new assessment and restoration techniques at a faster rate than any time in the past. This presentation will cover a few of the innovations that Stream Mechanics has been involved with.

The first innovation is the Stream Functions Pyramid. This hierarchical framework provides a broad-level approach for developing function-based goals, stream assessments, and stream mitigation debit/credit determinations. It is hopefully a bridge between understanding channel form and watershed processes, forcing the practitioner to think about what functions will be improved by a project. Next, several innovations related to developing design criteria will be provided. These include changes to excavated floodplain designs, minimum belt width standards, and proposed changes to channel pattern ratios. Finally, innovative approaches for designing headwater Piedmont and Mountain streams will be presented. This approach is similar to other design approaches that create channels smaller than a bankfull channel. In some cases, this approach includes restoring a valley bottom rather than a stream channel, an approach that is also similar to headwater coastal plain stream restoration.

*About the Speaker:* **Will Harman** is the owner of Stream Mechanics, a company focused on improving the science and application of stream restoration through education, applied research, and projects. Will has 20 years of experience in fluvial geomorphology and stream restoration. He has designed projects throughout the eastern United States that represent a wide range of conditions and challenges. Will has written numerous peer reviewed journal articles and proceeding papers and has taught workshops throughout much of the United States. Prior to forming Stream Mechanics, Will was Vice President of Ecosystem Restoration at Michael Baker Corporation. Will was also a founder of Buck Engineering and River Works, which specialized in stream restoration design and construction, respectively. Before starting these two companies, he was on the faculty at NC State University, where he co-founded and led the NCSU Stream

Restoration Institute, now the Stream Restoration Program. He has a Master's Degree in Geography from the University of North Carolina at Charlotte and Bachelor's degree in Geography from Appalachian State University. He is a licensed Geologist in North Carolina.

# The Mitigation Landscape in North Carolina – A Progress Report

**John R. Dorney**

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*Abstract:* Compensatory stream, wetland and buffer mitigation has been conducted intensively in North Carolina for the past several decades and now is an appropriate time to examine various policy-related issues concerning mitigation. First, all major mitigation providers in NC (Ecosystem Enhancement Program, NC Department of Transportation, private bankers, applicant-provided) provide equally high quality mitigation with regulatory success rates of 70% (wetlands) to 84% (streams) which is a great improvement over the 20 to 42% success rate for wetland mitigation in mid-1990's . Second, there is mixed evidence in the scientific literature about the scientific success of mitigation but in general, it appears that compensatory mitigation can result in ecological improvement. The most compelling NC example of this is the ongoing work done with Duke University's SWAMP study on Sandy Creek in Durham. Third, NC has achieved no net loss for wetlands and stream buffers (in buffered basins) but stream losses greatly exceed mitigation gains. Fourth, functionally based mitigation will be much more common in the future now that the NC Wetland Assessment Method is complete, the NC Stream Assessment Method is soon to be completed, and the NC Environmental Management Commission is going to public hearing with flexible buffer mitigation rules. Major areas of future focus for compensatory mitigation in North Carolina should include 1) incorporation of functional assessment methods into state and federal permitting programs, 2) addressing crucial concerns regarding compliance, 3) the expanding role of private banks in NC and parallel change in EEP's roles, 4) the need for additional monitoring, and 5) the need for more stream mitigation in order to achieve the goal of no net loss of streams across the state.

*About the speaker:* **John R. Dorney** has been employed by Atkins North America since October 2011 after working with the Water Quality Section of the N.C. Division of Water Quality for about twenty nine years. At Atkins, he is responsible for administering a contract with the US EPA for Clean Water Act assistance as well as being involved in stream and wetland functional assessment. While with the Division of Water Quality, Mr. Dorney was responsible for the 401 Water Quality Certification and Riparian Buffer Protection Programs for 14 years and then was responsible for developing and implementing new or modified wetland regulatory policies for seven years. Mr. Dorney has a B.S. degree in Biology, a M.S. degree in Botany and a M.S. degree in Civil Engineering with the latter degree from NC State University.

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# Evaluating natural and human influences on the integrity of North Carolina streams using a new rapid assessment method, the North Carolina Stream Assessment Method (NCSAM)

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*Abstract*: This research intends to evaluate the functional integrity of stream reaches throughout the major river basins of North Carolina with emphasis on the influence of local, network and non-network factors, both natural and human, on the functional integrity of streams. One of the stream assessment methods included in this study is the NC Stream Assessment Method (NCSAM), a new rapid field method developed specifically to guide stream compensatory mitigation and stream enhancement policies in NC. NCSAM is also reflective of the emerging focus on restoration of stream function, rather than simply form.

In this study, NCSAM assessments and instream habitat surveys will be conducted at approximately 65 locations across the state where there are current or recent water chemistry, benthic community, and stream gage data. GIS analysis of watershed land use, basin morphometry, and riparian buffers will also be performed for each site. The authors will present preliminary results from a subset of approximately ten field sites where field work was completed during the summer of 2012. These results will: quantify the concurrence of NCSAM results with the existing data from other assessment programs; examine correlations between NCSAM, local, and non-local characteristics of the watershed; and examine spatial and ecoregional variability of stream function across the state.

*About the Presenters:* **Susan Gale** is currently pursuing her MS in Watershed Hydrology at NCSU. She previously worked for the NC Division of Water Quality in the areas of water quality monitoring, quality assurance, and headwater stream mapping and modeling.

**Dr. Ryan Emanuel** is Assistant Professor of hydrology in the Department of Forestry and Environmental Resources at NCSU. He earned a Ph.D. in Environmental Sciences from the University of Virginia. He teaches courses on watershed hydrology and wetlands at NCSU and has over ten years of experience teaching hydrology to undergraduate and graduate students. Emanuel's research covers a range of topics related to interactions between plants, climate and the water cycle. He has conducted research in all parts of North Carolina and in other parts of the United States as well.

# River-based Greenway Network System


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*Abstract*: The development of river-based greenways is an essential element for sustainable development in urban areas. River-based greenways can help guide riparian greenway planning to enhance environmental quality in a region. Riparian greenways would be complementary and systematical, because a river-based greenway network system is able to connect the various habitats in ecosystem. Landscape ecological principles are crucial to the plan and design of a river-based greenway network system in order to maximize the benefits from the ecosystem to the community. The greenway network system can be referred to by path, edge, and corridor which reflect the main concept of the ecological principle in landscape ecology. In this respect, this study proposed a greenway network system in Gwacheon City. It also covered Yanjaecheon River, which runs through in the middle of Gwacheon City.

This study used field work and a GIS-based analysis to develop a suitable greenway network system based on the river for providing benefits of an ecosystem to a larger community. First, field work was conducted to examine flora and plant species and to evaluate the structure of the river bed using LAWA (Laenderarbeitsgemeinschaft Wasser). The results revealed the environmental quality of Yanjaecheon River. Second, a least-cost path method using GIS-based analysis was utilized to propose potential designs for the greenway network system. The least-cost path method consisted of four steps: 1) selecting a core area, 2) creating a cost raster, 3) confirming the destination area, and 4) creating a least cost routine by calculating a cost weighted surface from source area to destination.
The core area was selected from highly-rated quality environmental areas from the field study results of examination and evaluation on Yangjaecheon River. The cost raster map was created with land cover, eco-naturality, and hydrology in mind. The destination area, such as patch called in landscape ecology, was designated as a small green area in order to include forest and grassland. This process helped create a least-cost routine from source area to destination for greenway network systems based on rivers. The results of this study will contribute to planning small wetlands and habitats in order to fully realize green networks, with an emphasis on riparian greenways, in urban communities.



*About the Speaker*: **Lee, Jung A** is a Ph.D. Candidate in the Department of Environmental Science and Ecological Engineering at Korea University, Seoul, Korea. Her research interests include areas of environmental planning, ecosystem service, human behavior in environment, and ecological urban planning. *Phone*: +82-2-3290-3621

# A comparative study of hydromorphological structure assessment of damaged stream and reference stream

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*Abstract*: Stream is closely related to the rootage of vegetation and habitat of various creatures because physical structures of the stream are diverse. Many streams have been changed artificially and have damaged for the sake of human needs. In order to restore damaged streams, we should clarify the restoration goal for natural characteristics and ecological health of damaged stream. In this regard, the study of reference stream which is the criterion of stream restoration should be progressed simultaneously with damaged stream restoration. Because damaged stream is difficult to understand the previous structural and ecological functions. The purpose of this study is to establish the restoration goal of damaged stream based on the comparison of the hydromorphological structure between a damaged stream and a reference stream. The study sites are Anchang stream (damaged steam; stream length: 11.80km, basin area: 24.44km²) and Dongdal stream (reference stream; stream length: 13.55km, basin area: 53.70km²) in South Korea. LAWA (Laenderarbeitsgemeinschaft Wasser) was used as an assessment method to investigate the hydromorphological structure and the ecological characteristics of the study sites. As a result, the grade of structural condition of damaged stream was classified as 'Grade 4', which means 'Remarkable change' while reference stream was classified as 'Grade 2', which means 'Little change'. According to the structure of reference stream, the box culverts are needed to be removed from the damaged stream and disconnected riverside is also needed to be re-connected. In case of the place where occurs 'ground digging' should be managed to block off the flow of invasive plants. The agricultural canals of the riverside should be changed into eco-friendly form and riparian forest is needed to be restored. In addition, unique structure such as silence area and habitat should be created in riverside. The restoration of hydromorphological structure in damaged streams will provide habitat for a variety of organisms. The study of comparing hydromorphological structure of both streams suggested that the establishment of the damaged stream restoration guideline is necessary to restore damaged streams in a proper way.

*About the Author*: **Choi, Yun Eui** is a doctoral student in the Division of Environmental Science and Ecological Engineering at Korea University. Her research interests include ecological function of stream and wetland design. She has a B.S. degree in Landscape architect from Kyung Hee University.
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# Lewis Creek Preserve: The benefits of a joint restoration effort to improve stream and wetland habitat

**Deborah A. Daniel**

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*Abstract:* A stream restoration project was completed in 2011 along 1800 feet of Lewis Creek located at the Lewis Creek Nature Preserve in Edneyville, NC. Lewis Creek is on NC DWQ's 303d list for impaired biological integrity. After generations of row cropping and stream channelization, significant aquatic habitat impacts have occurred. As the stream banks eroded, the stream became more incised, sediment input increased and connection to the floodplain was lost which led to loss of macrobenthic and fish habitats. Along with restoring the stream channel and riparian buffer, the North Carolina Ecosystem Enhancement Program (NCEEP) worked with the Carolina Mountain Land Conservancy (CMLC) to enhance a remnant of a rare Southern Appalachian Bog located within the 10 acres of the Preserve. Historically, this bog was ditched to drain the wetland for pasture and row cropping Through joint efforts of the NCEEP and the CMLC, both the stream and the Preserve have seen improvement in riparian, stream and bog habitats. Sediment input is reduced, the stream is accessing its floodplain and small riparian wetlands are developing streamside. The plugged drainage ditches have improved bog habitat and increased its size. Wetland plants are flourishing and more bird species are inhabitating the bog. The open area between the riparian buffer and the bog was replanted with a field composed of native grasses and wildflowers to attract birds and bees, which pollinate nearby apple orchards. Exotic invasive species removal and installation of mulch trails and removable boardwalks by the CMLC and NCEEP are ongoing activities. Guided tours of the bog and the stream project include bird watching, wildflower identification and talks on the importance of preserving Southern Appalachian Bogs.

*About the Speaker*: **Deborah Daniel** is a Project Manager for the North Carolina Ecosystem Enhancement Program. She has worked for the EEP for seven years. As a project manager, Ms. Daniel is responsible for finding stream and wetland restoration projects and overseeing property acquisition, design, construction and monitoring. She has a BA in Chemistry, a BS and MS in Geology from East Carolina University.

# Bachelor's Delight Mitigation Bank: A groundbreaking partnership in coastal ecosystem restoration

**Doug Frederick, Ph.D.**

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*Abstract:* Development of the Bachelor's Delight Mitigation Bank, a coastal headwater stream and wetland restoration project required the collaboration of a real estate investment trust, a non-profit foundation, a North Carolina State University graduate student and a private environmental consulting firm. Degraded headwater habitat and projected stream and wetland credit demands, driven in large part by local military needs, along with prior mitigation banking efforts at NCSU's Hofmann Forest provided the ecological and economic incentives to convince all collaborators of the viability of the effort. This presentation will chronicle the mitigation bank development process from conception, proof of concept and design to execution of the mitigation banking instrument (MBI). This effort can be a model for public-private collaboration in ecosystem restoration of a large stream and wetland headwater system in the coastal plain of North Carolina.

*About the Speaker*: **Doug Frederick** is a Professor of Forestry in the Department of Forestry and Environmental Resources at North Carolina State University. He has been at NCSU for 35 years and specializes in forest management, hardwood silviculture and the restoration of forested wetland and stream systems. He has a Masters Degree in Forestry and Wildlife Management from West Virginia University and a PhD in Forestry and Pathology from the University of Idaho.

**Identifying Hot-Spots of Human Fecal Sources Impacting the Georgetown Drinking Water Supply**

**Sam Lee**

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Keywords: Microbial Source Tracking, Fecal Pollution, Karst
Duration: March 2012 – February 2013

*Abstract*: The City of Georgetown, KY relies on a vast karst spring network as a drinking water source. This karst feature has several inputs from sinkholes and streams in the Cane Run Watershed: a watershed associated with a variety of land uses in the recharge area. The recharge area encompasses the area from North Lexington to Georgetown and is composed of urban, suburban, agricultural and industrial usage. A serious water quality issue exists with respect to the impact of fecal contamination within the spring recharge area.

Problem Statement: Two previous studies conducted by my advisor, Dr. Brion, show that the sole source of drinking water for Georgetown, Royal Springs, is under human fecal influence. My project will determine if the source of this fecal load is within the recharge area of Royal Springs.

Project Objective:

The objective of this project is to identify hot-spots of fecal contamination and define the impact of these sources on the water quality received at the Georgetown Water Treatment Plant (WTP). This preliminary study follows an earlier study completed in the Cane Run Watershed with improved genetic classification tools. Previously inaccessible for sampling, an underground conduit is also available for the project. Access to this feature will provide samples that fully represent fecal load entering the Georgetown karst system. Similar to the previous study, this project will encompass screening the watershed to identify potential sources of untreated human and non-human sewage. Such sources often contain elevated levels of waterborne pathogens that are easily treatable – if first identified.

Goals and Outcomes:

Identification of fecal contamination is quantified by fecal load (E. coli), fecal source (two human host specific DNA markers) and fecal age (AC/TC ratio). These three criteria are used in a categorical model to assign a Sanitary Category Value (SCV) between 0 and 3 for each sample location. Low SCVs (<1.3) are associated with clean water, while high SCVs (>1.5) are associated with high values of fecal load, low fecal age and detectable concentration of human-specific markers. SCV measured during dry weather conditions are indicative of potentially leaking human sewers.

Work Plan:

Field sampling will be accomplished over four dry weather events at four (4) sampling sites within the Royal Springs Karstshed. These sites are comparable to previously selected and sampled sites in addition to the newly available conduit. Water samples collected from these will be taken back to the Environmental Research and Training Laboratories (ERTL) and processed within 24 Hours. This effort will span one year of sampling, laboratory analysis and investigation of these results to conclude in a proposal for a larger study.

*About the Author*: **Sam Lee** is a Civil Engineering Masters student at the University of Kentucky. He is specializing in Water Quality/Water Resources.

# Evaluating restored streams in North Carolina using the North Carolina Stream Assessment Method (NCSAM)

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*Abstract*: In 2011, North Carolina introduced the Stream Assessment Method (NCSAM), a state-wide, rapid, visual conditional assessment that utilizes Boolean logic for rating calculations. Throughout its development, NCSAM was extensively tested on natural systems of varying conditions, but has not yet been widely applied to restoration projects. To evaluate NCSAM's performance on restoration projects, 64 restored streams across the state were assessed using NCSAM, a GIS-based landcover assessment, and a benthic macroinvertebrate assessment. By incorporating assessments from all three levels of the ecological assessment framework—GIS (landcover), rapid (NCSAM), and intensive (macroinvertebrate)—distinct information from different spatial scales allows multiple comparisons with NCSAM to be made. Benthic macroinvertebrate assessments have long been used to gauge water quality and stream health within a reach. Separately, NCSAM and the GIS assessment will be modeled against the macroinvertebrate assessment to determine their respective levels of correlation. In addition, a priori (before construction) variables such as a project's ecoregion will be analyzed to determine if they may serve as 'flags' that a restoration project may warrant a more thorough post-construction evaluation than a level 1 GIS or level 2 rapid assessment can provide.

*About the Author*: **Mark Fernandez** is a graduate student pursuing a Master's degree in the Biological and Agricultural Engineering department at North Carolina State University**.** He received his Bachelor of Science in Civil Engineering from North Carolina State University. Currently his research seeks to use multivariate statistics to compare ecological assessments of varying intensities on restoration projects throughout North Carolina.

# Riparian 101: Homeowner Education for Streamside Re-Vegetation

**Katie Dylewski**

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*Co-authors:* Eve Brantley and Kaye Christian, Auburn University; Wendi Hartup and Mitch Woodward, North Carolina Cooperative Extension

*Abstract:* Regional Extension partners from Alabama, Florida, Georgia, and North Carolina developed an interactive streamside buffer repair kit to train local Extension professionals and stakeholders. The effectiveness of streamside vegetated buffers in reducing nonpoint source pollutant loads to streams is well known. The goal of this project was to provide Extension agents with tools to inform landowners on how they can address small stream instability issues before they become large, expensive problems that contribute to the degradation of local water quality. The Southeastern Tool for Research Preservation (STRP) kit includes modules related to plant selection, site preparation, and technical resources.

Tools created include a website, an onsite master kit, and a workshop template. The website was created to provide Extension professionals with information and resources specific to each state. Website topics include evaluating streambank erosion, native plant lists, native plant nurseries, native plant benefits, soils information, and live staking.

Currently, two Backyard Stream Repair workshops have been held both in North Carolina and Alabama where Extension professionals, local government employees, civil engineer consulting firms, landscape architects, and concerned citizens took part in hands-on activities to learn about streamside buffers, how to use native vegetation for small scale stream erosion, and when professional assistance is needed. To date, approximately 700 linear feet of streambanks have been repaired using native vegetation alone. A website (www.aces.edu/bufferkit) houses user-friendly information including workshop handouts, powerpoint presentations, Extension publications, and how to guides to use the buffer repair kit.

*About the Speaker:* **Katie Dylewski** is a Water Program Specialist at Auburn University in the Department of Agronomy and Soils. She studied Horticulture at Auburn University and graduated in 2010 with a M.S. in Horticulture. Her focus areas include watershed management, native plant selection, streamside vegetation, and low impact development.

# Live Stake Survivability of Four Indigenous Ornamental Shrub Species

**Jon Calabria, Ph.D., RLA**

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*Abstract*: Stream enhancement and riparian revegetation projects located in urban areas rely on ornamental shrub species to stabilize stream banks and improve habitat. Although some information exists on utilizing live stakes in these settings, practioneers have expressed an interest in optimizing species selection and placement in areas unsuited for tree species. This pilot study tested survivability of four ornamental shrub species in the Piedmont of Georgia by investigating cline and diameter on a south facing stream bank. The site is located under a transmission utility line and the trial occurred during drought conditions. Logit modeling results indicate survivability is highly variable when controlling for cline and diameter for *Cornus amomum* (Silky Dogwood), *Cephalanthus occidentalis* (Buttonbush), *Lindera benzoin* (Spicebush), and *Sambucus canadensis* (Elderberry). Initial findings are useful for specifying plant locations to optimize survivability and enhance habitat in these settings.

*About the Speaker:* **Jon Calabria** is a landscape architect and Assistant Professor in the College of Environment and Design at the University of Georgia. Dr. Calabria teaches undergraduate and graduate students about Green Infrastructure, ecological restoration, professional practice and construction techniques. He has landscape architecture degrees from UGA and Clemson and a PhD in Wildlife and Fisheries Biology from Clemson.

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