The 19th Annual Meeting of the American Ecological Engineering Society

Enabling Future Generations to Solve Our Planet's Grand Challenges

June 3-6, 2019

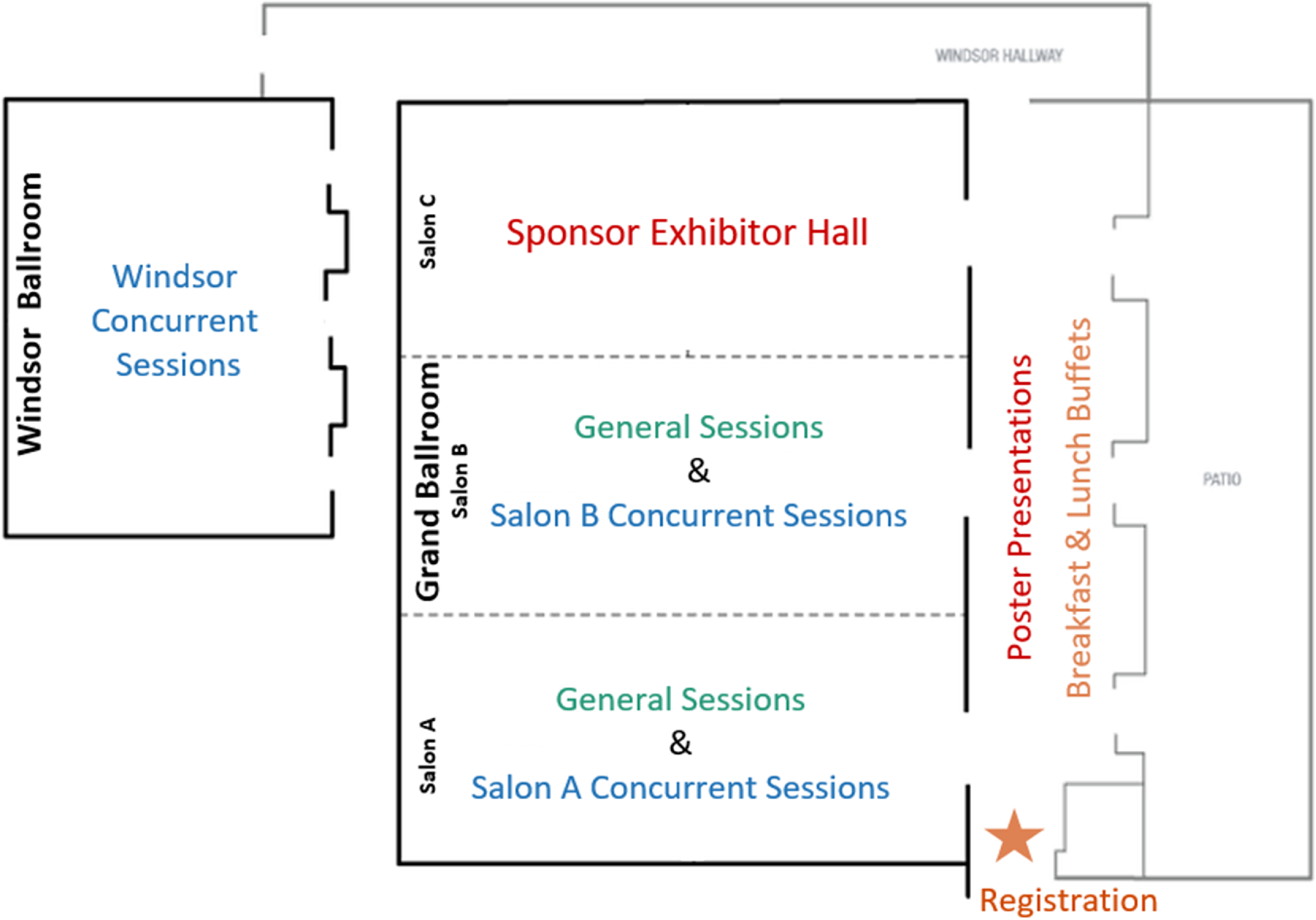
Renaissance Asheville Hotel, Asheville, North Carolina

Conference Hosts

American Ecological Engineering Society
NC State University Department of Biological and Agricultural Engineering
North Carolina State University College of Agriculture and Life Sciences
North Carolina State Extension
North Carolina Sea Grant

Meeting Website: https://www.bae.ncsu.edu/aees-2019/

Society Website: https://www.ecoeng.org/



Windsor Ballroom
Windsor Concurrent Sessions
WINDSOR HALLWAY
Grand Ballroom
Salon C
Sponsor Exhibitor Hall
Salon B
General Sessions & Salon B Concurrent Sessions
Salon A
General Sessions & Salon A Concurrent Sessions
Poster Presentations
Breakfast & Lunch Buffets
PATIO
Registration

About the Meeting

We are excited to host the 19th Annual American Ecological Engineering Society Meeting in Asheville, North Carolina. Located in North Carolina's scenic Blue Ridge Mountains, Asheville is known for its vibrant art scene, adventurous spirit, and commitment to environmental sustainability. This year's meeting theme is "Enabling Future Generations to Solve Our Planet's Grand Challenges". With this meeting, we hope to better contextualize the realm of Ecological Engineering while looking for the next generation to use these emerging practices to solve the world's grand challenges. The interplay between students, industry professionals, and academia will be a key element of the meeting. Over 35 industry professionals are attending the meeting as both sponsors and student mentors to provide insights to entering the field.

The American Ecological Engineering Society's mission is to promote the development of sustainable ecosystems that integrate human society with its natural environment for the benefit of both by fostering education and outreach, extending professional development and associations, raising public awareness, and encouraging original research.

Executive Committee

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Dawn Reinhold, AEES Secretary
Michigan State University
Brian Bledsoe, Prior AEES President
University of Georgia

Anand Jayakaran, AEES Vice President
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North Carolina State University – Biological & Agricultural Engineering Department
Irma Rose, Meeting Coordinator
North Carolina State University – Biological & Agricultural Engineering Department
Andrea Ludwig, Student Design Competition Planner
University of Tennessee

Meeting Partners

We gratefully acknowledge our meeting partners for their help in planning and promoting the 19th Annual Meeting!

Conserving Carolina

NC Plant Conservation Program

UNC Asheville Sustainability

US Fish & Wildlife Services

The North Carolina Arboretum

International Erosion Control Association

Meeting Wifi

Network: Renaissance_CONF

Password: heron (all lowercase)

Special Thanks to Our 2019 Sponsors!

We thank the meeting sponsors, who have made this event possible. Over 35 companies involved in all aspects of ecological engineering are providing support and exhibits throughout the meeting. As a result of this tremendous support, we are able to provide social events on all three nights of the conference to offer fun networking opportunities, lunches, prizes and a taste of Asheville.

STUDENT TRAVEL GRANTS PROVIDED BY THE NATIONAL SCIENCE FOUNDATION

"The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 'to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…' NSF is vital because the organization supports basic research and people to create knowledge that transforms the future." (https://www.nsf.gov/about/). We are very thankful for NSF's support and contribution through the student travel grant.

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MONDAY, JUNE 3, 2019			
4:00-6:00 pm	Sponsor Exhibit Booth and Poster Presentation Set-up		
6:00-9:00 pm	Informal Gathering at Twisted Laurel (130 College Street, Asheville, NC 28801)		
TUESDAY, JUNE 4, 2019			
6:30 - 8:00 am	Light Continental Breakfast and Registration		
7:30 - 8:00 am	Student Design Competition Meeting - Salon B		
OPENING GENERAL SESSION - Salon A & B			
Moderator	Trisha Moore, AEES President		
8:00 - 8:15 am	Conference Welcome - Trisha Moore, AEES President		
8:15 - 8:45 am	Julie Mayfield - Challenges for a Sustainable Future: Public Engagement is Key		
8:45 - 9:15 am	William Mitsch - History and Future of Ecological Engineering		
9:15 - 9:45 am	Sepideh Saidi - Be Open. Be positive. Be courageous.		
9:45 - 10:15 am	Rafael Vazquez-Burney - Dreams to Reality: Recent Experiences Implementing Ecological Engineering Projects		
10:15 - 10:45 am	Break		
10:45 am - 12:00 pm	**CONCURRENT SESSION 1**		
	Salon A	Salon B	Windsor Ballroom
Session Title	**Advancing Ecological Engineering Technology**	**Treatment Wetlands**	**Ecological Engineering in Food Production**
Moderator	W. Cully Hession	Tiffany Messer	Dan Hitchcock
10:45 am - 11:00 am	(1) Robert Dunn - Lidar and Geomorphic Change Detection: Useful Tools for River Ecosystem Assessment and Restoration Monitoring	(6) Scott Knight - Treatment Wetlands in Practice and Lessons Learned	(11) Stew Diemont - Wine in the Trees: Learning Adaptation to Climate Change from Traditional Viticulture Agroforestry in Portugal
11:00 am - 11:15 am	(2) W. Cully Hession - Unlocking New Insights into Riverscapes with Drone-Based Laser Scanners	(7) Michael Burchell - Breathing New Life into a 25 Year Old Wastewater Treatment Wetland	(12) Timothy Ormond - Have Your Creek and Eat It Too: Productive Food Forest Systems for Riparian Buffers
11:15 am - 11:30 am	(3) Brett Connell - High Definition Stream Surveys: A Better Way to Prioritize Your Streambank Restoration Projects	(8) David Austin - Nitrate Design Challenge: Can Surface Flow Wetlands Reduce Nitrate in Cold Water by Induced Electrical Currents?	(13) William Mitsch - Solving the Grand Challenges of Harmful Algal Blooms with Wetlaculture
11:30 am - 11:45 am	(4) Eban Bean - GatorByte: An Open Source Platform for Low-Cost, Real-Time Water Resource Monitoring	(9) Alex Horne - Oxygenation: Yes or No? Anoxia is Vital for Wetlands Pollution Treatment but Deadly for Lakes, Rivers, and Ocean Cleanups	~~(14) Yadir Simón Rodríguez Núñez – Evaluation of a Biological Filter and a Hydroponic System of Lettuce for the Treatment of Wastewater from an Aquaculture Recirculation System for the Production of Tilapia~~ CANCELLED
11:45 am - 12:00 pm	(5) Jochen Hack - A New Methodology to Assess the Ecosystem Service Potential of Urban Rivers in Developing Countries	(10) Mark Brown - A Floating Island Treatment System for Removal of Phosphorus from Surface Waters	~~(15) Ronald Aguilar – Protecting the Water Resource in Costa Rica~~ CANCELLED
12:00 pm - 1:00 pm	Lunch (Provided) - Lobby		

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1:00 pm - 2:15 pm	**CONCURRENT SESSION 2**		
	Salon A	Salon B	Windsor Ballroom
Session Title	**Stream Corridor Restoration I**	**Constructed Wetlands**	**Stormwater & Green Infrastructure I**
Moderator	Greg Jennings	Dawn Reinhold	Andrea Ludwig
1:00 pm - 1:15 pm	(16) Maddie Berg - Urban Stream Restoration: An Evaluation of Conveyance and Material Processing Channels	(21) Allison Lewis - The 4G Ranch Wetlands: Operating for Our Future	(26) David Wituszynski - Monitoring Bird and Insect Communities Within a Large-Scale Bioretention Project: Year 2
1:15 pm - 1:30 pm	(17) Dan Sweet - Emerging Concepts in River Restoration Design and their Application and Adaptation to Headwater Stream Restoration Projects in the Southeast	(22) Bingbing Jiang - Nutrient Retention in the First Full Year by a Wetlaculture Mesocosm System in the Former Great Black Swamp Upstream of the Highly Eutrophic Western Lake Erie	(27) Jenifer McIntyre - The Biological Effectiveness of Green Stormwater Infrastructure for Aquatic Toxicity
1:30 pm - 1:45 pm	(18) Chris Streb - Stream Restoration Using All Wood Structures	(23) Matt Huddleston - Savannah River Site's A-01 Constructed Wetland System: A Model for Sustainable Ecological Risk Mitigation	(28) Jillian Sarazen - Nitrogen and Phosphorus Removal in Bioretention Cells Receiving Agricultural Runoff from a Dairy Farm in South Burlington, VT
1:45 pm - 2:00 pm	(19) Greg Jennings - Who Gives a Dam? Removing Barriers to Aquatic Organism Passage One Step at a Time	(24) Natasha Bell - Potential of Floating Treatment Wetlands to Manage Phytophthora Species in Agricultural Runoff and Drainage	(29) James Bays - Optimizing Green Infrastructure Performance: Case Studies of Los Angeles Wetlands
2:00 pm - 2:15 pm	(20) Andy Brown - The Whole is Greater Than the Sum of Its Parts' - Aristotle	~~(25) Johel Venegas Castillo - Determination of the Parameters of a System of Artifical Wetlands of Vertical Subsuperficial Flow for the Optimations of the Design of Models of Black Box Under Tropical Conditions~~ CANCELLED	(30) Trisha Moore - The Role of Trees as Green Stormwater Infrastructure: Digging into the Data
2:15 pm - 2:30 pm	Break		
2:30 pm - 3:45 pm	**CONCURRENT SESSION 3**		
	Salon A	Salon B	Windsor Ballroom
Session Title	**Ecological Function of Stream Restoration**	**Wetland Hydrology**	**Coastal Ecosystems**
Moderator	Brian Bledsoe	Fouad Jaber	Steven Hall
2:30 pm - 2:45 pm	(31) Urban Withers - Linking Stream Restoration Success with Watershed, Practice and Design Characteristics	(36) Jack Kurki-Fox - The Potential Long-Term Impacts of Climate Change on Coastal Plain Wetlands in North Carolina	(41) David Eggleston - Integrating Ecosystem Service Considerations Within a GIS-Based Habitat Suitability Index for Oyster Restoration
2:45 pm - 3:00 pm	(32) Jeremy Melton - Comparison of Geomorphic and Habitat Metrics for Functional Lift from Urban Stream Restoration	(37) Brock Kamrath - Impact of Control Structures on the Restoration of Wetland Hydrology within the Great Dismal Swamp	(42) Steven Hall - Growing Coastal Infrastructure: Sharing the Vision for a Productive and Sustainable Coast
3:00 pm - 3:15 pm	(33) John Schwartz - Assessing Functional Lift for Urban Stream Restoration Projects	(38) Eric Neuhaus - Assessing the Success of Water Budget Modeling and Reference Wetlands for the Prediction of Wetland Hydrology in Wetland Restoration Sites in NC	(43) Samantha Francis - Green Concrete: The Bioreceptivity of Algae-Concrete for Macroinvertabrates, Preferences of False Dark Mussels, and a Lesson in Adaptive Management
3:15 pm - 3:30 pm	(34) Sara Donatich - Evaluating the Ecological Function of Restored Streams in Piedmont, North Carolina Using the Stream Quantification Tool	(39) Randall Etheridge - Managing Waterfowl Impoundment Hydrology to Provide Habitat and Reduce Nutrient Loss	(44) Mauricio Arias - Characterization of Ecosystem Metabolism of Restored Coral in the Florida Keys
3:30 pm - 3:45 pm	(35) Barbara Doll - Evaluation of Nutrient Reduction Crediting Strategies for Stream Restoration	(40) Tess Thompson - Estimating Flow Through Rock Weirs for Use in Ecological Engineering Design	(45) Sudhanshu Panda - Automated Geospatial Model Development for West Indian Manatees Habitat Suitability Analysis and Conservation Decision Support

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3:45 pm - 4:00 pm	Break		
4:00 pm - 5:15 pm	**CONCURRENT SESSION 4**		
	Salon A	Salon B	Windsor Ballroom
Session Title	**Ecology of the Built Environment**	**Student Design Competition Block**	**Stormwater & Green Infrastructure II**
Moderator	Theresa Thompson	Dedicated time slot for students to attend other concurrent sessions or to work on their design competition projects	Ani Jayakaran
4:00 pm - 4:15 pm	(46) Deborah January-Bevers - Looking Beyond Ecological Functions to the Value of Ecosystem Services in the Greater Houston Region		(51) Joey Smith - The Seasonality of Nutrients in Stormwater Runoff from Residential Sewershed in Columbus, Ohio
4:15 pm - 4:30 pm	(47) Scott Lowe - The Alternative Headwater Channel and Outfall Crediting Protocol		(52) Kathryn Boening - Hydrological Responses of Retrofitted Green Infrastructure
4:30 pm - 4:45 pm	(48) Wade Burcham - Stabilization Alternatives – Living Walls - Another Choice to Consider		(53) Karina Bynum - Solving the Watershed Challenge Through Optimized Solutions
4:45 pm - 5:00 pm	(49) Cristian Druta - Preventing Animal-Vehicle Crashes Using a Smart Roadside Detection Technology and Warning System		(54) Hunter Freeman - Are Stormwater Regulations Holding Back More Than Runoff? - An Evaluation of Watershed Protection Strategies
5:00 pm - 5:15 pm	(50) Timothy Ormond - Resilient Water Systems for Urban Agriculture: The Patchwork Urban Farms Experience		(55) Christine Pomeroy - Introduction of the Community-Enabled Life-Cycle Analysis of Stormwater Infrastructure Costs (CLASIC) tool
5:15 pm - 5:30 pm	Break		
5:30 pm - 7:00 pm	Career Fair and Poster Presentation Reception with Light Hor d'oeuvres (Salon C and Lobby)		
WEDNESDAY, JUNE 5, 2019			
6:30 am - 8:00 am	Light Breakfast Items - Yogurt & Fruit (For alternative options, see our list of suggested restaurants on the website under "About Asheville" tab)		
8:00 am - 9:15 am	**CONCURRENT SESSION 5**		
	Salon A	Salon B	Windsor Ballroom
Session Title	**Stream Corridor Restoration II**	**Lake & Reservoir Water Quality**	**Stormwater & Green Infrastructure III**
Moderator	Barbara Doll	Marc Beutel	Eban Bean
8:00 am - 8:15 am	(56) Joe Garner - Beginning a Career in Environmental Restoration and Planning: A Perspective for Students Looking to Join the Workforce	(61) Sumaia Islam - Ammonia Oxygen Demand Determination for the Design of an Oxygenation System in a Water Supply Reservoir	(66) Shaddy Alshraah - Soil Tillage for Stormwater Infiltration: Effects of Amendments and Vegetation Type Over Time
8:15 am - 8:30 am	(57) Michael Pannell - Stream Mitigation Design and Construction for an Over Widened Bedrock Channel	(62) Nathan Stoltzfus - Forming Public-Private Partnerships to Identify and Manage Agricultural Fields with Elevated Phosphorus in the Western Lake Erie Basin	(67) Mohammad Nayeb Yazdi - Assessing the Effect of Retention Ponds in Potentially Reducing or Buffering Downstream Loads to the Bay
8:30 am - 8:45 am	(58) Nolan Williams - A Methodology for Developing a Compound Flooding Model Using Long-Term Data Collection and Basic Stochastic Hydrology	(63) Tiffany Messer - Assessing the Water Quality Cocktail Entering Recreational Lakes	(68) Ani Jayakaran - The Role of Porous Asphalt in Stormwater Mitigation in Urban Landscapes
8:45 am - 9:00 am	(59) Paul Le Bel - Effective Stream Restoration Construction Management within Piscataway Creek	(64) Byran Fuhrmann - Mercury Cycling in a Eutrophic Reservoir	(69) Alessandra Braswell - Stormwater Management for Coastal Communities: A Case Study Review
9:00 am - 9:15 am	(60) Joel McSwain - Expanding Asset Protection to Include Stream Restoration Techniques	(65) Melissa Conn - Seasonal Zooplankton Community Structure and Mercury Bioaccumulation in a Hypereutrophic Reservoir	(70) Sarah Waickowski - Hydrologic and Water Quality Impacts of a Green Street Retrofit in Fayetteville, North Carolina
9:15 am - 9:30 am	Break		

9:30 am - 10:45 am	**CONCURRENT SESSION 6**		
	Salon A	Salon B	Windsor Ballroom
Session Title	**Watershed Approaches**	**Water Quality**	**Stormwater - Bioretention**
Moderator	David Sample	Tom Franti	Stacy Hutchinson
9:30 am - 9:45 am	(71) Joshua Robinson - Field-based Assessment of an Urbanized Mountane Headwater Catchment: The Impact of Watershed-wide Green Stormwater Infrastructure Retrofits on Sediment Washload	(76) McNamara Rome - The Case for Cyanobacteria-Based Water Quality Grades	(81) Andrea Ludwig - Thinking Twice About Rock Surface Cover in Nashville-Area Bioretention Applications
9:45 am - 10:00 am	(72) Roderick Lammers - Uniting Stormwater Management and Stream Restoration Strategies for Greater Water Quality Benefits	(77) Jeffrey Kast - Simulating the Role of Manure and Inorganic Fertilizer Applications on Water Quality in the Maumee River Watershed	(82) Thorsten Knappenberger - Bayesian Approach to Assess Stormwater Pollutant Reduction in Bioretention Cells
10:00 am - 10:15 am	(73) Hannah Kuhl - Stormwater and Tidal Hydraulics in an Urban Watershed: Land Use Change Impacts	(78) Fernando Rojano-Aguilar - Use of pH, Conductivity, and Temperature as Tracers to Assess Water Quality Changes in the Kanawha River, West Virginia	(83) Michael Ament - Assessment of Drinking Water Treatment Residuals to Enhance Phosphorus Retention within Green Stormwater Infrastructure
10:15 am - 10:30 am	(74) Cameron Jernigan - Forested Stormwater Wetland Demonstration in Greenville, N.C.	(79) Yin-Phan Tsang - Characterizing Natural Barriers to Non-native Stream Fauna in Hawai'i	(84) Aaron Akin - The Influence of Active Control on Urban Bioretention Systems
10:30 am - 10:45 am	(75) Peter May - The Performance of Two Simultaneously Operated Experimental Algal Floways Supporting Water Treatment on Anacostia River in Prince George's County, Maryland and Washington, D.C.		(85) Whitney Lisenbee - Enhanced Bioretention Cell Modeling: Moving From Water Balances To Hydrograph Production
10:45 am - 11:00 am	Break		
11:00 am - 12:00 pm	**CONCURRENT SESSION 7**		
	Salon A	Salon B	Windsor Ballroom
Session Title	**Stream Corridor Restoration III**	**Special Session - Large Scale Wetland Restoration**	**Value Added Products**
Moderator	John Schwartz	Michael Burchell	Stephanie Lansing
11:00 am - 11:15 am	(86) Amy Longcrier - The Case for More Data	(90) William Crumpton - Potential of Large Scale Wetland Restorations to Reduce Nitrogen Loads to Surface Waters in Iowa	(94) Danielle Delp - Utilizing Algae for the Production of High-Quality Biomethane via Anaerobic Digestion
11:15 am - 11:30 am	(87) Denise Alving - Using University of Maryland Campus Creek as a Study Site for Urban Creek Restoration		(95) David Penn II - An Investigative Study into Biomass Yield Production and Energy Content from Three Feedstocks as a Sustainable Solution for Right-of-Way Management
11:30 am - 11:45 am	(88) Isaac Hinson - Urban Environmental Restoration: Ecological vs. Social Values	(92) John Day - Mississippi Delta Restoration: Ecological Engineering on a Grand Scale	(96) Julia Burmistrova - Feasibility of Anaerobic Co-Digestion to Manage Food Waste and Wastewater Solids from Yosemite National Park, USA
11:45 am - 12:00 pm	(89) Christine Blackwelder - The Reedy Creek Project: A Watershed Scale Stream Restoration Project in Charlotte, NC		(97) John Mueller - The Bio-Intensive Greenhouse Agrodynamic System (BioGAS)

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12:00 pm - 1:15 pm	Lunch (Provided) - Lobby		
1:30 pm - 5:00 pm	**Local Field Tours**		
1:30 pm - 5:30 pm	Field Tour #1 - Ochlawaha Bog (Farmland to Wetland Restoration)		
2:00 pm - 5:30 pm	Field Tour #2 - North Carolina Arboretum (Stormwater Installations, Stream Restoration, and Botanical Gardens)		
2:30 pm - 5:30 pm	Field Tour #3 - UNC Asheville Sustainability Initiatives (Stormwater Installations, Pocket Wetlands, Green Roofs, and Gardens)		
2:45 pm - 5:30 pm	Field Tour #4 - New Belgium Brewery Stromwater Installations and Stream Restoration)		
5:45 - 9:00 pm	Dinner Reception at Smoky Park Supper Club Boathouse (350 Riverside Drive, Asheville, NC 28801)		
THURSDAY, JUNE 6, 2019			
6:30 am - 8:00 am	Light Breakfast Items - Oatmeal and Fruit (For alternative options, see our list of suggested restaurants on the website under "About Asheville" tab)		
8:00 am - 9:15 am	**CONCURRENT SESSION 8**		
	Salon A	Salon B	Windsor Ballroom
Session Title	**Stream Restoration - Functional Assessment**	**Ecological Engineering Curriculum**	**Emerging Technology & Methods**
Moderator	Sara Donatich	Stew Diemont	David Blersch
8:00 am - 8:15 am	(98) Daniel Smith - Do Roots Bind Soil? Comparing the Physical and Biological Role of Roots in Fluvial Streambank Erosion Resistance	(103) Jon Calabria - Educating Emerging Landscape Architects: Proctor Creek Case Study	(108) David Austin - Drawing the Circle Larger: Towards Integration of Heavy Industry with Remediation of Oceanic Dead Zones
8:15 am - 8:30 am	(99) Fouad Jaber - Impact of Riparian Re-Vegetation on Streambank Erodibility and Stability	(104) Mauricio Arias - Seeking Consensus for Ecological Restoration of South Florida Ecosystems in a Water Resources Sustainability Course	(109) Marc Beutel - Biomonitoring Mercury Contamination of the Landscape: Concentrations and Speciation in Tree Bark Near the Abbadia San Salvatore Mining District, Italy
8:30 am - 8:45 am	(100) Jonathan Page - Post-Restoration Monitoring of Stream Restoration Projects: What Have We Learned About Our Design Cross-Sections?	(105) Thomas G. Franti - EcoDesign Class Project: Teaching Ecological Engineering Through an International Project Collaboration	(110) Stephanie Lansing - Effect of Microbial Treatment Processes on Antimicrobial Resistance (AMR): Digestion and Composting
8:45 am - 9:00 am	(101) Brandon Quinn - Investigating Potential of Degradation of Streams in the United States	(106) Annabelle Arnold - The Development of a Chapter of the American Ecological Engineering Society	(111) David Blersch - Performance of 3D Manufactured Substrata in the Algal Turf Scrubber Approach
9:00 am - 9:15 am	(102) Michael Brooker - Functional Potential of Microbial Communities in Agricultural Floodplain Sediments Dominated by Metal Homeostasis and Antibiotic Resistance Genes	(107) Juan Castano - Co-Currence Network Analysis of Keywords in Ecological Engineering	(112) Jacob Mast - Demeter's Abacus: Biological Nutrient Computing
9:15 - 9:30 am	Break		
9:30 am - 12:45 pm	**Closing General Session - Ecological Engineering Perspectives (Salon A & B)**		
Session Title	**Ecological Engineering Perspectives**		
Moderator	Trisha Moore		
9:30 - 9:50 am	(113) Jay Martin - Defining Ecological Engineering Through Research Applications		
9:50 - 10:10 am	(114) Glenn Dale - Applications and Challenges for Ecological Engineering Down Under. An Australian Perspective.		
10:10 - 10:50 am	(115) Mark Brown - Beyond Growth: Economics as if the Planet Matters		
10:50 - 11:15 am	Closing Remarks, Student Poster Awards and Student Design Competition Awards Announced		
11:15 - 12:45 pm	Lunch (provided) and AEES Business Meeting - All Invited (Career Fair Raffle Winners Announced)		
1:00 - 5:00 pm	Post Meeting Rafting Tour (Optional - Additional Fees Apply)		

Business Luncheon Meeting of the American Ecological Engineering Society
Agenda
June 6th, 2019
11:30 am to 12:45 pm
Asheville, NC

1. *Call to order* (Trisha)

Reports:

2. Secretary's Report (5 mins)
    a. Approval of 2019 Minutes
    b. Membership Report
3. Treasurer's Report (5 mins)
4. 2019 AEES Initiatives (5 mins)
    a. Website revamp (recognize Brittany)
    b. Student support (NSF grant)
    c. CED/AED program relook (membership survey)
    d. Cross-society interactions
        i. ASABE
            1. co-sponsoring session at 2019 ASABE annual meeting (Defining Ecological Engineering Through Practice)
            2. standard development
5. Committee reports

New Business:

6. Upcoming conferences (15 mins)
    a. Candidate Conference locations in 2020
        i. University of Maryland (College Park/Baltimore, MD)
        ii. The Ohio State University (Columbus, OH)
    b. 2021
7. Action items to sustain AEES – Discuss initiatives & priorities for 2019-2020 (35 mins)
    a. "Vision document" that aligns with student and young professional development needs
    b. Connecting with other societies (e.g., IEES, EWRI)
    c. Others
8. Request for additional items (if any)
9. Officer election results (5 mins)
10. Transfer to new President and Officers (5 mins)
11. Adjourn until 2020

OPENING GENERAL SESSION

Challenges for a Sustainable Future: Public Engagement is Key

Presenter: Julie Mayfield, Asheville City Council Member and Co-Director, MountainTrue

Abstract: Welcome to a very special region in Appalachia that faces growing challenges such as wildfires, flooding, pollution, and landslides. Sustainable solutions are both human and ecology-based. My work on Asheville City Council has focused on public transit, affordable housing, managing growth, and making the transition to clean, renewable energy. Often, the work is more about connecting people and finding common ground. I've worked with local communities to protect our forests and rivers and to make our region healthier and more sustainable, and I advocate for these same issues with our legislators.

Biography: Julie Mayfield was elected to Asheville City Council in November 2015 and is also co-director of MountainTrue, a regional environmental advocacy organization. Her primary areas of advocacy are transportation, clean energy, affordable housing, and land use. She received her undergraduate degree from Davidson College and her law degree from Emory University School of Law.

History and Future of Ecological Engineering

Presenter: William Mitsch, Endowed Chair and Director of the Everglades Wetland Research Park, Florida Gulf Coast University

Abstract: Ecological engineers is defined as the design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both. The field was developed in 1970s and 1980s with the first book in 1989. Discussion of a national society (AEES) began at a meeting held at Ohio State University in 1999 with the first conference in 2000 in Athens, Georgia. Ecological engineering goals include the restoration of ecosystems that have been substantially disturbed by human activities such as environmental pollution or land disturbance and the development of new sustainable ecosystems that have both human and ecological value. There has been remarkable progress in the development of ecological engineering principles and practices. There is still little application of self-design and problem solving on mega-scale ecological problems that is needed more than ever. It is still not clear if self-design will ever be accepted in the current engineering paradigm. Ecologists, who have not been particularly active in the development of the field or establishment of its academic programs, need to get involved. I agree with Gosselin (2008) who suggests that ecological engineering and sustainable development will "breathe new life" into the old fields of engineering and ecology if we allow it. AEES is leading the way in the world on ecological engineering progress now but limitations now appear to be related to social and disciplinary regulations and lack of acceptance by tradition-bound disciplines.

Biography: Bill Mitsch has been a university professor specializing in wetland and aquatic biogeochemistry and ecological engineering for 44 years at 4 universities in the USA. He is Past President of the Society of Wetland Scientists and American Ecological Engineering Society, the latter which he founded. He is currently Eminent Scholar and Director, Everglades Wetland Research Park, and Juliet C. Sproul Chair for Southwest Florida Habitat Restoration at Florida Gulf Coast University (FGCU) in Naples

Florida where he has been since 2012. He received a B.S. in engineering from the University of Notre Dame, and an M.E. in environmental engineering and a Ph.D. in systems ecology under H.T. Odum, both at the University of Florida. Before his current position at FGCU he taught for 26 years as Distinguished Professor of Environmental Science and continues as Founding Director of the Olentangy River Wetland Research Park at The Ohio State University. He also taught at Illinois Institute of Technology and University of Louisville. He currently holds faculty appointments at University of South Florida, University of Florida, and The Ohio State University.

His over 700 publications include 5 editions of the standard textbook/reference book Wetlands and two books introducing the principles and practice of ecological engineering. He founded in 1992 and served for 25 years as editor-in-chief of the international journal Ecological Engineering. He has given 400 invited presentations around the world on wetlands, ecological engineering and restoration and related topics. including 22 invited talks around the USA and world in 2018. He has also been awarded four Fulbright scholarships for research and teaching in his career in Denmark, Botswana, Poland, and, in 2019, at Bangor University in Wales (UK).

Be Open. Be Positive. Be Courageous.

Presenter: Sepideh Saidi, Sepi Engineering & Construction

Abstract: Abstract not provided

Biography: Sepi Saidi is a visionary leader who founded SEPI Engineering & Construction in 2001 and has led the company to become a premier full service civil, environmental planning, and construction management engineering firm in the Southeast. The firm's awards include Fast 50 firm by Triangle Business Journal, Zweig White Hot Firm List, Inc. 5000, and being ranked as a Top 500 Design Firm on the Engineering News-Record's 2017 list. Incorporating the firm's core values, SEPI is dedicated to providing a unique work space and environment for its employees to plan, design, build, and give back to the communities in which we serve. With a dedicated passion to support organizations that align with the health, safety, and well-being of the families in our communities, Ms. Saidi and the firm are proud to be champions of community service.

A Professional Engineer and alumna of North Carolina State University, with degrees in Civil and Agricultural Engineering, Ms. Saidi has been named by the Triangle Business Journal as the 2018 Businessperson of the Year, was recently selected as a Charlotte Business Journal 2018 Women in Business Achievement Award winner, and has been inducted into the North Carolina Business Hall of Fame.

Dreams to Reality: Recent Experiences Implementing Ecological Engineering Projects

Presenter: Rafael Vazquez-Burney, Jacobs Engineering

Abstract: Nature-based solutions are gaining popularity with decision-makers and stakeholders in all sectors. Challenges such as water supply limitations, flooding, water quality deterioration, decline in ecological functions, and human physical and mental health all drive the need for Ecological Engineering approaches to solving our world's most challenging issues. This presentation will explore recent

examples of multi-functional and multi-beneficial Ecological Engineering projects implemented by both the public and private sector with a focus on the diverse teams needed to convert dreams to reality.

Biography: Rafael is a Professional Engineer and Principal Technologist with Jacobs Engineering in Tampa, FL with 13 years of experience specializing in Natural Treatment Systems for wastewater and stormwater. He attended the University of North Carolina at Asheville and North Carolina State University where he earned a Bachelors Degree in Environmental Engineering and Masters in Civil Engineering with a focus in wastewater treatment, water resources, and numerical modeling of natural systems. Since joining CH2M (now Jacobs) in 2006, he has led numerous projects related to the study, design, permitting, and construction of treatment wetlands. His primary interest is in research and design to improve wetland performance and maximize the benefits and uses of his projects by incorporating ecological engineering principles.

Concurrent Session 1

(1) Lidar and Geomorphic Change Detection: Useful Tools for River Ecosystem Assessment and Restoration Monitoring

Presenter: Robert Dunn, Geosyntec Consultants, Inc., rdunn@geosyntec.com

Co-Authors: David Vance, Geosyntec Consultants, Inc, dvance@geosyntec.com

Abstract: Traditional stream survey methods have long been the preferred method for river ecosystem assessment and monitoring, however, topographic surveys, utilizing newer methods (UAVs, ground-based Lidar, survey-grade RTK GPS, etc) are increasingly becoming more common in river ecosystem assessment and restoration monitoring. UAVs equipped with high-resolution Lidar scanners offer a suite of benefits for river restoration practitioners, including increased spatial coverage and data density, allowing practitioners to repeatedly collect topographic and geomorphic data beyond the traditional reach-scale, with less time than traditional methods. Further, the repeated acquisition of high-resolution topographic surveys over a river ecosystem allows assessment and/or monitoring of geomorphic change to be expanded spatially beyond reach-scale cross-sections and longitudinal profiles.

Employment of Geomorphic Change Detection (GCD) methods to repeat high-resolution topographic surveys of a river system allow practitioners to better understand the geomorphic rate and magnitude of change and how this relates to stream-system processes influencing form and function of a river system, especially in post-restoration scenarios. This presentation will highlight the use of UAV based Lidar in river assessment and monitoring. Additionally, the use of GCD software to generate spatially distributed maps of elevation, volume, and areal change will be presented, which portray a detailed depiction of the magnitude and extents of change at the reach and larger spatial scales.

Biography: Mr. Dunn is a water resource scientist and aquatic ecologist with Geosyntec Consultants out of Atlanta, Georgia. He graduated from Georgia College & State University with a Master's and Bachelors in Biology and has nearly 5 years of natural resource and ecological consulting experience in streams, rivers, lakes, and coastal ecosystems. Mr. Dunn has applied principles of biology ecology, and natural resource management to a range of projects but his passion lies in ecosystem assessment and restoration, particularly fluvial ecosystems, as he as certifications in geomorphic assessment, characterization, and monitoring (Rosgen Levels 1, II, and III). His Experience in high resolution aerial data, including LiDAR and photogrammetry includes utilizing aerial data to evaluate pipeline stream crossing hazards to develop design recommendations to mitigate hydrotechnical/fluvial hazards, performing geomorphic change detection to assess the geomorphological impacts to streams resulting from proposed operational changes at water diversion facilities, and using aerial data for river assessment and monitoring.

(2) Unlocking New Insights into Riverscapes with Drone-Based Laser Scanners

Presenter: W. Cully Hession, Virginia Tech, chession@vt.edu

Co-Authors: Jon Czuba, Virginia Tech, jczuba@vt.edu; Bryan Brown, Virginia Tech, brown51@vt.edu; Erin Hotchkiss, Virginia Tech, ehotchkiss@vt.edu; Nicholas Polys, Virginia Tech, npolys@vt.edu; Peter Sforza, Virginia Tech, psforza@vt.edu; Jonathan Resop, University of Maryland, resop@umd.edu

Abstract: Measurement of physical characteristics across space and time is essential for research and management of aquatic ecosystems. Physical parameters help us quantify and understand channel morphology, aquatic and riparian habitat, biological communities, ecosystem processes, and chemical fluxes, particularly as they relate to potential impacts of environmental change. Accurate measures of physical parameters are key for understanding the links between environmental conditions, aquatic biological diversity, and ecosystem function. This knowledge is particularly important in stream and river systems because biotic indices are used as measures for water quality and to assess the effects of pollution and land-use change. The overall goal of our ongoing research is to develop a methodological framework for collecting and analyzing cm-scale drone-based laser scanner (DLS) or lidar data, processing that data into spatially continuous maps of topography and vegetation that can be integrated with hydrodynamic models, water quality, and biological data to advance our understanding of riverscapes. The resulting high spatial resolution (cm scale) maps of topography and vegetation along with high temporal resolution (30 min) stream flow and water quality data will allow us to simulate how water moves through riverscapes, as well as quantify stream surface area and stream-floodplain connectivity dynamics at scales rarely available for freshwater research. These high-resolution data of the physical riverscape are well suited for integrating with high-temporal resolution sensor data (e.g., temperature, conductivity, turbidity, oxygen, CO2) that is necessary for understanding ecosystem processes. These efforts will reveal new insights into riverine ecosystem functioning. Our methods and results will be embedded into the Fusality framework, an online informatics service that uses a unified 3D spatio-temporal information model to ingest, represent, fuse, and portray a range of data.

Biography: Dr. W. Cully Hession is a professor in Biological Systems Engineering at Virginia Tech. Dr. Hession has worked as an engineer for the State of Virginia and the USDA-Agricultural Research Service, as a professor of Civil Engineering at the University of Vermont, and research leader at the Academy of Natural Sciences in Philadelphia. His research lab focuses on stream channel structure and sediment dynamics, influence of human activities on streams, techniques for measuring and improving in-stream habitat, and development of technologies and strategies for successful stream restoration. Recently, we have expanded into the following areas of research: floodplain dynamics; groundwater/surface water dynamics; UAVs for stream and floodplain mapping, visualization techniques for watersheds & monitoring data; and antibiotic resistant gene & bacteria transport in the environment. He is a Professional Engineering in Virginia and a Certified Ecological Designer (AEES).

(3) High Definition Stream Surveys: A Better Way to Prioritize Your Streambank Restoration Projects

Presenter: Brett Connell, Trutta Environmental Solutions, brett.connell@truttasolutions.com

Abstract: The High Definition Stream Survey (HDSS) approach was created to gather continuous geo-referenced video and in-stream data in a single pass. This enables faster evaluation of a broad range of in-stream and streambank conditions. The video and data are combined to create a virtual tour with four simultaneous views of a waterway (front, both banks, underwater). If the focus is stream restoration prioritization then every meter of streambank can be rated pursuant to BEHI standards and tied to GPS points overlaid on a waterway map. The resulting map highlights not only high priority restoration areas, but also areas that should be protected against future disturbance. HDSS is also a better way to document baseline conditions, monitor restoration results, assess in-stream habitat, document geomorphic conditions, identify current and potential infrastructure impacts, and provide a powerful "virtual tour" experience for stakeholder groups.

The clear advantages of HDSS over traditional assessment methods was demonstrated when we surveyed 125 miles of the Duck River in eight days using a team of two. The time saved enabled us to gather bathymetric measurements to update reservoir capacity and plan for future droughts. By the end of the survey, we had continuous video and in-stream data for all 125 miles of river at approximately one meter resolution. Traditional sample-based collection typically involves more people gathering limited data samples along a few very short sections of river at easy access points (typically bridge crossings and boat ramps), and extrapolating data in between. Such surveys typically cover less than 5% of a waterway, which means important water resource decisions are made with incomplete data. Fewer people, more coverage and less field time results in lower costs.

Biography: Mr. Connell specializes in the development and application of innovative technologies that help solve difficult water resource management problems. He earned his M.S. in Biosystems Engineering Technology from the University of Tennessee, a B.S. in Environmental Science from the University of Toledo, and an Associates Degree in Fisheries Management and Aquaculture from Hocking College.

(4) GatorByte: An Open Source Platform for Low-Cost, Real-Time Water Resource Monitoring

Presenter: Eban Bean, University of Florida, ezbean@ufl.edu

Co-Author: Piyush Agade, Program for Resource Efficient Communities, University of Florida, pagade@ufl.edu

Abstract: Urban water resources are increasingly becoming impaired across the United States due to urbanization, legacy stormwater infrastructure, and limited efficiency of current practices. The term 'Urban Stream Syndrome' was coined to reference the degraded condition of urban streams. Small and medium MS4 communities bear most of the burden of local governments to enact plans to restore these waters. However, competition for limited resources often constrain efforts to assess their water resources, let alone monitor them. Infrequent grab sampling provides a limited view of the overall water quality and flow dynamics. Off-the-shelf continuous monitoring systems are generally cost-prohibitive or

limit spatial distribution of monitoring resources. Until recently, the cost of communications could also be limiting, but the convergence of 1) lower cost solar and power storage, 2) rise of IoT – particularly in the DIY community, 3) advancements in microcontrollers, and 4) availability of customized printed circuit boards has allowed for the reality of low cost, real-time water quality monitoring. The convergence of these developments offers the opportunity to lower the cost of real-time water resource monitoring, and increase the spatial distribution to provide actionable information to these communities. GatorByte is a platform developed to provide the public with the technology and resources to collect actionable information on water resources. The hardware is built on the particle microcontroller and incorporates solar charging, Li-Po battery, cellular communications, SD card storage (backup), and small form factor, costing $1,000-$2,000 per unit. Sensors include temperature, conductivity, dissolved oxygen (DO), and pH, with optical DO, turbidity, NO3, and NH4 being incorporated soon. The second configuration adds a GPS receiver and a water-tight (IP-66) housing for collecting spatially distributed water quality data. Parts list and links, sensor performance and cost comparison, build instructions and videos, and cloud connected data visualization site are also in development.

Biography: Dr. Eban Bean is an Assistant Professor and Extension Specialist of Urban Water Resources Engineering at the University of Florida (Gainesville, FL) in the Agricultural and Biological Engineering Department. He is also a faculty member in the Program for Resource Efficient Communities and the Center for Landscape Conservation and Ecology. Dr. Bean has been working in water resources and water quality for the past 15 years, with a focus on design and evaluation of stormwater control measures (SCMs) for retention and pollutant removal. Prior to his current position, he was an Assistant Professor of Environmental Engineering at East Carolina University (2012-2016; Greenville, NC) and a Senior Staff Engineer at Geosyntec Consultants (2010-2011; Kennessaw, GA). Dr. Bean received his Bachelors (2003) and Master's (2005) degrees from North Carolina State University and received his Ph.D. from the University of Florida in Agricultural and Biological Engineering in 2010.

(5) A New Methodology to Assess the Ecosystem Service Potential of Urban Rivers in Developing Countries

Presenter: Jochen Hack, TU darmstadt, hack@geo.tu-darmstadt.de

Abstract: Natural rivers in urban areas bear significant potential to provide ecosystem services for surrounding inhabitants. However, surface sealing by houses and street networks, urban drainage, disposal of waste and wastewater resulting from advancing urbanization usually lead to deterioration of urban rivers and their riparian areas. This ultimately results in the loss of ecosystem service provision. This paper presents an innovative methodology for a rapid and low-cost assessment of the ecological status of urban rivers and riparian areas in developing countries under data scarcity conditions. The methodology uses a combination of low-cost field data and freely available high resolution satellite images to assess three ecological status categories: river hydromorphology, water quality and riparian land cover. The focus here is on the assessment of proxies for biophysical structures and processes representing ecological functioning that enable urban rivers and riparian areas to provide ecosystem services. These proxies represent a combination of remote sensing land cover- and field-based indicators. Finally, the three ecological status categories are combined to quantify the potential of 100 m river sections to provide regulating ecosystem service. The development and application of the

methodology is demonstrated and visualized for each 100 m section of the Pochote River in the City of León, Nicaragua. This spatially distributed information of ecosystem service potential of individual sections of the urban river and riparian areas can serve as an important information for decision making considering the protection, future use and city development of these areas as well as the targeted and tailor-made development of nature-based solutions such as green infrastructure.

Biography: Professor of Ecological Engineering and Leader of the inter- and transdisciplinary Research Group "SEE-URBAN-WATER" at the Institute of Applied Geosciences of the Technical University of Darmstadt. He has several years of experience of cooperation and exchange in teaching and research with Latin American universities through teaching, supervision of master's and doctoral students, excursions and coordination of different exchange programs. His research focuses on Integrated Water Resources Management (IWRM), urban hydrology and green infrastructure solutions / sustainable urban drainage systems, socio-ecology of urban rivers, assessment of hydrological ecosystem services and development of compensation mechanisms. Geographically it deals mainly with Latin America, in Central America specifically.

(6) Treatment Wetlands in Practice and Lessons Learned

Presenter: Scott Knight, Wetland Solutions, Inc., sknight@wetlandsolutionsinc.com

Abstract: Constructed treatment wetlands represent one of the successes of ecological engineering and have been widely applied to address a range of water quality problems. Additionally, treatment wetlands and other forms of ecological engineering can have the benefit of offering excellent ancillary benefits to both the public and wildlife. This presentation will focus on the application of a 120-acre groundwater recharge wetland to remove nutrients (and particularly nitrogen) in a treated wastewater effluent in North-Central Florida. This project converted an existing effluent sprayfield for the purpose of providing enhanced water quality treatment in water recharged to the Floridan Aquifer that daylights in artesian spring flows. This presentation will discuss the development of this project from a concept through the design, modeling, and project assumptions. The presentation will then discuss the construction, post-construction treatment performance, wetland operations, and challenges that were realized during and after the project was implemented. The final focus of the presentation will be on lessons learned during this and similar projects which will be interspersed in an effort to encourage improved application of ecological engineering concepts in practice. Questions and discussion will be encouraged.

Biography: Scott is a practicing water resources engineer who has worked on a wide variety of projects during his 14-year career. This has included floodplain management, hydrologic and hydraulic modeling, water quality modeling, water rights and consumptive use modeling, treatment wetland design, biological monitoring, springs ecology and sampling, and water quality monitoring. Scott's doctoral research focused on water use in the context of residential irrigation and improving the understanding of water use in the urban context. Scott currently works for Wetland Solutions, a small consulting firm that specializes in constructed treatment wetland design and environmental monitoring.

(7) Breathing New Life into a 25 Year Old Wastewater Treatment Wetland

Presenter: Michael Burchell, II, North Carolina State University, michael_burchell@ncsu.edu

Co-Author: Brock Kamrath, North Carolina State University; Jack Kurki-Fox, North Carolina State University

Abstract: Constructed wetlands are a great example of Ecological Engineering because they can provide a wide range of pollutant treatment even though limited amounts of fossil fuels are needed to build and operate these systems. However, operators of these systems often view them as nearly maintenance free, which is not the case. Lack of periodic maintenance can result in poor hydraulic performance that leads to reduced treatment efficiency. Many of these systems were constructed during the late 1990s to treat various pollutants, but are often used in tertiary treatment of domestic wastewater, particularly in smaller towns. A survey of existing systems in NC show many that do not have periodic maintenance and detrital buildup is a major problem. The pollutant treatment efficiency and internal hydraulics of a 2 cell treatment wetland in north central NC has been recently studied. This presentation will provide an overview of the signs and causes of a failing constructed wetland and the steps taken to return the wetland to its original treatment performance.

Biography: Michael R. Burchell II, Ph.D. is an Associate Professor and Extension Leader in the Department of Biological and Agricultural Engineering at North Carolina State University. Since 2003, he has been involved in research and outreach in the areas of wetland restoration, riparian buffers, constructed wetlands, innovative methods for stormwater treatment, and agricultural drainage water management. One of his main program goals is to improve design and implementation techniques of ecological engineering projects to maximize ecosystem services, particularly water quality improvement.

(8) Nitrate Design Challenge: Can Surface Flow Wetlands Reduce Nitrate in Cold Water by Induced Electrical Currents?

Presenter: David Austin, Jacobs, david.austin10@jacobs.com

Abstract: Nitrate pollution of estuaries and coastal regions creates algae blooms and is the principle culprit in the formation of oceanic dead zones. Natural and engineering wetland systems have a mixed record of nitrate removal in the watershed. The problem is that heterotrophic denitrification, in which organic carbon donates an electron to reduce nitrate, is negligible in cold water.

Chemoautolithotrophic denitrification, in which hydrogen sulfide donates an electron to reduce nitrate, is relatively cold insensitive. Thiobacillus denitrifications, a model organism for chemoautolithotrophic denitrification, just needs electrons to reduce nitrate. The donor source is irrelevant. If not practical to provide electrons with hydrogen sulfide, why not provide them with an electrical current?

In benchtop experiments, low current densities of around 20 – 50 mW/m2 have substantially reduced nitrate concentrations in subsurface flow wetlands (SSF). These microbial electrical technologies (METlands) have shown promise at experimental scales. Evolving this technology to large scales requires adapting them to surface flow wetlands. Few SSF wetlands process more than 4,000 m3/d of wastewater and then only at great cost and continual risk of clogging. In contrast, many surface flow (SF) wetlands process 10 to 100 times that flow of wastewater or stormwater.

As there is negligible resistance to electrical currents in wetland soils, SF wetlands are potentially ideal reactors to induce electrical fields with arrays of anodes and cathodes. It may be possible to employ higher current densities than used in METlands provided the current source is non-homogeneous square waves as are employed used in human-safe electrical fish barriers.

The challenge in this presentation is to create the first surface flow METland. Although currently a hypothetical concept, a pilot scale system would be relatively simple to construct in non-conducting troughs. Concepts and encouragement in this endeavor are the goal of this presentation.

Biography: David Austin is the lead technologist for Natural Treatment Systems in Jacobs Engineering Group. He is an environmental P.E. (MN), Certified Senior Ecologist (Ecological Society of America), Certified Lake Manager (North American Lake Management Society), and a past President of the American Ecological Engineering Society. His projects concentrate on reservoir management, treatment wetlands, wastewater reuse, and mine water reclamation. Previously, he was a marine salvage and diving officer in the Navy. Degrees: Mathematics (BA, UM-Twin Cities), Water Resources Management (MS, UW-Madison), and Civil & Environmental Engineering (MS, UC-Davis).

(9) Oxygenation: Yes or No? Anoxia is Vital for Wetlands Pollution Treatment But Deadly for Lakes, Rivers, and Ocean Cleanups

Presenter: Alex Horne, University of California – Berkeley, anywaters@comcast.net

Abstract: The self-sustaining anoxia of leaf litter layer is vital for pollution removal in wetlands. However, anoxia (dead zones) are undesirable for most oceans, lakes, reservoirs, stream and rivers, most of an estuary, and many smaller oceans. The new anoxia is mostly due to increases algal growth and subsequent decomposition on the sediments using up more oxygen than is naturally available. The scale of the needed restoration is enormous: there may be a million freshwater and over 500 ocean or estuarine dead zones created by human activities over the last 500 years. We can reverse the anoxia by constructing nutrient removal wetlands on land, but, with a few exceptions, this challenge has not been widely taken up by Ecological Engineers. A direct engineering solution is artificial replenishment of the oxygen demand using pure oxygen additions. The process is simple and mostly fool-proof but has not been sustainable… until the advent of large, inexpensive ocean wind turbines. Examples will be given for Direct Oxygenation of a large reservoir, the Savannah River Estuary, and proposed solutions to the Baltic Sea and the Gulf of Mexico.

Biography: Dr. Alex Horne was an Ecological Engineering professor at UC California, Berkeley for 32 years. His work has been on water pollution control on all 7 continents and most oceans. He first demonstrated reversal of eutrophication in a large reservoir by the addition of pure oxygen to the hypolimnion. He also designs wetlands to remove selected contaminants from whole rivers. He has over 300 publications and the undergraduate textbook, Limnology. Hobbies include his rock & roll band Mo' Waters.

(10) A Floating Island Treatment System for Removal of Phosphorus from Surface Waters

Presenter: Mark Brown, Howard T Odum Center for Wetlands/University of Florida, mtb@ufl.edu

Co-Authors: Treavor Boyer, Arizona State University; R.J. Sindelar, University of Montana; Sam Arden, University of Florida; Amar Persaud, University of Florida; Sherry Brandt-Williams, St. Johns River Water Management District, Palatka, FL

Abstract: The goal of this project was to design, build and test a pilot-scale floating treatment system for Total Phosphorus (TP) removal from nutrient impaired lakes in Florida, USA. The treatment system consisted of biological and physical-chemical treatment modules. First, investigations of prospective biological and physical-chemical treatment processes in mesocosms and in bench-scale experiments were conducted. Thirteen mesocosms were constructed with a variety of substrates and combinations of macrophytes and tested for TP and PO4 removal efficiencies and areal removal rates. Bench- scale jar and column tests of seven absorptive media, and three commercial resins were conducted to test absorptive capacity. Once testing was complete, a floating island treatment system (FITS) was designed and deployed for 8 months in a lake in Central Florida,.

Removal efficiencies of the mesocosms systems averaged about 40-50%, providing an average uptake of 5.0 g P m-2 yr-1 across all mesocosms. The best performing mesocosms were a submerged aquatic vegetation (SAV) mesocosm and an algae scrubber (AGS) removing 20 and 50 mg P m-2 day-1 for an average removal of 5.5 g P m-2 yr-1 and 12.0 g P m-2 yr-1 for the SAV and AGS systems respectively. Of the absorptive media, the best performance was alum residual, reducing PO4 concentrations by about 75% after 5 minutes of contact time. Of the commercial resins tested, the PhosX resin was superior to the others tested, removing about 40% of P after 30 minutes and 60% after 60 minutes. Under baseline operation conditions during deployment, the FITS exhibited mean PO4 removal efficiencies of 53% and using the 50th and 90th percentile of PO4 removal during deployment, and the footprint of the FITS system, yielded efficiencies for the combined FITS system of 56% and 86%, respectively, and areal removal rates between 8.9 and 16.5 g P m-2 yr-1.

Biography: Dr. Mark Brown is Emeritus Professor of Environmental Engineering Sciences and Director of the Center for Environmental Policy at the University of Florida. He is a systems ecologist, whose research focuses on systems ecology, emergy analysis, environmental policy, ecological engineering, and wetlands ecology. Current and past research includes applied and theoretical approaches to understand the urban nexus, the interface of energy, environment, and economics. He has served as consultant on development and sustainability issues to the USEPA, USAID, UNEP, and numerous Governments and private consulting firms worldwide. In his career at the University of Florida, he has mentored 45 PhD students and 64 master’s degree students.

(11) Wine in the Trees: Learning Adaptation to Climate Change from Traditional Viticulture Agroforestry in Portugal

Presenter: (11) Stew Diemont, SUNY – College of Environmental Science and Forestry, sdiemont@esf.edu

Abstract: The Greeks started it (2500 years ago). The Etruscans borrowed it (2000 years ago. The Romans transported it (1500 years ago). Traditional farmers in northern Portugal use it (today). The system: growing grapes up and between trees that border a diverse agroecosystem. The problem it

addresses: climate change is leading to water and heat stress of vineyards throughout the world. These traditional Portuguese viticulture systems do not need irrigation, unlike the conventional row cropping near them. It is possible that trees supporting grape vines are hydraulically redistributing water from deep zones to relatively shallow grape roots. Measurements of soil moisture and temperature conducted last year indicate that soil near trees is wetter and cooler, supporting this hypothesis. I will describe these traditional viticulture systems and how they could contribute to climate change adaptation, interview and soil fieldwork conducted, next stages of work, and how traditional systems such as these advance ecological engineering.

Biography: Stew Diemont is a past-President of the American Ecological Engineering Society. He is an Associate Professor in the Department of Environmental and Forest Biology at the State University of New York, College of Environmental Science and Forestry. He works often with indigenous and local people to better understand how traditional knowledge can be part of ecosystem design. With his students and the people of communities with whom he researches, he has studied soil, plants, fungi, insects, and birds, as well as talked much about traditional ecological knowledge and ecosystem design. He has worked with Mayan communities in Mexico, Belize and Guatemala; Zapotec in Mexico; Haudenosaunee of New York; and with traditional vineyard growers in Europe. He is particularly interested now in how food can be a part of ecological engineering in cities and rural areas.

(12) Have Your Creek and Eat It Too: Productive Food Forest Systems for Riparian Buffers

Presenter: Timothy Ormond, Blue Earth Planning, Engineering & Design, PC, tormond@blueearth.us

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

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

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

This presentation will provide an overview of food forest systems and focus on their application within riparian buffers. Key concepts of food forest systems including forest layers and plant guilds will be discussed, along with examples of polycultures and plant species with potential economic yields. Regional applications of food forest systems within riparian corridors will also be presented along with recommendations for future research.

Biography: Tim Ormond, P.E. is an Asheville-based environmental and water resources engineer with over two decades of experience. He specializes in hydrology and hydraulics, stormwater management, green infrastructure planning and design, and innovative research. Tim holds a B.S. degree in civil and environmental engineering, an M.S. degree in civil and water resources engineering as well as a permaculture design certificate. He is a licensed professional engineer in North Carolina, Tennessee, Texas, Massachusetts, and California. He is a co-founder of Blue Earth Planning, Engineering & Design, PC, a consulting firm which focuses on sustainable and regenerative design that is mindful of the interconnections of the water cycle, ecosystems, and people.

(13) Solving the Grand Challenges of Harmful Algal Blooms with Wetlaculture

Presenter: William Mitsch, Everglades Wetland Research Park, Florida Gulf Coast University, wmitsch@fgcu.edu

Co-Authors: Bing Bing Jiang, School of Geosciences, University of South Florida, bingbingj@mail.usf.edu; Sam Miller, Mendoza School of Business, University of Notre Dame, miller.549@nd.edu; Li Zhang, Everglades Wetland Research Park, FGCU, Naples, lzhang@fgcu.edu; Bhavik Bakshi, Chemical and Biomolecular Engineering, The Ohio State University, bakshi.2@osu.edu

Abstract: Humans have caused both landscape change and climate change, leading to ecological calamities around the world in freshwater and coastal waters. Harmful algal blooms (HABs), more common and wicked because of excessive and non-stop fertilization and runoff from farms and urban areas, are accelerated by increased water temperatures. We have also changed our landscapes by draining wetlands that could help with nutrient retention and carbon sequestration. The world has lost 87% of its wetlands, with half of that loss occurring in the 20th century alone. A nutrient recycling approach applicable to landscapes around the world called “wetlaculture” (wetlands + agriculture) could help solve downstream nutrient pollution problems while decreasing the amount of fertilizers added to landscapes. We have established field physical models, two in temperate Ohio and one in subtropical Florida, for estimating the amount of time needed for wetlands to accumulate nutrients before flipping the land to agriculture. In addition, our early business model suggests that farmers could make profits comparable to crop by receiving payment for ecosystem services (PES) coupled with public Environmental Impact Bonds sold to investors.

Biography: Dr. Mitsch is Endowed Chair and Director of the Everglades Wetland Research Park, Florida Gulf Coast University in Naples Florida. He has been a professor for 43 years at 4 universities, most at The Ohio State University. He has over 700 publications in wetlands/water quality, and ecological engineering including 5 editions of Wetlands. He received his Ph.D. in systems ecology at University of Florida and has advised, with thesis or dissertation, 79 graduate students. He was awarded the Stockholm Water Prize in 2004 and is currently Chair of the U.S. National Ramsar Committee.

(14) ~~Evaluation of a Biological Filter and a Hydroponic System of Lettuce for the Treatment of Wastewater from an Aquaculture Re-circulation System for the Production of Tilapia~~ – CANCELLED

Presenter: Yadir Simón Rodríguez Núñez, University of Costa Rica, yadir.rodriguez@ucr.ac.cr

Co-Authors: Ronald Esteban Aguilar Álvarez, University of Costa Rica, ronaldesteban.aguilar@ucr.ac.cr

Abstract: Agro-industry consumes 70 % of the fresh water for food production. For example, 50 % of fresh water is changed daily in intensive production systems (100 tilapias/m3). Negatively, wastewater from this system is delivered into the environment without any treatment. Intended to protect the water resource, this project proposes the implementation of aquaponic recirculation systems (ARS). ARS combines fish and vegetable production while saving fresh water by the treatment and recirculation of the water in the production system. In this study, the ARS consists of a circular fish tank (52 Oreochromis niloticus in 1.49 m3), sump tank (1 m3), a water pump, a biological filter (BF), and a hydroponic system (52 lettuces evenly distributed in 4 -2 m length- PVC beds). The BF and the HS work in parallel treating the water from the fish tank. The aim of this project was to determine the treatment efficacy of the BF and HS working on parallel; it was speculated that the system only requires the HS, reducing costs as the BF is expensive. During nine weeks, fish and vegetable growth were measured. Water quality parameters (NO2-, NH3, pH, Temperature, etc) along the ARS were measured to determine treatment efficiency. Results indicated that the water in the fish tank was under needed conditions for fish production (0.04 mg/l of NO2-, 0.11 mg/l of NH3, pH 6.35, 22.22 °C, etc). Fish growth rate was 7.77 g/week. Lettuce growth rate was 1.61 cm/week. No significant differences were found between the BF and the HS; however, trends indicated that better treatment occurred at the HS. The ARS saved 94.3% of fresh water. There is a need of properly managing the water resource and this work promote this kind of smart-food production in rural Costa Rica.

Biography: Bachelor of agricultural engineering and biosystems at the University of Costa Rica. He is currently finishing his final graduation work to obtain a bachelor’s degree in agricultural engineering and biosystems at the same university.

(15) ~~Protecting the Water Resource in Costa Rica~~ – CANCELLED

Presenter: Ronald Aguilar, University of Costa Rica, ronaldesteban.aguilar@ucr.ac.cr

Co-Authors: Mercedes Azofeifa, University of Costa Rica, sumazofeifap@gmail.com; Yadir Rodriguez, University of Costa Rica, yadirrn@gmail.com; Johel Venegas, University of Costa Rica, johel.venegas@gmail.com; Carlos chaves, UNED, cchaves@uned.ac.cr

Abstract: Given the effects of climate change, it is necessary to work on the protection of water resources to enable future generations to solve our planet’s grand challenges. The Department of Biosystems Engineering at the University of Costa Rica is promoting alternative systems for the adequate management of water. This work presents the approaches to assure 1) potabilization, 2) efficient use of water in food production, 3) wastewater treatment, and 4) landscaping restoration. Regarding potabilization, coverage in Costa Rica is greater than 90%; however, inhabitants in rural areas

do not have access to drinking water. Therefore, we are working on the development of household scale water purification system that meets the standards of potable water. Regarding the efficient use of water in food production, aquaponics is being implemented as an intelligent system for water management. With low water consumption, families and communities in rural areas can sustainably produce fish and vegetable. Regarding the treatment of wastewater, Costa Rica presents serious problems of operation and maintenance of conventional treatment plants. Negatively, surface and subsurface water bodies are seriously impacted. Therefore, the implementation of artificial wetlands is promoted as alternative systems to complement current wastewater treatment plants. In addition, wetlands are promoted for individual systems in homes and communities in rural areas. Finally, regarding landscaping restoration, work is being done on the restoration of artificial lakes in the cities, which present a deplorable state and threaten the health of the population that uses these spaces for recreation. For example, we analyze the current situation of these lakes to implement restoration techniques that promote ecosystem services. The results of these case studies have shown us that the sum of each effort in protection of water resources will promote resilient systems to face climate change, so as to ensure water resources for future generations.

Biography: I was born in 1984 in Costa Rica. In 2010, I graduated as an agricultural engineer from the University of Costa Rica. Since 2010, I am part of the faculty of the Biosystems Engineering School. During the period from 2012 to 2017, I completed my doctoral studies at the School of Biosystems Engineering at Michigan State University and, since 2018, I rejoined the University of Costa Rica. I enjoy the research of water treatment techniques to ensure water provision to future generations.

CONCURRENT SESSION 2

(16) Urban Stream Restoration: An Evaluation of Conveyance and Material Processing Channels

Presenter: Maddie Berg, James Madison University & Stantec, mber2223@gmail.com

Abstract: Due to the recent interest in stream restoration to help the Chesapeake Bay, this study was undertaken to evaluate the in-stream effectiveness of two restoration practices: conveyance channels and material processing channels. Ten streams, five of each restoration practice, were evaluated in terms of organic retention and macroinvertebrates. The upper and lower reaches of each stream were sampled with transects to measure organic retention percent cover and sampled with two methods for macroinvertebrates. Despite each site being evaluated only once during the summer of 2018, which was the highest rainfall on record in Maryland, trends were still apparent. Material processing channels had significantly higher organic retention compared to conveyance, as they had a larger average hydraulic radius and a greater presence of woody debris. Focusing on macroinvertebrate sampling methods, traditional kick-net sampling compared to novel habitube sampling collected similar species richness. Abundance varied greatly, though habitubes collected higher average abundance compared to traditional sampling. Results from this study suggest that urban stream restoration practices can impact organic retention within streams as well as the ability to provide the best habitat for in-stream biota. When designing streams to reduce downstream impacts, material processing channels should be considered as they retain organic matter and work to provide habitat potential. Due to similar species

richness collections across all reaches, habitubes have the potential to be a valid future sampling technique. This, or a similar study, should be continued over multiple years through different seasons to see if the trends persist or get stronger as the site ages.

Biography: Bachelor of Science obtained from California University of Pennsylvania (Spring 2017) after studying environmental science. Currently wrapping up a biology Master's at James Madison University (Spring 2019), with a thesis focused on urban stream restoration (an evaluation of conveyance and material processing channels). After graduation (May 2019) I will working at Stantec as an environmental scientist.

(17) Emerging Concepts in River Restoration Design and their Application and Adaptation to Headwater Stream Restoration Projects in the Southeast

Presenter: Dan Sweet, RES, dsweet@res.us

Abstract: River Restoration is a rapidly evolving multidisciplinary practice that has seen significant developments in recent decades including emphasis on both floodplain and base flow channel integration. Despite this progression, the field is still dominated by the implementation of single thread bankfull transport channels with an emphasis on geomorphic stability.

Emerging concepts in river restoration include recognition and incorporation of biotic drivers such as vegetation, wood, and beaver ecology. In conjunction, there is growing emphasis on anastomosing or anabranching stream types. Concepts such as stage zero, which is both a channel evolution model (CEM) and an implementation approach, river discontinuum theory, process-based restoration, string and bead theory, stream evolution corridors (SEC), and beaver dam analogs (BDAs) are increasingly put forth in published literature and are making their way into project implementation in the Pacific Northwest and the Colorado Front Range.

These principles and practices are still largely absent in east coast projects. This presentation reviews the literature and theory behind these emerging concepts and provides case studies of several large headwater stream mitigation projects in the Southeast where these practices are being adapted and applied. Implications for climate resilience both in terms of carbon sequestration and water table/baseflow augmentation are also discussed.

Biography: Dan Sweet is a stream restoration practitioner with 20 years of experience working primarily on headwater streams in the Mid-Atlantic and Southeast. Dan is fortunate to have developed a childhood past time building dams in creeks to catch crayfish into a fulfilling career playing in the river.

(18) Stream Restoration Using All Wood Structures

Presenter: Chris Streb, Biohabitats, cstreb@biohabitats.com

Co-Authors: Doug Streaker

Abstract: The use of wood in stream restoration structures is a logical refinement of stream restoration techniques in the Mid-Atlantic. Wood is a natural renewable resource, is less costly than the current preferred building material, and is a common feature in stream stability. With few exceptions in stream restoration in the Mid-Atlantic, wood has played a secondary role to rock in bed and bank stability

design. Adding wood to riffle features to improve their habitat quality, using buried wood as a bank stabilization and habitat improvement feature, using rootwads to attenuate velocities and improve bank cover are all highly valued applications of wood in stream restoration. In general, rock weir features and boulder walls are the designers 'go to' solutions in high flow conditions. We will describe a recently completed project in Anne Arundel County that uses driven pile and engineered wood structures to restore ~4100-ft of headwater stream. We will discuss design, regulatory, and construction elements and provide a roadmap for designers and contractors interested in considering the increased reliance on wood structures in their stream restoration designs.

(19) Who Gives a Dam? Removing Barriers to Aquatic Organism Passage One Step at a Time

Presenter: Greg Jennings, Jennings Environmental PLLC, greg@jenningsenv.com

Abstract: Connectivity is a fundamental requirement for optimal stream function. Barriers to aquatic organism passage (AOP) are often associated with impoundments, road crossings, and utility crossings. Ecological impacts of these structures include habitat loss in the channel and floodplain, excessive erosion and sedimentation due to hydraulic adjustments, and changes to the natural fluvial sediment transport regime. Remediation measures may include complete structure removal and restoration of the natural ecosystem or a combination of engineering practices to improve stream conditions while maintaining infrastructure functions. This presentation reviews several case study projects that successfully implemented natural stream enhancement techniques to address AOP barriers. Some projects include replacement of undersized and perched culverts with natural bottom crossing structures, while others removed unnecessary dams and culverts entirely. Most of the projects include natural stream bed structures consisting of rocks and logs to transition bed slope from upstream to downstream while facilitating aquatic organism passage. These step structures are critical elements of AOP projects that may be designed as step-pools, cascades, or riffles depending on site conditions and organism requirements. Specific design parameters include step height, flow depth, velocity, shear stress, and hydraulic convergence/divergence length. Design teams must include hydraulic engineers, geomorphologists, and ecologists to ensure that all stakeholder objectives are achieved. Construction teams must be experienced and qualified to install sustainable natural stream restoration measures. Lessons learned from AOP enhancement projects should be integrated into watershed planning to restore stream functions and to avoid future impacts of development infrastructure.

Biography: Dr. Greg Jennings founded Jennings Environmental PLLC following his retirement from the engineering faculty of North Carolina State University in 2013 to apply ecological engineering solutions to address environmental challenges. He has provided leadership and technical support for planning, implementation, and evaluation of 250 ecosystem assessment and restoration projects, including more than 40 miles of stream restoration. Greg is committed to advancing the science and practice of ecological engineering through collaborations with Universities, governments, and practitioners on demonstration and education projects.

(20) The Whole is Greater Than the Sum of Its Parts' – Aristotle

Presenter: Andy Brown, Trout Unlimited, andy.brown@tu.org; Jake McLean, Wildlands Engineering, jmclean@wildlandseng.com; Brady Dodd, National Forests in North Carolina, bdodd@fs.fed.us; Scott Loftis, North Carolina Wildlife Resources Commission, scott.loftis@ncwildlife.org

Abstract: The US Forest Service, NC Wildlife Resources Commission, Trout Unlimited and Wildlands Engineering will present the big picture and some key details in their collaborative efforts to re-connect and restore coldwater habitat in western NC on both public and private lands. Each of these organizations has great individual strengths as well as limitations in the management of the coldwater resource. Combined, they have made exponentially more progress in improving water quality and expanding habitat for aquatic species than they could have ever done alone. This is important ecologically, economically and to quality of life of the region: trout fishing contributes $383 million annually to the state's economy; over a dozen municipalities get their drinking water from just two of their conservation focal areas. Our presentation will focus on how we are utilizing citizen scientists to help identify and prioritize sites for corrective action and the ecological engineering designs we are employing to put effective conservation on-the-ground. We will take the audience through our broader focal area planning so that they can see the linkages we attempt to create among conservation projects so that benefits can accrue throughout a watershed. We will end by focusing on a few sites to present design-details on aquatic organism passage using stream simulation design, a US Forest Service developed ecological engineering technique that they are eager to share.

Biographies: Andy is Trout Unlimited's Coldwater Conservation Manager for the Southern Appalachian Region. Andy collaborates with private and public landowners, public land management agencies, TU members and other nonprofit conservation groups to develop and implement conservation projects that reconnect, restore and protect aquatic habitat for the benefit of native and wild trout populations and the associated ecology. Typically these projects involve constructing aquatic organism passage stream crossings at road/waterway intersections, remediating eroding roads and trails adjacent to streams, removing livestock from trout streams and replanting riparian areas to protect and keep trout waters cold.

Jake is a Senior Water Resources Engineer and the Asheville Team Leader for Wildlands. Jake has 17 years of experience working in the public and private sector on ecological restoration, stormwater and green infrastructure design, watershed planning, floodplain management, hydrologic/hydraulic analysis, scour and sediment transport analyses, and greenway & paddle trail projects. He has worked on aquatic organism passage projects involving dam and culvert removal, retrofit projects to replace old and undersized structures, and new crossings.

Brady is the Forest Hydrologist with the National Forests in North Carolina. Brady serves in a number of roles as hydrologist in national forest lands planning and management. Specific to this presentation, Brady develops and implements watershed restoration action plans to help protect, restore and manage water quality and quantity on the Pisgah and Nantahala National Forests in western NC.

Scott is the Mountain Aquatic Habitat Coordinator with the NC Wildlife Resources Commission. Scott has over 25 years' experience developing, planning, supervising construction and monitoring the biological effectiveness of aquatic organism passage and stream restoration projects to benefit the state's inland fisheries and non-game aquatic species, particularly in western NC.

(21) The 4G Ranch Wetlands: Operating for Our Future

Presenter: Allison Lewis, Jacobs, allison.lewis@jacobs.com

Co-Authors: Rafael Vazquez-Burney, Jacobs Engineering, Rafael.vazquez-burney@Jacobs.com

Abstract: In 2017, the largest groundwater recharge wetland in the world, known as the 4G Ranch Wetlands, was constructed in Pasco County. Groundwater recharge wetlands are constructed wetlands that do not have a surface water outflow and water is applied at the rate of infiltration to the underlying aquifer. The 4G Ranch Wetlands serve as a wet-weather management option for Pasco County's reuse system and recharge 5 mgd on annual average to the surficial and Upper Floridan Aquifer. Located in an area suffering prolonged drawdown by regional wellfields , the 4G Ranch Wetlands also restore nearby hydrologically-altered lakes and wetlands.

Through a public-private partnership, the 3,000-acre 4G Ranch was identified as a suitable site for the infiltration wetland system. In 2015, the 176-acre groundwater recharge wetland was designed, and construction followed in 2016 and 2017. The 4G Ranch Wetlands are comprised of 15 individual cells that are each operated via water level measurements and flow control valves. Driven by the 4G Ranch's desire to use the system for recreation, the wetland system includes several ecological design features and a mosaic of wetland habitats with transitional, shallow, and deep-water areas.

The wetlands have been in operation since 2017 and water levels of each wetland cell are adjusted seasonally to achieve healthy wetland hydroperiods and encourage the growth of desirable wetland species. Since operation, the 4G Ranch wetlands have been monitored for the success of the planted wetland vegetation establishment, the rate of infiltration, nitrate reduction, and presence and diversity of wildlife.

This presentation will describe the project, construction methods and lessons learned, and an update on the success of the overall wetland system following approximately two years of operation.

Biography: Allison joined CH2M now Jacobs as a water engineer after receiving her Masters in Environmental Engineering from the University of Florida in 2014. Her studies there focused on ecological engineering and wetlands. While attending UF, she had the opportunity to work with Dr. Bob Knight at Wetland Solutions where she gained experience in the ecological assessment of springs and the permitting and design of treatment wetlands in North Florida. Since joining Jacobs, Allison has supported various natural treatment systems projects including treatment wetland designs and ecological assessments, groundwater recharge wetland model updates, and biochemical reactor pilot studies and designs.

(22) Nutrient Retention in the First Full Year by a Wetlaculture Mesocosm System in the Former Great Black Swamp Upstream of the Highly Eutrophic Western Lake Erie

Presenter: Bingbing Jiang, University of South Florida, bingbingj@mail.usf.edu

Co-Authors: William J. Mitsch, Everglades Wetland Research Park, Florida Gulf Coast University, wmitsch@fgcu.edu

Abstract: Human-induced non-point sources of nitrogen and phosphorus have contributed to the world widely common occurrence of harmful algal blooms, such as the serious eutrophication issue of western Lake Erie in the Laurentian Great Lakes of North America. A sustainable wetland-agriculture integration system (we call it "wetlaculture") is proposed for reducing high nutrient loaded flows into natural waters and recovering farmland soil conditions by applying wetland treatment system. A physical wetlaculture mesocosm model has been developed on agricultural land in the northwestern edge of the former 4,000 km2 'Great Black Swamp' which was drained entirely in the 19th century. Twenty-eight vertical-flow mesocosms (Rubbermaid tubs 122 x 76 x 61 cm) were installed in the ground with appropriate plumbing in 2017 and planted in October 2017 with the sedge Schoenoplectus tabernaemontani. Drainage ditch water containing agricultural runoff is added by gravity to the mesocosms when there is ditch flow (normally from March to June plus November). In a 2x2x7 experiment the mesocosms were randomly assigned to 2 water depths and 2 hydraulic loading rates (HLR) with seven replicates of each treatment. Started in March 2018, inflow and outflow water samples were collected and analysis for soluble reactive phosphorus (SRP), total phosphorus (TP), nitrate+nitrite (NO3+NO2-N), total Kjeldahl nitrogen (TKN), and total nitrogen (TN) every two other weeks during sampling hydroperiods. TP and TN in the inflow water were 0.130±0.013 mg-P/L (n=34) and 5.982±0.128 mg-N/L (n=34) respectively, in the first year. Early data in 2018 suggest the wetlands have already become nutrient sinks with a positive removal rate of TP (32±5% (n=167) and TN (82±0.4% (n=208)). After 3 or 4 years, these wetland mesocosms will be flipped (rotated) to a commercial agricultural crop over a several year period to determine x number of years wetlands that are needed to produce y number of years of crops without the addition of fertilizers. This study will provide a valuable information on restoring wetlands from farmlands in the former Great Black Swamp strategically focused on reducing the nutrient loading to western Lake Erie from the Maumee River Basin. Eventually dynamic and spatial mathematical models basing on wetlaculture mesocosm data will be developed to predict the behavior of created and restored wetlands at a landscape-scale for protection of downstream aquatic ecosystems including Lake Erie.

Biography: Bingbing Jiang has been a Doctoral student at University of South Florida since September 2016. Currently she is also a research assistant at Everglades Wetland Research Park, visiting student at The Ohio State University, and courtesy faculty member at Florida Gulf Coast University. Her research is focusing on wetland biogeochemistry and ecosystem modeling. Her master degree is receive from Capital Normal University (Beijing, China) in 2010. In 2012, She had been a visiting scholar at Olentangy River Wetland Research Park, Ohio State University (Columbus, Ohio), Everglades Wetland Research Park, Florida Gulf Coast University, Kapnick Center (Naples, Florida) and Tulane University (New Orleans, Louisiana), separately. She had ten publications and abstracts related with wetlands since 2010.

(23) Savannah River Site's A-01 Constructed Wetland System: A Model for Sustainable Ecological Risk Mitigation

Presenter: Matt Huddleston, SynTerra, mhuddleston@synterracorp.com

Co-Authors: Anna S. Knox and Michael H. Paller, Savannah River National Laboratory, Aiken, SC

Abstract: In October of 2000, a constructed wetland treatment system began receiving a combination of stormwater and wastewater from the A-01 outfall located at the U.S. Department of Energy's Savannah River Site (SRS) in South Carolina. The constructed wetland treatment system was designed to treat approximately one million gallons per day of stormwater from a 200-acre watershed (42% of total flow) and effluent from research laboratories (58% of total flow) at SRS. The A-01 outfall is an NPDES permitted discharge, and prior to construction of the wetlands, contained copper at levels toxic to aquatic organisms. The conceptual design of the wetland treatment system was developed from pilot mesocosm studies to identify key aspects of wetland function and performance. The pilot studies determined specific design parameters such as physical/chemical characteristics of hydrosoil, appropriate hydraulic retention time, and selection of wetland vegetation effective for copper attenuation. The full-scale constructed wetland system consisted of an upstream retention basin that provided consistent flow via gravity to eight one-acre wetland cells planted with giant bulrush (Schoenoplectus californicus). The A-01 outfall has consistently achieved compliance for copper, mercury, and toxicity since the wetlands came on line 16 years ago. The constructed wetland system has provided numerous research opportunities from conceptual design through long-term operation. Much of the research will be highlighted here. The A-01 constructed wetland system received recognition from the U.S. Department of Energy and U.S. Environmental Protection Agency Region 4 as a model application of sustainable technology, having saved SRS over $60 million over the life of the system.

Biography: Dr. Matt Huddleston is an ecotoxicologist at SynTerra scientists and engineering firm in Greenville, South Carolina. Over his career, Matt has collaborated with engineers and scientists to design wetland systems for stormwater and wastewater management around the country. Matt holds a doctorate in environmental toxicology from Clemson University and bachelor's and master's degrees in biology from Eastern Kentucky University.

(24) Potential of Floating Treatment Wetlands to Manage Phytophthora Species in Agricultural Runoff and Drainage

Presenter: Natasha Bell, Clemson University, natashb@clemson.edu

Co-Authors: Daniel R. Hitchcock, Clemson University, dhitchc@clemson.edu; Steven N. Jeffers, Clemson University, sjffrs@clemson.edu; John C. Majsztrik, Clemson University, jmajszt@clemson.edu; Sarah A. White, Clemson University, swhite4@clemson.edu

Abstract: The National Academy of Engineering has identified 14 Grand Challenges for Engineering in the 21st Century, and three of these are: Providing access to clean water, managing the nitrogen cycle, and restoring and improving urban infrastructure. Green infrastructure and ecological water treatment technologies are low-cost, effective methods of remediating nonpoint source contaminants. Floating treatment wetlands (FTWs) consist of emergent vegetation established on a buoyant structure that floats on the surface of a water body with roots extended down into the water column. FTWs effectively

remediate mineral nutrients in agricultural runoff, but little is known about their potential to manage plant pathogen contaminants. Therefore, our objective was to quantify the effect FTWs had on the numbers of zoospores of Phytophthora species present in irrigation runoff. The research was conducted with a pilot-scale, model FTW system using replicated troughs (3 m × 0.6 m × 0.2 m). Zoospores of P. nicotianae were introduced at the beginning of each experiment to the proximal end of each trough (N=12). Troughs were randomly assigned to one of three treatments: Open water, FTW with no plants, or FTW with plants—either Agrostis alba or Pontederia cordata. Water continuously flowed through each trough at a calculated hydraulic retention time (HRT) of 1 or 4 h. Influent and effluent water samples were collected and monitored for the presence and activity of zoospores using a standard bioassay. Preliminary results indicated that troughs containing plants substantially reduced the activity of P. nicotianae in effluent samples compared to troughs that did not contain plants, especially at the 4-h HRT. The exact mechanism by which FTWs containing plants reduced zoospore activity is not known; however, it is likely due to interception of zoospores by plant roots, which may involve interactions with plant root exudates or the root-associated microbial community.

Biography: Natasha Bell is a Ph.D. Candidate and USDA National Institute of Food and Agriculture PreDoctoral Fellow in the Biosystems Engineering program at Clemson University. Her research focus is on the development of sustainable water remediation strategies that inform decision-making and policies within the water-energy-food nexus. She earned her M.S. in Soil and Water Resources Engineering from the Department of Agricultural and Biological Engineering at the University of Illinois Urbana-Champaign and her B.S. in Biosystems Engineering from Clemson University. Before returning to Clemson to pursue her Ph.D., Natasha worked for two years as a civil and environmental engineer for a consulting firm in New York City.

(25) Determination of the Parameters of a System of Artificial Wetlands of Vertical Subsuperficial Flow for the Optimations of the Design of Models of Black Box Under Tropical Conditions – CANCELLED

Presenter: Johel Venegas Castillo, University of Costa Rica, johel.venegas@ucr.ac.cr

Co-Authors: Ronald Aguilar Álvarez PhD, University of Costa Rica, ronaldesteban.aguilar@ucr.ac.cr

Abstract: The access of fresh water is a human right; however, population growth, food production, and climate change, restrict even more this resource. In addition, wastewater treatment is often neglected. In 2017, worldwide, 4600 km3/year were consumed, and it was estimated that 80% of the wastewater was delivered into the environment without treatment. Costa Rica faces this problem with the implementation of wastewater treatment policies. Currently, Los Tajos wastewater treatment plant treats 20% of the 2 million inhabitants in the Central Valley. Construction, operation, and maintenance costs make wastewater treatment plants inaccessible to rural areas in Costa Rica. Therefore, this study proposes constructed wetlands as a wastewater treatment alternative for rural Costa Rica as degradation rates of contaminates are speculated to be faster than in temperate zones. The aim of this study is to determine degradation rates (e.g.: k factors in the plug-flow model) for the optimization of constructed wetland design in the tropics. Nine lab-scale vertical subsurface flow constructed treatment wetlands were set up at the Research City, University of Costa Rica. Three wetlands are planted with Neomarica gracilis, three with Heliconia psittacorum, and three are control. This system treats wastewater (e.g.; black water) from the Department of Dentistry. Weekly, chemical oxygen demand,

total solids, and total nitrogen and phosphorus are analyzed at the inlet and outlet of each constructed wetland. Plant growth and tissues analysis are carried out to determine nutrient uptake by the plants. It is expected to 1) treat the wastewater, 2) determine removal rates of contaminants adjusted to the tropics, and 3) obtain higher removal by constructed wetlands planted with plants. All this effort will drive to a better design of constructed wetlands as an alternative wastewater treatment system in rural Costa Rica.

Biography: I was born on 9/9/1990 in San José, Costa Rica. Since I was a child I have been a lover of nature that my country offers and my ecological conscience was stimulated from very early on. I entered the University of Costa Rica to study Agricultural Engineering, which years later became Agricultural Engineering and Biosystems. With this new approach I could guide my studies with my desire to generate a contribution to the care of the environment.

(26) Monitoring Bird and Insect Communities Within a Large-Scale Bioretention Project: Year 2

Presenter: David Wituszynski, The Ohio State University, wituszynski.1@osu.edu

Co-Authors: Jack Hudak, The Ohio State University, hudak.97@osu.edu; Donald Hayford, Columbus Innovations, LLC, donald.hayford@columbus-innovations.com; Jay Martin, The Ohio State University, martin.1130@osu.edu

Abstract: Ecological Engineers aspire to design ecosystems that provide human services, but to accomplish this goal we may have to design novel ecosystems – that is, systems without any clear natural analog. Stormwater bioretention systems (rain gardens) are a good example of these: because of the demands on these systems for hydrological performance (as recipients of concentrated runoff from even small storms) and for human health (adequately fast drainage to prevent mosquito breeding), they are unlike any naturally-occurring ecosystem. However, this makes it difficult to evaluate their performance as ecosystems, and perhaps for this reason little work has been done to evaluate the ecological structure and function of bioretention basins. This work is important, as Ecological Engineers also aspire to "integrate human systems and natural systems for the benefit of both" (Mitsch and Jorgensen 1989). Without an understanding of the ecology of these systems, we have little hope of validating our desire to benefit natural systems.

This work aims to take a first step towards closing this gap in knowledge by quantifying changes in bird and insect communities in an area affected by a large-scale bioretention installation. We sampled a neighborhood of Columbus, OH for both of these taxa before and after construction of more than 400 bioretention basins (total constructed area: 0.35 acres, project area: 91.4 acres). Birds were sampled by passive acoustic monitoring; recordings were subsequentially processed for automatic identification of indicator species. Over the same period, insects were collected in pitfall traps both within bioretention systems and at nearby lawns. Comparison of the changes seen in these two communities gives a first-order insight into how the installed bioretention basins are functioning as ecosystems, and what ecological benefits might accrue from their installation.

Biography: David Wituszynski is a doctoral candidate under Jay Martin at the Ohio State University. He is currently working with an interdisciplinary team to evaluate the hydrological, ecological, economic, and community benefits of a large-scale green infrastructure installation in Columbus, OH. He spends a lot of time listening to recordings of birds and fixing composite samplers. His past work includes research into appropriate cookstove design and into human exposure to algal toxins in fish from Lake Erie. David grew up in New Hampshire and attended college in upstate New York. When he isn't uneasily eyeing his expected date of graduation, he enjoys reading, playing board games with friends, and exploring Columbus by bicycle.

(27) The Biological Effectiveness of Green Stormwater Infrastructure for Aquatic Toxicity

Presenter: Jenifer McIntyre, Washington State University, jen.mcintyre@wsu.edu

Co-Authors: Edward Kolodziej, University of Washington, koloj@uw.edu; Jay Davis, US FWS, jay_davis@fws.gov; John Stark, Washington State University, starkj@wsu.edu; Nathaniel Scholz, NOAA National Marine Fisheries Service, nathaniel.scholz@noaa.gov

Abstract: Urban stormwater runoff contains a complex mixture of contaminants that can be toxic to aquatic animals. Effects studied by our research group include acute mortality of aquatic invertebrates and fish, impairments to reproduction of aquatic invertebrates, and neurotoxicity of developing fish embryos. In the Pacific Northwest, native coho salmon (Oncorhynchus kisutch) are very sensitive to runoff with high rates of acute mortality in returning adult spawners. This same effect is reproducible in experimentally exposed adult and juvenile coho salmon. Green infrastructure is one approach being used to improve urban runoff for the protection of aquatic species. Bioretention – whereby runoff is treated by passive filtration through soil – is one such approach. Bioretention can prevent many of the acute toxic impacts of urban runoff on aquatic species. This presentation will review research conducted by the Puget Sound Stormwater Science Team – a collaboration of Washington State University, NOAA National Fisheries Service, U.S. Fish and Wildlife Service, and University of Washington – into the toxic impacts of urban runoff on aquatic animals and the ability of bioretention treatment to prevent those impacts.

Biography: Dr. Jenifer McIntyre is passionate about science that effects change. Her B.Sc. (1997) in environmental biology at Queen's University led to the ban of a pulp mill effluent used as a road dust suppressant. Her M.S. (2004) from the University of Washington on contaminant bioaccumulation led the Washington State Department of Health to issue a fish consumption advisory for Lake Washington. Her Ph.D. (2010) research at UW on olfactory neurotoxicity of copper in coho salmon helped pass legislation in Washington and California that phases out metals in brake pads. Dr. McIntyre currently focuses on the ecotoxicology of urban stormwater runoff and the biological effectiveness of green stormwater infrastructure. Dr. McIntyre is currently located at the Washington Stormwater Center in Puyallup, WA where she is an assistant professor of aquatic toxicology for Washington State University's School of the Environment.

(28) Nitrogen and Phosphorus Removal in Bioretention Cells Receiving Agricultural Runoff from a Dairy Farm in South Burlington, VT

Presenter: Jillian Sarazen, University of Vermont, jillian.sarazen@uvm.edu

Co-Authors: Stephanie Hurley, University of Vermont, stephanie.hurley@uvm.edu; Joshua Faulkner, University of Vermont, joshua.faulkner@uvm.edu

Abstract: Stormwater runoff from agricultural production areas contributes to the pollution and degradation of downstream water bodies. At dairy farms, this runoff carries sediments, pathogens, and nutrients; specifically, nitrogen and phosphorus. There is a need to evaluate potential onsite management practices to improve runoff quality and limit the transport of harmful pollutants. Bioretention cells, a type of green stormwater infrastructure (GSI), are designed and constructed depressions in the ground. They are typically filled with soil media, planted with selected vegetation, and are used in developed areas to manage the quantity and quality of stormwater runoff. In 2016, three bioretention cells were constructed to receive runoff from a dairy farm production area at the University of Vermont Paul R. Miller Research Complex. The production area consists of paved parking lots, rooftops and gravel roads. Across the three cells, we compare the effects from two treatments: a low-P compost layer and switchgrass, Panicum virgatum, on nutrient removal. During 25 storm events throughout the summer and fall of 2017 and 2018, flow-based water samples were taken using Teledyne ISCO automated water samplers at the inflow and outflow of each cell. These samples were analyzed for total phosphorus (TP), soluble reactive phosphorus (SRP), total nitrogen (TN), nitrate (NOx–N) and ammonium (NH4-N). Further monitoring of the system in 2019 will evaluate design modifications to increase hydraulic retention time to create an internal water storage zone in each cell for nitrate removal. This presentation will discuss the bioretention design, research questions, methods and results from the 2017 and 2018 monitoring seasons.

Biography: Jillian Sarazen is currently a first year master's student in the Plant and Soil Science Department at UVM. She graduated in 2016 from Oberlin College with a Bachelor's degree in Biology. As an undergrad, she participated in an REU program and monitored the effectiveness of a green roof. After graduating, she worked for the Bureau of Land Management and the US Forest Service in Northern California and Southern Oregon.

(29) Optimizing Green Infrastructure Performance: Case Studies of Los Angeles Wetlands

Presenter: James Bays, Jacobs, jim.bays@jacobs.com

Co-Authors: Wing Tam

Abstract: Since 2004, when Proposition O (Clean Water Bond) gained City-wide approval from residents, the City of Los Angeles, LA Sanitation and Environment (LASAN) has constructed over 60 Green Stormwater Infrastructure (GSI) projects to improve water quality, augment water supply, and protect public health while meeting Total Maximum Daily Loads for various pollutants in receiving waterbodies. In addition, the GSI projects enhances the environment, creates ecological systems, provides community green spaces and recreations, reduces localize floods, and facilitates community environment stewardship for healthy neighborhoods. LASAN was able to utilize the Clean Water Bond funds for the Optimization Phase of the GSI projects through performance assessment, monitoring, and management enhancement to ensure the constructed GSI projects are able to perform together as a functional GSI

system. The Optimization Phase is a critical element after construction in order to define the Standard Operating Procedures (SOPs) for Operation and Maintenance long-term sustainability. Conducted between 2013 through 2018, the optimization effort included water quality monitoring, flow measurement, system enhancement, development of standard operating procedures, and training.

Two GSI projects provide useful case histories of optimization and lessons learned on the implementation of natural treatment systems designed to treat stormwater from highly urbanized watersheds. The 9-acre South Los Angeles Wetland treats dry and wet weather runoff by capturing trash and associated pollutants. Echo Park is a 29-acre open space recreational facility centered on 13-acre Echo Park Lake. As part of a multi-year project, the lake was drained, dredged, trash capture devices were installed, constructed wetlands were added to improve water quality, aeration and recirculation system, permeable pavement, bioswales, and a historic water lotus bed was reconstructed and replanted.

Key issues addressed in these case studies include vegetation management and replanting, hydraulics, ecosystem functionality, adequacy of water supply during dry weather, algal management and physical site management.

Biography: Jim Bays is senior wetland scientist at Jacobs Engineering Group, specializing in the planning, design and assessment of natural treatment systems for improving water quality. Jim has over 40 years of experience in wetland ecology and management, and is Certified in Ecological Design from the American Ecological Engineering Society.

(30) The Role of Trees as Green Stormwater Infrastructure: Digging into the Data

Presenters: Trisha Moore, Kansas State University, tlcmoore@ksu.edu

Co-Authors: Alireza Nooraei, Kansas State University Department of Biological & Agricultural Engineering; Charles Barden, Kansas State University Department of Horticulture and Natural Resources

Abstract: The potential for urban trees and forests to enhance the capacity of urban landscapes and stormwater control measures to regulate stormwater runoff quantity and quality has been widely recognized. However, the processes by which trees may regulate urban runoff hydrology are controlled by a myriad of environmental, biological and other factors, thus clouding efforts to quantify stormwater regulating benefits. In this presentation, the results of a meta-analysis of over 50 studies in which key ecohydrologic (i.e., interception, throughfall, stemflow and transpiration) and/or water quality processes (i.e., nutrient cycling and leaching) associated with urban trees were measured will be presented. With respect to ecohydrologic processes, we found that the majority of variation in reported measurements could be explained with relatively simple models despite differences in climate, storm events, and tree characteristics among study locations. The data related to water quality tell a more complicated story, with landscape position and connectedness to street gutters and other artificial drainage networks exerting a strong control on the tree's role as a net nutrient sink or source to urban stormwater. While the data reported by existing studies and represented in this meta-analysis reflect the relationship between trees and stormwater at the tree- to site-scales, efforts to extrapolate these data and our understanding to the watershed scale will also be discussed.

CONCURRENT SESSION 3

(31) Linking Stream Restoration Success with Watershed, Practice and Design Characteristics

Presenter: Urban Withers, Virginia Tech, samuelw2@vt.edu

Co-Authors: Tess Wynn-Thompson, Virginia Tech; Eric Smith, Virginia Tech; W. Cully Hession, Virginia Tech

Abstract: In the United States, stream restoration is currently a billion-dollar industry (Bernhardt et al., 2005). Though it is commonly used as a method for stream impact mitigation, TMDL crediting, and storm water management, there is little scientific knowledge defending stream restoration as an effective tool for addressing these issues. In particular, few studies have been conducted with the goal of providing recommendations for future design improvements.

To improve stream restoration success rates by advising practitioners and stake holders in site selection and success assessment, 50 stream restoration projects were assessed at the watershed and project levels. Watershed, site, and design characteristics were quantified using ArcGIS and restoration design plans and monitoring reports. Using current literature and expert advice, a stream restoration assessment methodology was developed to assess project success. Statistical analysis was then completed to identify correlation between watershed and project level characteristics and stream restoration success. This presentation will discuss the watershed and practice characteristics used to assess stream restoration projects, the methodology used to determine success, and results of the statistical analysis correlating these variables.

Biography: Urban Withers is a current M.S. student studying Biological Systems Engineering at Virginia Tech under Dr. Tess Wynn-Thompson with a focus in stream restoration.

(32) Comparison of Geomorphic and Habitat Metrics for Functional Lift from Urban Stream Restoration

Presenter: Jeremy Melton, University of Tennessee – Knoxville, jmelto14@vols.utk.edu

Co-Authors: Dr. John Schwartz, University of Tennessee – Knoxville, jschwart@utk.edu

Abstract: Urban watersheds experience a variety of ecosystem stressors including hydromodification and impaired water quality. Impacts of hydromodification include rapid geomorphic adjustment to the channel and degraded habitat which potentially can affect detrimentally benthic macroinvertebrate and fish communities. Stream restoration is commonly implemented to resolute damage to these communities. Because geomorphic metrics define habitat structure they are a necessary component to stream condition and restoration design. Compensatory mitigation is required by the Clean Water Act for aquatic resource loss, and to ensure mitigation is obtained a functional lift analysis is conducted between the existing condition and the proposed restoration project. The existing tool used in Tennessee is the Stream Quantification Tool (SQT) and was based on the restoration of non-urban streams relying on geomorphic reference benchmarks. Unknown to date is the potential functional lift that may be achieved in urban streams. Our research explores the what functional lift is possible in restored urban streams by comparing three site classified streams: urban impaired, urban restored, and reference sites. All study sites were located in the Ridge and Valley Ecoregion (ER67) located in the eastern portion of Tennessee. Geomorphic and habitat data will be assessed to quantify the departure from impaired and restored streams from the reference streams. In doing so, a quantitative measure of the potential functional lift from geomorphic metrics will be achieved. This analysis is part of a broader study that also examined the biological communities and their relations among the three stream classifications – also quantifying the ecological departure from a reference condition.

Biography: Jeremy Melton is an Environmental Engineering graduate student at the University of Tennessee – Knoxville. His areas of interest include stream and habitat restoration, as well as green infrastructure and stormwater BMPs. Jeremy's thesis also involves analyzing the newly implemented TN Stream Quantification Tool (TN SQT). He and his team were awarded second place at WEFTEC 2018's Student Design Competition for a stream restoration design completed for the Children's Defense Fund in Clinton, TN.

(33) Assessing Functional Lift for Urban Stream Restoration Projects

Presenter: John Schwartz, University of Tennessee – Knoxville, jschwart@utk.edu

Co-Authors: Brian Alford, PhD, University of Tennessee – Knoxville, jalfor12@utk.edu; Grant Fisher, University of Tennessee – Knoxville, gfisher7@vols.utk.edu; Jeremy Melton, University of Tennessee – Knoxville, jmelto14@vols.utk.edu

Abstract: Ecological improvement from stream restoration projects particularly in urban watersheds have had mixed results. There are several possible reasons for the limited improvements including 1) inadequate ecological design criteria based on recolonization potential and habitat requirements determined by functional traits expression 2) pre- and post-monitoring assessment methods, 3) the biological assemblage chosen for the bioassessment, and 4) lack of a watershed-scale stressor analysis and adequate project scoping and prioritization. The 2015 document Tennessee Integrated Assessment of Watershed Health (TIAWH): A Report on the Status and Vulnerability of Watershed Health provides the watershed-scale analysis for project prioritization; however. for stream restoration design additional ecological information is needed particularly in urban streams. In addition, there is a critical need to better understand ecological responses to restoration in order to improve on design strategies, and assign restoration mitigation credits. Two research study goals are proposed: 1) collect geomorphic, habitat, and biological data urban restoration projects, and urban unrestored and reference stream sites, and analyze and compare functional lift per the state's stream quantification tool to better understand ecological impairment processes in urban streams; and 2) integrate a functional traits analysis methodology with the TIAWH Report to improve ecological design criteria for stream restoration particularly in urban watersheds. Site data were collected from twelve streams, four stream sites for each condition classification (urban unrestored, urban restored, and ecoregion reference). Results demonstrate in urban streams not all field-measured condition metrics discriminate functional lift, and the functional lift quantitative tool could be improved reflecting the metrics that do discriminate between the three conditional stream classes noted above.

Biography: Dr. John Schwartz is a professor in the Department of Civil and Environmental Engineering at the University of Tennessee-Knoxville, and Director of the Tennessee Water Resources Research Center.

His academic history includes a PhD in Environmental Engineering from the University of Illinois at Urbana-Campaign (2002), a MS in Fisheries Science from Oregon State University (1991), and a BS in Civil Engineering from the University of Missouri-Columbia (1982). My research program in water resources over the past 15 years at the University of Tennessee has focused on the assessment of stressed natural systems through investigations of altered physical, chemical, and biological processes that lead to degraded water quality and stream ecosystems, and the development of improved restoration approaches in human-dominated watersheds.

(34) Evaluating the Ecological Function of Restored Streams in Piedmont, North Carolina Using the Stream Quantification Tool

Presenter: Sara Donatich, North Carolina State University, srdonati@ncsu.edu

Co-Authors: Barbara A. Doll, North Carolina State University and NC Sea Grant, bdoll@ncsu.edu; Jonathan L. Page, North Carolina State University, jlpage3@ncsu.edu

Abstract: The Stream Quantification Tool (SQT), a rapid assessment and spreadsheet tool that quantifies stream function, was developed succeeding 2008 updates to federal compensatory mitigation rules to address the lack of method to evaluate stream function using function-based objective and verifiable performance standards. The SQT is an application of the Stream Functions Pyramid (Harman et al., 2012), which asserts that stream functions are interrelated and build on each other in a specific order, in which hydrologic processes are depicted as the fundamental support for hydraulic, geomorphic, physicochemical, and biological processes. To test the pyramid framework and the ability of the SQT (3.0) developed for NC to accurately detect and quantify stream function, a functional assessment was conducted on 19 reference-quality streams and six paired restored and degraded streams in Piedmont, NC. Natural variability of conditions for reference-quality reaches within the NC Piedmont region were documented and compared to the SQT's performance standards. Restoration success of the paired restored and degraded reaches was evaluated using the SQT. Multivariate statistics and regression analysis were performed to compare stream function relationships asserted by the pyramid framework to reference conditions. Multivariate relationships between function variables and biological condition were evaluated to generate significance weights for each variable to ensure the SQT places higher significance on variables that support healthy biota. Findings will influence adoption of the SQT by the NC Division of Mitigation Services to award function-based credits.

Biography: Sara Donatich, originally from Long Island, NY, is pursuing her Master of Science in Ecological Engineering from NC State University under the advisement of Dr. Barbara Doll. Prior to NC State, she worked on wetland and riparian restoration projects for the Natural Areas Conservancy, a non-profit partner of NYC Parks and Recreation, and performed environmental investigations on properties throughout NYC for Langan Engineering. Sara received her Bachelor of Arts in Environmental Science from Barnard College of Columbia University in 2013.

(35) Evaluation of Nutrient Reduction Crediting Strategies for Stream Restoration

Presenter: Barbara Doll, NC Sea Grant and NC State University Biological & Agricultural Engineering Department, bdoll@ncsu.edu

Co-Authors: Jeffrey Johnson, NC State University, jpjohnso@ncsu.edu; Jonathan Page, NC State University, jlpage3@ncsu.edu

Abstract: As the stream restoration field is currently a $1 billion/yr industry and growing, interest in providing nutrient credits in addition to mitigation credits has been introduced in some states. The Chesapeake Bay Expert Panel first introduced a protocol for awarding nutrient credits for stream restoration efforts 2013. The NC Division of Water Resources (DWR) is currently considering adopting similar voluntary credits that borrow heavily from the current Chesapeake Bay Protocol (CBP). The credit considers three potential nutrient credit elements for stream restoration projects including (1) prevented sediment during storm flow, (2) instream denitrification during base flow and (3) floodplain reconnection.

NC Sea Grant and NC State University conducted a review of the draft standards and tested the proposed nutrient credit calculation methods on four case study restoration projects in order to: 1) quantify the level of effort necessary to prepare nutrient credit estimates, 2) identify opportunities to address shortcomings and simplify the proposed credit standards and 3) where appropriate, develop modified nutrient credit standards for improving application and accuracy of reduction estimates. In addition, USGS gage station data analysis was conducted at five streams to evaluate relationships in channel size, hydrology, watershed size and floodplain flow frequency. In addition, a flood flow frequency analysis was performed to compare observed hydrologic connectivity to floodplains to estimated connectivity as prescribed by the CBP protocol 3. USGS gage data from 5 streams was analyzed and load reductions were computed using water quality data provided by local sources.

Based on the findings of this study, potential revisions to the CBP were recommended. This presentation will outline the results of this study and the proposed credit modifications.

Biography: Barbara Doll is an Extension Specialist for North Carolina Sea Grant and an Extension Assistant Professor in the Biological & Agricultural Engineering Department at NC State University Barbara holds a Ph.D. in Biological and Agricultural Engineering and is a licensed professional engineer who joined Sea Grant in 1992 to work on water quality issues. Much of Barbara's current research and outreach focuses on ecological restoration, reducing the impacts of nonpoint source pollution and assessing the effectiveness of restoration practices. She has developed and implemented several innovative stream restoration projects including the 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. Barbara currently serves as the principal investigator for more than $1.2 million in grant funding which supports outreach and research projects focused on evaluating the performance of stream restoration efforts, developing new techniques for ecological restoration, stormwater management and assisting communities with water quantity and quality challenges. She manages a team of engineers and graduate students who are funded by these projects. Barbara has authored a number of publications on stream restoration and stormwater runoff, including publishing in professional journals such as the Journal of the American Water Resources Association and WATER.

(36) The Potential Long-Term Impacts of Climate Change on Coastal Plain Wetlands in North Carolina

Presenter: Jack Kurki-Fox, Ph.D., North Carolina State University, jjkurkif@ncsu.edu

Co-Authors: Michael R. Burchell II, North Carolina State University, mrburche@ncsu.edu; Brock Kamrath, North Carolina State University, bjkamrat@ncsu.edu

Abstract: Wetlands are especially at risk due to climate change because of their intermediate landscape position, where small changes in precipitation and/or evapotranspiration can have substantial impacts on wetland hydrology. Because hydrology is the primary factor influencing wetland structure and function, the important ecosystem services wetlands provide may be altered or lost as a result of climate change. The objective of this project was to determine the range of possible impacts of climate change on the hydrologic regimes of non-riverine Coastal Plain wetlands in North Carolina.

DRAINMOD models were calibrated and validated for two minimally disturbed, natural wetland sites in the coastal plain of North Carolina using observed water table and local weather data. Downscaled climate projections for daily temperature and precipitation were obtained from the Bureau of Reclamation. Two representative concentration pathway (RCP) scenarios were evaluated: RCP4.5 and RCP8.5. Model simulations were run from 1986-2099, and outputs were evaluated by comparing results between the base period (1986-2015) and two future periods: 2040-2069 and 2070-2099. The model simulation results indicate projected mean water table declines of 25-75 cm by the end of this century (2070-2099) for the RCP8.5 (high-end) scenario and declines of 20-40 cm for the RCP4.5 (mid-range) scenario. These results provide an overview of the potential impacts of climate change on North Carolina wetlands, and provide a range of scenarios to inform and guide possible changes to water management strategies in wetland ecosystems to limit the loss of ecosystem services over the long-term.

Biography: Jack Kurki-Fox, Ph.D. is a recent graduate of the North Carolina State University Biological and Agricultural Engineering program. He is now a Research Associate in the North Carolina State University Biological and Agricultural Engineering Department. His current focuses are wetland restoration and stream restoration.

(37) Impact of Control Structures on the Restoration of Wetland Hydrology within the Great Dismal Swamp

Presenter: Brock Kamrath, North Carolina State University, bjkamrat@ncsu.edu

Co-Authors: Michael R. Burchell II, North Carolina State University, mrburche@ncsu.edu; Jack Kurki-Fox, North Carolina State University, jjkurkif@ncsu.edu

Abstract: The Great Dismal Swamp (GDS) is a 45,000-ha state and federally protected Coastal Plain peatland located on the border of North Carolina and Virginia. Drainage and logging over the past centuries have significantly altered the hydrology of the GDS, which has negatively affected its ecosystem structure and function. With the goal to restore wetland hydrology to portions of the swamp, NC State Parks and NC State University collaborated to install adjustable water control structures (WCS) at strategic locations within existing drainage ditches.

The objective of this study was to determine if the hydropatterns of two target restoration blocks have become comparable to nearby reference sites following the installation of the WCSs. Water level data was collected for three years prior to WCS installation (pre-WCS) and three years after WCS installation (Post-WCS) using monitoring wells and water level data loggers. The comparison of water level data from the pre and post periods using empirical cumulative distribution functions (ECDFs) indicated wetter conditions within the target restoration blocks relative to the nearby reference wetlands following installation of the WCSs. A more traditional Paired Before-After Control-Impact (BACIP) statistical analysis was also conducted. The BACIP analysis showed the monthly mean water levels in the target restorations blocks were significantly different from those in nearby reference wetlands prior to WCS installation and not significantly different after WCS installation. It is anticipated that the restoration of wetland hydrology will help prevent further ecosystem degradation and aid the effort to restore target forest communities within the swamp by reducing fire susceptibility, preventing peat oxidation, maintaining carbon storage, and reducing non-target vegetation competition.

Biography: Brock Kamrath is currently a PhD. student at NC State University in the Biological and Agricultural Engineering program. His research is focused on the restoration and creation of wetlands and their efficacy, as engineered systems, to provide water quality improvement.

(38) Assessing the Success of Water Budget Modeling and Reference Wetlands for the Prediction of Wetland Hydrology in Wetland Restoration Sites in North Carolina

Presenter: Eric Neuhaus, Wildlands Engineering, Inc., eneuhaus@wildlandseng.com

Co-Authors: Kirsten Gimbert, Wildlands Engineering, kgimbert@wildlandseng.com; Jeff Keaton, Wildlands Engineering, jkeaton@wildlandseng.com; John Hutton, Wildlands Engineering, jhutton@wildlandseng.com

Abstract: Many of the complex interactions that occur in wetlands are dictated by the hydrology. For wetland mitigation to be successful, accurate hydrology needs to be restored to reproduce high functioning ecological systems. Wetlands need to experience fluctuating hydroperiods with times of saturation and drawdown. To estimate how stream and wetland restoration designs will affect the hydrology and hydroperiod of proposed projects, modeling techniques and the use of reference wetland hydrology data have been utilized.

This study compares wetland reference hydrology, modeling results of predicted hydrology, and corresponding monitoring data for multiple wetland restoration sites in North Carolina. The Lyle Creek Stream & Wetland Mitigation Project improved 9.5 acres of wetlands on an active tree farm located in the headwaters of Lyle Creek in rural Catawba County, NC. The Little Troublesome Creek Mitigation Project restored 18.0 acres of wetlands in Rockingham County, NC. The Underwood Mitigation Project in northwestern Chatham County, NC restored and created a total of 13.8 acres of riparian wetlands and restored and enhanced 1.5 acres of non-riparian wetlands. The Owl's Den Stream and Wetland Mitigation Project restored approximately 10.0 acres of riparian wetlands in Lincoln County, NC. The Henry Fork Mitigation Site restored approximately 4.0 acres of riparian wetlands in Catawba County, NC. DRAINMOD, as well as reference wetland hydrology data was used on all the above sites to predict how construction of the project would improve site hydrology.

Biography: Mr. Neuhaus serves as a water resources engineer and project manager for Wildlands Engineering in the Asheville, NC office. He has eight years of experience working on a variety of projects including stream and wetland restoration, stormwater management, erosion and sediment control, hydrologic modeling, and groundwater modeling. Mr. Neuhaus' duties include project management, assistant project management, field data collection, site analysis, design development, preparation of construction plans, earthwork estimation, and construction administration. He also provides hydrologic modeling, water budget analysis, preliminary site evaluation, and design for wetland restoration projects.

(39) Managing Waterfowl Impoundment Hydrology to Provide Habitat and Reduce Nutrient Loss

Presenter: Randall Etheridge, East Carolina University, etheridgej15@ecu.edu

Co-Authors: Brian Hinckley, East Carolina University, hinckleyb11@ecualumni.ecu.edu; Trey Mason, East Carolina University, masonr18@students.ecu.edu; Ariane Peralta, East Carolina University, peraltaa@ecu.edu

Abstract: Hydrologic management intended to promote one ecosystem function can result in unintended consequences. For example, water levels are managed through seasonal drawdown and flooding for the growth of specific vegetation to attract waterfowl in moist soil managed (MSM) waterfowl impoundments. In contrast to these managed wetlands, agricultural (Ag) waterfowl impoundments are managed for row crop production during the growing season and double as waterfowl habitat during winter waterfowl migration. To attract waterfowl, both types of impoundments are flooded in the late fall and water is held in the systems into the spring. Residence time is often the design factor that is considered the most important when using wetlands to retain nitrogen. In the case of waterfowl impoundments, a residence time of months combined with large inputs of waterfowl waste promotes nitrogen export. Before a solution could be developed to reduce the loading to downstream ecosystems, the factors controlling the nitrate, ammonium, and organic nitrogen dynamics had to be identified. To better understand these factors, we combined 21 months of field monitoring of nitrogen concentrations at a high frequency (30-min) with seasonal soil core sampling. We measured potential nitrification, denitrification, and nitrogen mineralization rates and soil physiochemical properties for each soil core. In this study, the high organic nitrogen inputs by waterfowl during winter months combined with seasonal flooding resulted in high ammonium concentrations. This result was punctuated when specific conditions, such as anoxic conditions, inhibited nitrification rates. Taken together, monitoring seasonal N dynamics and measuring potential N process rates revealed opportunities to manage wetland hydrology to benefit waterfowl habitat and nitrogen retention.

Biography: Randall Etheridge is currently an assistant professor in the Department of Engineering and the Center for Sustainable Energy and Environmental Engineering at East Carolina University (ECU). Prior to joining ECU, he served as an agricultural engineer with the Southwest Florida Water Management District. In addition to leading the environmental engineering concentration at ECU, his work focuses on helping communities in eastern North Carolina address water quantity and quality issues. He received his PhD and BS in Biological and Agricultural Engineering from North Carolina State University.

(40) Estimating Flow Through Rock Weirs for Use in Ecological Engineering Design

Presenter: Tess Thompson, Virginia Tech, tthompson@vt.edu

Co-Authors: Suraye Solis, Wildlands Engineering, Inc., ssolis@wildlandseng.com

Abstract: Rock weirs are ubiquitous in ecological engineering design. By appearing more natural, rock weirs are preferred for use as hydraulic control structures in river engineering, stormwater management control structures, and mitigation wetlands. Although rock weirs are commonly used, few stage-discharge relationships for these structures exist. Consequently, designers often utilize the broad-crested weir equation and weir coefficients. However, the porosity and irregular crest of rock weirs result in discrepancy between the predicted discharge (obtained using broad-crested weir assumptions) and actual discharge. Therefore, a weir equation and coefficients that better predict discharge are needed to improve the design and implementation of rock weirs. The overall goal of this research is to determine a weir equation and corresponding discharge coefficients to predict flow through rock weirs. A flume study was conducted using Froude-scaled model rock weirs in a 1 m x 8 m x 0.4 m recirculating flume and the data were fit to standard weir equations to determine the coefficient and exponent for the weir equation. Results of this research are broadly applicable for engineering design in stream and wetlands restoration, as well as stormwater management.

Biography: Dr. Theresa “Tess” Thompson is an associate professor in Biological Systems Engineering at Virginia Tech and a Turner Fellow of Engineering. Her research in watershed management focuses on stream and wetland restoration, urban stream systems, and streambank erosion. A former president of the American Ecological Engineering Society, she currently serves as vice-chair of the River Restoration Technical Committee of ASCE-EWRI, as a member of the Chesapeake Bay Scientific and Technical Advisory Committee, and on the advisory board for the International Ecological Engineering Society.

(41) Integrating Ecosystem Service Considerations Within a GIS-Based Habitat Suitability Index for Oyster Restoration

Presenter: David Eggleston, North Carolina State University/CMAST, eggleston@ncsu.edu

Co-Authors: Seth Theuerkauf, NC State University, Center for Marine Sciences & Technology, seth.theuerkauf@tnc.org; Brandon Puckett, NC State University, Center for Marine Sciences & Technology, brandon.puckett@ncdenr.gov

Abstract: Geospatial habitat suitability index (HSI) models have emerged as powerful tools that integrate pertinent spatial information to guide habitat restoration efforts, yet have rarely accounted for spatial variation in ecosystem service provision. In this study, satellite-derived chlorophyll a concentrations for Pamlico Sound, North Carolina, USA were applied in conjunction with data on water flow velocities and dissolved oxygen concentrations to identify potential restoration locations that would maximize the oyster reef-associated ecosystem service of water filtration. These water quality services were integrated within an existing ‘Metapopulation Persistence’, GIS-based HSI model containing biophysical (e.g., salinity, oyster larval connectivity) and logistical (e.g., distance to nearest restoration material stockpile site) factors to identify suitable locations for oyster restoration that maximize long-term persistence of restored oyster populations and water filtration ecosystem service

provision. We compared the 'Water Filtration' optimized HSI with the HSI optimized for 'Metapopulation Persistence,' as well as a hybrid model that optimized for both water filtration and metapopulation persistence. This approach identified optimal restoration locations (i.e., locations corresponding to the top 1% of suitability scores) that were consistent among the three HSI scenarios (i.e., "win-win" locations), as well as optimal locations unique to a given HSI scenario (i.e., "tradeoff" locations). The modeling framework used in this study can provide guidance to restoration practitioners to maximize the cost-efficiency and ecosystem services value of habitat restoration efforts. Furthermore, the functional relationships between oyster water filtration and chlorophyll a concentrations, water flow velocities, and dissolved oxygen developed in this study can guide field- and lab-testing of hypotheses related to optimal conditions for oyster reef restoration to maximize water quality enhancement benefits.

Biography: Dr. David Eggleston is an Alumni Distinguished Professor at NC State University, and also serves as Director of NC State's marine laboratory, the Center for Marine Sciences and Technology (CMAST), located in Morehead City, North Carolina. He leads the Marine Ecology and Conservation program at NC State University, which emphasizes testing and refining general ecological theory and concepts in marine systems with the goal that answers will: (1) make important contributions to our understanding of ecological patterns and processes in marine ecosystems, and (2) be applied to sustainable management of natural resources and coastal communities. Research topics span fisheries ecology, habitat restoration, conservation biology, deep sea biology, detecting ecological impacts, behavioral ecology, population dynamics and modeling, and marine science education. Eggleston serves on the advisory boards of state, national and international coastal and marine science organizations. He has been recognized for excellence in research by the National Science Foundation via an Early Career Award, excellence in outreach via an Outstanding Extension Service Award by NC State University, and is a member of the NC Academy of Outstanding Teachers. He loves scuba-diving, boating, fishing, and playing drums in local bands.

(42) Growing Coastal Infrastructure: Sharing the Vision for a Productive and Sustainable Coast

Presenter: Steven Hall, North Carolina State University, Biological and Agricultural Engineering, shall5@ncsu.edu

Co-Authors: Matthew Campbell, Tyler Ortego, Robert Beine, Leonard Nelson

Abstract: We are in a time of transitions: from nonrenewable fossil fuels and materials to renewable materials; from a growing population to a stable or declining population; from a tribal world to a global world. How we handle these transitions will determine the health of these transitions. Simply being against hunger or war will not necessarily avoid them; active, creative solutions are needed. In the coastal realm, impacts of climate change, including larger and possibly more frequent coastal storms; coupled with sea level changes are already having significant impacts. Meanwhile, increased development and populations are further exacerbating the stresses in coastal zones. In rich areas, hard structures such as seawalls have been constructed, but exact an unsustainable price on both the ecosystem and the budget. In less developed regions, the impacts are often even more tragic, with loss of homes, livelihoods and lives. One creative alternative is to grow sustainable coastal infrastructure that reduces cost (and materials) by one or more orders of magnitude; while providing coastal

protection, habitat and related ecological services. This group has been working in this area for almost two decades and has a number of patents, publications and emplacements in a number of coastal locations. Recently, a patent was issued for a novel 3D printer that will enable further development of low density, customized biofriendly concrete structural frameworks that encourage natural growth of oysters, mussels and other organisms in customized reefs. This talk will discuss both the technology and recent work to share this in both traditional educational (classroom); extension; and research venues; and creative ways to share from social media to Comicon to entrepreneurial Senior design. We look forward to the chance to share the vision of our small contribution toward a transition to a more sustainable coast and future.

Biography: Steven Hall is Director of the Marine Aquaculture Research Center at North Carolina State University; and Editor of Aquacultural Engineering. His PhD is from Cornell University; MS from UC Davis; and Postdoc from McGill University. His interests focus on sustainable resource engineering in the aquatic environment. He was Assistant, Associate and Full Professor and Graduate Chair in the Department of Biological and Agricultural Engineering at LSU, where he retains adjunct status; has served on the faculty at the Au Sable Institute; and joined the BAE Department at NCSU in 2016. He has teaching, research and extension appointments and works throughout North Carolina and around the world, with past present and future collaborations on multiple continents, all focused on finding ways to enhance both productivity and sustainability in aquatic systems; and to share findings and encourage others to contribute to transitioning to a sustainable future.

(43) Green Concrete: The Bioreceptivity of Algae-Concrete for Macroinvertabrates, Preferences of False Dark Mussels, and a Lesson in Adaptive Management

Presenter: Samantha Francis, Ohio State University, francis.524@osu.edu

Co-Authors: Dr. Patrick Kangas, University of Maryland; Dr. Peter May, University of Maryland; Ms. Evelyn Tickle, James Madison University

Abstract: For centuries, humans have utilized artificial reefs as a means of increasing marine biodiversity in areas where we have found it lacking. As dredging, coastline development, and ocean acidification destroy natural environments, artificial reefs may eventually be the only option for critters that used to rely on oyster and coral reefs for habitat. As such, it is pertinent that humans take the opportunity– while we still have time– to understand what the best options are to create the most hospitable environmental for underwater colonizers, especially those that perform critical functions like water filtration. This presentation will review a yearlong study that compared the colonization of Ordinary Portland Cement, a patent-pending $CaCO_3$ concrete, and these concretes containing 50% algae by dried volume. Sixty disks of each substrate (6.5cm tall, 10cm in diameter) were hung at three different depths off of a bulkhead outside the Baltimore Aquarium. Twenty samples of each substrate type were collected every three months for a year and were analyzed for macroinvertabrate colonization. This will provide insight to determine what affect substrate type has on colonization and to decide whether concrete is a viable option for carbon-sequestration (in the form of algae). At the same time, the temporal and spatial elements of this study offer an excellent opportunity to look at the interactions and life cycles of the little-studied false dark mussel and barnacles that settled on the samples, both of which are important filter feeders in the eutrophied Chesapeake Bay. The confluence of these ideas will inform listeners about 1) the effect of substrate-type on colonization; 2) some of the habitat preferences and

the interspecific relationships between false dark mussels and barnacles; 3) a lesson in adapting to and taking advantage of opportunities offered by mesocosm-scale research.

Biography: Samantha Francis began her research on the bioreceptivity of algae-concrete her Junior year at the University of Maryland, College Park with the help of her advisors, Dr. Patrick Kangas, Dr. Peter May, and Ms. Evelyn Tickle. Graduating with a B.S. in Environmental Science and Technology in 2018, she has used the last year to continue her research in her free time before she starts her M.S. at Ohio State University's Department of Food, Agriculture and Biological Engineering in the fall of 2019. There, she will be working with Dr. Jay Martin on a USDA-NIFA, Public-Private Partnership project to identify fields with elevated nutrient levels where management practices will be installed and monitored in an effort to reduce nutrient runoff.

(44) Characterization of Ecosystem Metabolism of Restored Coral in the Florida Keys

Presenter: Mauricio Arias, University of South Florida, mearias@usf.edu; Michelle Platz, University of South Florida

Co-Authors: Michelle Platz, University of South Florida

Abstract: In response to worldwide stony coral population declines, coral restoration programs have formed to culture robust corals and repopulate denuded reefs. Little restoration site monitoring is occurring however, as such efforts are limited by time-consuming and expensive methods involving sporadic field surveys by divers. This study hypothesizes that in-situ, continuous monitoring technology can be implemented within coral restoration practices to inform management decisions through the provision of high-resolution monitoring information and the development of engineered restoration site models. To the knowledge of the authors, this study represents the first attempt to continuously monitor coral metabolism specifically within a coral nursery and at restoration sites using in-situ sensors. Metabolism, one of the defining characteristics of life, is the process by which organisms take up nutrients, extract energy, and form new cell materials. Coral metabolism includes net community production (NCP), including respiration and photosynthesis, and net community calcification (NCC), including calcification and dissolution. Previous metabolism studies on natural reefs observed metabolic patterns to be reflective of visual benthic community composition, which restoration practitioners use to assess coral success, therefore, changes in NCP and NCC over time can be used as indicators of coral health and functionality at restoration sites. Using the gradient flux approach and the Benthic Ecosystem and Acidification Measurement System (BEAMS), this study aims to increase coral restoration efficiency through the provision of reliable and continuous monitoring feedback within nurseries and at restoration sites throughout the Florida Keys. Target research outcomes include understanding how metabolism measurements using technology compare with those made using traditional measurement techniques, how high-resolution information can be used to understand relationships between coral metabolism and current velocity, how restoration site benthic models could be used as a restoration-site selection tool, and how monitoring methods using technology could be made more available to the restoration community.

Biographies: Mauricio Arias is an Assistant Professor in the Department of Civil and Environmental Engineering at the University of South Florida. He moved back to Florida in summer of 2016 after completing a Post-doctoral research fellowship in the Sustainability Science Program at Harvard

University in 2014-2016. His research aims at creating science-based linkages between the hydrological cycle, ecosystems, and society in order to promote sustainable management of water resources. He has studied hydrological, ecological, and sustainability issues in freshwater ecosystems around the world, primarily in Southeast Asia (Mekong), Brazil (Amazon) and Florida. He holds a Bachelor of Science and a Masters of Engineering in Environmental Engineering Sciences from the University of Florida, and a PhD in Civil Engineering from the University of Canterbury in New Zealand.

As a participant in the Professional Practice Program at the University of Cincinnati, Michelle explored applications of the engineering profession, from facility engineering to hydrologic modeling and ecological research on methane emissions. Throughout her undergraduate education, Michelle discovered a love of research and a deep passion for marine ecosystems. Michelle completed a BS in Environmental Engineering from the University of Cincinnati in the spring of 2017. Michelle seeks to pursue research investigating ecological engineering methods to restore coral reefs and protect the ecosystem services they provide. Michelle is a recipient of a NSF Graduate Fellowship.

(45) Automated Geospatial Model Development for West Indian Manatees Habitat Suitability Analysis and Conservation Decision Support

Presenter: Sudhanshu Panda, Institute of Environmental Spatial Analysis (IESA), University of North Georgia (UNG), sudhanshu.panda@ung.edu

Co-Authors: Jeffery Robertson, IESA, UNG; Ashleigh Wilson, Biology, UNG; and Jeff Turk, Director & Professor of Engineering, IESA, UNG

Abstract: West Indian Manatees in the Florida coast are being severely affected by major hazards like boating collisions, red tide outbreaks, depletion in seagrass availability, and cold stress. Conservation by government and public together is required to safeguard its population decline from the consequence of latest climate change impact and other human induced hazards. The objective of this study is to develop an automated geospatial model to analyze all relevant features responsible for the West Indian Manatee habitat suitability analysis and suggest proper decision support on its conservation. This study is completed on the western coat (Gulf of Mexico) of Florida. Geospatial data such as historical boating collison record, marina site locations, population, landuse (crop cover that uses chemical harmful to manatees), bathymetry information (determining easy passage for manatees without getting hit by boat anchors, etc.), red tide spatial distribution, climate change related sea and atmospheric temperature, and availability of seagrass, the major food source of manatees. Geospatial data were preprocess on ArcGIS ModelBuilder platform to create manatee habitat suitability analysis related contributing factor rasters. These rasters were multiplied with weights (percentage contribution to the whole system), prepared as a Delphi-based analysis method. 'Weighted Sum' tool in ArcGIS, combined all factors to provide the suitable habitat location for West Indian Manatee habitat on a scale of high-moderate-low. Present conservation location data of the State of Florida were obtained and analyzed to find the spatial location that need to be conserved to safeguard the manatees. The critical areas not already safeguarded are proposed to the Fish and Wildlife Department for consideration in the creation of new protected habitats. This suitability analysis allows West Indian Manatee populations room for future growth. This automated model process can be applied for other aquatic animal habitat suitability analyses and conservation decision support system development.

Biography: Dr. Sudhanshu Panda is a professional engineer, who specializes in soil and water engineering, precision agriculture/site specific crop management, and geospatial technology and its application in sustainable ecological/environmental management. He is working as a professor of GIS & Environmental Science in the Institute of Environmental Spatial Analysis at University of North Georgia. He received his PhD in Engineering from the Biosystems & Agricultural Engineering program of North Dakota State University, Fargo, ND, USA and earned his M.Eng. degree in Environmental Remote Sensing for Geoinformation Development from the School of Space Technology Application Research of Asian Institute of Technology, Bangkok, Thailand. He has his B.S. degree in Agricultural Engineering from Odisha University of Agriculture & Technology, Bhubaneswar, India. Dr. Panda has the unique experience of working in all three platforms of professional career, i.e., government field engineer, engineer in multi-national engineering consulting company, and academic with teaching and research in universities. His researches are in the field of bioenergy production, global warming and climate change, water resources/watershed management, precision agriculture, site specific crop management, forest management, animal health management, sustainable biodiversity management with geospatial technology and artificial neural network applications. Dr. Panda is a prolific modeler- developing models with ArcGIS ModelBuilder along with in statistics and artificial neural networks platform. He is a software developer with Visual Basics Studio and Python for environmental management decision support system development along with a strong expertise on WebGIS site development.

CONCURRENT SESSION 4

(46) Looking Beyond Ecological Functions to the Value of Ecosystem Services in the Greater Houston Region

Presenter: Deborah January-Bevers, Houston Wilderness, deborah@houstonwilderness.org

Co-Authors: Lindsey Roche, Houston Wilderness, lindsey@houstonwilderness.org; Lauren Harper, Houston Wilderness, lauren@houstonwilderness.org

Abstract: Natural landscapes serve our wellbeing in a variety of ways: water purification, flood protection, hurricane protection, carbon capture, recreation and wildlife enhancement. Identifying and understanding the services provided by local ecosystems can lead to cost-effective solutions to infrastructural and environmental problems while also creating enhanced wildlife habitat in urban/suburban areas. For the storm-prone Gulf-Houston region there is a critical need to better connect the ecosystem services (ES) provided by the diverse assemblages of forests, prairies, wetlands, riparian waterways and shorelines to maximize the economic and social benefits.

The region has a unique, clay-rich soil composition largely of vertisols and alfisols which greatly influences infiltration and runoff, especially during heavy rain events. Knowledge and understanding of the soil composition can help guide the discussion and implementation of projects targeting ES, particularly flood regulation, erosion regulation, and water provisioning.

This presentation is based upon Houston Wilderness' Ecosystem Services Primer which discusses ways for determining ES values using different study/valuation methods depending on the goals of a decision-maker. Local and regional case examples are discussed, where ES valuation options between gray and

nature-based infrastructure were analyzed and the natural solutions were implemented. In an expanding urban core such as the Gulf-Houston Region, there is a critical need to: (1) Engage in more region-based studies on ES to better understand the value of natural benefits and cost-effective infrastructure policies; (2) Compare the economic value of ES to other alternative approaches when making public policy decisions regarding land-use and infrastructure; and (3) More fully incorporate ES into infrastructure decisions. The presentation will also briefly discuss the Gulf-Houston Regional Conservation Plan and its “24% By 2040 Land-Use Strategy” to improve ecological and economic resiliency in the eight-county region through preservation/enhancement by increasing the current 9.7% in protected/preserved land to 24% of land coverage by 2040.

Biography: A native Houstonian, Deborah has been involved with public policy and civic projects in and around Houston and the State of Texas for over 30 years. She is currently President & CEO of Houston Wilderness (www.houstonwilderness.org) She received her Bachelor of Arts from the University of Texas in 1985 and her J.D. from the University of Houston Law Center in 1992. She has served as a policy director for the Greater Houston Partnership and Center for Houston’s Future, and Executive Director of the Quality of Life Coalition and Scenic Houston. Over the years, she has worked in Congress, in the Texas Legislature and with various city mayors and council members, along with a wide variety of non-profit and business organizations to help create, develop and implement a variety of policy initiatives to improve the Houston Region’s quality of life. Deborah and the other Houston Wilderness staff are currently working with 100+ civic, governmental and business organizations to develop and implement an 8-county Gulf-Houston Regional Conservation Plan to promote, protect and preserve the 10 distinct ecoregions in and around the Greater Houston Region.

(47) The Alternative Headwater Channel and Outfall Crediting Protocol

Presenters: Scott Lowe, McCormick Taylor, sblowe@mccormicktaylor.com

Abstract: The Alternative Headwater Channel and Outfall Crediting Protocol (February 2018) is developed to more accurately calculate the sediment and nutrient delivery for Total Maximum Daily Load (TMDL) credit involving headwater channels and outfall restoration projects experiencing vertical incision. Headwater streams in Maryland account for approximately 60% of the stream network. This network of streams is an important resource for supporting biodiversity, processing nutrients, filtering pollutants, mitigating flooding, recharging groundwater, habitat for aquatic and terrestrial organisms, and a food source for connected water bodies. The interconnection of this network is an important function in processing nitrogen due to a large channel bed surface function to overlying water volume leading to increase contact and exchange of water and nitrogen with the hyporheic zone.1 Long-term anthropogenic impacts threaten the functional benefits of headwater streams. Headcut development and migration disconnects or fragments a stream system. Headwater streams referenced in the protocol include zero and first order channels as defined using the Strahler2 and modified Horton3 methodology. The protocol calculates the potential sediment and nutrient delivery from vertical incision by computing the future equilibrium slope or the wedge of sediment transported downstream over a 30-year period. The protocol expands and builds upon currently approved crediting procedures in the “Final Recommendations of the Expert Panel to Define Removal Rates for Individual Stream Restoration Projects.” The method is currently in the final stages of acceptance by the Chesapeake Bay Program’s Urban Stormwater Work Group.

Implications of the new calculations of the prevention of sediment and nutrient loading for arresting channel incision includes increased cost effectiveness for headwater and outfall restoration projects. It also opens up the opportunity to transition headwater restoration projects from a linear foot model to a sediment/nutrient load model. A true focus on ecological uplift includes connecting streams to floodplains and preventing vertical disconnections has true potential for maximizing ecosystem wide functional uplift.

Biography: Mr. Lowe is a Director of Environmental Services for McCormick Taylor. He has over 23 years of experience performing all aspects of environmental design and permitting services throughout the Mid-Atlantic Region. Scott currently serves as the Environmental Restoration Coordinator for MDOT SHA's TMDL Program, assisting the program with developing BMP strategies and crediting and managing data collection and site selection for stream and outfall restoration projects.

(48) Stabilization Alternatives – Living Walls – Another Choice to Consider

Presenter: Wade Burcham, Geosyntec, wburcham@geosyntec.com

Abstract: Often there are better design options to protect stream banks and shorelines than traditional hard measures. Ideally, we want to use Mother Nature as a template, and utilize design concepts that incorporate only natural materials. However, projects occasionally present with situations such as schedule limitations (e.g. emergency repairs) or physical limitations (e.g. lack of space) that require the consideration of traditional measures. Designers must be able to rapidly sift through their toolbox of ideas to quickly determine the best solution. This presentation seeks to provide designers and planners with another tool to place in their toolbox; a tool that can meet many project limitations, and is regenerative. It can be used to retrofit and enhance traditional designs and methods. This design tool is living walls. Living walls such as Filtrexx's GreenLoxx® products, applications, and resources will be presented, along with case studies that describe considerations for product selection, design, construction, and lessons learned. Examples of both Non-MSE and MSE living walls will be presented, as well as a summary of some quantitative environmental impacts.

Biography: Wade Burcham is a PE and serves as Principal Water Resources Engineer with Geosyntec. He graduated from the University of Alabama in Birmingham. His 21 years of experience focused on natural stream stabilization, water resources engineering, stormwater management, municipal engineering, and contract administration has facilitated a balanced viewpoint from perspectives obtained as Civil Engineer, Municipal Consultant, and Developer's Representative. Wade enjoys learning Sustainable and Innovative Design Practices and applying those techniques in developing countries through his volunteer work with Engineering Ministries International and other Faith-Based Mission efforts.

(49) Preventing Animal-Vehicle Crashes Using a Smart Roadside Detection Technology and Warning System

Presenter: Cristian Druta, Virginia Tech Transportation Institute; cdruta@vtti.vt.edu

Co-Authors: Andrew Alden, Virginia Tech Transportation Institute, aalden@vtti.vt.edu

Abstract: Animal-vehicle collisions (AVC), and deer-vehicle collisions (DVC) in particular, are a major safety problem on Virginia roads. Mitigation measures such as improved fencing and location-specific

driver alerts are being implemented and evaluated in Virginia and elsewhere. One of the most promising mitigation methods uses a buried cable animal detection system (BCADS) to provide roadside or potential in-vehicle warnings to approaching drivers based on the active presence of an animal on or near the roadway. BCADS may also be deployed in combination with exposure controls such as fencing to provide monitored, at-grade, animal crossing zones where conventional passages are unavailable.

In a recent study, the Virginia Department of Transportation in collaboration with the Virginia Tech Transportation Institute implemented and monitored the performance of a buried system on a public road to provide a real-world assessment of system capabilities and possible operation issues.

A BCADS was installed on a road segment known to have a high rate of DVCs to sense crossings of large- and medium-sized animals and provided data on their presence and location along the length of the cable. A flashing light "Deer Crossing" warning sign was installed at the site and wirelessly linked with the BCADS to alert approaching drivers. Continuous all-weather video surveillance data were collected for a year to monitor animal movement and system performance.

Study findings indicate that the BCADS is capable of detecting larger animals such as deer, and sometimes smaller animals such as coyotes, with approximately 99% reliability. The system also performed well when covered by approximately 2 ft of snow. Vehicle speed and brake application data collected during warning sign activation showed that approximately 80% of drivers either braked or slowed in response to the flashing, indicating that the sign was effective.

Biography: Cristian Druta is a Senior Research Associate and project manager at Virginia Tech Transportation Institute (VTTI) and has been involved with simulative pavement testing, vehicle-roadway interaction, sensing technologies, and data collection and analysis research for the last 10 years. He has served as PI/Co-PI on a broad range of subject areas including materials characterization, vehicle instrumentation, energy harvesting from pavements, and wireless sensing technologies. He currently oversees research on animal-vehicle conflicts mitigation and vehicle-based road weather data collection.

(50) Resilient Water Systems for Urban Agriculture: The Patchwork Urban Farms Experience

Presenter: Tim Ormond, Blue Earth Planning, Engineering & Design, PC, tormond@blueearth.us; Sunil Patel, Patchwork Urban Farms, patchworkurbanfarms@gmail.com

Abstract: Urban farming has become increasingly recognized as an essential component of sustainable local food systems in the age of rapid climate change. Urban farming can help to regenerate barren landscapes, build important connections among individuals, communities, farmers and their local food systems as well as significantly reduce the carbon footprint of food production. One particular challenge in urban farming, compared to larger traditional farms, is the need for providing reliable, sustainable, cost-effective water supply systems for growing food.

Patchwork Urban Farms (PUF) was launched in Asheville, North Carolina in 2014 as a unique, mission-driven, multi-plot, urban farming initiative to provide ultra-local, organically grown food. PUF's mission involves building vital connections between landowners with small, underutilized, urban plots (primarily in residential areas) and the local community through CSA shares, partnerships with local restaurants,

farm stands to provide healthy food within under-served "food desert" neighborhoods, as well as providing food and farming education. Since its inception, PUF has grown into a cooperative with multiple farmers, more than 20 land share partners, work traders, interns, and hundreds of weekly consumers in the local community.

This presentation will provide an overview of the PUF model of regenerative urban agriculture of "reconnecting our lives with our landscapes" and focus on the challenges and successes of providing reliable, cost-effective, climate-resilient water supplies for its multi-plot, urban farm initiative. Lessons learned will be presented for various water source options including rainwater harvesting and municipal water supplies as well as the role of irrigation systems and water conservation strategies.

Biographies: Tim Ormond, P.E. is an Asheville-based environmental and water resources engineer with over two decades of experience. He specializes in hydrology and hydraulics, stormwater management, green infrastructure planning and design, and innovative research. Tim holds a B.S. degree in civil and environmental engineering, an M.S. degree in civil and water resources engineering as well as a permaculture design certificate. He is a licensed professional engineer in North Carolina, Tennessee, Texas, Massachusetts, and California. Tim is a co-founder of Blue Earth Planning, Engineering & Design, PC, a consulting firm whose mission is "to provide innovative water resources planning, engineering and design within a company framework which values the earth, people, and future generations over profit." He has also been a volunteer member of the Asheville-Buncombe Food Policy Council since 2014 and a work-trade partner with Patchwork Urban Farms.

Sunil Patel is a farmer, permaculturist, and food/farming thought-leader who has studied natural farming methods and worked for farmers in California, West Virginia, New Jersey, and Oregon. Along the way, he collected many skills including growing four-season biodynamic vegetables, managing a grass-fed dairy herd, making artisanal raw milk cheese, baking for production in a commercial wood-fired oven, natural building, and helping maintain permaculture sites. Early in Sunil's career, he managed a large CSA for about four years in his home state of Pennsylvania. In that time, he expanded a quarter acre plot into a 12-acre working farm. In January 2013, he relocated to Asheville to teach urban farming and in early 2014 Sunil launched Patchwork Urban Farms, a multi-plot, urban farm creating sharing networks around abundant landscapes in Asheville.

(51) The Seasonality of Nutrients in Stormwater Runoff from Residential Sewershed in Columbus, Ohio

Presenter: Joey Smith, The Ohio State University, smith.10402@osu.edu

Abstract: Discharge of excess nutrients to surface waters is a societal challenge because they cause algal blooms and hypoxia, resulting in degraded water quality (Watson et al. 2016), reduced and contaminated fisheries (Bukaveckas et al. 2017, Witusynski et al. 2017), threats to potable water supplies (Lee et al. 2017), and decreases in tourism, cultural activities, and coastal economies (Wolf et al. 2017, Watson et al. 2016). An understanding of the urban contribution to nutrient loading is needed, and, more specifically the seasonality in nutrient concentrations and loads needs further analysis since algal blooms and hypoxia are seasonal in nature and are most impacted by spring nutrient runoff. This study quantifies the variation of nutrients in stormwater runoff due to seasonal changes from four urban residential sewersheds located in the Clintonville neighborhood of Columbus, Ohio. Stormwater

samples were collected using automated samplers during stormflow and analyzed for pollutants, including dissolved and particulate nutrients. Total nitrogen concentrations were significantly (alpha = 0.05) higher in the spring when compared to the summer and fall. Significant seasonal variations in TP concentrations were observed at three of the four sewersheds, with fall and spring concentrations greater than those in summer. Among the top ten TSS concentrations observed from September 2016 to December 2018, seven occurred in the spring, two during the summer, and one in the fall. Causes for seasonality include fertilizer application in the spring, sodic soils following winter deicing salt applications, and the breakdown of leaves. Since seasonality was observed, future research efforts should to be focused on developing improved management of landscapes and stormwater during critical periods. Improved designs for stormwater control measures will help to abate pollutants in stormwater runoff from urban areas, improving the quality of surface waters worldwide.

Biography: Joey Smith graduated from The Ohio State University in May with his B.S. in Ecological Engineering and B.A. in Mandarin Chinese. He is staying at Ohio State to earn his M.S. in Ecological Engineering with co-advisors Dr. Ryan Winston and Dr. Jay Martin. His research focuses on stormwater nutrients and the Blueprint Columbus project, which is an initiative to install green infrastructure in Columbus, Ohio. In the future, he plans to travel to China to conduct Ecological Engineering research.

(52) Hydrological Responses of Retrofitted Green Infrastructure

Presenter: Kathryn Boening, The Ohio State University, boening.3@osu.edu

Co-Authors: Dr. Ryan J. Winston, The Ohio State University, winston.201@osu.edu; Dr. Jay F. Martin, The Ohio State University, martin.1130@osu.edu

Abstract: Blueprint Columbus is a $1.7 billion-dollar effort by the City of Columbus to rehabilitate its sewer infrastructure which currently results in both combined and sanitary sewer overflows. Part of the remediation approach is retrofitting green infrastructure, predominantly bioretention cells and permeable pavement, into existing Columbus neighborhoods. The project's first phase is in the Clintonville neighborhood where over 400 bioretention cells were installed and five streets or alleys were retrofitted with permeable pavement. Analyzes and testing were designed at two different scales to better understand how the connected green infrastructure functions. The first analysis conducted is a paired watershed experiment, developed to quantify the effects of Blueprint Columbus on stormwater runoff. Four sewersheds are being intensively monitored: one control (i.e., no green infrastructure) and three with varying densities of green infrastructure. Sewershed outfalls have been instrumented for continuous hydrologic monitoring and flow-proportional, composite sampling since 2016. Comparing hydrologic data across pre-retrofit, construction, and post-retrofit phases will quantify the impacts of the green infrastructure implementation. Comparisons for the three phases were hampered by differences in precipitation patterns and shorter antecedent dry periods observed 2018, which was the wettest year on record in Columbus, Ohio. The runoff coefficient for the watersheds with retrofits, did not increase as much over the past year compared to the other watersheds. The second scale at which the hydrological responses are examined is at individual bioretention basins. Individual bioretention cells are tested for runoff mitigation using simulated storm tests. Results from two tests of a single bioretention cell showed 45% and 55% runoff volume reductions. Monitoring will continue through 2022 and will help to establish a path forward for the City of Columbus's other planned retrofits and to better understand the functionality of the infrastructure over time.

Biography: Kathryn Boening is a graduate student at The Ohio State University under Dr. Jay Martin and Dr. Ryan Winston, pursuing a Masters degree in Ecological Engineering. Heralding originally from the Northern Kettle Moraine Forest of Wisconsin, Kathryn has always had an affinity for the outdoors and a drive to better the environment. Kathryn's current research focuses on sustainable urban development, specifically connecting stormwater and green infrastructure practices.

(53) Solving the Watershed Challenge Through Optimized Solutions

Presenter: Karina Bynum, Tennessee Water Resources, karina.bynum@tn.gov

Abstract: Watershed as a hydrologic unit in a developed landscape is controlled by socio-political and economic forces as well as the physical laws of nature. It is the community that defines how these forces are distributed, balanced or leveraged. A key connection between the socio-political and economic forces and the physical laws is evidenced in the quantity and quality of water resources. Access to abundant clean water underpins the health and prosperity of the community. The effects beyond the local community affect others and therefore are governed by regulations. The regulatory framework of discharge permits, TMDLs, mitigation crediting, flood control and stormwater management produced a system of incentives and restrictions as well as opportunities for stakeholder input. EPA's New vision, TMDL alternatives, integrated permitting, credit trading and various reduction strategies emerged in recent years to address the need to appropriately regulate water quality impacts in a more adaptable context and to accommodate effective stakeholder-driven processes. The regulatory framework needs to further prepare to include stormwater mitigation crediting, ecosystem restoration, credit trading, voluntary partnership agreements, citizen science and corporate sponsorship. To enable future generations to solve the challenge of assuring abundance of highest quality water for the lowest cost, we need to be prepared to develop and implement custom solutions that optimize the location, techniques, treatments, planning and management, include stakeholder engagement and involvement, and provide for funding, monitoring and reporting. While we understand the individual components of stormwater management, point source discharge treatment, stream restoration techniques, and land use planning, we must use them in the watershed context much like building an electrical circuit board to leverage their function, understand their controls and optimize their overall effect. Watersheds are complex adaptive systems and watershed health and water quality remain a challenge now and for generations to come.

Biography: Karina Bynum, Ph.D., P.E. works for the Division of Water Resources at TDEC (Tennessee Department of Environment and Conservation). Under TDEC's watershed approach, her work includes developing performance criteria for stormwater, optimizing wastewater operations for nutrient removal, developing TMDL monitoring plans, and consulting on stream and wetland restoration projects. Karina holds Bachelor's and Master's degree in civil and environmental engineering from Tennessee Technological University and a Ph.D. from the Czech Technical University in Prague on adaptive watershed restoration. Karina is a registered engineer in the state of Tennessee and has 20 years of regulatory experience.

(54) Are Stormwater Regulations Holding Back More Than Runoff? – An Evaluation of Watershed Protection Strategies

Presenter: Hunter Freeman, WithersRavenel, hfreeman@withersravenel.com

Abstract: Watershed ecosystems are complex areas consisting of streams, lakes, vegetation, and soil but prescriptive protection plans often fail to recognize humanity's connection to these natural environments. For years North Carolina's stormwater management regulations have been a three legged stool – TSS Removal, Peak Flow, and Nutrients. Show compliance with those standards at the site level, and you've protected the watershed, right? Our streams might disagree. What if we looked at more than just the design of the stormwater controls to predict the level of protection we provide the streams? It's time to evaluate other areas of land development regulations to help provide a more comprehensive assessment of our efforts to protect the natural resources of our ecosystems.

WithersRavenel has developed a watershed scale ecosystem evaluation methodology to guide future land development practices and incentivize conservation and high performing watershed protection strategies. As our state's population centers continue to grow, everything from conservation areas to the urban core plays a role in preserving the health of the waters. The evaluation's goal is to push developers towards the construction of sustainable communities that heighten both the quality of life and the ecosystem protection efforts.

The evaluation works as a weighted points system of 26 watershed protection strategies. The evaluation incentivizes strategies based on their potential value to the watershed and their ability to enhance community life. Points are scored in 6 categories – Conservation, Construction Site Controls, Stormwater Management, Landscaping, and Pilot Projects. A minimum required point total was established through a case study evaluation of numerous North Carolina communities. The point total requirement seeks to ensure that a variety of measures are used, and that cumulatively the ecosystem value of these strategies exceeds the value delivered through typical regulatory requirements.

Initial implementation has shown that by assessing multiple variables, the boundaries between stormwater management, land planning, and landscape architecture are less evident in the final product. Additionally, the evaluation has served to add value to high quality conservation areas and has been a catalyst for innovative stormwater management approaches.

Biography: Hunter leads the innovative stormwater design group at WithersRavenel. He specializes in delivering high performance stormwater projects focusing on sustainability, green infrastructure, and improving quality of life. He is currently working on projects ranging from community master planning, coastal resiliency, and stormwater program management.

(55) Introduction to the Community-Enabled Life-Cycle Analysis of Stormwater Infrastructure Costs (CLASIC) tool

Presenter: Christine Pomeroy, University of Utah, Christine.Pomeroy@utah.edu

Co-Authors: Tyler Dell, Colorado State University; Sybil Sharvelle, Colorado State University; Jennifer Eagan, University of Maryland
Abstract: Limited funds require many decision makers in the municipal environment to make difficult decisions in regard to stormwater programs. Many communities are trying to receive the most return on their investment in stormwater technologies by selecting technologies that can confer multiple environmental, social and economic benefits. There is a balance that is being sought by decision makers in using traditional gray infrastructure and newer green infrastructure for stormwater management, and the balance is being found through comparing costs of adopting each type of technology. The Water Research Foundation is leading a project intended to provide communities with a tool that takes into account the costs associated with planning, designing, acquiring, constructing, operating, maintaining, renewing, and replacing stormwater infrastructure. Additionally, the tool seeks to identify co-benefits that are achieved by various types of stormwater infrastructure while quantifying performance of the infrastructure. The results are expected to increase confidence in comparing benefits and costs of stormwater infrastructure alternatives using tools based on cost, design, and performance data sets with a peer-reviewed model.

CONCURRENT SESSION 5

(56) Beginning a Career in Environmental Restoration and Planning: A Perspective for Students Looking to Join the Workforce

Presenter: Joe Garner, GreenVest, LLC, garnercjoe@gmail.com
Abstract: This presentation focuses on my experiences as an entry-level environmental scientist including the transition from an undergraduate student and highlights my role providing construction oversight and project support at GreenVest, LLC. The Mattawoman Creek Mitigation Site (MCMS) is an eighty (80+) acre mitigation bank site in Maryland that features integrated stream and wetland components. Old Womans Run (OWR), the focus of stream restoration, was previously impaired and disconnected from its floodplain by an artificial levee created when the stream was historically straightened. A lighter-touch design approach was taken to restore OWR, achieving floodplain reconnection through strategically placed levee breaches and constructed in-stream large woody debris structures. Adjacent floodplain wetland restoration was designed and constructed to retain water for the maximum extent practical during more frequent (1.25, 1.5 year) out-of-bank events, supporting infiltration and evapotranspiration. In the northern portion of the site, large woody debris structures were installed in an unnamed tributary, providing habitat and promoting hydrology into adjacent restored wetlands. Various arrangements of brush and wood debris were used to create stream and wetland habitat. Experiences as an entry level scientist conducting stream and wetland restoration oversight have revealed many skills and lessons (some of which are not typically taught collectively in a college curriculum[PP1]) that would benefit aspiring ecological engineers and scientists. I hope to share insight on what students can expect when looking for environmental jobs and the skills they can focus on as undergraduates to better prepare themselves. This presentation is meant to describe my experiences with this innovative restoration project and foster discussion amongst students and those interested in ecological restoration.

Biography: Joe Garner is a recent graduate from the University of Maryland College Park with a B.S. in Environmental Science and Technology. He presented at last year's Annual AEES Conference on his research that assessed the application of harvested algae from an algal turf scrubber as a fertilizer. He is now an entry level environmental scientist with GreenVest, LLC, and provides construction oversight on large scale ecological restoration projects. Outside of his work with GreenVest, he continues to conduct research into the applications of algal fertilizer with Dr. Patrick Kangas, professor at the University of Maryland, and former AEES President.

(57) Stream Mitigation Design and Construction for an Over Widened Bedrock Channel

Presenter: Micheal Pannell, S&ME, Inc., mpannell@smeinc.com

Co-Authors: Patrick McMahon, S&ME, Inc., pmcmahon@smeinc.com; Brent Wood, S&ME, Inc., bwood@smeinc.com; Ken Barry, S&ME, Inc., kbarry@smeinc.com

Abstract: Many stream mitigation projects use the natural channel design methodology. But this approach is sometimes difficult to apply, particularly when performing on-site mitigation, where the constraints of the site often dictate what is possible. This presentation provides a look at the challenges of designing and constructing an on-site stream mitigation project comprising the enhancement of 850 feet of perennial stream channel lying on bedrock with adjacent fringe wetlands. Because the stream profile follows existing bedrock and the fringe wetlands were not to be disturbed, neither plan form realignment nor profile modification were proposed. For this reason, a reference reach was not considered in the final design.

The project challenges included design and construction of an appropriately dimensioned channel on bedrock while minimizing impacts to the adjacent wetlands. Baseline data for the existing stream were collected and used to establish a bankfull discharge for the proposed design. The existing channel dimension values were compared with published regional curve data for Ecoregion 71i to calibrate bankfull for the observed cross sections. Following calibration to the observed bankfull discharge, the slope was calculated based on the length of the existing alignment, and a new riffle cross section was developed. This restoration design implements a novel approach for using coir blocks to form the new channel cross section on the bedrock surface.

(58) A Methodology for Developing a Compound Flooding Model Using Long-Term Data Collection and Basic Stochastic Hydrology

Presenter: Nolan Williams, Robinson Design Engineers, nw@robinsondesignengineers.com

Co-Authors: Joshua Robinson, MS, PE, Robinson Design Engineers, jr@robinsondesignengineers.com; Anand Jayakaran, PhD, PE, anand.jayakaran@icloud.com

Abstract: Coastal regions across the globe have become increasingly susceptible to flooding impacts associated with urbanization, hydromodification, changing weather patterns, and the increased frequency and intensity of tropical storm systems. However, when flooding occurs in coastal environments, it can rarely be attributed to one single driver. In many cases, flooding in this

environment can be considered as "Compound Flooding;" that is flooding that results from the combined effects of several different hydrologic drivers, specifically rainfall-runoff processes and tidal forces. The complex flood behaviors of systems affected by both tidal effects and rainfall-runoff processes are often simulated using hydrology and hydraulic modeling software packages. The process of developing and operating computational models capable of accurately simulating these behaviors is resource intensive, and without proper calibration and verification, these models are capable of grossly misrepresenting system behaviors. As an alternative, this study details a method for predicting general flood behaviors using simple mathematical models developed using field data collection, long-term monitoring, and basic statistical hydrology analyses.

For this study, water level and rainfall depth recording instrumentation were installed along a tidally influenced tributary of the Ashley River, called Church Creek, located in Charleston, SC. Using data collected from this gage station, along with publicly available data from a series of gages operated by government agencies, regression analyses were used to mathematically isolate the effects of tide and rainfall-runoff on the peak water level of Church Creek. After isolating the separate effects of these two processes, a "Combined Flooding Function" was developed for predicting the peak water level in Church Creek based on the peak tide in the Ashley River and a multi-day rainfall total in the watershed. Using the function, joint-probability analyses were then used to investigate the recurrence of flooding based on a range of tide conditions and rainfall depths.

Biography: Nolan Williams is a Hydrologist and Engineer-in-Training with Robinson Design Engineers in Charleston, South Carolina. Nolan has a BS in Civil Engineering from the Georgia Institute of Technology. While at Georgia Tech, Nolan was involved in several projects and research efforts regarding urban hydrology and the use of green infrastructure in stormwater management. Since joining Robinson Design Engineers, Nolan has taken a special interest in furthering the use of data collection, long-term monitoring, and stochastic hydrology in engineering.

(59) Effective Stream Restoration Construction Management within Piscataway Creek

Presenter: Paul Le Bel, Hazen and Sawyer, plebel@hazenandsawyer.com

Abstract: The Washington Suburban Sanitary Commission (WSSC) retained Hazen to design protection measures for two dozen exposed sanitary sewer assets within the Piscataway Creek Basin in Prince George's County, Maryland, as part of its sewer repair, replacement and rehabilitation program. Hazen stream restoration designers developed Priority I-IV designs to restore stable channel form and function based on asset location, site constraints and erosion severity. Construction began in December of 2015 and was completed in 2019. During construction, Hazen designers worked closely with WSSC and its contractors to ensure protection measures met design intent. This presentation highlights several construction management topics deemed important to the owner (WSSC), the contractors, and the designers, including: (1) the determination of construction oversight budget and schedule; (2) the importance of designer presence during the first installation of any structure type (e.g., cross vane, j-hook); (3) communication and reporting mechanisms to provide both immediate/actionable feedback and record documentation; (4) the utility of scheduling tree removal site walks immediately after disturbance stakeout but prior to mobilization; (5) the development of efficient construction management habits; (6) satisfactory quality control of construction management reporting; and (7) the importance of flexibility to accommodate changes in existing conditions (such as new asset exposure,

the complete loss of assets occurring between design and construction, unanticipated bedrock, and new stormwater pipe discharges). This presentation will touch on lessons learned throughout the construction phase of the project, as well as key analyses and design decisions which affected construction.

Biography: Paul Le Bel is a Principal Engineer with Hazen who specializes in analysis, design and construction oversight for stream restoration, asset protection and urban stormwater management projects. Paul works throughout the Mid-Atlantic region to provide stream assessment, design and construction phase services for time sensitive projects. Paul works extensively with owners and contractors during the construction phase to ensure design intent is met and appropriate guidance is provided for field adjustments. He works out of the Fairfax, VA office where he is frequently involved in projects that benefit the Chesapeake Bay.

(60) Expanding Asset Protection to Include Stream Restoration Techniques

Presenter: Joel McSwain, Hazen and Sawyer, jmcswain@hazenandsawyer.com

Abstract: Throughout the Southeast and Mid-Atlantic, urban streams have eroded and incised over the years from more intense flow regimes. One by one, these streams expose sanitary assets buried decades ago. The repair and protection of damaged and exposed sanitary assets is often seen as a more immediate need than stabilizing the impaired stream that is often the culprit for the damage. The site evaluations commonly arrive at the question of spot repair and localized hard armoring versus addressing incision or lateral migration of an impaired and incised stream. Separate departments and separate budgets for municipal sanitary and stormwater can make coordination difficult, and the fact that critical asset exposures often appear one at a time can make larger and more expensive stream restoration solutions difficult to justify; however, there are clear benefits in providing a more holistic solution.

This presentation will focus on reasons to consider protection of sanitary assets and the restoration of degraded streams together for the best results including long-term asset stability, protection of other infrastructure, water quality, and added ecological benefits. Included will be evaluation tools and criteria for making design decisions, and discussion about what can be done by both public utilities and private consultants to ensure that the most efficient and effective approaches are considered and implemented. It will be shown how different municipalities have used the need for asset protection as an opportunity to evaluate surrounding stream conditions and then make informed decisions about the most effective locations and approaches for asset protection and stream restoration.

Biography: Joel McSwain is a Principal Scientist with Hazen and Sawyer and specializes in stream and wetland restoration. He has over 12 years of experience in the field and currently serves as lead stream restoration designer and project manager on a variety of stream and stormwater related projects.

(61) Ammonia Oxygen Demand Determination for the Design of an Oxygenation System in a Water Supply Reservoir

Presenter: Sumaia Islam, Georgia Southern University, si00614@georgiasouthern.edu; Francisco Cubas, Georgia Southern University

Co-Authors: Armond Jenkins, Georgia Southern University

Abstract: The Occoquan Reservoir, located in northern Virginia, is a eutrophic water supply reservoir that is part of an indirect potable reuse system. After the onset of thermal stratification, anaerobic conditions develop in the hypolimnion during summer months. To protect the reservoir's water quality, an oxygenation system was installed and operated for eight years during summer months to avert the onset of anaerobic conditions in the hypolimnion and subsequent release of reduced substances from the sediments. During the warmest months of the year, oxygen depletion rates above the sediment-water interface exceed artificial oxygen supply rates resulting in ammonia accumulation in the water column. Field observations and laboratory experiments revealed that sediment ammonia release rates ranged from 170-542 mg/m2·day. At these rates, ammonia concentrations reached values as high as 5.6 mg-N/L in the absence of oxygen, and as high as 2 mg-N/L when the oxygenation system was operational. Ammonia release rates were also used to determine the total ammonia oxygen demand during the stratification period. Results revealed that the hypolimnetic ammonia oxygen demand might reach values as high as 77 metric tons of oxygen during a stratification period of 140 days. Furthermore, ammonia oxygen demand represented 20-100%, and in some cases more than 100% of the hypolimnetic oxygen demand estimated from oxygen depletion curves, which are commonly used to design aeration/oxygenation systems. Ammonia oxygen demand is typically considered quite negligible when compared to the demand from organic matter or other reduced substances (e.g., iron and manganese). However, this study revealed that under extended anaerobic periods, ammonia oxygen demand was three times higher than the total oxygen deficit calculated from oxygen depletion curves measured in the reservoir. These results highlight the significance of estimating benthic fluxes of reduced substances (e.g. ammonia) while designing any oxygenation system.

Biography: Sumaia Islam is a grad student and Research Assistant at Civil Engineering Department at Georgia Southern University. Her research focused on release of reduced substances in aerobic and anaerobic condition for sediments. She is also working with characterization of organic matter released from sediment during hypolimnetic anoxia. Before starting her Masters', she graduated in Urban and Regional Planning from Bangladesh University of Engineering and Technology. She also worked for almost 1.5 years on different projects focused on sustainable water resource management, climate change mitigation and adaptation, water security for the poor and so on.

(62) Forming Public-Private Partnerships to Identify and Manage Agricultural Fields with Elevated Phosphorus in the Western Lake Erie Basin

Presenter: Nathan Stoltzfus, Ohio State University, stoltzfus.12@osu.edu

Co-Authors: Dr. Jay Martin, Ohio State University Department of Food, Agricultural, and Biological Engineering, Martin.1130@osu.edu; Dr. Margaret Kalcic, Ohio State University Department of Food, Agricultural, and Biological Engineering, kalcic.4@osu.edu; Greg LaBarge, Ohio State University Extension, labarge.1@osu.edu; Dr. Robyn Wilson, Ohio State University School of Environment and Natural Resources, wilson.1376@osu.edu; Dr. Brian Roe, Ohio State University Agricultural, Environment, and Development Economics, roe.30@osu.edu; Dr. Ryan Winston, Ohio State University Department of Food, Agricultural, and Biological Engineering, winston.201@osu.edu; Dr. Jessica D'Ambrosio, The Nature Conservancy, jessica.dambrosio@tnc.org; Dr. Kevin King, USDA ARS, kevin.king@ars.usda.gov

Abstract: Agricultural production can lead to significant nutrient loss that diminishes surface water quality. Globally, this results in eutrophication and harmful algal blooms (HABs) as is the case for the western Lake Erie basin Within this basin, the Maumee watershed is the largest phosphorus (P) source contributing to recurrent HABs, and this basin is dominated by agricultural land use. Some agricultural fields have soil test P concentrations exceeding maximum recommended agronomic levels of 40 ppm with more than 5% of cropland having soil test P levels exceeding 2.5 times the that recommendation (100 ppm). These "elevated P fields" are at risk of contributing disproportionate P loads that can persist for decades. Targeting these elevated P fields with best management practices (BMPs) is likely to be effective at reducing nutrient loads and the severity of future harmful algal blooms. Field-level soil data is needed to find and target these sites; however, the proprietary nature of this data inhibits this approach. To overcome this barrier, we have formed a public-private partnership with nutrient service providers (NSPs) to demonstrate how proprietary data can be used to target BMP implementation and test hypotheses about elevated P fields. Partner NSPs provide de-identified data used to identify potential sites for BMP implementation. Additionally, this data will be used to improve knowledge of the extent and distribution of elevated P fields in the watershed. We will work with the NSPs to recruit the farmers to participate in a study that implements BMPs on their fields. Water quality monitoring combined with socioeconomic analyses and watershed modeling will predict the impact that BMPs can have by targeting these fields. An extension program will promote the application of BMPs on elevated P fields and highlight the ability of public-private partnerships to address water quality issues.

Biography: Nathan Stoltzfus is a Professional Engineer with experience in site design, stream restoration design, hydrologic and hydraulic modeling, construction oversight, and project management. This, combined with his agricultural experience growing up around and working on family farms is helping him in his current role as Project Manager/Project Engineer at Ohio State University working on a large agricultural water quality research project

(63) Assessing the Water Quality Cocktail Entering Recreational Lakes

Presenter: Tiffany Messer, University of Nebraska – Lincoln, tiffany.messer@unl.edu

Co-Authors: Mary G. Keilhauer, University of Nebraska – Lincoln, mkeilhauer2@unl.edu; Dan D. Snow, Nebraska Water Center, dsnow1@unl.edu; Aaron Mittelstet, University of Nebraska – Lincoln, amittelstet2@unl.edu

Abstract: Neonicotinoid insecticides are one of the most important common use pesticide (CUP) classes present in agricultural and urban landscapes and their downstream aquatic ecosystems. Further, neonicotinoids have become ubiquitous in midwestern streams, which has resulted in an emergence of these contaminants being found in finished Midwestern drinking water and becoming associated with honeybee colony collapse disorder. Currently, little is known regarding human exposure to these contaminant mixtures in recreational reservoirs and lakes. The objective of this study was to examine and compare the potential for recreational exposure in three Midwestern reservoirs with varying size and land use (i.e., intensive agriculture, urbanized watersheds). Six sampling campaigns were conducted at three lake sites between April through October in 2018. Polar organic chemical integrative samplers (POCIS) were placed at the inlets of each lake and monthly samples were analyzed for 7 neonicotinoids (acetamiprid, clothianidin, dinotefuran, imidacloprid, metalaxyl, thiacloprid, and thiamethoxam). The use of POCIS enabled estimation of time weighted average concentrations of CUPs. Further, monthly grab water quality samples were taken at the POCIS location, midpoint of each lake, and outlet of each lake. All CUP sample extracts were analyzed using liquid chromatography tandem mass spectrometry (LC-MS/MS) analysis. CUP loading rates were determined using water level dataloggers (Onset HOBO) and a SonTek River Surveyor to measure hourly water levels, seasonal flow velocities, and geometric channel dimensions. Temporal and pesticide loading differences were observed between watersheds feeding urban and rural reservoirs. Several measured pesticide concentrations exceeded acute and chronic ecological limits. Results were used to develop vulnerability maps for CUP contamination the three recreational waters and estimate the seasonal influx of CUPs into these recreational lakes with the intention to provide recommendations of in situ best management practices for managing concentrations in the future.

Biography: Dr. Messer is an assistant professor in the Biological Systems Engineering Department and School of Natural Resources at the University of Nebraska-Lincoln. She holds degrees in Biosystems and Agricultural Engineering (University of Kentucky, B.S., 2008) and Biological and Agricultural Engineering (North Carolina State University, M.S. 2010, PhD, 2015). Messer completed a postdoctoral appointment in the Nicholas School of the Environment at Duke University (2015-2016). Her research interests reside at the intersection of engineering, ecology, and agriculture with an emphasis on environmental biogeochemistry and water resources in agricultural landscapes. Her research focuses on identifying, tracing, and treating contaminants in ecosystems impacted by human disturbances.

(64) Mercury Cycling in a Eutrophic Reservoir

Presenter: Byran Fuhrmann, UC Merced, bfuhrmann@ucmerced.edu

Co-Authors: Marc Beutel, Jeff Pasek, Sarah Brower, Andrew Funk

Abstract: Mercury is a toxic heavy metal with no known biotic function. Human exposure to elevated levels can cause a variety of serious health problems such as neurological disorders, kidney failure,

paralysis, and even death. In the US, mercury contamination is prevalent in approximately 50% of EPA superfund sites (Bigham et al., 2016) and the World Health Organization (WHO) currently considers mercury to be one of the top ten chemicals of major public health concern (Bose-O'Reilly et al., 2010). Mercury is typically found only in trace concentrations in natural ecosystems, however, it can be transformed into an organic form (methylmercury or MeHg) which has a high potential for bioaccumulation in aquatic food webs and is therefore a priority contaminant for lake and reservoir managers. The production of MeHg has been associated with the depletion of oxygen in eutrophic reservoirs during thermal stratification. The study tracked monthly changes in sediment and water column biogeochemical parameters during thermal stratification in Hodges Reservoir, a eutrophic reservoir in southern California, in order to assess which factors could be correlated with MeHg production. Attention was given to substrate availability for both MeHg production and anaerobic metabolism. Chemical speciation of mercury in sediment was determined monthly and changes with time were documented. A temporal mass balance of MeHg in the sediment, water column, and particulate matter was created in order to examine production and transport of MeHg. Thermal stratification in Hodges reservoir generally begins in early April and anaerobic conditions prevail within a few weeks, lasting until November. This extended period of anaerobic conditions makes it an ideal study site for temporal biogeochemical patterns, which fluctuated extensively throughout this period.

Biography: Byran Fuhrmann is currently a 3rd year PhD student in Environmental Systems at the University of California, Merced (UC Merced), where he studies mercury cycling in lakes and reservoirs. During his first year at UC Merced, he won the school wide graduate student presentation competition entitled "GradSlam!" and was selected to represent UC Merced in the state wide competition. He became interested in water quality after receiving his BS in Chemistry from Humboldt State University and joining an environmental laboratory as the quality assurance manager. During this time, he also completed an MBA focused on strategic sustainability from Humboldt State University. Afterwards, he went on to receive an MS in Environmental Engineering Sciences from the University of Florida before enrolling in the PhD program at UC Merced. He can be contacted at 714-329-6840 or at hgwaterchem@gmail.com.

(65) Seasonal Zooplankton Community Structure and Mercury Bioaccumulation in a Hypereutrophic Reservoir

Presenter: Melissa Conn, University of California, Merced, mconn4@ucmerced.edu

Co-Authors: Marc Beutel, Ph.D, University of California, Merced, mbeutel@ucmerced.edu; Byran Furhmann, University of California, Merced, bfuhrmann@ucmerced.edu; Sarah Brower, Ph.D, City of San Diego, SBrower@sandiego.gov

Abstract: Mercury and how it cycles in aquatic systems are current and future interests as regulations become increasingly demanding in efforts to reduce methylmercury (MeHg) in fish from reservoirs. California has numerous reservoirs that have been operating for decades as well as accumulating atmospheric mercury, which can eventually become MeHg. As mercury standards tighten to better protect human and wildlife health, there is growing interest in examining how MeHg is transported ecologically to inform potential option for mitigating MeHg production. Hypolimnetic oxygenation is an in-situ management tool that may prevent MeHg production by means of a well-oxygenated sediment-water interface, thereby inhibiting sulfate-reducing bacteria that produce MeHg.

The reservoir of interest, Hodges Reservoir, San Diego, will be installing an oxygenation system which will begin operation during the summer of 2020. Zooplankton community structure and mercury levels will be analyzed before and after oxygenation in an effort to determine how seasonal blooms impact zooplankton density and structure as well as potential bioaccumulation trends. This presentation will introduce the Hodges Reservoir oxygenation project and present data on seasonal patterns of zooplankton community structure and mercury content for 2017 and 2018. Results suggest that there is a "hot spot" for MeHg uptake into the base of the food web in the spring when thermal stratification is weak (allows MeHg to advect upwards into surface waters) and phytoplankton and zooplankton density is relatively low (MeHg is bio-concentrated into small biomass compartment).

Biography: Originally from Reno, Nevada, I received my BS in Environmental Science. Both my studies and fieldwork have emphasized aquatic ecology, limnology and stream/fish habitat monitoring. I moved to San Francisco for a few years and worked for an environmental consulting firm and decided to apply to a masters program in Environmental Systems at University of California, Merced. Having always had an interest in environmental chemistry, this became my chance to pivot back to my interest in limnology and to study trophic mercury bio-accumulation. Professionally, I plan to continue working in the water quality realm. I enjoy just about any outdoor activity but especially surfing and rock climbing.

(66) Soil Tillage for Stormwater Infiltration: Effects of Amendments and Vegetation Type Over Time

Presenter: Shaddy Alshraah, North Carolina State University, shalshra@ncsu.edu

Abstract: Managing stormwater to reduce volumes, peak flows, and pollutant loads is important for the North Carolina Department of Transportation (NCDOT) in order to comply with state and federal permits. Vegetation is an important element of roadside stormwater control measures (SCMs), as healthy roadside vegetation can reduce erosion and runoff. While grass is the typical vegetation along highways, wildflowers have also been planted by the NCDOT for over 30 years on roadside areas primarily for beautification. There may be additional areas that could be planted to wildflowers instead of grass to reduce maintenance and improve pollinator habitat. Previous studies have established that tillage and followed by establishment of a vigorous stand of vegetation can greatly increase infiltration relative to compacted soils. The main goal of this study is to evaluate the potential improvements in infiltration through the use of tillage together with compost and either grass or wildflowers over three years. At three NCSU experiment stations representing the Coastal Plain, Piedmont, and the Mountain regions, either wildflowers or grass were planted on tilled soil with or without compost. Infiltration, bulk density, root biomass, and soil cone index were measured every six months over a 24 month period. The results for infiltration after 24 months suggested few differences among treatments at all locations, but relatively high infiltration rates (18 to 22 cm.h-1) on average. Lower bulk density values were maintained in the compost-amended plots. Grass had relatively higher root mass than wildflowers within 30 cm depth. Cone index values increased with depth but were below 300 psi in the top 15 cm (tillage depth). Tractor traffic during mowing substantially reduced infiltration rates in the wheel tracks but there was some evidence of recovery in the compost-amended wildflower plots. The results suggest that wildflowers can provide effective infiltration in vegetated SCMs and that compost amendment may also help to limit the effects of traffic required for vegetated SCM maintenance.

Biography: Shaddy is a 3rd year Ph.D. student at NC State University majoring Soil Science. He received his Bachelor degree in Soil, Water, and Environment and a Master degree in Integrated Natural Resources Management from Jordan University of Science and Technology, Jordan. Also, he obtained a second master's degree from Tuskegee University, Alabama. His current research focuses on the potential improvements in stormwater infiltration through the use of tillage and amendments under different vegetation types.

(67) Assessing the Effect of Retention Ponds in Potentially Reducing or Buffering Downstream Loads to the Bay

Presenter: Mohammad Nayeb Yazdi, Virginia Tech, mnyazdi@vt.edu

Co-Authors: David Sample, Virginia Tech, dsample@vt.edu; Durelle Scott, Virginia Tech, dscott@vt.edu

Abstract: Urbanization has altered watershed hydrology by increasing impervious surfaces, and changing drainage patterns that increase volume and velocity of runoff. These changes increase sediment and nutrient loads to downstream waters result in poor surface water quality threatening aquatic ecosystem health. In response, retention ponds have become one of the alternative management practice to capture large volumes of runoff and trap suspended sediments and associated pollutants. The goal of this study is to better understand the behavior of a retention pond for removing nitrogen (N), phosphorous (P), and sediment, located in the City of Virginia Beach, which is within the Coastal Plain region and is part of the Chesapeake Bay watershed; which has a focus on reducing sediment and nutrients to reduce eutrophication of the Bay. To achieve this goal, we monitored water quality at the inlets and outlet of the retention Storm-weighted composite water samples were collected and analyzed for total N (TN), total P (TP), total suspended solid (TSS), ortho-phosphorous (PO4), total Kjeldahl nitrogen (TKN), nitrates (NOx), nitrite (NO2), ammonia (NH4), and particle size distribution (PSD). We estimated the efficiency of a coastal retention pond for removal N, P, and sediment; and investigated the effect of storm size, antecedent conditions, and residence time on the performance of the pond. During storm events in cold weather, we found the pond reduced the level of TSS and P significantly, while it exported N and the level of N increased in outflow of the pond. Also, PSD indicated that particle size in outflow of the pond decreased considerably in comparison to inflows. Understanding the functioning and performance of retention ponds within Coastal Virginia will help improve sediment and nutrient removal, and thus help improve the health of downstream ecosystems.

Biography: Mohammad Nayeb Yazdi is a Ph.D. candidate, studying biological system engineering at Virginia Tech. His research interests are watershed management by developing watershed models such as SWMM and HSPF for various scales of watersheds, evaluating the impacts of non-stationary events such as change of land-use and climate on hydrology and water quality of watersheds, and monitoring program for investigating of urban and agricultural runoff. At the present, Mohammad is working on two monitoring programs related to a retention pond and various land uses in Virginia Beach.

(68) The Role of Porous Asphalt in Stormwater Mitigation in Urban Landscapes

Presenter: Ani Jayakaran, Washington State University, anand.jayakaran@wsu.edu

Co-Authors: Thorsten Knappenberger, Auburn University, knappi@auburn.edu; John D Stark, Washington State University, starkj@wsu.edu

Abstract: Permeable pavements are one of several GSI techniques that are increasingly being used across the country to mitigate the effects of stormwater on downstream receiving waters. The performance of a 9-cell replicated asphalt pavement test facility was quantified in terms of water quantity and quality treatment, over a period of five years. The asphalt test facility has 9 lined cells – 3 cells are constructed with conventional asphalt and 6 with porous asphalt. Runoff from the impervious cells acted as a control and were compared to runoff from the pervious cells. Artificial and natural storm events were used to test both hydrologic and biogeochemical remediation of the two systems. Pollutants evaluated were suspended sediments, metals, nutrients, and hydrocarbons. Results from this work show that porous asphalt pavements are able to infiltrate as much as 99.5% of incident rainfall. Results also showed that porous asphalt pavements are highly efficient at removing total suspended solids (93.4%) especially coarse material, total lead (98.4%), and total zinc (97.8%). Dissolved metals and polycyclic aromatic hydrocarbons were not removed to any appreciable level. Removal efficiencies for total lead, total zinc, motor oil, and diesel hydrocarbons improved with the age of the system. Annual maintenance of the pavements did not yield significant pollutant removal efficiency differences between maintained and unmaintained PA cells. Research objectives associated with a follow up study to examine the incorporation of carbon fiber to strengthen porous asphalt pavements will also be presented.

Biography: Ani Jayakaran is an Associate Professor with Washington State University Extension. His role is to meet extension and research needs in a region experiencing the impacts of high urbanization, drought, and a changing climate. The scope of his work extends to the entire state of Washington, and involves disseminating strategies to manage water resources using Low Impact Development, and improving current engineering designs with ecosystems-centric solutions for handling stormwater through applied research. Ani holds a Bachelor's degree in Civil Engineering from India, and graduate degrees in Civil Engineering (MS) and Agricultural & Biological Engineering (PhD) from Ohio State University. He is a licensed engineer in the states of Washington and South Carolina.

(69) Stormwater Management for Coastal Communities: A Case Study Review

Presenter: Alessandra Braswell, Geosyntec, abraswell@geosyntec.com

Abstract: Designing stormwater management systems for coastal communities can be challenging due to many environmental factors. High groundwater, tidal effects, and flat topography present a reduced opportunity for gravity-driven systems; conventional "pipe and pond" methods are thus often not applicable. Additionally, sea level rise and a changing climate add an inherent level of complexity in designing drainage and stormwater management solutions for coastal communities compared to other regions. This presentation will cover a selection of stormwater management projects implemented in coastal communities. These case studies showcase some of the basic stormwater design principles for coastal communities, including methods like infiltration at the source, groundwater lowering, and

retrofit improvements that consider tidal influences. Lessons learned and opportunities for improvement will be highlighted.

Biography: Dr. Alessandra Braswell offers 7 years of water resources engineering experience with a focus in urban stormwater management, stormwater control measure (SCM) selection and design, and stormwater master planning. She received a Ph.D. and M.Eng. from North Carolina State University in Biological and Agricultural Engineering and a B.Sc. from University of Florida in Agricultural and Biological Engineering. Her graduate research focused on stormwater management in the urban environment, including modeling the annual hydrology of permeable pavements and assessing the water quality benefits of low impact development (LID) treatment trains. Alessandra has instructed stormwater design workshops throughout North Carolina and Ohio on topics including green streets, permeable pavement, and modeling SCM function under future climate scenarios.

(70) Hydrologic and Water Quality Impacts of a Green Street Retrofit in Fayetteville, North Carolina

Presenter: Sarah Waickowski, North Carolina State University, sewaicko@ncsu.edu

Co-Authors: Katy Shaneyfelt, Muller Engineering Company, kshaneyfelt@mullereng.com; Dr. William Hunt, North Carolina State University, wfhunt@ncsu.edu

Abstract: Impervious cover associated with urbanization has direct hydrological and water quality effects on landscapes and surface waters. Green streets have the ability to mitigate the impact of urban development by reducing and treating stormwater runoff at its source. An urban two-block corridor has been retrofitted in Fayetteville, North Carolina with green infrastructure to manage stormwater runoff. This is the first comprehensive green street in North Carolina, and the retrofit involves redeveloping an entire corridor during scheduled street repair. Stormwater control measures (SCMs) include: bio-infiltration bump-outs, permeable pavement, and suspended pavement systems. This study aims to evaluate the ability of the green street to manage stormwater runoff in an urban area and to gain a large-scale perspective on the environmental impacts of green streets. Water quality samples and stormwater runoff data have been analyzed at both the street level and individual suspended pavement systems to determine any significant statistical differences between the pre- and post-retrofit hydrology and water quality data. These data will be incorporated into pre- and post-retrofit PCSWMM models to optimize green street design in North Carolina. Monitoring green streets both pre- and post-retrofit is crucial in understanding and recognizing green streets' environmental impacts.

Biography: Sarah Waickowski is an Extension Engineer under the direction of Dr. Bill Hunt. Her responsibilities include applied research, demonstration projects, and outreach focusing stormwater control measures. She has experience designing and installing stormwater wetlands, wet pond retrofits, bioretention cells, street tree systems, and infiltration practices. She also assisted NC DEQ with the creation of the NC SCM Crediting Document.

CONCURRENT SESSION 6

(71) Field-based Assessment of an Urbanized Mountane Headwater Catchment: The Impact of Watershed-wide Green Stormwater Infrastructure Retrofits on Sediment Washload

Presenter: Joshua Robinson, Robinson Design Engineers, jr@robinsondesignengineers.com

Abstract: Most stormwater research in the southeastern US has occurred near the major academic research institutions located within the Piedmont. As a result, performance standards and design guidelines for green stormwater infrastructure (GSI) and other types of stormwater control measures (SCMs) do not readily transfer to the steep mountain environment, which is characterized by shallow soils, steep gradients, and intense rainfall. To provide insight into regionally-specific performance standards and design guidelines for GSI and SCMs, the author helped to establish an experimental watershed in Asheville, NC.

Storm event measurements of creek stage, discharge, and sediment concentration were collected within a first-order mountain stream draining approximately 100 acres of developed headwaters. These measurements were collected before and after the construction of six green stormwater infrastructure (GSI) retrofits upstream throughout the watershed. The experimental watershed is fully contained within the campus of Givens Estates, a retirement community of the United Methodist Church. The project is funded by the NC Clean Water Management Trust Fund, and the project is sponsored by RiverLink, an Asheville-based non-profit dedicated to promoting the environmental and economic vitality of the French Broad River and its watershed.

In this presentation the author will provide an overview of the experimental watershed and project history, outline the goals of the grant-funded project, and present data from storm event measurements before and after implantation of GSI retrofits. The author will also describe the applicability of the research, and how the lessons learned through this project can benefit the design of GSI projects in the difficult montane landscapes of the Southern Appalachians.

Biography: Joshua Robinson is the principal of Robinson Design Engineers, a group of water resources specialists working from offices in Charleston, SC and Asheville, NC. Joshua holds an MS degree in civil engineer environmental hydraulics from Georgia Tech, and a BS degree in civil engineering from The Citadel.

(72) Uniting Stormwater Management and Stream Restoration Strategies for Greater Water Quality Benefits

Presenter: Roderick Lammers, University of Georgia, rodlammers@gmail.com

Co-Authors: Tyler Dell, Colorado State University, tyler.dell@colostate.edu; Brian P. Bledsoe, University of Georgia, bbledsoe@uga.edu

Abstract: Urbanization alters the delivery of water, sediment, and pollutants to receiving streams. In response, channels erode which increases loading of sediment and nutrients, degrades habitat, and damages or destroys sensitive biota. Stormwater control measures (SCMs) are constructed in an attempt to mitigate some of these effects. In addition, stream restoration practices such as bank stabilization are increasingly promoted as a means of improving water quality by reducing downstream sediment and pollutant loading. Each unique combination of SCMs and stream restoration practices results in a novel hydrologic regime and set of geomorphic characteristics that interact to determine stream condition, but in practice implementation is rarely coordinated. In this study, we examine linkages between basin scale implementation of SCMs and stream restoration in Big Dry Creek, a suburban watershed in the Front Range of northern Colorado. We combine continuous hydrologic model simulations of watershed scale response to SCM design scenarios with channel evolution modeling to examine interactions between stormwater management and stream restoration strategies for reducing loading of sediment and adsorbed phosphorus. Model results indicate that integrated design of SCMs and stream restoration interventions can result in synergistic reductions in sediment and adsorbed pollutant loading. Not only do piecemeal and disunited approaches to stormwater management and stream restoration lose out on these synergistic benefits, they make restoration projects more prone to failure, wasting valuable resources that could be better applied for pollutant mitigation.

Biography: Roderick Lammers is a post-doctoral researcher and instructor at the University of Georgia. His research interests include stream erosion modeling, river restoration, and urban water management.

(73) Stormwater and Tidal Hydraulics in an Urban Watershed: Land Use Change Impacts

Presenter: Hannah Kuhl, College of Charleston, kuhlhm@g.cofc.edu

Co-Authors: Timothy J Callahan, College of Charleston, callahant@cofc.edu; Joshua Robinson, Robinson Design Engineers, jr@robinsondesignengineers.com

Abstract: The purpose of this study is to develop a water balance method for a suburban tidal creek watershed located in Charleston, South Carolina. The major objectives are to separate the relative functions and dynamics of tidal flows and stormwater runoff in the watershed at two spatial scales, and to characterize the vegetation cover types of selected sub-watersheds in this altered suburban landscape. Discharge (volumetric flow rate) and channel geometry of James Island Creek will be measured under a variety of tidal conditions to characterize the creek's stage-discharge and hydraulic geometry relationships and to compare those with four previously studied tidal creeks in the region. Stormwater runoff modeling will be conducted to provide estimates of runoff volumes that may enter the creek system during storm events. Variability in stormwater responses will be compared among sub-watersheds in relation to levels of development, and variation in extent of major vegetation cover types in these sub-watersheds will be evaluated in relation to the variation in stormwater responses. The broader impact of this study is that identifying locations or events of high stormwater delivery ("hot spots" and "hot moments") will enable scientists and managers to identify potential problem areas in urbanized tidal creek systems.

Biography: My name is Hannah Kuhl, I'm a graduate student at the College of Charleston. Originally from Austin, TX with a B.S. from Trinity University (in San Antonio, TX), I moved to Charleston, SC to pursue my Masters in Environmental Studies. During my time at Trinity I completed a number of things, including: a double major in Biology and Environmental Studies, a minor in Spanish, a study abroad program in Madrid, an internship with the Greater Edwards Aquifer Alliance, and a research assistantship studying grasses in the Texas Hill Country. Since I've lived in Charleston, I've primarily worked as a research assistant and teaching assistant (for introductory Biology labs) with the College of

Charleston. I have many interests in the broad fields of biology and ecology, and have just recently become fascinated with the interactions between hydrology and ecology. This graduate program and thesis project have given me the opportunity to learn about both the hydraulic dynamics and the ecology of the unique ecosystems in the Charleston area, including tidal creeks and salt marshes. I presented at AEES last year without results, and hope to give an update this year with completed results!

(74) Forested Stormwater Wetland Demonstration in Greenville, NC

Presenter: Cameron Jernigan, North Carolina State University, chjerni2@ncsu.edu

Abstract: NC Sea Grant and NC State University's Biological and Agricultural Engineering Department worked with Sounds Rivers, Inc. to conduct stormwater assessment, design and construction oversight for the retrofit of an existing abandoned and non-functioning farm pond into a forested stormwater treatment wetland. The project site is located on public land at Jaycee Park in Greenville, North Carolina and is protected by the Tar-Pamlico buffer rules. The existing condition of the pond provided a unique retrofitting opportunity due to the presence of mature tree species in the project boundaries combined with a desire to minimize riparian buffer impact. The design was based on current stormwater wetland practices but it limited the removal of trees and planted vegetation more specific to a natural forested wetland system. Construction of the forested wetland was completed in February 2019. Water quality monitoring is being conducted by East Carolina University to evaluate the treatment capability of the forested stormwater wetland.

Typically, constructed stormwater wetlands (CSWs) are designed to mimic the functions of natural wetlands to treat stormwater. The storage, complex microtopography, and vegetative community in CSWs combine to form an ideal matrix for the removal of many pollutants (NC DEQ). In North Carolina, the design and implementation of all Stormwater Control Measures (SCM) including wetlands must adhere to NC DEQ's Stormwater Design Manual. The Minimum Design Criteria (MDC) for CSWs prohibits trees on wetland dams and berms, and restricts tree planting within and around a CSW. So, an herbaceous vegetative community is the target for all CSWs. These rules stem from historic conditions of the first stormwater ponds and wetlands that were installed before maintenance was required and guidelines and training were developed for maintenance and inspection. These early SCMs became overgrown with trees, neglected, and failed to function. However, inland watersheds in the southeastern and south central United States were historically dominated by forested wetland systems (bottomland hardwood forests) that serve critical roles in water storage and treatment. With proper management, design, and ideal site conditions, a CSW that mimics forested wetland function may be a more appropriate BMP in certain situations. Trees could help to improve aesthetics, stabilization, and reduce temperature but also generate a well-functioning stormwater wetland and diverse ecosystem.

Biography: Cameron Jernigan, an eastern North Carolina native, serves as an Extension Assistant and member of the Stream Restoration Program at the BAE Department at North Carolina State University. His work involves assessment, design, implementation, and applied field research of stream restoration, ecological engineering, and a variety of Stormwater Control Measures. Cameron received his B.S. in Biological and Agricultural Engineering from NCSU in 2017.

(75) The Performance of Two Simultaneously Operated Experimental Algal Floways Supporting Water Treatment on Anacostia River in Prince George's County, Maryland and Washington, D.C.

Presenter: Peter May, University of Maryland Environmental Science and Technology, pimay@umd.edu

Co-Authors: Patrick Kangas, University of Maryland Environmental Science and Technology, pkangas@umd.edu

Abstract: Two experimental algal floways were set-up and operated for water quality improvement on the Anacostia River, which drains a largely urban watershed and passes through Washington DC. One floway was 1.0 square meter in area and the other was 3.6 square meters in area. Algae was harvested approximately once per week from late July to November 2018. Biomass productivity was 61.2 grams/m2/day for the larger floway and 45.5 grams/m2/day for the smaller one over the study period. The differences between the two systems may have been due to the greater edge effect in the small compared to the larger floway. Nutrient contents of the algae were relatively low at 0.9% for nitrogen and 0.1% for phosphorus. Multiplying the biomass productivity by the nutrient content shows that the algal floway could potentially remove 1200 kg of nitrogen/ha/year and 143 kg of phosphorus/ha/year. These performance data from the Anacostia River are compared with data from similar systems that have been operated around the Chesapeake Bay for perspective.

Biography: Peter has 30 years of experience in the environmental sector working in municipal, state, and federal government, NGO's and the private and academic sectors. He has a comprehensive background in urban ecology, the ecology of tidal marsh, urban stream and urban estuarine river system restoration. He has applied his skills to numerous projects throughout Maryland and the District of Columbia, New York City, Philadelphia and the San Francisco Bay area. He has applied ecological engineering principles in developing and deploying models for floating wetland islands, vertical wetland green bulkheads, boat wastewater and marina washwater "living machine" ecosystem treatment systems as well as the Algal Turf Scrubber® (ATS™) water treatment system which he was exposed to while working for its inventor, Dr. Walter Adey, at the Smithsonian Marine Systems Lab. He has applied the ATS™ ecotechnology to wastewater systems in NYC converting algal biomass to ethanol and biobutanol as well as the Port of Baltimore converting algae to a methane biogas and electricity using a microbial fuel cell.

(76) The Case for Cyanobacteria-Based Water Quality Grades

Presenter: McNamara Rome, Northeastern University, rome.m@husky.northeastern.edu

Co-Author: Ralph Edward Beighley, Northeastern University

Abstract: The lower basin of the Charles River, where it runs between Cambridge and Boston, is typical of an ecologically degraded urban river recovering from decades of pollution. Since the closure of combined sewer outfalls into the Charles River began in 1988, water quality in the lower basin has gradually improved. Consistent decreases can be seen with respect to nutrient levels as well as E. coli concentrations. However, elevated phosphorous levels and summer blooms of cyanobacteria remain a persistent hazard and obstacle to achieving the EPA's stated goal of a safe and swimmable Charles. We combine and analyze publicly available data sets from the Charles River Watershed Association, Massachusetts Water Resource Authority and the Environmental Protection Agency to understand trends in algal bloom duration, timing, and severity. Two years of daily summer water quality monitoring are used to elucidate the relationship between common in-vivo measurements (e.g. chlorophyll a, turbidity, and phycocyanin) and actual cell counts of toxin producing species. Our analysis shows that (a) current water quality fails to meet chlorophyll a standards set by the 2007 TMDL and (b) Chlorophyll a fails to capture the dynamics of algal blooms. We recommend a turbidity based framework for long-term cyanobacteria monitoring and trend assessment and suggest a revision to the EPA annual water quality report card to include consideration of cyanobacteria related health advisories.

Biography: Max Rome is a Ph.D. candidate at Northeastern University studying the role that biotic factors play in regulating harmful algal blooms in mildly eutrophic waterbodies. Previous to Northeastern Max worked on the design and construction of ecological wastewater treatment systems as a project manager at John Todd Ecological Design.

(77) Simulating the Role of Manure and Inorganic Fertilizer Applications on Water Quality in the Maumee River Watershed

Presenter: Jeffrey Kast, The Ohio State University, kast.14@osu.edu

Co-Authors: Jay Martin, The Ohio State University, martin.1130@osu.edu; Margaret Kalcic, The Ohio State University, kalcic.4@osu.edu; Anna Apostel, The Ohio State University, apostel.4@osu.edu; Grey Evenson, The Ohio State University, evenson.5@osu.edu; Rebecca Muenich, Arizona State University, rebecca.muenich@asu.edu; Awoke Dagnew, Graham Sustainability Institute, University of Michigan awoke@umich.edu; Colleen Long, Graham Sustainability Institute, University of Michigan longcm@umich.edu

Abstract: In the Western Lake Erie Basin, as in other watersheds supporting livestock, greater focus has been directed to the water quality impact of manure applications. Specifically, for Lake Erie, the focus is on phosphorus runoff, which drives the harmful algal blooms that occur annually in the lake. These concerns have led to recent regulations of manure application practices within the basin including a restriction of the potential window for manure applications. These concerns and actions are in response to nutrient reduction targets developed to improve Lake Erie's water quality. This study uses a field-scale SWAT model of the Maumee River watershed to simulate the impact manure and inorganic fertilizer applications have on phosphorus loadings from the basin. Results indicate that when phosphorus is removed from basin-wide manure applications total phosphorus (TP) spring-loads are reduced by 8% while dissolved reactive phosphorus (DRP) spring-loads are reduced by 12%. When inorganic phosphorus fertilizer is removed from the basin-wide fertilizer applications TP spring-loads decreased by 44% and DRP spring-loads decreased by 60%. Although removing inorganic phosphorus from basin-wide fertilizer applications resulted in greater spring-load reductions in both TP and DRP than basin-wide manure applications, both fertilizer types had similar phosphorus delivery factors. Manure applications resulted in a delivery factor of 15% and 6% respectively for TP and DRP while inorganic fertilizer applications resulted in a delivery factor of 13% and 4% for TP and DRP, respectively.

Biography: Jeffrey is a PhD student in the Environmental Science Graduate Program at Ohio State. The focus of his current work is on integrating farmer decision making into watershed modelling efforts in the Western Lake Erie basin. His work focuses on simulating the water quality impacts of changing land use and land management decisions made by agricultural producers within the Western Lake Erie basin during demographic, economic, political, and historical changes.

(78) Use of pH, Conductivity, and Temperature as Tracers to Assess Water Quality Changes in the Kanawha River, West Virginia

Presenter: Fernando Rojano, West Virginia State University, fernando.rojano@wvstateu.edu

Co-Authors: Fernando Rojano, West Virginia State University, fernando.rojano@wvstateu.edu; Ifeoma R. Ugwuanyi, Rutgers University, iru1@scarletmail.rutgers.edu; Vadesse Lhilhi Noundou, West Virginia State University, vlhilhinoundou@wvstateu.edu; Andrielle L. Kemajou Tchamba, West Virginia State University, akemajoutchamba@wvstateu.edu; Jesus E. Chavarria-Palma, West Virginia State University, jchavarriap@wvstateu.edu; David H. Huber, West Virginia State University, huberdh@wvstateu.edu

Abstract: The present study depicts an effort that combines experiments and modeling of a catchment area along the Kanawha river, West Virginia. Several stressors in the area regarding to mine activities, industry, agriculture and urban areas contribute to the deterioration of water quality of the Kanawha river. This study identified the effect of those stressors by means of tracers already embedded in the water. Tracers were used as they were measured on the field to minimize disturbance, and the changes were observed to determine effects of the drainage area between sondes. The experimental stage entailed four sondes, which were installed along the river to continuously measure pH, conductivity and temperature in an hourly time step during the period January-March, 2018. Such period was sufficient to capture dynamics of the tracers when subjected to storm-events. On the other hand, data about flow gages, meteorological data and land use were retrieved in BASINS and a hydrologic HSPF model was developed for the same area of study. Based on data availability, the calibration was conducted using a period of four years, and the HSPF model validation was conducted for January-March, 2018. In this way, it was possible to join water flow predictions with tracer measurements to identify the contribution of drainage areas between sondes. Consequently, this study deduces from a three-month-period of observation, mainly driven by storm-events, an adequate description of the area of study and assess water quality of the mainstream focusing on various point and non-point sources and correlating them with land use as well as discussing the capabilities and drawbacks of implementing this approach.

Biography: Fernando Rojano obtained the PhD degree on Biosystems Engineering by the University of Arizona in 2013. After that, Dr. Rojano went for a postdoctoral stay in Agrocampus Ouest-Angers in France to conduct research about environmental engineering. In specific, about fluid dynamics in conjunction with heat and mass transfer applied to agricultural buildings. Dr. Rojano went back to his home country and started working as a scientist in the Instituto de Ecologia in Mexico being focused on modeling bioprocesses. After September 2018, Dr. Rojano is assistant research professor at the West Virginia State University, being involved in water systems modeling and environmental engineering.

(79) Characterizing Natural Barriers to Non-native Stream Fauna in Hawaiʻi

Presenter: Yin-Phan Tsang, University of Hawaiʻi at Mānoa, tsangy@hawaii.edu

Co-Authors: Brendan Martina, Ralph W. Tingley III, Hannah Clilverd, Dana M. Infante

Abstract: Waterfalls, caused by the abrupt changes of elevation in streams, are natural barriers that influence the distribution and dispersion of aquatic species. While resulting habitat fragmentation has contributed to species specialization, the steep elevation changes are also considered barriers that inhibit passage of non-native species upstream. In Hawaiʻi, it is assumed that non-native species are unable to surpass waterfall barriers, yet they are present above some waterfalls, possibly facilitated by human introduction. In this study, we used a landscape approach to identify likely human introductions and examine the ability of non-native stream fauna to bypass waterfalls. We found that when a given catchment has a population density higher than 4.24 people/km2 or when road length density is greater than 0.01 km/km2 in a stream catchment, the presence of non-native species in the stream was likely due to human introduction. After filtering human-facilitated introduction, we found that 12 out of the examined 14 taxa were absent upstream of waterfalls, indicative of their inability to traverse waterfalls. Without human interference, waterfalls can be considered effective barriers to non-native species and can be instrumental in supporting exotic species eradication and control strategies.

(81) Thinking Twice About Rock Surface Cover in Nashville-Area Bioretention Applications

Presenter: Andrea Ludwig, University of Tennessee, aludwig@utk.edu

Co-Authors: Blue Curry, University of Tennessee, fcurry1@vol.utk.edu; Joshua Hayes, Metro Water Services Nashville-Davidson County, joshua.hayes@nashville.gov; Rebecca Dohn, Metro Water Services Nashville-Davidson County, rebecca.dohn@nashville.gov

Abstract: Bioretention practice failures have led to costly renovations and repairs in Tennessee cities, creating uncertainty in the future of these practices as part of effective green infrastructure systems for stormwater runoff management. Modifications, such as using river rock surface cover in place of a plant-based mulch cover and minimizing species diversity of plantings, have been implemented by designers and practice owners in an attempt to minimize maintenance and failure susceptibility. A field survey of 52 bioretention practices was conducted across Davidson County, Tennessee, to determine functional status and identify common failures in order to support maintenance recommendations for property owners and municipal governments. Specific research questions included: 1) Does surface cover affect media bulk density? 2) What is the organic matter content in bioretention media and does it change with practice age? 3) Is plant canopy establishment related to media bulk density? 4) What plants are successful? and 5) What conclusions can be drawn regarding media characteristics related to practice maturation and what maintenance recommendations can be made to address common failures. Results showed that media bulk density under rock surface cover was significantly higher than that under plant-based mulch cover ($p<0.01$); that media bulk density levels known to affect plant establishment in sandy loams (> 1.6) were reached in rock covered applications in a shorter practice age as compared to plant-based mulch applications; and that relationships exist between practice age, plant canopy, organic matter, and bulk density and that these findings could be used to inform function-driven maintenance activities.

Biography: Andrea Ludwig is an Associate Professor of Ecological Engineering in the Biosystems Engineering & Soil Science Department at the University of Tennessee and serves as the State Stormwater Management Specialist for UT Extension. In this role, she works with municipal governments across the state to educate stakeholders and create demonstrations of effective green infrastructure systems for sustainable urban landscapes. She is a lifetime member of AEES, holds a BS and MS from the University of Arkansas and PhD from Virginia Tech, and eagerly awaits the student design competition presentations at this amazing conference.

(82) Bayesian Approach to Assess Stormwater Pollutant Reduction in Bioretention Cells

Presenter: Thorsten Knappenberger, Auburn University, knappi@auburn.edu

Co-Authors: Anand Jayakaran, Washington State University, anand.jayakaran@wsu.edu; John D. Stark, Washington State University, starkj@wsu.edu

Abstract: Nutrients like nitrogen and phosphate as well as heavy metals are ubiquitous in stormwater runoff and stormwater is often introduced into surface waters without treatment. Thus, receiving waters are impacted, with serious consequences for aquatic organisms and the food web. Bioretention systems are suitable elements to reduce the nutrient load of stormwater and manage the amount of stormwater introduced to receiving waters. But most effective compositions of bioretention systems need yet to be determined.

We built 16 mesocosms with different porous media to study the contaminant retention capacities. We used four media (mix 1: 80% sand, 20% compost; mix 2: 60% sand, 40% compost; mix 3: 60% sand, 15% compost, 15% shredded cedar bark, 10% water treatment residuals; mix 4: 60% sand, 30% compost, 10% water treatment residuals) that had been replicated four times. We continuously acquired outflow data since 2011 and measured the contaminant transport for several storms.

We monitored 13 storms between 2012 and 2015 at our research facility on the Washington State University Research and Extension Center campus in Puyallup, Washington. Inflow and outflow concentrations were assessed with a Bayesian statistics. Inflow concentrations where then modelled based on Western Washington State phase 1 permittee stormwater data resulting in an outflow data set of realistic effluent concentrations per pollutant and tested bioretention mix.

None of the four tested bioretention mixes outperformed the other mixes. Effects of age of the bioretention system were found for nutrients but not for heavy metals. Nutrient removal increased with age of the bioretention mix while chemical oxygen demand increased with age. Removal of copper, zinc, and lead varied between 60 and 99%.

Biography: Thorsten Knappenberger has received his MS and PhD in agricultural engineering from Hohenheim University in Stuttgart, Germany. He joined Washington State University as a post doc in 2011 studying the colloid facilitated pollutant transport and stormwater mitigation. In 2014, he jointed Auburn University in Alabama as an assistant professor for soil physics.

(83) Assessment of Drinking Water Treatment Residuals to Enhance Phosphorus Retention within Green Stormwater Infrastructure

Presenter: Michael Ament, University of Vermont, mament@uvm.edu

Co-Authors: Eric Roy,University of Vermont, eric.roy.1@uvm.edu; Stephanie Hurley, University of Vermont, stephanie.hurley@uvm.edu; Eric Perkins, EPA, perkins.eric@epa.gov; Yongping Yuan, EPA, yuan.yongping@epa.gov; Mark Voorhees, EPA, voorhees.mark@epa.gov

Abstract: Bioretention systems are a form of green stormwater infrastructure that are becoming increasingly common for managing runoff from impervious surfaces. While bioretention systems function well for hydraulic control and sediment removal, their phosphorus (P) removal performance is highly variable. Amending bioretention soil media with P sorbing materials, such as drinking water treatment residuals (DWTRs), has potential to greatly enhance P removal from stormwater and improve downstream water quality. Here, we aim to assess this potential by 1) quantifying the P sorption capacity of different DWTRs, 2) determining the contact time required for effective P removal and 3) measuring P removal by bioretention soil media amended with DWTRs. To do this, we conducted P sorption isotherm experiments, continuous-flow small column experiments and contact time experiments on three different sources of DWTRs. We then conducted large column experiments using bioretention media blends with and without DWTRs. Finally, we measured a suite of physicochemical parameters in order to understand the drivers of P sorption by DWTRs at fine scales.

The DWTRs used in this study demonstrated high but variable capacities for P sorption (8-40 g P kg-1). Specific surface area correlated strongly with P sorption, but the total abundance of metal oxides in DWTRs did not. Contact time experiments revealed that P sorption is very rapid and that over 95% of P can be sorbed after one minute of contact. Preliminary large column results showed that P removal by DWTRs in bioretention media is effective but variable across DWTRs (70%-100% removal). These results suggest that amending bioretention media with DWTRs can greatly increase P removal from stormwater, but the longevity of this mechanism depends on physicochemical properties of the DWTR.

Biography: Mike is a first-year PhD student in the Department of Plant and Soil Science at the University of Vermont. His past research focused on ecosystem responses to variables of global change within natural and managed systems. As a PhD student, he’s combining ecological knowledge with engineering principles to design systems that reduce the flow of nutrients into the environment. In particular, he’s investigating the potential for drinking water treatment residuals to remove phosphorus from stormwater.

(84) The Influence of Active Control on Urban Bioretention Systems

Presenter: Aaron Akin, University of Tennessee, aakin4@vols.utk.edu

Co-Authors: Padmini Persaud, University of Tennessee, ppersaud@vols.utk.edu; Jon Hathaway, University of Tennessee, hathaway@utk.edu

Abstract: Extreme weather has coupled with the proliferation of impervious areas in urban areas to increase the frequency of flood events and deepen water quality concerns. Bioretention is a type of green infrastructure practice developed to mitigate peak flows, reduce runoff volume, and reduce nutrient loads in stormwater through physical and microbial processes. However, studies have shown inconsistency in the ability of bioretention to manage nutrients, specifically nitrogen. At the same time, innovative sensor and control technologies are being tested to actively manage urban stormwater, primarily in open water control systems to date. Through these controls, it may be possible to optimizing storage time and/or soil moisture dynamics within bioretention cells to influence microbial nutrient processing facilities within a system. A column study testing the influence of active control on bioretention system performance was conducted over a nine-week period. Active control columns were given 1 of 2 treatments: volume control where the system was held at a specific water level to the extent possible, or soil moisture control where the system was held near field capacity. These treatments were compared to two current operational standards in terms of water quality: free draining and internal water storage. The results suggest that active controls can improve upon standard bioretention designs, but further optimization is required to balance the water quality benefits of retention time, and storage needs within these systems for impending storms.

Biography: Aaron Akin is a graduate research student at the University of Tennessee pursuing a doctoral degree in Water Resources Engineering. His research focuses on integrating instrumentation and control systems with stormwater networks to create smart and adaptive stormwater systems.

(85) Enhanced Bioretention Cell Modeling: Moving From Water Balances To Hydrograph Production

Presenter: Whitney Lisenbee, University of Tennessee, wlisenbe@vols.utk.edu

Co-Authors: Dr. Jon Hathaway, University of Tennessee, hathaway@utk.edu; Dr. Ryan Winston, Ohio State University, winston.201@osu.edu; Dr.Mohamed Youssef, North Carolina State University; mohamed_youssef@ncsu.edu; Dr. Lamyaa Negm; North Carolina State University; lmnegm@ncsu.edu

Abstract: Over the last few decades, bioretention systems have become a leading stormwater control measure that improve urban runoff volumes and peak flows through increased infiltration. Although these systems have performed well in many site-scale field studies, less is known about how to model these systems. Modeling of bioretention provides an avenue for evaluating the effectiveness of an individual bioretention cell prior to devoting time and resources into a project. However, many hydrologic models capable of simulating bioretention largely consist of lumped parameters and simplifications that do not fully account for fundamental hydrologic processes such as soil-water interactions. DRAINMOD is an agricultural drainage model that has shown promise when applied to bioretention systems by using the soil-water characteristic curve to obtain detailed daily water balances over a continuous time-period (advances over most other models for bioretention). For this study, DRAINMOD was recoded to develop DRAINMOD-Urban which allows high temporal resolution inputs and outputs, more closely matching the travel times of urban systems. DRAINMOD-Urban simulations were conducted for two bioretention cells and compared to original DRAINMOD simulations. Resulting modeling revealed: (1) if DRAINMOD-Urban can effectively produce hydrographs, (2) how parameters calibrated for the original DRAINMOD model translate to DRAINMOD-Urban, and (3) how the performance of this enhanced model, DRAINMOD-Urban, compares to the previous DRAINMOD model as applied to bioretention.

Biography: Whitney Lisenbee received her B.S. and M.S. degrees in Biosystems and Agricultural Engineering from Oklahoma State University. Whitney is currently a Graduate Research Assistant, and recipient of the Chancellor's Fellowship, working on her Ph.D. is in Civil and Environmental Engineering from University of Tennessee-Knoxville. Her dissertation research is primarily focused on improving modeling of bioretention cells for stormwater management and watershed restoration. Her research concentration is in water resources and hydrology with interests including soil erosion, streambank stabilization, land use changes, urban hydrology, water quantity/quality, stormwater mitigation, and low impact development. She is also interested in conflicts between urban and agricultural water quantity and quality. Whitney is a member of the American Society of Agricultural and Biological Engineers (ASABE) where she received 3rd place in the Boyd-Scott graduate research award competition and 1st place in the K.K. Barnes undergraduate research competition. She is also a member of the American Society of Civil Engineers-Environmental & Water Resources Institute (ASCE-EWRI), American Ecological Engineering Society (AEES), and the American Society of Engineering Education (ASEE).

CONCURRENT SESSION 7

(86) The Case for More Data

Presenter: Amy Longcrier, Biohabitats, alongcrier@biohabitats.com

Abstract: Is Stream Restoration doing what we claim? Are crediting models too conservative or too generous? Is there more to the story than nutrient removal? Monitoring data comparing conditions before and after stream restoration is lacking. While we know some things anecdotally about restored streams – sediment reduction occurs, peak flows are attenuated, and habitat is improved. We know more about un-restored stream conditions empirically – bank erosion rates, nutrient content of sediment, and the rapid deterioration of stream conditions once disconnected from the floodplain. We lack empirical data comparing conditions before and after stream restoration during a length of time substantial enough to influence crediting methods and design practices. This presentation hopes to call into action the academic community to team with stream restoration professionals and establish a consistent approach to collect the necessary data to influence policy and improve design techniques. We all want our work to make the greatest positive impact possible on the environment; without a complete feedback loop, including concrete data, we can not be sure our methods are aligned with our collective goals.

Biography: Amy Longcrier is a professional engineer with a BS in Biostystems Engineering from The University of Tennessee. Ms. Longcrier began working in the engineering field in 2005 and at Biohabitats in 2008. She works closely with scientists, landscape architects, and other engineers to provide thoughtful, functional, and effective design solutions and develop construction documents. The majority of Ms. Longcrier's experience is in stream restoration where she supports the process from assessment through construction. Her design experience is primarily related to hydrology and hydraulics as they pertain to stream and wetlands systems.

(87) Using University of Maryland Campus Creek as a Study Site for Urban Creek Restoration

Presenter: Denise Alving, University of Maryland, College Park, dalving@umd.edu

Co-Authors: Annabelle Arnold, Faez Azizul, Mitchell Burke, Larry Davis, Trang Le, Calvin Lynn, Jacob Mast, Jonathan Moy

Abstract: Urban stream health is a pressing issue in today's society, as more of our natural bodies of water become surrounded by construction and development. Here we use a creek running through the University of Maryland, College Park campus as a study on stream restoration. Current and previous restoration projects on and around the campus creek will be discussed and a student-led restoration of the lower part of the stream will be introduced. The student-led group collected measurements of bank erosion and water quality, as well as soil classification and identification of plant and macroinvertebraete species. These measurements guide the proposal of a stream bank buffering system and wetland species planting in order to mitigate the effect of stormwater erosion. Design and construction of the system will be centered around restoring the biogeochemical cycling within the stream, as well as addressing the physiological needs of native plant and macroinvertebraete species within the stream and along the stream bank. Furthermore, the restoration seeks to address the needs of the students and faculty of the campus, by making the stream easily accessible and aesthetic.

Biography: Denise is a recent graduate of the University of Maryland, College Park, with a BS in Environmental Science and Biology. She will begin a PhD in Forest Resources at Pennsylvania State University in August. Throughout her time at the University of Maryland, Denise has been involved in sustainable projects, designing and constructing a greywater filtration system along with Gemstone Team PURIFY for UMD's 2nd place winning entry to the 2017 Solar Decathlon Competition. In her last two years at Maryland, she became involved in several projects with the UMD chapter of AEES, including founding and leading the Stream Restoration Project in September 2018. She hopes to continue working on the installation of the stream restoration system during this summer, and continue remotely during the fall.

(88) Urban Environmental Restoration: Ecological vs. Social Values

Presenter: Isaac Hinson, City of Charlotte, ihinson@charlottenc.gov

Abstract: With over 800,000 residents, the City of Charlotte is the largest municipality in North Carolina. One of Charlotte's main environmental focal points is improving the city's surface water quality, which is generally impaired due to past impacts and ongoing development. One mechanism for watershed improvement is the implementation of capital improvement projects, including stream restoration, wetland restoration, and stormwater control measures (SCMs). Traditional ecosystem restoration projects typically emphasize larger project size, minimal human disturbance, and extensive buffers, all of which are difficult to achieve in urban environments. Furthermore, urban watershed improvement efforts are limited by cost, multiple constraints, and limited functional potential. These urban circumstances have typically been viewed as obstacles to successful ecosystem restoration, as project success is often measured through indicators of ecological function. However, where urban projects lack in traditional project-scale ecological value, they provide great opportunities for human-nature interaction and exceptional social value. This social value can be difficult to quantify and compare to

ecological value but has the potential to exceed project-scale benefits. By bringing nature to the masses and incorporating opportunities for recreation and education, urban restoration projects provide tremendous opportunities to foster environmental appreciation and stewardship. The added social value for properly planned urban restoration projects transcends the ecological value of the project itself, and should be given greater consideration by the ecological restoration community. This presentation will evaluate Charlotte's past restoration practices and provide a conceptual framework for planning and implementing future projects that maximize both ecological and social values. This framework includes integrating restoration projects with greenways, parks, schools, and traditionally underserved communities; incorporating measures that provide for education and interaction; and modifying traditional restoration practices to provide community benefits.

Biography: Isaac Hinson is the Watershed Improvement Supervisor for the City of Charlotte Storm Water Services surface water quality improvement program. He has a B.S. in Biology from the University of North Carolina at Charlotte and a M.S. in Biology from Winthrop University. He is certified as a Professional Wetland Scientist by the Society of Wetland Scientists and has over 15 years of professional experience in water quality and stream and wetland science.

(89) The Reedy Creek Project: A Watershed Scale Stream Restoration Project in Charlotte, NC

Presenter: Christine Blackwelder, Wildlands Engineering, Inc., cblackwelder@wildlandseng.com

Abstract: The Reedy Creek Park and Nature Preserve consists of 927 acres of natural, forested habitat and is located within northeast Charlotte's university area. Charlotte-Mecklenburg Storm Water Services (CMSWS) identified this area as a unique opportunity to protect and restore a headwater stream network while providing stream and wetland credits for the City's Umbrella Mitigation Bank. Goals of the project included improving bed and bank stability, diversifying habitat, and improving the hydrologic connectivity of the streams, wetlands and floodplains through natural channel design techniques.

CMSWS partnered with Wildlands Engineering as the design-build firm to complete design, public outreach, easement acquisition, permitting, construction, and mitigation monitoring services. The project was constructed through the progressive design-build approach from November 2017 through February 2019. Over 5 miles of streams were restored and reconnected to their floodplains and almost 3 miles of headwater streams were protected. Stream restoration projects are ideal candidates for the design-build method as compared with the traditional low-bid build process, as the delivery method allows for field design changes during construction, which are a critical component for a successful stream restoration project.

This presentation will review the structure of the Reedy Creek watershed, which includes an agricultural subwatershed, an uncontrolled high-density residential subwatershed, a stormwater controlled residential subwatershed, and an undeveloped forested subwatershed. The varied complexities of design and construction from subwatershed to subwatershed will be highlighted and discussed, as will the innovative partnerships that allowed for execution of Priority 1 watershed restoration project of this scale.

Biography: Christine Blackwelder currently serves as a Senior Environmental Scientist for Wildlands Engineering's Charlotte, NC office. Christine has 17 years of experience in environmental restoration. As a technical leader in stream restoration for Wildlands, her duties include assessment, design, and management of ecological restoration projects, as well as conducting internal technical trainings. Wildlands Engineering specializes in stream and wetland restoration with a particular focus on innovative engineering for ecosystem renewal.

(90) Potential of Targeted Wetland Restoration to Reduce Nitrogen Loads to Surface Waters in Iowa

Presenter: William Crumpton, Iowa State University, crumpton@iastate.edu

Co-Authors: Greg Stenback, Iowa State University, gastenba@iastate.edu; Stephen Fisher, Iowa State University, swfisher@iastate.edu; Jana Stenback, Iowa State University, janazahn@iastate.edu

Abstract: The state of Iowa has adopted a statewide strategy to reduce nonpoint source nitrogen loads to surface waters by 41%. The strategy involves a wide range of in-field and off-field practices, but relies heavily on restoring thousands of wetlands targeted to intercept and reduce nitrate loads from about 4 million hectares of cropland. Wetland restoration is a promising strategy for reducing surface water contamination in agricultural watersheds and in particular for reducing agricultural nitrate loads to the Mississippi River and its tributaries. Nearly 90 wetlands have been restored through the Iowa Conservation Reserve Enhancement Program with the explicit goal of intercepting and reducing nonpoint source nitrate loads. These wetlands total over 300 ha of pool area and intercept nitrate loads from approximately 45,000 ha of primarily cultivated cropland. Over the past 10 years, we have measured nitrogen mass balances of a selected subset of these wetlands to evaluate their effectiveness at reducing agricultural, nonpoint source nitrogen loads and to develop models for predicting wetland performance at scale and in combination with other practices. The monitored wetlands were selected to ensure a broad spectrum of major external forcing functions affecting wetland performance including hydraulic loading rate, residence time, nitrate concentration, and nitrate loading rate. Nitrogen loads to the wetlands were primarily in the form of nitrate and all of the wetlands were effective in reducing both nitrate and total N loads. Nitrate removal efficiency (expressed as annual percent mass removal) ranged from 7-90% and was primarily a function of hydraulic loading rate and temperature. Mass nitrate removal ranged from 115-3430 kg N/ha/year and was primarily a function of hydraulic loading rate, temperature, and nitrate concentration. Our results demonstrate that wetlands can be effective sinks for nonpoint source nitrate loads across a wide range of conditions and that performance can be reasonably predicted based on hydraulic loading rate, temperature, and nitrate concentration. We extended these results to project statewide nitrate load reductions for Iowa using a combination of nutrient management and targeted wetland restorations. Results demonstrated that targeted wetland restorations will be critical to achieving Iowa's nutrient reduction goals.

Biography: William Crumpton is University Professor of Ecology, Evolution and Organismal Biology and chair of the undergraduate Environmental Science program at Iowa State University where he teaches courses on mass balance analysis and modeling and conducts research on the hydrologic and water quality functions of wetlands. His research focuses on wetland processes and functions, including the dynamics of energy flow and nutrient transformation in wetlands, the fate and effects of agricultural contaminants in wetlands, and the role of restored and constructed wetlands in watershed hydrology and water quality. Dr. Crumpton is an authority on the functions of wetlands in agricultural landscapes and his research provided the scientific and technical foundation for development and implementation of the Iowa Conservation Reserve Enhancement Program, a $100 million program using targeted wetland restorations to reduce nitrate loads from agricultural watersheds.

(92) Mississippi Delta Restoration: Ecological Engineering on a Grand Scale

Presenter: John Day, Louisiana State University, johnday@lsu.edu

Abstract: The Mississippi delta is one of the largest coastal ecosystems but it has suffered 25% wetland loss in the 20th century. The state of Louisiana is investing $50B in a 50-year Coastal Master Plan (CMP) to reduce flood risk for developed areas and restore deltaic wetlands to a more self-sustaining and healthy condition. Both hard structures (levees, floodwalls) and wetlands sustained by “soft” projects (river diversions, marsh nourishment, barrier island maintenance) can work together to reduce risk of future hurricane damage to coastal cities, towns and industry, while also protecting livelihoods and ways of life built around harvesting natural resources But the pace of greenhouse gas emissions driving climate change, as well as the inevitable rise in energy costs, will make achieving CMP goals ever more challenging and expensive. Regardless of the project portfolios evaluated in the current CMP, the hydrodynamic and ecological modeling underpinning CMP projections indicates that fully implementing the plan will reduce future deltaic land-loss rates by less than 20 percent. The cost of delta restoration is quite sensitive to project type and sequencing. Investment is, for example, front-loaded for river diversions and marsh creation but back-loaded for most other project types. Repeated evacuations followed by more or less managed retreat will also continue to be necessary for much of the population even if the existing CMP is improved to increase supply of fine-grained sediments to the MRD. The CMP is ecological engineering on a grand scale, but to be successful it must operate in consonance with complex social processes. This will mean living in a much more open system, accepting natural and social limitations, and utilizing the resources of the river more fully.

Biography: John W. Day, Jr. is Distinguished Professor Emeritus in the Department of Oceanography and Coastal Sciences, College of the Coast & Environment at Louisiana State University, where he has taught since 1971. He has published extensively on the ecology and management of coastal and wetland ecosystems, with emphasis on the Mississippi delta, and has over 350 peer-reviewed publications. He is co-editor (with B. Crump, M. Kemp, and A. Yáñez-Arancibia) of Estuarine Ecology 2013, 2nd edition; coeditor (with C. Hall) of Ecological Modeling in Theory and Practice; coeditor (with W. Conner) of The Ecology of the Barataria Basin, An Estuarine Profile, coeditor (with A. Yáñez-Arancibia) of the Ecology of Coastal Ecosystems in the Southern Mexico: The Terminos Lagoon Region; coeditor (with A. Yáñez-Arancibia) of Ecosystem Based Management of the Gulf of Mexico in 2013; and co-author of Americas Most Sustainable Cities and Regions – Surviving the 21st Century Megatrends (2016). Professor Day received his PhD in marine sciences and environmental sciences from the University of North Carolina in 1971 working with the noted ecologist Dr. H.T. Odum. Since then, he has conducted extensive research on the ecology and management of the Mississippi Delta and for the last 40 years, has studied coastal ecosystems in Mexico. He was a visiting professor in the Institute of Marine Sciences of the National University of Mexico in 1978-1979, at the University of Utrecht in the Netherlands during 1986, at the Laboratoire d’Ecologie, Unversité Claude Bernard in Arles France during 1992-93, and in the Department of Geography at Cambridge University in 2000-2001. He has also worked with the University of Campeche and the Institute of Ecology in Xalapa, Mexico. From 1992-2017, Professor Day worked in the Mediterranean studying the impacts of climate change on wetlands in Venice Lagoon and in the Po, Rhone and Ebro deltas. He has worked on using wetlands as a means of removing nitrogen from the Mississippi River. Dr. Day also served as a member of the hypoxia reassessment taskforce and published with Dr. William Mitsch on this subject. He is currently involved in research on the impacts of 21st century megatrends on sustainability of natural and human systems. He served as chair of the National Technical Review Committee reviewing the restoration program for the Mississippi delta and is currently active in delta restoration. He served as chair of the Science and Engineering Special Team on restoration of the Mississippi delta (a book on this effort was published in 2014). He serves on the Scientific Steering Committee of the Future Earth Coasts program, an international coastal science effort. He served on a National Research Council panel on urban sustainability. He is the recipient of a Fulbright Fellowship for study in France and the Estuarine Research Federation Cronin Award for excellence in teaching in coastal sciences. He has served as major professor for 70 MS and PhD students and has written and edited 14 books, published over 350 peer-reviewed articles, and has a total of over 400 publications. His work has been cited over 21,000 times

(94) Utilizing Algae for the Production of High-Quality Biomethane via Anaerobic Digestion

Presenter: Danielle Delp, University of Maryland, ddelp@umd.edu

Co-Authors: Andrea Yarberry, PhD,United States Department of Agriculture, ayarberry@gmail.com; Peter May, PhD, University of Maryland, pimay@umd.edu; Patrick Kangas, PhD, University of Maryland, pkangas@umd.edu; Freddie Witarsa, PhD, Colorado Mesa University, fwitarsa@coloradomesa.edu; Stephanie Lansing, PhD; University of Maryland, slansing@umd.edu

Abstract: Algal turf scrubbers (ATS) operate by extracting nutrients and filtering water through algal biomass growth on a lattice mat located on a raceway. This process creates a small, controlled algal bloom that uptakes nutrients from water pumped through the system, with regular harvesting of the biomass to maintain high growth rates. An ATS system, consisting of a 61 x 2 m runway with 1% slope, has been operating at the Port of Baltimore in Dundalk, Maryland for years, reducing nutrient contamination in the Patapsco River, which flows into the Chesapeake Bay. Starting in 2017, the algae that was harvested weekly from the ATS was utilized in a series of three anaerobic digesters (AD) to produce biogas for renewable energy production. Digesters 1 (D1) and 2 (D2) operated in parallel (1700 L each), while Digester 3 (D3) at 500 L was connected in series to D2, thus, increasing the hydraulic retention times (HRT) in the D2-D3 system. Over the 13-week experimental period, D1 and the D2-D3 system produced 1840 L and 2461 L of biogas, respectively. The average concentration of methane (CH4) in the biogas in D1, D2, and D3 was 73.0 ± 1.57, 68.9 ± 3.42, and 69.2 ± 2.81%, respectively. This quantity of biogas produced was lower in 2018 compared to 2017 due to a lower mass of ATS harvested in 2018 compared to 2017 due to unusually wet conditions in Maryland. However, the quality of the biogas was higher in 2018, as the hydrogen sulfide (H2S) content of the biogas remained below 5 ppm for all three digesters, which reduces the likelihood of corrosion in engines and fuel cells that use the biogas to generate electricity. The implications of the integration of the ATS nutrient removal technology with anaerobic digestion and renewable energy production will be discussed.

Biography: Danielle Delp is a PhD student. She currently researches the incorporation of algal bioremediation systems and anaerobic digestion technology in the lab of Dr. Stephanie Lansing at the University of Maryland in College Park, Maryland.

(95) An Investigative Study into Biomass Yield Production and Energy Content from Three Feedstocks as a Sustainable Solution for Right-of-Way Management

Presenter: David Penn II, Georgia Southern University, dp01512@georgiasouthern.edu

Co-Authors: Francisco Cubas, Georgia Southern University, fcubassuazo@georgiasouthern.edu; Celine Manoosingh, Georgia Southern University, cmanoosingh@georgiasouthern.edu; Subhrajit Saha, Texas State University, sks167@txstate.edu

Abstract: In recent years, there has been an increasing interest from state Departments of Transportation to assess the potential of using highway right-of-way (ROW) for viable renewable energy production. This study was to done to assess the viability of roadside feedstock production by establishing five ROW sites along I-16 in Georgia, where plots of Switchgrass, Big Bluestem, and Woodland Sunflowers were planted to measure biomass and energy production potential. Results revealed that sites 1-5 had mean dry biomass yields (averaged over two years) for Switchgrass ranging from 33 – 85 Mg/ha/yr. Similarly, mean dry biomass yields ranging from 6.0 – 62 Mg/ha, and 2.2 – 10.3 Mg/ha were measured for Big Bluestem and Woodland Sunflower respectively at same sampling locations. The energy content for each plant species was 22.44, 25.02, and 19.27 kj/g for Switchgrass, Big Bluestem and Woodland Sunflower respectively. Additionally, results showed that the energy production generated within the ROW ranged from 74.1 – 190.7 Gj/ha for Switchgrass, 15.0 – 155.12 Gj/ha for Big Bluestem and 4.2 – 19.8 Gj/ha for Woodland Sunflower. Increasing N rates up to 120 kg N/ha by the addition of fertilizer did not have a significant impact on biomass production and energy content. Similar biomass yields for Big Bluestem and Switchgrass samples treated with 0 and 60 kg N/ha fertilizer rates highlighted the potential to establish both species as a sustainable alternative for ROW biomass production with minimal fertilizer application. Despite woodland sunflower dry matter yields not being significantly affected by 0, 60 and 120 kg nitrogen (N) fertilizer rates, its low biomass yields highlighted the low production value of this feedstock in ROW areas. Finally, higher energy contents coupled with high dry matter yields indicated the potential of Big Bluestem and Switchgrass to emerge as viable candidates for highway ROW renewable energy production across southeastern Georgia.

Biography: David Penn II is the presenting author of "An Investigative Study into Biomass Yield Production and Energy Content from Three Feedstocks as a Sustainable Solution for Right-of-Way Management'. He was born on the 20th of August, 1991. He currently resides in Statesboro, Georgia, though he lived in Willingboro, New Jersey, as a child. He enrolled at Georgia Southern University for an undergraduate program in civil engineering. While at college, he ws was a Geographic Information Systems Intern (GIS) at the Georgia Environmental Finance Authority (GEFA) where he participated in and facilitated internal GIS committee meetings. After completing college he was employed at Terracon as an engineering technician before returning to Georgi Southern University to pursue a masters degree in civil engineering. He gives credit to his family for having instilled the right values at the right time, and for supporting him with his endeavors.

(96) Feasibility of Anaerobic Co-Digestion to Manage Food Waste and Wastewater Solids from Yosemite National Park, USA

Presenter: Julia Burmistrova, University of California, Merced, ju.burm@gmail.com

Co-Authors: Marc Beutel, University of California, Merced, mbeutel@ucmerced.edu; Steve Shackelton, University of California, Merced, sshackelton@ucmerced.edu; Jodi Bailey, Yosemite National Park and the National Park Service, jodi_bailey@nps.gov

Abstract: Yosemite National Park (YNP) is implementing a Zero Landfill Initiative to completely divert solid waste away from landfills. Regional landfill disposal is problematic for several reasons including high tipping fees, ever diminishing landfill capacity, air pollution emissions associated with waste transport and landfill management, and in the case of organic waste, a loss of the potential energy stored in the waste. More sustainable and local methods of managing solid waste are needed. Each year YNP receives 4-5 million visitors that produce an estimated 665 annual tons of solid municipal waste and 1.5 annual tons of wastewater solids. Much of this solid waste includes organic waste predominantly in the form of food waste. In this study we assess the feasibility of implementing a co-digestion program to convert organic waste to useable energy. Co-digestion is a form of anaerobic digestion in which food waste is combined with wastewater solids and treated in large anaerobic tanks or "digestors". The byproduct of anaerobic co-digestion, biogas (methane and carbon dioxide), is collected and combusted to produce energy. A new $80 million wastewater treatment plant is currently being planned for YNP near El Portal, California. This gives YNP a unique window to evaluate the feasibility of coupling organic solid waste and wastewater solids to enhance methane gas and energy production, while substantially lowering the amount of solid waste disposed in landfills. The presentation will include results of a biochemical methane potential (BMP) test, a key anaerobic treatment metric, performed using various combinations of YNP food waste and wastewater solids.

Biography: After earning a dual-BS in Bioenvironmental Engineering from Rutgers University (New Jersey), Julia moved all the way to sunny California to get an MS in Environmental Systems at University of California, Merced. Currently, she is working on an anaerobic co-digestion project in tandem with Yosemite National Park and their Zero Landfill Initiative. The project is taking an innovative look at the combination of food waste diversion and wastewater treatment. After she finishes her MS this summer, she hopes to continue her work in environmental engineering with a focus in sustainability and waste management, especially since there are many new global waste issues popping up today.

(97) The Bio-Intensive Greenhouse Agrodynamic System (BioGAS)

Presenter: John Mueller, Mueller Environmental & Sustainability, Inc., jmueller62@charter.net

Abstract: Agricultural practices in Western North Carolina have caused adverse environmental consequences associated with surface water runoff and air emissions. New management methods and technologies are needed to minimize environmental impacts and maximize the benefits of energy and fertilizer value that manure represents. Anaerobic digestion is the oldest and best developed technology for promoting biogas production and utilizing the resultant gas as fuel and the effluent slurry as fertilizer. Implementation of this technology at the small farm and homestead scale (e.g., micro-scale) provides opportunities for integrated systems approaches that can increase efficiency and profitability of operations while at the same time addressing environmental concerns. In an effort to

standardize and facilitate adoption and implementation of these advantages, the Biointensive Greenhouse Agrodynamic™ System (BioGAS™) was developed. BioGAS combines component design features and an eco-friendly, cradle-to-cradle, integrated systems approach with the objective of optimizing economic and environmental benefits of agricultural operations at the micro-scale. The Warren Wilson College Farm served as a case-study for this project. A site-specific conceptual design was prepared to provide a basis for this feasibility study. This feasibility study uses the conceptual design as a basis for cost/benefit analysis as well as identification of safety, policy, and funding considerations. The total initial capital investment is estimated at $3,500 with annual operation and maintenance costs of $2,850 and annual value of benefits of $3,500 This equates to a payback period of 5.4 years and a return on investment of 18.6%. This study demonstrates outstanding potential for innovative, integrated systems approaches to attain positive triple-bottom-line outcomes, including economic advantages to farmers, reduced environmental impacts, and social benefits to the community from increased supply of fresh local produce and a cleaner environment.

Biography: John Mueller graduated from Tulane University with a Bachelor of Science degree in Civil Engineering and from Lenoir-Rhyne University with a Master of Science degree in Sustainability Studies. His career in environmental consulting started with hazardous waste site investigation and remediation support as a technical assistance contractor to USEPA. His innovative approaches, streamlined management, and collaboration led to the fastest cleanup of a National Priorities List site in US history at the Southern Shipbuilding Corporation site. Since 2005 he has been serving Western North Carolina as President and Owner of Mueller Environmental and Sustainability, Inc. The company is dedicated to improving the quality of life and future prospects for residents and businesses in the region.

CONCURRENT SESSION 8

(98) Do Roots Bind Soil? Comparing the Physical and Biological Role of Roots in Fluvial Streambank Erosion Resistance

Presenter: Daniel Smith, Virginia Tech, dsmith36@vt.edu

Co-Authors: Theresa M Thompson, Virginia Tech, tthompson@vt.edu

Abstract: Today, it is recognized that plant roots affect fluvial erosion on streambanks through three main processes: 1) physical binding of soil particles by roots, 2) “gluing” soil particles together due to the release of extracellular polymeric substances by soil microorganisms, and 3) altering the streambank boundary layer, which reduces hydrodynamic forces and increases flow resistance. However, the relative importance of these mechanisms is not fully understood.

To quantify the effects of roots and soil microbial communities on erosion resistance, laboratory erosion testing was conducted using a jet erosion test (JET) device – an erosion measurement tool used measure soil erodibility and critical shear stress. Erosion resistance measurements were also correlated with plant, soil, and microbial parameters, including extracellular polymeric substances (EPS), aboveground biomass, root length density (RLD), and aggregate stability. The experimental setup included five

treatments: 1) sterile soil, 2) sterile soil with synthetic roots, 3) inoculated soil without roots, 4) inoculated soil with synthetic roots, and 5) inoculated soil with live roots.

Critical shear stress, the stress required to start erosion, was significantly increased in Treatments 2, 4, and 5 compared to Treatment 3 by 67%, 75%, and 79%, respectively. As RLD and aggregate stability increased in vegetated samples (Treatment 5), soil critical shear stress significantly increased as well. However, soil erodibility, the volume of soil loss over time per unit area, was also significantly increased by 33% in Treatment 4 compared to Treatment 1. In addition, Treatment 5 saw a significant 10% decrease in aggregate stability in samples compared to all other treatments. Synthetic roots increased critical shear stress and soil erodibility, and no significant differences were found between sterilized vs inoculated treatments. These results suggest that the physical presence of fibers or the biological activity of microorganisms alone may not significantly impact soil resistance to fluvial erosion.

Biography: Daniel first learned of his love for the environment during his sophomore year while taking a fundamentals of soil science class at the University of Maryland, College Park (UMD). The class taught him why soil was such a precious resource and instilled a desire to protect it from further degradation. As a result, Daniel received a B.S. in Civil and Environmental Engineering and Minor in Soil Science at UMD ('17). Starting in August 2017, Daniel joined the Biological Systems Engineering Department as a PhD student with Dr. Tess Thompson. His research project focuses on how plant roots and soil microorganisms impact streambank soil resistance to fluvial erosion. In order words, how effective are plant roots and soil microbes at protecting streambank soils from erosion by water?

(99) Impact of Riparian Re-Vegetation on Streambank Erodibility and Stability

Presenter: Fouad Jaber, Texas A&M AgriLife, fouad.jaber@ag.tamu.edu

Co-Authors: Destiny Russell

Abstract: Riparian and stream degradation is a major threat to water quality, in-stream habitat, terrestrial wildlife, aquatic species, and overall stream health. Conversely, proper management, protection, and restoration of riparian areas decrease bacteria, nutrient, and sediment loadings to waterbodies; lower in-stream temperatures; improve dissolved oxygen levels; improve aquatic habitat; and ultimately improves macrobenthos and fish community integrity. Two thirty meter reaches along a moderately erodible section of Geronimo Creek in Seguin, TX were selected for evaluating the impact of riparian revegetation as a restoration technique. One site was re-vegetated, and the other was left in its current condition. Water quality samples pre and post restoration are collected quarterly and after large storms. The impact of the re-vegetation was evaluated using the Bank Erodibility Hazard Index (BEHI) and cross section changes with time. Field measurements such as pH, electrical conductivity, temperature, total suspended solids (TSS), and dissolved oxygen data was also used to evaluate the restoration.

Biography: Dr. Fouad Jaber is an associate professor and integrated water resources management extension specialist with Texas A&M AgriLife Extension located at the Texas A&M AgriLife Research and Extension Center at Dallas. He has been conducting research and extension programs related to stormwater management, stream restoration, non-point source pollution management from the urban environment and water quality studies since 2002. Dr. Jaber is a registered Professional Engineer in the State of Texas.

(100) Post-Restoration Monitoring of Stream Restoration Projects: What Have We Learned About Our Design Cross-Sections?

Presenter: Jonathan Page, North Carolina State University, jlpage3@ncsu.edu

Co-Authors: Barbara Doll, North Carolina State University / North Carolina Sea Grant, bdoll@ncsu.edu

Abstract: Compensatory mitigation for impacts to streams and rivers is an established and growing industry across the United States. A state agency in North Carolina, the Division of Mitigation Services (NC DMS), facilitates many of the mitigation projects for streams. As these projects are implemented, post-construction monitoring is conducted to document and evaluate success of the project. Monitoring typically includes permanent cross-sections, vegetation plots, photo points, substrate surveys and longitudinal profile surveys. NC DMS has compiled a large database of monitoring data from projects over the last 20 years, however very little analysis of the dataset has been conducted. The general assumption is that newly constructed streams and rivers will adjust and evolve over time as the boundary conditions of the restored channel change as the project matures. The monitored cross-sections have been used to evaluate post-restoration channel adjustment trends. Within the current cross-section database there are 312 Reaches (individual streams) across 122 Sites represented, and within those Sites and Reaches there are 1,150 monitoring cross-sections with 3,944 resurveys. General as-built design parameters have been characterized. The mode of W/D for as-built restored streams in the NC Piedmont was 13 with 14 only having one less count. The majority the D50's were gravel. Sand bed streams accounted for 39% of all reaches, which was more than anticipated due to the geologic characteristics of the NC Piedmont. Preliminary normalized adjustment factors were calculated for the "Net" and "Absolute" changes in the channel's hydraulic geometry for riffles and pools. There were clear trends for the absolute riffle adjustments, which accounts for both increases and decreases in hydraulic geometry parameters. The median adjustment factors for Abkf, Wbkf, Dbkf and Dmbkf for each monitoring interval were all greater than 0.06 (6%) but less than 0.15 (15%) and increased for the overall monitoring period from MY 0 to MY 5 (0.14 to 0.24) for riffles and pools. There were visible trends for the absolute pool adjustments also. For alluvial streams, median adjustment factors for a one-year monitoring interval around 0.10 seems very reasonable if not lower than expected. However, there were also some larger adjustment factors observed in the preliminary data analysis that require further inspection. Further stratification of the dataset is ongoing to evaluate variability in adjustment factors due to hydraulic, geomorphic and watershed parameters not captured in the existing dataset. Relevant hydraulic (e.g. reach slope, shear stress, design bankfull discharge) and watershed (e.g. drainage area, landuse, impervious cover, basin slope) data are being curated from project data files and spatial datasets to support a robust analysis restored channel adjustment trends and factors contributing to those trends. Typical post-construction adjustment sequences and a channel evolution model will also be presented.

Biography: JP is a resident of Raleigh and an Extension Associate Engineer in the Department of Biological and Agriculture Engineering at NCSU while pursuing a PhD with Barbara Doll. He has extensive teaching, research, and applied experience in stream and river restoration, flood mitigation and upland stormwater controls. He supports these efforts with detailed hydraulic and sediment transport modeling

(1D and 2D), innovative GIS mapping and analysis, 3D CAD Design, and fluvial geomorphology characterizations.

(101) Investigating Potential of Degradation of Streams in the United States

Presenter: Brandon Quinn, North Carolina A&T University, bquinn@aggies.ncat.edu

Co-Authors: Manoj Jha, North Carolina A&T University, mkjha@ncat.edu; Niroj Aryal, North Carolina A&T University, naryal@ncat.edu; Peter Allen, Baylor University, Mike White, USDA-ARS Grassland Soil and Water Research Laboratory, Jeff Arnold, USDA-ARS Grassland Soil and Water Research Laboratory

Abstract: Excessive river erosion and corresponding sedimentation threatens critical infrastructure, degrades aquatic habitat, and impairs water quality. Stream power is the rate of potential energy outflow against the bed and banks of a channel per unit length. In many gravel-bedded rivers, floods that fill the channel banks create just enough stream power in shear stress to move the median-sized gravel particles on the bed surface (D50). With the use of D50 data, there is a potential to assess channel degradation, down cutting potential, timing of bed material movement, equilibrium slope and relative bed stability. Consequently, we evaluated D50 and channel geometry as a tool to predict the magnitude of erosion, sedimentation, and channel evolution for their effective management.

We gathered, compiled, and mapped a large nation-wide dataset of D50 and hydraulic geometry for gravel-bedded rivers in the United States representing diverse regions, soils, topography, climates and land uses. The data were used to explore relationships between the D50 and/or channel geometry parameters including bedrock depth with streambank erosion and sediment supply using ArcGIS. The results are expected to provide better predictive capability for river and stream erosion using a readily available or measurable D50. The importance of channel geometry, bedrock depth and grain size lies in that they reflect landslide history, land use history, hydrology, and relative roughness, among many other factors.

Biography: Brandon Quinn is a first year graduate student at North Carolina A&T State University in the department of Natural Resources and Environmental Systems. He graduated from Fort Valley State University with a bachelor's degree in Agricultural Engineering in 2015. His undergraduate research aimed to determine odor print characteristics of bio-diesel fuels produced from materials known as sources of possible allergens to people. Upon graduation, Brandon gained employment with the USDA-Natural Resources Conservation Service working with watersheds and the design and inspection of watershed structures. His current research involves the analysis of river and stream bed stability and degradation. Working closely with professors and other engineers, his research goal is to assist in the development of tools to predict river and stream erosion. After receiving his master's degree, Brandon plans to purse a PhD in Agricultural Engineering.

(102) Functional Potential of Microbial Communities in Agricultural Floodplain Sediments Dominated by Metal Homeostasis and Antibiotic Resistance Genes

Presenter: Michael Brooker, The Ohio State University, brooker.26@osu.edu

Co-Authors: Jonathan D. Witter, The Ohio State University, witter.7@osu.edu; Paula J. Mouser, University of New Hampshire, paula.mouser@unh.edu

Abstract: Riparian buffers are used in agricultural settings to reduce sediment and nutrient loads that impair downstream water bodies. While much is known about the physical and vegetative processes in these systems, less is known about the benefits or risks posed by microbial communities. A relatively new concept in the Midwestern United States is to implement two-stage designs in agricultural channels so that they resemble natural streams. This practice results in floodplains forming within the drainage channels, and allows for water quality improvements. Initially, we sampled sediments from fifteen floodplains to determine the heterogeneity of physical and chemical properties in two-stage channels that had been formed autonomously. The GeoChip 5.0 microarray – a genomic tool – was used to elucidate the microbial functional potential in a subset of theses samples. We detected an abundance of genes related to carbon cycling, organic remediation, and metal homeostasis, and found there to be a high degree of functional similarity across sites. Additionally, we detected a diverse set of antibiotic resistance genes. Our research had led us to ask the question: are two-stage channels sinks, reservoirs, or sources for antibiotic resistance to spread in the environment? Future research is needed to explore the selection and transport of antibiotic resistance in two-stage channel and other riparian systems.

Biography: Michael Brooker attended Ohio State University as an undergraduate focused on microbiology. Subsequently, he pursued graduate degrees in Environmental Science and Civil Engineering with a focus on water resources. His research has been focused in the field of biogeochemistry with emphasis on using (1) genomic tools to probe microbial communities; and (2) mass spectrometry to elucidate organic geochemistry.

(103) Educating Emerging Landscape Architects: Proctor Creek Case Study

Presenter: Jon Calabria, University of Georgia, jcalabr@uga.edu

Co-Authors: LAND 6390 Students

Abstract: Graduate students from an Ecological Restoration course assisted the US Corps of Engineers with the Proctor Creek Urban Water Federal Partnership Program. Over a dozen federal agencies are coordinating with each other and community stakeholders to improve urban watersheds across the United States. Focus areas include urban agriculture, flood management, human health and ecosystem restoration. Restoration is focused on improving degraded channels and addressing sedimentation in Proctor Creek. The Corps of Engineers quantified the benefits of restoration to many different areas and selected almost twenty candidate sites based on cost effectiveness analysis. For this project, students visited several of the sites and coordinated with project stakeholders to clarify co-benefits and suggest design alternatives. Several of the alternatives, along with lessons learned, will be discussed.

Biography: Dr. Calabria, a licensed landscape architect, has worked with diverse clientele on many conservation, restoration and development projects and brings these experiences to his teaching at UGA. Projects improved environmental quality within the human context. Dr. Calabria's research includes the amelioration of land use impacts on receiving waters, exploration of peoples' perceptions and attitudes toward water resources, and pedagogical evaluation of service-learning.

(104) Seeking Consensus for Ecological Restoration of South Florida Ecosystems in a Water Resources Sustainability Course

Presenter: Mauricio Arias, University of South Florida, mearias@usf.edu

Abstract: South Florida has a unique mosaic of ecosystems covering an extensive area of the peninsula. Now neighboring the largest metropolitan area in Florida, this area is home to the Everglades, historically decimated for land reclamation and agriculture. Water through the region is heavily controlled as it moves from Lake Okeechobee through a series of canals and reservoirs. Despite large and expensive efforts to restore the Everglades, the regional hydrology remains heavily altered. What is more, the earthen dyke surrounding Lake Okeechobee, built in the 1930s to protect settlements south of the Lake from flooding, is dangerously compromised, forcing the Army Corps of Engineers to maintain its level below originally intended. This has led to excessive amounts of nutrient-rich waters being directed to the Gulf and Atlantic coasts, aggravating the severe algal blooms occurring in the canals and off the coasts. Overall, this is the most complex water and environmental management problem in Florida nowadays, involving dozens of stakeholders, affecting millions of civilians, and compromising tourism, the state's largest industry. Graduate students in a Water Resources Sustainability course were presented with this problem, and throughout the semester we worked on finding sustainable management alternatives. The problem was approached using Water Diplomacy principles aiming to achieve consensus among stakeholders on how to manage water. Once critical stakeholders were identified, student took the role of each of them, and through a series of role game sessions ("stakeholder workshops"), we found consensus on a vision for the region, which highlighted the importance of ecosystem quality for the well-being of Florida's society. This vision then directed specific actions needed to be taken to address the problem, some of which may involve ecological engineering, but not all. This presentation will summarize this fascinating educational experience, seeking feedback on how to continue improving this process.

Biography: Mauricio Arias is an Assistant Professor in the Department of Civil and Environmental Engineering at the University of South Florida. He moved back to Florida in summer of 2016 after completing a Post-doctoral research fellowship in the Sustainability Science Program at Harvard University in 2014-2016. His research aims at creating science-based linkages between the hydrological cycle, ecosystems, and society in order to promote sustainable management of water resources. He has studied hydrological, ecological, and sustainability issues in freshwater ecosystems around the world, primarily in Southeast Asia (Mekong), Brazil (Amazon) and Florida. He holds a Bachelor of Science and a Masters of Engineering in Environmental Engineering Sciences from the University of Florida, and a PhD in Civil Engineering from the University of Canterbury in New Zealand.

(105) EcoDesign Class Project: Teaching Ecological Engineering Through an International Project Collaboration

Presenter: Thomas G. Franti, University of Nebraska-Lincoln, tfranti@unl.edu

Co-Authors: O. Grant Clark, McGill University, grant.clark@mcgill.ca

Abstract: The authors teach an Ecological Engineering course that is an international collaboration between the University of Nebraska-Lincoln and McGill University. The core learning experience is an EcoDesign Class Project. Learning outcomes are to work in a diverse team, collaborate using online tools, and create an ecological engineering design. Each student first completes a preliminary individual design idea. Teams comprising students from both universities then work together online using a "whiteboard-style" platform to develop and deliver a conceptual design. The design is assessed using a detailed rubric available to the students at the start of the project. The proposed system must: 1) provide at least two ecosystem services; 2) include both biotic and abiotic components; and 3) be specified for a real geographical location. The online whiteboards must include information about the collaboration (team-building, self-assessment, design methodology; individuals' contributions), site characterization (physical and ecological aspects), and system specification (ecosystem services provided, energy system diagram, relevant calculations, and design graphics). Finally, an abstract must summarize the project goals, ecosystems services, ecological paradigm, and substantive legitimacy; i.e.: How will the system work? Instructors and peers provide feedback on a draft version of the description and the instructors grade the final version.

Biography: Thomas G. Franti, P.E., is an Associate Professor and Surface Water Management Specialist with the University of Nebraska-Lincoln. For 25 years he has conducted research and extension education programs related to protecting surface water quality. He also has five years of consulting engineering experience related to site feasibility and landfill design and construction. He is a registered professional engineer in Wisconsin. He has written guides related to riparian buffer strips to protect streams from agricultural runoff, rain gardens for urban homeowners, and use of compost for erosion control on steep slope construction sites. He teaches two courses, Introduction to Ecological Engineering and Nonpoint Source Pollution Control Engineering.

(106) The Development of a Chapter of the American Ecological Engineering Society

Presenter: Annabelle Arnold, American Ecological Engineering Society at the University of Maryland, aarnold2@terpmail.umd.edu

Abstract: Since its 2015 conception, led by two ecotechnology design undergraduates, the American Ecological Engineering Society chapter at the University of Maryland has blossomed. From five active members then to almost thirty now, meeting attendance, event participation and project involvement have all increased drastically.

The first two executive boards of UMD's AEES spent their time organizing student government registrations, learning to navigate an expense account and to fundraise, and creating a basic framework to establish the society. There was not much time for members to plan, let alone implement, any real-world projects and as a result, the UMD chapter of AEES did not make an appearance at the national

conference its first year. However, the second year's team sent four members to the Georgia conference.

Last school year, the society adopted and focused on one project: the installation of a large-scale algal turf scrubber to educate students and faculty while reducing the campus contribution to stormwater runoff-related issues, awarded $1,000 between two grants. The members attended more campus-wide events and supported many sustainable engineering initiatives, making the club more popular among the student body. Fourteen AEES members attended the national conference!

This year, conference attendance has decreased to five members, but on-campus initiatives have increased four-fold! The society is focused on four projects: the algal turf scrubber (continued), a stream restoration project, an outdoor educational green wall, and stormwater management systems. These projects, together granted over $60,000 so far this year, have expose AEES members to institutional, financial and legal challenges that reflect those that professionals tackle and allow for close ties with many university departments. The society now has a more diverse set of majors and works alongside UMD's chapter of Engineers Without Borders. Now, professors and organization leaders contact the society for aid when planning and implementing their projects!

Biography: Annabelle Arnold is a junior at the University of Maryland studying Environmental Health and Global Poverty. She became involved in the UMD chapter of the American Ecological Engineering Society in 2017 when a project she was co-leading, the Algal "Terp" Scrubber, was adopted by the student organization as a structure that would ensure the implementation of the technology on campus. After a year in the society, she was nominated and voted in as President for the following year, this year, in which the club has taken on more projects than ever. Through collaboration with other student organizations and university departments and dedication to the pursuit of sustainably engineered solutions, the UMD chapter of the AEES is an example of how groups of students can self-organize to tackle real-world problems and create a better future. Annabelle hopes to share this message with other current and future AEES chapter leaders!

(107) Co-Currence Network Analysis of Keywords in Ecological Engineering

Presenter: Juan Castano, Universidad Tecnologica de Pereira, jmc@utp.edu.co

Abstract: The aim of this study is to identify core keyword of Ecological Engineering from 1997 to 2019 in papers three Ecological Engineering related journals.   A total of 739 papers were retrieved from Scopus. Keywords from these papers were extracted using the scopus data base, and were processed by scripting in R to obtain a node matrix with 2889 nodes, and an edge matrix with 7996 edges. A network analisys of these Matrix were conducted using Gephi 0.9.1. Using the weighted degree of the network, the top ten keywords with a high frequence of ocurrence were 'ecological engineering', 'biodiversity', 'restoration', 'phosphorous', 'sustainability', 'ecological restoration', 'soil', 'GIS', 'water quality' and 'biomass'. A total of 171comunities were identified. The main cohesive subgruops are around the keywords 'Restoration', 'Ecological Engineering", 'Conservation', 'GIS' and 'phosporous'. The low density of the network shows a high heterogeinity of keywords. The keywords 'ecological engineering', 'sustainabilitiy', 'biodiversity' and 'Restoration' represents, according the eigenvector centrality, the more influencing keywords of the network.

Biography: Juan Castano has a BS in Chemical Engineering; MSc in Sanitary & Environmental Engineering; PhD in Engineering. Associate Profesor at Universidad Tecnologica de Pereria in Pereira Colombia

(108) Drawing the Circle Larger: Towards Integration of Heavy Industry with Remediation of Oceanic Dead Zones

Presenter: David Austin, Jacobs, david.austin10@jacobs.com

Abstract: Oceanic dead zones are a growing problem worldwide. All occur in areas receiving nutrient-rich discharge from major river systems. In confined seas, such as the Baltic Sea, remediation by source reduction will take over a century. Action is needed now.

Injection of pure oxygen into anoxic deeps will destroy anoxia. Mature technologies exist from reservoir remediation to do so. Scale is challenging. Remediation of Baltic anoxia may take 50,000 tons $O2$ per day distributed at various deep zones. Over a one hundred-fold increase in scale from current technology presents formidable engineering and economic challenges.

Meeting those challenges entail drawing larger conceptual circle around the problem. Production of that much oxygen is only economically feasible through liquefaction of air. For every 10,000 tons of oxygen produced through fractional distillation of liquid air slightly less then 40,000 tons of liquid nitrogen will be produced. Liquid nitrogen can them serves as large-scale grid batteries for renewable energy.

When liquid air (or nitrogen) expands, it can power turbines returning energy to the grid within 10 seconds from the signal for demand. Round trip energy efficiency for liquid nitrogen grid batteries can be up to 45%. Renewable energy is currently in a phase of severe and increasing curtailment primarily because of lack of storage. Without storage, maximum green energy penetration is slightly less then 40% of the grid. With 12 hours of storage it is 80%.

Engineered remediation of oceanic dead zones has scarcely been contemplated. Nevertheless, all the technologies needed to do so are mature in various industrial sectors. Technical integration of these technologies is not simple, but the engineering challenges are straightforward. The challenge is finding economically viable solutions at scales that can be rationally integrated into other industrial sectors.

Biography: David Austin is the lead technologist for Natural Treatment Systems in Jacobs Engineering Group. He is an environmental P.E. (MN), Certified Senior Ecologist (Ecological Society of America), Certified Lake Manager (North American Lake Management Society), and a past President of the American Ecological Engineering Society. His projects concentrate on reservoir management, treatment wetlands, wastewater reuse, and mine water reclamation. Previously, he was a marine salvage and diving officer in the Navy. Degrees: Mathematics (BA, UM-Twin Cities), Water Resources Management (MS, UW-Madison), and Civil & Environmental Engineering (MS, UC-Davis).

(109) Biomonitoring Mercury Contamination of the Landscape: Concentrations and Speciation in Tree Bark Near the Abbadia San Salvatore Mining District, Italy

Presenter: Marc Beutel, University of California Merced, mbeutel@ucmerced.edu

Co-Authors: Valentina Rimondi, University of Florence, Italy, valentina.rimondi@unifi.it; Pilario Costagliola, University of Florence, Italy, pilario.costagliola@unifi.it; Pierfranco Lattanzi, Institute of Geosciences and Earth Resources/National Research Council of Italy, Florence, Italy, pierfrancolattanzi@gmail.com

Abstract: Tree bark of Black Pine (Pinus nigra) is being used as a biomonitor of atmospheric mercury (Hg) pollution at the historic Abbadia San Salvatore mining district in Southern Tuscany, Italy. Monitoring shows extreme concentrations of total Hg in surface bark (as high as 17 mg/kg dry weight) decreasing exponentially with distance away from ore processing areas. Additional work is underway to better understand Hg speciation in bark. Previous work by our research team using X-ray absorption near-edge structure spectroscopy showed that Hg in bark samples was dominated by metacinnabar (β-HgS) and Hg-cysteine complexes; Hg bound to tannic acid and Hg0 were also detected. This presentation highlights work using an alternative Hg speciation approach: thermal desorption. Using a Milestone DMA-80 analyzer, samples were heated and Hg concentration assessed incrementally using the following scheme: (1) 175 deg C = labile Hg including HgCl2; (2) 225 deg C = labile organic Hg including humic bound Hg, methyl Hg, and (CH3COO)2Hg; (3) 325 deg C = insoluble Hg sulfides; (4) 475 deg C = poorly labile Hg compounds including HgO and HgSO4; and (5) 750 deg C = immobile residual Hg. Testing, which is ongoing, will yield further insight into how Hg is trapped in tree bark, which in turn will help to inform the role in which tree bark can play in the biomonitoring of Hg pollution in the landscape.

Biography: Marc Beutel is an Associate Professor in the Civil and Environmental Engineering Department and the chair of the Environmental Systems Graduate Group at UC Merced. Beutel's research focuses on the sustainable control of dilute pollutants in managed surface waters including nutrients, pesticides, pathogens, and mercury, with a focus on redox mediated transformations in the environment, reservoir oxygen addition, and constructed treatment wetlands. He is currently working with several large California water utilities assessing how water storage reservoirs can be managed or treated in situ to reduce bioaccumulation of mercury in aquatic biota. Beutel is collaborating with colleagues at the University of Florence, Italy to use tree bark as a simple biomonitor for mercury contamination at historic mercury mines.

(110) Effect of Microbial Treatment Processes on Antimicrobial Resistance (AMR): Digestion and Composting

Presenter: Stephanie Lansing, University of Maryland, slansing@umd.edu

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Abstract: Antimicrobial resistance (AMR) is increasingly recognized as a critical human health threat. A great deal of concern has been focused on the potential overuse of antibiotics in agriculture, and its contribution to the emergence of AMR resistance and negative downstream effects on human health. In this work, we evaluated different dairy manure management practices in controlling spread of antimicrobial resistance from dairy farms, including anaerobic digestion, composting, lagoon storage, and solid-liquid separation with comparison of the antibiotic residual and antimicrobial resistance genes (ARGs) to the quantity of daily antibiotics administered at each of the 11 dairy farms studied over an 18-month period. In addition, we conducted in-depth evaluation of antibiotics and antimicrobial resistance genes transformations during anaerobic digestion and composting of dairy manure at the lab and field-scale.

The results showed that when using antibiotic concentrations seen in the field (0 – 1mg/L), the effect of digestion on antibiotic degradation was inconsistent for tetracycline (0-80% reduction), but high for sulfamethoxine (>95%), with inconsistent reductions is Sul1 genes and greater reductions in TetM genes during digestion. Composting pile management and compost temperature affected the antibiotic concentration reductions, without consistent results in degradation over time.

Current studies include analyzing the effect of higher temperature microbial-based treatment (thermophilic digestion and composting) on antibiotic residuals and ARGs, and investigating stakeholder perceptions (and misconceptions) of AMR prevalence and conveyance for farmers, veterinarians, and other stakeholders using interviews, focus groups, and surveys, with the creation of video and print communication content on AMR in agriculture. Additionally, we recently organized a workshop with the leaders in AMR social science research and AMR communication to identify research to date, and create a database of social science-based AMR information and AMR communication in agriculture.

Biography: Dr. Stephanie Lansing is an Associate Professor of Waste to Energy Technologies at the University of Maryland's Department of Environmental Science and Technology. She earned her Ph.D. and M.S. in Food, Agricultural and Biological Engineering from the Ohio State University. Her research interests include anaerobic digestion, microbial fuel cells, gasification, nutrient capture, and modeling, and includes projects using dairy, swine and poultry manure, food waste, algae, and wastewater in the US, Germany, Haiti, China, and Costa Rica. Her focus on waste to energy processes, includes how anaerobic digestion and composting of manure substrates affect antimicrobial resistance. She has over 15 years of experience in assisting farmers with anaerobic digestion of manure and food waste substrates, nutrient management, life cycle assessments, and waste treatment.

(111) Performance of 3D Manufactured Substrata in the Algal Turf Scrubber Approach

Presenter: David Blersch, Auburn University, dmb0040@auburn.edu

Co-Authors: Andres L. Carrano, Georgia Southern University; acarrano@georgiasouthern.edu; Virginia Davis Auburn University; Joseph Ekong, Ohio Northern University, j-ekong@onu.edu; Kamran Kardel Georgia Southern University, kkardel@georgiasouthern.edu; Zahra Karimi, Auburn University; Ali Khoshkhoo, State University of New York at Binghamton, khoshkho@binghamton.edu; Gabriel Proano Pena, Auburn University

Abstract: The performance of Algal Turf Scrubbers (ATS) rely upon the attachment of benthic filamentous algae to a substratum for remediation of aquatic pollution. The ATS process results in a mixed algal community of multiple phyla, providing a non-specific biomass product of varying quality for post-harvest utilization. This is a factor that has hindered the economic viability of the ATS approach for water remediation in most cases. Among possible process-based approaches for affecting algal community selectivity through competitive exclusion, re-engineering of the substratum for species-specific early colonization shows promise for positively affecting the process. We report on activities researching and developing novel substrata for use in ATS systems. Studies include investigation into advanced rates of early algal colonization using 3D-printed substrata forms, both idealized and reverse-engineered from natural substrata; optimization to increase biomass accrual rates on novel fibrous substrata; and design of new polymer composite materials that are species-selective through manipulation of surface free energy characteristics. Resulting substrata technologies have been tested in the laboratory, and demonstrate promise for understanding fundamental properties of the colonization ecology of attached benthic filamentous algae. Field applications of the materials technologies show advancements in biomass productivity that argue for considerations for scale-up for economic viability of ATS cultivation of algae.

Biography: David M. Blersch, Ph.D., is Assistant Professor in the Biosystems Engineering Department at Auburn University, where he teaches courses in Ecological Engineering, Aquaculture and Aquaponics, and Algae Systems Engineering. Dr. Blersch's research interests in ecological engineering algae cultivation for pollutant recovery and biomass production; aquaculture and aquaponics food production systems; and ecological systems modeling. Dr. Blersch is principal investigator for the Auburn University Algal Systems and Ecological Engineering Laboratory, and is PI for the Auburn University 3D-Printed Bio-Surfaces (3D-PBS) Laboratory. Dr. Blersch has environmental and ecological engineering research supported by USDA National Institute of Food and Agriculture; US National Science Foundation; US Environmental Protection Agency; and Alabama Agricultural Experiment Station, and is the author or co-author of 20 publications and over 100 presentations on ecological engineering for resource utilization in agricultural systems. Dr. Blersch holds a B.Sc. in Civil Engineering from the University of Notre Dame (Notre Dame, Indiana), and a M.Sc. and a Ph.D. in Biological Resources Engineering from the University of Maryland (College Park, Maryland).

(112) Demeter's Abacus: Biological Nutrient Computing

Presenter: Jacob Mast, The University of Maryland AEES, williamjmast@gmail.com

Co-Authors: Patrick Kangas, University of Maryland, pkangas@umd.edu; Peter May, University of Maryland, pimay@umd.edu

Abstract: Algal Turf Scrubbers™ (ATS) are an evolving technology used to mitigate stormwater nutrient run-off, while producing useful algal biomass. Algal production, and the nutrient sequestration therein, is a product of a variety of water conditions, mainly phosphorus and nitrogen content. In trying to implement ATS in our local watershed (three successful temporary installments, two larger scale buildings proposed), it has become a concern that different bodies of water, even small differences in the placement along a single water body, can produce measurable differences in algal production. Demeter's Abacus is a microcosm ATS, designed to operate off a 5 gallon water sample. Through its production of biomass (or its maintenance of a pre-seeded algae screen), a metric can theoretically be obtained for the eutrophication of that water body at that place. More specifically, the system could be used to test the viability of various locations for algae growth, becoming a decision-making tool for the site choices of future ATS installations. The cost of the entire system is being projected to be under $50, with access to 3D printing. In time, this system could provide a rough metric for eutrophication cheaply, helping communities identify point sources for stormwater nutrient pollution. As ATS approaches the farming community as a means of fertilizer run-off reclamation, this ability could be a sales/viability tool. I am currently looking for graduate school opportunities to advance this personal project.

Biography: Jacob is a senior at the University of Maryland majoring in Ecological Technology Design, and minoring in Soil Science. He advises five AEES student projects as Project Manager and Vice President of his chapter, and is a project leader for two of them. Jacob works for former AEES president Dr. David Tilley at Living Canopies, as well as the Maryland Food Collective. He is also a project leader for Roots Africa, and a competitor on the soil judging team. Please talk to him about algae, socialism, and your favorite blues guitarists.

CLOSING GENERAL SESSION

(113) Defining Ecological Engineering Through Research Applications

Presenter: Jay Martin, Ohio State University, martin.1130@osu.edu

Abstract: Following studies in the 1960s using wetlands for wastewater treatment, ecological engineering is now applied in many diverse settings including agricultural, commercial and patented designs. The goal of this presentation is to define ecological engineering by reviewing past descriptions and through Dr. Martin's research projects. This discipline will be characterized by reviewing the evolution of definitions including those from Odum (1963), Mitsch & Jorgensen (1989), and Matlock and Morgan (2011) that focus on supplementing natural ecosystems with human inputs and designing ecosystems for the mutual benefit of humans and nature. Key concepts that define and differentiate ecological engineering will be highlighted: self-organization, systems approach, and sustainable design. Relationships to ecological concepts such as diversity and resiliency will also be discussed by reviewing applications focused on agriculture, green infrastructure, watersheds and coastal systems. This talk will

be delivered during a special Ecological Engineering session at ASABE 2019. It will be debuted at AEES 2019 to receive feedback from those working in the field of Ecological Engineering before presenting to a broader audience.

Biography: Jay Martin is a professor of ecological engineering who analyzes and integrates human and natural systems. As a faculty member in the Department of Food, Agricultural and Biological Engineering and a Faculty co-lead for the OSU Sustainability Institute, he seeks to use natural systems to improve water quality and increase sustainability. His interdisciplinary research links field studies, watershed models, and socio-economic analyses with stakeholder groups to investigate connections between downstream water quality and management practices in upstream watersheds. Currently, Dr. Martin is leading a $5M USDA-NIFA project to establish a Public-Private Partnership with crop consultants and farmers, to identify fields with elevated nutrient levels where management practices will be installed and monitored in an effort to reduce nutrient runoff. He is also leading an interdisciplinary research team to evaluate the impacts of a large green infrastructure project, "Blueprint Columbus," on water, communities, ecosystems, economics and public health within the City of Columbus. Outside of Ohio, Dr. Martin's other research has included Mayan agroecosystems in southern Mexico, biodigesters in Costa Rica, Andes wetlands in Colombia, and the use of algae as a soil amendment by Oʻahu farmers in Hawaii. As of 2019, he has published over 65 peer-reviewed articles, successfully advised over 35 Graduate Students and Post Docs, and been awarded more than $17M to support his research program. He is certified as a Senior Ecologist by the Ecological Society of America and a registered Professional Engineer in Ohio.

(114) Applications and Challenges for Ecological Engineering Down Under. An Australian Perspective.

Presenter: Glenn Dale, Verterra Ecological Engineering, glenn.dale@verterra.com.au

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Abstract: Ecological Engineering offers great potential to help address the grand challenge of how people and nature can beneficially coexist on planet Earth. However, in an increasingly technological world, adoption of Ecological Engineering remains relatively limited, while conventional engineering approaches, based on minimizing the environmental impact of infrastructure and development, remain dominant, particularly in the developed world. Notwithstanding, many green shoots exist, signalling the potential for wider recognition and adoption of Ecological Engineering. Practical Ecological Engineering applications in Australia will be discussed, covering the mining, oil and gas, municipal and natural resource management sectors. The inter-relationships and commonalities between these highly divergent sectors will be highlighted. All apply a balance between the Malthusian doctrine of conserving earth's resources and the Solowian doctrine of harnessing technology to solve wicked problems. All incorporate engineering through quantitative approaches to ecological design to achieve defined performance characteristics.

Example applications of Ecological Engineering include:

1. Mined land rehabilitation: Application of Bayesian modelling to support design and construction of functional post-mining landscapes as an alternative geotechnically engineered landforms.
2. Waste water management: Replacement of energy intensive “grey” infrastructure and concentrated waste by-product, with carbon negative ecological treatment systems.
3. Alluvial gully rehabilitation: Cost-effective rehabilitation of alluvial gullies exporting vast quantities of sediment and nutrient to the iconic Great Barrier Reef through re-establishment natural processes informed by Bayesian decision support modelling.
4. Biosolids management: Exploitation of the biological heat of respiration, in combination with quantitative environmental characterisation, to facilitate conversion to an A Grade (unrestricted product) with significant soil health, crop productivity and environmental benefits.
5. Agricultural production: Quantitative approaches to land characterisation and crop assessment that positively contribute to agricultural productivity and water quality.

Structural challenges facing wider adoption of Ecological Engineering will be discussed, and approaches to overcoming some structural barriers will be explored.

Biography: Glenn is Managing Director and Chief Technical Officer of Verterra. Glenn holds a BSc in Forestry and Biochemistry, a PhD in Molecular & Quantitative Genetics and an MBA. He holds an appointment as Adjunct Associate Professor with the University of Southern Queensland, is a board member of the Australia New Zealand Biosolids Partnership, and is a founding committee member of Foresters without Borders Australia. After completing his PhD in Australia, Glenn received a Fulbright Scholarship and undertook postdoctoral research at North Carolina State University. Glenn has over 32 years’ practical experience in natural resource management and ecological engineering, with broad international experience including New Zealand, China, USA, England, Spain, Portugal, Malaysia, Colombia, Brazil, Tanzania and Rwanda. Glenn’s work was nominated as a finalist for the inaugural Institution of Engineers Australia National Salinity Prize in 2002, was runner up in the 2004 Australian Museum Eureka Science Prize for Industry, and was a finalist in the 2017 Premier of Queensland’s Export Development Awards.

(115) Beyond Growth: Economics as if the Planet Matters

Presenter: Mark Brown, Department of Environmental Engineering Sciences/University of Florida, mtb@ufl.edu

Abstract: To borrow a phrase from the title of E.F. Schumacher’s book Small is Beautiful: economics as if peopled mattered, we take a slightly wider perspective, and suggest an economics as if the planet mattered. We frame the economic system as a subsystem of the larger more encompassing geobiosphere and suggested that within this context, neoclassical economics is unlikely to provide a sustainable future for humankind. From this biophysical perspective, we suggested that increasing the amount or speed of money circulation as well as extracting more energy from whatever sources may be available will only compound problems in the long run and that relying on growth as the solution to what ails the global economy is not a desirable nor a tenable solution. What is required is an alternative economics… a new economics, that is not based on unlimited growth. An economics that does not equate money with wealth…an economics that actually measures well-being instead of GDP…an

economics that is based on longevity and quality instead of quantity and throughput. Whatever term we finally use to describe it, above all the new economy must be, as Buckminster Fuller said, "….an economy that works for 100% of humanity."

Biography: Dr. Mark Brown is Emeritus Professor of Environmental Engineering Sciences and Director of the Center for Environmental Policy at the University of Florida. He is a systems ecologist, whose research focuses on systems ecology, emergy analysis, environmental policy, ecological engineering, and wetlands ecology. Current and past research includes applied and theoretical approaches to understand the urban nexus, the interface of energy, environment, and economics. He has served as consultant on development and sustainability issues to the USEPA, USAID, UNEP, and numerous Governments and private consulting firms worldwide. In his career at the University of Florida, he has mentored 45 PhD students and 64 master's degree students.

POSTER PRESENTATIONS

(1) Assessing Spatial Complexity of Riverscapes Using Drone Based Lidar

Presenter: Charles Aquilina, Virginia Tech Biological Systems Engineering, aqua@vt.edu

Abstract: Light detection and ranging, or lidar is a form of remote sensing using laser pulses to measure distances. Recent advancement in lidar technology has made units small enough to mount on drones, which has opened the door high quality data to be more easily accessible. Recent studies have utilized aerial lidar, or drone based photogrammetry to measure characteristics of streams and rivers, as well as their associated riparian areas. These areas have been referred to as riverscapes. Riverscape's physical characteristics are traditionally difficult to measure, due to ever changing characteristics in space and time. Drone based lidar, or DBL, is uniquely positioned to provide high quality data on physical characteristics as it allows for increased temporal (daily, monthly, seasonal flights) and spatial (more than 400 pts/m 2 at 30 m elevation flight) resolutions. One use of this data is to analyze small changes of the topography of these areas.

Roughness is an important metric in biological studies and flood modeling. In previous studies, estimating roughness was limited to visual observations, back calculating from flow measurements, and other rudimentary methods. Using high resolution DBL derived ground and vegetation rater data, we will monitor small changes in vegetation and topography over the course of the stream. We will test various methods to use lidar data to determine roughness, such as using various software such as CloudCompare, a computer software for visualizing and analyzing lidar, as well as methods developed in previous studies, such as finding the standard deviation of the elevation change, the variation between maximum and minimum elevations in a pixel, and others. Roughness is one of many biological indicators determined by measuring physical parameters of streams and rivers. DBL is a game changing way that we can understand the spatial complexity, and habitat characteristics of riverscapes.

Biography: Charles Aquilina is a masters student in Biological Systems Engineering at Virginia Tech. His research focuses on using drone based lidar to find biological indicators in streams and riparian areas. His goal is to understand the spatial and temporal processes that determine long-term health of streams and rivers.

(2) Conservation, Strategy for the Improvement of Water Regulation, Case of the Otún River Basin, Pereira (Colombia)

Presenter: Juan Camilo Berrio, Universidad Tecnológica de Pereira, jcberrio@utp.edu.co

Abstract: The Otún river, located in the central Andes Colombia and a basin area of 480 km2, is the only source of water of around 450,000 inhabitants of the cities of Pereira, Santa Rosa de Cabal, Dosquebradas and Marsella. By 1940s the agriculture and cattle raising generated strong pressure in the upper basin affecting the water supply. Since then, local and national institutions have implemented conservation measures, including buying lands, and creation of national, state and municipal natural parks.

The objective of this study is to evaluate the impacts of these conservation measures on the Upper and Middle Basin of the Otún River after 70 years of conservation. The study focus on three aspects: the socio-economic impact generated by the creation of natural parks; the effects of forestation on water regulation and supply, and biodiversity; the current degree of vulnerability that the city of Pereira may have by the effects of climate change.

Preliminary results showed that, in the last 70 years, the land cover changed from 30 to 60% of conservated areas. Along with this change, the population living in the upper basin decreasing from 60 to 14 families (300 to 45 inhabitants). However, this depopulation was originated by a plage on the potato crops rather than by the new natural parks created.

The following steps we are working on are the comparison of water supply, before and after the conservation measurements, using a rainfall-runoff model using the software WEAP; The impact of Climate Change on the future water supply; and the assessment of the gains in biodiversity due to conservations measurements.

Biography: BS in environmental management; Esp in hydraulic and environmental engineering; MSc in physical instrumentation. Profesor at Universidad Tecnologica de Pereria in Pereira Colombia.

(3) Uptake and Adsorption of Perfluoroalkyl Substances by a Mixed Periphytic Algal Community Using an Algal Turf Scrubber Approach

Presenter: David M. Blersch, Auburn University, dmb0040@auburn.edu

Co-Authors: Roger Lopes Viticoski, Auburn University, rzl0027@auburn.eduAna Gabriela Itokazu, Auburn Uiversity, azi0011@auburn.edu; Vanisree Mulabagal, Auburn University, vzm0005@auburn.edu; Joel Hayworth, Auburn University, jsh0024@auburn.edu

Abstract: Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic organic chemicals that are persistent in the environment due to their fluorinated alkyl chains, and are reported to have adverse effects in humans and wildlife. Few technologies are known or available to economically remove them from environmental aquatic systems. The Algal Turf Scrubber ™ (ATS), a simulated stream system that treats water using periphytic algae, has been reported to remove pollutants from wastewater, but has not yet been tested for PFAS. The purpose of this project was to evaluate the suitability of an ATS approach for the remediation of a mixture of PFAS (PFOS, PFOA, PDHA, and HFPO-DA). The experimental design consisted of four treatment channels and four controls (two positive and two negative), in which algal turf cultures where exposed to the contaminant mixture at 2μg/L for a period of 72h. Water and biomass were repeatedly sampled from each channel and analyzed using ultra-high performance liquid chromatography coupled to triple quadrupole mass spectrometry (UHPLC-QqQ-MS). The substances were found in the biomass at 1.24 ± 0.40%, 1.21 ± 0.41%, 0.26 ± 0.16%, and 0.76 ± 0.27% of the initial concentration for PFOA, PFOS, HFPO-DA, PDHA, respectively. Bioaccumulation factors were also calculated and were found to be equal to 14.25 ± 10.41, 43.63 ± 17.04, 3.13 ± 1.86, 2.15 ± 0.39 L(kgww)-1, respectively, based on absorbed concentrations. Periphytic algae are in the bottom of several food chains and can potentially biomagnify PFAS into upper levels. Furthermore, findings in this study are in agreement with reports that suggests shorter chain compounds are less bioaccumulative than legacy substances. Even though the low elimination rates suggest unsuitability for remediation, results from this analysis contribute to the growing understanding on the bioaccumulation potential of these compounds.

Biographies: Roger Viticoski is a Civil Engineering Master's student at Auburn Univeristy, where he works as a Graduate Research Student. For his thesis studies, he is studying the possibility of an Algal Turf Scrubber to be used in the remediation of perfluorinated compounds, as well as toxic effects of such compounds in algae. He has a Bachelor in Civil Engineering from the Federal University of Rio Grande, in Brazil.

David M. Blersch, Ph.D., is Assistant Professor in the Biosystems Engineering Department at Auburn University, where he teaches courses in Ecological Engineering, Aquaculture and Aquaponics, and Algae Systems Engineering. Dr. Blersch has research interests in algae cultivation for pollutant recovery and biomass production; aquaculture and aquaponics food production systems; and ecological systems modeling. Dr. Blersch is principal investigator for the Auburn University Algal Systems and Ecological Engineering Laboratory, and is PI for the Auburn University 3D-Printed Bio-Surfaces (3D-PBS) Laboratory. Dr. Blersch has environmental and ecological engineering research supported by USDA National Institute of Food and Agriculture; US National Science Foundation; US Environmental Protection Agency; and Alabama Agricultural Experiment Station, and is the author or co-author of 20 publications and over 100 presentations on ecological engineering for resource utilization in agricultural systems. Dr. Blersch holds a B.Sc. in Civil Engineering from the University of Notre Dame (Notre Dame, Indiana), and a M.Sc. and a Ph.D. in Biological Resources Engineering from the University of Maryland (College Park, Maryland).

(4) Riparian Nitrogen Modeling: Assessment of Existing Approaches and Considerations of Channel Evolution

Presenter: Daniel Buhr, University of Georgia, db70846@uga.edu

Co-Authors: Roderick Lammers, University of Georgia, rod.lammers@uga.edu; Brian Bledsoe, University of Georgia, bbledsoe@uga.edu

Abstract: Eutrophication resulting from excessive loading of nutrients such as nitrogen is a leading cause of water quality impairment of freshwater and coastal ecosystems. The importance of streams and riparian zones as nitrogen transformers and sinks is well-known; however, the dynamic role of these coupled systems in landscape level nitrogen cycling remains poorly understood. Several models have been developed to simulate nitrogen transport through riparian zones, including the Riparian Ecosystem

Management Model (REMM), the Riparian Nitrogen Model (RNM), and variations of the Soil and Water Assessment Tool (SWAT). These models vary in complexity and operate across many spatial and temporal scales. The purposes of this research are to: 1) assess the approaches of these existing models (e.g., structure, input requirements, mechanistic detail, scale, etc.) for estimating nitrogen loading, and 2) use sensitivity analysis and model testing to identify the most important processes and parameters for inclusion in a parsimonious riparian denitrification model that is applicable at watershed scales up to approximately 100 km2. We summarize algorithms for hydrology, nutrient transport, and other relevant processes for each of the major models, and outline global sensitivity analysis approaches, where feasible, to identify the most sensitive parameters for estimating nitrogen loading through riparian zones into streams. These parameters, along with channel evolution processes currently omitted from existing models but hypothesized to be an important influence on riparian nitrogen cycling, will be incorporated into the River Erosion Model (REM). This research will improve understanding of the role that riparian zone-channel change interactions play in eutrophication, thereby helping to identify locations that may contribute a disproportionately large amount of nitrogen to aquatic systems.

Biography: Daniel is a second-year engineering Ph.D. student at the University of Georgia. He earned a B.S. in Biosystems Engineering from Michigan State University in 2017. His research interests include stream-riparian water quality, hydrologic modeling, and stream restoration.

(5) Assessment of Manganese/Iron Oxide-Modified Activated Carbon to Repress MeHg Production in Hg-Contaminated Sediments

Presenter: Julia Burmistrova, University of California, Merced, jburmistrova@ucmerced.edu

Co-Presenters: Marc Beutel, University of California, Merced

Co-Authors: Mark Seelos, Marc Beutel, Samuel Traina, Peggy O’Day, University of California, Merced

Abstract: Mercury (Hg) contamination of the environment poses a significant health threat to humans and wildlife. Human and wildlife exposure to Hg is primarily through fish consumption and mostly in the form of toxic methylmercury (MeHg), which bioaccumulates in higher organisms. The primary pathway for methylation of inorganic Hg to MeHg is by bacteria during sulfate reduction under anaerobic conditions. Therefore, the reduction-oxidation (redox) potential of the sediment-water system is a key control on processes associated with Hg methylation. This poster presents preliminary results from a study to assess the capacity of manganese/iron oxide-modified activated carbon (MOMAC) to repress MeHg production in Hg-contaminated sediments. The novel solid-phase amendment thermodynamically “buffers” the redox state of the sediment-water interface to create conditions unfavorable for sulfate reduction, while also providing sorption capacity to limit Hg and MeHg bioavailability. The study includes evaluation of sediment from two contrasting sites impacted by historical Hg mining in California and its use in gold extraction: profundal lake sediment in Guadalupe Reservoir, a water storage reservoir polluted by the historic New Almaden mercury mine south of San Jose, and wetland sediment from the Cache Creek Settling Basin which traps sediment from the upstream Sulfur Bank Mercury Mine superfund site. The project, which is funded via the Department of Energy’s Minority Serving Institutions Partnership Program, includes a substantial undergraduate research component aimed at enhancing the diversity of the STEM talent pool interested in research careers in environmental science and

engineering. The long-term aim of the study is to develop and test innovative, cost-effective sediment amendment technology to lower Hg bioaccumulation in contaminated sediments.

Biographies: Julia Burmistrova is a MS student in the Environmental Systems graduate program at University of California, Merced. She has a BS in Bioenvironmental Engineering with a minor in Environmental Policy, Institutions and Behaviors from Rutgers University, NJ. In addition to this post-MS research effort related to use of manganese-based sediment amendments, her MS research focused on the use of anaerobic co-digestion of wastewater solids and organic solid waste in coordination with with Yosemite National Park and their Zero Landfill Initiative. She hopes to continue her focus on environmental engineering by working for a sustainability consulting firm as the next step of her career.

Marc Beutel is an Associate Professor in the Civil and Environmental Engineering Department and the chair of the Environmental Systems Graduate Group at UC Merced. Beutel's research focuses on the sustainable control of dilute pollutants in managed surface waters including nutrients, pesticides, pathogens, and mercury, with a focus on redox mediated transformations in the environment, reservoir oxygen addition, and constructed treatment wetlands. He is currently working with several large California water utilities assessing how water storage reservoirs can be managed or treated in situ to reduce bioaccumulation of mercury in aquatic biota.

(6) Climate Change Analysis in a Small Watershed in the Central Andes of Colombia

Presenter: Norma Castro, Universidad Tecnológica de Pereira, nlcastro@utp.edu.co

Abstract: Modeling is a widely oriented tool to assist decision-making focused on the management of water resources; hence, various software applications support the development of rainfall-runoff models. This study aimed to calculate the impact of six different future climate scenarios on the discharge of a small watershed in the central Andes of Colombia South America. The Dali Creek watershed has an area of aproximately 3 km2. The land cover for most of the basin is secondary forest, cryptic wetlands, and small areas of grass. Two streamflow gages and 5 rainfall meters were deployed in the basin since 2014. The water evaluation and planning system software (WEAP) was used to develop and calibrate a rainfall-runoff model based on a soil moisture method. Six GCM models were downscaled to create future climatic scenarios. The preliminary results show that by the period 2018 – 2050, the stream flow ranges from – 9% to +9% approximately compared with the 5 years historical streamflow. The worst scenario upscaled for the Otun River basin, within which the Dali Creek is located, may imply a drinking water supply shortfall for the city of Pereira which holds half million inhabitants.

(7) The Green Wall's Potential for Multi-Disciplinary Research and Cooperation

Presenter: Kat Close, University of Maryland, College Park, kclose1@terpmail.umd.edu

Abstract: Humanity's relationship with the environment is growing more strained with each year, and it is increasingly urgent that a stable method of sustainable living is developed in order to prevent potential environmental catastrophes from occurring in the future. This change should not be lead by a single group of individuals, but driven by multi-disciplinary teams who utilize their range of skills in cooperation to create holistic solutions to this problem. Green walls are great examples of systems in which this interdisciplinary cooperation can be seen. As they are decorative, self-functioning structures

comprised of plant, irrigation, and electrical systems, they incorporate components and knowledge from numerous different subjects ranging from ecology to engineering to design. While knowing which perspectives to include and how best to apply them is integral to the efficiency of the project, developing interdisciplinary communication strategies is also key to preventing misunderstandings and the proper transfer and use of ideas in a project setting. As such, this green wall is just as much an experiment of construction as it is an experiment of team building, which is exemplified in the process of its production from concept to design to proposal to blueprint to building.

Biography: Kat Close is a current freshman at the University of Maryland, College Park where she is pursuing a double major in Environmental Science and Policy and Graphic Design. She has always been interested in the environment and sustainable development, and just recently became actively involved in that field through her membership with the American Ecological Engineering Society chapter at her college this past year. Since she has joined, she has become the unofficial graphic designer for the club in addition to becoming co-leader of the construction of two green walls on campus. Her role has taught her much about the process of designing and constructing eco-friendly structures along with managing a team and communicating with outside parties. She looks forward to continuing to learn throughout the duration of the project, and hopes to apply the knowledge she gains to a much more ambitious project in the future.

(8) Using Machine Learning and Remotely Sensed Data to Develop Spatiotemporal Maps of Flood Surge and Retreat

Presenter: Emine Fidan, North Carolina State University, eneminef@ncsu.edu

Co-Authors: Natalie Nelson, North Carolina State University, nnelson4@ncsu.edu

Abstract: Analysis of satellite imagery for flood monitoring is a rapidly developing area of research due to recent advances in the spatial and temporal resolution of satellite products. Although static flood maps are readily constructed through composites of satellite images and normalized difference indices, few approaches for generating time series of flood dynamics exist due to challenges associated with missing data, temporal mismatch between satellite image capture dates and flood events, and lack of in situ measurements. Time series visualization allows for the illustration of changes in flooded area over time and tracks the rapidly retreating flood process compared to static maps which represent flood extent when peak inundation was reached. Machine learning (ML) approaches offer novel opportunities to address these issues by synthesizing disparate data sources (i.e. stream gauge, satellite imagery) to generate spatiotemporal flood maps, but additional research is needed to develop such ML workflows. This study explores the use of ML to create flood time series, specifically as applied to an assessment of the surge and retreat of flood waters in eastern North Carolina following Hurricane Florence (2018). Using the Random Forest algorithm, geospatial data sources including land use, soil type, hydrography, elevation, road networks, social vulnerability, as well as MODIS satellite imagery, were used to produce spatiotemporal post-hurricane flood maps. With the effects of global climate change expected to drive increases in the frequency and magnitude of flood events, improved methods for mapping and analyzing floods will continue to increase in the future to guide management.

Biography: Emine is a PhD student in Biological and Agricultural Engineering at North Carolina State University. She received her undergraduate degree in Biosystems Engineering from the University of

Tennessee in May 2018. Her previous research at the University of Tennessee and Oak Ridge National Laboratory has focused on studying at-risk and endangered species in riverine systems. Currently, her doctoral research focuses on applying geospatial analyses toward understanding flood processes.

(9) Working with Water: Getting the Landscape Contractor Community Engaged

Presenter: Dennis Gregg, University of Tennessee – Knoxville, dennisgregg@gmail.com

Co-Authors: Andrea Ludwig, University of Tennessee – Knoxville, aludwig@utk.edu

Abstract: The landscaping and design community is playing a larger role in the management of land as urban and suburban areas grow in developing watersheds. Therefore, this is a critical stakeholder group in the mission of minimizing the effects of this land use change on downstream receiving water quality and aquatic ecosystems. As green infrastructure and natural drainage systems are being favored in new development projects and becoming more popular endeavors in retrofit scenarios, there is space for the landscaping and landscape design community to embrace working with water in the landscape as a specialized service. The University of Tennessee has partnered with local governments and the Tennessee Nursery & Landscapers Association to secure funding from the 319 Program (TN Dept. of Agriculture) to support workshops that would share these specialized tools among the landscaping community and deepen the experience and understanding of landscaping contractors in green infrastructure and natural drainage system design, build, and management. The workshop series focuses on three types of practices: rain gardens, micro wetlands, and streambank stabilization. The series will include design/build workshops and separate maintenance/management workshops. This poster presentation will share the approach being developed for delivery of this material as well as showcase some resources and information collected to date.

Biography: Dennis Gregg, MS Ecology, is a UT Extension Associate in the Biosystems Engineering & Soil Science Department and works with Dr. Andrea Ludwig on stormwater demonstration projects and educational opportunities for various targeted audiences. He was formerly the Executive Director of the Obed Watershed Community Association (OWCA) where he completed over 25 stream and wetland restoration and enhancement projects. He continues to manage projects for OWCA on an as needed basis. In addition, he has designed and built numerous stormwater BMP projects from rain gardens, water capture and irrigation systems, to pervious pavers and infiltration ditches. As part of his restoration activities, Dennis has become knowledgeable about both controlling invasives and appropriate native plants for stream banks, wetlands, and rain gardens.

(10) Short Paper Fiber as a Soil Amendment for Mine Reclamation in Central Appalachia

Presenter: Leslie Hopkinson, West Virginia University, leslie.hopkinson@mail.wvu.edu

Co-Authors: Levi Cyphers, West Virginia University, ljcyphers@mix.wvu.edu; Iuri Lira Santos, West Virginia University, iulirasantos@mix.wvu.edu; John Quaranta, West Virginia University, JDQuaranta@mail.wvu.edu

Abstract: Innovative reclamation strategies are needed in the coal producing region of Central Appalachia to reduce sediment yield and manage water quality concerns. This study tested the effect of adding short paper fiber as a soil amendment to help establish vegetative cover in coarse coal refuse.

Two blends of short paper fiber and refuse were tested (i.e., 80% refuse with 20% short paper fiber and 60% refuse with 40% paper fiber) as well as a control sample containing only coal refuse. All samples were tested using the same seeding mixture in identical growing conditions for 16 weeks. Ground cover, stem height and biomass were monitored. Maximum ground cover was observed in the 80/20 blend (=77.1%). Ground cover in the refuse samples did not exceed 0.5%. Similar results were observed with biomass measurements. Therefore, the addition of short paper fiber shows potential to support vegetation establishment in coarse coal refuse. This potential is currently being tested a at large-scale field site (~ 0.3 acre plots) on a coarse coal refuse pile in Greenbrier County, West Virginia. The large-scale testing also introduced the use of compacted low permeability barrier. Monitoring for vegetation ground cover, water quality, stability, and infiltration continues.

Biography: Dr. Hopkinson joined the Department of Civil and Environmental Engineering at West Virginia University in August of 2010 after completing her Ph.D. in Biological Systems Engineering at Virginia Tech. Her recent research interests include environmental fluid mechanics, mining reclamation, right-of-way reclamation, and watershed monitoring. Dr. Hopkinson regularly teaches courses in fluid mechanics, hydrology, and water resources engineering.

(11) A Comprehensive Study of Seeding and Mulching Practices in West Virginia

Presenter: Leslie Hopkinson, West Virginia University, leslie.hopkinson@mail.wvu.edu

Abstract: Continued persistence in ground cover is desired in right-of-way locations for the erosion benefits. We have been working on a comprehensive, long-term study at West Virginia University to develop a process for selecting seed mixture, additives, and mulch for construction sites in West Virginia. The work, sponsored by the West Virginia Division of Highways, began by examining existing conditions of roadside locations throughout the state. From the knowledge gained, we developed experimental seed mixtures that are being tested in a series of field studies.

Biography: Dr. Leslie Hopkinson is an Associate Professor of Civil and Environmental Engineering at West Virginia University. She earned a Ph.D. degree in Biological Systems Engineering at Virginia Tech, specializing in natural resources management and ecological restoration. Her recent research interests include environmental fluid mechanics, mining reclamation, right-of-way reclamation, and watershed monitoring.

(12) Removal of Suspended Sediments by An Algal Turf Scrubber

Presenters: Ana Gabriela Itokazu, Auburn University, azi0011@auburn.edu; David M. Blersch, Auburn University, dmb0040@auburn.edu

Abstract: Created originally for aquarium depuration, Algal Turf Scrubbers (ATS) have been explored as an alternative for nutrient recovery from many aquatic systems. A common critique of ATS use is the low quality of the biomass, compared to other algae cultivation, as it often has high percentages of ash material. Past environmental installations have shown biomass ash concentrations of 70% or higher, and sources of ash are thought to be either terrigenic (from the landscape) or biogenic (from in-community diatomaceous productivity). As such, the effective rates of suspended sediment recovery by an ATS system have not been adequately measured or modeled. The objective of this research was to measure

recovery of suspended sediment in an ATS system with a full mature algal turf. The experimental design was split between indoor, lab-scale ATS and pilot-scale, outdoor ATS floways. For both, the system ran in batches with 4 different concentrations of 60-micron silica as treatments, with background removal measured for the floway system, as the control. The experiments ran for 5 hours, with repeated frequent sampling of water and before-after sampling of biomass. Water sediment concentration was analyzed by optical density, and biomass was analyzed for ash content. The results demonstrate an exponential decay in water sediment concentration in all cases, with up to 90% removal in the first hour, on both indoor and outdoor systems. Ash percentage of algae increased in the indoor system in all cases, and mass balance on sediment shows that a majority of suspended sediment is removed by biomass adhesion. Ash percentage of the algae decreased in the outdoor system, suggesting that sediment load caused removal of biogenic ash through scour. The results demonstrate the conflicting role of the algal turf in sediment removal, and provide first estimates for removal rates for aquatic suspended sediments.

Biographies: Ana Gabriela Itokazu, Ms.C., is pursuing her Doctorate's degree in Biosystems Engineering at Auburn University, where she works as a Graduate Research Assistant. Ana Gabriela holds a Bachelor's degree in Biological Sciences and a Master's degree in Biotechnology, both from Federal University of Santa Catarina, Brazil. Currently she works in several research lines, assessing experimental design and providing technical support for ongoing research at Dr. Blersch's Laboratories. Previous work included environmental toxicology, environment restoration, extremophile physiology, and biological water treatment.

David M. Blersch, Ph.D., is Assistant Professor in the Biosystems Engineering Department at Auburn University, where he teaches courses in Ecological Engineering, Aquaculture and Aquaponics, and Algae Systems Engineering. Dr. Blersch has research interests in algae cultivation for pollutant recovery and biomass production; aquaculture and aquaponics food production systems; and ecological systems modeling. Dr. Blersch is principal investigator for the Auburn University Algal Systems and Ecological Engineering Laboratory, and is PI for the Auburn University 3D-Printed Bio-Surfaces (3D-PBS) Laboratory. Dr. Blersch has environmental and ecological engineering research supported by USDA National Institute of Food and Agriculture; US National Science Foundation; US Environmental Protection Agency; and Alabama Agricultural Experiment Station, and is the author or co-author of 20 publications and over 100 presentations on ecological engineering for resource utilization in agricultural systems. Dr. Blersch holds a B.Sc. in Civil Engineering from the University of Notre Dame (Notre Dame, Indiana), and a M.Sc. and a Ph.D. in Biological Resources Engineering from the University of Maryland (College Park, Maryland).

(13) Distribution of Plant Communities in Relation to Water Level Fluctuations at an Estuarine Marsh

Presenter: Yang Ju, The Ohio State University, ju.116@osu.edu

Co-Authors: Jorge Villa, The Ohio State University, villa-betancur.1@osu.edu; Gil Bohrer, The Ohio State University, bohrer.17@osu.edu

Abstract: Wetlands provide a wide range of vital ecosystem services, most of which are directly or indirectly regulated by wetland vegetation. Typically, wetlands are composed of different ecological patch types characterized by distinct plant communities whose distribution is largely affected by water

level fluctuations. Hydrological regime is also the major factor affecting many physical and biotic processes that determine wetland ecosystem services. In this study, we explored the distribution of different land-cover patches and its relationship with water level fluctuations over time at a freshwater estuarine marsh, the Old Woman Creek (OWC) National Estuarine Research Reserve. OWC is located at the southwest shore of Lake Erie and is characterized by four major land-cover types: open water, mud flat, emergent vegetation (Typha spp.) and floating vegetation (Nelumbo spp & Nymphaea spp.). We used satellite images at 1 m resolution to conduct unsupervised classification and examine the distribution of different land-cover patches from year 2004 to 2017. Water level of the corresponding years over the whole wetland was calculated using data collected from a monitoring site and a bathymetry map on a pixel base. We then correlated the water level with land-cover types over the study period. The areal distribution of the different land-covers changed over years. In general we found that area of Typha spp. decreased while that of Nelumbo spp. increased. Our future study will be focused on establishing criteria to predict distribution of plant communities based on the water level prior to growing season.

Biographies: Yang is a Ph.D. student in the Environmental Science Graduate Program at the Ohio State University. She is working with Dr. Gil Bohrer on modeling the methane emission from wetland. Before joining OSU, she received her master's degree in geography from Texas A&M University, and bachelor's degree in remote sensing science from Wuhan University in China.

Dr. Villa's involvement in wetlands began with undergraduate research while pursuing a Bachelor in Environmental Engineering in Colombia. He continued to study these ecosystems during his Masters in Forest and Environmental Conservation. Then he went on to pursue his PhD in Environmental Sciences, once again focused on Wetlands, at The Ohio State University. After returning to Colombia, he conducted research in tropical Andean peatlands and lowland mineral-soil freshwater wetlands. Dr. Villa has since rejoined OSU, now as a visiting Professor, in the department of CEGE.

(14) Planning for a Medium-Scale Algal Floway for Water Treatment in Central Maryland

Presenter: Patrick Kangas, University of Maryland, pkangas@umd.edu

Co-Authors: Patrick Hirsch, Haleigh Jowett, Gannon Kese, Garret Krug, Sarah Larkin, Alec Parsons, Peter May, University of Maryland at College Park

Abstract: A plan is presented for a 0.1 ha (1/4 acre) algal floway to be constructed on the Anacostia River near Bladensburg Waterfront Park in Prince Georges County, Maryland. The proposed site is on a small peninsula of land, separated from the main park by fencing and a tributary stream. In addition to the algal floway itself, the site plan includes a pit for air-drying the harvested algae, storage buildings and an interpretative walkway for visitors. Based on productivity of a small-scale algal floway that was operated at the site in the summer of 2018, the proposed medium-scale algal floway could remove 122 kg N/year (268 lbs/year) and 15 kg/year (33 lbs/year). When the State of Maryland's stormwater treatment credit algorithm is applied to the proposed algal florway, the 0.1 ha facility would remove pollutants from the equivalent of nearly 8 ha (20 acres) of impervious surface. The plan also proposes to mix dried algae with concrete to produce non-load bearing construction materials at a nearby concrete plant. A financial plan for the site is discussed based on stormwater treatment credits, by-product values of the harvested algae and the educational use of the complex.

Biography: Patrick Kangas is an associate professor at the University of Maryland in the Environmental Science and Technology Department. He has been studying ecological engineering since the 1970s and has served as President of the American Ecological Engineering Society.

(15) Understanding Ecological Characteristics of Urban Stormwater Low Impact Strategies for Optimized Treatment Benefits

Presenter: Lee-Hyung Kim, Kongju National University, leehyung@kongju.ac.kr

Co-Authors: Franz Kevin Geronimo, Kongju National University

Abstract: Nature-based solutions (NBS) including low impact development (LID) techniques and green infrastructures (GI) has become the focus of many countries nowadays since it is inspired and supported by nature and use, or mimic, natural processes to contribute to the improved management of water. Since stormwater runoff has high uncertainties due to environmental factors, appropriate design approach requires identifying the treatment mechanisms occurring inside each system. As such, the ecological mechanisms and environmental design through the comparison of influent water characteristics, pollutant reduction efficiency and growth of microorganisms in filter media of ten LID technologies were investigated and derived. The LID technologies include an infiltration trench, a rain garden, two constructed wetlands, two tree box filters, two bioretention systems, a permeable pavement and an infiltration garden which have long-term monitoring data since 2008 inside Kongju National University in Cheonan city, South Korea were utilized for this study. These LID technologies were developed to manage urban stormwater runoff from transportation land uses such as roads and parking lots, and roof. High influent concentrations of pollutants were found in the road compared to parking lots and roof. This finding may be used for proper selection of LID technology type and its corresponding components including filter media and plants. Microorganisms commonly found in soils collected from LID technologies include Proteobacteria (PTB), Acidobacteria (ACB), Actinobacteria (ATB), Chloroflexi (CF), Planctomycetes (PTM), Bacteroidetes (BTD), Verrucomicrobia (VCM). The nitrifying bacteria, PTB was found to be the most dominant species among the microorganism phyla at above 36%. This finding implied that selecting filter media suitable for microorganism growth can enhance the treatment capacity of LID technologies. These findings were useful in selecting and designing LID technologies applicable to various land uses.

Biography: Prof. Kim's primary research interests are in environmental sciences and engineering, with emphases on nonpoint source control, water quality, decentralized urban stormwater management, total daily maximum load (TMDL), sediment control, ecological restoration technology, low impact development(LID), Green stormwater infrastructure (GSI), etc. Since 2003, Prof. Kim have performed many government research projects concerned with stormwater management. Recently LID and GSI are the important research fields on my team. Several Filipino, Nepali, Pakitani and Korean students are studying in my research team with Ph.D and master's program. Also, since 2009, I am a board member of "IWA diffuse pollution specialist group" and doing various international activities by organizing workshop, providing lectures and involving international cooperation works.

(16) Level of Soil Compaction is More Important than Compost Volume for Determining Soil Hydraulic Properties in a Sandy Loam Soil

Presenter: Christina Kranz, North Carolina State University, cnkranz@ncsu.edu

Co-Authors: Joshua L. Heitman, North Carolina State University, jlheitma@ncsu.edu; Richard A. McLaughlin, North Carolina State University, rich_mclaughlin@ncsu.edu

Abstract: Land development compacts soils through excavation and heavy equipment traffic. Compacted soils have limited infiltration and are susceptible to erosion. Infiltration can be improved through compost incorporation but recommended rates of amendment vary widely among sources. The objective of this study was to determine the effects of compost amendment rate on saturated hydraulic conductivity (Ks) and water retention in order to identify target compost rates for enhanced soil infiltration. Soil cores were prepared in the laboratory using a sandy loam soil amended with certified yard waste compost at 0, 10, 20, 30, 40, and 50% by volume. Each compost rate was further divided into high (0.55 m3 m-3) and low (0.4 m3 m-3) porosity sets. Saturated hydraulic conductivity was measured using a combination of constant and falling head methods. Water retention was measured by pressure plate extraction at 2.5, 4.9, 9.8, 19.6, and 32.7 kPa. Preliminary results indicated that porosity level was a more important determinant of Ks than was rate of compost addition. The results suggest if a soil is amended with compost but becomes compacted, benefits of the compost for infiltration may be limited even at a high rate of the amendment.

Biography: Christina N. Kranz is a PhD student at North Carolina State University studying soil physics. Her research focuses on optimizing compost application rates for vegetation health, maximal stormwater infiltration, and runoff quality. She is working with the North Carolina Department of Transpiration to improve best management practices in stormwater management along roadsides.

(17) Between the Sea and a Hard Place: Quantifying the Effects of Coastal Squeeze on Salt Marsh Persistence Under Rising Sea Levels

Presenter: Roderick Lammers, University of Georgia, rodlammers@gmail.com

Co-Authors: Brian P. Bledsoe, University of Georgia, bbledsoe@uga.edu

Abstract: Coastal salt marshes are important ecological features that also provide substantial services to human populations, including mitigation and attenuation of wave induced erosion and storm surge. As sea levels rise, salt marshes can migrate inland; however, this inland migration can be halted by hard barriers such as sea walls and bulkheads. This “coastal squeeze” shrinks salt marsh habitat as rising seas inundate the seaward side and barriers prevent inland migration. Previous work has optimistically suggested that salt marshes would persist under sea level rise because of their ability to migrate landward; however, these analyses failed to account for this coastal squeeze phenomenon. We present preliminary results of coupled numerical modeling to assess the effects of coastal squeeze on future salt marsh prevalence on the Georgia coast. We use the Sea Levels Affecting Marsh Migration (SLAMM) model to simulate salt marsh habitat changes from 2010 – 2100. We couple SLAMM with a land use projection model (SLEUTH) and a logistic regression model that predicts the probability that individual coastal parcels have hard armoring such as bulkheads and sea walls. This enables us to incorporate the effects of existing and future development, and individuals’ decisions about coastal armoring to provide more realistic projections of the viability of salt marsh habitat. These results will be vital for coastal

managers; for example, to determine what areas should be protected from development to sustain salt marsh habitat.

Biography: Roderick Lammers is a post-doctoral researcher and instructor at the University of Georgia. His research focuses on understanding anthropogenic impacts on water resources and aquatic habitat and providing guidance on mitigating these effects.

(18) An Emergy Comparison of Annual and Perennial Small Grain Cropping Systems

Presenter: Eugene Law, Cornell University, EPL49@cornell.edu

Co-Authors: Christopher Pelzer, Cornell University, CJP254@cornell.edu; Sandra Wayman, Cornell University, SW783@cornell.edu; Antonio DiTommaso, Cornell University, AD97@cornell.edu; Matthew Ryan, Cornell University, MRR232@cornell.edu

Abstract: Perennial grain crops have the potential to transform agricultural systems by supplying food and forage while simultaneously regenerating soil health, protecting water quality, and requiring fewer energy and labor inputs. ‘Kernza’ intermediate wheatgrass (Thinopyrum intermedium) and ‘ACE-1’ perennial cereal rye (Secale cereale) are two promising varieties that are being studied in field trials at Cornell University. Here we report on an emergy evaluation of the environmental sustainability of these two crops in comparison to annual winter wheat and malting barley grown using organic management. To calculate emergy transformities and sustainability indices renewable inputs (solar insolation, precipitation, wind energy, and nitrogen fixation), nonrenewable local inputs (soil loss), and nonrenewable imported inputs (fuel, fertilizer, crop seed, machinery, and labor) and crop products (grain yield and forage biomass) were tracked over a two-year period in a cropping systems field experiment at the Cornell Musgrave Research Farm in Aurora, New York. The largest difference in emergy inputs between the two types of systems were due to fewer required field operations (e.g. tillage and planting in the second and third years) in perennial grain cropping systems that decreased the total fuel, machinery, and labor inputs to those systems compared to annual systems. Significantly higher soil loss in annual systems also contributed to higher emergy input to those systems. Lower grain yields from the perennial crops, however, did decrease the emergy efficiency of those systems. Intercropping medium red clover (Trifolium pratense) increased the emergy efficiency of all cropping systems due to crop complementarity that led to increased grain yields and more forage production. Overall, the Emergy Sustainability Indices calculated indicate that perennial small grain cropping systems are more sustainable due to the higher proportion of renewable resources they utilize for food and forage production.

Biography: Eugene Law is a PhD candidate in the Sustainable Cropping Systems and Weed Ecology and Management Labs at Cornell University in Ithaca, New York. He is currently working to develop perennial small grain cropping systems by exploring aspects of agronomy, pest management, soil health, economics, and energy.

(19) Quantifying Stormwater Benefits of Individual Native Trees in Western Washington

Presenter: Ben Leonard, Washington State University, bleonard314@gmail.com

Co-Authors: Dr. Anand Jayakaran, Washington State University, anand.jayakarn@wsu.edu; Dr. Jamie Duberstein, Clemson University, jamieduberstein@gmail.com; Dr. Dylan Fischer, The Evergreen State College, fischerd@evergreen.edu; Carly Thompson, Washington State University

Abstract: Managing stormwater is a serious challenge in urban areas, particularly for rapidly growing urban communities in Western Washington State. Native trees, which are often removed during development, may be especially well suited for mitigating the effects of stormwater runoff. Not only does their below ground biomass facilitate soil permeability, but trees provide the ability to directly offset runoff burdens through the processes of transpiration and interception. While the stormwater benefits provided by large stands of trees is well known, few studies have attempted to quantify the benefits provided by individual trees in the region. The purpose of this study is to develop a rigorously derived hydrologic dataset that shows how stormwater is captured by existing common native evergreen and deciduous trees, based on the physio-climatic conditions of the Pacific Northwest. Information from this study will then allow local managers to ascribe stormwater credits and/or BMPs to native trees in a quantitative manner.

Two evergreen species, Douglas fir (Pseudotsuga menziesii) and Western red cedar (Thuja plicata), and two deciduous species, bigleaf maple (Acer macrophyllum) and red alder (Alnus rubra) are currently being evaluated at two climatically diverse study areas near Olympia, WA. Each tree is instrumented with sensors that measure transpiration and interception in addition to localized air and soil parameters. When combined, data from these sensors will provide a complete view of how much rainfall is managed by an individual tree. Data are being collected over two years to include seasonal variability that is typical of the region.

Biography: I am a 3rd year PhD student studying how green infrastructure can be used to help solve many of the stormwater problems we face in the Pacific Northwest. I currently study at the Washington State University Puyallup Research and Extension Center with my advisers Drs. John Stark and Jen McIntyre. I am currently evaluating the effectiveness of bioswales and permeable pavement to manage stormwater runoff. Recently, I have started a project with Dr. Anand Jayakaran looking at the use of trees as BMPs.

(20) Effects of Toxicity and Structural Alterations Caused by Perfluorinated Alkyl Acid on the Microalgae Scenedesmus Obliquus UTEX 393

Presenters: Meizhu Liu, Auburn University, mzl0093@auburn.edu; David M. Blersch, Auburn University, dmb0040@auburn.edu

Co-Authors: Ana Gabriela Itokazu, Auburn University, azi0011@tigermail.auburn.edu

Abstract: Recently, it has been found that Perfluorinated Alkyl Acids (PFAAs) are toxic substances and potentially harmful to humans and the environment. Used in some industrial applications for many years, these compounds are very persistent and do not easily degrade in the environment. In addition, there is some evidence that they are carcinogenic and endocrine disruptors in higher animals. Further evidence has shown the potential for bioaccumulation in food chains and for transmission through food webs in aquatic systems. Little is known, however, on the effect of these substances on specific species of algae found in the environment. The purpose of this study is to test the toxicity of two PFAAs substances on algae using a standard test on the green algae Scenedesmus obliquus. The growth curve of Scenedesmus obliquus will be a parameter for the toxicity of that green algae, and the concentration of pigment will gauge the cellular health. Biomass and water samples will be analyzed, and a mass balance of PFOA and PFOS in the overall samples will be performed. The results will use Scenedesmus obliquus Half Maximal Effect Concentration (EC50) for PFOS and PFOA providing the information about the fate of these two compounds in the water system and algal cell system. This study can show how the toxicities of PFOS and PFOA present in cell structure level. The data from this test will provide some basic knowledge about PFOA and PFOS, and inform further studies on ecological transfer in food webs of these and other PFAAs compounds.

Biographies: Meizhu Liu, a master student in the Biosystems Engineering Department at Auburn University. Meizhu Liu is one of the students of Dr. Blersch, who also interested in algae cultivation for wastewater treatment. Meizhu Liu is also a member of Alabama's Water Environment Association (AWEA/WEF Auburn Chapter). Meizhu Liu has a Bachelor's Degree in Biological Science from Hengshui University in China.

David M. Blersch, Ph.D., is Assistant Professor in the Biosystems Engineering Department at Auburn University, where he teaches courses in Ecological Engineering, Aquaculture and Aquaponics, and Algae Systems Engineering. Dr. Blersch has research interests in algae cultivation for pollutant recovery and biomass production; aquaculture and aquaponics food production systems; and ecological systems modeling. Dr. Blersch is principal investigator for the Auburn University Algal Systems and Ecological Engineering Laboratory, and is PI for the Auburn University 3D-Printed Bio-Surfaces (3D-PBS) Laboratory. Dr. Blersch has environmental and ecological engineering research supported by USDA National Institute of Food and Agriculture; US National Science Foundation; US Environmental Protection Agency; and Alabama Agricultural Experiment Station, and is the author or co-author of 20 publications and over 100 presentations on ecological engineering for resource utilization in agricultural systems. Dr. Blersch holds a B.Sc. in Civil Engineering from the University of Notre Dame (Notre Dame, Indiana), and a M.Sc. and a Ph.D. in Biological Resources Engineering from the University of Maryland (College Park, Maryland).

(21) Longevity of Bioretention Depths for Preventing Acute Toxicity from Urban Stormwater Runoff

Presenter: Lane Maguire, Washington State University, lane.maguire@wsu.edu

Co-Authors: Jay W. Davis, US Fish and Wildlife Service, jay_davis@fws.gov; Jennifer K. McIntyre, Washington State University/ Puyallup Research and Extension Center, jen.mcintyre@wsu.edu

Abstract: The migration of coho salmon every fall from the ocean to freshwater streams coincides with increasing rainfall in the Pacific Northwest. Much of this rainfall runs off of asphalt and other impervious surfaces found in urban areas, such as the Puget Sound Basin, and into the very streams where salmon spawn. Exposure to urban stormwater runoff, which contains a complex mixture of contaminants, can be acutely toxic to coho salmon. Previous studies have demonstrated the effectiveness of bioretention treatment systems in treating urban runoff and preventing acutely lethal and sublethal effects to aquatic organisms. Municipalities are especially motivated to incorporate bioretention treatment systems into

existing infrastructure in order to comply with National Pollutant Discharge Elimination System (NPDES) permit requirements. NPDES permits are administered by the Washington Department of Ecology (Ecology) and require local governments to manage polluted stormwater in order to mitigate the effects of pollution and contamination on downstream waters. The current study aims to determine the effectiveness and longevity of bioretention soil media over time at various infiltration depths, including those shallower than 18 inches, the depth currently required by Ecology. Stormwater runoff is being collected from a busy, urban road site and applied to experimental columns, containing five different depths of bioretention soil media. Runoff is applied at an accelerated rate in order to simulate 10 water years over two calendar years. The chemical and biological effectiveness of the columns in treating urban stormwater runoff will be assessed using analytical chemistry and the health of two fish species: juvenile coho salmon and zebrafish embryos. The study outcomes are expected to help inform stormwater managers, National Pollutant Discharge Elimination System (NPDES) permit coordinators, and others involved in stormwater management.

Biography: Lane Maguire is a graduate research assistant at Washington State University (WSU) – Puyallup Research and Extension Center. She received her B.S. in Environmental Science from the University of Oklahoma in 2017. At WSU, she is currently evaluating the longevity of varying bioretention depths for preventing acute toxicity from urban stormwater runoff in the hopes of optimizing biorentention design guidelines.

(22) Mapping Lake Chemical and Physical Characteristics for Optimal BMP Placement

Presenter: Tiffany Messer, University of Nebraska-Lincoln, tiffany.messer@unl.edu

Co-Authors: Mary Keilhauer, University of Nebraska-Lincoln, mkeilhauer2@unl.edu; Aaron Mittelstet, University of Nebraska-Lincoln, amittelstet2@unl.edu; Matthew Russell, University of Nebraska-Lincoln, matthew.russell@unl.edu

Abstract: Best Management Practices (BMPs) for lake management have traditionally been regarded as black box systems. Floating treatment wetlands (FTWs), which consist of emergent macrophytes growing on a floating mat at the air/water interface, are becoming a common practice to reduce nutrients in lakes. However, a research gap exists for identifying appropriate placement of these systems to maximizing removal potential for target contaminants (i.e., nitrogen, phosphorus). Therefore, the objective of this study was to utilize an EXO2 Sonde and a River Surveyor to create a method for mapping water chemistry and hydrologic characteristics in a recreational lake in Lincoln, Nebraska. Holmes Lake, predominantly urban, was chosen for its small lake (0.4 km2) and watershed (14 km2) area, which make it ideal for BMPs like FTWs. The method was tested during the growing season over a two year period from 2018-2019 to observe hydrologic and water chemistry dynamics. Results provided insight for optimal placement of FTWs to maximize contact with nitrate and identify potential hot spots for denitrification. Although this method was designed to determine optimal placement of FTWs, this method has the potential to be utilized for designating optimal fishery habitat, identifying BMP placement adjacent to lakes (i.e. buffer strips), and identifying initial harmful algal bloom locations. Further, the developed methodology provides practitioners an opportunity to understand lake water chemistry and hydrologic and processes more holistically.

Biography: Mary is originally from El Salvador, but grew up near Atlanta, Georgia. She received her B.S. in Environmental Engineering from North Carolina State University. During her time as an undergraduate Doris Duke Conservation Scholar, she found her passion while studying aquatic ecology and hydrology from the Caribbean to New England. She has a particular interest in water chemistry, groundwater, and fishery populations. These experiences led her to joining the Messer Research Team and pursuing her M.S. in Hydrological Sciences at the University of Nebraska-Lincoln in Fall of 2017. Outside of academics, she enjoys outdoor activities, especially backpacking and kayaking, and hanging out with her dog, Watson.

(23) Testing Potential Bioretention Soil Media Amendments for Removal Potential of Polycyclic Aromatic Hydrocarbons and Escherichia coli

Presenter: Chelsea Mitchell, Washington State University, chelsea.mitchell@wsu.edu

Co-Authors: Anand D. Jayakaran, Washington State University, anand.jayakarn@wsu.edu; Jennifer K. McIntyre, Washington State University/ Puyallup Research and Extension Center, jen.mcintyre@wsu.edu

Abstract: Current stormwater permitting regulations per the Washington Department of Ecology's Stormwater Manuals do not include performance measures for key pollutants like certain organic contaminants (Polycyclic Aromatic Hydrocarbons – PAHs) and bacteria (total and fecal coliforms, enterococci, Escherichia coli). As a first step in determining Best Management Practices (BMPs) for the removal of these contaminants from stormwater runoff, a bench scale study will be conducted to assess the contaminant removal efficiencies of several emerging bioretention soil media (BSM) amendments. The following treatments will be compared in a bench scale stormwater filtration experiment: 1) sand (control), 2&3) sand amended with two different high temperature pyrolysis biochars, and 4) sand amended with alum (i.e., aluminum sulfate). These treatments have been chosen for their adsorptive properties and their ability to enhance desirable hydraulic properties in stormwater bioretention systems. In a series of three dosing experiments, mini bioretention columns will be dosed with 1) clean fish rearing water (to condition columns) 2) PAH spiked stormwater (used motor oil mechanically dispersed in water), and 3) Escherichia coli spiked synthetic stormwater. Influent and effluent from the columns will be analyzed for standard parent PAH compounds and E. coli concentrations. Danio rerio (zebrafish) embryo bioassays will be conducted on samples from the column conditioning experiment to test the potential for the tested medias to leach toxicants. Additional D. rerio bioassays will be conducted on the PAH spike experiment samples to estimate the ability of the medias to prevent PAH toxicity. The results from this study will help inform the experimental design of a larger bioretention experiment focused on understanding the mechanisms of bioremediation in stormwater bioretention systems.

Biography: Chelsea is a first year PhD student studying at Washington State University with research interests in stormwater, aquatic toxicology, and green infrastructure. Her current research focuses on removal of organic contaminants and bacterial pathogens from stormwater runoff using bioretention. When not conducting research Chelsea enjoys skiing, biking, and gardening.

(24) Characterization and Management of Depressional Wetlands in the Prairie Pothole Region

Presenter: Brady Nahkala, Iowa State University, bnahkala@iastate.edu

Co-Authors: Amy L Kaleita, Iowa State University, kaleita@iastate.edu; Emily Heaton, Iowa State University, heaton@iastate.edu; Andrew Vanloocke, Iowa State University, andyvanl@iastate.edu; Alex R Martin, Iowa State University; Michelle L Soupir, Iowa State University, msoupir@iastate.edu; Pawan Upadhyay, Iowa State University; Patrick Edmo

Abstract: Prairie potholes are surface depressions left behind after deglaciation in regions of the Midwest, Montana and three Canadian provinces, known as the Prairie Pothole Region (PPR). These hydrologically isolated depressions are small, shallow, semi-permanent waterbodies fed mostly by surface runoff. In Iowa, the majority of these potholes have been artificially drained to improve farming conditions, altering their provision of ecosystem services such as flood mitigation, wildlife habitat, and nutrient filtering. Crop losses are observed regardless of drainage condition. Acknowledging the need for data-driven sustainable management, multiple inter-disciplinary studies have been conducted at Iowa State assessing hydrologic dynamics, nutrient dynamics and crop suitability within potholes.

Eight potholes in central Iowa were monitored for the 2016, 2017, and 2018 growing seasons. Depth of inundation, nutrient concentration, soil characteristics, plant biomass, soil moisture, and nitrate flux data were collected. Pothole hydrology was modeled using the Annualized Agricultural Non-Point Source Pollution (AnnAGNPS) software and calibrated to monitoring data. Alternative management strategies were modeled to assess hydrologic response. Crop suitability was modeled in AgroIBIS VSF to assess yield responses to varying climate conditions for corn and miscanthus, an alternative perennial crop. Gas chambers and lysimeters were deployed to monitor nutrient fluxes, and water quality samples were taken from standing water during inundation events.

Current conclusions from these studies include: 1) farmed potholes are an economic loss in most conditions, 2) potholes were less hydrologically connected than hypothesized despite physical proximity, 3) dissolved reactive phosphorus concentrations were higher than expected and increased over the course of an inundation event, and 4) potholes are hotspots for nitrous oxide gas emissions.

Ongoing work includes development of an easy to use tool for farmers and landowners to explore management options for and impacts of their potholes; and field trials on alternative crop survival in potholes.

Biography: Brady Nahkala is pursuing a Masters of Science in Agricultural and Biosystems Engineering at Iowa State University. He received his Bachelors of Science from Iowa State University in Biosystems Engineering with a bioenvironmental emphasis.

(25) Investigating UAV Near Infrared Imagery for Turbidity Monitoring in Small Streams

Presenter: Elizabeth M. Prior, Auburn University, emp0025@auburn.edu

Co-Authors: Frances O'Donnell, Auburn University, fco0002@auburn.edu; Christian Brodbeck, Auburn University, brodbcj@auburn.edu

Abstract: Unmanned aerial vehicles (UAV) are increasingly being used for field data collection and remote sensing purposes. Their ease of use, ability to carry sensors and cameras, low cost, precise maneuverability and navigation makes them a versatile tool. The goal of this research project is to investigate if near infrared imagery obtained from an UAV can be utilized to measure the turbidity and total suspended solids of small streams at various water depths. This has been demonstrated for large rivers ranging from the surface to almost two meters in depth, but not for small streams at various depths. Turbidity of a waterway is caused by agitated sediments flowing from construction sites, roads, or erosion from riparian zones due to anthropogenic or natural causes. Turbidity is an important measure of a creek's health because it affects water quality.

In this study, UAV near infrared imagery and water samples at varying depths were collected before and after rain events from a recently restored reach of Moores Creek in Lanett, Alabama. The water samples were processed for levels of turbidity and total suspended solids. Data collection is still underway, but once the data has been received and analyzed, a regression model relating near infrared imagery of the stream to the samples will be developed. If successful, this method would allow an entire stream to be assessed as a whole rather than relying on single data points from turbidimeters or turbidity sensors.

Biography: Elizabeth M. Prior is a senior at Auburn University studying civil engineering with a focus in water resources. She will be presenting research that she conducted for her Auburn University Undergraduate Research Fellowship. She will be starting her PhD program in August at Virginia Tech within the Remote Sensing Interdisciplinary Graduate Education Program and in the Biological Systems Engineering Department.

(26) An Investigation into Salt Intrusion to Coastal Agricultural Fields

Presenter: Diana Rashash, NC Cooperative Extension, diana_rashash@ncsu.edu

Co-Authors: Carl Crozier, North Carolina State University, carl_crozier@ncsu.edu; Alex Manda, East Carolina University, mandaa@ecu.edu; Mike O'Driscoll, East Carolina University, odriscollm@ecu.edu; Andrea Gibbs, NC Cooperative Extension, andrea_gibbs@ncsu.edu; Al Wood, NC Cooperative Extension, al_wood@ncsu.edu; Austin Brown, NC Cooperative Extension

Abstract: In early 2018, agents in several coastal North Carolina counties (Hyde, Pasquotank, and Camden) mentioned increased grower concerns about salt content in agricultural fields and concurrent declines in crop productivity. Members of a multidisciplinary team from North Carolina State University (with expertise in crops, soils, and water quality) and East Carolina University (with expertise in hydrogeology) began investigating impacted fields from each of the three counties.

The goals of the study were to (a) determine the means by which salts were transported into agricultural fields and (b) evaluate the extent of saltwater intrusion in the study region. Soil testing and monitoring (exchangeable sodium percent, soil moisture content, soil electrical conductivity, and soil temperature), shallow ground water monitoring (salinity, temperature, and water level), surface water monitoring

(salinity, temperature, and water level) and geophysical techniques (direct current electrical resistivity, ground penetrating radar, capacitively coupled resistivity) were used in conjunction with weather data to meet the project goals. This poster presents information gathered to-date, and the current direction of the study.

Biography: Diana is an Area Specialized Agent – Water Quality & Waste Management for 18 counties in southeastern NC, plus other counties upon request. She has held this position for the past 23 years. As such, she deals with a wide variety of water issues. Her background is in Applied Biology (BS – Ga Tech) and Environmental Sci. & Engineering (MS & PhD – Va Tech).

(27) A Closer Look at The Impact Of Alterations of The Natural Flow Regime Due to Urbanization on Benthic Macroinvertebrate Biodiversity and Ecosystem Function

Presenter: Anthony Roux, Mecklenburg County Storm Water Services and University of North Carolina Charlotte, tony.roux@mecklenburgcountync.gov

Co-Authors: Sandra M. Clinton, PhD, University of North Carolina Charlotte, sclinto1@uncc.edu

Abstract: We investigated the relationship between alterations of the natural flow regime due to urbanization and benthic macroinvertebrate biodiversity and function by evaluating 4 streams in the Piedmont, North Carolina spanning a gradient of low to high % Impervious Cover. We used the Indicators of Hydrologic Alteration (IHA) metrics to assess changes in stream hydrology ranging from an 11- to a 24-year period using flow data from USGS Gage stations in each stream. We sampled the benthic macroinvertebrate community in these streams using the North Carolina Standard Bioassessment Sampling Method (NCDWR). All taxa were identified to the lowest possible taxonomic level. We found that EPT and Total Taxa Richness decline with increasing %IC. Shredders declined as herbivores increased in richness with increasing %IC. We expect that the IHA metrics will show that the 1-, 3- and 7-day maximum and minimum flow conditions increase with %IC. We also expect that the declines in biodiversity and changes in functional feeding group trait abundance will be correlated to the IHA metrics. We also expect that the IHA metrics may not show small changes in the flow regime when the watershed has greater than 50% impervious area at the beginning of the study period as the significant changes had already occurred. By correlating biodiversity and taxa traits with changes in hydrology associated with urbanization, we can better understand the role of managing storm water as one component in restoring stream function and stimulating benthic macroinvertebrate community recovery.

Biography: Anthony Roux is a Senior Environmental Specialist in the Water Quality Program of the Mecklenburg County Land Use and Environmental Services Agency and a Ph.D. student in the Infrastructure and Environmental Systems Program at the University of North Carolina at Charlotte. He has worked at MCWQP for 34 years serving as the supervisor of the Mecklenburg County State Certified Biological Laboratory for the past 24 years coordinating the stream bioassessment program (fish, benthic macroinvertebrate and algae). Mr. Roux has worked with the Charlotte-Mecklenburg Storm Water Services to evaluate the various stream restoration projects in Charlotte and Mecklenburg County. Mr. Roux is currently pursuing a Ph.D. in Environmental Engineering at UNC Charlotte studying the impact of urbanization on stream biodiversity and ecosystem function. He has a B.S. in Biological

Life Sciences, a B.S. in Zoology, and a M.S. in Zoology from North Carolina State University and a M.S. in Aquatic Ecology from the University of Notre Dame.

(28) Urban Stormwater Pollution Generation: a Review

Presenter: Ian Simpson, Ohio State University, simpson.725@osu.edu

Co-Authors: Ryan Winston, Ohio State University, winston.201@osu.edu

Abstract: Urban stormwater runoff quality is degraded by increases in imperviousness and anthropogenic pollutant sources, causing negative impacts to surface waters. As the rural to urban migration continues, we expect continued degradation of water resources without novel solutions to stormwater treatment. In order to optimize these solutions, an understanding of pollutant generation is needed, so that the best return-on-investment for stormwater treatment can be achieved. In watershed-scale models, urban runoff is often lumped as one component of non-point source pollution, however, differences in stormwater quality from various land uses may exist. This intensive review of literature will characterize distinct urban land uses across the world, including residential, commercial, industrial, downtown, institutional, and highway areas and utilize these data to predict event mean concentrations and loads of nutrients, sediment, and heavy metals. Beyond understanding land use differences, this study will explore how factors such as region, Köppen-Geiger climate zone, sampling technique, percent imperviousness, and temporal changes affect pollutant generation. Aggregated data from over 400 catchments across the globe will be used throughout this study. Outcomes of the study will include an improved understanding of how land use on a global scale affects stormwater quality, supporting decision makers implementing stormwater control measures.

Biography: Ian Simpson is nearing the end of his first year as a PhD student in the Department of Food, Agricultural, and Biological Engineering at the Ohio State University, advised by Dr. Ryan Winston. Ian is a 2018 graduate of Ohio Northern University with degrees in Civil and Environmental Engineering and Applied Mathematics. Much of Ian's work will focus urban land uses and its affects on water quality and quantity in hopes to optimize the use and placement of stormwater control measures. Ian is also involved in various projects monitoring the effectiveness of green infrastructure throughout the Columbus area, gaining knowledge on how different stormwater control measures prosper in different areas of an urban environment. Ian has high aspirations with the research he is conducting and hopes to one day obtain a researching professor position at a prestigious university, where he can continue to learn and pass down his expertise to future engineers and scientists.

(29) Environmental Education for Scout Leaders in the State of Risaralda – Colombia

Presenter: Stephania Suarez Grajales, Universidad Tecnológica de Pereira, stsuarez@utp.edu.co

Co-Authors: Juan Mauricio Castaño Rojas, PhD, jmc@utp.edu.co

Abstract: The Scout Association of the State of Risaralda, with approximately 200 volunteers composed of children, youth and adults, performs environmental volunteer activities such as trash collection, tree planting, landscape ornament, among others. However, these activities do not create impacts in terms of knowledge because many of the leaders have no training in environment-related topics.

In this study, we initially evaluated, using 50 online surveys and 20 interviews, the demographic compositions of the scouts' leaders and their knowledge background in environmental-related topics such as conservation, climate change, risk management, and solid waste management. Later we developed for them online modules on environmental issues such as conservation, climate change, risk management, and solid waste.

Preliminary results show that many leaders have no specific training in environmental issues because of their disciplinary origin (lawyers, accountants, housewives, or people with any professional degree). Hence, despite that one objective of the scout organization is the non-formal education, the scout leaders lead volunteering activities focused more on ludic and public service rather than education.

In order to overcome this lack of training, a total of four online training modules covering topics on conservation, risk management, climate change, and solid waste management are now available for the scouts' leaders. We expect that this training helps the scouts' leaders to plan and conduct better and comprehensive activities with their members.

Biography: BS in Environmental Administration,MSc Student in Environmental Sciences. Member of the research group Ecology, Engineering and Society- EIS of the Universidad Tecnológica Pereira- Colombia.

(30) Mobile Aquaponics Teaching Assistant (MATA)

Presenter: Sophia Toler-Smith, University of Maryland, stolersmith@gmail.com

Co-Presenters: Jacob Mast, Meghan Collins

Co-Authors: Jacob Mast, Alice Xie, Jake Hirata, Diego Santella

Abstract: The Mobile Aquaponic Teaching Assistant (MATA) is a small scale aquaponic system purposed as a teaching tool for primary education levels. Time and time again it has been proven that young students learn best by interacting with the material being taught. This is easily accomplished when learning about shapes, numbers, and graphs, but is much more difficult when learning about something as complex as the environment. Through MATA young students can be introduced to the co-dependent systems involved in aquaponics in a hands on way. Teachers would be better able to teach students about how many systems interact to make the environment around us. With a more robust understanding of the environment, we believe that the next generation of students, and subsequently adults, will better understand the world around them and be more able to tackle the problems of tomorrow.

Biography: Sophia Toler-Smith is a senior undergraduate student at the University of Maryland. She is majoring in Environmental Science and Technology with a concentration in ecological technology and design. She has a strong interest in sustainable urban planning and design with aspirations to get involved the field once she graduates. She has a vision of "greening cities" by increasing the amount of trees, green walls, green roofs and green space to cities.

(31) Assessment of a Natural Wetland's Pollutant Removal Efficiency in an Urbanizing Watershed: Ecosystem Service or Disservice?

Presenter: Jarrod Underwood, East Carolina University, underwoodw08@students.ecu.edu

Co-Authors: Charles Humphrey, East Carolina University, humphreyc@ecu.edu; G. Iverson, East Carolina University; M. O'Driscoll, East Carolina University

Abstract: Wetlands have been shown to provide various ecosystem services including flood water retention, water quality improvement, and habitat for wildlife and aquatic organisms. Wetlands are commonly created and/or restored to accentuate these processes. Some wetlands though, may be exporters of carbon and other pollutants and thus could provide a disservice to the environment. The goal of this project was to determine if a natural wetland receiving drainage from an urbanizing catchment was a source or sink of nutrients and bacteria. Inflow and outflow samples from the wetland were collected monthly for one year and analyzed for dissolved nitrogen, phosphate, and E. coli concentrations. Physicochemical properties of the samples including pH, dissolved oxygen, turbidity, specific conductance, flow, and temperature were measured in the field during sample collection. The pollutant treatment efficiency of the wetland was evaluated by comparing differences in mass loading of nutrients and E. coli entering and exiting the wetland. Preliminary data show the wetland to be a sink for total dissolved nitrogen (90% reduction), phosphate (80%), and E. coli (76%). However, the wetland was experiencing erosion due to excess urban runoff, and water exiting the wetland was more turbid than the inflow. Reduction of urban runoff and stabilization of the wetland is suggested to allow the wetland to continue to provide ecosystem services with regards to nutrient and bacteria attenuation.

Biography: Jarrod Underwood is currently a graduate student (MS) in the Environmental Health Program at East Carolina University (ECU). Jarrod earned his BS in Biology from ECU, and his research interests include evaluating public health implications of various environmental exposures.

(32) Towards Wetland Creation and Restoration in the Lake Erie Basin with Reduced Feedbacks from Methane Emissions

Presenter: Jorge A. Villa, The Ohio State University, villa-betancur.1@osu.edu

Co-Authors: Yang Ju, The Ohio State University, ju.116@buckeyemail.osu.edu; Camilo Rey-Sanchez, The Ohio State University, reysanchez.1@osu.edu; Timothy H. Morin, State University of New York, thmorin@esf.edu; Gil Bohrer, The Ohio State University, bohrer.17@osu.edu

Abstract: Removal of nutrients of anthropogenic origin is crucial to control and prevent persistent episodes of algal blooms in Lake Erie, which drastically reduce habitat quality and threatens human health. Wetland creation and restoration is one of the current alternatives available to help control nutrient runoff. However, negative feedbacks from methane (CH4) emissions due its effects on the radiative balance of the atmosphere represent a real concern. In this study, we explore the conditions that enhance methane emissions from Old Woman Creek (OWC), an estuarine wetland of Lake Erie dominated by Typha angustifolia. We combined CH4 fluxes measured by the Eddy Covariance technique during two consecutive growing seasons with continuous measurements of water temperature and water temperature. Our results showed that there is up to a 2-fold increase in CH4 fluxes during sudden episodes when the barrier that separate the estuary and the Lake opens. When the barrier is closed, larger CH4 fluxes occurred at higher temperatures but were relatively smaller at lower water levels.

Consequently, it is reasonable to assume that annual CH_4 emissions can be reduced if water levels are maintained low during the warmest time of the year and abrupt changes in water levels caused by barrier openings are controlled. We suggest that wetland creation and restoration designs of wetlands similar to OWC must incorporate control systems that allows regulating water levels to ensure reductions of negative feedbacks from CH_4 emissions.

Biography: I'm a wetland scientist with a keen interest in the study of wetland ecosystem services. My professional goal is to provide stakeholders with quantitative information useful in decision-making processes regarding wetland management aiming to increase ecosystem services. This includes ecological engineering-based approaches to wetland creation and restoration.

(33) Evaluating Fugitive Methane Emissions from Hydraulic Fracturing Using Eddy Covariance Methods

Presenter: Chante Vines, The Ohio State University, vines.24@osu.edu

Co-Authors: Andres Camilo Rey Sanchez,The Ohio State University, reysanchez.1@osu.edu; Derek Johnson, West Virginia University, Derek.Johnson@mail.wvu.edu; Jackie Hatala Matthes, Wellesley College, jmatthes@wellesley.edu; Sarah Russell, Wellesley College, srussell@wel

Abstract: Horizontal drilling and hydraulic fracturing (HF) have increased natural gas exploration within the Marcellus Shale. In many sites, mobile monitoring has shown positive correlations between methane concentration and gas production due to released fugitive emissions. However, mobile monitoring does not provide temporally continuous observations. Furthermore, natural emissions around the site may add to the observed methane fluxes. We set up an eddy covariance tower in West Virginia near a hydraulic fracturing site. Continuous measurements 6 months prior to the start of any drilling activity allowed us to parameterize a model for the baseline methane concentration. Our observations continued during the stages of well development including construction of the well pad, vertical drilling, and horizontal drilling, and will continue through the hydraulic fracturing and production stages. An artificial neural network (ANN) model trained with emissions before HF was used to model methane concentrations throughout the drilling timeline. Methane isotopic data assists in determining between the sources of methane concentration – biological (microbes in streams or livestock) or hydraulic fracturing activity. Most of the observed values that exceed the 95-percentile confidence limit of the modeled baseline concentrations are during the horizontal and vertical drilling periods and show a typical geological isotopic ratio. This work aids in quantifying greenhouse gas emissions due to anthropogenic activity. Policymakers may employ research such as this to mitigate future leaks from shale development.

Biography: Chante' Vines is a graduate student at The Ohio State University in the Department of Civil, Environmental, and Geodetic Engineering.

(34) Soil Fracking to Alleviate Compacted Rain Gardens

Presenter: Jenna Williams, University of Tennessee Knoxville

Co-Authors: Matt Johnsen, James Lewis, Christian Patterson, Ryan Watson, Andrew Sherfy, Dr. Andrea Ludwig, and Dr. John Tyner

Abstract: This poster analyzes the compaction of urban soils, particularly compaction in rain gardens. When this compaction occurs, rain gardens cannot function properly therefore eliminating their benefits. A device was built to remediate the compaction at a low cost, using a method similar to fracking in the oil industry. Initial testing of the device shows the ability to increase infiltration rates as high as a 60 fold increase.

(35) Functional Assessment of Stream Restoration for Water Quality Benefits in Urban Watersheds

Presenter: Holly Yaryan Hall, University of Georgia, Holly.YaryanHall@uga.edu; Devan Fitzpatrick, University of Georgia, Devan.Fitzpatrick@uga.edu

Co-Authors: Devan Fitzpatrick, University of Georgia, Devan.Fitzpatrick@uga.edu; Brian Bledsoe, University of Georgia, bbledsoe@uga.edu

Abstract: Nature-based infrastructure projects in riverine corridors are an essential component of efforts to transform and enhance urban infrastructure. Several states including North Carolina, Tennessee, Wyoming and Colorado are developing procedures for quantifying improvements in stream functioning (aka functional lift) resulting from stream restoration activities, as well as determining the location and viability of stream restoration projects and mitigation banks in both rural and urban settings. Most statewide protocols as currently designed and operationalized do not reflect the best available science on how hydrology and geomorphology influence stream functions, especially interactions between water quantity and water quality. By heavily downweighting the functional potential of any restoration project in a watershed with some urbanization, the tools have the potential to disincentivize or inhibit restoration of urban streams that still have significant capacity for functional lift and provisioning of co-benefits. This runs counter to recent efforts to advance urban stream restoration as a means of improving water quality. We are performing an evaluation of existing stream functional procedures as they relate to urban streams and water quality, and developing recommendations for a straightforward but rigorous approach to evaluating the functional capacity of urban streams and their potential for restoration. Specifically, the study addresses functional lift derived from a variety of practices: erosion control, bed and bank stabilization, floodplain reconnection, riparian buffers, in-stream enhancement, control of watershed processes, and channel reconfiguration.

Biography: Holly Yaryan Hall is a registered professional engineer. She is pursuing a Ph.D. at the University of Georgia, where her research focuses on applied fluvial geomorphology: stream stability, sediment transport, and aquatic ecosystem restoration. Prior to UGA, Holly served 4 years as a senior member of the Water Resources Engineering team at EMH&T, where she consulted on a variety of stream restoration, floodplain, transportation, and stormwater projects. She also has 9 years of experience with the Ohio Department of Transportation, including district in-house design, statewide policy, and transportation research. Holly holds bachelor's and master's degrees in civil engineering from Princeton University and Colorado State University, respectively, and a master's degree in teaching from the University of South Carolina.

Devan Fitzpatrick is pursuing a M.S. at the University of Georgia, where her research focuses on the interface between societal needs, ecology, and water resources engineering. She received her Bachelor's Degree in Environmental Engineering from Oregon State University. During her time at

Oregon State she participated in two Research Experience for Undergraduates Programs that focused on using moss and lichens as environmental biomonitors. Devan worked as both a river restoration technician and as an Environmental Specialist for The Oregon Department of Environmental Quality.