

# Stream Restoration in the Southeast: Connecting Communities with Ecosystems



November 15-18, 2010  
Marriott City Center Hotel  
Raleigh, 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

# Conference Agenda and Abstracts

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### Conference Hosts

North Carolina State University Stream Restoration Program  
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North Carolina Cooperative Extension  
USDA NIFA Southern Regional Water Program

### Conference Partners

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NC Division of Forest Resources  
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### Website

<http://www.ncsu.edu/srp/2010conference/>

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## About the Conference

Welcome to the 2010 Southeast Stream Restoration Conference in Raleigh, NC. This is the 9<sup>th</sup> conference on this topic since 1998 and the second time we have convened in Raleigh. This conference includes more than 300 attendees representing 20 states and 150 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 *Connecting Communities with Ecosystems*. The opening general session features a diverse group of invited speakers with expertise in municipal restoration programs, ecological function assessment, community-focused restoration design and landowner education. We encourage you to take advantage of the opportunities to network with all the presenters on this and other important restoration issues.

We thank the conference sponsors and exhibitors who are listed in the program. More than 40 companies, nonprofit organizations, and government agencies involved in all aspects of ecosystem restoration are providing sponsor support and exhibits throughout the conference.

We ask that you please complete the conference evaluation forms and turn those in before you leave to help improve future educational programs. Enjoy your time in Raleigh!

2010 Southeast Regional Stream Restoration Conference Coordinators:

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



*NOTES:*



<p><b>Tuesday, 1:30-3:00pm</b></p> <p><i>State Ballroom AB</i></p>	<p><b>Concurrent Session I</b>  <b>A. Communities and Streams – pp. 22-25</b>  <i>Moderator: Barbara Doll, NC Sea Grant</i></p> <p><i>Ted Brown, Biohabitats, Inc. – Stormwater facilities as community spaces</i></p> <p><i>Jon Calabria, University of Georgia – Explorations in community and environmental enhancement</i></p> <p><i>Matt Tobolski, Susan Hatchell Landscape Architecture – Regenerating urban ecosystems</i></p> <p><i>Joshua Gilman, MACTEC Engineering and Consulting, Inc. – Integrating urban communities with stream restoration – Innovations in technical and social paradigms</i></p>
<p><i>University Ballroom</i></p>	<p><b>B. Aquatic Ecosystem Functions – pp. 26-29</b>  <i>Moderator: Karen Hall, NC State University</i></p> <p><i>Will Harman, Stream Mechanics – The functional lift pyramid: A conceptual model for evaluating the benefits of stream restoration</i></p> <p><i>John Schwartz, University of Tennessee Knoxville – Use of fish functional traits for ecosystem restoration assessment: A focus on impairment due to suspended sediment</i></p> <p><i>Shane Keebaugh, Wildlands Engineering – The re-introduction of the federally threatened Cherokee darter at the Bannister Creek Mitigation Bank</i></p> <p><i>David Gillette, UNC Asheville – Impacts of stream restoration on fish and macroinvertebrate communities in five western North Carolina streams</i></p>
<p><i>State Ballroom C</i></p>	<p><b>C. Restoration Planning – pp. 30-35</b>  <i>Moderator: Beth McGee, NC Clean Water Management Trust Fund</i></p> <p><i>Nancy Daly, NC Ecosystem Enhancement Program – NC Ecosystem Enhancement Program watershed planning and the new federal mitigation rule</i></p> <p><i>Tom Van Arsdall, KY Dept. of Fish and Wildlife Resources – KY Dept. of Fish and Wildlife Resources wetland and stream mitigation program</i></p> <p><i>James Boenig, San Antonio River Authority – SARA Stream Restoration, a program approach</i></p> <p><i>Michael McDonald, NC Ecosystem Enhancement Program – The Ecosystem Enhancement Program’s local watershed planning approach to project implementation</i></p>
<p><b>3:00-3:30</b></p>	<p><b>Break Sponsored by Mayfly Sponsors</b></p>

<p><b>Tuesday, 3:30-5:00pm</b></p> <p><i>State Ballroom AB</i></p>	<p><b>Concurrent Session 2</b></p> <p><b>A. Community Engagement – pp. 36-41</b>  <i>Moderator: Jeff Jurek, NC Ecosystem Enhancement Program</i></p> <p><i>Greg Phillips, GBMc &amp; Associates – Natural form and function versus aesthetics, flooding concerns and public opinion in urban restoration projects</i></p> <p><i>Eve Brantley, Auburn University – Good streams make good neighbors</i></p> <p><i>Joel Tillery, CH2M HILL – The Friday funnies are back! Implementing stream restoration projects on private property</i></p> <p><i>Vincent Sortman, Biohabitats, Inc. – Stream daylighting at the Dell</i></p>
<p><i>University Ballroom</i></p>	<p><b>B. Water Quality – pp. 43-48</b>  <i>Moderator: Dave Penrose, Watershed Science</i></p> <p><i>Sara McMillan, UNC Charlotte – Is stream restoration enough? Linking restoration with watershed-based stormwater management in urban streams</i></p> <p><i>Sandra Clinton, UNC Charlotte – Linking microbes and ecosystem processes in restored urban streams: An analysis of denitrifier diversity</i></p> <p><i>Kris Bass, NCSU Water Quality Group – Water quality impacts of Coastal Plain stream restoration</i></p> <p><i>Melanie Small, UNC Chapel Hill – Restoring streams for reduced suspended sediment loads in the Triassic Basin: Time to re-evaluate our expectations</i></p>
<p><i>State Ballroom C</i></p>	<p><b>C. Dam Removal – pp. 49-54</b>  <i>Moderator: Jason Zink, NC State University</i></p> <p><i>Lynnette Batt, American Rivers – Connecting communities with rivers through dam removals and blue trails</i></p> <p><i>Nathan Jean, Stantec – Buckhorn Creek restoration</i></p> <p><i>Phillip Todd, SEPI Engineering &amp; Construction – Fish passage at lock and dam #1 on Cape Fear River</i></p> <p><i>Benjamin Leatherland, Env Services &amp; Consulting – Low head dams – By sky and paddle</i></p>
<p><b>5:00-6:30pm</b></p>	<p><b>Poster Presentations and Reception Sponsored by Stonefly, Mayfly, and Caddisfly Sponsors</b>  <i>(After hours: Cherry Bomb Grill, 301 W. Martin St. – about 4 blocks away)</i>  <i>Directions: Walk north on Fayetteville St, take a left on W. Martin St. Corner of Dawson and Martin.)</i></p>



DAY 3, Wednesday, November 17 (breakfast provided)	
8:00-9:30am	<p><b>Concurrent Session 3</b></p> <p><b>A. Urban Stream Challenges – pp. 55-61</b>  Moderator: Harry Tsomides, NC Ecosystem Enhancement Program</p> <p><i>State Ballroom AB</i> Warren High, MACTEC Engineering and Consulting, Inc. – Restoring function to an intensely urbanized stream – Mill Creek in Cincinnati, OH</p> <p>Emily Reinicker, Wildlands Engineering, Inc. and Beth Poovey, LandDesign, Inc. – She loves me, she loves me not: Charlotte’s love affair with Little Sugar Creek rekindled</p> <p>Robert Siegfried, Whitman Requardt &amp; Associates, LLP – Restoration of Neabsco Creek, Prince William County, Virginia</p> <p>Todd St. John, Kimley-Horn &amp; Associates, Inc. – Making stream restoration work for the community and environment</p>
<i>University Ballroom</i>	<p><b>B. Riparian Restoration – pp. 62-67</b>  Moderator: Eve Brantley, Auburn University</p> <p>Christopher Kaase, Appalachian State University – The effects of stream restoration on woody riparian vegetation in the northwestern North Carolina mountain region</p> <p>Karen Hall, NCSU Water Quality Group – A five-year study of container and bareroot vegetation survival on an NCSU stream mitigation project</p> <p>Joshua Rogers, City of Chattanooga – Small scale stream mitigation within a highly urbanized watershed</p> <p>Sherrie Emerine, NC State University – Biology and control of porcelain berry (<i>Ampelopsis brevipedunculata</i>), an invasive Vitaceae in North Carolina</p>
<i>State Ballroom C</i>	<p><b>C. Coastal Stream Restoration – pp. 69-75</b>  Moderator: Sarah King, NC Clean Water Management Trust Fund</p> <p>Jeff Furness, PotashCorp – Restoration of Coastal Plain headwater systems: Lessons learned and performance monitoring</p> <p>Joshua Gilman, MACTEC Engineering and Consulting, Inc. – New stream mitigation requirements in coastal South Carolina – Providing mitigation in an atmosphere of dynamic policy and emerging science</p> <p>Tracy Stapleton, NC DENR Ecosystem Enhancement Program – A NC Sandhills headwater stream and wetland restoration project: Background and monitoring strategy</p> <p>Joshua Robinson, BurnsRobinson, PC – Applying geomorphology and two-dimensional hydraulic modeling to the management of municipal Coastal Plain canals</p>

9:30-10:00am	Break Sponsored by Mayfly sponsors
<p>Wednesday, 10:00-11:45</p> <p>State Ballroom AB</p>	<p><b>Concurrent Session 4</b></p> <p><b>A. Community Restoration Case Studies – pp. 77-86</b>  <i>Moderator: Will Summer, NC Clean Water Management Trust Fund</i></p> <p><i>Becky Ward</i>, Ward Consulting Engineers, P.C. – Designing stream stabilizing measures for short stream segments in urban areas</p> <p><i>Travis Crayosky</i>, Williamsburg Environmental Group, Inc. – Powhatan Plantation stream restoration project</p> <p><i>Amit Sachan</i>, Dewberry – Challenges and constraints of urban stream restoration – Case Study: Roanoke Rapids reach 2 &amp; 5</p> <p><i>Joshua White</i>, Michael Baker Engineering, Inc. – The Ararat River project – Restoring a large river for a small community</p> <p><i>William Wilhelm</i>, Kimley-Horn and Associates, Inc. – Case studies in urban stream restoration</p>
<p>University Ballroom</p>	<p><b>B. Riparian Monitoring – pp. 87-96</b>  <i>Moderator: Tom Losordo, NC State University</i></p> <p><i>Daniel Ingram</i>, WK Dickson – A comparison of vegetation surveying methods for mitigation projects</p> <p><i>Zack Mondry</i>, NC Ecosystem Enhancement Program – Evaluating stream restoration: A need to tailor goals, monitoring, and success</p> <p><i>Forbes Boyle</i>, UNC-Chapel Hill – Advantages of monitoring vegetation restoration with the Carolina Vegetation Survey protocol</p> <p><i>Thomas Wentworth</i>, NC State University – Use of survival data for planted woody stems to refine a vegetation monitoring protocol for restoration sites</p> <p><i>Michael Wood</i>, Catena Group – Are you losing credits in the dirt? The value of a proper and comprehensive soil investigation</p>
<p>State Ballroom C</p>	<p><b>C. Rural Stream Restoration – pp. 97-105</b>  <i>Moderator: Deborah Daniel, NC Ecosystem Enhancement Program</i></p> <p><i>Harry Tsomides</i>, NC Ecosystem Enhancement Program – Multi-agency and stakeholder collaboration on a stream and Southern Appalachian Bog wetland restoration project in the New River basin of North Carolina</p> <p><i>Michael Geenen</i>, NC State University – An innovative, low cost stream restoration and mitigation in the Flint Hill Prairie region of North Central Oklahoma</p> <p><i>Suzanne Hoehne</i>, Biohabitats, Inc. – Rural stream restoration: Lessons learned in design and implementation</p>

	<p><i>Greg Jennings, NC State University – Stream and wetland restoration at Rendezvous Mountain Educational State Forest</i></p> <p><i>Darrell Westmoreland, North State Environmental – Innovative habitat structures in mountain streams</i></p>
<b>11:45-1:00</b>	<b>Lunch Sponsored by Stonefly Sponsors</b>
<b>Wednesday, 1:00-2:30pm</b>	<p><b>Concurrent Session 5</b></p> <p><b>A. Community Partners – pp. 106-109</b>  <i>Moderator: Bern Schumak, NC Clean Water Management Trust Fund</i></p>
<i>State Ballroom AB</i>	<p><i>Warren High, MACTEC Engineering and Consulting, Inc. – Economics of urban stream restoration – Realizing benefits and optimizing funding</i></p> <p><i>Kayne Van Stell, Michael Baker Engineering – Restoring streams in a community park setting: Lessons learned in public perception</i></p> <p><i>Carmen Agouridis, University of Kentucky – Cane Run Watershed Assessment and Restoration Project: Improving community awareness and education</i></p> <p><i>Jess Roberts, Auburn University – Parkerson Mill Creek: Replacing problem with opportunity</i></p>
	<p><b>B. Planning and Technology – pp. 111-116</b>  <i>Moderator: Bill Gilmore, NC Ecosystem Enhancement Program</i></p>
<i>University Ballroom</i>	<p><i>Colleen Kiley, NC Ecosystem Enhancement Program – Spatially tracking statewide stream restoration</i></p> <p><i>Michelle Drostin, NC Ecosystem Enhancement Program – The implementation of five diverse watershed plans in the Upper Neuse: Measures of effort and success</i></p> <p><i>Jason Doll, Moffat and Nichol – The evolution of stream assessments in the context of watershed planning</i></p> <p><i>Frank Henning, Region IV Land Grant Universities – Southern Regional Watershed Education efforts to improve stormwater management and elevate ecological function of streams</i></p>
	<p><b>C. Ecosystem Modeling – pp. 117-124</b>  <i>Moderator: Deborah Amaral, NC Ecosystem Enhancement Program</i></p>
<i>State Ballroom C</i>	<p><i>Brian Belcher, Beaver Creek Hydrology, LLC – NCD 2010: A model for predicting river geometry using hydrodynamics and particle separation technology</i></p> <p><i>Keil Neff, University of Tennessee – Restoring pool-riffle habitat in Beaver Creek, Knox County, Tennessee: Lessons learned in a planform-constrained urban stream</i></p>

	<p><i>Michael Chelminski</i>, Stantec – The applicability of 2D and 3D models in evaluating stream restoration designs</p> <p><i>Chris Estes</i>, Estes Design, Inc. – Designing scour, putting research into practice</p>
<b>2:30-3:00pm</b>	<b>Break Sponsored by Mayfly Sponsors</b>
<b>Wednesday, 3:00-4:30pm</b>	<p><b>Concurrent Session 6</b></p> <p><b>A. Stream Design Innovations – pp. 125-130</b>  Moderator: <i>Zan Price</i>, NC State University</p>
<i>State Ballroom AB</i>	<p><i>George Athanasakes</i>, Stantec – Application of the FLOWSED and POWERSED models in river stability, bridge design and river restoration</p> <p><i>David Bidelspach</i>, Stantec – Geomorphic lessons learned from floodplain interactions and urban stream natural channel restoration</p> <p><i>Dani Wise-Johnson</i>, VHB, Inc. – Refining data collection for urban stream restoration projects: Use of acoustic doppler current meter and traditionally collected velocity data</p> <p><i>Kelly Ramsey</i>, USDA Natural Resources Conservation Service – Evaluation of NRCS stream work in southwest Virginia</p>
	<p><b>B. Riparian Restoration Tools – pp. 131-135</b>  Moderator: <i>Kevin Boyer</i>, NC Clean Water Management Trust Fund</p>
<i>University Ballroom</i>	<p><i>Periann Russell</i>, NC Division of Water Quality – Development and application of headwater stream models in North Carolina</p> <p><i>Kyle McKay</i>, US Army Corps of Engineers – Developing a Piedmont stream conceptual model</p> <p><i>Robert Peet</i>, UNC Chapel Hill – Application of Carolina Vegetation Survey inventory data for generation and evaluation of restoration targets</p> <p><i>Elizabeth Matthews</i>, UNC Chapel Hill – An expert system for generating restoration targets for Carolina Piedmont riparian vegetation</p>
	<p><b>C. Monitoring and Evaluation – pp. 136-142</b>  Moderator: <i>Marc Recktenwald</i>, NC Ecosystem Enhancement Program</p>
<i>State Ballroom C</i>	<p><i>Elisa Aylin Lewallen</i>, Brown and Caldwell – Streambank erosion monitoring in Gwinnett County, Georgia</p> <p><i>Jill Stachura</i>, Brown and Caldwell – Watershed improvement planning and project implementation to target sediment load reductions in Gwinnett County, Georgia streams – A case study of improvements at a County park</p>

	<p><i>Scott Peyton, Stantec – Application of the Watershed Assessment of River Stability and Sediment Supply (WARSSS) Model to a transportation planning project</i></p> <p><i>Eric Kulz and Tammy Hill, NC Division of Water Quality – Compensatory stream and wetland mitigation in North Carolina: An evaluation of regulatory success</i></p>
<b>DAY 4, Thursday, November 18</b>	
8:30am-12:00pm	<p><b>Field Tour: Tour of three highly urbanized stream restorations in Raleigh, NC</b></p> <p>Please meet in the hotel lobby between 8-8:15am.</p>

Please see our list of Poster Presentations on pp. 143-160  
and our Exhibitor contact information on pp. 161-163.

#### CONTINUING EDUCATION CREDITS

11 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 either the Pre-conference workshop #1 or the fieldtrip. 10 CEUs are approved for Landscape Architects by the NC Board of Landscape Architects (Course # 7490). Other professionals may appeal to their respective boards to obtain professional education credits.

## Urban Stream Restoration: A Focus on Rocky Branch

Barbara Doll, PE

North Carolina Sea Grant  
Flex Lab Building, Module 1  
NC State University, Box 8605  
Raleigh NC 27695-8605  
barbara\_doll@ncsu.edu

*Abstract:* Urban development has taken its toll on creeks, streams and rivers across the nation. Parking lots, roads and rooftops cause stormwater to course through stream channels, causing the erosion of stream banks, which can contribute a large portion of sediment load in many stream systems. Many of these streams suffer a complete loss of ecological function as they end up buried in culvert pipe or armored with concrete and riprap. Highly degraded urban streams have frequently been forgotten and neglected in the urban landscape. This presentation will focus on techniques for revitalizing urban streams with a special focus on approaches for reconnecting people with these “lost” ecosystems. Several restoration case studies from around the globe will be explored with a special focus on Rocky Branch restoration on NC State University.

North Carolina Sea Grant and NC State University have recently completed the implementation of a three-phase stream restoration and greenway plan to renovate Rocky Branch, an urban creek that runs more than a mile through the heart of the university campus. The ultimate goal of the project is to create a safe and accessible outdoor teaching laboratory. The restoration has focused on stabilizing the creek; improving water quality, aquatic and wildlife habitat; and integrating the creek into the campus environment. In addition to fixing the creek, 6000 feet of greenway have been built and connected to Pullen Park and the City of Raleigh Greenway System. Phase I, from Gorman St. to Dan Allen Dr., was completed in spring of 2002. Phase II, from Morrill Dr. to Pullen Rd., was completed in 2006. Phase III, the connecting segment from Dan Allen Dr. to Morrill Dr. was completed earlier this year.

Rocky Branch drains into Walnut Creek, which is a tributary of the Neuse River. In 1978 the Division of Water Quality classified Rocky Branch as one of the state’s most polluted urban streams. The stream was channelized and its floodplains filled. It has experienced heavy development within its drainage area. As a result, the stream is narrow, deep, suffering from severe erosion and is an unsafe eyesore on the campus.

Using natural channel design techniques, the restoration allows the stream to meander through a newly created floodplain. Native vegetation provides habitat, cover and food for wildlife. Plantings have increased the width of the forested buffer zone, creating a wildlife corridor and shading the creek. The greenway path along the restored creek provides a transportation alternative and brings people close to the creek. Interpretative signs installed along the

greenway explain the restoration concepts. A pedestrian underpass installed at Pullen Road connects the Rocky Branch trail to Pullen Park and the Raleigh Greenway System, expanding the network of public green space. The underpass brings people closer to the stream and allows safe passage for pedestrians and wildlife beneath a major thoroughfare. Phase III “daylighted” 235-feet of stream. The stream was removed from culvert pipes and recreated to have a streambed and a small floodplain. This unearthing of the channel has further increased visibility and access to the creek.

In addition, Rocky Branch provides educational opportunities for many citizen groups, reaching hundreds of people each year. Local school groups, professional organizations and representatives from other universities often attend tours of the restored sections.

North Carolina Sea Grant and the NC State University’s Facilities Division have worked together to obtain more than \$8.5 million dollars for the project from both federal and state agencies, including the NC Department of Transportation (TEA 21 and stream mitigation funds), NC Clean Water Management Trust Fund (CWMTF), Environmental Protection Agency 319 (through NC Department of Environment and Natural Resources, DENR), City of Raleigh, Federal Emergency Management Agency (FEMA), the NC Division of Water Resources, DENR and NC State University stormwater and capital improvement funds.

*About the Speaker:* A licensed professional engineer, **Barbara Doll** 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.

Doll has both a bachelor’s and a master’s in civil engineering from NC State, and she is currently working towards a Ph.D. in the Biological and Agricultural Engineering Department. Prior to joining Sea Grant, Doll worked as a staff engineer for Soil and Material Engineers in Raleigh, N.C. and as a research assistant in the Civil Engineering department at NC State.

# Raleigh Stormwater Program's Stream Restoration Projects

## Mark Senior, PE

Stormwater Services Division  
City of Raleigh Public Works Department  
PO Box 590  
Raleigh NC 27602  
mark.senior@raleighnc.gov

*Abstract:* What constitutes stream “restoration”? – Webster’s Dictionary defines restoration as: - “to bring back to a former, normal, or unimpaired condition”. Based on this definition, accomplishing a true stream restoration is probably impossible in an urban setting. In some cases, trying to achieve true stream restoration may cause more harm than good. Accordingly, Raleigh has scaled back its stream restoration goals to “restoring” degraded urban streams to the maximum extent practicable while:

- Recognizing existing site constraints (available space and existing uses)
- Retaining as much mature vegetation as possible, and
- Recognizing the need to “overdesign” for the powerful flows that urban streams are subject to.

In some cases, this means applying a smaller scale “fix” than would normally be envisioned. In more extreme cases, it means diverging from traditional stream restoration techniques, such as laying back the banks and planting vegetation, and instead resorting to more exotic solutions.

This presentation will look at several recent urban stream “restorations” where unique approaches and techniques have been utilized in order to address the many challenges posed by the urban environment.

*About the Speaker:* **Mark Senior**, PE, is a Senior Project Engineer and leader of the Surface Water Quality Group for the City of Raleigh's Stormwater Utility within the Public Works Department. Mark has been employed with the City of Raleigh in various water resources positions since 1984. Mark's recent projects include water quality retrofits involving stream daylighting, stream restoration/stabilization, constructed wetlands, green roofs, rain gardens and cisterns. He is a member of the State Sediment Control Technical Advisory Committee and the Upper Neuse Technical Advisory Committee. He has a bachelor of science degree from Rutgers University and a master's of science degree from NC State University.





# Restoration of Ecosystem Functions in an Urban Riparian Stream Complex in the Piedmont of North Carolina

Curtis Richardson, Ph.D.

Nicholas School of the Environment  
Box 90333  
Levine Science Research Center, Duke University  
Durham, NC 27708-0333  
curtr@duke.edu

*Abstract:* Water quality in Upper Sandy Creek, a headwater stream for the Cape Fear River in the North Carolina Piedmont, is impaired due to high N and P concentrations, sediment load, and coliform bacteria. The creek and floodplain ecosystem had become dysfunctional due to the effects of altered storm water delivery following urban watershed development where the impervious surface reached nearly 30% in some sub-watersheds. At Duke University an 8-ha Stream and Wetland Assessment Management Park (SWAMP) was created in the lower portion of the watershed to assess the cumulative effect of restoring multiple portions of stream and former adjacent wetlands, with specific goals of quantifying water quality improvements. To accomplish these goals a three-phase stream/riparian floodplain restoration (600 m), storm water reservoir/wetland complex (1.6 ha) along with a surface flow treatment wetland (0.5 ha) was ecologically designed to increase the stream wetland connection, and restore groundwater wetland hydrology. The multi-phased restoration of Sandy Creek and adjacent wetlands resulted in functioning riparian hydrology, which reduced downstream water pulses, nutrients, coliform bacteria, sediment, and stream erosion. Storm water event nutrient budgets indicated a substantial attenuation of N and P within the SWAMP project. Most notably, (NO<sub>2</sub><sup>-</sup> + NO<sub>3</sub><sup>-</sup>)-N loads were reduced by 64% and P loads were reduced by 28%. Sediment retention in the storm water reservoir and riparian wetlands showed accretion rates of 1.8 cm yr<sup>-1</sup> and 1.1 cm yr<sup>-1</sup>, respectively. Nearly 500 metric tons of sediment are retained in the wetland/water reservoir complex each year.

*About the Speaker:* **Curtis Richardson, Ph.D.**, is Professor of Resource Ecology at Duke University in the Nicholas School of the Environment and Earth Sciences ([www.nicholas.duke.edu/](http://www.nicholas.duke.edu/)) and is Director of the Wetland Center ([www.env.duke.edu/wetland/](http://www.env.duke.edu/wetland/)). He earned his Ph.D. in Ecology from University of Tennessee. At Duke he has taught courses in wetland ecology and management, wetland restoration and applied ecology for nearly 3 decades. He is an internationally acclaimed ecologist and wetland soil scientist who has dedicated his research career to conducting studies on phosphorus biogeochemistry and wetland restoration ecosystems around the world. Major research efforts have focused on wetlands as nutrient sinks and transformers on the landscape. He has spent considerable efforts translating this research into realistic management techniques that can be used to sustain ecological functions in wetland ecosystems on the landscape. He has directed research on some of the most important wetland issues of our time, including long-term studies on the effects of wastewater in wetlands in

Michigan, Pocosin peatlands losses in North Carolina, the restoration of the Everglades of Florida and more recently scientific assessment of wetland restoration in the Iraq marshes. He is author or co-author of over 150 peer reviewed papers and reports. His recent book is published by Springer is entitled "the Everglades Experiments: Lessons for Restoration. He has been listed in Who's Who in Science annually since 1989 and was elected President of the Society of Wetland Scientists in 1987-88. In 2006, he received the National Wetlands Scientist of the Year Award from the Environmental Law Institute. Dr. Richardson is a Fellow of the Society of Wetland Scientists, the Soil Science Society of America, and the American Association for the Advancement of Science.

## Greenways: Tools for Integrating Communities into Stream Restoration and Preservation Projects

**Chuck A. Flink, FASLA**

Chuck Flink  
Greenways Incorporated  
5850 Fayetteville Road, Suite 211  
Durham, North Carolina 27713  
chuck.flink@greenways.com

*Abstract:* Greenways are multi-objective corridors that are often times built along streams and rivers, often times within the floodplain. As such, they offer the possibility for use as an environmental education resource – an outdoor classroom that can bring people in close and meaningful contact with riparian landscapes. This is one of the more undervalued roles that greenways can play. Coupled with an appropriate outreach and education program, greenways can become an important vehicle for teaching citizens about geomorphology, riparian ecology and the impacts that urban development has on natural systems.

*About the Speaker:* **Chuck Flink, PL**, is founder and owner of Greenways Incorporated, and is recognized as a leading national authority for the planning, design and implementation of greenway and trail systems and facilities. He has worked on greenway projects in 125 communities and 35 states. He has also worked on greenway projects in Argentina, Canada, Japan and the Island of St. Croix. Chuck has shared his extensive knowledge on greenway design development as a featured and keynote speaker at more than 100 national and international conferences. As a registered landscape architect in three states, Chuck has been involved in planning for more than 1,500 miles of multi-use greenway corridors throughout the United States.

## Effective Restoration in Rural Watersheds

**J. Richard Everhart**

1830 Zephyr Mountain Park Road  
State Road, NC 28676  
jreverhart@triad.rr.com

*Abstract:* The Mitchell River and its watershed, located in Surry County in northwest North Carolina, was designated an Outstanding Resource Water over 20 years ago. Since that time the river and its watershed have been the focus of local efforts to protect and improve water quality through stream restoration, land protection and the application of agricultural best management practices. The lessons learned in this effort are now being implemented throughout Surry County to improve water quality in the Fisher and Ararat Rivers and to enhance recreational opportunities along with the economies of Mount Airy, Elkin and the other small towns in Surry County.

*About the Speaker:* **Dick Everhart** is a retired District Conservationist with the USDA Natural Resource Conservation Service (NRCS) in Stanly & Surry Counties, NC. For 28 years, Dick focused on natural resource inventory, and conservation planning and application working with both private landowners and state and local governments. Partnered with many state, local and non-profit programs, Dick has inventoried and monitored bog turtles and developed better management programs for their wetland habitats in Surry and neighboring counties. In addition, Dick was a founding member and has served as a key leader for the Mitchell River Coalition, where he has worked to implement stream restoration and land protection programs. Dick received a B.S. in Biological Sciences from Hobart College, Geneva, NY.

# Developing Master Plans for Community-based Stream Restoration Designs

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

Wildland Hydrology Consultants  
11210 N. County Road 19  
Fort Collins, CO 80524  
wildlandhydrology@wildlandhydrology.com

*Abstract:* Common problems and objectives must be resolved with common solutions. Such solutions are based on an understanding of 1) shared objectives, 2) the specific causes of impairment, 3) the stream potential within imposed constraints, and 4) the economic, social and political settings of the watershed community. Group dynamics become a positive force when a general consensus is met on potential attainable solutions. Large-scale restoration “master plans” involving numerous owners and many miles of stream systems have been more effective to meet efficient, economical and sustainable solutions as opposed to the “piecemeal” approach of individual reach designs, permits and implementation. Master plans also provide an added opportunity for many Federal, State and Private entities to provide financial contributions and support that would not generally be available to much smaller individual projects. Examples are presented and discussed where this approach has been successfully implemented.

*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 43 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.

# Stormwater Facilities as Community Spaces

**Ted Brown, PE, LEED AP**

Biohabitats, Inc.  
The Stables Building, 2081 Clipper Park Rd.  
Baltimore, MD 21211  
tbrown@biohabitats.com

*Abstract:* Stormwater management can be more than holes in the ground. At its best, stormwater can be incorporated into community spaces to enhance habitat, create recreational opportunities, add beauty and interest, and function as a community asset. This talk will provide real-world examples for stormwater practices that are fun, artistic, and still provide water quality and quantity control. The talk will review the concepts of living infrastructure, working landscapes, and stacked benefits. General examples will be reviewed, followed by more detailed case studies of integrated landscapes where ecological restoration and stormwater management functions are prominent within community spaces. The discussion will also touch on how to overcome common obstacles and think outside the box for these types of restoration projects. The role that LEED and Sustainable Sites designations can have in these types of projects will also be discussed.

*About the Speaker:* **Ted Brown** has over 16 years of experience in environmental restoration, watershed management and planning and stormwater management services. For the last four years, Ted has served as a project manager and water resource engineer at Biohabitats. He has been involved in stormwater BMP and green infrastructure planning and design projects for New York City in support of their long term control plan, watershed planning and policy development for Montgomery County, Maryland in support of the latest generation of NPDES MS4 permit, and several stormwater and ecological master planning efforts for major Universities including: the University of North Carolina at Chapel Hill, Wake Forest University, Rutgers University, and the University of Delaware. In each of these institutional master planning efforts, green infrastructure and ecological sustainability have been focal points of the campus strategy and institutional vision. Prior to joining the Biohabitats Team, he worked for eight years at the Center for Watershed Protection, a nationally recognized non-profit that develops innovative technical guidance relating to watershed assessment and management, stormwater management, NPDES regulatory compliance, and natural resource conservation.

## Explorations in Community and Environmental Enhancement

Jon Calabria, Ph.D., ASLA

University of Georgia  
School of Environmental Design  
0409 Caldwell Hall, 302 Herty Dr.  
Athens GA 30602  
jcalabr@uga.edu

*Abstract:* Renewed interest in the integration of stream systems and human settlement patterns underpins many advances to minimize anthropogenic impacts on aquatic resources. Some of these enhancements and restoration activities are compelled by regulatory measures. Other activities are voluntary or market driven. Either way, these interventions seek to reintroduce extant ecological functions into the landscapes that sustain communities. The recognition of ecosystem services and underlying functions that sustain communities is often called green infrastructure. Aquatic resources provide many of these functions; however land use has compromised their ability to fully function. A suite of low impact development BMP's can offset some of these negative land use effects. Additionally, if these BMP's are integrated into the landscape and community fabric, they will have greater acceptance by people who can steward and enjoy them. If people become aware of the landscape function and the varied, but aligned values of enhancing and restoring these functions, we can begin to approach sustainability.

The challenge of balancing ecology and communities is wide ranging. Examples along the continuum of approaching sustainability include a retrospective critique on the Owens Bell Project in Asheville, NC that has thrived for the past five growing seasons. This project relied on natural channel design techniques to provide an armature for water quality treatment and habitat creation in a park bordered by infill redevelopment. This project sought to incorporate and align many of the stakeholders' goals in an urban context. The design also responded to human visual preferences to create a dynamic landscape that recognizes ecological succession trajectories. Half a decade later, the challenges of maintenance are evident and the alignment of overlapping values has yet to be fully valued by some of the stakeholders.

*About the Speaker:* Dr. Jon Calabria holds degrees from Clemson and University of Georgia, where he has recently returned to teach at the College of Environment and Design. Prior to teaching at UGA, Jon was the French Broad River Watershed Training Center Coordinator in Western North Carolina. He managed full delivery, water quality based education and demonstration projects for the Biological and Agricultural Engineering Department at North Carolina State and has constructed projects to educate others about improving water quality and habitat potential within the human context. Low Impact Development techniques and practices underpin Jon's work in surface water systems and the landscapes that feed them.



## Regenerating Urban Ecosystems, Reviving Urban Communities:

Matt Tobolski, ASLA

Susan Hatchell Landscape Architecture  
4716 Sinclair Dr.  
Raleigh, NC 27616  
mbtobol@gmail.com

*Abstract:* The effects of stormwater on urban water system health have been well documented. This project examines major areas of research within stream restoration and their potential application of riparian regeneration in heavily urbanized areas. The goal of this project is two-fold; to explore the feasibility of addressing urban stormwater conditions as well as providing a network of protected lands that are managed for multiple uses including: landscape protection, biodiversity management, recreation, connectivity, and cultural/historic resource protection.

This project looks at the relationship of ecology and design in order to form a better understanding of the role of humans' in creating, transforming and restoring landscapes, and the value of aesthetics in the restoration of urban stream corridors. These corridors often serve as the backbone for local and regional greenway networks; which can offer the required connectivity and provide the alternative basis for an integrated system of urban green spaces.

The development greenways coupled with stream restoration bring together a range of formerly divergent disciplines such as civil engineering, landscape architecture and wetland ecology to address complex problems posed by expanding human development, urbanization and brownfield redevelopment. This paper includes a case study review of projects where integration of these disciplines has occurred and resulted in successful regeneration of urban streams. The selected projects have been able address the ecological health, hydrologic requirement as well as social needs of the community and serve as models for future urban stream restoration projects.

*About the Speaker:* **Matt Tobolski**, Assoc. ASLA is a project designer with Susan Hatchell Landscape Architecture, PLLC (SHLA). His responsibilities include layout, design and GIS production for greenway, park and university projects. He recently received his Master's of Landscape Architecture from North Carolina State University with a focus on stormwater management and stream restoration in urban environments.

## Integrating Urban Communities with Stream Restoration – Innovations in Technical and Social Paradigms

**Joshua B. Gilman, PE, D.WRE**

MACTEC Engineering and Consulting, Inc.  
2801 Yorkmont Road, Suite 100  
Charlotte, NC 28208  
jbgilman@MACTEC.com

*Abstract:* Restoration may be defined as the reestablishment of predisturbance natural functions and related chemical, biological, and physical processes lost or damaged as a result of watershed management and human activities (National Research Council 1992) such as urban development and agricultural practices. In the context of streams, the potential to reestablish natural functions relies on the dominant physical processes (water and sediment discharge regime) which are often in a state of flux, or otherwise permanently altered. For this reason, the approach and design philosophy applied to urban stream restoration should only incorporate natural channel design as one of several considerations, with additional emphasis on analytical tools to define the current and future watershed conditions and corresponding stream restoration design. Similarly, matters of social paradigm, public policy, property ownership, human services (water, sewer, power, etc.) and constructability should be considered when shaping project goals, objectives, and success expectations.

This presentation provides insight into how various project elements contribute to project success for a range of stream restoration projects, comparing hypothetical rural and urban stream restoration projects, with reference to specific examples (East Fork Little Sandy River, KY; Meetinghouse Branch, MD; and others). While the overall project goals for such a diverse range of endeavors is commonly “restoration” the means and timeline by which that is accomplished may be drastically different. By highlighting the similarities and differences between rural and urban stream restoration processes, this presentation promotes innovations in technical and social paradigms which collectively serve to integrate urban communities with stream systems.

*About the Speaker:* **Mr. Gilman** is currently a senior water resources engineer with the Charlotte, North Carolina branch of MACTEC Engineering and Consulting, Inc. with more than thirteen years of experience ranging from watershed planning and management to implementation through natural channel design and urban stream stabilization. Mr. Gilman provides management leadership and technical support in the design, construction, and monitoring of stream and wetland restoration and enhancement projects.

# The Functional Lift Pyramid: A Conceptual Model for Evaluating the Benefits of Stream Restoration

Will Harman, P.G.

Stream Mechanics  
5645 Normanshire Drive  
Raleigh, NC 27606  
wharman@stream-mechanics.com

*Abstract:* Federal mitigation guidelines require stream restoration practitioners to determine the functional improvement of their project. Functional lift is therefore defined as the difference in the pre-restoration functional condition and the post restoration functional condition. The functional lift can then be used to develop stream mitigation credits. Beyond mitigation, most other restoration projects are grant funded. The determination of functional lift is still important to these projects, to quantify the overall benefit of restoration.

The functional lift pyramid provides a framework for assessing stream functions. The pyramid shows that restoration of functions most occur in a certain order for maximum functional lift to occur. Hydrology functions create the base of the pyramid. These functions determine how much water is produced by the watershed and include measures such as the rainfall-runoff relationship and bankfull discharge determination. Hydraulic functions are shown above hydrology functions and describe the flow dynamics in the channel and floodplain where floodplain connectivity and flow dynamics are critical measures. Geomorphic functions are next and integrate the hydrology and hydraulic functions to transport sediment and create diverse bed forms. Once this structure is in place, physiochemical functions can improve; e.g. increased dissolved oxygen, lower stream temperature, denitrification, and organic processing. At the top of the pyramid are the biological functions because they rely on all of the below functions. These functions include the life cycles of fish and macroinvertebrates, riparian condition, and more.

The functional lift pyramid helps practitioners set goals to ensure that the design addresses the appropriate functions. In addition, the pyramid can be used to design monitoring plans that quantify functional lift. A detailed case study will be provided to illustrate these concepts.

*About the Speaker:* **Mr. Harman** is the founder and Principal of Stream Mechanics. Prior to forming Stream Mechanics, he was Vice President of Ecosystem Restoration with Michael Baker Corporation. In the course of his 19-year career, he has participated in hundreds of stream restoration projects, representing a wide variety of settings and techniques. He teaches stream restoration workshops and gives lectures to federal, state, and local agencies, universities, and private engineering firms. He has a Masters degree in Geography from the University of North Carolina at Charlotte and Bachelors degree in Geography from Appalachian State University. He is a licensed Geologist in North Carolina.

# Use of Fish Functional Traits for Ecosystem Restoration Assessment: A Focus on Impairment Due to Suspended Sediment

John S. Schwartz, Ph.D., PE

University of Tennessee Knoxville  
Dept. of Civil & Environmental Engineering, 63 Perkins Hall  
Knoxville, Tennessee 37996-2010  
jschwart@utk.edu

*Abstract:* Loss of ecological integrity due to excessive suspended sediment in rivers and streams is a major cause of water quality impairment in the United States. Although 32 states have developed numeric criteria for turbidity or suspended solids, or both according to the USEPA (2006), criteria is typically written as a percent exceedance above background and what constitutes background is not well defined. Defining a background level is problematic considering suspended sediments and related turbidity levels change with flow stage and season, and limited scientific data exists on relationships between sediment exposure and biotic response. A species-based stressor analysis may identify the need to improve water quality and physical habitat conditions locally for one or more species, but limit outcomes quantifying what ecological functions have potentially been lost, and need to be uplifted. An assessment framework based on fish functional traits is proposed in order to identify biological impairment due to excessive suspended sediment. Outcomes from this assessment approach can be used to interpret and guide watershed-scale restoration planning, quantifying biological-based targets for ecological uplift. Illustrating this approach, results from a study in the Great Plains will be presented, in which site occurrences of 20 fish traits were correlated with suspended sediment transport metrics. Sediment metrics were parameterized by magnitude-frequency and duration. Ecological interpretations of significant correlations with trait occurrence and sediment metrics were used to regionally identify stream restoration needs. In addition, an example will be presented on the use of fish functional traits for an urban stream restoration with 3 years pre-construction and 2 year post-construction monitoring data, a temporal-based analysis. The proposed assessment framework utilizing fish functional traits provides a means to evaluate potential ecological gains from various reach-scale restoration designs, and support project objectives that require aquatic life enhancement in sediment-impaired streams.

*About the Speaker:* Dr. John Schwartz is an associate professor in the Department of Civil and Environmental Engineering at the University of Tennessee. He has a PhD in Environmental Engineering from the University of Illinois at Urbana-Champaign (2002), a MS in Fisheries Science with a minor in Water Resources from Oregon State University (1991), and a BS in Civil Engineering from the University of Missouri at Columbia (1982). At the University of Tennessee, Dr. Schwartz's research areas include: ecohydraulic-based stream restoration, ecological engineering, river mechanics, and water quality.

# The Re-introduction of the Federally Threatened Cherokee Darter at the Bannister Creek Mitigation Bank

Shane Keebaugh

Wildlands Engineering  
1305 Lakes Parkway, Suite 129  
Lawrenceville, GA 20043  
skeebaugh@wildlandsinc.com

*Abstract:* The Bannister Creek Mitigation Bank (BCMB) is located in the Etowah watershed in northern Georgia. As a 404 compensatory mitigation bank, BCMB restored approximately 10,00 LF of stream using priority I and II techniques and preserved an additional 6,000 LF. The project restored Bannister (DA=5mi<sup>2</sup>) and Brewton (DA=8mi<sup>2</sup>) Creeks which are part of the historic range of the federally threatened Cherokee Darter (*Etheostoma scotti*). During baseline sampling three individuals were found in the preservation reach of Brewton Creek, which is located immediately upstream of the restoration reach. As a result, several design considerations were made to account for the potential to restore Cherokee Darter habitat including the incorporation of large woody debris, avoiding passage barriers, and adjustments to profile to insure adequate bedform diversity was present for the species. The restoration was completed in December 2008. Six months after construction was completed, BCMB was chosen as the site to relocate a population of Cherokee Darters that were to be destroyed by the inundation of the newly impounded Hickory Log Creek Reservoir. BCMB is in year two of the seven year monitoring period required by the USACE Savannah District. This monitoring will assess the geomorphic condition of the restored channels, fisheries and macrobenthic invertebrate communities, and riparian buffer re-vegetation. Additional fisheries monitoring is being conducted to determine the success of the darter relocation including genetic analyses and long-term viability of the population. To date, baseline sampling, two years of post-restoration fisheries monitoring has been completed. Preliminary analysis of the monitoring has shown an increase in total site fish taxa from 21 to 28 species. Additionally, one year after relocation, darters are still present on the site and were found in post spawn condition. Discussion will focus on the documented biological improvements following restoration activities.

*About the Speaker:* Mr. Keebaugh has 8 years of professional experience in environmental planning, mitigation banking, and ecological restoration focusing on environmental permitting and aquatic restoration. Mr. Keebaugh's areas of expertise include aquatic ecology, wetland and stream mitigation and mitigation banking, wetland restoration and design, stream restoration utilizing natural channel design and bioengineering techniques, wetland and stream construction observation, threatened and endangered species surveys and consultation, fisheries assessments, benthic macroinvertebrate assessments and monitoring, water quality monitoring, environmental sensing and data logging implementation, Section 404 permitting, and GPS/GIS application and natural resource mapping.

# Impacts of Stream Restoration on Fish and Macroinvertebrate Communities in Five Western North Carolina Streams

David Gillette, Ph.D.

UNC-Asheville  
One University Heights, CPO #2330  
Asheville, NC 28804  
dgillett@unca.edu

*Co-author(s):* David P. Gillette, Paul D. Tobler

*Abstract:* Although improvement of in-stream biotic communities is a common goal of many restoration projects, it is widely acknowledged that post-restoration monitoring is often inadequate to assess project outcomes relative to this goal. In the present study, we sampled five stream restoration projects in the French Broad River Basin of western North Carolina, and compared the fish and macroinvertebrate communities at these restored sites to those of nearby degraded stream reaches. We found no significant differences in invertebrate-based measures of habitat quality, such as Percent of invertebrates belonging to the orders Ephemeroptera, Plecoptera and Trichoptera (% EPT), and the Family-based Index of Biotic Integrity (FBIBI). The total number of fish species was slightly higher in restored reaches, while total fish abundance was higher at degraded sites. Analysis of fish species based on their ecosystem role (“functional group”) showed significant differences between restored and degraded sites, with degraded sites having more benthic pickers and grazers, and restored sites having more suction piscivores. Our results suggest that stream restoration practices can lead to change in biotic communities, but that other factors may limit the extent of this impact. We discuss some of these factors, including non-point pollution, and availability of source populations from which fishes and invertebrates can migrate to restored sites.

*About the Speaker:* **David Gillette** is Assistant Professor of Environmental Studies at the University of North Carolina at Asheville. Dr. Gillette is a stream ecologist, focusing his research on the impacts of human activities on river and stream ecosystems, and how these ecosystems recover from such impacts. He is currently involved in a multi-year project assessing ecosystem response to removal of a dam on the North Toe River in Yancey County, NC. Dr. Gillette’s research focuses primarily on fishes and macroinvertebrates. He holds a B.S. in Biology from Bates College in Lewiston, ME, a M.S. in Biology from Emporia State University in Kansas, and a Ph.D. in Ecology and Evolutionary Biology from the University of Oklahoma. Dr. Gillette’s research has been published in peer-reviewed journals such as *Transactions of the American Fisheries Society*, *Journal of Fish Biology*, and *Copeia*.

## NC Ecosystem Enhancement Program Watershed Planning and the New Federal Mitigation Rule

Nancy N. Daly

NC Ecosystem Enhancement Program  
1652 Mail Service Center  
Raleigh, NC 27699  
nancy.daly@ncdenr.gov

*Abstract:* Watershed planning has been a cornerstone of the NC Ecosystem Enhancement Program (EEP) and its predecessor program the Wetland Restoration Program since 1997. While there have been a lot of changes in the way that North Carolina performs mitigation, EEP's commitment to provide high quality, watershed based compensatory mitigation has remained unchanged. In 2009-2010, EEP reevaluated its watershed planning processes to ensure that current watershed planning processes comply with the 2008 federal mitigation rule (33 CFR Parts 325 and 332) requirement for a watershed approach to mitigation. Based upon this review, EEP updated its processes and developed standardized methodologies that address federal requirements for a watershed approach and incorporate lessons learned. An update of EEP watershed planning processes will be provided, with a focus on EEP's support and approval of watershed plans developed by entities outside of EEP. Success stories of collaborative efforts will be provided and discussion centered on what is working well and what can be improved in EEP's watershed planning process.

*About the Speaker:* Nancy Daly received a B.S. Biology from UNC-Chapel Hill and MS Biology from UNC-Wilmington. She worked in the private sector on stream and wetland mitigation projects for six years, followed by two years with a local land trust where she focused on conservation planning and land protection. She has been in her current position as EEP Statewide Project Coordinator for three years and focuses efforts on watershed planning and interagency coordination.

## Kentucky Department of Fish and Wildlife Resources Wetland and Stream Mitigation Program

Tom Van Arsdall

Kentucky Department of Fish and Wildlife Resources  
#1 Sportsman's Lane  
Frankfort, KY  
tom.vanarsdall@ky.gov

*Co-author(s):* Joseph Zimmerman

*Abstract:* The Kentucky Department of Fish and Wildlife Resources Wetland and Stream Mitigation Program is one of two in-lieu fee programs in Kentucky that provides compensatory mitigation for wetland and stream impacts across the state. The program was established in 2002 with an agreement between the US Army Corps of Engineers and Kentucky Department of Fish and Wildlife Resources. Currently, a new agreement with the US Army Corps of Engineers is being drafted to address new regulations set by the Final Compensatory Mitigation Rule. Program changes based on the Final Compensatory Mitigation Rule will likely affect permanent protection methods, success criteria, service area boundaries, and credit scenarios. Since 2002, the program has 54 projects (83 miles/ 46 acres) of wetland and stream mitigation approved by the Interagency Review Team. These projects account for 142,672 EIU credits, 96,218 AMU credits, and 46 wetland credits. The average cost per project for the program is 162 per linear foot, 389 per EIU, and 153 per AMU. The approved stream projects have drainage areas that range from less than 1 square mile to over 100 square miles and utilize various approaches of Priority I, II, and III restoration. Three preservation projects (1,602 ac) have been approved by the Interagency Review Team to protect high quality streams and wetlands in areas that harbor species of greatest conservation need. The program works in 10 service areas across Kentucky. Consultants have been selected for two year contracts to provide engineering services for five service areas with consistent mitigation requirements. Major issues encountered during the short life of the program include obtaining donated permanent conservation easements from private landowners, working in larger drainage areas with high gravel loads, and establishing set protocols within state government to maximize program efficiency and timeliness.

*About the Speaker:* Mr. Arsdall received his bachelor's and master's degrees in Atlanta at Emory University and Georgia Tech, respectively. The first ten years of his career were with Dames & Moore environmental consultants in Lexington, KY and Atlanta, dealing with a variety of mostly water-related issues. He then worked for the Kentucky Division of Water for 22 years, where his last job was Manager of the Water Quality Branch overseeing the monitoring, water quality standards, TMDL, and 401 programs. His work with the 401 program in the Division of Water exposed him to the emerging science of stream geomorphology, and after retiring in 2008, he was able to get on with KY Fish and Wildlife in 2009 and continue his career in the Wetland and Stream Mitigation Program. In his spare time, he enjoys singing with a community chorus, exercising, gardening, hunting, fishing, and hiking.





## SARA Stream Restoration, A Program Approach

James Boenig, P.E.

San Antonio River Authority  
100 East Guenther  
San Antonio, TX 78259  
jboenig@sara-tx.org

*Co-authors:* James Boenig, Bruce Cole

*Abstract:* The San Antonio River Authority (SARA) Stream Restoration Program (program) is an internal initiative developed to incorporate natural channel design (NCD) techniques into restoration of impacted streams and stormwater conveyance projects, improve riparian management practices and influence land development policy throughout our four county jurisdiction. NCD empirical design data and project experience does not currently exist in our watershed. Only in its second year, program objectives and challenges have been identified and several concurrent efforts to implement the program are currently ongoing.

This presentation will outline a comprehensive, multi-discipline team approach to: identify the needs of our watershed; develop program funding strategies; integrate NCD guidelines into the local design, construction and maintenance community; and provide landowner/public outreach. Activities for this year include; constructing a demonstration project, developing regional design curves, adopting program NCD requirements and guidelines, incorporating design verification through LIDAR and modeling, volumetrically measuring vegetation and erosion rates, analyzing the feasibility of stream mitigation banking, and providing training/education workshops for designers and the general public.

SARA believes that our program approach is essential for connecting the network of activities that other agencies and the public can understand, communicate with, and support. The program team needs to understand both the technical and public opinion needs of the watershed, to develop funding strategies with mutual benefits, and to implement new ideas into existing programs wherever possible. Although NCD solutions may not be feasible in all situations, we believe incorporation of the most appropriate methods into the most appropriate projects will create significant positive impacts in the effectiveness of watershed management.

*About the Speaker:* **Jim Boenig** is Manager of the San Antonio River Authority (SARA) Engineering Department. Jim is native to the San Antonio area and obtained a B.S. in Agricultural Engineering from Texas A&M University in 1983. Jim has 26 years of civil engineering experience; 11 years in private consulting and 15 years with SARA, serving as Departmental Manager since 2002. His Engineering experience includes: stormwater conveyance and detention; wastewater collection, treatment and reuse systems; street design; and residential and commercial site development. Jim is responsible for project management as a Local Sponsor

to the USACE on the San Antonio River Improvements Project, the largest urban river ecosystem restoration project in the US. In the last two years, Jim has initiated and is developing the SARA Stream Restoration Program, to incorporate natural channel design (NCD) techniques into restoration of impacted streams and stormwater conveyance projects throughout SARA's four county jurisdiction.

# The Ecosystem Enhancement Program's Local Watershed Planning Approach to Project Implementation

**Michael McDonald**

NC Ecosystem Enhancement Program  
5 Ravenscroft Dr. Suite 102  
Asheville, NC 28801  
mike.mcdonald@ncdenr.gov

*Abstract:* The Ecosystem Enhancement Program's Local Watershed Planning (LWP) process produces four major products: a Preliminary Findings report, a Watershed Assessment Report, a Project Atlas, and a Watershed Management Plan. EEP Project Managers use the Design-Bid-Build (DBB) procurement process and LWP Project Atlases to implement priority projects identified within the LWP study area. Project opportunities identified through the LWP process represent those sites where EEP can achieve the greatest return on its investment in terms of long-term functional benefits to local water quality, hydrology and habitat. Sites are prioritized based on localized benefits to the watershed area studied. This presentation takes a look at the statewide LWP planning process and how it is integrated into DBB project implementation. It highlights successful LWP and DBB efforts with specific project examples including how and who was involved at the state and local levels to identify and implement those projects and how those projects tie into the overall goals of that LWP. The presentation will also touch on EEP's full delivery procurement process and private mitigation bank connections to the LWP process.

*About the Speaker:* **Michael McDonald** is the Western Regional Supervisor for the Ecosystem Enhancement Program based in Asheville, North Carolina. He has been working in the water resources field for more than 17 years with experience ranging from groundwater remediation to stream and wetland restoration, research, and management.

# Natural Form and Function versus Aesthetics, Flooding Concerns and Public Opinion in Urban Restoration Projects

Greg Phillips

GBMc & Associates  
219 Brown Lane  
Bryant, AR, 72022  
gphillips@gbmcassoc.com

*Co-authors:* Greg Phillips, Kyle Hathcote

*Abstract:* Under what context is a stream restoration project considered an urban stream restoration project? When the goals of the restoration project are not simply to return a reach of stream channel and riparian area to its natural form and function, but to create an environment that is park like, easily accessible to park goers, aesthetically pleasing to the public (and not too different than before), historically significant, easy to maintain, and capable of transporting high flows as efficiently as a concrete rectangular channel, then the project can truly be called an urban stream restoration. An urban stream restoration project completed on a third order perennial stream in Northwest Arkansas serves as an example of such an urban project. Problems such as those listed above, encountered during phase 1 of the project, are being addressed with different strategies in phase 2 of the project. A focus on communication of plans with the public, coordination with city utilities and floodplain managers, input from long term residents and stream advocates all served to facilitate a restoration project that is returning the stream to a natural condition that it has not experienced for over 100 years.

*About the Speaker:* Greg Phillips is a Senior Scientist with GBMc & Associates, Inc. He has a diverse background in aquatic biology, toxicology, and hydrology. With over 15 years of experience in water resources projects his key areas of interest include: watershed management; stream protection and restoration; surface water quality modeling; and aquatic community bioassessment. During the past decade Mr. Phillips has gained considerable experience assessing the impact of watershed land use changes and their affect on stream morphology, habitat and water quality. This experience has led to development of watershed management plans and stream restoration projects in mostly urban and developing areas. Greg is a graduate of Ouachita Baptist University where he majored in Biology. He completed graduate studies at the University of Arkansas in Aquatic Ecology and holds a certificate in Watershed Management from Michigan State University. He is a member of the American Water Resources Association and the North American Benthological Society.

## Good Streams Make Good Neighbors

Eve Brantley, Ph.D.

Auburn University  
235 Funchess Hall  
Auburn, AL 36849  
brantef@auburn.edu

*Co-author(s):* Eve Brantley, Jess Roberts, Katie Dylewski, Auburn University; Jof Mehaffey, William McLemore, Goodwyn, Mills, Cawood

*Abstract:* Motivations for implementing a stream project are as different as the communities that are involved with the projects. A comparison of three urban stream projects completed in Alabama will be presented. High erosion rates along Little Shades Creek and a threatened sewer line prompted a neighborhood in Vestavia Hills, Alabama to seek assistance and funding from a broad array of partners. Channel modification, in-stream structures, native vegetation plantings, and stormwater controls were installed as components of this project. In Montgomery, Alabama, aesthetics and the opportunity to improve stream functions as part of an urban park revitalization project were the driving forces behind the Ida Belle Young Park White Slough restoration project. To improve stream and floodplain functions, a new, smaller channel was designed at the existing elevation along with the creation of a floodplain. Native vegetation and in-stream structures were installed and the stream is being monitored for biological recovery. The need for a stream and floodplain restoration project that may be used for demonstration and education and municipal park improvement are a few of the reasons for the Town Creek Park stream restoration project in Auburn, Alabama. A new channel was constructed that allows for floodwater overflow connection with the existing floodplain. Floodplain connectivity, in-stream structures, and well-established native vegetation have been critical to the success of this project. Although unique in their inception and implementation, a thread of similarity to improve stream health and increase community appreciation of local waters is present among the successful urban projects.

*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. Her employment experiences include working as a local watershed coordinator, directing a citizen water monitoring program, and facilitating a coastal water quality stakeholder group. Eve has a BS degree in Biology from Berry College, a MS in Forest Resources from Clemson University, and a PhD from Auburn University School of Forestry and Wildlife Sciences.



# The Friday Funnies are Back! Implementing Stream Restoration Projects on Private Property

Joel Tillery

CH2M HILL  
1000 Abernathy Road, Suite 1600  
Atlanta, GA 30328  
joel.tillery@ch2m.com

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

*Abstract:* Gwinnett County, Georgia, an outlying county in the metro Atlanta region, is actively planning and implementing watershed and stream improvements through a Watershed Improvement Program (Program) to restore lost habitat and improve water quality of streams in the region. To date, nearly 25 projects restoring approximately 10 miles of stream have been implemented, most of which has occurred on property owned solely by Gwinnett County. As the Program matures, the County must begin to work with private landowners to find new project opportunities and continue the good work of restoration and watershed improvement.

In January, 2007, a potential stream restoration project was identified along a tributary to the Chattahoochee River when a homeowner contacted the County about severe stream bank erosion and property loss. The project, which extended approximately seven hundred feet through six different residential lots, provided an opportunity to work with homeowners to expand the reach of the County' program onto private property. Project design began later that year.

Homeowners were regularly engaged during the design to keep them informed of the proposed restoration plans, coordinate on project access, and ensure their continued support of the work. Prior to construction, property owners were requested to sign right-of-entries and conservation easements to ensure that the work was protected in perpetuity. Several issues arose concerning these documents and the project was nearly derailed as a result. Ultimately, these issues were resolved and the construction was able to move forward.

This presentation will explore the "Friday Funnies," a frequent email subject line used by one homeowner when communicating an issue, like the infamous Bobcat Caper or the strange green stuff emerging from the ground that left unattended may cover the entire work area. Ultimately, the successful implementation of the project has built tremendous support for the Program and each property owner is now a vocal advocate for the County's endeavors. On July 5th, 2010, three years since beginning the project, one homeowner wrote, "Y'all have done some terrific work on the project, Joel. The punch list looms as the cherry on top of a very cool bit of work." With any luck, the project will soon be complete!



*About the speaker:* **Mr. Tillery** is a water resources engineer with CH2M HILL in Atlanta, GA. He has nearly 8 years of experience with a variety of water resources project including stormwater master planning and stormwater modeling, stormwater infrastructure design, stream and wetland restoration design, and watershed assessment and planning. Mr. Tillery specializes in implementation of water quality improvement and ecosystem restoration projects and serves as a regional technology leader for ecosystem restoration planning and management. He holds a bachelors degree in agricultural and biological engineering from Mississippi State University, a masters degree in civil engineering from Colorado State University, and has received specialized training through numerous stream restoration short courses.

## Stream Daylighting at the Dell

Vince Sortman

Biohabitats, Inc.  
1732 Wazee Street Suite 209  
Denver, CO 80202  
vsortman@biohabitats.com

*Abstract:* With Meadow Creek piped below “the Dell” at the main entrance to its campus, the University of Virginia identified this neglected creek and area as an ideal location to implement part of its stormwater master plan. The purpose of the Stream Daylighting Project at the Dell was to provide water quantity and quality benefits, mitigate for construction of a new multipurpose arena downstream, and refurbish a recreation area at one of the “front doors” to the University of Virginia. The project provided stormwater quality using bioretention facilities to collect and treat runoff from nearby impervious areas, while a large detention pond was installed to address stormwater quantity issues. Mitigation for ecological disturbance at the arena construction site was provided by daylighting over 1,000 linear feet of Meadow Creek through the Dell. The daylighted channel has been integrated into the existing recreational land uses and avoids existing infrastructure. A large bankfull channel would not have met these objectives. Instead, an innovative design allows the natural base flow of Meadow Creek into the daylighted channel but bypasses large storm flows underground to protect the existing facilities in the Dell. The native plant palette selected for the stream and pond replicates the riparian vegetation of Virginia from the coastal plain, through the piedmont, to the Blue Ridge physiographic provinces. This enhances an educational resource and learning laboratory for students in the School of Architecture and College of Arts and Sciences. Biohabitats, in collaboration with Nelson, Byrd, Wolz Landscape Architects, designed the stream and pond to completely alter the character of the Dell from overlooked to campus centerpiece.

*About the Speaker:* **Vince Sortman** is a senior fluvial geomorphologist with Biohabitats, Inc. He is the Technical Team Leader, responsible for the design and implementation of their stream restoration projects. Over the past 20 years he has designed dozens of stream restorations ranging from a few hundred feet to several miles. Most of his projects are in urban settings and therefore require innovative solutions to unique problems. His restoration designs are based on fluvial geomorphic principles and natural channel processes. He has been a guest lecturer and has taught fluvial geomorphic principles and channel restoration techniques at numerous seminars throughout the country. Vince has a master’s of science degree in geology from Colorado State University where he studied fluvial geomorphology under Dr. Stanley Schumm.



# Is stream restoration enough? Linking restoration with watershed-based stormwater management in urban streams

Sara McMillan, Ph.D.

UNC Charlotte  
9201 University City Blvd  
Charlotte, NC 28223  
smcmillan@uncc.edu

*Co-author(s):* S.K. McMillan<sup>1</sup>, A. Apple<sup>2</sup>, and S.M. Clinton<sup>3</sup>

<sup>1</sup>Department of Engineering Technology, University of North Charlotte, Charlotte, NC, USA.

<sup>2</sup>Department of Civil and Environmental Engineering, University of North Carolina at Charlotte, Charlotte, NC, USA,

<sup>3</sup>Department of Biology, University of North Carolina at Charlotte, Charlotte, NC, USA,

*Abstract:* Ecologically based stream restoration is a critical component of reestablishing ecosystem services (e.g. water quality, biotic integrity, ecosystem processes), but these efforts alone are unlikely to improve stream condition because they do not match the scale of the problem. In urban watersheds, the capacity of streams to provide ecosystem services is limited as a result of channel incision, removal of geomorphic features and removal of riparian vegetation, but the dominant driver is stormwater runoff. We are currently working to elucidate the linkage between ecologically-based BMPs (e.g. ponds and wetlands) and receiving streams in a series of restored urban streams in Charlotte, NC. Enhanced geomorphic heterogeneity in restored streams enhances rates of biogeochemical processes by increasing contact between nitrogen in stream water and biologically active streambed sediments. When coupled with ecologically based BMPs, the potential exists to further enhance these processes and improve water quality. The effect of constructed wetlands on instream nitrogen cycling was measured in two restored streams and compared to three other streams without directly connected BMPs. Instream denitrification rates were measured via acetylene block with amendments from BMP-treated and untreated stormwater runoff as well as ambient stream water. Denitrification rates were greatest in restored streams with instream structures compared to unrestored streams with both low and high urbanization. Although addition experiments with wetland-treated water generally lowered rates of denitrification because rates were mostly closely linked to NO<sub>3</sub><sup>-</sup> supply, rates remained higher than unrestored counterparts. These results suggest that by combining instream restoration with retention and removal of nitrogen by BMPs within the watershed, watershed managers can effectively link nitrogen sinks to enhance ecosystem processes and greater achieve water quality improvements.

*About the Speaker:* **Dr. Sara McMillan** is an Assistant Professor in the Department of Engineering Technology at UNC Charlotte and a licensed Professional Engineer in North Carolina. She obtained her undergraduate and master's degrees in Civil and Environmental Engineering from the University of Iowa. She obtained her Ph.D. under the direction of Hans Paerl and Michael

Pieler at UNC Chapel Hill where she focused on nitrogen biogeochemistry in coastal headwater streams. Dr. McMillan's research on biogeochemistry and water quality of aquatic ecosystems has extended to urban systems since moving to UNC Charlotte with a focus on the interactions between nutrient and carbon transformations. Her current research projects include: understanding the impact of instream geomorphic structures on nitrogen retention in restored streams; characterizing hyporheic flowpaths in streams and their impact on nutrient cycling; and investigating the effects of stormwater BMPs on ecosystem function in receiving streams.

# Linking Microbes and Ecosystem Processes in Restored Urban Streams: An Analysis of Denitrifier Diversity

Sandra Clinton, Ph.D.

Dept of Biology/University of North Carolina at Charlotte  
9201 University City Blvd  
Charlotte, NC, 28223  
sclintol@uncc.edu

*Co-authors:* S.M. Clinton, Department of Biological Sciences, UNC-Charlotte, S.K. McMillan, Department of Engineering Technology, University of North Charlotte, and L. Haitcock, Department of Biological Sciences, UNC-Charlotte

*Abstract:* Stream microbial communities play significant roles in nutrient cycling, organic matter decomposition, and food web relationships; however, these organisms are rarely integrated into restoration plans. On the other hand, given the complexity of stream microbial communities, it is difficult to provide recommendations to practitioners about how to incorporate microbes into restoration strategies or watershed planning. The overall goal of this research is to understand and predict how changes in environmental conditions and microbial populations affect denitrification in urban streams. Nitrogen removal by enhancing denitrification rates is often a stream restoration goal and in-stream structures such as debris dams, large woody debris additions, and riffle-pool sequences have the potential to enhance these rates. However, quantitative assessment of the effects of these restoration elements on denitrification rates and populations of denitrifying bacteria in restored urban streams is largely untested. We are currently measuring benthic microbial diversity in five urban streams with varying landscape histories in Charlotte, North Carolina, U.S.A. using automated ribosomal spacer analysis (ARISA) and denitrifier diversity using terminal restriction fragment length polymorphism (TRFLP). Additionally we are targeting benthic microbial communities at the downwelling and upwelling habitats around in-stream structures. The streams have similar nutrient concentrations but vary in the amount of algal biomass and sediment organic matter. Microbial diversity varied both within and among sites and may be related not only to seasonal changes, but also to the effects of scouring floods. By applying molecular techniques to stream ecosystems we can begin to understand changes in urban stream microbial diversity and link these patterns to ecosystem processes.

*About the Speaker:* **Dr. Sandra M. Clinton** is an Assistant Professor in the Department of Biology and the Associate Director for Research Projects with the Infrastructure, Design, Environment and Sustainability Center at UNC Charlotte. She holds a B.Sc. in Biology from McGill University (Canada), a master's in Zoology from Arizona State University and a Ph.D. in Forest Resources from the University of Washington. Dr. Clinton's research is broadly focused on understanding how the structure of biological communities effects ecosystem processes such as metabolism and nitrogen cycling. Dr. Clinton's current research projects include: understanding

controls on stream microbial diversity and how changes in microbial community structure can explain variability in rates of nutrient cycling and energy flow; investigating the effects of stormwater inputs on ecosystem function; and describing the natural microbial fauna of oysters and mussels from protected and polluted environments.

# Water Quality Impacts of Coastal Stream and Wetland Restoration

**Kris Bass, PE**

NCSU Water Quality Group  
Campus Box 7637  
Raleigh, NC 27695-7637  
kris\_bass@ncsu.edu

*Co-Authors:* Kris Bass, Mike Burchell, Evan Corbin, Randall Etheridge, Francois Birgand, Robert Evans, NC State University

*Abstract:* NCSU BAE has been involved with several innovative coastal restoration projects. Our partnerships with other Universities, non-profits, and government agencies have helped us to push the science and understanding of these projects forward through practical research applications. As interest in the water quality impacts of these projects has increased, we are exploring ways to better quantify and understand the complex processes of restoration projects. We have used automated sampling and flow monitoring equipment, dye tracer studies, and other techniques to gather detailed information on stream flow and nutrient cycling of several restored sites. Although we are still developing methodologies to generate more detailed results, initial efforts show some positive trends in flow dynamics and nutrient processing. This presentation will show the results of several monitoring efforts, discuss some of the challenges faced, and also show the setup of a new intensive monitoring project.

*About the Speaker:* Kris Bass is part of the NCSU Water Quality Group. He and his co-authors have particular interest and experience with coastal stream and wetland restorations. They hope to promote advances in restoration science and design by combining innovative applications with practical research results. Besides his interest in creative restoration and stormwater approaches, Kris also organizes an annual Coastal Restoration Tour. He is currently offering cut-rate deals on next year's tour for anyone who comes up with a great question or generally sticks around for the post-session discussion!



# Restoring streams for reduced suspended sediment loads in the Triassic Basin: Time to re-evaluate our expectations

Melanie J Small

UNC Chapel Hill  
UNC -CH, Department of Geography, CB 3220  
Chapel Hill, NC 27599  
mjsmall@email.unc.edu

*Co-author(s):* Melanie J. Small, Martin W. Doyle, Jeffrey Muehlbauer, Joel Sholtes

*Abstract:* Streams are regularly restored with the goal of reducing erosion and delivery of suspended sediment to downstream areas. An urban stream running through erodible Triassic Basin soils, Ellerbe Creek has experienced large amounts of incision (up to 10 ft in some areas), channel widening, and has been placed on the NC Department of Environment and Natural Resources' 303(d) list as impaired for ecological/biological integrity. Ellerbe Creek also drains into nutrient-sensitive Falls Lake and the Neuse River. Thus, reducing nutrient and sediment loads were a main incentive for stream restoration. In the fall of 2008, a 2500 ft section of Ellerbe Creek in Durham, NC was restored. Sections of the stream were regraded by remeandering the stream and introducing several grade control features. Stream banks were stabilized, and a low floodplain bench was excavated along some portions of the reach. Banks were planted with vegetation, and a substantial "no-mow" area was established. We examined the effect of restoration on the suspended sediment balance within the restored reach. ISCO automated water samplers were placed upstream and downstream of the restored reach. Baseflow samples were taken hourly for 24 hours, once a month. Water samples during storms were taken hourly when possible.

Preliminary analysis of the data indicates that the actual restoration activities introduced a large amount of sediment into the channel. 20 months later, water sampling continues to indicate that the stream reach exports large amounts of sediment during storm flows. During base flows, the stream reach appears to temporarily store sediment which is then flushed from the system during even small spates. This data questions our expectations for stream restoration as a mechanism for reducing suspended sediment loads, especially in streams with flashy hydrographs running through erodible soils.

# Connecting Communities with Rivers through Dam Removals and Blue Trails

**Lynnette Batt**

American Rivers  
331 West Main Street, Suite 504  
Durham, NC 27701  
lbatt@americanrivers.org

*Co-author(s):* Lynnette Batt, Associate Director of River Restoration, Matt Rice, Associate Director of Conservation

*Abstract:* Engaging communities in restoration projects is an effective way to provide multiple social and environmental benefits. With programs in both river restoration and blue trail development, American Rivers is developing projects that emphasize this combined approach. Their river restoration program, recently established in North Carolina, is centered on the selective removal of outdated dams and other barriers in streams and rivers. Their blue trails program, with a strong presence in South Carolina and beginning to emerge in North Carolina, supports river-based recreation such as canoeing, kayaking and fishing and has an ultimate goal of protecting landscapes critical to river health. While dam removal provides a host of ecological benefits, it also opens up the river for blue trail development. This can help glean project support, enhance local recreation-based economies, and reconnect people with nature.

This innovative approach is now being demonstrated on Hitchcock Creek in southern North Carolina, near the City of Rockingham. In 2009 the 15-foot high, 110-year old Steeles Mill Dam was removed to open up nearly fifteen miles of spawning habitat for anadromous fish such as American shad, hickory shad and American eel. With the dam out of the way, the City of Rockingham, American Rivers and other partners are now gearing up for the establishment of a 12-mile long blue trail that will include riparian land protection, dedicated access points, and mapping. With funding from NOAA, post dam-removal monitoring is underway of river geomorphology, fish communities and mussels, providing opportunities for local environmental education.

American Rivers has identified several other potential dam removal-blue trail projects around the state, including in the Yadkin-Pee Dee and Neuse river basins, which they plan to pursue.

*About the Speaker:* **Lynnette Batt** is the Associate Director for River Restoration in North Carolina with the organization American Rivers. She provides technical assistance to communities across the state on removing unsafe and outdated dams to restore rivers. She also manages the region's American Rivers-NOAA Community Based Restoration Program, which provides grants for dam removals that benefit migratory fish. Through coordination with other AR staff, Lynnette helps use river restoration projects to support the development of recreational blue trails.

## Buckhorn Creek Restoration

**Nathan Jean, PE**

Stantec Consulting, Inc.  
801 Jones Franklin Road  
Raleigh, NC 27606  
nathan.jean@stantec.com

*Co-author(s):* Nathan Jean (Stantec), Brad Fairley (Stantec), Jeremy Thigpen (Progress Energy Carolinas)

*Abstract:* Buckhorn Creek is a tributary to the Cape Fear River with a drainage area of approximately 36 square miles. Carolina Power and Light constructed a low-head hydroelectric generating facility on Buckhorn Creek in 1903. With the generating facility decommissioned several years ago, Progress Energy decided to remove the structure and restore Buckhorn Creek to a more natural state in 2008. Stantec was retained to lead a design-build team. Challenges during the design phase included the absence of any original design drawings of the generating facility, a large amount of bedrock and dealing with sediment on the floor of the former impoundment. Following the completion of the design and the acquisition of the necessary permits, the project went to construction in the fall of 2009. North State Environmental provided construction services on the project. Challenges during construction included the discovery of a large number of treated timbers, the demolition of the heavily reinforced concrete structures and more than 31 inches of rain which produced flows as high as 812 cfs. Construction was complete by the end of 2009. Progress Energy is happy with the project. It has achieved its objectives of restoring Buckhorn Creek to a more natural state and enhanced fish habitat. It has also provided an opportunity and opportunity for more than 2,000 feet of stream mitigation credits if Progress chooses to pursue them.

*About the Speaker:* **Nathan Jean** is a professional engineer with wide experience in the water resources engineering field. He has worked on a variety of water resource engineering projects located across the country. Types of projects include, stream and wetland restoration, geomorphic surveys, sediment studies, watershed implementation plans, Watershed Assessment of River Stability and Sediment Supply (WARSSS), large highway drainage projects, culvert investigations and sizing, street flooding investigations, and stormwater management facility design.

Nathan has degrees in Agricultural Engineering and Forest Hydrology from North Carolina State University and has completed Rosgen level four training.

# Fish Passage at Lock and Dam #1 on Cape Fear River

Phillip Todd

SEPI Engineering & Construction  
1025 Wade Avenue  
Raleigh, NC 27605  
ptodd@sepiengineering.com

*Co-authors:* Phillip Todd, SEPI Engineering & Construction, Don Carmen, US Army Corps of Engineers – Wilmington District

*Abstract:* The US Army Corps of Engineers (Corps) has designed a fish passage project at Lock and Dam (L&D) #1 on the Cape Fear River. Fish passage projects provide access for fish migration over man-made structures like dams and are an alternate to dam removal. These projects have been implemented in the Midwest, and this project incorporated lessons learned from Midwest projects.

L&D #1 opened in 1915, and is a rock filled timber crib structure. Small craft passage is achieved through the adjacent lock chamber.

Past attempts improve fish passage include opening the Lock chamber, allowing fish to swim into the downstream side of the chamber. Once fish have entered the lock chamber, water level was raised, and fish were released upstream.

The project provides mitigation for potential impacts on the Endangered shortnose sturgeon due to the Wilmington Harbor Deepening (Deepening). Project design and construction project fulfills a commitment by the Corps and the State of North Carolina (State); a requirement of the National Marine Fisheries Service for the Biological Opinion for the Deepening. Locking for fish passage had been previously maximized and is not an acceptable alternative. Project construction provides greater access to historic spawning grounds utilized the sturgeon and other anadromous fish without compromising congressionally authorized purposes or affecting water users.

The design team encountered many challenges to complete the design of this project, including:

- Compressed design schedule to meet funding through American Recovery and Reinvestment Act (ARRA);
- Stability of the 100-year-old Lock and Dam structure;
- Substrate suitability that affected retaining wall design, installation and long term sustainability;
- Project funding, and,
- Construction methods.

The presentation will describe: the design of project; project challenges and how the design team overcame these challenges; and proposed monitoring of fish migration.

*About the Speaker:* **Phillip Todd** graduated from NC State University with a Bachelor of Science in Biological Sciences and earned a Master of Public Administration from NC State University. Mr. Todd has over 17 years as an environmental scientist and project manager in transportation and environmental planning, including natural resources, ecosystem restoration, buffer mitigation, stream mitigation, wetland mitigation and Section 404/401 permitting. Since joining SEPI Engineering & Construction, Inc in 2005, he has managed several ecosystem restoration projects.

## Low Head Dams - By Sky and Paddle

### Benjamin Leatherland

Env Services & Consulting  
PO Box 11437  
Blacksburg, VA 24062  
bleatherland@es-and-c.com

*Co-author(s):* Benjamin Leatherland, Matthew O'Rourke, Stuart Lynde

*Abstract:* Low head dams are located throughout the southeastern United States, and are largely unregulated and unmapped in most states. While these dams and other similar structures (e.g., low-water bridges, culverted crossings, and riverbed utility lines) often serve as attractive recreational features during hot summer months when water levels are low, they function as impediments to aquatic life movement, represent public safety hazards at higher streamflows, and alter the natural hydrology of our river systems. Dams and structures that have outlived their usefulness are prime candidates for removal or alteration, particularly in conjunction with stream restoration and public safety projects. Grass-roots organizations have even formed in many local communities to encourage removal of dams that are specifically associated with recent drowning deaths.

This presentation will focus on a project to locate, categorize, and document low head dams along the Roanoke River in Virginia. This project will utilize existing online mapping and aerial photography resources, combined with field verification, measurement, and photo-documentation to develop a list of existing low head dams and their individual characteristics. The goal of this project is to provide regulatory agency staff, environmental restoration professionals, paddlers, fishermen, swimmers, and emergency services personnel with an online, interactive tool for identifying low head dams. Ultimately, the intent of this work will be to help facilitate removal of these dams and aquatic life impediments in order to restore natural streamflow to the affected reaches, to protect human life, to enable native aquatic species to expand their ranges, and to improve public safety. This presentation will also document the steps taken by ES&C to conduct the project, in hopes that other individuals will take the initiative in their own watersheds to conduct similar efforts. Such projects can be a great way to contribute to environmental restoration efforts, improve public safety, and get to know your local waterways by paddle.

*About the Speaker:* **Mr. Leatherland** holds a B.S. in Earth Science (Biology minor) from the University of North Carolina at Charlotte, and a M.S. in Geography (Environmental Planning) from UNC-Charlotte. He has over ten years of experience in environmental science and natural resource management, along with two years experience in urban/regional/municipal planning. He is currently responsible for project management, stream and wetland restoration, erosion and sediment control, wetland delineation, environmental assessment, Section 404/401

permitting, and lake management at Environmental Services & Consulting in Blacksburg, Virginia.

He has additional experience in watershed management and planning, natural channel design, sustainable development planning, habitat restoration and monitoring, geomorphic stream surveying, urban/regional planning, NEPA/SEPA Environmental Assessment (EA) documentation, bioengineering streambank stabilization, construction plan preparation, aquatic bioassessment, wildlife surveying, air quality monitoring, protected species surveying, cultural/historic resource investigation, and groundwater monitoring.

# Restoring Function to an Intensely Urbanized Stream - Mill Creek in Cincinnati, Ohio

Warren C. High

MACTEC Engineering and Consulting, Inc.  
4460 Lake Forest Drive, Suite 200  
Cincinnati, OH 45242  
wchigh@MACTEC.com

*Co-authors:* Warren C. High, Wesley Wimmer, PE

*Abstract:* The Mill Creek has been referenced as one of the 10 most endangered streams in the United States by American Rivers. Under a federal Consent Decree, the Metropolitan Sewer District of Greater Cincinnati performed several projects that were intended to return previously lost function to this stream. The specific goals of these projects were focused on improving water quality, reducing erosion and sedimentation, reducing flooding, eliminate landfill leachate, protect infrastructure, restore forested riparian buffer, restore aquatic habitat, and provide for recreation and education. In addition to performing natural channel restoration for over one mile of stream and riparian corridor, these projects included the removal of a low head dam (less than ten feet), removal of a low water crossing, a leachate collection system and bioengineering of an historic landfill, and a greenway trail system.

Achieving consensus from innumerable political jurisdictions, city and county departments, regulatory agencies, watershed groups, concerned citizens, and property owners was critical before any design could commence. The project corridor was severely constrained by existing buildings, utilities, infrastructure, bridges, and unwilling property owners. The design incorporates the use of robust instream structures such as riffles, rock cross vanes, and J-hook vanes; bank treatments included joint planting, live staking, wrapped earth and branch packing. The project is currently constructed and operating.

This presentation will focus on key design elements, construction methods, and lessons learned in the process of designing, building, and monitoring this series of projects. The wide array of measures touches on almost all aspects of urban stream restoration.

*About the Speaker:* **Mr. High** holds a BS in Fishery and Wildlife Biology and MS Environmental Management. He has over 25 years of experience in ecosystem restoration and water resources. He has performed over 100 ecosystem restoration projects for developers, municipalities, state DOTs, NRCS, Corps of Engineers, and environmental groups. He is currently serving as Senior Principal and Project Manager at MACTEC Engineering and Consulting where he manages and reviews stream restoration projects throughout the eastern portion of the U.S.





## She Loves Me, She Loves Me Not: Charlotte's Love Affair with Little Sugar Creek Rekindled

**Emily Reinicker, PE**

Wildlands Engineering, Inc.  
1430 S. Mint Street, Suite 104  
Charlotte, NC 28203  
ereinicker@wildlandsinc.com

**Beth Poovey, RLA**

LandDesign  
223 North Graham St.  
Charlotte, NC 28202  
bpoovey@landdesign.com

*Co-authors:* Emily G. Reinicker, PE, CFM- Wildlands Engineering, Inc., Beth Poovey, RLA- LandDesign, Inc.

*Abstract:* It is nature's love story, Little Sugar Creek cast aside as an urban storm drain and forgotten, buried under concrete parking lots. Planning for Little Sugar Creek's revitalization began in 2001 with a master plan for a 16-mile corridor of riparian-based greenway extending from Cordelia Park north of Charlotte's uptown to the SC state line. Mecklenburg County Park & Recreation and Storm Water Services have played match-maker, wooing the Charlotte community to embrace the creek. Ten years later, the one-mile urban portion forming a linear park is nearing completion.

This presentation explores the real experience of integrating a greenway corridor with stream enhancement, providing urban environmental restoration alongside usable park land and open space for the Charlotte community. The design approaches for the greenway and stream enhancement were developed hand-in-hand, building upon public reactions to previous projects. We learned that taming of the "wild-and-woolly" riparian plantings would garner public affection; the project team studied how best to use native plants in a more publicly pleasing presentation. A public safety mantra of "Look, but don't touch!" chaperoned our interface of the public greenway with 303(d)-listed waters. Aesthetic meanders and structure placement were optimized to showcase the sight and sound of gurgling riffles and graceful curves at viewing overlooks. Real estate was maximized by incorporating storm water treatment wetlands onto the floodplain bench.

Lover's quarrels erupted over allocating ample floodplain width for stream stability while leaving enough high ground for park space; skeletons came out of the closet during construction when sandy subsoils and old concrete foundations were uncovered; a multi-million dollar commercial re-development adjacent to the project has imposed high expectations akin to a critical mother-in-law's outspokenness.

Early public reactions indicate that the relationship has turned a corner and Charlotte is falling more in love with Little Sugar Creek every day.

*About the Speaker(s):* **Emily Reinicker** currently serves as a water resources engineer for Wildlands Engineering's Charlotte, NC office. She has 11 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.

Joining LandDesign in 1999, **Beth Poovey** is a Senior Associate and Landscape Architect. Her 12 years of experience include master plan development, greenway and park design, streetscape design, site planning, landscape design, monumentation design, site analysis, graphic design, and public involvement process. She served as the Project Manager for the Little Sugar Creek Greenway Master Plan, which spans 15 miles in North and South Carolina, and she is currently the Project Manager for several urban sections of the Little Sugar Creek Greenway in Uptown Charlotte, NC. Ms. Poovey is a registered landscape architect in North Carolina. She earned a Diploma of Landscape Architecture from Ryerson Polytechnic University in Toronto, Ontario and a Bachelor of Arts in Sociology from Simon Fraser University in Vancouver, British Columbia.

## Restoration of Neabsco Creek, Prince William County, Virginia

### Robert Siegfried

Whitman Requardt & Associates, LLP  
9030 Stony Point Parkway, Suite 220  
Richmond Virginia 23235  
bsiegfried@wrallp.com

*Co-authors:* Robert Siegfried, Whitman, Requardt & Associates, LLP and Tom Dombrowski, Prince William County, Virginia

*Abstract:* Prince William County, through watershed assessments, identified Neabsco Creek as a priority for stream restoration. Within the Neabsco Creek watershed, the Prince William County Park Authority owns over 20,000 linear feet of stream channel in Andrew Leitch Park. Three segments of stream channel within the park, totaling approximately 1,000 linear feet, were selected for the County's first stream restoration project. The programmatic goals for this stream restoration project are:

- Constructing the project in a public park to facilitate educating the public, county staff and elected officials about stream restoration.
- Developing a design that could be built by a trained and supervised County construction crew.
- Providing stream mitigation for impacts associated with a roadway project.
- The restoration plans were developed based on the following design objectives:
- Preserve the majority of the mature riparian vegetation by avoiding planform changes, and designing around large significant trees.
- Provide vertical channel stability using constructed riffles.
- Provide bank stability using log toes and stone toes on outer meanders.
- Improve sediment sorting and transport by grading inside meanders to activate normal point bars formation.
- Enhance in-stream habitat by incorporating large woody debris into pools.
- Protect existing infrastructure

#### Lessons Learned:

- Significant improvements can be made to stream stability, sediment transport, habitat, and ecology without re-alignment of the planform.
- Large woody debris should be an integral component of any stream restoration.
- Construction crews can quickly learn construction practices unique to stream restoration given appropriate supervision and training.

- A tracked Grade-all can minimize damage to mature riparian trees, resulting in a restoration that has more shade and more sources of woody debris, and is more acceptable to the public.
- Once a stream reach is restored, watershed stressors such as acute pollution events become more apparent.

*About the Speaker:* **Robert Siegfried** has 25 years experience providing environmental services to local, state and federal agencies. Mr. Siegfried leads the restoration practice for Whitman Requardt & Associates, a 90 year old engineering firm with offices in Maryland, Virginia, Delaware and Pennsylvania. He has completed over 100 acres of wetland mitigation design and 3 miles of stream restoration design.

## Making stream restoration work for the community and environment: Two very different examples of meeting the needs of the community as well as the stream

Todd St. John, P.E., LEED® AP

Kimley-Horn and Associates, Inc.  
3001 Weston Parkway  
Cary, NC 27513  
todd.stjohn@kimley-horn.com

*Co-authors:* Todd St. John, Will Wilhelm, Kimley-Horn and Associates, Inc.

*Abstract:* In its purest form, stream restoration is completely focused on restoring natural habitat, morphology, and function to a stream to recreate an environment untouched by human impacts. However, in urban environments, the natural habitat includes people — and our needs and desires.

One of the primary goals of the recently constructed Smallwood and Edna Metz Parks stream stabilization project in Raleigh was to protect the existing trees and character of the parks, as well as to protect existing infrastructure and reduce sediment input. To these ends, innovative ideas such as the use of concrete “A-vanes” and a soldier pile retaining wall with a faux rock finish were integrated into the landscape to preserve the existing trees and park characters as well as to provide means of stabilization to the highly constrained stream system.

The residential and commercial development at Stonebridge in Cary — constructed in late 2007 — also made use of stream restoration as a means of meeting the aesthetic and human interaction needs of the project as well as the regulatory needs to address stormwater and minimize environmental impacts. This project included a small amount of day-lighted stream associated with a greenway that was landscaped to be aesthetically pleasing and to invite human interaction. It also included a small stream restoration with wetland preservation and integrated stormwater measures at one of the main entrances as a gateway amenity.

*About the Speaker:* Whether it was a string of unfortunate clerical errors or not, the records do indeed show that **Todd St. John** has an undergraduate degree from the University of Virginia in Environmental Science and a Masters of Science degree from NC State University in Civil Engineering. He has a PE license in North and South Carolina and is a LEED Accredited Professional (leaving him with an impressively long string of letters after his name on his business card). For nine years, he was with the North Carolina Division of Water Quality where he developed NCDWQ and USACE policies regarding stream restoration design and compensatory stream mitigation (among other fun stuff). For past seven years he has worked for Kimley-Horn and Associates, not only living with policies he created, but tinkering with the new ones too.

# The effects of stream restoration on woody riparian vegetation in the northwestern North Carolina mountain region

Christopher Kaase

Appalachian State University  
4660 Highway 194 South  
Banner Elk, NC, 28604  
ctkaase@gmail.com

*Co-Authors:* Christopher Kaase, Gabrielle Katz

*Abstract:* Re-vegetation is nearly ubiquitous to stream restoration. This research examined the early effects of restoration (<1 to 7 years post-project completion) on woody riparian plant communities on temperate mountain headwater streams. We sampled 27 sites within reference, restored, and degraded groups. Data recorded were species richness, stem density, basal area, site and channel canopy cover, and channel width. Vegetation and channel structural metrics were compared with ANOVAs, and community composition was examined using importance scores and multivariate ordination analysis. Reference and restored sites had similar richness and density. Restored and degraded sites had similar richness, density, basal area, canopy cover, and channel structure. Species dominance differed among all treatments. Degraded conditions were dominated by small-statured, opportunistic species. Restored sites were characterized by the shrub species used for re-vegetation and opportunistic species associated with degraded sites. At reference sites, typical regional riparian forest conditions were present. Overall species composition showed a distinct pattern for reference conditions that was different from both degraded and restored sites. These data suggest that within 7 years of project completion mountain stream restoration projects do not yet resemble regional reference conditions. However, restored sites do differ compositionally from degraded sites. Possible explanations for these differences include insufficient time for vegetation development towards reference conditions, resilience of the degraded state, or creation of a stable novel anthropogenic ecosystem type at restored sites. Long-term monitoring of riparian re-vegetation trajectories is needed to facilitate understanding of restoration outcomes and to inform best management practices.

*About the Speaker:* **Christopher Kaase** is a 2010 graduate of Appalachian State University, with a master's degree in Geography. His thesis work focused on woody riparian vegetation on high-order mountain streams in northwestern NC. Kaase is currently working as an AmeriCorps Project Conserve volunteer. His host site is the Blue Ridge Conservancy in Boone, NC, where his responsibilities include conservation easement monitoring and GIS.

# A five year study of container and bareroot vegetation survival on an NC State University stream mitigation project

**Karen Hall**

North Carolina State University  
Campus Box 7637  
Raleigh, NC 27695  
karen\_hall@ncsu.edu

*Co-authors:* Jean Spooner, Jamie Blackwell, NCSU Water Quality Group

*Abstract:* A stream mitigation project to offset campus impacts was completed in 2004. The project was located at the College of Veterinary Medicine on the campus of North Carolina State University in Raleigh, North Carolina. The restored channel was approximately 700 feet long with wide buffers on each side of the stream. A randomized complete block design was employed for experimental vegetation plots. Treatments included container versus bareroot vegetation of five species of riparian trees including *Betula nigra* (river birch), *Liriodendron tulipifera* (tulip poplar), *Fraxinus pennsylvanica* (green ash), *Platanus occidentalis* (sycamore), and *Quercus michauxii* (swamp chestnut oak). Data on tree survival, stem diameter, tree height and gradient response were collected and analyzed. Results will be discussed during this presentation.

*About the Speaker:* **Karen Hall** is an Extension Associate in the Biological and Agricultural Engineering Department at North Carolina State University. She has worked at NCSU for 10 years serving as a riparian vegetation specialist for stream and wetland restoration projects. Ms. Hall also coordinates watershed restoration projects and BMP implementation throughout the state. She has a B.S. degree in Biology from UNC-Chapel Hill and an M.S. degree in Forestry from North Carolina State University.





## Small scale stream mitigation within a highly urbanized watershed

Joshua Rogers

City of Chattanooga  
1250 Market Street, Suite 2100  
Chattanooga, TN, 37402  
rogers\_joshua@chattanooga.gov

*Co-Authors:* J. Rogers, M. Minkara, R. Robinson, W. Boyd, City of Chattanooga,  
J. Wise, DMS Mapping & Engineering

*Abstract:* An Aquatic Resource Alteration Permit (ARAP) was obtained to perform work in an unnamed tributary of Citico Creek (Chattanooga, TN). Citico Creek watershed is highly urbanized consisting of 70% single/multi-family residential, 16% industrial, 4% commercial, and 10% undeveloped landuses. Citico Creek is on the 303(d) list for low dissolved oxygen, total phosphorus, nitrate+nitrite, E. coli, and other anthropogenic habitat alterations. Mitigation was required to “off-set” the piping of approximately 150 feet of an unnamed tributary of Citico Creek. Tennessee’s stream mitigation guidelines identified the project as a level 3 alteration (elimination/encapsulation). The ARAP was obtained under the conditions that in-system mitigation would be performed at a ratio of 4:1 to fulfill the suggested level 1 enhancement.

City of Chattanooga staff identified a parcel of City owned property to be used for the mitigation site. Absence of the need for land acquisition, appropriate channel length, and location of the stream in a high-traffic high-visibility area were primary reasons for site selection. The permittee – a regional blood center – accepted the site for the reasons of improving local waterways and the proximity of the site to a major client (a hospital) of the permittee who also maintains the site. Project goals included bank stabilization, removal of invasive vegetation, increased canopy, and the re-establishment of small segments of stream channel and stream banks. Creating a publically acceptable stream mitigation plan was an additional objective; the channel was located between two main cross streets at the entrance to the hospital, so it was highly visible.

Bank stabilization was performed with the use of living-walls, live stakes, and grass seed. A total of 368 native plants were planted. The shrub mix included silky dogwood, hearts a bustin, elderberry, redbud dogwood, buttonbush, inkberry, and Virginia sweetspire. Year one monitoring was performed in February 2010; at this time a total of 168 plants remained. As this did not meet the required 75 percent survival rate, replacement plantings were planned. Sections one and three of the mitigation had a very low plant survival rate, so canopy was not increased. The longer section (section two) had the best plant survival rate consisting primarily of buttonbush. Before-plantings canopy cover averaged 60 percent. Canopy was significantly increased to over 90 percent around the mitigated banks. Eroded banks were repaired using 920 feet of seeded Filtrexx Filter Soxx. Portions of the constructed wall failed after the first rain following the installation. Although vegetation had partially taken, sloughing/pull-away of the

Filter Soxx still occurred on the steeper banks. Replacement/repair of these sections was planned.

Community outreach efforts were not made at the outset of the project. Public approval was considered by originally selecting more ornamental species, but due to budget constraints and availability of plantings, less ornate plants had to be purchased. Neighborhood perception of an “unmaintained, weedy” site grew at a rate corresponding to the plant growth. Without the understanding of the importance of stream buffers the citizens saw the site as strictly a beautification project that was not being maintained. This required creative adjustment of the maintenance plan and landscaping that was not originally budgeted. Weed control fabric and river rock were installed around the plantings to allow for cutting of the surrounding grass without fear of accidentally cutting the new shrubs. This extra effort appeased the local citizens who view and walk this section of channel daily.

Monitoring and repairs are ongoing to ensure an acceptable level of project success. Involved parties include: Tennessee Department of Environment Conservation (TDEC), City of Chattanooga, the permittee, the site manager, the engineer (DMS Mapping & Engineering), the contractor (Earthscapes), and of course the residents. Lessons learned include: 1) while it can be difficult to get all interested parties to agree on a plan in a given timeframe, the importance of timing as it relates to weather and rainfall cannot be overstated when vegetation is vital for overall success and 2) public education through personal contact at the project outset is crucial for the understanding and acceptance of the mitigation plan.

*About the Speaker:* **Joshua Rogers** is a Water Quality Specialist in southeast Tennessee for the City of Chattanooga. He received a B.S. in Biology from Piedmont College and a M.S. in Wildlife and Fisheries (Hydrology emphasis) from the University of Tennessee. He works in urban stormwater management performing stream research/assessment, watershed delineations and other GIS analyses, water quality sampling, and biological monitoring.

# Biology and control of porcelain berry (*Ampelopsis brevipedunculata*), an invasive Vitaceae in North Carolina

**Sherrie Emerine**

NC State University  
4401 F Williams Hall North Carolina State University  
Raleigh, NC 27695  
seemerin@ncsu.edu

*Co-author(s)*: Sherrie Emerine, Robert J. Richardson

*Abstract*: Porcelain berry (*Ampelopsis brevipedunculata*) is an exotic invasive woody perennial climbing vine in Vitaceae. Native to Asia, porcelain berry was likely introduced into the United States in the 1870's for ornamental plantings. It is spread by birds, small mammals, and flowing water, and is found in early successional fields, vacant lots, edges, pastures, rights-of-way, along streams and rivers, and in thickets. In North Carolina, dense infestations of porcelain berry often occur along greenways and in riparian areas. It exhibits rapid growth which allows it to overtop and shade out other species, and its climbing habit damages trees and other vegetation.

Greenhouse and field studies of selected herbicides are currently being performed to develop porcelain berry control recommendations. Initial data were subjected to analysis of variance and Fisher's protected LSD was used for mean comparison ( $P < 0.05$ ). In both greenhouse trials, cut-stem treatments of triclopyr 30% v/v provided 100% control. Aminopyralid 5% v/v and glyphosate 50% v/v applied to cut stems provided 65% control or better. Cut-stem treatments of aminocyclopyrachlor 5% v/v with basal oil, imazapyr 1% v/v with basal oil, and basal bark treatments of triclopyr 3% v/v with basal oil and aminocyclopyrachlor 1% v/v with basal oil provided poor to moderate control. Field results show that cut-stem treatments with triclopyr 30% v/v with or without basal oil and basal bark treatments with triclopyr 3% v/v provided greater than 75% control. Results of basal bark and cut-stem treatments with glyphosate 50% v/v, aminocyclopyrachlor 5% v/v with basal oil, and imazapyr 1% v/v with basal oil are inconclusive and additional trials will be conducted to further examine these potential treatment options for this weed.

*About the Speaker*: **Sherrie Emerine** was a veterinary technician for many years, but changed her career focus when she was enlightened about the threats posed by exotic invasive plants and animals. She earned her Bachelor's degree from North Carolina State University in Plant Biology, and is now pursuing a Master's degree here at N. C. State in Crop Science under the advisement of Dr. Rob Richardson. Sherrie's special interest is invasive exotic plants and their impacts on natural systems.



## Restoration of Coastal Plain Headwater Systems: Lessons Learned and Performance Monitoring

**Jeff Furness**

PotashCorp  
1530 NC Hwy 306 S  
Aurora, NC 27806  
JFurness@Pcsphosphate.com

**Kevin Tweedy**

Michael Baker Engineering  
8000 Regency Parkway Suite 200  
Cary, NC 27518  
ktweedy@mbakercorp.com

*Co-author(s):* Jeff Furness, PotashCorp, Kevin Tweedy, Senior Engineer, Michael Baker Engineering, Inc.

*Abstract:* PotashCorp's operations in Aurora, NC has overseen the restoration of 28,000 linear feet of riparian headwater stream systems in two projects from 2008 to 2010 utilizing the US Army Corps of Engineers and the NC Division of Water Quality publication "Information Regarding Stream Restoration with Emphasis on the Coastal Plain" (2007). The Upper Back Creek project encompasses 217 acres and three headwater drainages, while the Hell Swamp project totals 1,297 acres along eight headwater drainages, and both are located between Bath and Belhaven, NC. Site identification, design, construction, and monitoring were all specifically geared towards this new stream restoration approach for Coastal Plain systems. Since few restoration projects have been implemented to date that make use of this guidance, technical design information for these systems was limited.

This presentation will briefly discuss design criteria data developed from 13 reference locations within intact, riparian headwater systems located in the Coastal Plain of North Carolina. However, the primary goal of this presentation is to present lessons learned from the design implementation, construction, and post-restoration monitoring of these projects.

In respect to design implementation and construction, the presentation will focus on constructability issues, site considerations, site preparation, and construction methods including equipment used and techniques. Data presented will include construction costs, schedules, and as-built survey information.

For post-construction performance monitoring, the presentation will summarize the types of monitoring being conducted to evaluate the effectiveness of the restoration work. Such monitoring activities include topographic and geomorphic surveys, groundwater hydrology,

surface flow hydrology, vegetation, and visual observations. The Upper Back Creek site is currently in its second year of post-construction monitoring, while the Hell Swamp site is in its first year of monitoring.

*About the Speaker(s):* **Mr. Furness** holds a B.S. from Michigan State University in Fisheries and Wildlife Biology and a M.S. from Kansas State University in Environmental Biology. He is currently a Senior Scientist at PotashCorp in Aurora, NC where he has worked for 22 years. His main responsibilities include wetland and stream permitting and mitigation, environmental assessments, and reclamation of mined land. He has overseen the restoration of 7,300 acres of wetlands and 44,000 feet of coastal plain streams since 1995.

**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 12 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.

# New Stream Mitigation Requirements in Coastal South Carolina - Providing mitigation in an atmosphere of dynamic policy and emerging science

**Joshua B. Gilman, PE, D.WRE**

MACTEC Engineering and Consulting, Inc.  
2801 Yorkmont Road, Suite 100  
Charlotte, NC 28208  
jbgilman@MACTEC.com

*Abstract:* Development projects in Coastal Plain region South Carolina have recently been required to provide direct compensatory mitigation for impacts to coastal streams, in addition to the previously required wetland mitigation. This revised policy by the U.S. Army Corps of Engineers and the South Carolina Department of Health and Environmental Control has challenged current projects proposed by the South Carolina Department of Transportation (SCDOT) with providing sufficient stream mitigation credits in an efficient and timely manner. Because the market for Coastal Plain stream mitigation is new, there are neither stream mitigation banks nor in lieu fee programs available to satisfy the need for stream credits. To allow urgent roadway improvement and safety-related projects to be permitted, the SCDOT has had to rely on permittee-responsible mitigation (PRM) for stream mitigation consisting of in-watershed, in-kind (similar habitat) project-specific stream mitigation actions.

This presentation describes the experiences of the SCDOT with the developing the stream compensatory mitigation in the Coastal Plain with the use of a PRM example. SCDOT is proposing improvements to a section of U.S. Highway 17-A located in Berkeley County South Carolina. The U.S. Highway 17-A project will impact approximately 1,700 linear feet of stream and/or linear features requiring compensatory mitigation of nearly 6,000 stream credits.

While this presentation will provide details regarding the selected site and the proposed mitigation strategy, it will also reflect on the stream mitigation process by focusing on specific factors contributing to project success. Although this project successfully served the needs of the specific SCDOT project, actually accomplishing site selection, property owner partnership, and an approved final mitigation plan may not always occur in such a smooth and timely manner. This presentation will identify how the existing process could be improved and specific measures to ensure timely permitting and effective mitigation implementation.

*About the Speaker:* **Mr. Gilman** is currently a senior water resources engineer with the Charlotte, North Carolina branch of MACTEC Engineering and Consulting, Inc. with more than thirteen years of experience ranging from watershed planning and management to implementation through natural channel design and urban stream stabilization. Mr. Gilman provides management leadership and technical support in the design, construction, and monitoring of stream and wetland restoration and enhancement projects.





# A NC Sandhills Headwater Stream and Wetland Restoration Project: Background and Monitoring Strategy

**Tracy Stapleton**

Eastern Project Manager  
Ecosystem Enhancement Program  
NC Department of Environment and Natural Resources  
tracy.stapleton@ncdenr.gov

**Amber Coleman, LSS, PWS**

Stantec Consulting  
801 Jones Franklin Road Suite 300  
Raleigh NC 27606  
amber.coleman@stantec.com

*Co-Author(s):* Amber Coleman, Stantec Consulting Services, Inc., Tracy Stapleton, NC Ecosystem Enhancement Program

*Abstract:* The UT to Jumping Run Creek stream and wetland project is located in the Sandhills of North Carolina, north of the City of Fayetteville. The project is located on a 225 acre conservation easement purchased by the State of North Carolina's Ecosystem Enhancement Program in 2007. Formerly in pasture and row crop agriculture, original site streams were straightened and excavated, reducing natural stream functions and draining wetlands. The project is made up of a long, gentle valley with a 0.7 square mile drainage area at the upstream end sloping down to a 1.2 square mile drainage area at the downstream end of the project. Existing conditions surveys and watershed analyses were taken into account when developing site specific goals and objectives. As designed and constructed, the restored stream transitions from a headwater stream into a single thread channel, and consists of over 8,000 linear feet of stream. The broad headwater stream valley was integrated into the project consistent with recent regulatory guidance. Adjacent soils are mainly Deloss, Roanoke and Pactolus series with areas of hydric soils and also sandy upland soils. Riparian wetlands were restored adjacent to the stream, while beyond the sandy uplands non-riparian wetlands were also restored on-site. Filling of ditches and raising of the stream bed elevation restored a total of over 90 acres of wetlands. Construction and planting were completed in April 2010 and monitoring for success began immediately. Typical monitoring methodology consists of groundwater gauge data collection, typical geomorphological survey and CVS methodology vegetation plots. A portion of the vegetation monitoring is being implemented using random transects to more fully assess the overall vegetative health of the site. Additionally, the braided headwater stream reach will be visually monitored using a unique assessment form to document various indicators of success.

*About the Speaker(s):* Tracy Stapleton is a Project Manager in eastern North Carolina with the NC Ecosystem Enhancement Program, managing stream and wetland restoration projects, as well as

stormwater BMP projects. After receiving a Bachelor's Degree in Environmental Science from NC State University and volunteering with the Peace Corps in Honduras, she returned to NCSU to complete a Master's Degree in Soil Science and Forestry in 2004. She has been with the Ecosystem Enhancement Program ever since. Tracy is a native North Carolinian, from Sanford, and now lives in Apex.

**Amber Coleman** is a soil and wetland scientist at Stantec Consulting in Raleigh NC. She obtained an undergraduate degree in Environmental Sciences and a masters degree in Soil Science from Virginia Tech. Ms. Coleman has over 10 years of experience working on stream and wetland mitigation projects in the southeast; primarily within North Carolina. She works on many aspects of the process including site assessments, mitigation plan and permit application development, planting plan layout, as well as post-construction monitoring. Amber is also the current president of the North Carolina Association of Environmental Professionals.

# Applying Geomorphology and Two-Dimensional Hydraulic Modeling to the Management of Municipal Coastal Plain Canals

Joshua L. Robinson, MS, PE

BurnsRobinson, PC  
184 East Chestnut Street  
Asheville, NC 28801  
jrobinson@burnsrobinson.com

*Abstract:* The primary goal of any ecosystem restoration project should be to return as much natural function to the ecosystem as possible. Natural physical processes are the foundation of healthy ecology; thus, the challenge of ecosystem restoration design is to properly balance natural function with property protection, aesthetics, recreation, cost, and longevity.

Municipal canals in the coastal plain have been foundational to the establishment of lowland communities in the Southeast, providing flood protection, navigation, power generation, irrigation, and passive recreation. And although the hydrologic landscape of these communities can never be restored to their pre-colonial condition, many communities are exploring ways to reintroduce natural function into municipal canals in an effort to add recreational, ecologic, and aesthetic value.

BurnsRobinson has recently applied a process geomorphology / two-dimensional hydraulic modeling approach to two canal rehabilitation projects in South Carolina. Both of the channels are trapezoidal, deliberately incised, and include straight sections and curved sections. Although the scale of the projects differed by an order of magnitude, the use of fundamental hydraulic modeling tools and geomorphology enabled the design team to specify organic stabilization measures that worked with the natural geomorphic and ecologic tendencies in the channels.

The first project was bank stabilization conceptual design and hydraulic modeling for the St. Stephen Power Plant Intake Canal. The second was a stormwater canal stabilization project along Turkey Creek in urban Sumter. One-dimensional and two-dimensional hydraulic models were used to analyze steady and unsteady flows in the canals, elucidate complex hydraulic conditions, and compare channel response to conceptual design measures. By understanding the active natural processes and tendencies of these waterways, the design team was able to avoid unintended consequences, create multi-faceted project value, and help a canal function more like a stream.



# Designing Stream Stabilization Measures for Short Stream Segments in Urban Areas

Becky Ward, PE

Ward Consulting Engineers, P.C.  
8368 Six Forks Road, Suite 104  
Raleigh, North Carolina 27615  
bward@wce-corp.com

*Abstract:* Viable stream stabilization projects, even on small channel segments, can effectively improve stream water quality from mass wasting in urban areas. Opportunities and constraints for the evaluation and design of urban stream segments will be presented. Typical project sizes range from one (1) to five (5) property owners in residential areas.

The findings are based on the analysis and design of 23 projects within the City of Raleigh completed through the City Stormwater Petition Program. The projects were completed to address severe erosion or structural flooding issues. Priority 4 bank stabilization was the primary project objective to stop sediment import into the stream from degrading banks. Floodplain benching and improved profile transitions were accomplished where possible. Some of the physical limitations of working in fully developed areas include working with existing utilities and infrastructure, limited site access, construction maneuverability, and considerations for existing landscaping and mature trees. Design solutions are often limited by suitable tie in locations within the project boundaries both horizontally and vertically and available area for suitable proposed bank slopes. Good designs look for opportunities to relieve or structurally stabilize areas of high shear stresses in these typically incised systems.

Project designs will be discussed to show the site issues, resulting design solutions, and long term benefits. An important part in the design is good communication with individual property owners to explain the design plan in non-technical terms and construction expectations/impacts. Cost-effective approaches for long term stabilization using natural channel materials and structural measures will be presented.

*About the Speaker:* Ms. Ward has more than 30 years of experience in civil engineering and stormwater analysis and design and is the president of Ward Consulting Engineers, P.C. a woman owned business enterprise specializing in stormwater management founded in 1992 as Becky L. Ward Consulting and incorporated in 2004 under its current name. Ms. Ward, a licensed Professional Engineer, has earned a Bachelor of Science in Civil Engineering with an environmental concentration from Michigan State University and a Masters of Civil Engineering in water resources from North Carolina State University.

Ms. Ward has been working on the evaluation of streams for restoration potential for over ten years in North Carolina. She has experience collecting existing morphological data on over 40,000 linear feet of degraded and references reach streams. Ms. Ward's area of expertise is in

providing hydrologic and hydraulic analysis, stream morphological assessment, stream restoration design, stream monitoring, and site civil engineering design. She has managed a wide range of projects including storm drainage collection system retrofits and improvements in urban areas, residential and commercial design, flood investigations on FEMA regulated and non regulated streams for roadway structures and trails, watershed analysis for flood damage assessment and water quantity issues, storm water quality best management design & inspection, dam design and rehabilitation, detention design, erosion control analysis, stream morphological assessment and restoration, subdivision design, commercial/ office park development, and has extensive construction management experience.

## Powhatan Plantation Stream Restoration Project

Travis W. Crayosky

Williamsburg Environmental Group, Inc.  
5209 Center Street  
Williamsburg, VA, 23188  
tcrayosky@wegnet.com

*Abstract:* James City County implemented their first stream restoration project in 2008 as part of the Powhatan Creek Watershed Management Plan. Williamsburg Environmental Group, Inc. (WEG) worked closely with James City County to provide stream restoration assessment, design, permitting, and mitigation banking assistance as part of the proposed Powhatan Plantation Stream Restoration Project. The project included approximately 2,639 linear feet (LF) of stream restoration, of which nearly 1,200 LF involved Priority I restoration activities. Diamond Resorts granted an easement to complete the project that will ultimately protect 27.9 acres of stream and wetland/upland complex in perpetuity.

The unnamed tributary to Powhatan Creek has an approximate 150-acre urbanized watershed. Unattenuated stormflows had significantly degraded the existing stream system. An approximate 8-foot headcut was migrating upstream causing severe bank erosion and channel instability. Floodplain wetlands were being dewatered due to the deeply incised stream and water quality benefits typically provided by the riparian buffer are limited. Large colonies of the state-listed Virginia least trillium (*Trillium pusillum* var *virginiana*) were identified and protected to the greatest extent practicable.

The design was based on natural stream channel design principles and restored steeper, headwater, sand-bed stream within an urban environment. Stormwater management retrofits, in-stream habitat and grade control structures, constructed riffles, and extensive native plantings will were implemented. The Project is currently being monitored for 10 years (Years 1, 2, 3, 5, 7, and 10). 2010 represents Year 2. Annual monitoring efforts will include stream surveys (longitudinal profiles and cross-sections), pebble counts, numerous geomorphological ratio computations, and vegetation assessments. Pre- and post-restoration data will be compared for stream stability and aquatic fauna trend analyses. Additional areas potentially colonized by Virginia least Trillium are also currently being evaluated.

The Project has been used as a demonstration site for private landowners and a host of local, state, and federal entities. On October 29, 2009, the U.S. Army Corps of Engineers – Norfolk District used the site for natural stream channel design training in the Coastal Plain of Virginia. In addition, a local environmental group has referenced the site as the example for stream restoration improvements needed in James City County. One local member of the group created a blog to follow the maturation of the site (<http://www.howitgrows.com/2010/01/powhatan-creek-restoration.html>). A fitness trail was re-aligned to promote additional public outreach and education to the community and Diamond Resort visitors. Local media outlets also have



published several articles in the local newspaper prior to, during, and post-restoration. To date, the cooperative effort among James City County, WEG, and Diamond Resorts, as well as the surrounding community, has made the Powhatan Plantation Stream Restoration Project tremendous success for outreach, education, and connection of the community to these natural resources.

*About the Speaker:* Mr. Travis Crayosky is the Program Manager for Streams at Williamsburg Environmental Group, Inc. His principal areas of specialization are in the assessment, design, implementation, and monitoring of stream and wetland projects. With over 13 years of experience, he has managed a variety of projects ranging in size and complexity from small, local enhancement task orders to multi-million dollar restoration efforts. He has been a speaker at numerous conferences, workshops, and seminars addressing a wide range of topics associated with stream restoration and environmental planning. Mr. Crayosky has also participated in several local, state, and federal stream assessment and design committees. He has a B.S. in Earth Sciences and an M.S. in Forest Hydrology from Penn State. He served as the Project Manager for the Powhatan Plantation Stream Restoration Project.

# Challenges and Constraints of Urban Stream Restoration - Case Study: Roanoke Rapids Reach 2 & 5

Amit Sachan, PE, CFM

Dewberry  
2301 Rexwoods Drive, Suite 200  
Raleigh, NC, 27607  
asachan@dewberry.com

*Co-authors:* Amit Sachan, PE, CFM, Project Manager/Water Resources Engineer ; Michael A. Hanson, PE, LEED AP, Senior Manager, Water Resources Department

*Abstract:* In recent times, stream restoration techniques have been used for environmental preservation and improvement of water quality in the rural and urban settings within North Carolina and several other states. The use of such established techniques can provide short-term and long-term enviro-economic benefits and promote sustainable development leading to a 'greener' future. The presentation will provide an overview of the unique challenges and constraints faced during urban stream restoration on four (4) recent projects with an emphasis on Roanoke Rapids Stream Restoration.

The City of Roanoke Rapids, NC contacted Dewberry & Davis, Inc. to obtain Clean Water Management Trust Fund (CWMTF) grant to perform stream restoration on two streams (Reach 2 and 5) to address stream bank stabilization, sediment removal, and environmental preservation issues. The unique location of these streams along the famous historic Roanoke Canal Trail and being surrounded by urban area emphasized the need for restoration as well as preservation. The existing streams lacked sinuosity and had riparian buffer zones that had been highly impacted by bank erosion and minimal plant diversity. Bank erosion was resulting in private and public property loss and contributing significant sediment into Roanoke River impacting spawning and feeding grounds for anadromous fish and several species of State-status Threatened mollusks. The reference reaches were selected based on the Rosgen parameters obtained from the survey data. A Priority Level 1 restoration was performed on each stream to provide a new alignment with greater sinuosity and raise the channel to reconnect to its bankful floodplain. A riparian buffer was provided for both streams based on species noted during the vegetative study of the project site and reference sites, and supplemented by multiple native riparian plants.

The project helped the City of Roanoke Rapids, achieve channel stability and protection of private and public property from erosion and flood losses while preserving natural conditions favorable for wildlife and plant species. The presentation aims at summarizing the lessons learned on fours (4) projects while emphasizing on a project within the City of Roanoke Rapids, NC along with three other recent projects in relatively urban settings.

*About the Speaker(s):* **Mr. Sachan** is a Water Resources Project Manager with Dewberry in Raleigh, NC. He has 8 years of experience on a variety of Water Resources Projects. His experience includes Hydrologic and Hydraulic modeling, Floodplain Mapping, Stormwater Master Planning, Stream Restoration, and Capital Improvement Projects. He is a Certified Floodplain Manager and is a licensed engineer in North Carolina. Mr. Sachan received his B.S. in Civil Engineering from IIT Bombay and an M.S. from Virginia Tech. He has an MBA from North Carolina State University.

**Mr. Hanson** is a Senior Associate with Dewberry and the Manager of Water Resources for Dewberry's Raleigh office. He has over 20 years of civil/water resources engineering experience working on a variety of projects. His experience includes development and management of stormwater modeling, master planning, stream restoration, design and permitting using SWMM, HEC-RAS, CivilStorm and ADICPR and water quality modeling using WASP and WMM. He leads marketing activities and provides technical oversight for projects including flood modeling and mapping production, stormwater BMP design and permitting; stakeholder facilitation; GIS applications and water resources construction administration. Mr. Hanson graduated from the University of Florida with a BS in Civil Engineering in 1989. He is a registered professional engineer in North Carolina, South Carolina, Mississippi and Florida. He is also a LEED accredited professional through the US Green Building Council.

## The Ararat River Project – Restoring a Large River for a Small Community

Joshua White, PG, CFM, EI

Michael Baker Engineering, Inc.  
8000 Regency Parkway, Suite 200  
Cary, NC 27518  
jawhite@mbakercorp.com

*Abstract:* The Ararat River Project is located in Surry County, NC, in the City of Mount Airy. The project was undertaken on behalf of the City of Mount Airy, Resource Institute, Inc. (a non-profit organization), and the Surry Soil and Water Conservation District. The project was funded by the City of Mount Airy, the NC Clean Water Management Trust Fund, the NC Division of Water Resources, and the NC Park and Recreation Trust Fund. The project restored approximately 3 miles of the Ararat River, constructed a 2-mile riverside greenway, refurbished one riverside park and constructed two additional parks. The Ararat River is a large channel, approximately 70 feet wide with a 75 square mile watershed, that runs along the east side of Mount Airy and is prone to severe erosion.

The Ararat River restoration provided improved channel stability, aquatic habitat, and water quality. In addition to the environmental benefits of a restored river, the project provides educational, recreational, and aesthetic benefits to area visitors and the 73,000 local residents of Surry County. Upstream of the project area, the Ararat River is a stocked fish hatchery, and the NC Wildlife Resources Commission plans to extend the fishery into the newly restored sections of the Ararat River. The greenway and river corridor extend to three area schools, with bridge and pedestrian connections. In addition to the educational opportunities provided by the new parks and greenway, the project is designed to encourage area youth to have a more active lifestyle, building healthy habits that will last a lifetime. Finally, the project will expand the City's stated goal of becoming an ecotourism destination.

This presentation will focus mostly on the Ararat River restoration (i.e. dealing with the channel instability, and design and construction techniques) and how the parks and greenway designs compliment the river restoration work. The Ararat River Project, which won a 2010 ACEC Environmental Grand Award, is unique in that it is large enough to support canoeing and other recreational activities, but is sufficiently narrow and forested to allow users a sense of privacy and closeness to nature.

*About the Speaker:* Joshua White is a geomorphologist 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, Certified Floodplain Manager, and an Engineering Intern in North Carolina and for the past six years has worked for Michael Baker Engineering in all aspects of ecological restoration.

## Case Studies in Urban Stream Restoration

### William Wilhelm, P.E., CFM, CPESC

Kimley-Horn and Associates, Inc.  
4651 Charlotte Park Drive, Suite 300  
Charlotte, NC 28202  
will.wilhelm@kimley-horn.com

*Co-author(s):* Tommy Cousins, PWS, EarthMark Mitigation Services, Tommy.Cousins@EarthMark.us; William R. Wilhelm, P.E., CFM, CPESC, Kimley-Horn and Associates, Inc., Will.Wilhelm@kimley-horn.com

*Abstract:* The criticism about the feasibility and value of urban stream restoration for mitigation typically involves their perceived low ecological value compared to their high costs. Rural projects usually generate similar compensatory mitigation credits at lower implementation costs. However, it is recognized that urban watersheds contain the majority of stream and wetland impacts and are typically more degraded and impacted ecosystems than rural. This presentation will focus on two urban stream restoration case studies to show the challenges of finding a balance between credit and cost. The intent is to spark discussion on how to better assign ecosystem credits to these projects' value to make similar future projects more viable.

Both projects were completed by EarthMark Mitigation to provide full delivery stream and wetland mitigation credits to the North Carolina Ecosystem Enhancement Program.

The Tarlton Site was an urban, in-line lake inside the Fayetteville City limits used for swimming and as a residential amenity. Several dam failures in the 1990s were left unrepaired and led to an unsightly, stagnant impoundment area. Beavers moved in and exacerbated the situation. The unstable, unsafe conditions were of significant concern for the adjacent landowners and the City.

The restoration project removed the remnants of the dam failures, including the beaver dam and beavers, and restored a natural stream channel and associated wetlands. The stream channel design and vegetative plantings re-established a fully functioning, complex stream and wetland ecosystem.

The second case study involved the restoration of 3,000 linear feet of Stricker Branch, a tributary to Irish Buffalo Creek near downtown Concord. About 1,000 feet of Stricker Branch had been impounded as a pond for the adjacent textile mill and the remaining sections were channelized. The historic mill pond was taken off-line and converted into a stormwater pond/amenity for the mill redevelopment, which contains office and retain space. The entire 3,000 feet was restored using natural channel design techniques and re-vegetation.

*About the Speaker:* **Will Wilhelm** is a water resource engineer who manages numerous watershed projects involving best management practices for water quality and quantity and ecosystem

restoration designs. Mr. Wilhelm is one of the driving forces behind Kimley-Horn's watershed restoration and environmental practices. He has been involved in all aspects of urban and rural watershed and stormwater management projects, including feasibility and planning, permitting, public involvement, modeling, design, construction management, and monitoring. Mr. Wilhelm is a registered professional engineer in North Carolina and Tennessee, a certified floodplain manager and a certified professional in erosion and sediment control. Mr. Wilhelm holds bachelors of sciences in civil engineering and environmental engineering from North Carolina State University.

# A Comparison of Vegetation Surveying Methods for Mitigation Projects

**Daniel Ingram**

WK Dickson  
720 Corporate Center Drive  
Raleigh, NC 27607  
dingram@wkdickson.com

*Co-Author(s):* Daniel Ingram, W.K. Dickson; Norton Webster, Environmental Banc & Exchange, LLC

*Abstract:* Mitigation monitoring constitutes a substantial portion of the total costs over the life of a project. It is important that mitigation providers collect data to support the goals and objectives of the mitigation plan as well as to fulfill regulatory requirements. The traditional method for vegetation monitoring has been to record planted tree survival and note the amount of natural regeneration in fixed plots. We will compare the costs and utility of traditional vegetation monitoring and EEP-CVS vegetation monitoring. We will also discuss modified vegetation monitoring protocols such as belt transects and plotless methods that may more accurately and efficiently provide the necessary survival data.

*About the Speaker:* **Mr. Ingram** has 12 years experience in natural resources consulting and natural resources management. Daniel is currently project manager for monthly and annual monitoring on 22 stream restoration sites across North Carolina. Daniel has planned, managed, and executed a broad range of ecological projects including: mitigation planning, monitoring, stream and wetland restoration, wetland delineation and permitting, endangered plant and animal surveys, and biological monitoring in upland and aquatic sites. These projects have been conducted for federal, state, and local governments as well as private developers and industry. His experience is concentrated in the southeastern United States.





# Evaluating Stream Restoration: A Need to Tailor Goals, Monitoring, and Success

Zack Mondry

NC Ecosystem Enhancement Program  
1652 Mail Service Center  
Raleigh, NC 27699-1652  
zackary.mondry@ncdenr.gov

*Co-authors:* Zackary J. Mondry, Mac Haupt

*Abstract:* Over the last decade stream restoration projects have been implemented by a variety of entities and in diverse geomorphic, land-use, and hydrologic settings. However, project goals, monitoring protocols, and success criteria are comparatively homogeneous. For example the goal of improved aquatic habitat is pervasive enough that sinuous channels with repeating riffle-pool sequences have been designed and constructed in urban, water quality-impaired systems lacking valuable aquatic populations. Or, reference reach parameters and a sediment transport analysis based only on a critical dimensionless shear stress have been employed with the goal of creating stable channels that are subsequently aggraded by fine sediment from rapidly urbanizing watersheds. Further, monitoring protocols and success criteria dictated by the Stream Mitigation Guidelines (USACE, 2003) utilized in North Carolina do not reflect a range of project settings or hydrologic conditions. The guidelines require physical channel surveys every year regardless of water-year characteristics, and narrowly define success in such terms as a lack of bar formation.

We present cases in which project goals should be tailored based on site geomorphic and land-use settings. For example if we anticipate that a site will be affected by inputs of significant fine sediment, then the goal of improved aquatic habitat by way of a sinuous channel with coarse riffles and deep pools may be inappropriate, and a lack of bar formation would not be an appropriate success criteria. Tailoring project goals would in turn call for more adaptive monitoring schemes. For example if project objectives did not include strict maintenance of regularly-spaced riffles and pools there may be more emphasis placed on overbank flows, flood attenuation, and riparian vegetation success. In this case visual stream assessment could be adequate to go along with vegetation measurements and hydrologic monitoring.

*About the Speaker:* **Zack Mondry** is a Senior Stream Monitoring 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 project site selection, assessment, and design review. He previously worked as a USFS Hydrologist in Arizona and California, and has also done watershed science work in Alaska, Montana, and Washington states. Zack received a B.S in Geology from Oregon State University and an M.S. in Geology from Humboldt State University where he studied flood effects on riparian vegetation and channel morphology

while being advised by Tom Lisle and Harvey Kelsey. In his spare time he enjoys playing and teaching bluegrass music on upright bass, mandolin, and guitar.

## Advantages of monitoring vegetation restoration with the Carolina Vegetation Survey protocol

M. Forbes Boyle

University of North Carolina - Chapel Hill  
Department of Biology, CB# 3280, University of North Carolina  
Chapel Hill, NC 27599-3280  
mboyle@unc.edu

*Abstract:* Since May 2005, the Carolina Vegetation Survey (CVS) has collaborated with North Carolina's Ecosystem Enhancement Program (EEP) to develop protocols for monitoring vegetation on wetland restoration projects. To reduce sampling bias and error, and to ensure that measurements are repeatable across restoration sites, CVS designed a monitoring scheme that utilizes fixed-area plots to record vegetation data. Furthermore, a multi-tiered approach has been incorporated into the protocol to accommodate varying project goals. With increasing level, the information gathered on vegetation and environment becomes increasingly detailed. Sampling levels include: 1 - Planted Stem Inventory, 2 - Total Woody Stem Inventory, 3 - Community Occurrence, 4 - Community Composition, and 5 - Community Composition and Structure. Between May 2005 and June 2010, 30 design/monitoring firms used Level 1 and 2 CVS protocol across 78 sites within North Carolina. CVS uses levels 4 and 5 to document high quality reference areas. In addition to protocol development, the CVS has designed data entry and quality-control tools to optimize the quality and flow of vegetation and environmental data from field sites into a common CVS-EEP data archive. This rigorous data system allows for efficient report generation by project. Summary reports include survival/growth of planted stems, direction of compositional change between sample years, and warnings such as increased abundance of exotic species. The CVS protocol and its associated tools were designed to improve quality and efficiency of resampling events and to track individual planted stems for more accurate assessment of restoration success/failure. Also, the use of a consistent methodology across the region has increased efficiency as well as predictability of success. In this presentation, we explore advantages of using the CVS protocol and tools for monitoring restoration projects. We also examine plans for improvement of the protocol, including automated species selection based on site criteria.

*About the Speaker:* Forbes Boyle is a Research Specialist in the Plant Ecology Research Group (<http://www.bio.unc.edu/Faculty/Peet/lab/>) at the University of North Carolina - Chapel Hill, and serves as the Program Manager of the Carolina Vegetation Survey (CVS) (<http://cvs.bio.unc.edu/>). Since joining the CVS in 2006, Forbes has been involved in numerous projects aimed at providing the N.C. Ecosystem Enhancement Program (EEP) effective guidance and tools for restoration and mitigation activities throughout the state. He received his M.S. in Forest Resources from Clemson University, and is in the final stages of completion of his PhD from the same department. His dissertation focuses on the description and prediction of vegetation across seral stages of ecological site types within the southern Appalachian Mountains. Other research interests include multivariate statistical modeling of forest

landscape change, utilizing long-term, high-quality fixed-area plot datasets to improve existing vegetation classification models in the southeastern US, and applying environmental - vegetation models to guide local ecological restoration efforts. Forbes has also taught courses in field botany, dendrology, experimental statistics, and natural resources measurements.

## Use of survival data for planted woody stems to refine a vegetation monitoring protocol for restoration sites

Thomas R. Wentworth, Ph.D.

North Carolina State University  
Dept. of Plant Biology, Campus Box 7612  
Raleigh, NC 27695-7612  
tom\_wentworth@ncsu.edu

*Co-authors:* Thomas R. Wentworth, Michael T. Lee, M. Forbes Boyle, Mac Haupt, Robert K. Peet

*Abstract:* The Carolina Vegetation Survey (CVS), in collaboration with North Carolina's Ecosystem Enhancement Program (EEP), has developed a vegetation monitoring protocol for restoration sites. A goal of this protocol is to provide a consistent, efficient, and repeatable means for tracking performance of individual planted woody stems. CVS currently maintains data for woody stems from 662 permanent monitoring plots across 72 restoration projects. Dimensions measured annually for these stems include height, diameter at decimeter height (DDH), and diameter at breast height (DBH). In addition, each stem's coordinates within a monitoring plot are recorded, along with the stem source (live stake, bare root, ball and burlap, etc.). Annual updates are also recorded for stem vigor and damage observed. Monitoring firms requested that CVS review the protocol to determine if the number of stem dimensions measured could be reduced without loss of data utility. Because current regulatory requirements specify minimum survival rates of planted woody stems, CVS examined survival data for planted woody stems as functions of stem dimensions. Increasing DBH contributed to greater likelihood of survival for stems  $\geq 5$  cm DBH. Both larger DDH and greater height contributed to greater likelihood of survival for all stems. A model predicting annual survival rate for stems based on stem height alone performed nearly as well as a model based on both stem height and DDH. Because measurement of DDH requires more time and effort than measurement of stem height, EEP and CVS are considering modifying the protocol to eliminate DDH measurements, simplifying woody stem monitoring. The CVS-EEP restoration plots database offers the potential for a variety of other assessments, such as determining which types of woody plants (species, source) are best suited for particular site conditions.

*About the Speaker:* **Thomas R. Wentworth** is Alumni Distinguished Undergraduate Professor of Plant Biology at North Carolina State University. Tom graduated from Dartmouth College in 1970 with a bachelor's degree in biological sciences. He received his Ph.D. in plant ecology from Cornell University in 1976, when he joined the Department of Botany (now Plant Biology) at NC State University. His research focuses on plant community ecology, with special interest in the description and classification of vegetation, and the environmental interpretation of community patterns, particularly biodiversity. Much of his recent research has focused on the vegetation of the Carolinas through collaboration with the Carolina Vegetation Survey, of which he is a founding member. Tom has served on the Board of Directors of the Organization for Tropical Studies (1978-1988), and both the Board of Scientific Advisors (1979-present) and the Board of

Directors (1987-2008; chair 2001-2007) of the Highlands Biological Station. He is a member of the Ecological Society of America, The Torrey Botanical Society, the Southern Appalachian Botanical Society, the International Association for Vegetation Science (IAVS), and the honor societies of Phi Beta Kappa, Phi Kappa Phi, and Sigma Xi. He was Business Manager of the North American Section of IAVS from 1991-1995. Tom has been a member of the Association of Southeastern Biologists (ASB) since 1976, where he has served as Vice President (2005-2006), President-Elect (2007-2008), President (2008-2009), and Past President (2009-present). He was awarded ASB's Meritorious Teaching Award in 2001.

# Are You Losing Credits in the Dirt? The Value of a Proper and Comprehensive Soil Investigation

Michael G. Wood, LSS

The Catena Group  
410-B Millstone Drive  
Hillsborough, NC 27278  
mwood@thecatenagroup.com

*Abstract:* Since the inception of stream/wetland mitigation, the criteria used by regulators to determine the presence of hydric soil and the success of a mitigation site have remained fairly constant. This is despite much recent research and studies on the development of hydric soils which provide additional criteria for determining their presence. As a result, credits are not being obtained for many sites, even in some cases where the successful restoration of the hydrologic regime is documented. There are several reasons for this failure, but the primary reason is that the site has not been evaluated by an experienced soil scientist prior to site design and throughout the monitoring period.

Understanding the processes of hydric soil development and soil pedogenesis allows for a comprehensive account of the history of the site, such as the historic hydrologic regime as well as past disturbances. This information is intrinsic to correctly designing the site. Each site is unique and therefore the soil and site evaluation needs to be a relative comparison of that particular site. Such an evaluation allows the following:

1. A determination of the hydric status of the soils that fall within the “fringe zone” of hydric versus non-hydric.
2. A better understanding of the soil forming processes that have/are occurring, and how this understanding can maximize the efficacy of the site for mitigation
3. A scientific approximation of the soil morphological changes that are expected to occur based upon the mitigation plan
4. Setting attainable success criteria
5. The economic benefit from a proper soil evaluation

*About the Speaker:* **Michael Wood** is a North Carolina Licensed Soil Scientist and the President of The Catena Group, Inc. He is a member of the Soil Science Society of America – North Carolina Chapter and the National Society of Consulting Soil Scientists. He has been delineating wetlands since 1992 from New England to Georgia. He first began evaluation mitigation sites in 1995 as an employee of the NC Division of Coastal Management. He worked for NCDOT from 1996-2001 where he continued delineating wetlands and evaluating mitigation sites. He has continued this involvement as a private consultant as the owner and founder of The Catena



Group. He was recently chosen to serve as a peer-review team member for the Eastern Mountains and Piedmont Regional Supplement to the Corps of Engineers Wetland Delineation Manual. Michael holds a B.S. in Recreation Management from the University of Vermont, 1986, and a M.S. in Soil Science from the University of Rhode Island, 1996.

# Multi-agency and stakeholder collaboration on a stream and Southern Appalachian Bog wetland restoration project in the New River basin of North Carolina

Harry Tsomides

NCDENR – EEP  
5 Ravenscroft Drive, Suite 102  
Asheville, NC 28801  
harry.tsomides@ncdenr.gov

*Co-Authors:* Harry Tsomides (NC Ecosystem Enhancement Program), Chris McGrath (NC Wildlife Resources Commission)

*Abstract:* The recently constructed (Spring 2010) unnamed tributary (Ut) to Crab Creek project is an example of a non-urban, design-bid-build, multi-stakeholder stream and wetland restoration effort in the mountains. This project couples Local Watershed Planning (LWP) and partner agency goals with specific project implementation goals. The project was acquired in tandem by the North Carolina Ecosystem Enhancement Program (NCEEP) and North Carolina Wildlife Resources Commission (NCWRC). It is located within a priority subwatershed identified by LWP stakeholders and its implementation will help achieve several key goals of the LWP effort as well as fulfilling compensatory mitigation requirements within the New River basin. This project will address the two most significant watershed impacts identified during the LWP watershed assessment process, degradation of riparian habitat and sedimentation. Additional goals for this project are to enhance and preserve riparian buffers on a headwater trout stream; enhance aquatic and terrestrial habitat along the stream corridor; improve wetland functions by connecting and expanding multiple wetland community types; and improve and expand Southern Appalachian Bog wetland habitat for the Bog Turtle, *Glyptemys muhlenbergii*. Some of the unique aspects and challenges of the project that will be discussed include the planning effort and stakeholder involvement leading up to the project, the opportunity to improve and expand bog turtle habitat in a Southern Appalachian Bog wetland, the unexpected construction challenges encountered in building this large stream and wetland project during a winter of unusual storm activity, and the advantageous use of onsite natural materials such as native cobble and transplanted woody vegetation during the project construction.

*About the Speaker:* Harry Tsomides, M.S., is Project Manager and Environmental Senior Specialist with the NC Ecosystem Enhancement Program (EEP), where he has been employed since 2005 working on projects in the western half of the state. He has managed 25 different EEP projects totaling over 145,000 linear feet of streams and 60 acres of wetlands, conducting landowner recruitment and helping to coordinate permitting and technical review, construction and monitoring activities, and maintenance. In conjunction with stream and wetland mitigation projects, Harry has also worked extensively with landowners, state, and county agencies to implement farm improvements and livestock best management practices encompassing over 150

streamside acres as part of water quality improvement goals. Prior to joining EEP Harry worked for 11 years in multiple areas of environmental assessment, restoration and remediation as a private sector environmental consultant. He has a bachelors degree from Clark University and a master of science degree from Rice University.

# An Innovative, Low Cost Stream Restoration and Mitigation in the Flint Hill Prairie Region of North Central Oklahoma

**Michael Geenen**

North Carolina State University  
4237 Saddle Notch Dr  
Fort Collins, CO 80526  
michael.geenen@gmail.com

*Co-author(s):* Michael Geenen, David Bidelspach

*Abstract:* The Nature Conservancy with association with North State Environmental constructed 1500 ft of restored intermittent and ephemeral channels within the Dry Creek watershed in Osage County Oklahoma early 2010. This project is a mitigation project that was paid for by violation fees that were paid to the US Fish and Wildlife Service. Protecting 39,000 acres of cross timbers and tallgrass, Tallgrass Prairie Preserve is uniquely situated to protect the headwaters of Sand Creek and the land that drains into it.

Dry Creek was eroding, which resulted in a stream with an overly deep, overly wide channel and active head cuts. The increased sediment entering into the channel from bank erosion converted a gravel-bottomed stream into a silty stream, impairing the viability of existing fisheries adapted to gravel streams. Numerous issues contributed to this erosion including historical grazing practices and land management activities.

A restored stable stream is one that can transport its water and sediment loads while maintaining its pattern form and dimension. The restoration returned reaches of an Unnamed Tributary of Dry Creek to a stable condition using a natural channel design approach.

The design was focused around the project goals and objectives. The goals and objectives were bank erosion reduction, vegetative cover, geomorphic stability, future bison accessibility, native plant and material use, and cost. First, bank erosion should be reduced by 50% over the next three years, creating a more ecologically functional stream using three methods. Vegetative cover for the project should be increased by 80% over the next three years. This cover consists of native species and will be monitored. Geomorphic stability would be achieved by flood plain grading, channel grading and structure placement. Only naturally available materials from the Flint Hill Prairie were used for structures. Bison will access the site freely and the design was not to inhibit their accessibility or be compromised by the accessibility of the bison. It was The Nature Conservancy's goal to use only native material from the prairie for the restoration of UT to Dry Creek. Finally, a goal of the project included innovation as well as cost efficiency. To meet the cost goal the project was assessed, designed, constructed and monitored for less than \$30/lf.

This project required a design for restoration treatment to meet the project goals and objectives. This presentation will summarize the project and share lessons learned and data from 9 months of monitoring of the UT to Dry Creek Stream restoration project.

# Rural Stream Restoration: Lessons Learned in Design and Implementation

Suzanne Hoehne

Biohabitats, Inc.  
120 Webster St Suite 326  
Louisville, KY 40204  
shoehne@biohabitats.com

*Co-authors:* Ozburn, Nicholas (Kentucky Department of Fish and Wildlife Resources)

*Abstract:* “Terry’s Branch is a small perennial stream located in Knott County, Kentucky. It’s rugged 2.8 square mile watershed has experienced the effects of logging, damming, and relocation typical in Eastern Kentucky. Terry’s Branch was selected as a stream mitigation site by Kentucky Department of Fish and Wildlife Resources (KDFWR). Biohabitats was selected by KDFWR to design, oversee, and monitor the restoration of the lower 2,900-foot reach of Terry’s Branch to improve aquatic and riparian habitat. Due to the large amount of legacy sediment within the floodplain, the restoration focused on creating a new floodplain within the This approach utilizes techniques that will allow the stream to respond to future changes in the upstream watershed landuse, while providing temporary stabilization as the vegetation becomes established. The construction of Terry’s Branch was completed in 2007 and currently is in its third year of a five year monitoring program. Monitoring results have indicated some physical adjustments and biological improvements including increased fish species richness and IBI score. This case study highlights the successes and challenges of the project including lessons learned.”

*About the Speaker:* **Suzanne Hoehne** is an Environmental Scientist for Biohabitats, Inc. with experience in the hydrology, ecology, geomorphology and hydraulics of a variety of natural ecological systems.. She has a master’s degree in Engineering from the University of Wisconsin Madison and a bachelors in Biology from the University of Wisconsin Oshkosh.

Nick Ozburn received his bachelors degree from the University of Illinois and master’s from Auburn University. His educational focus was in aquatic ecology. For the past three years, he has coordinated restoration projects for the Stream and Wetland Mitigation Program at KY Fish and Wildlife.



## Stream and Wetland Restoration at Rendezvous Mountain Educational State Forest

Greg Jennings, PhD, PE

Co-author(s): <sup>1</sup>Greg Jennings, <sup>1</sup>Mike Shaffer, <sup>1</sup>Karen Hall, <sup>1</sup>Justin Church, David Bidelspach,  
<sup>1</sup>Mike Geenen, Dan Clinton, <sup>1</sup>David Penrose, <sup>2</sup>Bill Swartley, <sup>2</sup>Tom Gerow, <sup>3</sup>Darrell Westmoreland

<sup>1</sup>North Carolina State University Department of Biological and Agricultural Engineering,

<sup>2</sup>North Carolina Department of Environment and Natural Resources Division of Forest  
Resources,

<sup>3</sup>North State Environmental, Inc.

*Abstract:* Beginning in 2005, North Carolina State University and the North Carolina Division of Forest Resources implemented a comprehensive stream restoration project on Purlear Creek on the Rendezvous Mountain Educational State Forest property in northwestern North Carolina, USA. The goals were to improve water quality and habitat in mountain streams to provide recreational fisheries. This project serves as a public demonstration and research site to promote best management practices for restoring and maintaining natural stream functions in watersheds with excessive stream sedimentation resulting from forestry and agricultural land uses. The restoration project included several components: (1) stream channel realignment and floodplain vegetation planting for a 200-m tributary in 2006; (2) restoration of a 2-ha wetland by ditch-plugging and planting in 2006; (3) stream bank stabilization and in-stream structure installation in a 500-m reach of Purlear Creek in 2007; (4) stream channel realignment and floodplain vegetation planting for a 600-m reach of Purlear Creek in 2007; and (5) stream channel realignment and floodplain vegetation planting for a 500-m reach of Purlear Creek in 2009. During each phase, engineered plans were created based on reference streams to restore natural physical and ecological stream functions. During construction, educational workshops were conducted to teach contractors, consultants, and agency representatives about natural stream construction techniques. Comprehensive project site monitoring includes hydrology, morphology, vegetation, and in-stream habitat. Results to date indicate that the stream system is stable with a growing diverse plant and animal community. Ongoing benthic macroinvertebrate studies indicate rapid reestablishment of stable populations. This presentation will highlight lessons learned during and following project implementation while highlighting the need for long-term monitoring studies to evaluate ecosystem restoration performance.

*About the Speaker:* **Dr. Greg Jennings** is a Professor and Extension Specialist in Biological and Agricultural Engineering at North Carolina State University. He teaches courses in stream restoration and ecological engineering and co-leads the NCSU Stream Restoration Program, which teaches professional development workshops and conducts applied research and demonstration projects throughout North Carolina. Dr. Jennings is a licensed professional



engineer with a Ph.D. from the University of Nebraska and B.S. and M.S. degrees from Pennsylvania State University.

## Innovative Habitat Structures in Mountain Streams

### Darrell Westmoreland

North State Environmental  
2889 Lowery Street  
Winston-Salem, NC 27101  
darrell@nsenv.com

*Abstract:* In an industry of cad drawings, specification books, plan details, and Excavators, there is a desire to standardize and simplify our designs and construction methods. The public and mother nature has more than their share of standard drawings placed throughout their communities. What they both desire is stable systems to function and appear natural and not manmade. The reality is, we can only try to build what Mother Nature creates over many years and we only have few months to complete our projects. So, how do we take our desire to restore our rivers streams, and wetlands to a natural state that is functional and stable? By using Innovative designs and construction methods to create natural looking restoration projects that both the public and mother nature will admire.

*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 ten 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 330,000 linear feet of stream restoration and 450 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.

# Economics of Urban Stream Restoration - Realizing Benefits and Optimizing Funding

Warren C. High

MACTEC Engineering and Consulting, Inc.  
4460 Lake Forest Drive, Suite 200  
Cincinnati, OH 45242  
wchigh@MACTEC.com

*Abstract:* Stream restoration projects in an urban setting are costly and can rarely be justified for the water quality and habitat benefits alone. When the full benefits that are realized by an urban stream restoration project are measured and weighed, then the true benefit to cost evaluation can occur. Defining and quantifying these benefits can assist in developing project support, funding, expedited approval, larger projects, and substantially better projects.

This presentation looks at the various aspects of stream restoration that are traditionally considered including water quality improvements, erosion reduction, habitat improvement, decreased flooding, infrastructure protection and riparian restoration. Going beyond the traditional benefits, this paper will address recreation opportunities, land use improvements, brown field restoration, economic redevelopment, education, social benefits, crime, property values, tax base, and other benefits that are less tangible, but sometimes as important as all of the typical benefits.

Funding is the weak link for any project. This paper will discuss methods to attract and combine multiple funding sources to assist with project planning, design, and construction. An understanding of what these funds are and where these funds come from will allow the stream professional to make better use of them.

This project will use existing projects from around the country to depict and quantify these benefits. The goal of this paper will be to convey a more comprehensive understanding of urban stream restoration benefits that can be used to achieve community support and non-traditional funding.

*About the Speaker:* **Mr. High** holds a BS in Fishery and Wildlife Biology and MS Environmental Management. He has over 25 years of experience in ecosystem restoration and water resources. He has performed over 100 ecosystem restoration projects for developers, municipalities, state DOTs, NRCS, Corps of Engineers, and environmental groups. He is currently serving as Senior Principal and Project Manager at MACTEC Engineering and Consulting where he manages and reviews stream restoration projects throughout the eastern portion of the U.S.

## Restoring Streams in a Community Park Setting: Lessons Learned in Public Perception

**Kayne Van Stell**

Michael Baker Engineering  
8000 Regency Parkway  
Cary, NC 27518  
kvanstell@mbakercorp.com

*Abstract:* Michael Baker Engineering, Inc. provided restoration designs and construction oversight for over 2,500 linear feet of urban stream systems located in the City of Roanoke Rapids, NC. The Parks project encompasses three city owned recreational parks (Long, Smith, Rochelle) and the three tributaries flowing into the Roanoke River. The project, funded through the NC Clean Water Management Trust Fund, was designed to provide water quality and ecosystem improvements, address public safety and infrastructure concerns from the City, and provide opportunities for environmental education and increased park usage.

This presentation will focus on lessons learned from the project, including site challenges, construction methods, coordination and safety efforts, and managing the public perception of the project. In addition, the presentation will address the different bank stabilization methods used at the three parks intended to maximize the floodprone widths while minimizing bench excavation in order to prevent damage to the large canopy trees during construction.

The primary objective was to reduce stream bank erosion and create a stable, functioning stream system by implementing a modified natural channel design approach within a community park setting. An added challenge of the project was to establish and protect riparian buffers using aesthetically desirable native plant species, suitable for use in a park setting that also comply with local buffer protection rules and the requirements.

The post-construction coordination has involved the development of a riparian buffer maintenance plan that the City has implemented to allow safe access to the trails within the buffer, without compromising the overall integrity of the restoration work. The Parks project was completed in the spring of 2010 and the community response has been generally positive as the established vegetation has been maintained and park usage continues to increase.

# Cane Run Watershed Assessment and Restoration Project: Improving Community Awareness and Education

Carmen Agouridis, Ph.D., PE

University of Kentucky, Department of Biosystems and Agricultural Engineering  
128 C.E. Barnhart Building  
Lexington, KY 40546  
cagourid@bae.uky.edu

*Co-authors:* Amanda A. Gumbert, Stephen F. Higgins

*Abstract:* The Cane Run Watershed, the major source of drinking water for the city of Georgetown, Kentucky (located 10 miles north of Lexington, Kentucky with a population over 40,000) has been identified as having high levels of sedimentation/siltation, pathogens, and nutrient/organic enrichment. These agricultural and non-agricultural nonpoint sources of pollution have resulted in the watershed being placed on Kentucky's list of impaired streams. The University of Kentucky is leading a phased project funded by EPA 319(h) funds to complete a watershed based plan (WBP) and begin the initial implementation of this plan. Project efforts are focused on the upper Cane Run watershed (15,000 acres), which is the recharge zone for the Royal Spring Aquifer and the city of Georgetown. The watershed includes a portion of the city of Lexington and the Kentucky Horse Park, both of which are preparing to host the 2010 World Equestrian Games. The University of Kentucky is leading education and outreach strategies by involving stakeholders through a watershed council and bringing together powerful partnerships to assess current watershed conditions and develop restoration plans. Partners reflect a broad spectrum of the community and include federal, state, and local governments, private landowners, private businesses, and non-profit organizations. Targeted audiences for education and outreach activities include project partners, watershed residents, watershed professionals, students, and visitors. The goal is to build awareness, stewardship and cooperation among these audiences, reaching them via printed and web-based materials, a watershed festival, tours, and educational signage along greenways in the watershed.

*About the Speaker:* **Carmen T. Agouridis** is an Assistant Professor in the Biosystems and Agricultural Engineering Department at the University of Kentucky. Her research focuses on stream restoration and assessment, mined land reclamation, riparian zone management, hydrology of surface waters, and the environmental impacts of animal agriculture. She is the recipient of over \$2.8 million in grants, has authored numerous publications, and is the lead designer of the Guy Cove Project which resulted in the creation of over 1 mile of stream on a valley fill. Having received training in Rosgen Levels I-IV along with courses at the North Carolina Stream Restoration Program and various conference workshops, she teaches Introduction to Stream Restoration, which is a senior-level and graduate-level course.

## Parkerson Mill Creek : Replacing Problem with Opportunity

Jess Roberts

Auburn University  
237A Funchess Hall  
Auburn, AL 36849  
jtr0007@auburn.edu

*Co-authors:* Jessica T. Roberts, Eve F. Brantley, Katie L. Dylewski

*Abstract:* The Parkerson Mill Creek Watershed project in Auburn, Alabama is a long-term effort that began in the early part of the decade. The overall goal of the project is to improve stream functions, enhance habitat, and improve water quality through the implementation of management practices based on scientific data, existing plans, and in cooperation with a multi-sectoral group of stakeholders and partners. Unlike many urban stream projects the land use within the watershed is unique containing urbanized, residential, and agriculture lands within 6000 acres – this fact being a primary driver for creative partnerships, attractive education and innovative solutions.

The stream's headwaters begin on the north edge of Auburn University's campus and flow through much of main campus, research farmland, industrial areas, residential properties, and a golf course before entering Chewacla Creek just south of the H.C. Morgan wastewater treatment plant at the edge of traditional forests of Chewacla State Park. The watershed project has evolved throughout the decade as interest in this stream and watershed has changed. Interest increased recently after the stream was listed on the Alabama 303(d) list as failing to meet its designated Fish and Wildlife use.

In 2010 a Total Maximum Daily Load (TMDL) is to be established for Parkerson Mill Creek and a watershed management plan is to be completed. These actions and the planning up to this point have provided a foundation to examine this system. It has been discovered that partnerships are crucial, there is more than one solution, and there is a discrepancy in data available and standard regulatory requirements. Challenges and lessons learned in an urban watershed for planning, recommended best management practices, anticipated implementation, and improvement strategies are to be presented.

*About the Speaker:* **Jessica Roberts** is employed at Auburn University through Alabama Cooperative Extension System, working with the Water Program. Ms. Roberts has a bachelor's and a master's degree from North Carolina State University in Biological and Agricultural Engineering, with focus on Watershed and Stream Assessment and Restoration. Ms. Roberts also has a graduate certificate for the Design and Analysis of Environmental Systems and great interest in the interactions between the stormwater/stream interface.



# Spatially Tracking Statewide Stream Restoration

Colleen Kiley

North Carolina Ecosystem Enhancement Program  
1652 Mail Service Center  
Raleigh, NC 27699  
colleen.kiley@ncdenr.gov

*Co-authors:* Colleen Kiley, GISP, NC Ecosystem Enhancement Program GIS Coordinator

*Abstract:* Geographical Information Systems (GIS) has become an integral tool in stream and wetland restoration. The Ecosystem Enhancement Program (EEP) developed a geodatabase to manage the complex and extensive spatial data collected during the restoration process. EEP's geodatabase has been designed to support the program from the watershed planning phase to site construction to monitoring and close out. It allows EEP staff to share a common framework with planning, design, and monitoring partners, and supports mobile GIS and web based applications.

In the past, GIS data associated with restoration projects were stored in individual project managers' files, each in a format that differed from manager to manager. EEP, as a program, takes a watershed approach to mitigation, so it made sense to have a comprehensive GIS database that allows EEP to evaluate the data at the watershed scale. EEP's geodatabase provides project managers with a consistent format for important site features such as stream centerlines, buffer areas, easement boundaries, and wetlands. Portions of the database can be "checked out" and given to planning consultants to update with new potential restoration projects, or to monitoring contractors to update the status of constructed features on a site. The edited database is then checked back into the master EEP database to update the official copy. The result is a more fluid process of collecting data, storing it in a standard format, and updating it over time.

EEP has been testing the geodatabase during the past year and has developed an online application that merges spatial data with data from our information management system. The database will be integrated fully into production this year and planning has begun for an updated online GIS mapping system.

*About the Speaker:* **Colleen Kiley**, GISP, is the GIS Administrator for the North Carolina Ecosystem Enhancement Program. She specializes in hydrologic modeling, geodatabase design, and data coordination for stream mitigation. She earned a B.S. in Geology from Washington and Lee University, studying under a fluvial geomorphologist, and went on to earn her M.S. in Coastal Zone Management from Florida Institute of Technology where she used GIS to model shoreline erosion rates on the first National Wildlife Refuge. Her recent projects include creation of a geodatabase for spatially tracking stream and wetland mitigation, development of a



GIS methodology for calculating riparian buffer widths, and database design for mitigation asset accounting.

# The Implementation of Five Diverse Watershed Plans in the Upper Neuse: Measures of Effort and Success

**Michele Drostin**

NC Ecosystem Enhancement Program  
1652 Mail Service Center  
Raleigh, NC 27699  
michele.drostin@ncdern.gov

*Abstracts:* The NC Ecosystem Enhancement Program (EEP), Upper Neuse River Basin Association (UNRBA) and PBS&J have been working together for the past two years to implement five watershed plans in the Upper Neuse River Basin including the Lick Creek, Little Lick Creek, Ellerbe, Lake Rogers/Ledge and Upper Swift Creek watershed plans. Each plan varies in scope, content and process. Much of this work has focused on generating comprehensive mapping and site level atlases, developing outreach materials, facilitating public and local government participation, developing management strategies and conducting landowner outreach and education. All plans were funded by EEP (or its predecessor, Wetland Restoration Program) except the Lick Creek Watershed Restoration Plan which was funded by a 319 Non Point Source grant. Both the Lick Creek Watershed Restoration Plan and the Little Lick Creek Local Watershed Plan were developed by UNRBA.

This presentation explores the process of implementing these five diverse plans and discusses the different approaches and outcomes based on location, watershed character, land use, local issues, local awareness, local government involvement and project site feasibility constraints. We will also discuss the level of implementation success and lessons learned as it relates to the mission and goals of UNRBA, EEP and the local stakeholders and as it relates to achieving restoration activities on the ground.

*About the Speaker:* **Michele Drostin** has been a watershed planner for the Ecosystem Enhancement Program for four and a half years. Prior to this, she was the stewardship coordinator for the North Carolina National Estuarine Research Reserve and before that, worked as the watershed outreach coordinator for the Georgia Watershed Protection Branch.

# The Evolution of Stream Assessments in the Context of Watershed Planning

## Jason Doll

Moffat and Nichol  
1616 E. Millbrook Rd. Suite 160  
Raleigh, NC 27609  
jdoll@moffatnichol.com

*Abstract:* Depending on their management objectives, many watershed plans include a geomorphic stream assessment component of some form and these assessments vary widely in their level of complexity and the project resources invested in their execution. These stream assessments often involve an initial desktop-level assessment of readily available GIS data and/or some form of modeling analysis in combination with boots-in-the-water field assessments. The sheer volume of watershed plans conducted for NCEEP has provoked a wide array of approaches to this assessment need in North Carolina. Based on 17 years of watershed planning experience, much of which has been conducted directly for NCEEP, Mr. Doll will review the range of approaches to stream assessments for watershed plans in which he and his colleagues have been involved. The review will illustrate the evolution of stream assessments within the context of watershed plans over the last decade and expand on which approaches have worked well and which have not in terms of producing accurate and usable results, and which have worked well or not in terms of matching the appropriate level of project resources to the importance of the management decisions that were made on the basis of the assessment. Some of the key stream assessment components to be considered in the review will include:

- 1) Modeling of stream power and stream velocity to evaluate such parameter against published critical shear stress thresholds.
- 2) GIS and statistical modeling evaluations of riparian buffer vegetation disturbance as an indicator of likely channel instability.
- 3) NRCS stream visual assessment protocols (SVAP)
- 4) Full watershed stream walks with Rosgen Level 2 assessments
- 5) NCDWQ aquatic habitat assessments.
- 6) Various rapid stream assessment protocols.

*About the Speaker:* **Jason Doll** grew up in the most rural part of the northeastern North Carolina coast and then attended NC State University where he earned a Bachelor's Degree in Fisheries and Wildlife Science. He now has 17 years experience in watershed planning, water quality modeling, stormwater management and ecological restoration. His experience includes six years with NCDWQ as a water quality modeler directly involved in NPDES permitting, river basin planning, and rule making. In his 11 years in private consulting Mr. Doll has lead public and private sector projects utilizing a wide array of assessment and modeling tools to address environmental degradation and guide management decisions to protect natural resources and/or achieve ecological uplift, often within the context of watershed plans.

## Southern Regional Watershed Education Efforts to Improve Stormwater Management and Elevate Ecological Function of Streams

Frank Henning, Ph.D.

Region IV Land Grant Universities Water Liaison  
313 Hoke Smith Building  
Athens, GA, 30677  
fhenning@uga.edu

*Co-authors:* Southern Regional Water Program's Watershed Education and Restoration Team

*Abstract:* The Southern Regional Water Program and Extension faculty from Land Grant Universities in Region IV partnered to offer multiple regional workshops focused on practices that improve water resource management in developing watersheds. Soil Scientists, engineers, hydrologists, horticulturalists, and landscape architects from Land Grant Universities combined their skills to offer practical training on innovations in stormwater management, ecosystem engineering principles and keys to riparian vegetation success.

*Partners:* USDA NIFA Southern Regional Water Program, University of Georgia, NC State University, Auburn University, University of Kentucky, Texas A&M, Clemson University, and University of Florida.

One focus of this watershed training effort was innovative stormwater management. Innovations in wetlands, stormponds, cisterns and rain gardens were introduced. Hands-on activities included green roof, cistern, wetland and bioretention tours along with the installation of engineered soil, native plant material and mulch in a 1,200 square foot educational rain garden.

A second focus of this regional effort was ecological assessment, and restoration of streams. Participants learned stream restoration techniques as they assessed the structural and biotic components of an impaired stream on the University of Georgia Campus. Participants used stream assessment data to plan future restoration, and education in order to maximize ecosystem uplift.

A third focus for 2010 was to increase knowledge on the use of vegetation for stormwater treatment and riparian ecosystem restoration. A webcast was used to deliver information on watershed, soil and plant material components of riparian ecosystem restoration.

Among program participants that responded to a post training surveys, statistically significant knowledge gains were made in ecosystem awareness, erosion control techniques, stormwater management techniques, watershed restoration techniques, rain garden installation practices, stakeholder involvement, land use planning & conservation, soil consideration for treating stormwater, and streamside and stormwater vegetation installation and management. All respondents indicated that the training improved their ability to provide effective water

resource education in developing watersheds, 95.8% plan to use the information gained from this workshop in their current water resource programs, or to start new programs, and 84% plan to conduct a workshop or other educational using the knowledge gained from this training.

Online Learning centers were created by the Southern Regional Water Program's Watershed Education and Restoration Team in order to increase the distribution of knowledge on water resource management and ecosystem restoration:

<http://www.caes.uga.edu/extension/water/learningcenters.html>

*About the Speaker:* **Frank Henning** is the Region IV EPA-Land Grant Universities Liaison. As a liaison, Dr. Henning builds linkages between EPA and Land Grant Universities in AL, FL, GA, MS, NC, KY, SC, and TN. He works to identify opportunities to transfer and adapt successful elements of environmental programs throughout the region in order to improve research, education, and policy decisions. His work has focused on enhancing ecosystem services in rural and developing watersheds. He has initiated efforts to reduce hydrologic and water quality impacts, including work with irrigation efficiency, rainwater harvesting, stream vegetation, stormwater infiltration, and animal waste management. Prior to work as a Liaison, he served as a UGA Watershed Extension Agent in the Upper Oconee Watershed where he assisted local governments initiate stormwater programs and improve water resource education. He also worked as a Special Extension agent for Water Quality in the Little River – Rooty Creek Watershed, where his work focused on nutrient and animal waste management. Dr. Henning earned a Ph.D. in Horticulture from The University of Georgia, a MS. in Soil Science/Environmental Chemistry from Auburn University and a B.S. in Biology from William and Mary.

# NCD 2010: A Model for Predicting River Geometry Using Hydrodynamics and Particle Separation Technology

**Brian Belcher, Ph.D., PE**

Beaver Creek Hydrology, LLC.  
907 National Ave.  
Lexington, KY, 40502  
brian@beavercreekhydrology.com

*Co-Authors:* Brian J. Belcher, PhD, PE, Tien Mun Yee, PhD, PE

*Abstract:* NCD 2010 is a model for designing stable 3D flow patterns. Input includes the upstream riffle geometry and particle size distributions of the bed and point-bars or other natural deposits. The model's algorithms make use of recent theories developed on turbulent macro structures, velocity distributions and particle separation technologies and are capable of generating an infinite number of unique solutions for each study reach. Each solution is optimal with respect to energy expenditure and forms continuous patterns of unique meanders designed to separate particles from the flow and deposit them on the point-bar using a confined vortex theory. The program accepts as input a set of vertices representing the valley-fall direction and returns curves in 3D space representing the optimized channel thalweg and banks. The initial solution is created by allowing the meander wavelength to fall in the range of measured geomorphic data. Natural variation is accomplished using the Mersenne Twister Random Number Generator coupled with the clock randomizer and Box Muller transformation to obtain a normally distributed set of meanders. Sine-generated curves are used as the first solution for each unique meander bend and then Bezier curves are fitted to each bend using a least-squares optimization routine. This same procedure is repeated for each meander until enough are spliced together to cover the valley-fall line, with first-order continuity at each splice. A search technique is then used to locate the points of minimum radius of curvature, which are then resized based on the particle separation theory. Channel geometry is optimized for area and perimeter at user-specified intervals based on the velocity-deficit formulated with relative roughness and coupled with secondary currents in the meander bends. Model output is presented for several design scenarios. The method is shown to compare favorably with the Rosgen reference reach design method.

*About the Speaker:* **Dr. Belcher** is a researcher, educator and professional engineer specializing in applications of natural channel design and stream restoration practices. He is Vice-President of Beaver Creek Hydrology, LLC., an engineering company located in Lexington, KY that focuses on eco-hydraulic restoration design. Brian teaches the senior capstone design course for the Department of Civil Engineering at the University of Kentucky (UK) and co-teaches a professional short course on stream restoration through UK's Dept. of Biosystems and Agricultural Engineering.



# Restoring Pool-Riffle Habitat in Beaver Creek, Knox County, Tennessee: Lessons Learned in a Planform-Constrained Urban Stream

Keil Neff

University of Tennessee, Department of Civil and Environmental Engineering  
223 Perkins Hall  
Knoxville, TN, 37996  
kjn.water@gmail.com

*Co-authors:* John S. Schwartz, Associate Professor, University of Tennessee, Department of Civil and Environmental Engineering, jschwart@utk.edu

*Abstract:* Urbanization impacts watershed hydrology, in-stream hydraulics, and channel geomorphology causing geomorphic and ecological disturbances in natural stream systems. Pool-riffle structure, capable of supporting diverse biological ecosystems, is frequently disturbed in urban streams because of channel incision and the loss of channel-scale helical flow patterns, which are responsible for maintaining pool-riffle sequences. The objective of the current study was to restore pool-riffle bedform and channel hydraulics to maintain pool-riffle structure in an incised, straightened 300-m reach of Beaver Creek, Knox County, Tennessee. Urban development laterally constrained restoration design thereby limiting meandering planform alterations, which included a shopping mall and a paved greenway. River2D, a two-dimensional depth-averaged hydrodynamic model was used to design bed, bank, and in-stream features to support maintenance of velocity acceleration/deceleration sequencing, energy dissipation and complex flow patterns, and bed and bank stability. At each riffle location, bank material was removed on both sides of the channel to form an area of lateral expansion about 15-20 m in length. In the project reach, four expansion areas dissipate energy and create hydraulic macro-eddies during near bankfull stages. Because of the lack of bedload supply, gravel and cobble substrate was imported for riffle construction. From River2D model output, boundary shear stresses were calculated to size stable riffle substrate (3.5-inch D50), and velocity vector patterns were used to aid in design of stable bank features. The River2D model was also used during the design process to model habitat quality and to observe flow patterns at multiple stages for improved ecosystem function. The newly-placed riffle expansions open the stream to view by the community actively using the existing greenway, providing a unique opportunity for citizen education.

**Key Words:** pool-riffle sequences, urbanization, ecohydraulics, stream restoration

*About the Speaker:* Keil J. Neff, EI, is a PhD candidate in Civil Engineering at the University of Tennessee focusing in water resources. His research activities include urban stream rehabilitation, watershed hydrology, water quality characterization, hydraulic modeling, and aquatic toxicology. With his major professor, Dr. John Schwartz, they focus on understanding how human activities impact water quality, physical adjustment processes, and stream



biological communities in order to develop and apply ecological engineering techniques for improving stream functionality.

## The Applicability of 2D and 3D Models in Evaluating Stream Restoration Designs

Michael Chelminski, PE

Stantec Consulting, Inc.  
30 Park Drive  
Topsham, ME, 04086  
michael.chelminski@stantec.com

*Abstract:* The project involves the application of multiple numerical hydraulic models for the evaluation of existing and proposed stream restoration designs. The objective of this work is to evaluate the apparent suitability of various numerical model schemes for use in stream restoration designs. The basis of comparison for the numerical models will be the one-dimensional HEC-RAS model developed by the US Army Corps of Engineers, which is a widely used model available at no cost. Evaluated models will include a two-dimensional, depth-average numerical model (River2D), a three-dimensional model (SSIIM2), and a three-dimensional computational fluid dynamics (CFD) solver (Flow3D). The goal of this work is to evaluate the relative suitability, appropriateness, and potential value of multi-dimensional models relative to use of one-dimensional models (i.e., HEC-RAS) for restoration design and evaluation.

*About the Speaker:* **Michael Chelminski** is a Senior Associate with Stantec Consulting Services Inc. in Topsham, Maine. His expertise includes dam removal planning, design, and permitting, upstream and downstream fish passage evaluation and design, and numerical free surface modeling. His project work in the last year includes four completed dam removals in New England, upstream and downstream fish passage evaluations and designs in the U.S. and Canada, effluent mixing studies, and research-directed work on fish passage evaluation. He has BS and MS degrees in civil engineering and is a licensed Professional Engineer.



## Designing scour, putting research into practice

Christopher J. Estes, RLA

Estes Design, Inc.  
P.O. Box 79133  
Charlotte, NC 28271  
Chris@EstesDesign.com

*Abstract:* Naturally formed plunge pools (scour holes) are common features urban stream systems where the transition between a pipe and a natural stream channel occurs. Contrary to common perception, these pools provide critical benefits to municipal stake holders, developers, downstream property owners and to the hydraulic and biological integrity of the stream.

In 2004, Estes Design Inc. and the University of North Carolina-Charlotte completed research on naturally formed plunge pools in urban stream systems. This research concluded existing methods for designing stilling basins and energy dissipating pools failed to predict naturally formed pool geometry seen in the field. It also concluded that naturally designed pools cost significantly less than rip-rap aprons to construct.

Pools occur naturally in a stream as part of the riffle-pool sequence. This sequence provides a dynamic check and balance system for regulating velocity and reducing erosion. Correctly sized pools are self regulating and therefore maintain themselves. Pools also improve habitat diversity and serve as refuge for aquatic species during low flow periods.

Rip-rap aprons are designed to protect culvert outlets from scour for a calculated distance downstream where the hydraulic velocities decrease to a non-erosive level. However, in many urban settings a correctly designed apron may need a significant area and length, increasing cost, impacts and impeding the natural riffle pool sequencing.

Development and maintenance activities associated with culvert crossings are associated with regulated impacts to jurisdictional streams. A portion of those impacts are typically attributed to the armoring of outlets. Naturally designed plunge pools, in lieu of rip-rap aprons, can reduce these regulated ecological impacts. Many new culvert crossings in urban areas have successfully incorporated natural plunge pools.

Occasionally, new culvert crossings are designed or constructed incorrectly, conflicting with conditions of the Clean Water Act section 404 permits. This issue is typically due to culverts placed too high above the channel bed to meet the aquatic passage condition, or due to unanticipated additional impacts from armoring the culvert inlets and outlets. In many cases, a natural plunge pool can mitigate these ecological problems by restoring natural aquatic function while also providing more efficient energy dissipation.

*About the speaker:* **Christopher J. Estes** is president of Estes Design, Inc., an environmental design and consulting company that specializes in Low Impact Development, storm water quality, and environmental regulatory services.

Mr. Estes received a B.A. in Landscape Architecture from the School of Environmental Design at the University of Georgia in 1988. Before starting Estes Design, Mr. Estes worked for the City of Charlotte Engineering Department for 11 years, including 9 years in the Storm Water Services Division.

Mr. Estes early career began with initiating and managing Charlotte's storm water stream restoration program for 8 years completing over 60 design build stream projects and 15,000 feet of urban stream between 1993 and 2000. Mr. Estes initiated five collaborative natural stream& urban storm water research projects between the City of Charlotte and the University of North Carolina Charlotte, including Charlotte's first pervious concrete parking lot BMP in 2003.

At Estes Design, Mr. Estes continues to collaborate with Universities in the southeast including North Carolina, South Carolina, Georgia and Kentucky. Mr. Estes maintains collaborative relationships in Denmark and England.

Currently, Mr. Estes is focusing his efforts on surface waters mitigation including the restoration and protection of water quality by targeting sources of negative impact associated with impervious pavement. His most recent projects include combining Best Management Practices such as bio-retention and pervious concrete. His latest research includes storm water infiltration rates into piedmont soils and BMP systems that best exploit this.

# Application of the FLOWSED and POWERSED Models in River Stability, Bridge Design and River Restoration

George Athanasakes, PE

Stantec Consulting, Inc.  
1901 Nelson Miller Parkway  
Louisville, Kentucky 40223  
george.athanasakes@stantec.com

*Co-authors:* George Athanasakes, Scott Peyton, Dave Rosgen

*Abstract:* Streams must be able to transport the sediment supplied by their watersheds without aggrading or degrading. As such, designers need tools to assess river stability and evaluate the efficiency of restoration designs to transport sediment. The FLOWSED and POWERSED models, as programmed in RIVERMorph™, provide users with such tools to predict total annual sediment yield (FLOWSED) and aggradation or degradation potential (POWERSED). This presentation assesses the ability of FLOWSED and POWERSED to predict river stability and also evaluates the model prediction of sediment transport capacity for a three-cell bridge design.

Four river reaches of Douglas Creek, Montana, were compared to an upstream sediment supply reach to determine the potential of the stream to accommodate the delivered sediment. The predicted bed stability for the four reaches using FLOWSED and POWERSED was compared to observed resurvey data. The results show that the stability predictions from POWERSED (stable, aggrading or degrading) for the four reaches on Douglas Creek agree with actual channel stability observations.

An additional study was undertaken to investigate if FLOWSED and POWERSED could adequately predict the sediment transport response through an existing multiple cell box culvert. An unnamed tributary to Little Bennett Creek in Maryland was used as the study site where a three-cell bridge (culvert) was constructed that consisted of three, ten-foot wide cells. The models accurately predicted channel and culvert response relative to observed depositional patterns and demonstrate the value they can have in the future engineering design of culverts and bridges.

Overall, FLOWSED and POWERSED show great utility for river restoration and cumulative watershed impact assessments over a wide geographical range. The results of this study provide confidence of the applications FLOWSED and POWERSED can have for appropriate stability predictions, better bridge and culvert designs, and for realistic sediment consequence prediction for river restoration.

*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 15 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.

## Geomorphic lessons learned from floodplain interactions and urban stream natural channel restoration

David Bidelspach , PE

Stantec Consulting  
754 Mount Mahogany  
Livermore, CO 80536  
david.bidelspach@stantec.com

*Abstract:* Natural Channel Design as a method for stream restoration is limited in many applications related to dynamic floodplain interactions and urban channels. Stable streams are defined to be in a state of dynamic equilibrium that in many cases can't be achieved due to limitations in project goals and objectives. Changes in the flow regime, sediment supply, slope and substrate can cause local channel instabilities that can lead to systematic reach wide instability and possible channel evolutions. Many stream restoration projects can be good examples and experimentations of the effect of changes in flow regimes that affect sedimentation and erosion rates.

The major goal of stream restoration projects in the southeast are usually trying to create a stable restored channel that many times have unstable and conflicting boundary conditions. The use of reference reaches have been limited to idealized boundary conditions and in practice are not applicable to transition reaches, floodplain shear stress/scour and high bedload systems in the southeast. Other goals of urban stream restoration projects include limiting flood risk, increase public use, increase habitat, property protection, mitigation and aesthetics. The dynamic equilibrium of a stable stream is not accepted in goals and objectives of many stream restoration projects. A process focused design for stream restoration will evaluate risk on multiple design flows that are at and above a bankfull stage.

This presentation will discuss many lessons learned from evaluating the geomorphic potential and departure analysis of a disturbed urban river system and restored river systems that have failed. The paper presents a method of evaluating risk related to sediment transport and routing and evaluating the uncertainty of an urban stream restoration. The paper also discusses recommendations and design tools to limit risk of failure on urban stream restoration projects. Finally, a couple examples of high risk stream restoration projects and techniques for stabilization will be discussed and highlighted.

*About the Speaker:* **David Bidelspach** is a Stream Restoration Engineer and Fluvial Geomorphologist with Stantec Consulting. He currently lives in Livermore Colorado and is working on projects in the USA and Canada.



# Refining Data Collection for Urban Stream Restoration Projects: Use of Acoustic Doppler Current Meter and Traditionally Collected Velocity Data

**Dani Wise Johnson**

VHB, Inc  
351 McLaws Circle Suite 3  
Williamsburg, VA 23185  
dwjohnson@vhb.com

*Co-author(s):* Dani Wise Johnson, VHB, Inc., Joanna Curran, PhD., University of Virginia, Kristen Cannatelli, PhD Candidate, University Of Virginia

*Abstract:* The research discussed in this presentation is being conducted at the Meadow Creek restoration project site in Charlottesville, Virginia. The project is in cooperation with the City of Charlottesville and is funded through the Virginia Aquatic Resources Trust Fund.

Restoration projects within urban systems frequently encounter various complexities and constraints. One of the common complexities associated with urban projects relates to the influence of stormwater on the hydrograph for a given drainage area. While restoration practitioners rely on tools such as Manning's equation and hydraulic and hydrologic modeling for estimates of bankfull discharge; it can often be challenging to determine a reliable value for a given reach. Verifying this discharge rate and the associated elevation of bankfull is critical to the design of a successful restoration project. The collection of field data to achieve an accurate bankfull discharge measurement has previously been limited by the ability to be on-site during various flow conditions and collect velocity data during a range of flows at a station. In an effort of collect reliable data at the Meadow Creek restoration site prior to design and construction, an Acoustic Doppler Current Meter (Sontek) was installed to take continuous measurements of stage and velocity at a given cross section. The data is stored on a data logger and downloaded periodically. That information is processed and over time, provides a stage-discharge relationship for that given location related to the sampled flow events. To augment this data set and validate the accuracy of the information collected by the continuous gage, velocity was also measured at this location using a hand-held velocity meter at various stages. The two data sets will be compared and utilized to create the most reliable stage-discharge relationship for this channel. This information will be used in the restoration project design and subsequent monitoring.

*About the Speaker:* **Dani Wise Johnson** is a Senior Hydrologist with Vanasse Hangen Brustlin, Inc (VHB) in Williamsburg, Virginia. 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.

# Evaluation of NRCS Stream Work in Southwest Virginia

**Kelly Ramsey, PE**

USDA Natural Resources Conservation Service  
1606 Santa Rosa Road, Suite 209  
Richmond, VA 23229  
kelly.ramsey@va.usda.gov

*Abstract:* The Natural Resources Conservation Service (NRCS) works with private landowners to implement conservation plans to address resource needs, including managing streams to meet ecological and landowner needs. Over the last few years, the NRCS has increased its effort to provide streambank stabilization assistance utilizing current stream innovations and improvements. Virginia NRCS provides technical assistance to landowners to plan, design, and construct various stream stabilization measures on numerous streams with variable landowner, stakeholder, and resource goals.

An effort by NRCS to plan, design and construct current streambank stabilization measures was initialized in rural southwest Virginia in 2007. A number of sites were selected that represent typical streambank stabilization issues encountered by NRCS. The sites were experiencing local scour erosion due to changes in the watershed or lack of riparian buffers.

NRCS National and regional staff suggested approaches for bank protection and stabilization of actively eroding streams. These stabilization measures included streambank soil bioengineering, cross vanes, J-hooks, stream barbs, and toe armor. Virginia NRCS prepared designs that utilized or modified these recommendations and concepts. The construction of the projects was completed by the spring of 2009 with NRCS local staff providing some construction assistance for the installation of the stream stabilization treatments. An assessment of the performance of the constructed projects was completed in the spring of 2009.

The planning, design and construction phases of the projects were evaluated to determine the future application of stabilization treatments for various NRCS conservation programs across Virginia, including the Emergency Watershed Protection program.

The oral presentation and paper will present the results of the evaluation and the improvements Virginia NRCS is taking to better implement the planning, design, and construction of current stream stabilization measures.

*About the Speaker:* **Kelly Ramsey, PE**, is a hydraulic engineer with the USDA Natural Resource Conservation Service (NRCS) in Richmond, VA. Kelly has 12 years experience in stormwater and watershed management, dam design and modifications, environmental regulations and permitting, hydrologic and hydraulic modeling, and stream stabilization/restoration assessment and design. Kelly's recent projects include developing a stream stabilization technical reference manual for VA NRCS personnel to better manage stream to meet ecological and landowner

needs, stream morphology assessments for private landowners, and providing stream stabilization training to NRCS personnel. Kelly received a B.S. degree in Biological Systems Engineering from VA Tech, Blacksburg, VA.

# Development and Application of Headwater Stream Models in North Carolina

**Periann Russell**

NC Division of Water Quality  
2321 Crabtree Blvd Suite 250  
Raleigh, NC 27604  
periann.russell@ncdenr.gov

*Co-authors:* Periann Russell, Susan Gale

*Abstract:* The protection of headwater streams in North Carolina is hampered by lack of high quality, accurate maps. NC Division of Water Quality (DWQ) is working cooperatively with other state agencies to develop spatial models to predict the location and extent of intermittent and perennial headwater streams of the state with a known, consistent level of accuracy. Primary benefits of the headwater stream effort include producing models that can be reasonably applied to watersheds at an ecoregion scale; producing inventory maps to a level of accuracy not previously available; and establishing standard methodologies for field data collection, spatial model development and model application. To date, NC DWQ has developed, applied and tested spatial headwater stream models for the Carolina Slate Belt, Triassic Basins, Sand Hills and the Rolling Coastal Plain ecoregions. Accuracy assessments completed for each ecoregion model have consistently shown high levels of accuracy in headwater stream map representation at three levels: 1) location, 2) stream length, and 3) flow duration (intermittent or perennial). Accurate representation of headwater streams will greatly improve the ability to protect and enhance the state's aquatic resources, and support other state agency and private industry efforts in planning and restoration.

*About the Speaker(s):* **Periann Russell** is a geomorphologist for the NC Division of Water Quality – Wetlands Program Development. She specializes in landform development and interactions between hillslope and fluvial processes and currently leads the DWQ Headwater Stream Spatial Dataset program. This program utilizes field and GIS data to develop and test models to predict location, length and flow duration of headwater streams. Ms. Russell has 20 years of experience conducting applied research in varied landscapes across the east and west coasts of the US. She has taught courses in geology, geomorphology and most recently, NC DWQ stream delineation.

**Susan Gale** is a biologist and water quality specialist and has been working for the NC Division of Water Quality for eleven years. For the last 2 years, she has been working with the NC DWQ Headwater Stream Spatial Dataset program in the Wetlands Program Development Unit conducting field work and leading the GIS effort to support the program. Ms. Gale has over 10 years experience in surface water chemistry and biology as well as monitoring, assessment and spatial analysis.

# Developing a Piedmont Stream Conceptual Model

Kyle McKay

US Army Corps of Engineers  
1660 S. Lumpkin St. #10  
Athens, GA, 30606  
kyle.mckay@usace.army.mil

*Co-author(s):* Kyle McKay, Bruce Pruitt, Chris Anderson, Joanna Curran, Ana Del Arco Ochoa, Mary Freeman, Brenda Rashleigh, and Dean Trawick

*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 paper presents a Piedmont stream conceptual model mapping common system drivers to states to ecosystem services which was developed by a multidisciplinary, interagency committee of subject matter experts. The presentation will (1) discuss the role of conceptual modeling in stream restoration, (2) present the Piedmont stream conceptual model, (3) demonstrate the model's utility in appropriately diagnosing drivers and stressors, and (4) highlight the role of conceptual modeling in communicating the benefits of ecosystem restoration.

*Biosketch:* Kyle McKay is a research civil engineer with the U.S. Army Engineer Research and Development Center (ERDC) Environmental Laboratory. Kyle holds a BS in Environmental Engineering from Colorado State University and an MS in Civil Engineering from the University of Illinois Urbana-Champaign, and he is currently pursuing a doctorate in Ecology from the University of Georgia. Since joining ERDC in 2007, Mr. McKay's research has focused broadly on examining physical processes and ecological outcomes with specific applications to: developing techniques for quantifying benefits of ecosystem restoration, marsh restoration in coastal Louisiana, system-wide benefits of fish passage improvement on the Truckee River, vegetation-flow interaction, and effects of woody vegetation on levee integrity. He is stationed in Athens, Georgia to facilitate cooperative research between ERDC, the University of Georgia, and EPA Ecosystem Research Division.

## Application of Carolina Vegetation Survey inventory data for generation and evaluation of restoration targets

Robert Peet, Ph.D.

University of North Carolina, Chapel Hill  
Chapel Hill, NC 27599-3280  
Dept. Biology, CB#3280  
Chapel Hill, NC 27599-3280  
peet@unc.edu

*Co-authors:* Robert K. Peet\*, Thomas R. Wentworth, Michael Schafale, Alan S. Weakley, and M. Forbes Boyle

*Abstract:* Effective design of targets for vegetation restoration requires detailed information from appropriately selected, high-quality reference areas. The Carolina Vegetation Survey (CVS) is a multi-institutional research program designed to document the composition and status of the natural vegetation of the Carolinas for purposes of inventory, monitoring of environmental impacts, assessment of conservation status, and generation of scientifically rigorous restoration targets. Toward this end CVS uses a standard protocol to collect, prepare, and database high-quality reference-area data. The North Carolina Ecosystem Enhancement Program supports the work of CVS so as to provide optimal targets for vegetation restoration. Over the past 23 years, CVS has acquired consistent quantitative records from over 7,000 vegetation plots distributed across the Carolinas and containing occurrences of over 2500 species. These plot records include information on total species composition, vegetation structure, tree size distributions and environmental setting and have allowed for the first time an accurate documentation of the range of natural communities and species habitats found in the region. Approximately 495 vegetation types recognized in the federally mandated U.S. National Vegetation Classification (NVC) are represented by vegetation plots in the CVS database and have been used to generate quantitative summary information about typical site conditions, distribution, and species frequency and abundance. CVS is currently using these plot data to propose refinements in the NVC to make it more effective for our region and as a tool for generating restoration targets. Application of the CVS database of plots and community composition allows relatively easy generation of otherwise unattainable, state-of-the-art predictions of the natural vegetation of a site that should satisfy the most stringent current and future restoration guidelines. As a consequence, application of the CVS database can greatly increase the efficiency and effectiveness with which agencies and contractors conduct restoration work while significantly reducing their costs.

*About the Speaker:* **Robert K. Peet** is Professor of Biology at UNC Chapel Hill where he has been on the faculty since 1975. His research in ecoinformatics includes both the development of international databases and data standards that will allow new forms for synthesis, and the use of the resulting resources to develop a boarder and more general understanding of vegetation. His current research on the vegetation of the Southeastern United States includes on-going studies of the long-term dynamics of Southeastern Piedmont forests, impacts of human-altered

hydrology and siltation on floodplain ecosystems, compositional variation in fire-maintained Coastal Plain pinelands, and more generally factors influencing the composition and species diversity of terrestrial plant communities. His work is defining the new discipline of ecoinformatics and he has taken the lead in developing international databases and standards for data exchange. He is also interested in issues related to scholarly communication in the digital age. Dr. Peet has contributed to the scientific community in numerous ways including founding the Journal of Vegetation Science, organizing the Vegetation Section of the Ecological Society of America, and serving as the Secretary of the Ecological Society of America. He is currently President of the International Association for Vegetation Science. He has also served as Editor-in-Chief of the premier journals in his field, Ecology and Ecological Monographs. He is co-founder of the Ecological Society of America's Panel on Vegetation and is directing its collaborative project with federal agencies and NatureServe to establish the information infrastructure needed to support the U.S. National Vegetation Classification.

# An expert system for generating restoration targets for Carolina Piedmont riparian vegetation

Elizabeth R. Matthews

Curriculum for the Environment and Ecology, University of North Carolina  
207 Coates Building, CB# 3275  
Chapel Hill, NC 27599-3275  
erm@email.unc.edu

*Co-authors:* Elizabeth R. Matthews, Michael Lee, M. Forbes Boyle, and Robert K. Peet

*Abstract:* Selection of restoration targets is an important component of ecological restoration projects. Targets aid in the design of restoration projects, the establishment of restoration goals and the assessment of restoration success. However, many restoration projects proceed with insufficient reference information because of limited time, limited funding, or difficulty in identifying appropriate reference sites. Additionally, due to these resource constraints, it is challenging to incorporate the natural variation of vegetation and environmental conditions in the description of targets. However, vegetation databases and plant community descriptions can provide this essential reference information for restoration activities. In order to provide this vital reference information, we sampled high-quality riparian vegetation across the North Carolina Piedmont and developed a classification and description of Piedmont riparian plant communities. We present an expert system for developing restoration targets for Piedmont riparian vegetation based upon these quantitative plant community descriptions. Our methodology for matching sites to community descriptions provides savings to the user by preventing the need for field work beyond the restoration site and can be readily accessible to resource managers and restoration practitioners over the web. Our approach for matching new restoration sites to appropriate vegetation descriptions is based on quantitative environmental data, where classification methods identify key variables in discriminating between potential vegetation types, allowing restoration professionals to focus on a subset of the possible environmental data. However, our tool is flexible and is able to match restoration sites to the most similar quantitative plant community descriptions based on easily obtainable, common environmental data. This approach and infrastructure can be readily applied to other locations and vegetation types. We are currently working with the North Carolina Ecosystem Enhancement Program to develop a set of such tools applicable to a broad range of restoration settings.

*About the Speaker:* **Elizabeth (Liz) Matthews** is a graduate student in the Plant Ecology Lab at UNC-Chapel Hill working with Drs. Robert K. Peet and Alan S. Weakley. Her dissertation research is focused on alluvial plant communities of Piedmont brownwater rivers. As part of her dissertation work, Liz developed a classification and description of North Carolina Piedmont alluvial vegetation. She has also explored drivers of riparian plant community richness and composition in the NC Piedmont, in addition to developing a restoration tool for utilizing quantitative plant community descriptions in the development of restoration targets.



# Streambank Erosion Monitoring in Gwinnett County, Georgia

Elisa Aylin Lewallen

Brown and Caldwell  
990 Hammond Drive, Suite 400  
Atlanta, Georgia 30328  
alewallen@brwnncald.com

*Co-authors:* Lori Visone, P.E., Jill Stachura, Laurie Hawks, Joel Sholtes with Brown and Caldwell and Pete Wright, P.E. with Gwinnett County

*Abstract:* Gwinnett County is located in the urbanizing Piedmont area northeast of Atlanta. Increased stream erosion and sedimentation problems have occurred over the past several decades. As part of the County's overall watershed program, Watershed Improvement Plans (WIPs) have been developed, which are targeted to identify improvement projects that will enhance the aquatic integrity of impaired streams and reduce the total suspended solid load. In areas where sediment yield exceeds the 1,600 lb/ac/yr threshold, the County identifies BMPs retrofits and stream restoration projects in an effort to lower sediment yields.

A TSS production model (WIP Tools) was developed to calculate the sediment load based on land cover and stream erosion. The first WIP Tools version was based entirely on washoff rates for given land cover categories (e.g., impervious, disturbed). This washoff TSS production was then implicitly split – 15% upland and 85% stream generated. Although much of the sediment in County streams is thought to originate from streambank erosion, the justification behind this assumption was limited. The second WIP tools version used actual stream walk data to generate stream bank erosion rates. However, an assumed rate of erosion was used since no actual data was available for this parameter.

In an attempt to get a more quantifiably realistic erosion rate, Brown and Caldwell has conducted erosion monitoring at 50 sites within the County since 2005, which has spanned drought and extreme wet years. In addition, the USGS has collected TSS loading data at each of its gaging stations over the past 10 years. The purpose of this presentation will be to compare the assumed model erosion rates with the the measured rates at the 50 stations from 2005 through 2010. The USGS data will also be compared with the model results for TSS loading at each of the watershed outlets.

*About the Speaker:* Ms. Lewallen has over 12 years consulting experience in watershed and stormwater management. She has a BS in Natural Resources from Cornell University and a Master of Science and Master in Public Policy from Indiana University. Ms. Lewallen has worked for public and private clients on water quality sampling programs, biological assessments, stormwater management and permitting, and various types of watershed planning studies. She currently manages the water resources group for Brown and Caldwell in Atlanta, Georgia.

# Watershed Improvement Planning and Project Implementation to Target Sediment Load Reductions in Gwinnett County, Georgia Streams – A Case Study of Improvements at a County Park

Jill Stachura

Brown and Caldwell  
990 Hammond Drive, Suite 400  
Atlanta, GA 30328  
jstachura@brwnald.com

*Co-authors:* Jill Stachura, Pete Wright, P.E. - Gwinnett County Department of Water Resources

*Abstract:* Growth in Gwinnett County, Georgia has brought its share of impacts to County streams and rivers, including excess sedimentation and severe streambank erosion from altered hydrology. The Gwinnett County Watershed Improvement Program has taken a unique approach to improving watershed conditions. Based on a watershed assessment and protection plan completed in 1999, total suspended solids (TSS) was identified as the primary pollutant in the County's streams. The County determined that a TSS goal of 1,600 lbs/ac/yr in its watersheds would maintain viable aquatic ecosystems. The County began developing Watershed Improvement Plans (WIPs) in order to identify where the problems were occurring and develop projects to meet the TSS load reduction goals. In order to select the most cost effective projects to achieve the TSS goals at the subwatershed and stream reach scale, WIP Tools was developed. WIP Tools is a grid based flow accumulation model that is deployed as an extension in ArcMap. The output of the WIP Tools extension are data layers that can be used to identify areas of high TSS loads and incrementally propose projects and model the reduction to the stream and watershed sediment loads. Based on WIP Tools, a project was selected and implemented from the CIP. The project consisted of 1,300 linear feet of stream restoration and installation of stormwater BMPs at a heavily used County Park. Based on WIP tools, this project will reduce TSS load by 200,000 lb/yr. Two streams in the park were impaired as a result of intense development in the watershed. The streams were extremely incised and widened with severe bank erosion, and the excessive sedimentation negatively impacted the aquatic habitat. The stream restoration measures included bank grading and in-stream structure installation to control grade, reduce bank shear stress and improve floodplain connectivity. Bankfull benches were installed to increase flood storage and reduce bank shear stress. Structures include cross vanes, J-hooks, a boulder cascade, and rootwads. The project also included the construction of bio-retention cells for treatment of runoff from the dog park area.

*About the Speaker:* **Jill Stachura** is a senior project manager with Brown and Caldwell in Atlanta, GA. She received her MS in Geography/Geomorphology from the University of Georgia in 1996. She has 13 years of experience managing stormwater and watershed projects including numerous ecosystem restorations. She also has experience with environmental compliance, soil and groundwater investigations, and remediation projects for municipal and industrial clients throughout the U.S. She has developed and executed numerous water quality sampling

programs, watershed assessments and improvement plans. She has extensive permitting experience including Section 404, state stream buffer variance, and NPDES.

# Application of the Watershed Assessment of River Stability and Sediment Supply (WARSSS) Model to a Transportation Planning Project

Scott D. Peyton, PE

Stantec Consulting, Inc.  
11687 Lebanon Road  
Cincinnati, OH 45241  
scott.peyton@stantec.com

*Abstract:* The Eastern Corridor Multi-Modal Transportation Project is a large public infrastructure investment study that will provide recommendations for important transportation improvements in the Cincinnati area. The project will provide long-term transportation solutions necessary to meet growing usage patterns and important social and economic benefits to the region.

A key step in developing the alignment of the Eastern Corridor Project is siting a new bridge location across the Little Miami River. The Little Miami is a tributary to the Ohio River with a drainage area of over 1,750 square miles, a state and national scenic river, and is an important cultural and ecological feature in southwest Ohio. The geomorphically active river meanders through a broad alluvial valley and has shown a propensity for significant pattern adjustments over the past 80 years.

Stantec used WARSSS to assess the river for geomorphic stability. Over two and a half miles of river was studied in detail to provide recommendations for the bridge project. The WARSSS approach is an innovative way to apply cutting edge geomorphic theory and principles to a real world problem to arrive at site specific and sustainable solution. Stantec performed a Reconnaissance Level Assessment (RLA), a Rapid Resource Inventory for Sediment and Stability Consequence (RRISSC), a Prediction Level Assessment (PLA), and year one monitoring. Specific tasks included hydrologic and hydraulic analyses, repeat longitudinal profile, cross sections, and sediment surveys, Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) characterizations, vegetation reviews, and meander and depositional pattern evaluations.

The traditional method used for this type of study, a hydraulic computer model, would not have been as site specific or yielded the detailed results necessary to make bridge crossing recommendations. The WARSSS approach also allowed the transportation planners to assess future river patterns and profiles and bridge clear span requirements.

*About the Speaker:* **Scott D. Peyton** is a water resources engineer and project manager with Stantec Consulting Services Inc. in Cincinnati, OH. Mr. Peyton has direct project experience with ecosystem and stream restoration and enhancement projects including 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 stormwater and water resources projects including watershed management and planning.

# Compensatory stream and wetland mitigation in North Carolina: An evaluation of regulatory success

Eric W. Kulz and Tammy L. Hill

NC Department of Environment and Natural Resources  
Division of Water Quality (401/Wetlands)  
2321 Crabtree Blvd., Suite 250  
Raleigh, NC 27604  
eric.kulz@ncdenr.gov  
tammy.l.hill@ncdenr.gov

*Co-Author(s):* Eric W. Kulz and Tammy L. Hill, NC Dept. of Environment and Natural Resources

*Abstract:* The North Carolina Division of Water Quality utilized Wetland Program Development Grant funds from the U.S. Environmental Protection Agency to investigate the regulatory success rates of wetland and stream mitigation projects throughout North Carolina. A probability sampling design was implemented to collect information to facilitate comparison of current statewide mitigation site conditions with regulatory requirements during 2007-2009 using NCDWQ file review (including mitigation plans and mitigation project monitoring report data) and direct observations of site conditions. Statistical analyses of study data were performed using SUDAAN software, and results were weighted by both component counts and mitigation size (i.e. acres of wetlands, linear feet of streams). Overall mitigation success rates were estimated at 74% for wetlands and 75% for streams in NC. Compared to the results of previous studies, the wetland mitigation success rate has increased dramatically since the mid-1990's. Bonferroni corrections were utilized to allow comparison of multiple levels within domains of interest. Domains included mitigation provider (mitigation banks, North Carolina Ecosystem Enhancement Program's design-bid-build and full-delivery programs, North Carolina Department of Transportation and private permittee-responsible mitigation) and method (creation, restoration, enhancement and preservation), as well as project location, age and size. The differences between success rates for mitigation providers was generally not significant, although permittee-responsible mitigation yielded higher success rates in certain circumstances. In terms of mitigation methods, both wetland and stream preservation showed high rates of success, and the stream enhancement success rate was significantly higher than that of stream restoration. When mitigation size was factored into the analysis, the Piedmont physiographic region yielded a lower stream mitigation success rate than other areas of the state. Recently-constructed wetland mitigation projects demonstrated a lower success rate than those built prior to 2002. While improvements in hydrologic modeling and increased understanding of soils issues and stream restoration techniques have enhanced mitigation success since the mid-1990's, analysis results showed that no single mitigation provider, mitigation type or geographic region achieved a 100% success rate according to the standards approved in mitigation plans. Continued opportunities for improvement exist in the areas of regulatory record-keeping,

understanding the relationship between post-construction establishment and long-term ecological trajectories of stream and wetland restoration projects, incorporation of ecological metrics into mitigation monitoring and success criteria, and adaptation of stream mitigation designs to promote greater success in the Piedmont physiographic region.

*About the Speaker(s):* **Mr. Kulz** has been with the Wetlands and Stormwater Branch for over five years, and has been responsible for review of stream mitigation plans and monitoring reports, conducting site visits to proposed mitigation sites, as well as compliance evaluations of mitigation sites in monitoring. Prior to working with the 401 Unit, Mr. Kulz was with DWQ in the Raleigh Regional Office where his responsibilities included evaluations of surface water features to determine the applicability of state riparian buffer rules and enforcement of surface water protection rules, regulations and statutes. In addition, Mr. Kulz is an instructor in the DWQ Surface Water Identification Training and Certification Program. Prior to working for the Division of Water Quality, Mr. Kulz spent 15 years with environmental consulting firms in Raleigh and Durham, North Carolina. Mr. Kulz holds a B.S. in Biology from the University of Miami (Coral Gables, FL), 1982, and a M.S. in Biology from Nova University (Ft. Lauderdale, FL), 1988.

**Ms. Hill** has been with the Wetlands and Stormwater Branch for four years, and has been responsible for review of wetland mitigation plans and monitoring reports, compliance evaluations of mitigation sites in monitoring, and mitigation-related data management and special studies. Prior to working for the NC Division of Water Quality, Ms. Hill spent several years focusing on aquatic chemistry with environmental laboratories and consulting firms in and around Denver, Colorado. Ms. Hill holds a B.A. in Environmental Studies, Biological Sciences from UNC-Wilmington, 1997, and a M.E.M. in Environmental Management, Water Resources from Duke University, 2006.

## Poster Presentations

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# A quick and automated stream design model using ArcGIS model builder coupled with ground water flow

**Blair Borries**

Georgia College and State University  
305 N. Jefferson St. Apt A  
Milledgeville, GA 31061  
bblueberries@gmail.com

*Co-Authors:* Samuel Mutiti (PhD), Assistant Professor of Geology, Georgia College and State University

*Abstract:* A good stream design project should be thorough, time-effective, cost-effective, as well as pass the scrutiny of the general public. The challenge of meeting the cost and time requirements is that a lot of geomorphic, hydraulic, and ecological analyses must be conducted to ensure a stream design meets the desired goals before it can even get to its final stages. These analyses are both time consuming and very expensive, which in most cases reduces public support and funding for potentially good projects. To address some of these issues, I created a flexible stream design model using ArcGIS model builder that automatically generates numerous design iterations at various locations. The flexibility within this model permits adherence to a wide range of reference-reach conditions or regime ratios. Ultimately the model produces three dimensional breaklines to create triangulated irregular networks and perform various analyses. The models can be used to stream-lined one dimensional hydraulic assessments and cut/fill analyses within the GIS environment. It also has the capabilities for automated structure design and batch processing of the required material dimensions. This model was applied to streams serving as mitigation for the impacts of mining in the Midwest (over 30 miles of streams were designed). We are currently using the stream design model to develop a design for a stream restoration project at Andalusia, home of Flannery O'Connor, in Milledgeville Georgia. The model outputs are coupled with a 2-dimensional sub-surface hydraulic and flow model to evaluate the capacity to restore natural hydrology and explore surface-ground water interactions.

*About the Author:* **Blair Borries** is a Graduate Assistant at Georgia College and State University in the Biological and Environmental Studies Program. He earned his B.S. in Biology from Indiana University – Bloomington. He has been employed as a Watershed Coordinator for Soil & Water Conservation Districts in Indiana and as a stream biologist and GIS analyst for a consulting firm in the coal regions of Indiana, Kentucky, and Illinois. As a biologist, Blair has conducted numerous biological studies using fish and macroinvertebrates for baseline data on watershed plans and Clean Water Act permits. Blair has spent considerable effort using GIS to model pollutant loads and to create tools that expedite natural channel design in constructed valleys of reclaimed surface coal mine areas. As a graduate student his research is focused on

understanding the implications of shallow groundwater and sub-surface geophysics in restoring and protecting natural channels and wetlands.

## Challenges of stream restoration in the Alabama Black Belt

Eve Brantley, Ph.D.

Auburn University  
235 Funchess Hall  
Auburn, AL 36849  
brantef@auburn.edu

*Abstract:* The Alabama Black Belt is unique due to its soils derived from alkaline, Selma chalk, or acid marine clays. Commonly, these soils exhibit poor drainage and high shrink / swell potential. These two characteristics were a challenge and aid as a Priority 2 stream and floodplain restoration project was implemented on White Slough in the Catoma Creek watershed, Montgomery, Alabama. A Section 319(h) grant from the Alabama Department of Environmental Management helped fund the construction of 2100 linear feet of stream and 2 acres of floodplain in the City of Montgomery's Ida Belle Young Park. White Slough is a typical urban stream impacted by polluted stormwater runoff and flashy hydrology. It drains 1.5 square miles (960 ac) of watershed with land uses including high density residential and the Blount Cultural Park, an area of ponds, green space, and resident Canada geese. Goodwyn, Mills, and Cawood, Inc. designed and implemented project components including temporary and permanent vegetation, erosion and sediment control, channel realignment and floodplain construction, energy dissipation structures, and in-stream structures. Project challenges included extremely heavy rains during construction and predation of the temporary and permanent vegetation by Canada geese. The clayey nature of the soils worked to the project's advantage, as they tended to not move during high flow events. However, establishment of vegetation has been a challenge in these soils. Hydroseeding was employed to promote the establishment of grasses and herbaceous plants in March and April 2010. Permanent vegetation installed along the stream and floodplain includes native grasses, herbaceous plants, shrubs, and trees. A wetland enhancement in the park was completed in July 2010 in partnership with local high schools and community groups. Additionally, bioswales were constructed to offset runoff associated with the newly finished tennis courts for Ida Belle Young Park.

*About the Author:* Eve Brantley is an Assistant Professor with the Auburn University Department of Agronomy and Soils and the Alabama Cooperative Extension System Water Resource Specialist. Her employment experiences include working as a local watershed coordinator, directing a citizen water monitoring program, and facilitating a coastal water quality stakeholder group. Eve has a BS degree in Biology from Berry College, a MS in Forest Resources from Clemson University, and a PhD from Auburn University School of Forestry and Wildlife Sciences.

## Casey & Casey Law Office: Integrating three treatments, multiple partners and one small parcel in a well-loved watershed

Teresa Buckwalter, M.L.A.

Brushy Fork Environmental Consulting, Inc.  
1638 Brushy Fork Road  
Trade, TN 37691  
teresa@bfec.org

*Abstract:* Affectionately known as "Kraut Creek" for the effluent of a former sauerkraut factory along its banks, Boone Creek runs through downtown Boone, North Carolina. Many local residents have become passionate about protecting and restoring this creek. The Kraut Creek Committee, made up of a group of interested citizens evolved out of a planning class at Appalachian State University which studied how to increase not only the health of the creek, but also citizen interest in the Creek. Since its inception in 2006, the committee has helped effect change throughout this small, urban watershed with an overall watershed plan, a demonstration project completed, and three additional projects in the works.

One of these projects is the Casey & Casey Law Office, located on a small tract along King Street, Boone's main downtown thoroughfare. A partnership between the landowner, Kraut Creek Committee, National Committee for the New River and NC State University's Biological & Agricultural Engineering Department is yielding an integration of stormwater and stream enhancement.

Three treatments including a rain garden, permeable pavers and streambank enhancement will treat stormwater from a new building for the law office before it enters an un-named tributary to Kraut Creek. The new permeable paver parking lot will incorporate three different base materials, the effects of which will be studied by NC State's Biological & Agricultural Engineering Department to improve knowledge of the use of permeable pavers and base material in the mountains of North Carolina. Scheduled for completion in October of this year, the project is anticipated to have lasting outcomes: from improved aesthetics, water quality and knowledge-base, this project will be another building block in the overall improvement of this urban watershed.

## Stream Resurrection: Mitigating erosion control failure

Michael Burkhard

NC DENR – Division of Water Quality  
610 East Center Avenue, Suite 301  
 Mooresville, NC 28115  
Michael.Burkhard@ncdenr.gov

*Co-Author(s):* Christopher J. Estes, Estes Design

*Abstract:* A local municipality cleared approximately five and a half acres to construct a sewer right of way through moderately sloping topography with highly erosive soils. Several oversights lead to compounded problems that resulted in multi-level failures in the erosion control plan. The result was sedimentation of 1500 feet of jurisdictional streams with an estimated 300 cubic yards of sediment. A real-time response plan was successfully executed resulting in significant improvement hydraulics and biology.

The existing erosion control plans did not adequately address the site conditions. Existing drainage patterns were not identified and the implications of existing topography and soil conditions were overlooked. The original ground cover did not germinate and follow up monitoring and maintenance was not carried out. This resulted in over burdened and prolonged failure of the existing erosion control devices.

A two pronged simultaneous approach was employed to mitigate the impacts. The first priority was to stabilize and secure the site from further erosion by assessing conditions, repairing and installing necessary erosion control measures. Secondly, a stream cleanup was coordinated with the design of a new erosion control plan that defined site measures for sustaining long term stability.

All drainage ways and sources of sediment were identified. Additional erosion control measures were installed as existing measures were repaired. Approximately 2500 feet of terraces were installed and a 40 foot high embankment was reconstructed. Vacuum trucks and hand labor were used to remove sediment from the stream channel. At one point three vac trucks and nine laborers were involved in sediment removal.

The two month operation resulted in immediate return of aquatic life including amphibians and reptiles. The site is currently being monitored to ensure success of the erosion control plan and to document the recovery of aquatic species.

# Evaluations of greenway trail characteristics and trail experiences

Jinhyung Chon

Division of Environmental Science & Ecological Eng.  
Anamdong, Seongbukgu, Korea University  
Seoul 136-713 Korea  
jchon@korea.ac.kr

Co-Author(s): JungA Lee

*Abstract:* For the past 15 to 20 years greenways have captured attention due to their linear shape and potential to better connect urban systems (Stearns 1995) but research has rarely examined the human-experience in trail based greenways and how experience may relate to design. While many authors have focused on the physical characteristics and multiple criteria that must be applied in greenway planning and management, only a few have examined human interaction with the environment through visual aspects of perception and preference.

There were two primary objectives. First, this study examined if and how perceptions might differ if characteristics within the viewshed along a greenway trail corridor scene were changed. Second, the study examined how perceptions of trail characteristics influenced the overall likability of the greenway trail corridor. Findings may help improve understanding of the role of greenway trail characteristics in relation to other variables which can be influenced through planning and design.

This study used environmental perception theory as a basis for aesthetic research to better inform the design, layout and maintenance of greenway trail corridors. Study results can be useful in understanding how greenway trails in urban areas are perceived and to develop designs that would improve the user experience.

Several greenway trail characteristics had a significant influence on travel environments and between travel directions. Study also found that greenway trail characteristics including amount of vegetation, built structures on trail, adjacent auto traffic, background buildings, trail surface, and trail width were significant predictors of likability

Results contained various practical implications. The study can assist planners, designers, and managers of multiple objective greenway trails at several points in the project process. First, results showed that several trail characteristics elicited significant relationships to likability.

## Pre-Construction Water Quality data of a Rural Watershed-Scale Restoration Project: NCEEP's Big Harris Creek Project

Deborah Daniels

NC Ecosystem Enhancement Program  
5 Ravenscroft Dr., Suite 102  
Asheville, NC 28801  
deborah.a.daniel@ncdenr.gov

*Abstract:* Big Harris Creek, a 10-square mile watershed draining to the First Broad River in Cleveland County, is the focus of the largest stream restoration project the NC Ecosystem Enhancement Program has ever conducted. The project encompasses 4.5 square miles (or 85%) of the upper half of the Big Harris Creek Watershed and is within an NCEEP Targeted Local Watershed (TLW). The goal of the project is to address water quality and habitat impacts (degraded riparian buffers, stream bank erosion and in-stream sedimentation) caused by a long history of row crop and livestock production. The project includes approximately 6.0 miles of stream and 1.5 miles of ephemeral channel restoration/enhancement, 0.5 miles of stream preservation, several acres of wetlands and over 125 acres of riparian buffer, all of which are under permanent conservation easement. Livestock exclusion fencing and alternative watering are being installed. Grant funding for a stormwater wetland BMP is being pursued.

This watershed-scale project provides a great opportunity for a synergy of effort with NCEEP and its partners the Division of Water Quality WAT, Cleveland County SWCD, Mountain Valleys RC&D, NCSU, and Stantec Engineering Services to achieve common resource management goals for water quality, aquatic habitat monitoring and research. Water quality, macro-benthic and fisheries data have been collected throughout the Big Harris Creek project area and the Little Harris Creek watershed (serving as a control area to provide comparisons against reference conditions). Water quality data gathered from 15 months of baseflow and stormflow conditions and macro-benthic data collected in 2009 are presented here. Funding to continue these sampling efforts after project construction is being pursued.

By concentrating a mix of watershed restoration and protection technologies within a high-priority watershed, NCEEP and its partners are increasing the likelihood of measurable long-term benefits to local watershed functions and to the downstream resource.

*About the Author:* **Deborah A. Daniel** is a Project Manager and Environmental Specialist for the North Carolina Ecosystem Enhancement Program (NCEDEP). She had been employed with NCEEP since 2005. As project manager in the Western Field Office, Deborah has managed six design build bid projects totaling 44,000 linear feet of streams and 15 acres of wetlands in the Broad River and French Broad River basins. Project management involves locating potential projects, landowner recruitment, coordinating with partnering agencies to provide alternative agricultural best management practices, review and oversight of design and construction deliverables and monitoring activities. She has also worked extensively with several



conservation groups and local watershed partnerships. Deborah came to NCEEP from East Carolina University where she has 23 years of experience in nutrient chemistry and sediment analysis in estuarine and freshwater systems ranging from Florida to the Arctic Ocean. Deborah has bachelor degrees in inorganic chemistry and geology and a M.S degree in geology with concentrations in biogeochemistry and paleo-ecology.

# Regulations and mitigation policies are not having the intended effects of providing fish passage or preventing net loss of streams in Georgia, USA

William W. Duncan

US Fish and Wildlife Service, Georgia Ecological Services  
105 Westpark Dr., Suite D  
Athens, GA 30606  
will\_duncan@fws.gov

*Co-authors:* Katie M. Bowers, Louisiana State University, Department of Environmental Sciences

*Abstract:* Stream-road crossings can impede the upstream and downstream movement of aquatic organisms. Consequently, the Savannah District of the US Army Corps of Engineers worked with state and federal natural resource agencies to develop specific Regional Conditions (i.e. regulations) that are intended to minimize impacts to fish passage following the construction of crossings. In an effort to evaluate the effectiveness of some of those efforts, the US Fish and Wildlife Service (USFWS) commissioned this study. We found that most new crossings failed to meet more than one requirement in the Regional Conditions. Only ¼ of the surveyed new crossings were expected to be passable by small-bodied fishes based on multiple fish passage criteria. By comparing crossings that received USFWS comments on their permit applications to those that received none, we found compelling evidence that the substantial effort invested in permit review currently results in few tangible benefits to culvert design and fish passage under the current management framework. The measured total stream impact length in this study was 46% higher than the amount of impact proposed in permit applications for perennial streams, and 24% higher than that proposed for intermittent and ephemeral streams. Although most permit applications proposed impacts less than the 100 ft threshold required for mitigation, impacts at most sites exceeded 100 ft. Consequently, only 22% of the perennial stream length impacted in this study received mitigation even though 91% of the impacted stream length qualified. Collectively, these results indicate that regulations and mitigation policies are not having their intended effects of providing fish passage or preventing net loss of streams. We suggest that additional studies such as this one be conducted and used to evaluate and improve agency effectiveness.

*About the Author:* **Will Duncan** is an aquatic ecologist for the US Fish and Wildlife Service, Georgia Ecological Services. His research and interests include evaluating the efficacy of management efforts, like stream mitigation and policy changes, that are designed to improve aquatic habitat and imperiled species populations in the southeastern US. Recent investigations include critical evaluations of the effects of channel entrenchment on instream habitat, and disconnects between regulations and culvert construction for fish passage. Will also serves as the Science and Data Committee Co-chair for the Southeast Aquatic Resources Partnership, an organization dedicated to developing and using regional approaches to habitat restoration and conservation. Will earned his Ph.D. in Ecology at the University of Georgia.

## Nutrient injections: Evaluating differences in nutrient retention in restored and unrestored stream reaches

Angela Gardner

NC State University  
Campus Box 7625  
Raleigh, NC 27695  
angardne@ncsu.edu

*Co-Author(s):* Angela Gardner, Dr. Sara McMillan, Dr. Greg Jennings, and Alea Tuttle

*Abstract:* Improvement of water quality is consistently listed as one of the top goals for a successful stream restoration project. However, little data exists on the magnitude of impact restoration has on the ability of a lotic ecosystem to retain nutrients. Monitoring nitrogen retention in both restored and degraded urban streams will help the restoration community begin to understand and predict the effects that ecologically based restoration elements will have on instream water quality. Also, testing several reaches within a watershed of varying restoration ages can give an indication as to the timescale for recovery and the reestablishment of nutrient retention in streams. Knowledge of said timescale can aid in the development of success criteria for restoration projects.

Monitoring of this nature can be achieved by implementing nutrient injection experiments. In a WRRRI study currently being conducted by NC State and UNC Charlotte, nutrient injections are being performed on six paired (restored-unrestored) stream reaches of varying ages of restoration with varying restoration techniques. In these experiments, nutrients (N and P) are injected in solution with a conservative solute (NaCl) at a consistent rate using a Mariotte Jar set-up. A conductivity probe is placed at the end of the study reach to monitor the NaCl concentration. The conductivity probe will measure the increase in conductivity as the solution mixes within the system. Once the conductivity plateaus and the stream is well mixed with the nutrient injection solution, water quality samples are taken at several points along the reach. From these samples conductivity and nutrient concentrations are analyzed in a laboratory to develop a curve showing the change in nutrient concentration along the length of the stream. Such data will be paramount in understanding the role stream restoration plays in altering nutrient retention capabilities of lotic ecosystems.

This project is sponsored by Water Resources Research Institute.

## Lone Oak Stream Mitigation Bank: Site Selection under 33 C.F.R.

**John Hutton**

Wildlands Engineering  
5605 Chapel Hill Rd  
Raleigh, NC 27607  
jhutton@wildlandsinc.com

*Abstract:* The Lone Oak Mitigation Bank is located in Albemarle County, VA within the Middle James River Basin. The project consists of approximately 27,000 lf of stream restoration, enhancement, and preservation. The Bank will provide stream credits to offset Section 404 impacts occurring within the Middle James River Basin. This discussion will focus on the bank selection and development process during the transition to 33 C.F.R., parts 325 and 332 or “The New Mitigation Rule.”

The Middle James River service area consists of four 8-digit Hydrologic Unit Codes. Annual impacts within the service area averaged 37,000 linear feet from 2005 to 2007 based on market analysis. High demand and relatively low competition in 2007 made the Middle James an ideal location for a mitigation bank. In anticipation of the transition to 33 C.F.R., Wildlands used a watershed suitability model to identify the best locations within the James River Basin to look for mitigation sites. The Lone Oak Farm was identified as the largest cattle farm on Ballinger Creek, a direct tributary to the James River. Ballinger Creek is listed on the State’s 303(d) list for fecal coliform. Ballinger Creek is also historic habitat for the federally endangered James spiny mussel however sediment impacts to the system have reduced habitat and a detailed survey indicated no mussel presence on the property.

Wildlands worked with a private equity group to purchase the farm and subdivide out the 322 acres that is being used as the mitigation bank. This project is an example of how private mitigation banking can be used to achieve real ecological benefits under 33 C.F.R. Restoration of the site is expected to significantly decrease fecal coliform and fine sediment levels in the system, create appropriate habitat for the James spiny mussel, and connect significant wildlife corridors in the area. The site is currently under construction with completion expected in Winter 2010/2011.

# When a Meadow becomes a Cliff: A Participatory Study of Wet Meadow Incision following Wildfire

Jonathan Long

USDA Forest Service Pacific Southwest Research Station  
291 Country Club Dr, TERC 3rd Floor  
Incline Village, NV 89451  
jwlong@fs.fed.us

*Co-Author(s):* Jonathan Long, Mae Burnette, Phil Endfield, Judy DeHose

*Abstract:* We present a participatory case study to evaluate impacts of a severe wildfire on a headwater wet meadow on the White Mountain Apache Reservation in east-central Arizona. In the summer of 2002, the Rodeo-Chediski fire damaged many important springs and wetlands in the rugged northwestern quarter of the reservation, which is the homeland of the White Mountain Apache Tribe. A post-fire assessment led by Tribal staff over the next year found that two remote wet meadows, Turkey Spring and Swamp Spring, were experiencing accelerated erosion. In the Southwest, such wet meadows are considered particularly valuable ecosystems because of their ecological functions and relative rarity. Cross-sectional and longitudinal surveys of the sites from 2003-2004 measured the extent of incision. Treatments including rock riffle structures to regain channel stability, revegetation to stabilize the soils, and a road crossing redesign were implemented at Swamp Spring. Meanwhile, the Turkey Spring site was largely untreated, and damage to the road network curtailed access to the site for several years. In 2009 and 2010, a partnership involving members of the nearby community of Cibecue, Tribal Forestry and Hydrology staff, and Forest Service scientists resurveyed the channels at both sites. Results indicate that the Swamp Spring channel remained stable following treatment, while the Turkey Spring channel has continued to incise 8 years after the fire. A historical photograph from 1959 suggests that the site was previously unincised. Consequently, these data allowed the team to calculate rates of channel incision and soil loss before and after the wildfire. Community members and resource managers have gained empirical evidence to evaluate the impacts of severe wildfire and the potential benefits of post-wildfire treatments within highly erodible landscapes in the region. This collaborative effort has demonstrated the potential for community engagement and creative partnerships in long-term monitoring of watershed conditions.

# Modelling Streambank Erosion using LiDAR in the Cacapon River Watershed, WV

**Jonathan L Pitchford**

West Virginia University  
505 Prospect St Ext  
Point Marion, PA 15474  
pitchfordj@yahoo.com

*Co-Authors:* Jonathan L Pitchford, James T Anderson, Michael P Strager

*Abstract:* An important component of stream restoration is on site streambank and riparian assessment; however, recently developed remote sensing technologies such as Light Detection and Ranging (LiDAR) are being integrated into stream assessments allowing larger areas to be evaluated without extensive field surveys. The purpose of this study is to use LiDAR and other remotely sensed data to develop a Bayesian model of streambank erosion potential from riparian and stream channel features such as bank stress, soil type, pool/riffle/run sequence, buffer width, large woody debris, vegetation community structure, concavity of the streambank, flow accumulation, and soil moisture in the Cacapon River Watershed in West Virginia. Model validation is being accomplished by comparing Bayesian probabilities of erosion potential to erosion rates measured with erosion pins, and by comparing model performance with a field based assessment, Bank Erosion Hazard Index (BEHI). Applications for the model include watershed scale assessment of streambank erosion potential without the need for extensive field surveys.

*About the Author:* **Jonathan Pitchford** is a PhD student at West Virginia University where he is evaluating stream restoration practices and studying the causes of streambank erosion in the Cacapon River Watershed in the eastern panhandle of West Virginia. Pitchford received a bachelor's in zoology from Auburn University, a master's in biology from Appalachian State, and worked as an intern for the Canandaigua Lake Watershed Program before accepting a research assistantship at WVU. Jonathan's current pursuits involve quantifying improvements in water quality resulting from a stream restoration project and using remote sensing and GIS to model erosion potential. He plans to complete his doctoral work in May of 2012 and hopes to find work in the southeastern U.S.

## Rural Stream Restoration in Watauga River Basin

Jessica Pleasants

Brushy Fork Environmental Consulting, Inc.  
1638 Brushy Fork Road  
Trade, TN 37691  
jessica@bfec.org

*Abstract:* Communicating information about stream health is crucial to implementing the remediation strategies often required for the long-term wellbeing of any degraded watershed. Establishing relationships within a community is paramount to obtaining landowner participation, especially in a rural mountain setting. The focus of this project was to 1) educate landowners on the benefits of healthy streams and 2) implement cost-effective measures to restore streams within the Roan Creek Watershed. The Shull Stream Restoration Project is located on a large rural tract of land outside of Mountain City, TN. The project reach includes Roan Creek, a 303(d) listed stream within the Watauga River Basin. The goal of this project was to restore approximately 1,600 linear feet of Roan Creek, with the installation of natural structures, planting of native riparian vegetation, as well as agricultural exclusion (fencing). A TN Department of Agriculture 319 grant, coupled with additional grant sources, funded the restoration project. Roan Creek is a perennial channel that flows with a bankfull width of ~140 ft and depth of ~4-5 feet. The project site displayed multiple areas of degradation with little native-riparian vegetation along banks due to past/recent livestock grazing. Additionally, a steep ravine on river left coupled with adjacent cropland on river right confine the stream through the project reach. Project design implementation included the installation of several rock vanes, j-hooks, bank sloping, and a native riparian buffer. The Shull Project has facilitated valuable local contacts and landowners willing to participate in this cost-share program, thereby advancing the objectives of this watershed grant. By stabilizing streambanks, reducing erosion, and enhancing riparian and aquatic habitat, this project was a successful endeavor. However, long-lasting impacts also include a deeper understanding of how to foster stream health within the local community.

*About the Author:* Jessica Pleasants is an environmental technician for Brushy Fork Environmental Consulting, Inc. (BFEC), an environmental consulting firm based in Trade, TN, serving the High Country of North Carolina, Tennessee, and Virginia. She specializes in stream assessment, environmental permitting, and grant writing. Many of the projects Jessica is currently involved with are grant-driven watershed studies in rural mountain communities. She is also an active member of the Watauga River Conservation Partners, a local non-profit. Jessica has a B.S. from UNC-Chapel Hill and a master's from Appalachian State University, both in the field of Biology.

## Do engineered structures in restored urban streams accelerate benthic denitrification?

Alea Tuttle

UNC-Charlotte  
9201 Univ. City Blvd  
Charlotte, NC 28223  
atutt115@uncc.edu

*Co-Authors:* Sara McMillan, Sandra Clinton, Alea Tuttle, Leah Haithcock

*Abstract:* Do engineered structures in restored urban streams accelerate benthic denitrification? Stream restoration activities are used to mitigate anthropogenic disturbances with the goal of decreasing erosion and nutrient concentrations while increasing biodiversity and returning ecosystem function. Many restoration plans have designed or unintentional impacts on surface and subsurface transient storage. Transient storage capacity is increased by features that slow and detain water. Engineered riffles, log vanes, and stone weirs potentially increase hyporheic (subsurface) storage by creating localized areas of downwelling and upwelling around the structures. To evaluate the potential role of these structures in enhancing ecosystem function, we measured denitrification and reach-scale  $\text{NO}_3^-$  retention in three restored reaches paired with non-restored reaches upstream and two other non-restored watersheds with low and high urbanization respectively. In addition to enhancing streambed heterogeneity, these structures create unique hydraulic flow paths during baseflow and assist in the retention of organic debris. Downwelling through these carbon collection points may increase the availability of dissolved organic carbon (DOC) in hyporheic waters to denitrifying microbial communities. This driver of nitrogen retention is expected to be seasonally relevant with autumn leaf fall and day length affecting the quality and quantity of DOC. Our results reveal higher transient storage in the restored reaches with concurrent higher rates of denitrification in streambed sediments.

*About the Author:* Alea Tuttle is a graduate student in Earth Sciences at the University of North Carolina Charlotte, pursuing a Masters Degree researching stream biogeochemistry and restoration ecology. She received a Bachelor of Science from the Rubenstein School of Environment and Natural Resources at the University of Vermont in Burlington, VT. She has participated in long term monitoring programs for both lotic and lentic systems through the Vermont State Division of Water Quality, and for the Arctic Streams Long Term Ecological Research program administered by the Marine Biological Laboratory in Woods Hole, MA. Currently in progress thesis research examines Dissolved Nitrogen and Carbon availability and uptake through denitrification in restored urban streams.



# Stream Channel Morphology in Southern Appalachian Old-Growth Forests

Jason Zink, P.E.

North Carolina State University  
Campus Box 7625  
Raleigh, NC 27695-7625  
jmzink@gmail.com

*Co-authors:* Jason Zink, Zan Price, Dr. Greg Jennings, NC State University

*Abstract:* The design of stream restoration projects frequently includes consideration of an unaltered, or reference, stream reach. To find these reference reaches, designers typically identify stable stream channels in non-urbanized watersheds. While the watersheds for reference reaches are often forested, most have been subject to historical anthropogenic impacts, potentially affecting the current form of the stream channels. Watersheds with no, or minimal, historic impact are very rare in the eastern United States.

The Joyce Kilmer/Slickrock Wilderness, in the Nantahala National Forest of North Carolina, includes over 6 mi<sup>2</sup> of virgin, or primary-growth, forest. The wilderness area also contains an additional 23 mi<sup>2</sup> of largely second-growth forest, with minimal human impacts. This wilderness area comprises the watersheds for several miles of streams with a wide range of drainage areas, slopes, stream types, and bed materials.

Study goals included quantifying the morphological parameters of unaltered streams and formulating stream restoration design recommendations. Longitudinal profile and cross-section data was collected for streams of different sizes and types throughout the wilderness area. Channel bedform information, such as pool and step spacings, riffle slopes and lengths, and step heights, was identified. Cross-sectional area, width, mean depth, and maximum depth were determined for each cross-section. The channel dimensions from the primary and second-growth forests were compared to published hydraulic geometry relationships, or regional curves, for the mountains of North Carolina.

Despite variations in stream slope and stream type, hydraulic geometry for the study cross-sections can be predicted by drainage area. Additionally, hydraulic geometry relationships for the streams in undisturbed watersheds appear to be comparable to those from watersheds with historical impacts, such as the regional curve for the mountains of North Carolina. Qualitative observations of these undisturbed streams offer lessons that can be used to improve stream restoration design.

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<p>Wildland Hydrology  11210 N. County Road 19  Fort Collins, CO 80524  970-568-0002  <a href="http://www.wildlandhydrology.com">http://www.wildlandhydrology.com</a></p>	<p>Williams Forestry &amp; Associates  P.O. Box 189  Millville, PA 17846  570-458-0766</p>
<p>WK Dickson  720 Corporate Center Dr.  Raleigh, NC 27607  919-782-0495  <a href="http://www.wkdickson.com">http://www.wkdickson.com</a></p>	<p>Wolf Creek Engineering  51 North Knob Lane  Weaverville, NC 28787  828-658-3649  <a href="http://www.wolfcreekeng.com/">http://www.wolfcreekeng.com/</a></p>



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