Aerial view of Lake Norman near Jetton Park in Cornelius, provided by VisitNC.com

wrri

NC WATER RESOURCES RESEARCH INSTITUTE

25th Annual Conference
March 22-23, 2023
Raleigh, N.C.

NC STATE UNIVERSITY

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NC WATER RESOURCES RESEARCH INSTITUTE

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NORTH CAROLINA
WATER RESOURCES ASSOCIATION

WRRI would like to thank our partner, the NC Water Resources Association, for sponsoring the student poster presentation awards and supporting the student networking session.

For more information about the benefits of being an NC WRA member, including benefits for students, please visit **ncwra.org**

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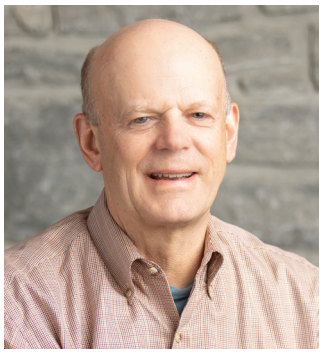
Carolina Wetlands Association

Guest Speakers - March 22
Looking Toward Our Water Future

Elizabeth S. Biser

Secretary, NC Department of Environmental Quality

Governor Roy Cooper named Elizabeth S. Biser as Secretary of the North Carolina Department of Environmental Quality in June 2021. She is the first woman confirmed to serve as DEQ Secretary. Secretary Biser oversees the state agency whose mission is to protect North Carolina's environment and natural resources. The organization has offices from the mountains to the coast and administers regulatory and public assistance programs aimed at protecting the quality of North Carolina's air, water and land, its coastal fisheries, and the public's health. Secretary Biser has experience representing public, private and non-profit organizations on a wide variety of issues. She previously served as Director of Legislative and Intergovernmental Affairs when the agency was known as the North Carolina Department of Environment and Natural Resources, and most recently served as the President of Biser Strategies LLC and the Senior Policy Advisor of the Recycling Partnership. Previously, she was the Vice President of Policy and Public Affairs of the Recycling Partnership, and Government Relations & Policy Advisor of Brooks, Pierce, McLendon, Humphrey & Leonard, LLP. She holds a Bachelor of Arts and a Master of Public Administration from the University of North Carolina at Chapel Hill.



Bill Holman

NC State Director, The Conservation Fund

Bill Holman is NC State Director of The Conservation Fund. He directs The Conservation Fund's conservation acquisitions program in NC. His current projects include advocating for North Carolina's Land & Water Fund and Parks & Recreation Trust Fund in the state legislature, protecting drinking water supplies in Maggie Valley, advocating for One Water management approaches in the Upper Cape Fear and Upper Neuse River Basins, and helping Eastern North Carolina recover from hurricanes and become more resilient. Holman directed Duke University's Nicholas Institute for Environmental Policy Solutions state policy program from 2007 – 2012. He served as Governor Jim Hunt's Secretary of the NC Department of Environment and Natural Resources from 1999 – 2000 and as Assistant Secretary from 1998 – 1999. He worked as Executive Director of the NC Clean Water Management Trust Fund, a water quality financing program, from 2001 – 2006. He chairs the Steering Committee for the NC Land for Tomorrow Coalition and the Board of the Forest Restoration Alliance. He also serves on the Executive Committee of Smokies Safe Passage. He served on the Board of the Environmental Research Institute of the States from 2011 – 2020. Governor Jim Hunt presented the Order of the Long Leaf Pine to Holman in 2000. The Water Environment Federation presented its Outstanding Contributions to the Water Environment for Non-Members Award to Holman in 2014. The NC Wildlife Federation added Holman in its Conservation Hall of Fame in 2018. Holman graduated magna cum laude with a BS in biology from NC State University in Raleigh in 1978. He completed hiking the Appalachian Trail in 1975.

Juanita Wilson

Co-chair, Board of Directors, Nikwasi Initiative

Juanita Wilson is an enrolled member of the Eastern Band of Cherokee Indians (EBCI). She oversees the Training & Development department of the EBCI. Wilson and her team are responsible for the professional development of 1,200+ employees. Wilson graduated from Western Carolina University (WCU) with a Bachelor of Science in Sociology. She completed her Master of Science in Leadership and Management at Montreat College. Wilson started her professional journey working with a regional entity called, "Region A Partnership for Children (RAPC)," whose mission was to fund programs that work to prepare children to enter kindergarten ready to learn. This sparked Wilson's love for collaborative partnership work. Wilson has been privileged to serve on numerous boards and committees across North Carolina, and has participated in state-wide and national leadership development programs. Ask Wilson about her most valuable career experience and she will tell you it was being part of developing and directing the,"WNC Leadership Institute," which served as an umbrella for two programs focused on cultural and multiple-county leadership capacities. Ask Wilson what keeps her going and she will tell you with complete assurance, that service to the community is key to contentment and with the support of her family, she will continue working for a strong and positive future.

Victor Engel

Director, USGS South Atlantic Water Science Center

Dr. Victor Engel is the Director of the U.S. Geological Survey's South Atlantic Water Science Center. Since June 2020 he has overseen a diverse, collaborative research portfolio and extensive surface water, groundwater and water quality monitoring networks in South Carolina, North Carolina and Georgia. He recently served as the US Forest Service National Hydropower Program Manager and Instream Flow Coordinator (2017-2020) and held a previous position with the USGS at the Wetland and Aquatic Research Center (2012-2017). He began his professional career as a Research Hydrologist with Everglades National Park. Dr. Engel holds graduate degrees from the University of Florida (M.S. 1996) and Columbia University (Ph.D. 2002), and he completed post-graduate work at Duke University in 2003. He is based outside of Atlanta, GA.

Guest Speakers - March 23
Building Community Stewardship Through Art

Derrick Beasley

Multidisciplinary Artist, Cultural Organizer, and Social Entrepreneur

Derrick Beasley is a multidisciplinary artist, cultural organizer and social entrepreneur. His creative practice explores possibilities for living through the end of the world, particularly for Black folks. Derrick creates art, spaces and business that explore a few key questions, including: What about our relationship to the nonhuman world needs to change in order to survive the end of the world? What ways of being should discontinue to shift this relationship?

Tonya Holy Elk Locklear

Poet and Author

Poet, author and educator, Dr. Tonya Holy Elk Locklear grew up in southeastern North Carolina. She's an enrolled member of the Oglala Lakota Nation of Pine Ridge, South Dakota, and has kinship ties to the Lumbee Tribe of North Carolina. Tonya's focus is Native American Literature, and her poetry is themed around land, kinship and food while reminding readers about the importance of preserving Native American culture and identity through oral history traditions. As a poet and workshop facilitator, she shares her work within the community through workshops and a literary project for youth in collaboration with North Carolina Poet Laureate, Jaki Shelton Green. Tonya has traveled and presented her poetry in many venues, and she has published work in poetry anthologies, various Indigenous journals, and upcoming in the North Carolina Literary Review magazine. Her new poetry collection, entitled Soul Food, is forthcoming from That Painted Horse Press in Los Angeles, California.

Erika Young

NC Sea Grant Educator and Potter

Dr. Erika Young serves as the Sea Grant Coastal and Marine Education Specialist. She previously served on faculty at the University of North Carolina Pembroke for 13 years, teaching biology, zoology, marine biology, and environmental sciences and serving as a research mentor for undergraduates. She holds a bachelor's degree from the UNCP, a master's degree from Western Carolina University, and her doctorate from UNC Chapel Hill, where she focused on aquatic ecology with emphasis in bird and fish use of estuarine habitats, oyster biodeposition, meiofauna, and sea-level rise. She is currently working on her NC Environmental Educator Certification and also serves as a Project Explore Coach for the NC Arboretum, a Morehead Planetarium Science IMPACTOR, and creates professional development workshops for formal and informal educators. She especially enjoys working with teachers and students in underserved communities, as she grew up in Robeson County and is a member of the Lumbee Tribe. Erika took her first pottery class in 2001 for fun while in graduate school. She was able to take a 30-day course in mixed media in Costa Rica, digging river clay and learning on a traditional kick wheel. After a few years on and off, she was able to focus on pottery once again in 2016 and has not stopped. Pottery allows her to create and imitate her favorite groups of marine creatures into functional and nonfunctional art. Her pieces have created an open dialogue between science and the public simply by identification.

Baxter Miller

Photographer and Creative Director

Baxter Miller is a creative director and communications strategist based in Eastern North Carolina, where she has spent the majority of her life and career deeply rooted. Together with her partner and collaborator, Ryan Stancil, along with a team of experts, they conceived of and produced Rising: Perspectives of Change Along the North Carolina Coast, a research and multimedia exhibition bridging the arts, sciences and humanities that engaged at-risk communities in conversation about climate-related changes, community resilience and adaptation.

Professional Development and Networking

Professional Development
WRRI will offer the following PDH/CEU credits for the 2023 Annual Conference:

- 10 PDH credits for Professional Engineers and Surveyors*
- 10 PDH credits for Professional Geologists*
- 10 CECs for Soil Science Society of NC (5 each day)
- 10 CECs for Certified Floodplain Managers (5.5 on Day 1 and 4.5 on Day 2)

In order to receive any type of credit for the conference, you must fulfill the following requirements:

- Register and complete payment for the event in advance.
- Provide your signature on a sign-in sheet at the registration desk.
- Submit a completed Sponsor Evaluation. This form will be available at the registration desk. Please provide the day(s) of your attendance on the form. If you attend both days, you only need to submit one form.
- Complete the online conference evaluation linked in the inside cover of your conference booklet. Link: go.ncsu.edu/wrri_aceval

Once these requirements have been met, you will receive an electronic certificate of completion.
Please allow several days for processing. See Anna A. Martin with questions.

Note: While WRRI offers Professional Development Credit for this program, it is up to each professional to determine if the content is relevant to their individual practice and suitable for their continuing education. Upon completion and return of required paperwork, each attendee will receive an electronic certificate for their records and self-reporting.

*WRRI is an approved sponsor for NCBELS (License # S-0302) and NC Board for Licensing of Geologists (pre-approved provider list).
WRRI is currently seeking approval from the NC Board of Landscape Architects for credit approval.

Networking
The WRRI Annual Conference is an excellent opportunity to meet fellow researchers, students, and water resources practitioners. We encourage all attendees to utilize networking breaks, luncheons, and the reception to connect with other attendees.

We'd like to highlight a few opportunities:

- **Visit the designated job board** – Is your organization hiring or are you looking for a new job? Visit the job board located in the exhibit hall! Bring printouts of job announcements to pin on the job board or stop by to see what opportunities are available.
- **Networking lunch** – On Wednesday, reserved tables will be available for student attendees to get to know one another.
- **Networking breaks** – Enjoy refreshments and exhibits in Room 1 D&C throughout both days of the conference.
- **Poster session and reception** – Build your network over drinks and hors d'oeuvres as you view poster presentations!
- **Student networking session** – Get to know fellow students and learn about careers and pathways in water resources from professionals in the field. Ice cream will be provided by the NC Water Resources Association!

Agenda

Wednesday March 22

7:30-8:45 am	**Registration**
Lobby	Check in and enjoy coffee and hot morning refreshments
8:45-10:00 am	**Opening Panel**
Room 1A	**Looking Toward Our Water Future** **Moderator: Susan White, NC Water Resources Research Institute, NC Sea Grant, and NC Space Grant**
	Secretary Elizabeth Biser, NC Department of Environmental Quality
	Victor Engel, USGS South Atlantic Water Science Center
	Juanita Wilson, Nikwasi Initative
	Bill Holman, The Conservation Fund
	Moderated discussion and audience questions
Room 1 D&C 10:00-10:20	**Networking Break:** Enjoy refreshments and exhibits
10:20-11:50 am	**Concurrent Session 1**
Room 6	**Impacts of Animal Agriculture on Water Quality** **Moderator: Haley E. Plaas, UNC Chapel Hill**
10:20-10:40	Mehdi Lamssali, North Carolina A&T State University, Combined Anaerobic Degradation and Microalgae Treatment of Swine Waste Water Using Lab-Scale Bioreactors
10:40-11:00	A B M Tanvir Pasha, NC State University, Assessing Temporal Variability of Antibiotic-Resistant E. Coli in Surface Water Near Animal Feeding Operations
11:00-11:20	Colleen Brown, UNC Wilmington, Tracing Nutrient Pollution from Industrialized Animal Production in the Cape Fear River Watershed
11:20-11:40	Daniel Line, NC State University, Effects of Livestock Exclusion on Pollutant Export from a North Carolina Beef Cow Pasture
11:40-11:50	Additional time for questions
Room 3	**Practical Tools for a Sustainable Water Future** **Moderator: Caroline Loop, Wake County Environmental Services**
10:20-10:40	Brian Hinckley, East Carolina University, Let's Get Creative: How to Build a Scalable Real-Time Hydrologic Data Monitoring Network with Cost-Effective DIY Solutions
10:40-11:00	J. Curtis Weaver, USGS South Atlantic Water Science Center, Low-flow Statistics for North Carolina: Today and Tomorrow
11:00-11:20	Michelle Moorman, US Fish and Wildlife Service, wqReport: A Tool for Compiling and Visualizing Watershed Data
11:20-11:40	Trish D'Arconte, NC Dept of Environmental Quality, NC DEQ's Updated Stormwater Nitrogen and Phosphorus (SNAP) Tool, Version 4.2
11:40-11:50	Additional time for questions

Agenda continued

Room 4	**Out of the Box: Creative Approaches to Community Collaboration and Engagement** **Moderator: Frank López, NC Sea Grant and NC WRRI**
10:20-10:40	Sheila M. Saia and Corey Davis, State Climate Office of North Carolina, The Past, Present, and Future of Our Coast and Climate
10:40-11:00	Riley Lewis, Coastal Carolina Riverwatch, Water Quality for Fisheries
11:00-11:20	Michael R. Burchell, NC State University, Can Citizen Scientists Fill the Gap in State Ambient Wetland Monitoring Programs?
11:20-11:40	Rebecca Coppa, NC DEQ, How to Enhance Your Enviroscape Presentation
11:40-11:50	Additional time for questions
Room 2 11:50-1:30	**Networking Lunch:** Specific tables have been reserved for students
1:30-3:00 pm	**Concurrent Session 2**
Room 6	**Too Much Water: Adapting to Change** **Moderator: Cayla Cothron, NC Sea Grant**
1:30-1:50	Helena Garcia, UNC Chapel Hill, Dynamic Vulnerability: Reconstructing Historical Flood Footprints and Exposure in Eastern North Carolina
1:50-2:10	Lauren Grimley, UNC Chapel Hill, Linking Tropical Cyclone Precipitation in Future Climates to Shifts in Flood Exposure
2:10-2:30	Adam Gold, Environmental Defense Fund, Emerging Research on Natural Infrastructure for Flood Mitigation
2:30-2:50	Roger D. Shew, UNC Wilmington, A Changing Lower Cape Fear River Estuary: Impacts of Rising Waters on Ecosystems and Infrastructure
2:50-3:00	Additional time for questions
Room 3	**Innovations in Wastewater Treatment** **Moderator: Layla El-Khoury, NC State University**
1:30-1:50	Holly Haflich, UNC Chapel Hill, and Hezhou Ding, NC State University, Separation of Volatile Fatty Acids (VFAs) from Anaerobic Digestion (AD) Bioreactors Using Different Electrodialysis (ED) Configurations
1:50-2:10	Allison Lee, UNC Chapel Hill, Daily Inflow and Infiltration at Wastewater Treatment Plants across North Carolina
2:10-2:30	Guy Iverson, East Carolina University, Evaluating Nitrogen Treatment by Onsite Wastewater Systems in Raleigh Belt Geology: A Preliminary Assessment
2:30-2:50	Charles Humphrey, East Carolina University, Nutrient and Bacteria Treatment by Five Onsite Wastewater Systems in the Triassic Basin Region of the Falls Lake Watershed, North Carolina
2:50-3:00	Additional time for questions
Room 4	**Utilizing Data to Enhance Decision Making** **Moderator: Tiffany VanDerwerker, NC State University**
1:30-1:50	Ellie Cardenal, AECOM, Using Data Visualizations and Spatial Analysis to Support Environmental Decision Making
1:50-2:10	Gregory Melia, NC DEQ - Division of Mitigation Services, Application of Water Quality Measurement Data from Stream Mitigation to Improve Standardization of Stream Project Selection and Refine Pollutant Reduction Models Employed in Design Justification
2:10-2:30	Toby Feaster, U.S. Geological Survey, Effects of Impoundments on Selected Flood-Frequency and Daily Mean Streamflow Characteristics in Georgia, South Carolina, and North Carolina
2:30-2:50	Rosemary Fanelli, U.S. Geological Survey, Overview of Multi-Decade Water-Quality Monitoring at Triangle Area Water Supplies
2:50-3:00	Additional time for questions
Room 1 D&C 3:00-3:20	**Networking Break:** Enjoy refreshments and exhibits

Agenda continued

3:20-4:50 pm — **Concurrent Session 3**

Room 6

Modeling Current and Future Water Quantity and Quality in the Cape Fear River Basin from Community to Watershed Scale

Moderator: Danica Schaffer-Smith, The Nature Conservancy

3:20-3:40	Danica Schaffer-Smith, The Nature Conservancy, Watershed Modeling of Pollution Hotspots Under Extremes Highlights Landscape-Scale Intervention Priorities in the Cape Fear River Basin
3:40-4:00	Elly Gay, NC State University, Strategic Riparian Buffers to Improve Coastal Resilience in the Cape Fear River Watershed
4:00-4:20	Jacqueline S. Welles, U.S. Geological Survey, Flood Risk and Reward: Quantifying differences in flood risk under alternative management strategies for vulnerable communities of the Cape Fear River Basin, North Carolina
4:20-4:50	Panel discussion

Room 4

Finding the Sweet Spot: Information Exchange to Inform Prioritizing Stormwater Management Actions

Moderator: Kristina Hopkins, U.S. Geological Survey

A single abstract for this panel is included under "Kristina Hopkins" on page 28.

3:20-3:35	Kristina Hopkins, U.S. Geological Survey, Session Overview
3:35-3:50	Jason Hunt, City of Charlotte, Charlotte, NC: A Large Community Perspective
3:50-4:05	Bill Lee, Town of Cary, Cary, NC: A Small Community Perspective
4:05-4:45	Kristina Hopkins and Charlie Stillwell, USGS: Interactive Discussion

Room 3

Panel Discussion on the Waters of the US and State

Moderator: Rick Savage, Carolina Wetlands Association

A single abstract for this panel is included under "Rick Savage" on page 33.

3:20-4:50

Phil May, Inver Environmental Consulting, LLC

Kelly Moser, Southern Environmental Law Center

Sue Homewood, NC Division of Water Resources

Norton Webster, Carolina Wetlands Association and Ecoterra

Chris Hopper, U.S. Army Corps of Engineers

4:50-5:00 — **Break**

Room 1 D&C
5:00-7:00

Poster Session and Reception

Join us for research poster presentations and a chance to meet the poster authors. Network with conference participants and exhibitors. Enjoy heavy hors d'oeuvres, wine, beer, and refreshments.

Agenda

Thursday March 23

8:30-9:30 am — **Opening Panel**

Room 1A

Building Community Stewardship Through Art
Moderator: Christy Perrin, NC WRRI and NC Sea Grant

Baxter Miller, Photographer and Creative Director

Derrick Beasley, Multidisciplinary Artist, Cultural Organizer, and Social Entrepreneur

Tonya Holy Elk Locklear, Poet and Author

Erika Young, NC Sea Grant Educator and Potter

Moderated discussion and audience questions

Room 1 D&C
9:30-9:50

Networking Break: Enjoy refreshments and exhibits

9:50-11:40 am — **Concurrent Session 4**

Room 3

Calling All Utilities: Sustaining Healthy Water Systems
Moderator: Kaitlin Tucker, NC WRRI

9:50-10:10	Taylor Holiday and Mitchell Turnage, Raftelis, Evolving Stormwater Utilities in NC
10:10-10:30	Ruth Rouse and Dave Halley, OWASA and True North Forest Management Services, Healthy Forest = Healthy Watersheds: OWASA's Forest Management Program to Protect its Water Supplies
10:30-10:50	Simon Warren and Rachel Weinberg, Raftelis, Strategies for Addressing Water Affordability through Data, Benchmarking, and Partnerships
10:50-11:10	J.V. Loperfido, City of Durham, Public Works Department, Pollutant Source Tracking: Using Multiple Methods to Find Causes of Water Quality Issues in Urban Streams
11:10-11:30	Nicole Barclay, UNC Charlotte, Prediction of Stormwater Pipeline Condition via Machine Learning
11:30-11:40	Additional time for questions

Room 4

Below the Surface: Understanding Groundwater Quality and Flow
Moderator: Sascha Medina, NC Space Grant

9:50-10:10	Tiffany VanDerwerker, NC State University, Assessing groundwater quality in deep aquifers near Fayetteville, NC: Testing the waters for an alternate drinking water source
10:10-10:30	Craig R. Jensen, NC State University, Predicting future PFAS concentrations in groundwater discharging to streams near the Fayetteville Works Facility
10:30-10:50	Julianna Tresca, NC State University, Utilizing R Statistical Software to Assess PFAS Groundwater Contamination Impacts in North Carolina
10:50-11:10	Hayden Rudd, NC State University, Diagnostic Screening of Private Well Water Using High Resolution Mass Spectrometry to Support Well Users and Local Health Officials
11:10-11:30	August Young (Frechette), Duke University, Spatial Mapping of Porosity as a Function of Reynolds Number and Pore Scale Geometry
11:30-11:40	Additional time for questions

Agenda continued

Room 6	**Changing Streams: Identifying and Managing the Impacts of Erosion** **Moderator: Susan White, NC WRRI, NC Sea Grant, and NC Space Grant**
9:50-10:10	Layla El-Khoury, NC State University, Quantifying and Predicting Streambank Erosion in the Ridge and Valley and Blue Ridge Physiographic Regions of Virginia to Benefit Eastern Hellbender Populations
10:10-10:30	Laura Gurley, U.S. Geological Survey, Using Repeat Lidar to Identify Streambank Erosion Hotspots in Raleigh, North Carolina
10:30-10:50	Karl W. Wegmann, NC State University, Channel Head Erosion in Response to Aanthropogenic Landscape Modification: A case study from William B. Umstead State Park in the Piedmont of North Carolina, with implications for stream water quality
10:50-11:10	Robert Patterson, Amy Barber, Jason Barnhill, City of Burlington, Urban Riparian Buffers: Maintaining and Managing an Ecologically Functioning Riparian Buffer on Little Alamance Creek in Burlington, North Carolina.
11:10-11:30	Jack Kurki-Fox, NC State University, Flood Mitigation Assessment of Stream Debris Removal
11:30-11:40	Additional time for questions
11:40-1:00 pm	**Networking and Awards Luncheon**
Room 2	Bradley Whitman and Danny Edwards of NC Department of Environmental Quality, Division of Water Resources Public Water Supply Section will present the Source Water Protection Award winners. WRRI Annual Conference student poster competition winners will be announced.
1:00-2:30 pm	**Concurrent Session 5**
Room 6	**Spotlight on Estuaries: What You Need to Know About Water Quality and Public Health** **Moderator: Riley Lewis, Coastal Carolina Riverwatch**
1:00-1:20	Andrew George, UNC Chapel Hill, Fostering Environmental Health Literacy While Addressing Arsenic Contamination in Private Wells in the Carolina Terrane
1:20-1:40	Haley E. Plaas, UNC Chapel Hill, Harmful Cyanobacterial Aerosolization Dynamics in the Airshed of a Eutrophic Estuary
1:40-2:00	Julia Harrison, NC State University, Investigating Tryptophan-like Fluorescence as a Correlate with Fecal Indicator Bacteria in Estuarine Waters
2:00-2:20	Emily Corbitt, UNC Wilmington, Occurrence and Distribution of Per-and Polyfluoroalkyl Substances in Tidal Creeks of Southeastern North Carolina
2:20-2:30	Additional time for questions
Room 4	**Healthy Waters: Nutrients, Flow, and Management** **Moderator: Erika Young, NC Sea Grant**
1:00-1:30	Michael O'Driscoll, East Carolina University, Tailoring Ecological Flow Guidance to Coastal Watersheds: Examples from the Trent River
1:30-2:00	Christopher L. Osburn, NC State University, Source Identification of Dissolved Organic Matter (DOM) in Surface Waters Using Fluorescence and a Simple and Rapid Linear Regression Method
2:00-2:20	Guy Iverson, East Carolina University, Quantifying Water Quality Downgradient from Onsite Wastewater Systems in the Raleigh Belt: A Preliminary Assessment of Phosphorus and Escherichia coli Concentrations
2:20-2:30	Colin Finlay, East Carolina University, Nitrogen Processing in Regenerative Stormwater Conveyance Systems (Lightning)
Room 3	**Innovative Approaches for Removing Contaminants** **Moderator: John Fear, NC WRRI and NC Sea Grant**
1:00-1:20	Mohammad Khalid, UNC Charlotte, Biochar – A Multi-Beneficial and Cost-Effective Amendment to Clay Soil
1:20-1:40	Jessica A. Deaver, NC State University, Evaluating Metal Cation Diversity in Microbial Polyphosphate Granules and its Effect on Enhanced Biological Phosphorus Removal from Domestic Wastewater

Agenda continued

1:40-2:00	Irene Mulloy Manning, UNC Chapel Hill, Hydrolytically Stable Ionic Fluorogels for High-Performance Remediation of Per- and Polyfluoroalkyl Substances (PFAS) from Natural Water
2:00-2:10	Genevieve Guerry, East Carolina University, Societal Perceptions of PFAS Contamination in Eastern North Carolina (Lightning)
2:10-2:30	Additional time for questions
Room 1 D&C 2:30-2:45	**Networking Break:** Enjoy refreshments and exhibits
2:45-4:15 pm	**Concurrent Session 6**
Room 4	**Falls Lake Nutrient Management Summary of the Science and Resulting Recommendations for a Revised Strategy** **Moderator: Forrest Westall, McGill Associates and Upper Neuse River Basin Association**
2:45-3:05	Alix Matos and Forrest Westall, Brown and Caldwell, McGill Associates, and UNRBA, Falls Lake Watershed Characterization, Data Evaluation, and Modeling Results to Inform a Revised Nutrient Management Strategy for Falls Lake
3:05-3:25	Doug Durbin and Alix Matos, Brown and Caldwell, Falls Lake Data Evaluation and Modeling Results to Inform a Revised Nutrient Management Strategy for Falls Lake
3:25-3:45	Forrest Westall, McGill Associates and UNRBA, Key Concepts and Principles for Developing a Revised Nutrient Mangement Strategy for Falls Lake
3:45-4:15	Forrest Westall, McGill Associates and UNRBA, Audience Participatory Feedback Session Regarding Development of a Revised Nutrient Management Strategy for Falls Lake
Room 6	**Let It Rain: Data and Innovative Considerations for Stormwater Management** **Moderator: Gloria Putnam, NC Sea Grant**
2:45-3:05	Chris Norcross, NC State University, Adaptations in Beaver Habitat Selection May Offer Partial Nature-Based Solutions to Multiple Stormwater Problems in Urban Watersheds
3:05-3:25	Barbara Doll, NC Sea Grant and NC State University, Characterizing Water Quality Status, Trends and Potential Watershed Management Opportunities from Charlotte-Mecklenburg National Pollutant Discharge Elimination System (NPDES) Stormwater Data
3:25-3:45	Jingyi Qi, UNC Charlotte, Simulating Green Stormwater Infrastructure Implementation In Residential Areas
3:45-4:00	Additional time for questions
Room 1B	**Student Networking and Career Panel** **Moderator: Annie Grant, NC WRRI and NC Sea Grant**
2:45-4:15	Create connections with fellow students and learn about different career pathways in water resources. Ice cream will be provided by NC Water Resources Association! This session will be facilitated by NC WRRI.
4:15pm	**Conference Adjourns**

Notes

List of Poster Presentations

Alphabetical by presenter last name

^ *Denotes student presenter;* * *Denotes presentation covers current or previous WRRI-funded work*

1. Investigating Ecological Risks Posed by Wastewater-Derived Pesticides

^ Presenter: **Denise Adjidjonu**, UNC Charlotte, dadjidjo@uncc.edu
Co-authors: Jacelyn Rice-Boayue, UNC Charlotte; Sara Kamanmalek, Smith College; Yina Xie, California Department of Pesticides

2. Nitrogen and Phosphorus Remediation in Mesocosm Floating Treatment Wetlands? Receiving Municipal and Aquacultural Wastewater

^ Presenter: **Matthew Barnes**, East Carolina University, barnesma17@students.ecu.edu
Co-authors: Natasha Bell, Rachel Gittman, and Ariane Peralta, East Carolina University; Steven Hall, NC State University

3. Fecal Contamination Source Tracking and Forecasting to Support Recreational and Cultural Development in the Great Coharie River Watershed

*^ Presenter: **Benjamin Clark,** NC State University, bjclark4@ncsu.edu
Co-authors: Angela Harris and Daniel Obenour, NC State University; Ryan Emanuel, Duke University; Philip Bell, Great Coharie River Initiative

4. A New Forensic Tool Establishing Source and Fate of Per-and Polyfluroalkyl Substances (PFAS): Compound-Specific Isotopic Analysis Using Gas Chromatograph-Isotope Ratio Mass Spectrometry

^ Presenter: **Allison Dombrowski,** UNC Wilmington, add2529@uncw.edu
Co-authors: Ralph Mead and Chad Lane, UNC Wilmington

5. Evaluation of Embedded Benefits for NC Biochar Amended Soil Applications

^ Presenter: **Neetu Donkada**, UNC Charlotte, ndonkada@uncc.edu
Co-authors: Denise Adjidjonu and Jacelyn Rice-Boayue, UNC Charlotte

6. Exploring the Drivers of Household Participation in Voluntary Buyouts with an Agent-Based Model

^ Presenter: **Lauren Grimley**, UNC Chapel Hill, lauren.grimley@unc.edu
Co-authors: Antonia Sebastian, UNC Chapel Hill; Tatiana Filatova, Delft University of Technology

7. Harmful Cyanobacteria Blooms Prevail in Urban Waterbodies and Out-compete a Diverse Collection of Phytoplankton Genera

^ Presenter: **Amy Grogan**, UNC Wilmington, aeg7670@uncw.edu
Co-authors: Catharina Alves de Souza, Michael A. Mallin, and Lawrence B Cahoon, UNC Wilmington

8. Comparison of Remotely Sensed and Water Balance-Based Estimates of Evapotranspiration in Small Headwater Catchments

^ Presenter: **Papa Gueye**, USDA Forest Service, pogueye@ncsu.edu
Co-authors: Johnny Boggs, USDA Forest Service; Zakiya Leggett, NC State University; Gee Sun, USDA Forest Service

9. The Effect of Construction Runoff of Water Within Mecklenburg County

*^ Presenter: **Darrell Holmes Jr.**, L.E.A.P Forward, dholme26@email.cpcc.edu
Co-authors: Olya Keen, UNC Charlotte; Eboné M. Lockett, Harversting Humanity

10. Urban Development and Stormwater Sediments: Identifying Vulnerable Populations in Charlotte, NC

^ Presenter: **Chandler Horton**, UNC Charlotte, chorto28@uncc.edu
Co-authors: Fushcia-Ann Hoover and Nicole Barclay, UNC Charlotte

11. Development of Large Volume Filtration-based Virus Concentration Method for Increased Detection Sensitivity of SARS-CoV-2 from Wastewater

^ Presenter: **Md Ariful Islam Juel**, UNC Charlotte, mjuel@uncc.edu
Co-author: Mariya Munir, UNC Charlotte

12. Optimization and Comparative Study of SARS-CoV-2 RNA Extraction Protocols for Enhanced Viral RNA Yield in Wastewater Samples

^ Presenter: **Nita Khanal,** UNC Charlotte, nkhanal2@uncc.edu
Co-authors: Md Ariful Islam Juel and Mariya Munir, UNC Charlotte

13. Quantifying Algal and Nutrient Concentrations in Urban Stormwater and Beaver Ponds

^ Presenter: **Emma Lacy**, UNC Charlotte, elacy@uncc.edu
Co-authors: Sandra Clinton, UNC Charlotte

14. SARS-CoV-2 Epidemiology & Wastewater Surveillance at North Carolina Agricultural and Technical State University

^ Presenter: **Mehdi Lamssali**, North Carolina A&T State University, mlamssali@aggies.ncat.edu
Co-authors: Shilpi Bhatia, Tinyiko Vallerie Nicole Maswanganye, Mehdi Lamssali, Olusola Jeje, Dongyeng Deng, and Liesl Jeffers-Francis, North Carolina A&T State University

15. Biodegradable Dissolved Organic Carbon in Stream Outflow of Urban Stormwater and Beaver Ponds

^ Presenter: **Jordan Landis**, UNC Charlotte, jlandi12@uncc.edu
Co-authors: Sandra Clinton, UNC Charlotte

16. Analysis of Variances in Charlotte-Mecklenburg School Systems' School Water Quality as it Correlates to Other School Demographics in the Community

*^ Presenter: **Jazzie Lee and Evelyn Romero**, UNC Charlotte and Harvesting Humanity, evelynromero2k@gmail.com; leejazzie0@gmail.com
Co-authors: Olya Keen, UNC Charlotte and Eboné M. Lockett, Harversting Humanity

17. Aquifer Response to Changes in Barometric Pressure: Insight into the Degree of Confinement of Aquifers

Presenter: **Madan Maharjan,** UNC Pembroke, madan.maharjan@uncp.edu
Co-authors: Jesse Rouse, Coastal Carolina University; Cody Gless, UNC Pembroke

18. Distribution of Metals, PAHs and Phosphorus in Sediments of 21 Wet Detention Ponds in Wilmington, N.C.

Presenter: **Michael Mallin**, UNC Wilmington, mallinm@uncw.edu
Co-authors: Lawrence B. Cahoon, Matthew R. McIver, and Nicholas D. Picha, UNC Wilmington

19. Utilizing High Resolution Mass Spectrometry for the Assessment of Emerging Contaminants in the River and Intracoastal Waters of Wilmington North Carolina

^ Presenter: **Jacquelin Meade**, UNC Wilmington, jrm7627@uncw.edu
Co-authors: Winifred Johnson, UNC Wilmington

20. The Effects of a Beaver Complex on the Biochemistry of an Urban Stream

^ Presenter: **Jamil Millner Jr.**, UNC Charlotte, jmillne1@uncc.edu
Co-authors: Craig Allan, UNC Charlotte

21. Enhancing Perspectives on Lake Impairments Using Satellite Observations

^ Presenter: **Michael Moerk**, Wake Forest University, moermj18@wfu.edu
Co-authors: Courtney Di Vittorio, Wake Forest University

22. Analysis of Fertilizers in Local Water Supply from Residential Runoff

*^ Presenter: **Ibrahim Mutakabbir**, UNC Charlotte and Harvesting Humanity, iaam123.phase@gmail.com
Co-authors: Olya Keen, UNC Charlotte and Eboné M. Lockett, Harversting Humanity

23. Application of Sonification to Represent Data in a New Format

^ Presenter: **Riley Nelson**, NC State University, rknelso2@ncsu.edu
Co-authors: Katherine Martin, NC State University

24. Upstream and Downstream Influences on Spatiotemporal Specific Conductivity Patterns along the Tar-Pamlico River

Presenter: **Michael O'Driscoll,** East Carolina University, odriscollm@ecu.edu
Co-authors: N. Bell, S. Brink, R. Etheridge, K. Hagge, B, Hinckley, J. Hoben, G. Jacobson, S. Moysey, A. Peralta, and T. Van Niekerk, East Carolina University; J. Howell, Sound Rivers; V. Lakshmi, University of Virginia; C. Harris, Virginia Institute of Marine Sciences; T. Mulrooney and S. Radel, NC Central University

25. Factors Influencing Denitrification in Wilmington Stormwater Control Systems

^ Presenter: **Nicholas Picha**, UNC Wilmington, ndp5254@uncw.edu
Co-authors: Michael Mallin, Lawrence Cahoon, and Devon Eulie, UNC Wilmington

26. Extreme Weather Impacts on Long-Term Trends in Organic Matter Quality in the Neuse River Estuary, Eastern North Carolina

^ Presenter: **Emily Piwowarski**, NC State University, eapiwowa@ncsu.edu
Co-authors: Christopher Osburn, NC State University

27. Tailoring Activated Carbon for Improved Reactivity Towards Aqueous Contaminant Degradation

^ Presenter: **Ethan Quinn**, NC State University, esquinn@ncsu.edu
Co-authors: Douglas Call, NC State University

28. Evaluating Spatial Overlaps in Heat and Flood Hazards Using Bayesian Maximum Entropy: the Case Study of Durham, NC

^ Presenter: **Hunter Quintal,** UNC Chapel Hill, hquintal@email.unc.edu
Co-authors: Marc Serre and Antonia Sebastian, UNC Chapel Hill

29. Evaluating Molecular Biomonitoring of Macroinvertebrate Biodiversity

^ Presenter: **Rachael Rowe**, UNC Charlotte, rrowe11@uncc.edu
Co-authors: Sandra Clinton, UNC Charlotte

30. Analysis of Potential Contamination Risks to Waterways As a Result of Construction

*^ Presenter: **Kai Spence**, UNC Charlotte and Harvesting Humanity, kaispence1976@gmail.com
Co-authors: Olya Keen, UNC Charlotte and Eboné M. Lockett, Harversting Humanity

31. New Insight on Cyanobacterial Diversity and Toxin Production Potential in the Chowan River and Albemarle Sound Using Metagenomics

^ Presenter: **Sarah Watson**, NC State University, sdwatso2@ncsu.edu
Co-authors: Haley E. Plaas, UNC Chapel Hill; Colleen Karl, Chowan Edenton Environmental Group; Hans W. Paerl, UNC Chapel Hill; Ryan W. Paerl, NC State University

Poster Presentaion Abstracts

Alphabetical by presenter last name

*^ Denotes student presenter; * Denotes presentation covers current or previous WRRI-funded work*

1. Investigating Ecological Risks Posed by Wastewater-Derived Pesticides

^ Presenter: **Denise Adjidjonu**, UNC Charlotte, dadjidjo@uncc.edu
Co-authors: Jacelyn Rice-Boayue, UNC Charlotte; Sara Kamanmalek, Smith College; Yina Xie, California Department of Pesticides

Municipal wastewater treatment plants (WWTPs) have been identified as sources of pesticide pollution, especially in urban areas. Conventional WWTPs have been shown to be inefficient at pesticide removal from influents originating from residential and outdoor usage. These contaminated effluents have adverse effects on the aquatic environment by exceeding toxicity thresholds set by the US Environmental Protection Agency (EPA). In this study, we will evaluate WWTP contributions to pesticide loadings in the state of California under varying streamflow conditions. Using monitoring data in collaboration with the California Department of Pesticide Regulation (CDPR), a GIS-based spatial model will be generated to compare selected pesticide concentrations at WWTP effluent receiving streams with stipulated aquatic benchmarks. These concentrations will be categorized by region, dilution factor (DF), and by Strahler Stream Order (SSO) across the state. The results of this study intend to highlight the ecological impacts of wastewater-derived pesticides and demonstrate the influence of streamflow conditions on these concentrations. Finally, this study will contribute to monitoring and mitigation efforts on vulnerable watersheds in the state.

2. Nitrogen and Phosphorus Remediation in Mesocosm Floating Treatment Wetlands? Receiving Municipal and Aquacultural Wastewater

^ Presenter: **Matthew Barnes**, East Carolina University, barnesma17@students.ecu.edu
Co-authors: Natasha Bell, Rachel Gittman, and Ariane Peralta, East Carolina University; Steven Hall, NC State University

Agricultural processes and domestic wastewater infrastructure introduce nutrients like nitrogen (N) and phosphorus (P) and contribute to eutrophication of receiving waters. Floating treatment wetlands (FTWs) have been proposed as a cost-effective approach to remediate nutrients from various sources. FTWs can be implemented in substantial numbers due to their low cost, ease of installation, and makeup of easily accessible and reusable components. However, evaluation of how design features influence nutrient removal is needed to predict FTW nutrient removal efficacy. The goal of this research project is to implement pilot-scale mesocosm FTWs to measure the extent that mixtures versus single species of wetland plants remove nutrients from municipal and aquaculture wastewater. The municipal wastewater FTW system is located at Greenville Utilities Commission wastewater treatment plant in Greenville, NC, and receives treated wastewater amended with additional N and P. The aquaculture FTW system is installed at North Carolina State University's Marine Aquaculture Research Center in Smyrna, NC, which contains saltwater recirculating aquaculture systems. FTW units consist of 150-gallon troughs which contain floating mats and either zero plants (control) or 18 plants per tank. Experimental treatments include either single, two, or three plant species (Juncus effesus, Pontederia cordata and Panicum virgatum for municipal wastewater FTWs and Juncus roemerianus, Spartina alterniflora, and Distichlis spicata for aquatulure wastewater FTWs) with three replicates of each treatment. N and P removal from the water column, as well as plant uptake rates will be presented.

3. Fecal Contamination Source Tracking and Forecasting to Support Recreational and Cultural Development in the Great Coharie River Watershed

*^ Presenter: **Benjamin Clark,** NC State University, bjclark4@ncsu.edu
Co-authors: Angela Harris and Daniel Obenour, NC State University; Ryan Emanuel, Duke University; Philip Bell, Great Coharie River Initiative

The Coharie Native American Tribe of Clinton, NC consider themselves river people, with the name of river they settled near, The Great Coharie river, being the inspiration for their tribal name. This tributary holds immense sentimental value to the Tribe. Recently the Tribe has been concerned with the declining water quality and environmental injustices that have been documented in the area (Harris et al., 2021; Quist et al., 2022; Strickling & Obenour, 2018; Wing et al., 2000). To address these concerns, a sampling scheme was constructed in partnership with tribal officials to include fortnightly and bi-hourly sampling at three locations in the watershed: Sevenmile Swamp, Marsh Swamp, and The Great Coharie River at Five Bridges Road. Bi-hourly sampling was dependent on seasonality and stream flow intensity. Each sample was tested for fecal indicator bacteria (FIB), nutrients and other water quality parameters with a sonde. The data will be used for the future creation of statistical models to help the Coharie Tribe make educated decisions about water-based recreational and cultural activities. Initial results indicate that the Great Coharie River frequently has high levels of fecal contamination, with all three sites having a geometric mean concentration of Escherichia coli above the 126 MPN/100 mL benchmark recommended by the EPA (USEPA, 2012). As of October 2022, Sevenmile Swamp, Marsh Swamp, and The Great Coharie River at Five Bridges Road also exceed the regulatory statistical threshold value (410 MPN/100 mL) 25%, 50% and 25% of the time respectively. (USEPA, 2012).

4. A New Forensic Tool Establishing Source and Fate of Per-and Polyfluroalkyl Substances (PFAS): Compound-Specific Isotopic Analysis Using Gas Chromatograph-Isotope Ratio Mass Spectrometry

^ Presenter: **Allison Dombrowski**, UNC Wilmington, add2529@uncw.edu
Co-authors: Ralph Mead and Chad Lane, UNC Wilmington

PFAS are a group of chemicals which have been manufactured since the 1940s. PFAS function as water proofing agents and dispersants and are used in common place household items such as non-stick cook and baking ware, grease proof food wrappers, water repellent clothing, as well as for industrial uses such as in fire suppressing foam. PFAS have been linked to serious public health risks such as the elevation of pregnancy-induced hypertension, testicular cancer, kidney cancer, high cholesterol, and thyroid disease. While the distribution of PFAS are well established, it is difficult to identify who is contributing to PFAS detected in the environment. A tracing method for these chemicals is urgently needed so regulatory bodies can monitor emission and enforce limits placed on companies who are releasing PFAS into the environment. This project will focus on creating a new methodology for analyzing PFAS chemicals using gas chromatograph-isotope ratio mass spectrometry (GC-IRMS). These methods could then be used to identify unique δ 13C and δ18O isotopic signatures of PFAS chemicals from different manufacturers (i.e., PFAS manufacturing companies source carbon from different petroleum sources, the different petroleum sources will have distinct isotopic signatures). Tracing methods such as these are essential to water resource management. Assigning unique δ 13C and δ18O isotopic signatures to specific chemical manufacturers could allow regulatory bodies to identify the original point source of the PFAS. In addition, identification of the original point source of PFAS would further our understanding of how PFAS are transported through the environment.

5. Evaluation of Embedded Benefits for NC Biochar Amended Soil Applications

^ Presenter: **Neetu Donkada**, UNC Charlotte, ndonkada@uncc.edu
Co-authors: Denise Adjidjonu and Jacelyn Rice-Boayue, UNC Charlotte

Stormwater runoff continues to be a source of pollution in urban areas, due to rapid urban developments and ever-changing climatic patterns. To counter these challenges, green infrastructure (GI) such as bioswales and other biofilter systems have been shown to improve soil retention and mitigate erosion caused by runoff at various scales. Biochar has also been found to be a cost-effective soil amendment in GI applications and has shown promise in improving urban habitats through contaminant removal and carbon sequestration. Additionally, biochar has been shown to improve nutrient release and cycling in depleted soils for plant growth and development. For this study, the embedded benefits of biochar amended GI sites will be evaluated using a triple bottom line (TBL) framework and model. We will model the economic,

environmental, and social co-benefits associated with biochar amended GI systems. Based on these benefits, we shall generate a framework using GI metrics such as construction and maintenance costs and improvements to ecosystem services. Other GI metrics will include air quality levels, urban heat mitigation, carbon sequestration rates, and energy demand reductions. These metrics will be incorporated into a user interactive TBL model for application in North Carolina. The resulting model will be used in a case study to provide insight into biochar's embedded benefits for stormwater management applications. We will also identify limitations and areas where future research will be needed. Future integration of this TBL model can be incorporated into the optimization of storm water best management practices (BMPs).

6. Exploring the Drivers of Household Participation in Voluntary Buyouts with an Agent-Based Model

^ Presenter: **Lauren Grimley**, UNC Chapel Hill, lauren.grimley@unc.edu
Co-authors: Antonia Sebastian, UNC Chapel Hill; Tatiana Filatova, Delft University of Technology

Projections of future flood risk rest heavily on assumptions about the degree of adaptation taken in response to changes in perceived risk. For example, in response to a flood, individuals and communities implement adaptation measures to eliminate (e.g., relocate) or decrease (e.g., elevate) their exposure to flooding in the near or immediate term. A voluntary property buyout occurs when the government purchases properties at risk of flooding from willing sellers, demolishes the structure, and converts the land to open space. While a household's decision to participate in a buyout is constrained by the federal and program regulations, it is also impacted by social, behavioral, and financial drivers. In this study, we build a simple data-driven, agent-based model to explore drivers of household participation in buyouts. Our experiment is based on case studies of community and household response to tropical cyclone flooding eastern NC. The data-driven model integrates detailed flood hazard information, household survey, and socio-demographic information. We expect that the cost to rebuild, social network, and tie-to-place will have strong influences on household decision-making. The outcome of this model is to explore how community and household flood risk management strategies can interact across space and time to alter the distribution of flood risk.

7. Harmful Cyanobacteria Blooms prevail in Urban Waterbodies and Out-compete a Diverse Collection of Phytoplankton Genera

^ Presenter: **Amy Grogan**, UNC Wilmington, aeg7670@uncw.edu
Co-authors: Catharina Alves de Souza, Michael A. Mallin, and Lawrence B Cahoon, UNC Wilmington

Harmful algae blooms are a prolific issue in stormwater ponds and other waterbodies receiving polluted stormwater runoff in coastal North Carolina. To date 87 algal blooms have been sampled in the Wilmington area (2019 – 2022) encompassing a diverse collection of taxa. Cyanobacteria were found to be the most dominant comprising 70% of the blooms surveyed. Eighteen total genera of cyanobacteria have been identified, 13 of which represent groups capable of producing toxins. An additional 19 genera of primarily chlorophytes made up the remaining 30% of blooms. The results of this study demonstrate that cyanobacteria species are capable of out competing a diverse group of other non-toxic phytoplankton including chlorophytes, chrysophytes, diatoms, and euglenoids. As many cyanobacteria are diazotrophic they can prevail over other taxa in nitrogen limited environments supporting a greater base population. Likewise, cyanobacteria akinetes can remain in the sediment during non-favorable conditions supporting perennial bloom events. Cataloguing cyanobacteria presence and abundance in urban waterbodies is an important foundational step in mitigating the spread and prevalence of harmful blooms and their impact on public and environmental health.

8. Comparison of Remotely Sensed and Water Balance-Based Estimates of Evapotranspiration in Small Headwater Catchments

^ Presenter: **Papa Gueye**, USDA Forest Service, pogueye@ncsu.edu
Co-authors: Johnny Boggs, USDA Forest Service; Zakiya Leggett, NC State University; Gee Sun, USDA Forest Service

Evapotranspiration (ET) is a key component of the water budget and provides valuable information to land managers on how to optimize the benefits and protect water resources. Assessing the accuracy of remotely sensed ET estimates to map components of the water budget in small headwater catchments can lead to improved water management options. In this study, ET derived from Landsat 8 was compared to water balance-based ET (WBET) estimates for three forested headwater catchments in the Piedmont region of North Carolina. Landsat satellite images from the winter, summer, and fall were used to generate nine years (2013-2021) of annual ET estimates. Annual WBET was computed based on annual watershed water balances for each watershed (ET = Precipitation (P) – Discharge (Q). Mean annual Landsat ET was 1164 mm, 1086 mm, and 1127 mm in the treated (young pine), partially treated (young pine/mature hardwoods), and control (mature hardwoods) watershed, respectively. WBET ET was 898 mm, 977 mm, and 934 mm in the same watersheds. The R 2 between WBET and Landsat was 0.12, 0.27, and 0.47 in the treated, partially treated, and control watershed, respectively. The higher R 2 value in the control watershed when compared to treated and partially treated suggests that Landsat ET was more accurate for the mature hardwood stand than the young pine stand. This study is ongoing and additional remotely sensed data will be linked to the WBET method to further explore how remote sensing products can be used to map ET in small watersheds.

9. The Effect of Construction Runoff of Water Within Mecklenburg County

*^ Presenter: **Darrell Holmes Jr.**, L.E.A.P Forward, dholme26@email.cpcc.edu
Co-authors: Olya Keen, UNC Charlotte; Eboné M. Lockett, Harversting Humanity

The county of Mecklenburg's construction activity has been active due to the recent advancement and development of housing construction, but the impact on water resources is understudied. The goal of the study is to determine the increase in suspended solids and other elements such as clay, gravel and cement, caused by construction and its effect on the water quality within mecklenburg county. Testing of the water purity will be required to determine if contamination from construction sediments is present. A total suspended solids test could be useful to determine if any runoff debris is present within the water. Test strips and color kits could be used when determining the volume of contamination from sediment such as clay and cement. We will identify several field sites where water can be collected such as a stream before and after it was impacted by outstanding construction runoff. This study could result in data that displays the amount of sediment runoff entering the Mecklenburg County water systems. Contamination concerning cement and clay due to ineffective disposal processes would be showcased. The water systems of Mecklenburg County affect many residents, and this research will bring light to the impacts of land development on water quality within the county. Results of the study would be shared via newsletter by The Mecklenburg Times, giving residents information relating to them. This project is supported by NC WRRI CCRG and I am collaborating in this work with Harvesting Humanity LLC. and UNC Charlotte Department of Civil and Environmental Engineering.

10. Urban Development and Stormwater Sediments: Identifying Vulnerable Populations in Charlotte, NC

^ Presenter: **Chandler Horton**, UNC Charlotte, chorto28@uncc.edu
Co-authors: Fushcia-Ann Hoover and Nicole Barclay, UNC Charlotte

Charlotte, NC is one of the fastest growing cities in the United States. This rapid development often comes at a cost, leading to inequitable growth and environmental issues related to urban sprawl. While numerous studies have evaluated the impacts of urbanization and increased impervious area on stormwater and hydrologic function, including the socioeconomic factors influencing stormwater risk, more research is needed to better understand the intricacies

of stormwater and environmental justice impacts which vary spatially and by water quality parameters. In Charlotte, sediment is a primary water pollutant of concern, evidenced by the several Mecklenburg County watersheds impaired due to elevated turbidity levels from sediment loading. These impaired watersheds coincide with multiple minoritized communities. Despite the potential risk to these communities and the environmental injustice concerns, research from a spatial and socioeconomic lens is lacking. Our project examines stormwater as a spatially oriented sector that involves both public and private entities, which often place stormwater management at the intersection of environmental and social issues. We use existing publicly available data on in-stream water quality, impervious surface cover, city parcel data, and census tract demographics to 1) identify spatial patterns of sedimentation within Charlotte, 2) determine which communities are most at-risk for ill-effects from sedimentation, and 3) assess how Charlotte's stormwater ordinances and zoning practices will impact future sedimentation in urban waterways, based on current best-management practice (BMP) investments. Our preliminary hypothesis is that more impaired sub-watersheds will have fewer BMPs and will coincide with areas of higher residents of color.

11. Development of Large Volume Filtration-based Virus Concentration Method for Increased Detection Sensitivity of SARS-CoV-2 from Wastewater

^ Presenter: **Md Ariful Islam Juel**, UNC Charlotte, mjuel@uncc.edu
Co-author: Mariya Munir, UNC Charlotte

Wastewater Based Epidemiology (WBE) is a public health tool that uses wastewater to monitor human pathogenic viruses including COVID-19 by quantifying SARS-CoV-2 viruses. The successful implementation of WBE depends on precise viral copy quantification, which is affected by the concentration method used. Current methods can only process small volumes of wastewater, making it difficult to detect viruses during the early stage of community infections or in low COVID-19 prevalence areas. This paper evaluates the performance of a large volume-based concentration method for increased SARS-CoV-2 detection sensitivity. A dead-end hollow fibre ultrafilter (UF) and electronegative membrane filtration (EMF) were used as primary and secondary concentration methods for concentrating virus from wastewater. This study found that a modified UF-EMF method, incorporating sonication and centrifugation, showed 100% SARS-CoV-2 positive detection in low COVID-19 infection periods compared to only 9% positive detection with the EMF method alone. During high COVID-19 infection, the small-volume and large-volume filtration methods showed similar detection sensitivity. The combination of UF-EMF method can be more informative for detecting SARS-CoV-2 during the early stages of infection, which can help prevent future outbreaks.

12. Optimization and Comparative Study of SARS-CoV-2 RNA Extraction Protocols for Enhanced Viral RNA Yield in Wastewater Samples

^ Presenter: **Nita Khanal,** UNC Charlotte, nkhanal2@uncc.edu
Co-authors: Md Ariful Islam Juel and Mariya Munir, UNC Charlotte

The detection of SARS-CoV-2 in wastewater provides a cost-effective alternative over expensive approaches such as random testing of groups and individual clinical tests and has the potential to
detect asymptomatic cases. One widely used Virus concentration method for large-volume wastewater is Electronegative Magnetic Filtration (EMF), which is an easily available and cost-effective tool for detecting and quantifying the presence of the virus in wastewater samples. However, there is a lack of research on the use of efficient RNA extraction methods in conjunction with the EMF method. The aim of this study was to achieve efficient, optimized, and cost-effective RNA extraction kits by combining them with the EMF Method of Virus Concentration. To achieve this, two RNA extraction methods, the QIAamp Viral RNA Mini-Kit and the Zymo Quick RNA viral Kit, which used Lysis buffer principles, were modified and compared, in order to improve the RNA yield using the entire volume of filtered samples. These two optimized methods were then compared with two other extraction methods, the RNeasy
power water kits, and the All prep power viral DNA/RNA kit. These use a different principle called bead beating and recommend using the whole volume of filtered samples. The results showed that the Zymo Quick RNA viral kit had significantly better performance ($P<0.05$) in terms of Cq value (29-31), Copies per reaction, and copies per liter (100,000 to 350,000) than the other kits, as well as better recovery of the surrogate Bovine Corona Virus (BCoV). This suggests that the Zymo kit is more efficient at extracting and purifying viral RNA, leading to more accurate quantification of the virus and informing public health decision-making. Additionally, it can result in more sensitive and specific diagnostic tests, which is crucial for early detection and control of the virus.

13. Quantifying Algal and Nutrient Concentrations in Urban Stormwater and Beaver Ponds

^ Presenter: **Emma Lacy,** UNC Charlotte, elacy@uncc.edu
Co-authors: Sandra Clinton, UNC Charlotte

Increases in impervious cover from exponential growth in urban development have caused increased runoff of nutrients and sediment into urban stormwater and beaver ponds.These excess nutrient inputs can potentially lead to algal blooms. While there are many studies of algal blooms in freshwater ecosystems, urban ponds have been understudied. Our objective was to compare algal biomass, composition, and nutrient levels in three stormwater and beaver ponds in the Charlotte-Mecklenburg region. Four surface water samples were collected from around each pond, composited into 1 sample per pond and filtered for chlorophyll a and ash free dry mass. A subsample was collected and preserved with Lugol's Iodine for algal composition. One water sample was collected at the pond outlet for total phosphorus (TP) analysis. We hypothesized that algal biomass will be higher in stormwater ponds due to more sunlight and phosphorus inputs compared to beaver ponds. Results indicate that algal biomass was higher in stormwater ponds compared to beaver ponds; however, one beaver pond consistently had the highest biomass. Algal composition varied with more green and blue-green algae in the stormwater ponds compared to beaver ponds. Diatoms and desmids were less common in both ponds. We continue to analyze the TP data and will collect data through summer 2023 to quantify seasonal patterns. It is critical to understand the overall trend in algal blooms in urban ponds due to their potential negative effects on water quality including potential neurotoxin concentrations, decreased water clarity, and low oxygen concentrations following algal decomposition.

14. SARS-CoV-2 Epidemiology & Wastewater Surveillance at North Carolina Agricultural and Technical State University

^ Presenter: **Mehdi Lamssali,** North Carolina A&T State University, mlamssali@aggies.ncat.edu
Co-authors: Shilpi Bhatia, Tinyiko Vallerie Nicole Maswanganye, Mehdi Lamssali, Olusola Jeje, Dongyeng Deng, and Liesl Jeffers-Francis, North Carolina A&T State University

SARS-COV-2, the agent responsible for COVID-19, has been detected in the feces of infected patients in multiple studies. The prevalence of this virus in a community within the public space such as hospital and educational institutions can be determined through low-cost Wastewater-based epidemiology (WBE). The objective of this study was to determine SARS-CoV-2 RNA concentrations from wastewater over a year (Spring-Fall'21) across North Carolina Agricultural and Technical State University (NCAT) campus. Technical replicates for N1 gene concentrations showed an interesting trend overall with Ct values ranging between 20-40 cycles for Spring-Fall'21. Samples (n=10) with Ct values below 29 were sequenced to determine the viral lineage present on campus and all four SARS-CoV-2 variants; Alpha, Delta, Omicron and B20 were detected during 2021. Furthermore, two different sampling methods employed: grab and composite were correlated with clinical COVID-19 positive cases on campus. A significant difference ($p<0.05$) between composite and grab sampling methods in Fall'21 was reported. This study not only demonstrates some of the present challenges for pandemic responses but also shows the potential of sewage sampling for SARS-CoV-2 as the risk of COVID-19 spread on campus is continually monitored. Across the United States, Wastewater sampling is being widely in response to the ongoing pandemic and has become an efficient way for targeted policies toward community health decision-making.

15. Biodegradable Dissolved Organic Carbon in Stream Outflow of Urban Stormwater and Beaver Ponds

^ Presenter: **Jordan Landis**, UNC Charlotte, jlandi12@uncc.edu
Co-authors: Sandra Clinton, UNC Charlotte

Urbanization has resulted in increased water runoff from impervious surfaces which has led to degraded local streams. In response, urban areas have relied on stormwater infrastructure to reduce runoff into streams by retaining water in ponds. However, stormwater ponds are likely to foster high density algae growth due to their surrounding anthropogenic environment. High algal concentrations create elevated concentrations of high quality dissolved organic carbon (DOC) that would be more bioavailable for microorganisms to respire. Beaver ponds are a natural alternative to stormwater ponds that have the potential to abate microbial respiration in-pond and downstream due to higher concentrations of terrestrially sourced, low quality DOC. This study seeks to measure biodegradable dissolved organic carbon (BDOC) at downstream progressions of urban stormwater and beaver ponds. Samples will be collected from pond in-flow, in-pond, and out-flow, and will be incubated containing an inoculum curated of native microorganism colonies to each pond to be measured intervally for DOC concentration and quality. The percent loss of DOC concentration, BDOC, will quantify DOC reactivity and quality. Additionally, the optical methods fluorescence index (FI), fluorescence humification index (HIX), and specific ultraviolet absorbance (SUVA) will be used to measure DOC quality by examining carbon compound characteristics to understand the input source of pond DOC. These findings will establish how urban stormwater and beaver ponds contribute to downstream DOC concentration and quality, which can impact carbon flow through freshwater ecosystems as well as carbon emissions from urban ponds.

16. Analysis of Variances in Charlotte-Mecklenburg School Systems' School Water Quality as it Correlates to Other School Demographics in the Community

*^ Presenter: **Jazzie Lee and Evelyn Romero**, UNC Charlotte and Harvesting Humanity, evelynromero2k@gmail.com; leejazzie0@gmail.com
Co-authors: Olya Keen, UNC Charlotte and Eboné M. Lockett, Harvesting Humanity

Even in a world of increasing awareness of equity and justice, there are certain circumstances where neighborhoods and the zip codes they reside in are not equally created, treated, or resourced. This includes neighborhood schools where students not only focus on academics but also interact and learn about their community. Much like other differences in resources across the Charlotte-Mecklenburg School District, we hypothesize that the disparities in zip code data (health, wealth, and diversity) in our city will closely correlate with variances in the environmental water quality of the school facility itself. Thus, we aim to collect at least (3) different representative samples of water from at least (10) different schools throughout the pipelines in the Charlotte-Mecklenburg School District. Schools, where samples will be taken, will strategically represent diverse ranges of demographics (including location and income levels). It is expected that the variances in the quality of water will correlate with the resource and economic distribution of the communities each school resides in. We would test for contaminants such as metals and other toxins produced by bacteria within the water pipelines. These toxins are capable of introducing negative side effects on the health of the individuals drinking them and can show how the lack of equity impacts communities economically. By conducting this research we can take steps toward fixing the water problem here in the Charlotte-Mecklenburg School District and also work to solve the disparities within our communities. Collected data will be creatively distributed to local community members and local government.

17. Aquifer Response to Changes in Barometric Pressure: Insight into the Degree of Confinement of Aquifers

Presenter: **Madan Maharjan**, UNC Pembroke, madan.maharjan@uncp.edu
Co-authors: Jesse Rouse, Coastal Carolina University; Cody Gless, UNC Pembroke

Coastal regions of southeastern North Carolina and northeastern South Carolina rely on Cretaceous aquifers as a primary water source for municipalities, industries, and agriculture. This groundwater is deemed safe and seen as a reliable source of water given the fact that these aquifers are assumed to be confined. However, the aquifers do not necessarily have the same level of confinement everywhere. For instance, it is possible for streams to have vertically incised the confining layer or for there to be areas where the confining layer is thin or even missing. This research will look at observations of potential variations in the confinement of the Black Creek Aquifer in Robeson County. This region is experiencing higher frequency and higher magnitude of storm events recently causing more frequent floods for extended periods that could deteriorate groundwater quality allowing surface water infiltration if the aquifer is semiconfined. We have been monitoring groundwater levels and barometric pressure within Robeson County since December 2017 using a network of 13 monitoring wells across the county that are tapped into the Black Creek Aquifer. Well hydrographs show a trend that is similar to the Lumber River following Hurricane Florence for several days. This trend following Florence raised the question of whether the Black Creek Aquifer has a significant level of confinement as generally believed or if there are potential areas of transmission from surface water. The analysis of groundwater levels and barometric pressure data from the county wells and state wells in the county was conducted to study the aquifer response to the changes in barometric pressure during three tropical storms (Florence, Michael, and Dorian) and compared with the results obtained during calm weather conditions. The results show that the aquifer has spatially and temporally varying water levels, peak lag times, and rise in water levels as the result of the tropical storms. The aquifer has noticeably different values of barometric efficiency during the three tropical storms. The larger the storm the more significant the change in aquifer water levels. Most importantly, barometric efficiency goes above and beyond the normal range indicating that the aquifer was under significant stress from both natural and anthropogenic activities. If the aquifers are experiencing induced infiltration from surface water sources there are implications for public health and even economic impacts as this would suggest vulnerability of groundwater resources in the region.

18. Distribution of Metals, PAHs and Phosphorus in Sediments of 21 Wet Detention Ponds in Wilmington, N.C.

Presenter: **Michael Mallin**, UNC Wilmington, mallinm@uncw.edu
Co-authors: Lawrence B. Cahoon, Matthew R. McIver, and Nicholas D. Picha, UNC Wilmington

Sediments of 21 urban and suburban wet detention ponds in New Hanover County, N.C. were surveyed for primary pollutant metals, polycyclic aromatic hydrocarbons (PAHs) and phosphorus (P) in summer and fall 2022. The sampling program was undertaken because the public is often exposed to such ponds, and uses them for fishing and pet use, with unknown chemical dangers. Additionally, our field teams have encountered homeless camps in woods adjacent to such ponds, with the potential for their water use from the ponds. A variety of drainage basins were sampled, including three golf course ponds, three fire department ponds, several residential area ponds and ponds representing recreational areas and waste runoff areas; a control pond was sampled within Carolina Beach State Park. Results are compared to various pond attributes including drainage area, land use, sediment grain size and organic content. Two types of P were analyzed for; water soluble and more tightly bound fractions extracted by the Melich 3 reagent. High levels of P were characteristic of ponds in dense suburban drainage; some showing water column cyanobacterial blooms. Also, ponds frequented by waterfowl, regardless of watershed characteristics, showed high sediment P concentrations. Notably, the proportions of readily soluble and tightly bound P varied considerably, often within the same ponds.

19. Utilizing High Resolution Mass Spectrometry for the Assessment of Emerging Contaminants in the River and Intracoastal Waters of Wilmington North Carolina

^ Presenter: **Jacquelin Meade**, UNC Wilmington, jrm7627@uncw.edu
Co-authors: Winifred Johnson, UNC Wilmington

Human activity introduces thousands of chemical compounds into coastal areas through point and nonpoint pollution. Some of these compounds are later determined to be harmful due to their longevity, accumulation, distribution, or biological impacts. While many targeted analytical methods are optimized for monitoring specific compounds, anthropogenic compounds that have not been measured are present within our water systems. Several previously unidentified compounds have been successfully detected and identified with the application of high-resolution mass spectrometry, and new research in this field is successfully identifying previously unidentified pollutants in the environment with non-target mass spectrometry methods. The goal of this project is to investigate emerging contaminants and annotate potential compounds of concern within the river and intracoastal waters of Wilmington, North Carolina. Sampling sites include monthly sampling in the Cape Fear River and the Intracoastal Waterway, as well as seasonal and tidal sampling of three tidal creeks. Through the development and application of an optimized non-target mass spectrometry method, our analysis has allowed for the successful identification of multiple compounds present in the river and intracoastal waterway samples in addition to over 3,000 mass spectrometric features that have possible matches in compound databases. Year-long sampling provides a dataset to capture seasonal as well as site specific variability in the abundance of organic pollutants and putative identification of emerging contaminants for future monitoring in these water systems.

20. The Effects of a Beaver Complex on the Biochemistry of an Urban Stream

^ Presenter: **Jamil Millner Jr.**, UNC Charlotte, jmillne1@uncc.edu
Co-authors: Craig Allan, UNC Charlotte

The American Beaver (Castor canadensis) is found in many of the creeks, ponds, rivers and lakes throughout Mecklenburg County, NC. An improved understanding of the influences of beaver pond complexes on the hydrology and water quality in urbanized watersheds streams can help guide watershed managers as how to handle the presence of beavers in varying situations. The impacts of a beaver pond complex on biogeochemical cycling within urban stream ecosystem is poorly understood. We are examining the biogeochemical cycling of carbon (C), nitrogen (N) and phosphorus (P) within a first order stream of a recently suburbanized watershed in Mecklenburg County. We have instrumented the watershed to measure precipitation inputs, evaporation, groundwater level, soil moisture, pond water levels and streamflow into and from the pond complex. Stream water, precipitation and pond water samples are collected weekly and are being analyzed for pH, turbidity, specific conductance, TSS, DOC, ammonium, nitrate, total nitrogen, total dissolved phosphorus, and orthophosphate. Monitoring began in May 2022 and is expected to conclude in June 2023.

21. Enhancing Perspectives on Lake Impairments Using Satellite Observations

^ Presenter: **Michael Moerk**, Wake Forest University, moermj18@wfu.edu
Co-authors: Courtney Di Vittorio, Wake Forest University

A significant challenge in developing water quality improvement plans and monitoring systems for inland lakes within North Carolina is the scarcity of in-situ data. This project aims to support nutrient management planning efforts by developing new methodologies for estimating water quality parameters from satellite observations. The study site of interest is High Rock Lake, North Carolina, an impaired water body according to the North Carolina Department of Environmental Quality. Water quality parameters of the lake such as turbidity, total suspended sediment, and chlorophyll-a concentrations can be estimated by calibrating models that directly relate satellite reflectance to these parameters. Analysis of historical in-situ data alongside concurrent satellite overpasses has been used to calibrate models, which report coefficients of determination of 0.74 and 0.71 for the total suspended sediment and turbidity models respectively. 13 in-situ data collection campaigns have also been executed to complement historical data, and a model estimating chlorophyll-a concentrations from Sentinel-2 imagery using these data is being developed. These developed models can offer insight into the concentrations of various water quality parameters and provide a cost and time-effective water quality monitoring system. Engagement with High Rock Lake stakeholder groups that are involved in the nutrient management planning process, and discussion of how these satellite-derived water quality estimates can be applied is ongoing. The goal of this project is that High Rock Lake would serve as a pilot case for inland lake monitoring and that its application would improve state-wide nutrient management processes.

22. Analysis of Fertilizers in Local Water Supply From Residential Runoff

*^ Presenter: **Ibrahim Mutakabbir**, UNC Charlotte and Harvesting Humanity, iaam123.phase@gmail.com
Co-authors: Olya Keen, UNC Charlotte and Eboné M. Lockett, Harversting Humanity

Landscape, lawn care, and agriculture activities often overuse chemical fertilizers contaminating runoff and eventually bodies of water. Bodies of water contaminated include rivers, streams, ground water, and even drinking water. These chemicals are toxic to wildlife in a multitude of ways. Algae blooms and mass culling of aquatic wildlife are examples of the effects on wildlife. I plan on testing local water sources as well as using public databases to trace sources of nutrient pollution. There is little coverage on the direct effects of lawn care runoff on the environment. I aim to see how much domestic use of fertilizers affects the local water sources as compared to agricultural activities. I will take field samples from residential runoff, local lakes, and streams in Charlotte, North Carolina. Water samples will be taken and tested for total nitrogen, total phosphorus,nitrate, and ammonia. Testing will be done using Hach tests and a Hach spectrophotometer DR6000. Samples will be taken during the winter and spring. I expect to find a significant amount of water pollution as a result of lawn care practices, especially during the spring. Results will measure the concentration of fertilizers in local bodies of water and provide an estimate on the percentage of water pollution caused by lawn care compared to agriculture and untraceable pollution. This project is supported by NC WRRI CCRG and I am collaborating in this work with Harvesting Humanity LLC. and UNC Charlotte Department of Civil and Environmental Engineering.

23. Application of Sonification to Represent Data in a New Format

^ Presenter: **Riley Nelson**, NC State University, rknelso2@ncsu.edu
Co-authors: Katherine Martin, NC State University

Sonification of data, or translation of data into sound, can show researchers patterns within their research that would be difficult to find in visual representations. The use of sonification also encourages a broader range of audience due to the elimination of scientific jargon and allows access for those with visual impairments. The immediate objective of this research is to explore the application of sonification to multiple different forms of data in order to see the validity of conveying data in this structure. To test the validity of conveying data with sonification, we took data from the United States Geological Services that reports the calcium, magnesium, potassium, and sodium levels in one stream gage location from 1958 to 2021. From there, r-coding was used to reorganize the data so it was in a form that would be applicable for TwoTone Data Sonification. After reorganizing the data, the data was put through the TwoTone Data Sonification program to produce a scientific data sonification. Repeating this process with several other data sets, we will present our data at the WRRI meeting to introduce data sonification as a promising technique to help researchers and the public to better understand the data that has been collected.

24. Upstream and Downstream Influences on Spatiotemporal Specific Conductivity Patterns along the Tar-Pamlico River

Presenter: **Michael O'Driscoll**, East Carolina University, odriscollm@ecu.edu
Co-authors: N. Bell, S. Brink, R. Etheridge, K. Hagge, B, Hinckley, J. Hoben, G. Jacobson, S. Moysey, A. Peralta, and T. Van Niekerk, East Carolina University; J. Howell, Sound Rivers; V. Lakshmi, University of Virginia; C. Harris, Virginia Institute of Marine Sciences; T. Mulrooney and S. Radel, NC Central University

Changes in the balance between freshwater and saltwater can affect human and ecosystem health and impair coastal infrastructure. For example, Greenville's water supply intake is located along a tidally- influenced segment of the Tar River. Improved understanding of the salinity dynamics along the Tar-Pamlico River can help to evaluate risks to water resources and aquatic ecosystems. Through the Coastlines and People project, a watershed monitoring and modeling program was initiated to improve understanding of how watershed processes impact water quality. Monthly monitoring at 36 (river and estuarine) sites, from Rocky Mount to Bayview, was initiated in January 2022. While several other field and lab water quality parameters were collected, initial efforts have focused on evaluating the spatiotemporal variability in specific conductivity (SC-a salinity proxy) from inland to estuarine settings. For the first year of monitoring, SC ranged from 75 us/cm along the Tar River (Rocky Mount) to over 34,000 us/cm along the Pamlico River Estuary (Bayview). The farthest downstream that freshwater conditions were observed was at Washington, with highly variable SC (100-20,000 us/cm) due to flow and tidal conditions. The greatest seasonal variability in SC was observed along the riverine-estuarine transition zone near Washington. Longer term records indicate that during low-flows, saltwater intrusion events have occurred at Grimesland (~7 miles inland) and further upstream. Downstream of Greenville, in addition to upstream controls (geology, land-use, road salt, wastewater inputs, evapotranspiration, discharge), there are downstream controls on SC associated with saltwater intrusion events (influenced by low flows, wind, and tides).

25. Factors Influencing Denitrification in Wilmington Stormwater Control Systems

^ Presenter: **Nicholas Picha**, UNC Wilmington, ndp5254@uncw.edu
Co-authors: Michael Mallin, Lawrence Cahoon, and Devon Eulie, UNC Wilmington

Stormwater runoff transports pollutants such as excess nitrogen in the form of nitrate into aquatic ecosystems. Stormwater runoff draining an increasingly urbanized landscape characterized by development in the form of impervious surfaces such as parking lots, roads and sidewalks further contribute to this issue. Although wet retention ponds are normally only required to reduce suspended solids pollution, these wet ponds can be improved to help treat nutrient pollution as well. Denitrification is one way in which the microbial community can naturally remove nitrogen in the form of nitrate, from these receiving water bodies. This study measured the rates of denitrification in the sediments of nine stormwater retention ponds in the Wilmington, N.C. area. Water temperature, dissolved oxygen concentration, nitrate and DOC in the water column and factors such as watershed area, impervious surface coverage within the watershed, sediment organic matter concentration, and sediment grain size were measured at each site. We found nearly all ponds with increased concentrations of nitrate and dissolved organic carbon, with cooler water temperatures and in watersheds with higher percentages of impervious surface coverage yielded higher denitrification rates overall. Within these ponds, sites with aquatic vegetation growth had overall higher rates of denitrification when compared with bare sediment free of vegetation, yet only showed statistically higher rates in one pond consistently. This research will aid in the future development and construction of wet retention ponds to control stormwater runoff and mitigate the impacts of nitrogen loading in coastal ecosystems.

26. Extreme Weather Impacts on Long-Term Trends in Organic Matter Quality in the Neuse River Estuary, Eastern North Carolina

^ Presenter: **Emily Piwowarski,** NC State University, eapiwowa@ncsu.edu
Co-authors: Christopher Osburn, NC State University

Although climate change is expected to intensify storm severity, questions remain as to their specific impact on coastal waters. The quality of organic matter (OM) entering coastal waters due to severe weather is understudied, with implications for coastal ecosystem function. We examined how storm-dependent OM quality changed between dissolved (DOM) and particulate (POM) fractions in river water reaching the Neuse River Estuary (NRE), eastern North Carolina. OM properties were compared between baseflow and stormflow at the tidal freshwater reach of the estuary and at the estuary outflow into Pamlico Sound. We used data collected between 2000 - 2020 by the Neuse River Modeling and Monitoring (ModMon) program to examine DOM and POM concentrations, DOM and POM carbon to nitrogen (C:N) ratios, nitrogen to phosphorus (N:P) ratios, and chlorophyll a (Chl a) concentrations. C:N ratios indicate OM source, while N:P ratios indicate nutrient limitation; both inform about coastal eutrophication. We hypothesize a consistent increase in C:N ratios of DOM and POM concomitant with a decrease in N:P ratios as a result of enhanced runoff from the landscape into the estuary, caused by extreme weather events. Changes in the ratios were expected to precede reduced Chl a concentrations, followed by a rebound due to internal OM loading with return to baseflow. Our study will elucidate coherent changes to DOM and POM quality expected in this estuary with extreme weather under a changing climate.

27. Tailoring Activated Carbon for Improved Reactivity Towards Aqueous Contaminant Degradation

^ Presenter: **Ethan Quinn**, NC State University, esquinn@ncsu.edu
Co-authors: Douglas Call, NC State University

Pyrogenic carbonaceous materials (PCMs), such as activated carbon (AC), are conventionally utilized as adsorbents in water treatment to sequester harmful compounds. However, recent studies have shown that these materials possess the ability to exchange electrons with aqueous contaminants. This reactive behavior may provide new strategies to degrade organic contaminants. To realize these benefits, a better understanding of how to tune the chemical and physical properties that influence these reactions is needed. While studies have examined how PCM synthesis conditions impact electron exchange behavior, there is little information on the effect of post-pyrolysis treatment. To provide the basis for tailoring PCMs for specific contaminant transformations, we subjected AC cloth to hydrogen peroxide and nitric acid. After the treatments, we performed mediated electrochemical reduction (MER) to quantify the electron accepting capacity (EAC) and mediated electrochemical oxidation (MEO) to quantify the electron donating capacity (EDC) of the AC. Our results indicate that both treatments resulted in the appearance of several oxygen containing chemical functional groups, as revealed by X-ray photoelectron spectroscopy. The MER tests showed that both treatments increased the EAC; however, the magnitude was dependent on the chemical type, and incubation time. Density functional theory analysis revealed that for both treatments, pore volume and sample surface area decreased. MEO tests are currently being conducted to quantify the EDC of the materials. Additionally, we will determine if larger EAC and EDC values correlate with transformation effectiveness of a model organic contaminant. These results provide a foundation for customizing PCMs for organic contaminant transformations.

28. Evaluating Spatial Overlaps in Heat and Flood Hazards Using Bayesian Maximum Entropy: the Case Study of Durham, NC

^ Presenter: **Hunter Quintal**, UNC Chapel Hill, hquintal@email.unc.edu
Co-authors: Marc Serre and Antonia Sebastian, UNC Chapel Hill

While the magnitudes of flood and heat hazards are expected to increase under climate change, it remains unclear where these two hazards overlap and where they may combine to increase vulnerabilities under climate change. Compound hazard quantification is important for the Southeastern United

States because the region is experiencing rapid population growth and a shift in the distribution of annual precipitation – two drivers that may further amplify urban flooding and heat waves. In this case study of Durham, NC, we develop two Bayesian Maximum Entropy (BME) spatiotemporal covariance models using BMEGUI software to identify flood and heat wave hotspots. We employ flood service requests between 2004 and 2001 from the City of Durham and NOAA Heat Watch Raleigh-Durham measurements from a heat wave event in July 2021 to inform the covariance models. In each model, we remove a global mean trend, capture Voronoi points in the kriging interpolation, and penalize the time metric when estimating contiguous mean and variance for each hazard. These findings separately assess hazard hotspots, which we overlay to measure spatial overlaps in heat and flood hazards across Durham. City planners will benefit because these findings will improve understanding of community exposure to the two hazards in this otherwise data-poor region, which could facilitate mitigation and adaptation measures as well as improve knowledge of urban flood and heat wave risk when paired with site-specific vulnerability information.

29. Evaluating Molecular Biomonitoring of Macroinvertebrate Biodiversity

^ Presenter: **Rachael Rowe**, UNC Charlotte, rrowe11@uncc.edu
Co-authors: Sandra Clinton, UNC Charlotte

Macroinvertebrates are a common, diverse group used for biomonitoring in freshwater ecosystems. Traditional monitoring methods require taxonomic expertise and often cannot easily resolve species level differences. Environmental DNA (eDNA) may be an effective tool for biomonitoring; however, current methods are not universal and require further data to assess its role and reliability. Our research was to develop and outline a reasonable method for using eDNA as a biomonitoring technique for macroinvertebrates in a variety of freshwater ecosystems. We sampled surface water from 10 urban streams over 5 weeks during summer 2022 for eDNA metabarcoding. Sites were selected to represent a gradient of impervious cover and were part of Charlotte-Mecklenburg Storm Water Services (CMSWS) biomonitoring program, allowing us to compare traditional versus molecular monitoring. We applied this technique to quantify macroinvertebrate biodiversity across a variety of freshwater ecosystems, including beaver habitats, restored streams, and Native American protected streams. Our initial results indicate that we were successful in targeting macroinvertebrates; however, there were multiple additional taxa identified such as microorganisms and vertebrates. We are continuing to process our sequences to assess the impact of weekly sampling and compare our data to the samples collected by CMSWS. Our results will contribute to the scientific knowledge around using eDNA for biomonitoring that is needed to develop this method for benthic macroinvertebrates. While traditional methods still play an important role, molecular methods can allow us to easily increase the number and diversity of freshwater ecosystems monitored and expand our understanding of these systems.

30. Analysis of Potential Contamination Risks to Waterways As a Result of Construction

*^ Presenter: **Kai Spence**, UNC Charlotte and Harvesting Humanity, kaispence1976@gmail.com
Co-authors: Olya Keen, UNC Charlotte and Eboné M. Lockett, Harversting Humanity

New Construction is a rising staple in North Carolina (NC). Buildings and homes are being developed at a rapid rate, much like the spread happening across the county of Mecklenburg. Assembly of such structures involves the use of materials such as treated woods, stones and rocks, plastic, and structural steels. These materials have been known to contain both natural and artificial chemicals and minerals that pose health risks through long exposure. It stands to reason that there could be dangers to the quality of water as a result of exposure to such contaminants. This study will analyze the compound structure of water in or near construction sites. With the use of test kits and an Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES) the site samples will be examined for the presence of arsenic, iron, and manganese, as potential contaminants. Instruments will also be used to measure Total Organic Halides (TOX). This study aims to enhance the knowledge base of local residents and uncover risks to surrounding communities and wildlife brought about by construction. Testing will involve sampling nearby water sources and analyzing data. Collected data will be compiled and distributed to local community members and county officials with the aim of developing safer construction practices that leave more of the site undisturbed and awareness of the need for sustainable construction materials. This project is supported by NC WRRI CCRG and I am collaborating in this work with Harvesting Humanity LLC. and UNC Charlotte Department of Civil and Environmental Engineering.

31. New Insight on Cyanobacterial Diversity and Toxin Production Potential in the Chowan River and Albemarle Sound Using Metagenomics

^ Presenter: **Sarah Watson**, NC State University, sdwatso2@ncsu.edu
Co-authors: Haley E. Plaas, UNC Chapel Hill; Colleen Karl, Chowan Edenton Environmental Group; Hans W. Paerl, UNC Chapel Hill; Ryan W. Paerl, NC State University

Expansion of cyanobacterial harmful algal blooms (CHABs) threaten water quality and environmental health in the Chowan River-Albemarle Sound estuarine continuum. Water samples were taken from NC-DEQ and CEEG stations throughout the Chowan River and Albemarle Sound in Summer 2020 during peak CHAB season with the goal of determining the cyanobacterial community members and their potential to produce cyanotoxins and other secondary metabolites that potentially impact co-occurring organisms. This study represents the first time a large-scale microbial genomic analysis has been done in this system. A total of 186 high and medium quality MAGs were assembled from Illumina sequencing reads. Results from the Chowan River indicate that the CHAB genera Dolichospermum and Microcystis, especially the prior, were abundant over the course of the study. A larger number of CHAB associated genera occurred in the Albemarle Sound including: Sphaerospermopsis, Nodosilinea, Dolichospermum, Prochlorotrichaceae, Leptolyngbyaceae, Raphidiopsis, and Microcystis. Classes of biosynthetic gene clusters identified in these abundant populations include terpenes, cyanobactins, microviridins, non-ribosomal peptide synthases, polyketide synthases, and lanthipeptides. Putative biosynthetic gene clusters were identified for several cyanotoxins and other noxious compounds, many of which are understudied. These compounds include geosmin, microcystin, saxitoxin, anabaenopeptin, puwainaphycin, nostophycin and more. Interestingly Dolichospermum genomes associated with a large-scale bloom event lacked microcystin genes and microcystin concentrations were low during the bloom event based on LC/MS measurements. Our results highlight high cyanobacterial diversity in the CR-AS capable of producing multiple cyanotoxins and secondary metabolites that are not monitored and have never been assayed to our knowledge.

Notes

Prediction of Stormwater Pipeline Condition via Machine Learning

*Presenter: **Nicole Barclay**, UNC Charlotte, nbarclay@uncc.edu
Co-authors: Michael Smith, Jingyi Qi, Christopher Schultz, and Cullen McNinch, UNC Charlotte

When the converging impacts of aging infrastructure, urban growth, and increasingly intense rainfall events are considered, there is a clear need to optimize proactive planning for stormwater pipeline repair and maintenance. In addition, utilities must consider budget and personnel time constraints for necessary stormwater asset management projects. The use of machine learning models can be beneficial as a cost-effective, proactive approach to identifying at-risk stormwater pipelines and supporting their prioritization for repair or replacement. Once relevant and reliable input data are obtained and processed, engineering and planning staff can produce classification models to predict the existing pipeline inventory's condition categories (e.g., low risk, medium risk, and high risk). This work shows the training and validation of several supervised machine learning models, including neural networks and decision tree models, to classify pipeline conditions. The performance of each model was evaluated and compared to select the most applicable one that can be adapted and used by NC stormwater utilities for conducting predictive condition assessments. Ultimately, this work encourages machine learning in the water and stormwater utility sectors by showing the development process of these data-driven models for asset management purposes.

Tracing Nutrient Pollution from Industrialized Animal Production in the Cape Fear River Watershed

^ Presenter: **Colleen Brown**, UNC Wilmington, cnb6822@uncw.edu
Co-authors: Michael A. Mallin and Ai Ning Loh, UNC Wilmington

The coastal plain of North Carolina, where the Cape Fear River Basin is located, has one of the highest concentrations of poultry and swine concentrated animal feeding operations (CAFOs) in the world. These CAFOs produce excessive amounts of manure that the surrounding lands are unable to naturally remove, causing loading of nutrients and other pollutants to local waterways. These industrialized waterways in the Cape Fear River Basin are vulnerable to nutrient pollution, which can be transported downstream to large cities and eventually drains into the Atlantic Ocean. To determine the source and transport of nutrients throughout the Cape Fear River Watershed, including the Northeast Cape Fear, Black, and lower Cape Fear River watersheds, the organic stable isotopic compositions of d15N and d13C and nutrient concentrations of nitrogen(N) and phosphorus species were identified from water samples across spatial and temporal scales. Our results showed that higher d15N values, characteristic of animal-derived waste, was significantly higher ($p<0.05$) in waters proximal to CAFOs and point-source wastewater discharge areas, in contrast to waters unimpacted by CAFOs, including one control site and two estuarine sites. Statistical analyses demonstrated that nitrate concentrations were positively correlated with higher d15N values, suggesting that animal manure and human wastewater are the more important drivers of nutrient pollution in this watershed rather than fertilizers, which have characteristically lower d15N values, from traditional row crop farming. Our results also suggested that during appropriate hydrological conditions, CAFO-derived N can be detected many kilometers downstream from their freshwater source areas to the estuary.

Can Citizen Scientists Fill the Gap in State Ambient Wetland Monitoring Programs?

Presenter: **Michael Burchell,** NC State University, mike_burchell@ncsu.edu
Co-authors: Molly Landon, NC State University; Rick Savage, Amanda Johnson, Patty Cervenka, and Chase Bergeson, Carolina Wetlands Association; Kim Matthews, RTI

Wetlands are important aquatic ecosystems that provide a myriad of ecosystem services. The are complex, so to understand their condition and functions, data collection on water quality, soil chemistry, hydrology, plants, and animals is required. Monitoring wetlands over time is important to detect potential impacts from stressors (e.g. climate change, urbanization, and fragmentation) and help inform restoration criteria. Unlike lakes and streams, many states like North Carolina do not have a systematic, long-term ambient wetland monitoring program. Our goal is to create a sustainable network of wetland monitoring sites across North Carolina. In this pilot program, we have developed and are testing different protocols and training methods to enable volunteers or citizen scientists to conduct wetland monitoring. The study areas are in the eastern Piedmont, located on properties protected from future development so to provide a long-term baseline of wetland condition. The data collected (hydrology, vegetation, soils, amphibians, water quality) is based on previous larger-scale NC wetland monitoring studies that will allow comparisons. We are also evaluating using digital applications (iNaturalist) and electronic data forms (Wildnote) for collecting data and the development of an online data portal to view results and engage with our volunteer citizen scientists. We are also conducting periodic surveys of the volunteers to asses and inform the path for year two of the program. Training efforts from year one (2022) will transition in year two (2023) where volunteers lead the data collection; these outcomes will ultimately define the feasibility of a long-term and sustainable program.

Using Data Visualizations and Spatial Analysis to Support Environmental Decision Making

^ Presenter: **Ellie Cardenal**, AECOM, ellie.cardenal@aecom.com
Co-authors: Rosa Gwinn, AECOM

This presentation will share examples of how data visualization and high-level spatial analysis can be used to characterize and support decision making on a wide variety of environmental concerns. Presentation attendees will learn the following: 1) the power of data visualizations in complex decision making and communication, 2) the breadth of publicly available environmental datasets, and 3) simple, yet effective spatial analysis tool(s) and techniques and their potential applications. A case study will be presented of using data visualizations and high-level spatial analysis to screen geographic areas with respect to PFAS- (per- and polyfluoroalkyl substances) impacted water supplies, regulatory criteria and socioeconomic status. For example, analyses of this type can be used to help target Bipartisan Infrastructure Law (BIL) funding for communities most in need. This strategy can be used by many communities and organizations interested in effectively utilizing publicly available datasets to simplify decision making and visually communicating complex concepts and analyses to stakeholders. In the end, it is extremely important to effectively convey results of the analysis to stakeholders which may include citizens, government entities, regulatory agencies, and/or funding programs. Spatial analysis tools and the data visualizations they produce are an excellent way to convey complex results efficiently in a format that is compatible with websites, public meetings, and reports.

How to Enhance your Enviroscape Presentation

Presenter: **Rebecca Coppa**, NC Dept. of Environmental Quality, rebecca.coppa@ncdenr.gov,
Co-authors: Lauren Daniel, NCDEQ

In this session we will discuss our favorite materials to use with the watershed/nonpoint source enviroscape model and then we will learn about (and participate in) some new activities that can accompany your enviroscape presentation for different age levels! From doing an erosion/stormwater walk or bingo game, discovering where water is on earth, to thinking about how our choices can impact those downstream from us, and more.

Occurrence and Distribution of Per-and Polyfluoroalkyl Substances in Tidal Creeks of Southeastern North Carolina

^ Presenter: **Emily Corbitt**, UNC Wilmington, erc6940@uncw.edu
Co-authors: Ralph Mead and Lynn Leonard, UNC Wilmington

Per- and polyfluoroalkyl substances (PFAS) are anthropogenic organic compounds that are desirable for hundreds of applications due to their surfactant properties, water and oil repellency, and high thermal stability. Widespread use of these unregulated chemicals, combined with their mobility and resistance to degradation, has led to a global distribution. PFAS are linked to negative health effects in humans and marine species, so their presence in surface waters has serious implications for human health and the health of economically important fisheries. Knowledge of PFAS at the land-sea interface is also crucial for understanding long-range transport and bioaccumulation in marine organisms. The objective of the present research is to determine the occurrence and distribution of PFAS in tidal creeks of southeastern North Carolina. Surface waters were collected from the mouths and headwaters of seven tidal creeks and analyzed for a suite of 14 legacy (e.g. PFOA and PFOS) and replacement (e.g. GenX) PFAS by LC-MS/MS. Preliminary results indicate an average total PFAS concentration of 14.4 ± 3.1 ng/L in the creek headwaters and 5.5 ± 1.4 ng/L in the creek mouths. A change in PFAS distribution was observed between headwaters and mouths with total short chain PFAS (C4-C7) composing 80.1% of total PFAS in the headwaters and 47.2% of the total PFAS in the mouths. Results of this study will allow for constraint of PFAS inputs and cycling within understudied salt marshes. These findings could have serious implications for aquaculture, human exposure, and overall health of North Carolina tidal creeks.

NC DEQ's Updated Stormwater Nitrogen and Phosphorus (SNAP) Tool, Version 4.2

Presenter: **Trish D'Arconte**, NC DEQ Nonpoint Source Planning Branch, trish.darconte@ncdenr.gov

The NC Department of Environmental Quality has released a revised version of its Excel-based tool (SNAP4.2) for calculating average annual nitrogen and phosphorus export carried in runoff from developed areas and the reductions in export that can be provided by a large set of Stormwater Control Measures. State-level watershed management regulations require the use of this tool for new development meeting certain requirements. This tool can be used for estimating changes in nitrogen and phosphorus export in runoff through a variety of land development scenarios, many types of stormwater treatment, and stormwater retrofit projects. This presentation will provide a quick introduction to the tool and its many uses.

Evaluating Metal Cation Diversity in Microbial Polyphosphate Granules and its Effect on Enhanced Biological Phosphorus Removal from Domestic Wastewater

Presenter: **Jessica Deaver**, NC State University, jdeaver@ncsu.edu
Co-authors: Julianne Buggs, NC State University; Paul Westerhoff, Arizona State University; Jacob L. Jones, NC State University; Aaron J. Bell, NC State University; Christopher R. Winkler, NC State University; Douglas F. Call, NC State University

Many water resource recovery facilities (WRRF) use enhanced biological phosphorus removal (EBPR) to remove phosphorus from wastewater, preventing high phosphorus effluent discharges that can cause eutrophication. In EBPR, anaerobic/aerobic cycling initiates specialized metabolisms in phosphorus accumulating organisms (PAOs), resulting in hyperaccumulation of intracellular phosphorus stored as polyphosphate. WRRF often report unstable EBPR, and factors affecting instability are not well understood. One possible factor is availability of positively-charged metal cations acting as counterions to negatively-charged polyphosphate. Previous studies demonstrated links between polyphosphate stability and cations Mg^{2+}, Ca^{2+}, K^{+} and Na^{+} in bench-scale and full-scale studies. Using scanning transmission electron microscopy/energy dispersive x-ray spectroscopy (STEM/EDS) on full-scale facility samples, our preliminary results showed a wider diversity of metal cations, including Al^{3+}, Pb^{2+}, Ba^{2+}, Fe^{3+}, comprise polyphosphate granules than previously reported. Our work aims to understand prevalence of various metal cation-polyphosphate associations and their effect on EBPR stability. We perform phosphorus and metal release tests on activated sludge from full-scale facilities to determine correlations between phosphorus and metal cation release. These facilities vary in their use of metal-based amendments (e.g., aluminum, iron) to trim phosphorus concentrations on a continuous basis and/or stabilize EBPR during disruptions. Results suggest phosphorus release correlates to release of certain cations, including not only Mg^{2+} and K^{+} but also Fe^{3+} and Mn^{2+}. Our initial observations also show Al^{3+} from alum amendments is incorporated into phosphorus granules, suggesting PAO phosphorus removal may be impacted when facilities add metals. Research outcomes will help inform EBPR processes to improve reliability.

Characterizing Water Quality Status, Trends and Potential Watershed Management Opportunities from Charlotte-Mecklenburg National Pollutant Discharge Elimination System (NPDES) Stormwater Data

Presenter: **Barbara Doll,** NC Sea Grant and NC State University, bdoll@ncsu.edu
Co-authors: Jack Kurki-Fox, NC State University, Barbara Doll, NC Sea Grant and NC State University; Dan Line, NC State University

NC State University evaluated Charlotte-Mecklenburg Storm Water Services' (CMSWS) water quality data for the period of 2007 to 2020 to identify trends and future monitoring, management and planning decisions to protect and restore urban streams. Pollutant concentrations and loads were compared among monitoring sites and to relevant state standards. Point source and nonpoint source loads were also compared. Trends were analyzed using the US Geological Survey's WRTDS regression method, which accounts for variations due to time, discharge and season. The Soil & Water Assessment Tool (SWAT) and EPA's Spreadsheet Tool for Estimating Pollutant Loads (STEPL) were used to develop total nitrogen and total phosphorus loads for select watersheds to see how well the predicted loads matched the loads calculated from measured water quality and flow. Most water quality parameters were below regulatory standards with the exception of copper, fecal coliform and nitrate. Copper was exceeded in ~80% of the sites with over 80% of the exceedances occurring during stormflow. Fecal coliform exceeded the aquatic life standard in about 80% of the samples. Nitrate levels were a concern in all watersheds with major wastewater treatment plants, which were estimated to account for 75% of the TN load and 47% of the TP load in the study area. Land cover change was significant to changes in channel flow events and macroinvertebrate metrics. Findings of this effort including recommendations for how CMSWS could modify their sampling program to improve the value of the data for management purposes will be reviewed in this presentation.

Falls Lake Data Evaluation and Modeling Results to Inform a Revised Nutrient Management Strategy for Falls Lake

Presenter: **Doug Durbin and Alix Matos**, Brown and Caldwell, ddurbin@brwncald.com; amatos@brwncald.com

Falls Lake is the most studied reservoir in NC. Over the past two decades, water quality and algal species/biovolume data have been collected approximately monthly by several organizations. Special studies of lake bathymetry, water movement, sediment depth and quality, benthic nutrient fluxes, and algal toxins have also been conducted. This presentation will briefly summarize these studies and their application by the Upper Neuse River Basin Association (UNRBA) to develop two Falls Lake water quality models using the Watershed Analysis Risk Management Framework (WARMF) and the Environmental Fluid Dynamics Code (EFDC). Key findings from the data and modeling will be discussed along with their implications for the development of a revised nutrient management strategy for Falls Lake. Considerations for a site-specific chlorophyll-a criteria will also be discussed.

Quantifying and Predicting Streambank Erosion in the Ridge and Valley and Blue Ridge Physiographic Regions of Virginia to Benefit Eastern Hellbender Populations

^ Presenter: **Layla El-Khoury**, NC State University, lcelkhou@ncsu.edu
Co-authors: Barbara Doll, NC Sea Grant and NC State University; Jack Kurki-Fox, NC State University; Melanie Carter, Virginia Tech

Stream erosion monitoring and assessment were conducted at 15 streams in the Blue Ridge and Ridge and Valley physiographic provinces of Virginia. Streambank erosion was measured at 82 cross sections and compared to erosion predictions estimated using the Bank Assessment for Non-point source Consequences of Sediment (BANCS) method. Several multivariate statistical models - Lasso, Ridge, PCR and Random Forest - were used to predict streambank retreat using the individual BANCs variables. Historical erosion rates were quantified for six streams using aerial photos taken in 2007, 2011, 2015 and 2019. LiDAR data was collected at 3 streams in 2021 and 2022. Geomorphic Change Detection (GCD) software was then used to calculate the reachwide erosion and deposition for each stream from this data. Streambank erosion volumes were calculated and compared at three streams using four approaches 1) physical surveys, 2) aerial photo analysis, and 3) LiDAR surveys and 4) model predictions. Total erosion volumes based on the physical surveys ranged from 0.01 to as high as 0.35 tons per year per linear foot of stream per year. The BANCS method overly stratified the data into Bank Erosion Hazard Index (BEHI) categories and as a result produced poor streambank erosion prediction curves. Four regression models provided more reliable predictions of streambank retreat than the BANCS model. The aerial imagery analysis and the physical stream surveys produced comparable total volumes of erosion. The GCD appeared to underestimate the volumes and included a higher range of uncertainty.

Overview of Multi-Decade Water-Quality Monitoring at Triangle Area Water Supplies

Presenter: **Rosemary Fanelli**, U.S. Geological Survey, rfanelli@usgs.gov
Co-authors: Jessica Diaz and Deanna Hardesty, U.S. Geological Survey

The quality of surface water supplies in North Carolina face increasing pressure from population growth, climate change, and contamination from various sources. Recognizing these potential pressures, several local governments partnered with the U.S. Geological Survey in 1988 to form the Triangle Area Water Supply Monitoring Project (TAWSMP) to systematically evaluate the quality and quantity of surface water supply sources in the region, including Jordan Lake and several additional reservoirs. This project continues today, and the current TAWSMP monitoring network includes 10 streamflow gages in local tributaries; 13 routine water-quality monitoring locations at four tributaries and nine water supply reservoir sites; and additional tributary locations to examine storm runoff water quality. Long-term water quality monitoring at these sites has included extensive nutrient and sediment sampling, which is critical for assessing water supply vulnerability to eutrophication and for identifying sources of excess nutrients and sediment. Contaminant monitoring has also been a primary focus of this project— recent monitoring work examined the presence and distribution of 1,4-dioxane, bromide, chromium, and mercury, and TAWSMP will begin PFAS sampling at all sites in 2024. Moreover, the historic streamflow and water quality records at these monitoring sites have also been incorporated into regional and national USGS studies, further enhancing our understanding of spatial and temporal patterns in regional water quantity and quality. This presentation will review results from recent and historic monitoring, how these sites have helped inform regional and national USGS science efforts, and future plans for TAWSMP.

Effects of Impoundments on Selected Flood-Frequency and Daily Mean Streamflow Characteristics in Georgia, South Carolina, and North Carolina

Presenter: **Toby Feaster**, U.S. Geological Survey, tfeaster@usgs.gov
Co-authors: Jonathan W. Musser, U.S. Geological Survey

The U.S. Geological Survey (USGS) has a long history of working cooperatively with the Georgia, South Carolina, and North Carolina Departments of Transportation developing methods for estimating the magnitude and frequency of floods for rural and urban basins that have minimal to no regulation or tidal influence. The USGS is currently working with the DOTs in GA, SC, and NC to update flood-frequency statistics for rural streams at gaged and ungaged locations. As part of that study, flood-frequency statistics were computed at 72 regulated streamgages across the three States. In a companion study with the SCDOT, the USGS is assessing the effects of impoundments on flood-frequency characteristics by comparing annual exceedance probability (AEP) streamflows from pre- and post-regulated (before and after impoundment) periods at 18 USGS long-term streamgages (30 or more years of record). For an assessment of how differences in such statistics can be influenced by period of record and hydrologic conditions captured in those records, which could be considered as natural variability, AEP streamflows at an additional18 long-term USGS streamgages that represent unregulated conditions in those three states were computed and compared for the first and last half of those records. A subset of the 72 regulated streamgages that are located predominately above the Fall Line, also have been used to develop regional regression equations that can be used to estimate flood-frequency statistics at ungaged regulated locations in GA, SC, and NC. This presentation will provide an overview of the results of this cooperative investigation.

Nitrogen Processing in Regenerative Stormwater Conveyance Systems

*^ Presenter: **Colin Finlay**, East Carolina University, finlayc21@students.ecu.edu
Co-authors: Michael O'Driscoll, John Hoben, Charles Humphrey, Guy Iverson, and Ariane Peralta, East Carolina University

Aquatic ecosystems provide functions including water quality improvement and habitat to support biodiversity. Microbes inhabiting aquatic ecosystems enhance water quality by converting water-soluble forms of nitrogen to gaseous forms, thereby reducing the nitrogen load into downstream waterways. In urban catchments, decreased permeability and overuse of fertilizers have increased nutrient loads, while simultaneously decreasing the opportunity for microbial processing of nutrients during flashy storm events. To reduce urban flooding and improve water quality, the City of Greenville installed a variety of stormwater control measures in Town Creek, including an in-stream regenerative stormwater conveyance (RSC) system. Therefore, evaluation of microbial nutrient processing within these stormwater control measures is needed. Following installment, monthly water quality and discharge data were collected from the Town Creek RSC, from July 2020 to June 2021. Based on these data, it was estimated that median total dissolved nitrogen concentrations declined by ~15% along the RSC. During the Spring of 2021, bacterial community composition, dissolved oxygen, and flow rates within the RSC were also analyzed. Storm-induced flooding and acute road salt additions influenced bacterial community composition within the RSC. Future work beginning in January 2023 will investigate the impacts of seasonality and precipitation on nitrogen processing in this in-stream RSC, and a nearby stormwater outflow RSC. This in-depth study of nitrogen processing will enable assessment of how these recently installed stormwater control measures are performing.

Dynamic Vulnerability: Reconstructing Historical Flood Footprints and Exposure in Eastern North Carolina

^ Presenter: **Helena Garcia**, UNC Chapel Hill, hmgarcia@unc.edu
Co-authors: Antonia Sebastian, Kieran Fitzmaurice, Hope Thomson, Harrison B. Zeff, and Greg Characklis, UNC Chapel Hill

Vulnerability to flood impacts within communities changes in space and through time. Understanding the impacts that consecutive flood events have on communities is crucial for understanding how vulnerability changes and for whom. However, there is limited information on the extent of historical flooding events because researchers often focus on modeling the largest flood events in the record. Thus, there is little information on where consecutive flood events have occurred and who has experienced recurrent damage. To understand how flood damage in consecutive events between 1998-2018 has impacted households of different socio-economic standing in eastern North Carolina (ENC), we implement a random forest machine learning model to reconstruct spatial footprints of flood events at a 30-meter resolution. We use parcel level National Flood Insurance Program (NFIP) policies and claims data along with high-resolution geospatial data to predict flood absence and presence for ten events in the historical record. We overlay results of consecutive flooding with socio-demographic data from the U.S. Census Bureau to determine the demographic characteristics of who has experienced repetitive flood damage. The results of this work provide data for investigating how flood hazard and exposure have changed over time in ENC and how these changes have impacted the vulnerability of different communities. Furthermore, this database of

historical flood footprints represents an initial step towards identifying hotspots of recurrent flooding in low resource areas. Once identified, adaptation and recovery strategies can focus on these areas to mitigate additional increases in their dynamic vulnerability.

Strategic Riparian Buffers to Improve Coastal Resilience in the Cape Fear River Watershed

^ Presenter: **Elly Gay**, NC State University, etgay@ncsu.edu
Co-authors: Katherine Martin, NC State University; Peter Caldwell, USDA Forest Service; Danica Schaffer-Smith, Arizona State University and The Nature Conservancy; Rebecca Muenich, Arizona State University; Julie DeMeester, The Nature Conservancy; Shannon McAvoy, NC State University

Forests conversion to development is inextricably tied to adverse effects on water quality and availability. While development within a watershed can have a localized effect, it is important to note the compounded effect on downstream areas, particularly if these areas are vulnerable coastal communities. In developing watersheds where maintaining widespread forest cover to protect water resources might be an impracticable option, implementation of riparian buffers (streamside forests/vegetation) might be critical to supporting watershed function under changing conditions. However, the scale and placement of riparian buffers needed to mitigate these conditions at a regional watershed level, particularly for downstream coastal areas, is not well understood. Therefore, we coupled the Soil and Water Assessment Tool and the FUTURES urban growth model to assess strategic buffer placement in the Cape Fear River Watershed, a regional scale watershed that connects the Piedmont to the coast. We tested the efficacy of riparian buffers under a coupled climate/land change scenario with three buffer treatments: no-buffers (business as usual), complete buffers (all streams), and strategic buffers (around water quality hotspot areas). Output of the FUTURES model shows a 2% increase in development across the watershed from 2011-2060. Preliminary results from the hotspot analysis indicate the highest accumulated total nitrogen and total phosphorus levels occur in downstream areas of the coastal plain, while the highest total suspended sediment yield is concentrated upstream in the headwater region. Findings from this research will contribute to the science of protecting entire watershed health in a highly developing region.

Fostering Environmental Health Literacy While Addressing Arsenic Contamination in Private Wells in the Carolina Terrane

Presenter: **Andrew George,** UNC Chapel Hill, andrewg@unc.edu
Co-authors: Kathleen M. Gray, Sarah Yelton, and Megan Lane, UNC Chapel Hill; Veronica Oakler and Christina Diaz, Clean Water for North Carolina

North Carolina has more households reliant on private wells (~25%) than any other state (Murray et al., 2021). Prior research across North Carolina has found that over 26% of wells that have been tested contained contaminants at levels exceeding at least one federal health-based standard (Eaves et al., 2022; Sanders et al., 2012). Inorganic arsenic has been detected in over 12% of private wells sampled in NC. Studies also have documented naturally occurring inorganic arsenic in the geological region of the Carolina terrane (or Carolina slate belt) (Eaves et al., 2022; Sanders et al., 2012).Among counties within this region, private well testing in Union County has identified exceedances of the federal drinking water standard for arsenic in almost 20% of wells tested. The UNC Superfund Research Program (SRP) is working with community-based partners (Clean Water for NC, the Union Co. NAACP, and the Union County Health Department) to recruit private well users to participate in a drinking water study in Union County. In addition to well testing, we are exploring how different recruitment methods affect participation. This study, which is informed by the Environmental Health Literacy framework, focuses on understanding participant motivation and self-efficacy. Recruitment methods included the following: mailing tailored, printed information to residents, distributing printed information in the community, and canvassing high-risk neighborhoods. Sampling is expected to be completed in spring 2023. Preliminary analysis suggests over 88% of potential participants have not previously tested their water.

Emerging Research on Natural Infrastructure for Flood Mitigation

Presenter: **Adam Gold**, Environmental Defense Fund, agold@edf.org

Following severe flooding from Hurricanes Matthew (2016) and Florence (2018), the state of North Carolina (NC) took significant action to help rebuild, create community resilience programs, and better understand ongoing impacts of climate change. These state actions have led to the creation of the Flood Resiliency Blueprint, which will provide accessible tools and state-of-the-art flood risk analysis across NC. Importantly, this Blueprint will help prioritize the implementation of flood mitigation projects in NC with a preference for natural infrastructure projects that reduce flooding while providing year-round co-benefits. Watershed-scale implementation of natural infrastructure has proven effective in other geographic areas, and modeling studies suggest that natural infrastructure can be effective in NC. Here we highlight and discuss three emerging research topics related to the natural infrastructure practice of "water farming" – climate accounting, water quality impacts, and financial tools for implementation. Better understanding these emerging research topics will inform best practices for siting, managing, and funding natural infrastructure for flood mitigation in NC.

Linking Tropical Cyclone Precipitation in Future Climates to Shifts in Flood Exposure

*^ Presenter: **Lauren Grimley**, UNC Chapel Hill, lauren.grimley@unc.edu
Co-authors: Katherine Hollinger and Gary Lackmann, NC State University; Antonia Sebastian, UNC Chapel Hill

Climate change increases the likelihood of the interactions between the drivers of flooding, and this is especially complex in estuarine communities where water levels are controlled by localized rainfall, rivers, and the coast. Storms that generate pluvial flooding, beyond tropical cyclones, are a growing problem. In this study, we use a storyline approach to investigate how exposure to precipitation-driven flooding might occur in warmer climates. We focus on New Bern, NC where we have a hydrodynamic model and in-situ water level measurements and roadway images at 3 sites for multiple months. We approximate the return-period for each storm event where roadway inundation was recorded by our sensors using precipitation frequency estimates from NOAA Atlas 14. This information helps us understand what storms cause different urban areas to be inundated. The data collected from these sensors is also useful for evaluating our flood model for more recent events. To imagine the impacts of tropical cyclones in future conditions, we compare the number of structures exposed to damaging water levels for Hurricane Florence across various scenarios. We use an atmospheric model (e.g., WRF) to generate wind and precipitation fields that are used as inputs the flood model (e.g., SFINCS). Sea level rise is included as a linear addition to the coastal water levels based on trends at a nearby NOAA tide gage. An outcome of this research is to generate information on how flood hazards and risks might shift so that communities can better prepare for the future.

Societal Perceptions of PFAS Contamination in Eastern North Carolina

^ Presenter: **Genevieve Guerry**, East Carolina University, guerryg19@students.ecu.edu
Co-authors: Jamie DeWitt, East Carolina University

Per- and Poly-fluoroalkyl substances (PFAS) are among the most ubiquitous environmental hazards, representing a chemical class that presents a toxic threat to environmental health. Exposure to these chemicals through multiple routes can lead to human health problems. Public perceptions and knowledge of these chemicals are important to further disseminate information and assess risk. A chemical plant located on the banks of the Cape Fear River in North Carolina has been releasing both allowably and intentionally different PFAS compounds into the water for decades. The Cape Fear River is also a major source of drinking water for the growing city of Wilmington, NC, and surrounding communities. Community partners from the Cape Fear River region and Washington, NC shared their perspectives through social media and an in-person survey. Systematic sampling was used for two Facebook groups to understand social media interaction with PFAS news. A convenience sample was

taken at a community oyster roast in Washington, NC an area at the time that had no known contamination of PFAS. The survey taken by the non-impacted community demonstrated a high knowledge pertaining to PFAS. This project highlighted the need for stronger partnerships between advocacy organizations and academic researchers since advocacy organizations are where people turn for information. This work will be a starting point for research into the psychological and physiological changes to chemical hazards in North Carolina.

Using Repeat Lidar to Identify Streambank Erosion Hotspots in Raleigh, North Carolina

Presenter: **Laura Gurley**, U.S. Geological Survey, lgurley@usgs.gov
Co-authors: Kristina G. Hopkins and Charles C. Stillwell, U.S. Geological Survey

Although streambank erosion is a natural process in fluvial systems, excess sediment in stream water can have negative impacts. For example, excess sediment can negatively affect aquatic habitat, transport harmful sediment-associated constituents, cause infilling of downstream reservoirs, and give rise to poor water clarity. The City of Raleigh, North Carolina recognizes the prevalence of streambank erosion in urban streams but lacks an understanding of the spatial extent of streambank instability. To guide effective mitigation efforts, a comprehensive approach to identify streambank erosion hotspots is needed. Current approaches, such as stream walks or citizen complaints, can be inefficient, inconsistent, and expensive. New tools are needed to remotely identify streambank erosion hotspots throughout the city. The U.S. Geological Survey developed high-resolution lidar-derived metrics to pair with field geomorphic assessments in order to develop a streambank erosion model to remotely map streambank erosion potential. The topography of stream channels was characterized using lidar-derived 1-meter digital elevation models (DEMs) and positive landscape openness datasets from years 2015 and 2022. The 2022 and 2015 DEMs were differenced to characterize changes in elevation of stream channels over time. In this presentation, we present the lidar-derived datasets that may have the most opportunity for improving streambank erosion modeling.

Separation of Volatile Fatty Acids (VFAs) from Anaerobic Digestion (AD) Bioreactors Using Different Electrodialysis (ED) Configurations

^ Presenter: **Holly Haflich**, UNC Chapel Hill **and Hezhou Ding**, NC State University, hhaflich@ad.unc.edu; hding4@ncsu.edu
Co-authors: Douglas F. Call, NC State University; Orlando Coronell, UNC Chapel Hill

VFAs are high-value carboxylic acids with several applications. AD of food waste is a biological method of producing VFAs. As VFAs and ammonium accumulate during AD, the production of additional VFAs becomes inhibited. To reduce the inhibitory effects and recover VFAs, a separation technique must be implemented to separate VFAs and ammonium from AD. ED is an electrochemical method that can remove and recover VFAs (anionic) and ammonium (cationic) from AD by electrically transporting charged solutes through ion exchange membranes; therefore, VFA production could be enhanced by recycling the VFA and ammonium-depleted AD effluent back to the AD reactor to dilute the VFA and ammonium content. Although previous work showed combining ED and AD enhanced VFA production, there has been no evaluation of how ED parameters, which impact solute removal, affect the overall VFA production during AD. Therefore, we evaluated the impact of seven ED configurations on VFA and ammonium separation and subsequent VFA production in sequential batch ED-AD. We operated identical AD reactors for 25 days, where the digestate was extracted and treated by one of the ED configurations. The ED-treated AD effluent was then recirculated back to AD reactors to dilute the VFA and ammonium concentrations. Results showed the number of membranes in ED had the greatest impact on VFA and ammonium removal. We are currently conducting VFA analysis to investigate the total VFA production in each AD reactor fed with ED-treated effluent. These results provide insight into ED parameters that enhance VFA recovery and production from ADs.

Investigating Tryptophan-Like Fluorescence as a Correlate with Fecal Indicator Bacteria in Estuarine Waters

^ Presenter: **Julia Harrison**, NC State University, jmharr26@ncsu.edu
Co-authors: Natalie Nelson, Angela Harris, and Chris Osburn, NC State University

The use of portable fluorometers has the potential for reporting water quality covariates that could be used to predict fecal indicator bacteria (FIB). A covariate that has been seen to correlate closely with FIB in freshwater systems is Tryptophan-like-fluorescence (TLF), a measure of the excitation-emission peak associated with the essential amino acid, tryptophan, that is present in proteins. However, implementation of TLF in estuarine systems requires further study. Due to high productivity and dynamics of estuarine systems, the relationship between TLF and FIB is likely less direct than in freshwater systems. The goal of this study was to assess the relationship or interferences that other water quality covariates and environmental conditions have on field-sensed TLF in estuarine waters and its relationship with FIB concentrations. To do so, a multiparameter water quality sonde was deployed in the Newport River Estuary, equipped with Turner's TLF sensor and other water quality sensors. Grab samples were collected for FIB Enterococci enumeration and lab analysis of optical properties. Lab-measured TLF correlated more closely with Enterococci than field-sensed TLF (Pearson r = 0.66, 0.47, respectively). Normalizing TLF to fDOM to account for background humic signals resulted in a stronger correlation with Enterococci (Pearson r = -0.59) however, solely fDOM was seen to correlate more with Enterococci (Pearson r = 0.63). Combined, these preliminary results indicate that TLF may serve as an effective predictor of FIB, but that other variables, like fDOM, may provide redundant information with TLF and may serve as more useful FIB predictors.

Let's Get Creative: How to Build a Scalable Real-Time Hydrologic Data Monitoring Network with Cost-Effective DIY Solutions

Presenter: **Brian Hinckley**, East Carolina University, hinckleyb21@ecu.edu
Co-authors: Ciprian Popoviciu, Colby Sawyer, Randall Etheridge, Tyler Kossover, and Zeke Holloman, East Carolina University

Real-time data streaming in hydrology has been around for decades, but only within the last few years have the associated hardware and software costs decreased enough to allow everyone, not just corporations, to innovate in this space. Real-time data streaming has several advantages over traditional practices of manually downloading data such as quickly identifying issues to minimize data loss and time and money saved with less travel. New technologies such as LoRa make it easy to deploy and network low cost, low power sensors. We deployed multiple LoRa gateways throughout Greenville, NC with the goal of building out a monitoring system of the towns tributaries and streams. Data is collected by sensors equipped with LoRaWAN transmitters connecting to the gateways, which in turn sends it to a cloud hosted backend for storage, analytics, and visualization. While this data flow has greatly decreased costs compared to traditional cellular commercial streaming solutions, pre-existing monitoring sites using traditional streaming solutions can be collated into our database using external protocols such as rest API's, MQTT, and FTP, further increasing our platforms utility. Furthermore, the platform provides an opportunity to reduce the overall costs of instrumentation by an order of magnitude thus opening the door for higher density data collection. For example, we are utilizing LoRa enabled ultrasonic distance sensors priced at $70, significantly cheaper than traditional vented pressure transducers without communication capabilities priced at $500+. In this presentation we will discuss the architecture of this platform, the preliminary hydrology results, and our future plans.

Evolving Stormwater Utilities in NC

Presenter: **Taylor Holiday and Mitchell Turnage**, Raftelis, tholliday@raftelis.com; mturnage@raftelis.com

Stormwater utilities started cropping up around NC in the 1990s, as larger cities became subject to MS4 requirements. Over the last 30 years, industry standard practices have evolved, technology has changed, and financial practices and resources have expanded. In working with utilities of all ages, we see patterns

in the way utilities mature. Using the Cities of Raleigh and Burlington as case studies, this session will look at the evolution of stormwater utilities. The City of Burlington has historically charged one flat stormwater fee per customer. They are moving toward an impervious area-based fee which better aligns the costs of service provision with demand. At the same time, the City is evaluating its level of service, considering whether it might be able to do more to assist with drainage issues on private property. Burlington participates in the Little Alamance Creek Healthy Streams Cooperative between the City of Burlington, the City of Graham, and NCDOT. The program helps promote water quality monitoring, stream enhancements, public outreach and education, and pollution prevention and reduction. The City of Raleigh has had an impervious area-based fee for many years. Presently, its conducting longer-term capital program and financial planning and, in light of its demonstrated stable revenue source, is considering issuing its first stormwater utility revenue bonds in the near future. Raleigh has a Stormwater Management Advisory Committee (SMAC) that approves projects and costs associated with the Raleigh Rainwater Rewards Program. This program provides stormwater customers an affordable way to reduce their runoff.

Finding the Sweet Spot: Information Exchange to Inform Prioritizing Stormwater Management Actions

Presenter: **Kristina Hopkins**, U.S. Geological Survey, khopkins@usgs.gov

This participatory session will be an information exchange for water resource professionals. The session will focus on approaches used to target the placement of urban stormwater management practices. Attendees will share their perspectives on (1) deciding when/where/how to implement stormwater management strategies and (2) what information and tools are used to guide stormwater management intervention selection and placement. Participants will discuss how they weight constraints (e.g., costs, site logistics) versus opportunities (e.g., new development, new funding resources) to identify the "sweet spot" for stormwater management implementation that optimizes resources and effectiveness. The session conveners will develop a list of information gaps that could be beneficial to participants to inform prioritization of stormwater management action. While the discussion will focus predominantly on installing new or retrofitting stormwater control measures, concepts may be transferable to reducing impervious surface area, tree plantings, preservation, stabilizing and restoring streams, etc.

Nutrient and Bacteria Treatment by Five Onsite Wastewater Systems in the Triassic Basin Region of the Falls Lake Watershed, North Carolina

Presenter: **Charles Humphrey**, East Carolina University, Humphreyc@ecu.edu
Co-authors: Jordan Jernigan, Guy Iverson, and Mike O'Driscoll, East Carolina University

The Triassic Basin is characterized as having soils with high shrink-swell potential and low Infiltration capacity associated with expansive clay minerology making soil-based treatment and dispersal of wastewater challenging. Many onsite wastewater systems (OWS) were installed in this region 40 or more years ago and are still in operation, but there is a lack of field data regarding their performance. Five sites with OWS including 4 conventional-style and 1 single-pass sand filter were evaluated for their nitrogen, phosphorus, and E. coli treatment efficiencies. Concentrations of nitrogen and phosphorus in groundwater sampled from wells near the OWS were between 54 to 95% and 55 to more than 99% lower respectively, relative to concentrations in wastewater. Effluent from the sand filter had mean nitrogen and phosphorus concentrations that were 78% and 82% lower relative to influent concentrations. Mass removal efficiencies ranging from 26 to 92% for nitrogen and 18 to more than 99% for phosphorus were reported near the systems with further reductions down-gradient. Groundwater near 3 of the 4 soil-based OWS had median E. coli concentrations of less than 3 MPN 100 mL^{-1}. However, one OWS with less than 10 cm of vertical separation to groundwater, and effluent from the sand filter OWS both had median E. coli concentrations that exceeded 2,400 MPN 100 mL^{-1}. Malfunctioning and improperly maintained systems are sources of nutrients and bacteria to adjacent surface waters. OWS that are installed with sufficient separation to groundwater and that are maintained may be effective at nutrient and bacteria treatment.

Evaluating Nitrogen Treatment by Onsite Wastewater Systems in Raleigh Belt Geology: A Preliminary Assessment

Presenter: **Guy Iverson,** East Carolina University, iversong18@ecu.edu
Co-authors: Charles P. Humphrey Jr., Michael O'Driscoll, Natasha Bell, John Hoben, Will Shingleton, Precious Esong Sone, East Carolina University

On-site wastewater systems (OWSs) can be a significant source of nitrogen to water resources, which can be problematic for nutrient-sensitive waters. Recent work in the Falls Lake Watershed found that OWSs in the Triassic Basin can contribute elevated nitrogen to shallow groundwater and surface water. However, these studies noted a need for more work to assess nutrient inputs from OWS in the Raleigh Belt, which was the goal of this study. Three residences within the Raleigh Belt were identified and instrumented with piezometers between and/or downgradient of OWS drainfields. Two of the sites were intersected by small streams that drain the community, and both streams at these sites were also monitored. Approximate bimonthly sampling began in February 2022 and will continue through Spring 2023. Wastewater from OWS tanks, groundwater beneath and/or downgradient of OWS drainfields, and/or adjacent streams were sampled and analyzed for total dissolved nitrogen (TDN), chloride, ammonium, and nitrate. Preliminary results indicated that wastewater contained the greatest median concentration of TDN (59.3 mg/L). Median TDN concentration in drainfield groundwater, downgradient groundwater, and adjacent streams was 83%, 97%, and 97%, respectively, lower than wastewater. Mass removal of TDN (via a mixing model) ranged from 57 – 91%, suggesting that dilution was not the only reduction mechanism. Despite these reductions, concentrations of TDN in groundwater and surface water remained elevated relative to reference conditions to the ecoregion where this study occurred. Continued work at these sites will provide additional information to constrain OWS treatment by soils in Raleigh Belt geology.

Quantifying Water Quality Downgradient from Onsite Wastewater Systems in the Raleigh Belt: A Preliminary Assessment of Phosphorus and Escherichia coli Concentrations

Presenter: **Guy Iverson**, East Carolina University, iversong18@ecu.edu
Co-authors: Charles P. Humphrey Jr., Michael O'Driscoll, Natasha Bell, John Hoben, Will Shingleton, and Precious Esong Sone, East Carolina University

Onsite wastewater systems (OWSs) are commonly used in rural communities to provide wastewater treatment in North Carolina. OWSs can be a significant source of phosphorus and Escherichia coli, which can degrade or impair water resources. Recent studies in the North Carolina Piedmont have focused on the Triassic Basin but emphasize a need to study OWS treatment in other Piedmont geological provinces. This study assessed phosphorus and E. coli treatment by OWSs in Raleigh Belt geology. Three residences using OWSs were identified within the Raleigh Belt, and each site was instrumented with piezometers to sample groundwater beneath the drainfield. Additionally, 2 of the 3 sites drained to an adjacent stream, which was also monitored. Samples were collected approximately bimonthly beginning in February 2022 and will continue through Spring 2023. Wastewater, groundwater underlying drainfields, and streams were analyzed for total dissolved phosphorus (TDP) and E. coli. Wastewater contained the highest median concentrations of TDP (6.69 mg/L) and E. coli (414,000 MPN/100 mL). Median concentrations of TDP and E. coli were 0.11 mg/L and 3629.4 MPN/100 mL, respectively, in drainfield groundwater. Streams contained a median TDP and E. coli concentration of 0.05 mg/L and 1,282.9 MPN/100 mL, respectively. These data show that OWS are highly effective (> 98%) at reducing TDP and E. coli concentrations. However, streams contained TDP and E. coli concentrations that were elevated relative to ecoregion reference conditions (TDP) and recreational water quality recommendations (E. coli). Continued work at these sites will further constrain OWS treatment in Raleigh Belt geology.

Predicting Future PFAS Concentrations in Groundwater Discharging to Streams Near the Fayetteville Works Facility

^ Presenter: **Craig Jensen**, NC State University, crjense2@ncsu.edu
Co-authors: David P. Genereux, NC State University; Detlef R. U. Knappe,

North Carolina State University; D. Kip Solomon, University of Utah; Troy E. Gilmore, University of Nebraska Lincoln

Widespread PFAS contamination of groundwater in the area surrounding the Fayetteville Works facility near Fayetteville, NC has put critical drinking water resources at risk. Analysis of discharging groundwater at the groundwater-surface water interface in October 2020 provides insight into historical PFAS input to the groundwater system and future discharge of PFAS to four tributaries of the Cape Fear River. SF6, 3H, and 3H/3He age-dating methods were used to estimate the age of groundwater at 20 points below the streambeds of Kirks Mill Creek, Willis Creek, Mines Creek, and Georgia Branch. Groundwater ages show a transit time distribution (TTD) spanning 0 to 39 years with a flow-weighted mean age of 19 years. Groundwater ages and concentrations of 37 different PFAS indicate PFAS input to the groundwater system steadily increased from the documented start of PFAS production at Fayetteville Works until roughly the present day. Historical PFAS input, and a rapidly-declining input in recent years based on reported deep reductions in PFAS air emissions since 2019, were weighted by the TTD using convolution modeling to predict past and future flow-weighted mean concentrations of PFAS in groundwater discharging to the tributaries. The predicted PFAS concentrations represent the spatially-integrated concentration in output from the contaminated groundwater system to streams. Modeling results under various scenarios of declining PFAS input post-2019 suggest that groundwater will continue to contain total quantified PFAS concentrations above 70 ng/L until at least 2060.

Biochar – A Multi-Beneficial and Cost-Effective Amendment to Clay Soil

^ Presenter: **Mohammad Khalid**, UNC Charlotte, mkhalid1@uncc.edu
Co-authors: Denise Adjidjonu, Jacelyn Rice-Boayue, and Mariya Munir, UNC Charlotte

Highways are considered a major source of pollution to stormwater and its runoff can introduce various contaminants including nutrients, Indicator bacteria, heavy metals which can have negative impacts on receiving waters. This study assessed the ability of biochar for contaminants removal and to improve the water retention and hydraulic conductivity of soil biochar mixture. Ten commercially available biochar has been strategically selected. Lab scale batch testing was done at 3% and 6% by the weight of the soil to find the preliminary estimate of contaminants removal along with hydraulic conductivities, and water retention capacity. Furthermore, from the above conducted studies, six best performing candidate and application rate of 6% has been selected for the column studies. Soil biochar mixture was filled in 3in assembled column up to a fixed height of 30in based on hydraulic conductivity. Total eight column experiments have been conducted for nutrient, heavy metal and indicator bacteria analysis over a period of one year, which includes a drying as well as a deicing period. The saturated hydraulic conductivity was greatly improved which is attributed to high porosity of biochar soil mixture. The column effluents were examined and the data demonstrate that most of the biochar successfully removed up to three logs for the indicator bacteria and up to 90% nutrients removal efficiency has been found with three biochar. These results demonstrate that biochar could be efficiently applied with clay soil to improve the soil hydraulic characteristic was well as remove the pollutants from the stormwater runoff.

Flood Mitigation Assessment of Stream Debris Removal

Presenter: **Jack Kurki-Fox**, NC State University, jjkurkif@ncsu.edu
Co-authors: Barbara Doll, NC Sea Grant and NC State University; Daniel Line, NC State University

Millions of dollars are spent each year in North Carolina to remove debris (primarily large wood) from streams to reduce future flooding; however, aside from anecdotal observations, there has been little analysis or scientific documentation of the flood reduction benefits of these actions. There are also potential negative impacts of debris removal as large wood naturally supplied by the adjacent riparian buffer and upstream watershed sources is critical to stream and river habitat. The goal of this project was to quantify the flood reduction benefits of debris removal. Three streams that were allocated funds for debris removal activities were selected for debris inventory and hydraulic modeling analysis. At each stream, channel cross sections were surveyed and the woody debris in the channels were inventoried along a 2500-foot reach. The survey cross sections and NCEM LiDAR data were used to develop 2D HEC-RAS models of each stream and several scenarios were evaluated: (1) existing condition with inventoried debris, (2) debris removed, and (3) 25%, 50% and 75% of the channel blocked by wood debris. Discharges corresponding to the 10-, 25-, 50-, and 100-year return periods were modeled. In addition to site specific modeling, a sensitivity analysis was conducted by varying the width of the floodplain, the stream channel slope and percent channel blockage in the hydraulic model. The impacts of debris removal across various storm return periods will be presented along with recommendations for debris removal site selection and evaluation.

Combined Anaerobic Degradation and Micro-algae Treatment of Swine Wastewater Using Lab-Scale Bioreactors

^ Presenter: **Mehdi Lamssali**, North Carolina A&T State University, mlamssali@aggies.ncat.edu
Co-authors: Dongyang Deng, Shobha Mantripragada, Lifeng Zhang, and Liesl Jeffers-Francis, North Carolina A&T State University

The recent rapid increase in global pork demand has engendered an escalation in swine wastewater production, which has become a substantial environmental concern. The untreated disposal of swine wastewater containing high levels of organic compounds and nutrients is responsible for significant impacts on both public health and the ecosystems alike, prompting issues such as eutrophication or hypoxia. Moreover, industrial contaminants belonging to the PFAS category such as GenX have also been reported in agricultural wastewater systems posing a considerable risk to human health. For this reason, this paper's objective is to present a combined approach to treating swine wastewater collected from North Carolina Agricultural and Technical University (NCAT) through anaerobic degradation and micro-algae treatment using lab-scale bioreactors as well as investigate the effect COD/Sulfate ratios and the presence of GenX on organics and nutrient degradation potential. Various operational parameters such as COD, nutrients, and solids are monitored. Results of anaerobic degradation demonstrated efficient degradation under a COD/Sulfate ratio of 2:1 suggesting a significant reduction in present organic matter through an observed COD reduction of 86% and 88 % across reactor B, C containing swine wastewater and 61% for reactor D with the presence of GenX. Similar results were also reported among sulfate concentrations with a degradation of 87%, 82 % & 66 % across reactors B, C and D respectively. Nutrient and solids degradation have also been assessed. SEM analysis along with FTIR, Raman, and XPS characterization were also used. Micro-algae are then utilized for post-treatment of swine wastewater.

Daily Inflow and Infiltration at Wastewater Treatment Plants Across North Carolina

^ Presenter: **Allison Lee,** UNC Chapel Hill, alee2@unc.edu
Co-authors: Ricky Strott, UNC Chapel Hill; Larry Cahoon, UNC Wilmington; Steven Berkowitz, NC Dept. Health and Human Services; Larry Engel, UNC Chapel Hill; David Holcomb, UNC Chapel Hill; Ariel Christensen and Stacie Reckling, NC Dept. of Health and Human Services and NC State University; Helena Mitasova, NC State University; Aaron Salzberg, UNC Chapel Hill; Jill Stewart, UNC Chapel Hill; Virginia Guidry, NC Dept. of Health and Human Services; Rachel Noble, UNC Chapel Hill; Marc Serre, UNC Chapel Hill

Inflow and infiltration (I&I) describe the entry of stormwater and groundwater, respectively, into wastewater infrastructure. I&I increases wastewater flows, contributing to higher operating costs at wastewater treatment plants (WWTPs) and increasing the likelihood of wastewater bypass. I&I can also inform calculations under development for wastewater-based disease surveillance programs. We used antecedent precipitation as a predictor of wastewater flow to estimate I&I experienced at North Carolina (NC) WWTPs. We obtained precipitation and flow data from 1,742 rain gauge stations and 28 WWTPs, respectively, from 2017 through mid-2022. We then employed a space/time geostatistical framework to estimate daily precipitation experienced at each WWTP point location. From these estimates, we created multivariable linear

regression models for each WWTP, using 1-, 3-, 7-, 10-, and 14-day antecedent precipitation increments as predictors of wastewater flows. From these models, we attributed the y-intercept to average daily baseflow, the portion of flow predicted from 1-day antecedent precipitation to inflow, and the remaining flow to infiltration. We found that baseflow ranged from 0.04-43.70 million gallons per day. Daily inflow, averaged across the study duration, ranged from 2% to 14% of baseflow across WWTPs. Likewise, average daily infiltration ranged from 5% to 42% of baseflow across WWTPs. This work highlights the wide range of I&I experienced across NC WWTPs. The I&I regression model uses precipitation to predict daily I&I for each WWTP, serving as a useful tool for statewide and national wastewater surveillance programs. We plan to extend our future analyses to estimate precipitation over WWTP sewershed areas.

Water Quality for Fisheries

Presenter: **Riley Lewis**, Coastal Carolina Riverwatch, rileyl@coastalcarolinariverwatch.org
Co-authors: Lisa Rider, Coastal Carolina Riverwatch

The purpose of the Water Quality for Fisheries Program and assessment is to identify and address the impacts of water quality on North Carolina fisheries. The Program included water quality surveys given to commercial and recreational fishers in coastal NC, the creation of an Industry working group to elaborate on top rated concerns, and outreach material to share results and impacts with the public. The Assessment is a living document that has been written by the research and assessment team at CCRW, and includes staff, interns, board members, the Industry Working Group (made up of commercial and recreational fishing representatives), and advisors that work specifically on prioritized water quality concerns in North Carolina. The Project and Assessment are categorized by the following methodologies for addressing each water quality concern: Infrastructure, Policy and Enforcement, Research, and Outreach. Water Quality Priorities Identified by Coastal North Carolina Fisheries Representatives are ranked as 1) Agriculture and Factory Farm Runoff, 2) Stormwater Runoff from Roads, Highways, and Parking Lots, 3) Industrial Pollutants, 4) Plastic Pollution and 5) Municipal Wastewater Treatment Plants and Septic Tanks. As part of the 2021-22 WQ4F Program, a 30 minute Documentary Film "Tidal Alert: The State of Water Quality and its Impacts on Coastal Fisheries" has been created to showcase the research findings and elaborate on water quality issues as they relate to fisheries.

Effects of Livestock Exclusion on Pollutant Export from a North Carolina Beef Cow Pasture

Presenter: **Daniel Line**, NC State University, dan_line@ncsu.edu
Co-authors: Barbara Doll, NC State University

Fencing was installed to exclude cattle from two adjacent small streams on a beef and swine farm located in central North Carolina. The two streams, referred to as UTA and North, originated in a pasture used for beef cow production and application of swine waste. Rainfall and discharge were continuously monitored for 1.34 years prior to and 1.8 years after the fencing was installed in order to quantify the effect of the livestock exclusion on pollutant export/loads in the two streams originating in the pasture. Monitoring results documented reductions in total nitrogen (TN), phosphorus (TP), and total suspended solids (TSS) export via the North stream by 15%, 54%, and 67%. Monitoring on the UTA stream was restarted 3.7 years after the initial 1.8 years and continued for about 1 year to assess the effect of natural vegetation growth and stream channel soil recovery. The combined reductions for the two periods were 39%, 64%, and 74% for TN, TP, and TSS. Export of TN, TP, and TSS during the later monitoring period decreased by 13%, 60%, and 22% compared to the initial 1.8-year monitoring period. These results indicated that exclusion fencing was effective at reducing pollutant export during the first 1.8 years, and that its effectiveness increased after about four years. Consequently, studies that report effectiveness during the first 2-4 years after exclusion likely underestimate the long-term effectiveness of the exclusion fencing.

Pollutant Source Tracking: Using Multiple Methods to Find Causes of Water Quality Issues in Urban Streams

Presenter: **J.V. Loperfido**, City of Durham Public Works Department, john.loperfido@durhamnc.gov
Co-authors: Clifton F. Bell, Tamara L. Sorell, Brown and Caldwell

Urban watersheds contain complex hydrologic pathways that can make it difficult to find and eliminate pollution sources to streams. Stormwater utilities often rely on stream monitoring and illicit discharge detection and elimination (IDDE) methods which are usually suitable for finding singular pollution sources. However, some water quality issues in urban streams arise from simultaneously occurring processes, making the identification of pollutant sources difficult. This was the case in two streams in Durham, NC where previous monitoring identified low dissolved oxygen (DO) concentrations and stream sediment containing metals and polynuclear aromatic hydrocarbons (PAHs). Since traditional IDDE methods were not able to identify causes for these issues, a multi-method field monitoring approach was used in this project. In Sandy Creek Tributary A, causes of low DO concentrations were investigated using traditional stream sampling and IDDE methods paired with a thermal imagery stream survey and microbial source tracking. In Warren Creek, metals and PAHs in the stream sediment were examined using synoptic sampling techniques and a screening-level risk assessment. The multi-method approach used in this project enabled identification of several causes of water quality issues in these two streams. These causes included pollutant discharge to the storm drainage system, non-point source pollution, and natural stream/groundwater interactions. This project highlighted the usefulness of using multiple field-monitoring methods to unravel the complex interaction of urban hydrology with pollutant flows in these streams. Understanding of pollutant flows provides direction on strategies for managing pollution discharges to the storm drainage system and improving instream water quality.

Hydrolytically Stable Ionic Fluorogels for High-Performance Remediation of Per-and Polyfluoroalkyl Substances (PFAS) from Natural Water

*Presenter: **Irene Mulloy Manning,** UNC Chapel Hill, irene.manning@unc.edu
Co-authors: Nick Guan Pin Chew, Haley P. Macdonald, Orlando Coronell, and Frank A. Leibfarth, UNC Chapel Hill

Per-and polyfluoroalkyl substances (PFAS) are small molecules used widely in industrial processes, consumer products, and fire-fighting foams. They contaminate waters worldwide and are associated with adverse human health effects, necessitating effective remediation strategies. Motivated by the limitations of current technologies, we identified two design parameters native to anionic PFAS, fluorophilicity and ion exchange, which we hypothesized could be synergistically leveraged for selective PFAS sorption. The synthesis of systematic libraries of Ionic Fluorogels with varied compositions of fluorous and electrostatic components led to the identification of optimized resins demonstrating selective, rapid removal of anionic PFAS, facile regeneration, and promising removal of PFAS in flow-through packed beds. Careful choice of the fluorinated matrix enabled chemical stability and avoided PFAS production and leaching. The design principles developed will inform further materials development and optimization toward multikilogram-scale synthesis for pilot-scale implementation.

Falls Lake Watershed Characterization, Data Evaluation, and Modeling Results to Inform a Revised Nutrient Management Strategy for Falls Lake

Presenter: **Alix Matos and Forrest Westall**, Brown and Caldwell, McGill Associates, and Upper Neuse River Basin Association, amatos@brwncald.com and forrest.westall@mcgillassociates.com

The Upper Neuse River Basin Association (UNRBA) has recently developed an updated watershed model for the Falls Lake watershed using the Watershed Analysis Risk Management Framework (WARMF). The UNRBA conducted extensive coordination with local governments, state and federal agencies, and subject matter experts to obtain local data for input to the model. This presentation will review the unique characteristics of the Falls Lake watershed and the

progress to date to reduce nutrient loading to Falls Lake. A brief summary of the model inputs and the simulated loading to Falls Lake under varying hydrologic conditions will be presented along with source contributions by land use type and other source categories. A summary of the model calibration for stream flow and water quality concentrations will be provided as well as comparison to monitoring studies of forested catchments in the watershed by the US Forest Service. Application of the watershed model to develop lake water quality models for Falls Lake will be discussed in the next presentation of this session.

Application of Water Quality Measurement Data from Stream Mitigation to Improve Standardization of Stream Project Selection and Refine Pollutant Reduction Models Employed in Design Justification

Presenter: **Gregory Melia**, NC DEQ Division of Mitigation Services, Gregory.Melia@ncdenr.gov
Co-authors: Danielle Mir, Periann Russell, and Lin XU, NC DEQ Division of Mitigation Services

The NC DEQ Division of Mitigation Services (DMS) provides much of the compensatory mitigation in North Carolina via stream, wetland, and buffer restoration projects. Projects are selected through a competitive proposal process comparing prospective projects for their functional improvement potential to include qualitative, descriptive metrics for reductions of fecal coliform bacteria (FCB), nutrients, and sediments. Projects that are selected for implementation are then subject to a design process that includes the use of a simple model adopted by DMS to provide a component of design justification in the form of quantitative reduction estimates for these same pollutants. The primary stressors for most projects evaluated are related to pasture operations. To better inform and quantitatively define these water quality metrics in project selection and refine coefficients in the model reduction estimates, DMS and its academic partners are rigorously monitoring a series of reaches for fecal coliform, nutrients, and sediment subject to pasture related stressors. Measurement of water quality and loads that represent the settings and practices typical for NC mitigation taken in concert with other project attributes that may be deterministic for concentrations and loads will help achieve these refinements to selection and reduction estimates. Categories of potential deterministic variables will be discussed including landform, soils, and pasture management.

wqReport: A Tool for Compiling and Visualizing Watershed Data

Presenter: **Michelle Moorman**, US Fish and Wildlife Service, michelle_moorman@fws.gov
Co-authors: Laura DeCicco, John Faustini, Nathan Hall, Ashton Drew

wqReport is an R-based tool that utilizes the dataRetrieval R package to streamline the preparation of water-quality assessment reports for National Wildlife Refuges and HUC8 or HUC10 watersheds throughout the United States. Reports are prepared through automated retrieval of data from online databases followed by automated processing, including standardization and collation of the data and generation of tabular and graphical data summaries. In the summer of 2019, the Southeast Inventory and Monitoring Branch of the U.S. Fish and Wildlife Service (USFWS) collaborated with the University of North Carolina's Institute of Marine Sciences and KDV Solutions to complete a pilot project demonstrating the feasibility of automating the collection, assembly, and summary of data resources from the Water Quality Portal, a cooperative effort by U.S. Geololgical Survey (USGS), the Environmental Protection Agency (EPA), and the National Water Quality Monitoring Council (NWQMC) that integrates publicly available water quality data from multiple sources. The pilot work provided USGS and USFWS the core code and structure to generate automated reporting. This past year, our team worked together to (1) improve the code to meet agency requirements and publication quality standards and (2) to integrate edits and new features requested by USFWS. We are currently using wqReport to prepare water quality reports for all 131 Refuges in the Southeast Region, which will be archived in ServCat. We will present the tool and its applications in this webinar and expect it will be of interest to anyone needing water-quality information.

Adaptations in Beaver Habitat Selection May Offer Partial Nature-Based Solutions to Multiple Stormwater Problems in Urban Watersheds

^ Presenter: **Chris Norcross**, NC State University, conorcro@ncsu.edu
Co-authors: Karl Wegmann, NC State University

The North American beaver (Castor canadensis) has been an integral part of healthy stream ecosystems for much of recent evolutionary time (>7 million years). Today, the increasing urbanization of many watersheds has contributed to significant societal-level concerns involving terrestrial water availability, water quality, and downstream flooding. Existing research indicates that historic land use practices likely altered the physical shape of Piedmont stream valleys, leading to elevated bank heights and incised stream channels. More recent increases in impervious land cover have consequently increased the speed and volume of stormwater runoff reaching stream channels. Frequent bankfull stormflow conditions in urban watersheds increase in-channel stream power and cause routine overbank flooding onto adjacent floodplains. Beavers in urban watersheds in the Raleigh and Durham, North Carolina areas, appear to have adapted to these effects of watershed urbanization by selectively colonizing urban riparian wetlands rather than constructing dams across the main stream channels; they maintain these alternate habitats by building small floodplain dams to retain captured stormwater in low relief areas behind natural levees. Our ongoing research suggests that, by taking advantage of anthropogenically-altered stream morphology and hydrology, beavers may be helping to capture and retain some stormwater runoff in urban wetlands, potentially improving overall water quality, supporting important wetland habitats, and mitigating undesirable downstream effects such as flooding and eutrophication. We believe that, where they are permitted to exist in our watersheds, beavers offer low-cost, nature-based partial solutions to multiple water-related issues.

Tailoring Ecological Flow Guidance to Coastal Watersheds: Examples from the Trent River

Presenter: **Michael O'Driscoll**, East Carolina University, odriscollm@ecu.edu
Co-authors: B. Christian, G. Iverson, J. Petersen-Perlman, R. Asch, Neda Safari, Kayla Robinson, and Taylor Savitski, East Carolina University

Ecological flows define the quantity and timing of streamflow necessary to maintain ecological integrity in river systems. Progress has been made on quantifying the ecological flow needs for North Carolina's inland rivers. However, there is limited understanding of the ecological flow requirements for coastal rivers and estuaries, where flow characteristics are more complex due to wind and tides. There is a need to develop ecological flow guidelines for NC coastal rivers and estuaries as recent studies have shown a decline in low flows along Coastal Plain rivers. Low flows can affect coastal ecosystem processes due to their influence on saltwater intrusion, water level, water quality, residence time, and habitat connectivity. To develop a framework for evaluating coastal ecological flows, we reviewed pre-existing literature and implemented a pilot project on the Trent River. These efforts focused on understanding water level and specific conductivity dynamics in the riverine-estuarine transition zone, effects of low flows and increased salinity on wetland habitat and fish communities, influence of water use on low flows, and stakeholder preferences regarding potential policy actions. In the inland portion of the watershed, low flows influenced river stage variability and the extent of aquatic habitat. Near sea level, the influence of flow on stage variability was diminished due to downstream controls on water levels. In the riverine-estuarine transition zone, low-flows can influence inland saltwater intrusion, which can impact fish and vegetation communities. Stakeholder surveys revealed openness to monitoring and regulating large-quantity users and preferences for creating subsidies to increase water conservation.

Source Identification of Dissolved Organic Matter (DOM) in Surface Waters Using Fluorescence and a Simple and Rapid Linear Regression Method

Presenter: **Christopher L. Osburn**, NC State University, closburn@ncsu.edu
Co-authors: Jordan Bryan and Peter Hoff, Duke University

Dissolved organic matter (DOM) is an important component of the

biogeochemistry and ecosystem function of streams and rivers. Unlike inorganic nitrogen nutrients, organic nitrogen (DON) nutrients can vary considerably depending on the contributions of various sources. Properties of DOM in natural waters have been measured using fluorescence spectroscopy, which is inexpensive compared to more sophisticated chemical analysis and is fast enough to enable its use in routine water quality monitoring. However, estimating contributions of DOM sources to surface waters from fluorescence data in a similarly efficient manner remains an area of active research. In this presentation, a simple linear regression method for estimating the relative amounts of DOM sources in a stream or river sample is shown. The regression estimates are more accurate than those of previous approaches, such as PARAFAC, and are orders of magnitude faster to compute. Code and data to implement the method are described for a variety of computing environments, including Google Colaboratory, to facilitate use for water quality and research applications.

Assessing Temporal Variability of Antibiotic-Resistant E. Coli in Surface Water Near Animal Feeding Operations

*Presenter: **A B M Tanvir Pasha,** NC State University, apasha@ncsu.edu
Co-authors: Angela Harris, NC State University

Fecal contamination in surface water is a major health concern and has the potential to disseminate antimicrobial resistance (AMR) organisms in the environment. North Carolina has nearly 9000 poultry and hog farms across the state, representing the potential risk of pathogen transmission in surface water during extreme precipitation. Water samples were collected from the upstream and downstream of Neuse and Cape Fear Rivers from July 2021 through September 2021, inside Duplin and Wayne Counties. 35% of the samples (n=26) on Neuse River and 42% of the samples (n=26) on Cape Fear River exceeded the EPA safety limit for general E. coli for recreational water quality (126 CFU/100mL), respectively. Cefotaxime-resistant E. coli was detected in 15% of the samples from both rivers, indicating contamination from nearby CAFOs. Optimized and validated LA35 gene targets for swine and poultry were detected using ddPCR in 38% of the samples from Neuse River downstream and Cape Fear River upstream site. Cape Fear River downstream site detected LA 35 target in 46% of the samples. Detection of LA 35 target and general E. coli concentrations for Neuse River was not correlated (t-test, $p>0.10$); however, it was correlated for Cape Fear River (t-test, $p<0.01$) [pearson's $r=0.16$]. Intermittent detection of LA35 and its correlation with E. coli suggest that swine and/or poultry feces is present in these rivers. However, the proportion of contamination that can be attributed to these hosts remains unclear. Developing improved poultry and swine MST assays will be important to distinguish between these hosts.

Urban Riparian Buffers: Maintaining and Managing an Ecologically Functioning Riparian Buffer on Little Alamance Creek in Burlington, North Carolina

Presenter: **Robert Patterson**, **Amy Barber, and Jason Barnhill**
City of Burlington, abarber@burlingtonnc.gov

While the importance to protect and enhance urban streams is well known across many professional fields, the degradation of streams is commonly observed among water resource managers as Urban Stream Syndrome sweeps through urban watersheds everywhere. The interest in managing a successful riparian buffer program in urbanized areas is rapidly growing. In 2009, a 7+ acre riparian buffer conservation easement was dedicated as part of a Division of Mitigation Services stream restoration project. The project was aimed at improving water quality, enhancing flood attenuation, and restoring aquatic habitat through the implementation of several measures, including the establishment of a vegetative buffer adjacent to Little Alamance Creek flowing through the City of Burlington. With no long-term management plan in place, the buffer quickly became overgrown with densely grown invasive vegetation which limited visibility, threatening public safety in a downtown park. Simultaneous to these concerns, the establishment of a riparian buffer along Brown Branch, a tributary to Little Alamance Creek, was underway as part of a separate stream restoration project in the Arboretum at Willowbrook Park. Residents, City officials, and public safety managers quickly began questioning the goal and future appearance of the newly planted buffer. The need for long-term planning to manage the buffer while balancing the safety and aesthetic needs of an urban park yet maintains th e ecological function healthy stream buffers became a priority. Join City of Burlington staff as they discuss the challenges and successes of an urban buffer program in the City.

Harmful Cyanobacterial Aerosolization Dynamics in the Airshed of a Eutrophic Estuary

*^ Presenter: **Haley E Plaas**, UNC Chapel Hill, hplaas@live.unc.edu
Co-authors: Ryan W. Paerl, NC State University; Karsten Baumann and Nathan S. Hall, UNC Chapel Hill; Colleen Karl, Chowan Edenton Environmental Group; Kimberly J. Popendorf, University of Miami; Malcolm A. Barnard and Naomi Chang, UNC Chapel Hill; Nathaniel Curtis, Hwa Huang, Olivia L. Mathieson, and Joel Sanchez, NC State University; Daniela J. Maizel, University of Miami; Amy Bartenfelder, Jeremy S. Braddy, Karen L. Rossignol, Randolph Sloup, and Hans W. Paerl, UNC Chapel Hill

In addition to negative effects on water quality in aquatic ecosystems, cyanobacterial harmful algal blooms (CHABs) also impact air quality via emissions carrying cyanobacterial cells their metabolites. However, the environmental controls on CHAB-derived aerosol and its potential public health impacts remain largely unknown. The aims of this study were to 1) investigate the occurrence of microcystins (MC) and toxic cyanobacterial communities in aerosol, 2) elucidate environmental conditions promoting their aerosolization, and 3) identify associations between CHABs and aerosol concentrations in the airshed of the Chowan River-Albemarle Sound, a eutrophic estuary in North Carolina, USA. In summer 2020, continuous aerosol samples and interval water samples were collected at two sites for analyses of cyanobacterial community composition and MC concentration. Supporting measurements were made in parallel to analyze environmental factors driving changes in CHAB-derived aerosol. A CHAB dominated by Dolichospermum occurred from late June to early August during this study. MC was not quantified in aerosol, but several aquatic CHAB genera recovered from Chowan River surface water were identified in aerosol during multiple time points, including Anabaena, Aphanizomenon, Dolichospermum, Microcystis, and Pseudanabaena. Cyanobacterial enrichment in aerosol was ultimately indistinctive between subspecies, but in association with the CHAB, the median aerosol mass concentration increased to 8.97 μg m-3 (IQR = 5.15), significantly above the non-bloom background of 5.35 μg m-3 (IQR = 3.70) ($W = 1835$, $p < 0.001$). Results underscore the need for highly resolved temporal measurements to conclusively investigate the role that CHABs play in regional air quality.

Simulating Green Stormwater Infrastructure Implementation In Residential Areas

^ Presenter: **Jingyi Qi,** UNC Charlotte, jqi1@Uncc.edu
Co-authors: Nicole Barclay, UNC Charlotte

Adverse stormwater runoff risks are elevating as urbanization increases due to the replacement of natural soil cover with impervious surfaces. Green stormwater infrastructure, often used in conjunction with traditional gray stormwater management systems, aims at mitigating excess urban runoff quantity and associated potential impairment to water quality by using nature-based designs. However, GSI is less implemented in residential areas with regulatory limitations. Thus, in face of the irregular precipitation patterns associated with climate change, there is an urgent need to better devise decision support tools to better understand potential impediments among residents for GSI uptake. This study shows an agent-based model (ABM) based on two prominent behavior theories, the theory of planned behavior and the innovation diffusion theory, to simulate the GSI adoption in residential areas using a case study based in Mecklenburg County, NC. This work explores the presence of cognitive biases including risk aversion and status quo bias. The results suggest that the impact of risk aversion can be significant when the number of existing GSI adopters is low, which stabilizes the prevalence of the status quo bias among the target population. It is recommended to use proper framing when approaching GSI adopting issues with residents to minimize the status quo bias.

Healthy Forests = Healthy Watersheds: OWASA'S Forest Management Program to Protect Its Water Supplies

Presenter: **Ruth Rouse and Dave Halley**, Orange Water and Sewer Authority (OWASA); True North Forest Management Services, rrouse@owasa.org
Co-authors: Monica Dodson and Johnny Riley, OWASA

OWASA recognizes that healthy, diverse forests are more resistant and resilient to stresses from drought, infestation, wildfire, storms – all potential impacts of climate change. However, when they first began to manage their 2400 acres of forest lands through practices that included cutting trees, prescribed burns, and other tools to improve their health, they met a lot of opposition to their proposed plans. OWASA re-evaluated their approach and worked with agencies, non-profit organizations, and the community to develop a vision and guiding principles for their forest stewardship program. Based on the guiding principles, OWASA used GIS to prioritize its forest lands for management, identify areas to protect, and began developing and implementing forest stewardship plans. OWASA's stewardship plans account for site-specific conditions including the type, composition, age, and quality of existing forests; underlying site conditions such as soils, slope, and orientation; and hydrology. By following science-based principles and strategies, the long-term health, vitality, and resilience of OWASA's forest land will be better than if they took no action. As a result, OWASA will better protect long-term water quality. Data collected by federal and state agencies on one of OWASA's tracts indicates that OWASA's forest stewardship program does not negatively impact water quality and has resulted in an increase in species diversity. Several neighboring landowners have asked for guidance to implement similar stewardship programs on their land, further protecting OWASA's water supply watershed.

Diagnostic Screening of Private Well Water Using High Resolution Mass Spectrometry to Support Well Users and Local Health Officials

*^ Presenter: **Hayden Rudd**, NC State University, hrudd@ncsu.edu
Co-authors: Elizabeth Guthrie Nichols and Ayse Ercumen, NC State University; Damian Shea, Statera Environmental, Inc.; Evan Kane and Amy Keyworth, Wake County

Private well users are a vulnerable population as private wells have minimal regulation and regular testing is left to the well user. Testing private well water for all regulated organic contaminants requires multiple laboratory methods. Local health officials are often uncertain which tests are most appropriate for a given well. To assist private well users and county health officials with well testing decisions and recommendations, high resolution mass spectrometry (HRMS) was used as a qualitative, diagnostic screening tool to detect a diverse array of organic chemicals in private well water samples. HRMS was used to analyze 25 private well water samples from Wake County along with one municipal tap water sample for comparison. Across the 25 well water samples, suspect screening HRMS analyses detected 106 organic chemicals; 35 detected compounds are chemicals of concern included on the USEPA's Tox21 list. There were 2 regulated chemicals detected – bis(2-ethylhexyl) phthalate and diethyl phthalate. Each well averaged 11 organic chemicals and 4 chemicals of concern. The HRMS results were reported back to well users and county health officials. Well users were interviewed before sample collection and after individual reporting-back meetings. Health officials were interviewed after reporting back of study results. All interviewees found the HRMS results useful and accessible, and the results prompted health officials to reconsider testing recommendations. This study demonstrates the utility of HRMS screening of private well water to inform well testing decisions.

The Past, Present, and Future of Our Coast and Climate

Presenter: **Sheila M. Saia and Corey Davis,** State Climate Office of North Carolina, ssaia@ncsu.edu

North Carolina's Coastal Plain region is home to a unique interplay between land, weather, and water, which has shaped its geology, cultural history, and climate, and will continue to affect how humans live and work here in the future. Last summer, in collaboration with NC State's Coastal Resilience and Sustainability Initiative, the North Carolina State Climate Office highlighted these coastal characteristics and human-felt impacts in a five-part series titled "Our Curious Coast" on the Climate Blog (https://climate.ncsu.edu/climate-blog/). These posts included insights from more than a dozen experts in areas such as oceanography, anthropology, and climate science. In this presentation, we will share more about this blog post series and key takeaways that are pertinent to water resource management professionals, such as the benefits and challenges of our coastal geography, the important role of wetland habitats for wildlife and humans alike, and how climate change is affecting coastal communities in North Carolina–and what they are doing to respond to, adapt for, and mitigate against its effects.

Panel Discussion on the Waters of the US and State

Presenter: **Rick Savage**, Carolina Wetlands Association, rick.savage@carolinawetlands.org

With an impending final definition of Waters of the US (WOTUS) scheduled for release in December 2022, and a Supreme Court decision on the Sackett vs EPA case anticipated early in 2023, federal jurisdiction over wetlands and surface waters under the Clean Water Act (CWA) is likely to see yet another shift in direction – a frequent occurrence over the last several years. In addition, the State of North Carolina has temporary rules in place for non-federal jurisdictional features with proposed permanent rules under review. This panel will include specialists from legal, consulting, non-profit, and regulatory fields to provide a moderated discussion related to this seemingly ever-shifting topic. A brief history of WOTUS and State Waters regulations will be provided, along with an update on the current (March 2023) status of federal and state rules, followed by a moderated discussion including potential legal challenges, implementation issues, and effects of any changes in jurisdiction that may result from these actions. Open dialogue and audience questions will be encouraged.

Watershed Modeling of Pollution Hotspots Under Extremes Highlights Landscape-Scale Intervention Priorities in the Cape Fear River Basin

Presenter: **Danica Schaffer-Smith,** The Nature Conservancy, d.schaffer-smith@tnc.org
Co-authors: Julie E. DeMeester, The Nature Conservancy; Daoqin Tong and Soe W. Myint, Arizona State University; Dominic A. Libera, NC State University; Rebecca L. Muenich, Arizona State University

Extreme weather conditions are associated with a variety of water quality issues that pose harm to humans and aquatic ecosystems. Under dry extremes, contaminants become more concentrated in streams with a greater potential for harmful algal blooms, while wet extremes can cause flooding and broadcast pollution. Developing interventions to improve water quality in a changing climate requires a better understanding of how extremes affect watershed processes, and which places are most vulnerable. In collaboration with the U.S. Geological Survey, The Nature Conservancy and University Partners developed a detailed Soil and Water Assessment Tool (SWAT) water quantity and quality model of the Cape Fear River Basin (CRFB) in North Carolina. The CFRB is a large and complex basin undergoing urbanization and agricultural intensification, with a history of extreme droughts and floods. The SWAT model incorporated contemporary land use, point and non-point sources, and daily weather conditions from 1979 to 2019. To identify locations where interventions are more likely to improve water quality under climate change, we created a Water Quality Risk Index summarizing contaminant load average and variability across normal conditions, dry extremes, and wet extremes. The landscape generated the majority of contaminants, including 90.1% of sediment, 85.4% of total nitrogen, and 52.6% of total phosphorus at the City of Wilmington's drinking water intake. Approximately 16% of the watershed contributed most of the pollutants across conditions. Scenarios can help evaluate the benefits and trade-offs among a variety of strategies, considering water quality, water provisioning, and flood-risk reduction potential.

A Changing Lower Cape Fear River Estuary: Impacts of Rising Waters on Ecosystems and Infrastructure

Presenter: **Roger D. Shew**, UNC Wilmington, shewr@uncw.edu

The Lower Cape Fear River Estuary extends from the river mouth at Bald Head Island to upstream of Wilmington, North Carolina - a 50 km (30 mi) distance. Port deepening since the late 1800's to plans for further deepening to 14+ m (47 ft) has led to and will increase saltwater intrusion and consequent changes in vegetation. Migration of freshwater species upstream in the Cape Fear and its tributaries has occurred as well as the formation of ghost forests, etc. Sea Level Rise (SLR), which has somewhat accelerated in the last 20 years as measured at the Wilmington tide gauge, is leading to further issues with consequential inundation to ecosystems and infrastructure. SLR projections of 0.4 – 0.6 ft (1.3 – 1.9 m) over the next 30 – 50 years will lead to significant issues in the upper reaches of the estuary that include even more frequent High Tide Flooding events, which have also greatly increased in the last two decades. Projections and possible consequences from these natural and anthropogenic effects will be highlighted along with some mitigation scenarios. It is noteworthy that even in the Wilmington area where SLR is one-half of that being experienced in northeastern NC and near Charleston, SC, that inundation scenarios will be both environmentally and economically (stormwater, roads, housing, planned development, and tourism losses) significant.

Utilizing R Statistical Software to Assess PFAs Groundwater Contamination Impacts in North Carolina

*^ Presenter: **Julianna Tresca**, NC State University, jetresca@ncsu.edu
Co-authors: Elizabeth Nichols, North Carolina State University; Andy Neal, NC Dept. of Environmental Quality

Per- and poly-fluoroalkyl substances (PFAS) are a diverse class of fluorinated chemicals with global distribution in surface and groundwater resources. In 2019, The North Carolina Department of Environmental Quality (NC DEQ) initiated routine PFAS monitoring in groundwater using their state-wide monitoring network. This project first curated NCDEQ's PFAS dataset (2019-2021) in order to build an interactive web application to visualize PFAS data using R statistical programming software and the Shiny-R studio app package. In using the app, users can easily visualize which NC counties have PFOA and PFOS concentrations equal to or above the EPA health advisory for drinking water standards. Users can also determine PFAS detection and concentrations across NC aquifers. The app shows the NC DEQ has not detected PFOA or PFOS above EPA advisory levels in monitoring wells of the Upper Black Creek (Kubc), Beaufort (Tb), and Lower Cretaceous (Klcrt) aquifers. No PFAS analytes were detected in the Lower Cretaceous aquifer (Klcrt) or Beaufort (Tb) aquifer. The R Shiny App statistical software is a useful tool to provide stakeholders access to evaluate PFAS trends in statewide datasets and to support public and governance decision-making.

Assessing Groundwater Quality in Deep Aquifers Near Fayetteville, NC: Testing the Waters for an Alternate Drinking Water Source

*^ Presenter: **Tiffany VanDerwerker**, NC State University, tiffanyvanderwerker@gmail.com
Co-authors: David Genereux, NC State University

Elevated concentrations of per- and polyfluoroalkyl substances (PFAS) have been observed in private drinking water wells within a 21-mile radius of the Chemours PFAS manufacturing plant. Almost 7,000 such wells are known to be contaminated with PFAS. The goal of our study was to collect new groundwater quality data to evaluate whether deeper aquifers are a good alternate source of high-quality PFAS-free drinking water for Chemours-area residents with contaminated wells. We collected groundwater samples from seven wells in fractured basement rock and two wells in the Upper Cape Fear Aquifer (UCFA). Samples were analyzed for VOCs, nutrients, major ions, metals, radionuclides, bacteriologic constituents, and PFAS, with few exceedances of drinking water quality standards (DWS). Fractured Basement Rock: Gross alpha radioactivity at one well (16 pCi/L) exceeded the primary DWS. Manganese (0.055 and 0.27 mg/L) at two wells exceeded the secondary DWS and one well exceeded the secondary DWS for chloride (350 mg/L). Quantifiable PFAS concentrations were less than 10 ng/L and did not exceed EPA health advisory levels (HALs). UCFA: Arsenic at one well (16 µg/L) exceeded the primary DWS. Manganese (0.27 mg/L) and iron (0.97 mg/L) at one well exceeded respective secondary DWS. Both wells had PFOA concentrations above the drinking water HAL (3.9 and 28.9 ng/L). Where the UCFA is not thick enough to serve as a drinking water source, fractured basement rock may provide a good alternative water supply. Drawbacks for deeper wells may include elevated salinity, cost of installation, and unknown PFAS migration into deeper aquifers.

Strategies for Addressing Water Affordability through Data, Benchmarking, and Partnerships

Presenter: **Simon Warren and Rachel Weinberg**, Raftelis, rweinberg@raftelis.com

The cost of providing clean and safe water is increasing, forcing water, sewer, and stormwater utilities to raise their rates. Utility bills across the country have been rising, resulting in customers paying a higher percentage of their income on utility bills. Affordability programs can be powerful tools to address the challenges brought by both increased costs of service and increased rates, but they must be executed effectively and implemented within legal and regulatory constraints. Utilities that understand their current affordability challenges and have clear goals can make services more accessible to customers while ensuring steady funding. Easily accessed data can be used to assess the depth and breadth of affordability in your community. Affordability metrics and community dialogue can be used to establish measurable and meaningful affordability goals. Collaboration with community partners to administer and conduct outreach for affordability programs can help to increase participation within state and local regulations. This presentation will discuss how to leverage data and partnerships to successfully implement or improve utility programs. Attendees will learn where and how to access and analyze relevant data to calculate affordability metrics specific to their community and discuss the limitations of such data sources. Drawing on first-hand experience with several well-established affordability programs, we will discuss how to determine realistic expectations for program participation and barriers customers face to applying for assistance. The discussion will then focus on practices that have worked in North Carolina's specific conditions to achieve affordability goals and reach as many eligible customers as possible.

Low-flow Statistics for North Carolina: Today and Tomorrow

Presenter: **J. Curtis Weaver**, USGS South Atlantic Water Science Center, jcweaver@usgs.gov
Co-authors: Toby D. Feaster, Anthony J. Gotvald, and Katharine R. Kolb, USGS South Atlantic Water Science Center

The U.S. Geological Survey (USGS) has long been a provider of low-flow statistics (e.g., the annual 7Q10 and 30Q2, winter 7Q10) used for many purposes in North Carolina (NC), most notably for water-supply planning and applications for point-source discharges to streams under the National Pollutant Discharge Elimination System. The USGS is regarded as an objective "third party" between municipalities, industries, and individuals seeking to use available waters from streams for various purposes and the regulators who must manage and protect the water resources across the State. Over the past 50 years, the USGS office in North Carolina has manually provided estimates of low-flow statistics in response to individual site-specific requests, but this service is becoming unsustainable due to increasing demand and the need for more timely delivery of data. To address this need, the USGS South Atlantic Water Science Center began a low-flow-regionalization study in April 2022 that will update low-flow statistics for gaged streams across the three-state study area of Georgia, South Carolina, and NC. The 4-year study also will provide techniques for estimating low-flow statistics at ungaged stream locations. Following the study, these techniques will be implemented within the USGS StreamStats application to allow users to rapidly estimate and obtain low-flow statistics for ungaged stream locations. This presentation will discuss the history of low-flow statistics in NC, the current study underway for the three-state region, and an example of a StreamStats low-flow determination in the state of Alabama that is anticipated to one day be available for NC.

Channel Head Erosion in Response to Anthropogenic Landscape Modification: A Case Study From William B. Umstead State Park in the Piedmont of North Carolina, With Implications for Stream Water Quality

Presenter: **Karl W. Wegmann**, NC State University, kwwegman@ncsu.edu
Co-authors: Rachel M. Atkins and DelWayne R. Bohnenstiehl, NC State University

Channel heads in Piedmont forests often show evidence of headward erosion. European-American settlement of the southern Piedmont resulted in the extensive clearing of forested hillslopes, causing significant upland soil erosion. This land disturbance resulted in the infilling of low-order piedmont valley bottoms and the down-valley displacement of channel heads. We investigated the relationship between local slope and contributing drainage area at 40 stream channel heads in North Carolina's Umstead State Park. Of the 40 investigated channel heads, 23 are located down-valley from their predicted location by an average of 175 ± 110 m. We estimate 280 ± 175 m^3 of additional soil erosion as channel heads migrate to their predicted equilibrium slope-area positions. Drainage density is used to extrapolate volumes to the 23 km^2 park by conservatively estimating that 50% of the first-order channel heads will migrate in the future, implying an additional 90 ± 55 x 103 m^3 of sediment erosion in the coming decades. Scaling these volume estimates to sampled soil nutrient values indicates that an additional 1,050 ± 660 t of C, 50 ± 30 t of total N, and 15 ± 9 t of P may enter the fluvial system in response to soil erosion at migrating channel heads in Umstead, which represents 1% of the surface area of Wake County. Regional water quality challenges posed by suspended sediments and nutrients will persist for hundreds to perhaps thousands of years, partly from non-point sources as first-order channels continue to erode headward toward their equilibrium landscape positions.

Flood Risk and Reward: Quantifying Differences in Flood Risk Under Alternative Management Strategies for Vulnerable Communities of the Cape Fear River Basin, North Carolina

Presenter: **Jacqueline S. Welles**, U.S. Geological Survey, jwelles@contractor.usgs.gov
Co-authors: Laura Gurley, U.S. Geological Survey; Danica Schaffer-Smith, The Nature Conservancy

In the past 5 years, the state of North Carolina has experienced five 0.2% annual exceedance probability storms that caused billions of dollars in damage, loss of life, water quality issues and highlighted the need to prepare for more frequent extreme events in the future. Satellite radar data analysis conducted by The Nature Conservancy (TNC) indicated that hurricane Florence flooded 186 towns and cities within the Cape Fear River Basin (CFRB), 16 of which experienced flooding on more than 50% of their land. Combining flood risk, landcover, and social vulnerability information revealed numerous candidate locations for interventions that could potentially reduce flooding in the CFRB, yet additional watershed modeling could provide estimates of the value of projects aimed at reducing flooding and protecting water quality across large, complex basins like the CFRB. The U.S. Geological Survey, TNC, and Arizona State University partnered to develop a Soil and Water Assessment Tool (SWAT) model of water quantity and quality for the CFRB. To assess the extent of intervention needed to reduce flooding impacts on vulnerable communities, this project simulates large-scale floodplain and upland forest restoration using the SWAT CFRB model and determines the resulting stage and flood extent reductions using available 'flood libraries.' Results from this modeling effort provides new data and methods that can be used by decision-makers and the public to understand and mitigate hazards to the most vulnerable communities in the Cape Fear River Basin and beyond.

Key Concepts and Principles for Developing a Revised Nutrient Management Strategy for Falls Lake

Presenter: **Forrest Westall**, McGill Associates and Upper Neuse River Basin Association, forrest.westall@mcgillassociates.com

Falls Lake is a manmade impoundment that provides regional benefits to central NC including flood control, drinking water, recreation, and aquatic life. The Falls Lake Nutrient Management Strategy passed in 2011 included an adaptive management provision that allows for re-examination of the Rules. The Upper Neuse River Basin Association (UNRBA) has undertaken this responsibility and invested approximately $10 million in the collection of monitoring data and development of watershed and lake models to improve the scientific understanding of the system. Key findings from this effort were summarized in the preceding two presentations. Throughout this process, the UNRBA has been engaging stakeholders to transition from scientific study to policy recommendations. One key outcome of this coordination was the Interim Alternative Implementation Approach (IAIA) for existing development. This five-year program is ongoing and serves as a pilot study for an investment-based compliance approach for existing development nutrient load reduction requirements (rather than tracking pounds of nutrient reductions). Staff from the Division of Water Resources, environmental advocacy and land conservation groups, and UNRBA members have been very complimentary of this alternative approach. This presentation will describe the preliminary concepts for a revised nutrient management strategy that have resulted from the data, modeling, pilot IAIA, and stakeholder discussions.

Audience Participatory Feedback Session Regarding Development of a Revised Nutrient Management Strategy for Falls Lake

Presenter: **Forrest Westall,** McGill Associates and Upper Neuse River Basin Association, forrest.westall@mcgillassociates.com

In the first two presentations of this session, the Upper Neuse River Basin Association (UNRBA) summarized the data collected in Falls Lake and its watershed, the models developed to simulate nutrient processing and delivery to Falls Lake, and key scientific findings that must be considered in the development of a revised nutrient management strategy. The third presentation described concepts for a revised nutrient management strategy for Falls Lake that reflects input from internal and external stakeholders including representatives of agriculture, forest management and research, and State agencies. This last presentation will be a participatory session where the audience is asked to provide feedback on the proposed concepts for the revised strategy including the use of an investment-based compliance approach, expansion of the strategy to include system-wide solutions, and hurdles to implementation.

Spatial Mapping of Porosity as a Function of Reynolds Number and Pore Scale Geometry

^ Presenter: **August Young (Frechette)**, Duke University, ahf12@duke.edu
Co-authors: Zbigniew J. Kabala, Duke University

Cost-effective in-situ groundwater remediation relies on proper quantification of the "immobile" zone – the volume of the pore space where through-flow does not penetrate and contaminants remain sequestered. Contaminants remain in high concentration here due to slow diffusion rates into well-connected pore spaces (i.e., mobile zones). Contaminant removal by treatment methods that fail to disturb and displace the immobile zone (i.e., steady flow pump and treat) is lengthy and therefore, costly. But effectively accessing the immobile zone requires that it first be quantified. Traditionally, the effective porosity of a medium (i.e., the porosity conducive to through-flow) is assumed to be constant. But we know this assumption to be false; effective porosity is a hydrodynamic quantity, which means that the immobile zone is too. To properly quantify the immobile zone, we study the medium at the pore scale and assume a variety of idealized pore geometries. When subject to through-flow, mobile and immobile zones naturally form. The boundary between these zones is hydrodynamic in nature and known as the separatrix. We numerically simulate the flow fields that result from a range of Reynolds numbers to observe the movement of the separatrix within the pore space. Associated stream plots illustrate the location of the separatrix. Following, we show that effective porosity, as defined by the location of the separatrix, is a hydrodynamic parameter. We illustrate this fact by spatially mapping effective porosity for vertical circulation well flows and specifying the corresponding dependence on Reynolds number for a variety of idealized pore geometries.

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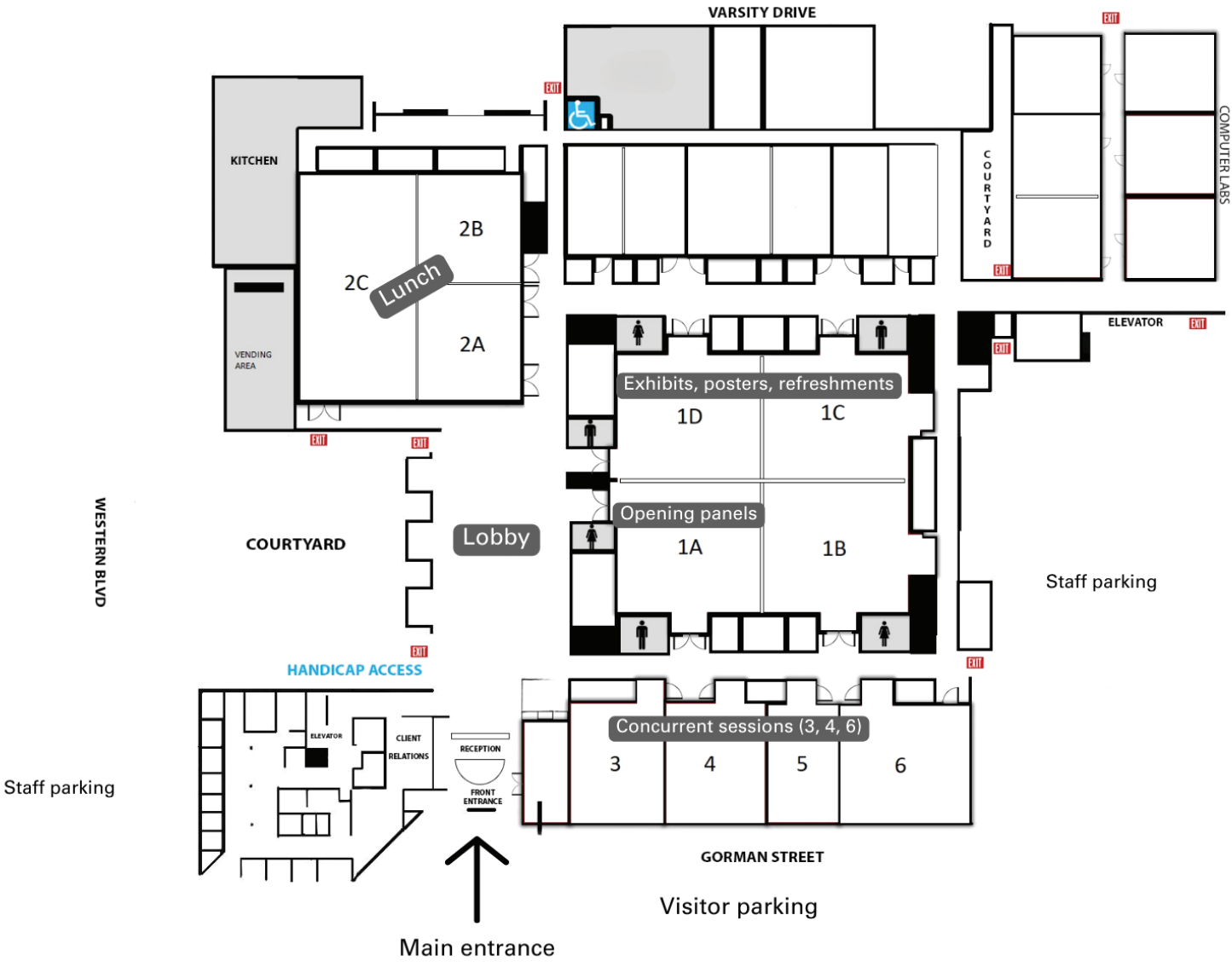


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