The Alabama Section of THE AMERICAN WATER RESOURCES ASSOCIATION

2017 Alabama Water Resources Conference Presentations

September 2017

Alabama Section of the American Water Resources Association Symposium Program

Wednesday, September 6, 2017
Theme: Effective Water Resources Communication
Registration Open – (Lobby)
Welcome & Introduction – (Salons E-H) Kenneth Odom, PE, PhD, Southern Company, AWRA President
Overview of Symposium Eve Brantley, PhD, Alabama Cooperative Extension System, President Elect, AWRA
Influencing Positive Change Barry Fagan, PE/PLS, ENV SP, CPMSM CPESC, Volkert, Inc.
Building Blocks for a Community Watershed Jonika Smith, Jefferson County Dept. of Public Health's Watershed Protection Program, Education and Outreach
NETWORKING BREAK
Commercials, Songs and Everybody's an Expert: Thoughts on the communication of science Matt Waters, PhD, Auburn University
Getting Stakeholders to the Table and Keeping Them Engaged Sabra Sutton, CH2M
A Picture is Worth More Than a Thousand Words: Communication through art
Wrap Up and Adjournment Kenneth Odom, PE, PhD, Southern Company, AWRA President

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AWRC Conference Program
Session Topics and Presenters

Thursday, September 7, 2017

Ballroom D – Session One: Watershed Management

Have the local government entities involved in water resources management evolved over the period 1990 to the present day? Have their changing roles influenced the development of water policy in the state? *Mary Wallace Pitts, University of Alabama*

Growing and Maintaining a Vibrant Watershed Group in North Central Alabama *Kevin Jenne, Watershed Coordinator, Choccolocco Creek Watershed*

Implementation Assessment for Water Resource Availability, Protection, and Utilization for the Choctawhatchee, Pea and Yellow Rivers Watersheds *Barbara Gibson, Choctawhatchee, Pea and Yellow Rivers Watershed Management Authority*

What Difference Does a Year Make? The influence of drought periods on low flow statistics and water quality trends *Lynn Sisk, TTL, Inc.*

Ballroom E – Session One: Aquatic Ecology/Biology

Quantification of Functional Marker Genes for Denitrifying Microbial Populations in the Chandeleur Islands Impacted by the 2010 Gulf of Mexico Oil Spill *Nikaela Flournoy, University of Alabama*

Non-Lethal Estimation of Proximate Body Composition of Channel Catfish Using Bioelectrical Impedance Analysis *Julie Sharp, University of Alabama*

Estimating Nitrogen Removal Services of Eastern Oyster in Mobile Bay, Alabama *Quan Lai, Auburn University*

Macroinvertebrate Community Response to Drought Years in Regulated and Unregulated Reaches of the Tallapoosa River, Alabama *Kristie Ouellette, Alabama Cooperative Fish and Wildlife Research Unit*

Ballroom F-H – Session One: Water Quantity

Limits to Water Entrepreneurship and How to Overcome Them: A case analysis *Craig Armstrong, University of Alabama*

EPA's Water Conservation & Efficiency Best Practices (formerly Region 4's Water Efficiency Guidelines) *Rosemary (Hall) Calli, Aquatic Ecotoxicologist, EPA Region 4*

Updating Low-Flow Frequency and Flow-Duration Statistics in Alabama *Toby Feaster, U.S. Geological Survey*

Hydrologic Classification of Alabama Rivers Based on Cluster Analysis of Dimensionless Signatures *Sarah Praskievicz, University of Alabama*

Ballroom D – Session Two: Water Policy/Law
Aftermath: Water policy implications of *Florida v. Georgia* *Bennett Bearden, Water Policy and Law Institute, University of Alabama*
Multi-Decadal Decline of Alabama Streamflow *Glenn Tootle, University of Alabama*
A Paleohydroclimate Perspective on Alabama Water Policy *Matthew Therrell, University of Alabama*
Bridging Water Policy and Aquatic Species Conservation: What we have learned from a two-inch fish *Patrick O'Neil, Geological Survey of Alabama*
Ballroom E – Session Two: Drought/Climate Issues
Past and Future Predicted Effects of Sea Level Rise and Human Activities on Habitats and Shorelines in Coastal Alabama's Weeks Bay Watershed *Scott Jackson, Ecology and Environment, Inc.*
Land-Atmosphere Coupling and Soil Moisture Memory Contribute to Long-Term Agricultural Drought *Sanjiv Kumar, Auburn University*
Development of Bivariate and Multivariate Coastal Drought Index: A comprehensive drought assessment tool for coastal areas, bays and estuaries *Subhasis Mitra, Auburn University*
Medium Range Forecasting of Reference Evapotranspiration in Continental U.S. Using Numerical Weather Predictions *Hanoi Medina, Auburn University*
Ballroom F-H – Session Two: Weeks Bay Session
Creating a Clean Water Future for the Weeks Bay Watershed *Roberta Swann, Mobile Bay National Estuary Program*
Weeks Bay Watershed Hydrologic and Water Quality Modeling *Latif Kalin, Auburn University*
Weeks Bay Watershed Management Plan: Overview of watershed conditions and water quality *John Carlton, Double J Farms*
Ecosystem Review and Analysis for the Weeks Bay Watershed Management Plan *Tim Thibaut, Barry A. Vittor & Associates, Inc.*
Management Recommendations for the Weeks Bay Watershed Management Plan *Michael Eubanks, Thompson Engineering, Inc.*

Ballroom D – Session Three: Modeling in Water Management
Application of AnnAGNPS to Model an Agricultural Watershed in East-Central Mississippi for the Evaluation of an On-Farm Water Storage (OFWS) System *Ritesh Karki, Auburn University*
Implementing a Modified HAND Method for Real-Time Continental Inundation Mapping *Ryan McGehee, Auburn University*
Challenges, Perspectives and Understandings Regarding Wetland Function: A comparative case study *Rasika Ramesh, Auburn University*
Using Drone Images to Capture Channel Geometry for Hydrological Modeling *Thorsten Knappenberger, Auburn University*
Ballroom E – Session Three: Water Quality
Common Mistakes in Applying Statistics to Water Quality Data and How to Avoid Them *Jason Heberling, Heberling Environmental Consulting*
Establishing Comprehensive Volunteer Water Quality Monitoring *Jason Kudulis, Mobile Bay National Estuary Program*
Water-Soluble Carbohydrates Sensing System Using Boronic Acid Modified Poly (amidoamine) Dendrimers *Xiaoli Liang, University of Alabama*
Reconstructing Sediment Inputs, Water Quality and Phytoplankton Communities in Wolf Bay, Alabama from the Sediment Record *Matthew Waters, Auburn University*
Ballroom F-H – Session Three: Restoration/Remediation
Bear Point Bayou: A case study in urban coastal stream restoration *Kit Hamblen, CH2M*
Update on Grant Funded Comprehensive Steam Restoration Projects in the D'Olive Watershed, Baldwin County, Alabama *Paul Lammers, Mobile Bay National Estuary Program*
Faunal Habitat Linkages for Alabama Barrier Island Restoration Assessment at Dauphin Island *Clint Lloyd, Auburn University*
Primum Non Nocere: Fundamentals of ecological-driven remediation *John Schell, TEA, Inc.*
Ballroom D – Session Four: Connecting Agencies, Industries and Stakeholders
Examples of Local Municipalities Working with Their Universities *Michael Freeman, AWWA*
Inland Navigation in Alabama *Larry Merrihew, Coalition of Alabama Waterway Associations*
Finding and Nurturing Public Support: What cultural rhetorics can contribute to public debates on environmental initiatives and clean water policies? *Cindy Tekobbe, University of Alabama*
Alabama Oyster Shell Recycling Program: Connecting people to their Coast *Mark Berte, Alabama Coastal Foundation*

Ballroom E – Session Four: Stormwater Management
Realizing Our Sustainability Potential: Utilizing urban trees for stormwater management *Jeremy Bailey, GreenBlue Urban*
The Alabama Clean Water Partnership: Engaging students for clean water *Ashley Henderson and Sabrina Wood, Alabama Clean Water Partnership - Alabama and Tallapoosa River Basins*
Mapping and Analysis of Sedimentation in a Suburban Lake *Bret Webb, University of South Alabama*
Stormwater User Fees in Alabama *Byron Hinchey, Amec Foster Wheeler*
Ballroom F-H – Session Four: Restoration GIS in Water Management
Evaluating Baseline Watershed Conditions and Identifying Restoration Opportunities Using Mobile Data Collection Software *David Bell, CH2M*
Using GIS and Story Maps for Watershed Management and Monitoring *John Cartwright, Mississippi State University*
High Definition Stream Survey of the Duck River: Covering 120 miles in 8 days with only 2 people *Brett Connell, Trutta Environmental Solutions*
Alabama Dam Safety: Inventory update and beyond *Jeff Zanotti, Amec Foster Wheeler*

Friday, September 9, 2017

Ballroom D – Session Five: Water Resources Education and Stewardship
How You Can Be a Part of Alabama Dam Safety *Wade Burcham, Integrated Science & Engineering*
4-H Alabama Water Watch: Increasing environmental literacy and watershed stewardship through youth-focused citizen science *Mona Dominguez, Auburn University*
Establishing a Coastal Alabama Conservation Corps *Tom Herder, Mobile Bay National Estuary Program*
Accessible County Level Water Resource Fact Sheets: Experiences from your neighbor *Vincent White, USGS*
Ballroom E – Session Five: Flood Issues
Is the Present a Key to the Past or Is the Past a Key to the Present: A look into the paleoflood record of the Tennessee River in Alabama *Lisa Davis, University of Alabama*
How Can We Prepare Alabama for the Era of Water Crisis? *Jonghun Kam, Princeton University*
Gradient-Based Flood Map: A science-based policy alternative to the 100-year flood zone *Rachel Lombardi, University of Alabama*
Increasing Flood Risk Awareness and Resilience through the Alabama Floodplain Management Program *Clay Campbell, Amec Foster Wheeler*

Ballroom F-H – Session Five: Ground Water Availability/Management
Developing New Groundwater Sources: Science or serendipity? *Marlon Cook, Cook Hydrogeology, LLC*
Extremophile Relationship to Geologic Setting in the Sulfur Springs Located at Blount Springs, Alabama *David Frings, Samford University*
Status and Trends of Streamflow Recession in Tennessee from Distributional Properties of Day-Over-Day Declines *Elena Crowley-Ornelas, USGS, Texas Water Science Center*
Assessment of Groundwater Resources in Nanafalia Aquifer 2010-2016 *Amye Hinson*, *Geological Survey of AL*
Ballroom D – Session Six: Water/Wastewater Systems Management
Disinfection of Liquid Human Waste through Photoelectrochemical Process *Qing Peng*, *University of Alabama*
Scope and Impacts of Household Raw Wastewater Discharges in Three Alabama Counties *Mark Elliott*, *University of Alabama*
Tracking Wastewater Influence on Oysters (Crassostrea virginica) in a Freshwater Dominated Urbanized Estuary *Haley Nicholson*, *University of South Alabama*
Keeping Lagoons EPA Compliant *Wade Stinson, Wastewater Compliance Systems*
Ballroom E – Session Six: Ecological Flows
Quantifying Streamflow Alteration in Basins Draining to the Gulf of Mexico *Brian Breaker, USGS*
Hydrologic Alteration and the Clean Water Act: Part I *Gerrit Jobsis, American Rivers*
Hydrologic Alteration and the Clean Water Act: Part II *Randall Haddock, Cahaba River Society*
Minimum Streamflow Requirements Necessary for Streambed Inundation Using Graphical and Mathematical Methods for Alabama Streams *Claire Rose, USGS*
Ballroom F-H – Session Six: Coastal Issues
Beach Restoration Design and Construction on Dauphin Island, Alabama *Beau Buhring, South Coast Engineers*
A Multifaceted Approach for Continuous and Near-Real-Time Observations of Sediment, Heavy Metals and Nutrient Fluxes into Mobile Bay, Alabama *Natasha Dimova, University of Alabama*
Going with the Flow: A novel, inexpensive method for collection of suspended sediment in the coastal environment *Emily Elliott, University of Alabama*
Coastal Marine Planning in Alabama *Christian Miller, Mobile Bay National Estuary Program*

Abstracts
(alphabetical order by author's last name)

Oral Presentations

Limits to water entrepreneurship and how to overcome them: A case analysis

Craig Armstrong, Paul Drnevic, Louis Marino, Jeffrey Martin & **Theresa Welbourne,** University of Alabama

The Southeastern United States' waterways and aquifers support tens of millions of lives and are crucial to the economies of this region. Waterways and aquifers support shipping, industry, agriculture, and recreational uses. In these ways, water is an economically valuable commodity, yet water is somehow treated differently because it is both a private good and a public good. A person who consumes private goods, such as food, shelter, and clothing, limits the availability of that good to others. A public good, such as a state park, is a commodity that everyone shares. Water is a unique commodity because it both a private and public good. For example, you can enjoy the view of the lake (a public good) that provides drinking water to your municipality or help run your factory (private good). As a private good, the price of water varies depending on who is using it. The price of residential use of water services (drinking water, sewage, and stormwater management) for around 7,500 gallons a month ranges in price from $10 to $60. That's 90,000 gallons a year for $720 for residential use. In contrast, commercially-intensive water users such as electric utilities, mining, and pulp and paper processing, may use on the order of tens of millions of gallons a year for a permit fee of a few thousand US dollars. Like precious minerals and oil, water is a commodity that is in fact scarce but, unlike precious minerals and oil, is priced as a commodity that is abundant. The price of water as a private good is essentially free. In summary, water is crucial to the economic well-being of the Southeastern United States, has the characteristics of being both a public or private good depending on how it is used and who is using it, and is priced as though it were an abundant resource when it is in fact scarce. These factors pose substantial barriers to entrepreneurs who want to create new technologies to treat and conserve water. Who pays for the technology that improves water usage by shipping companies or recreational boaters? What are the incentives for industries to invest in new technologies for water conservation and treatment if water is so inexpensive as a private good? This study draws from a case analysis of an entrepreneur who successfully identified a niche market for introducing a water conservation product and is now attempting to expand his business. The key dimensions of this analysis draw from research frameworks for the entrepreneurial process: how to identify promising opportunities, how to create a unique value proposition, how to identify and enter niche markets, and how to expand into larger markets and applications for the product or service. Framing these questions within the context of "water entrepreneurship" illuminates why we haven't seen growth in commercially viable innovations in water management. For example, an entrepreneur or research scientist may have developed the concept for a uniquely valuable product or service for water management, but may not be able to identify an addressable market. Entrepreneurs who do find addressable markets may still face limitations to growth depending on the scalability of the product or service into new, larger markets. We focus on specific tactics entrepreneurs and scientists can use to identify and successfully exploit opportunities to introduce uniquely valuable products or services in water management. Our answers to these questions provide insights for entrepreneurs, water management professionals, and policy makers.

Realizing Our Sustainability Potential: Utilizing Urban Trees for Stormwater Management
Jeremy Bailey, GreenBlue Urban

Using urban trees as green infrastructure for our cities is arguably the most sustainable stormwater management solution available. Drainage problems arising from increasing levels of urbanization have exacerbated the limitations of conventional surface-water drainage measures. The possibilities there are to turn stormwater runoff from a hindrance to an opportunity are limitless. Street trees can be essential components to the management of stormwater in urban areas. Like their woodland forest equivalents, urban trees direct precipitation into the ground through trunk flow and absorb rainfall through their roots – making them an invaluable sustainability asset in the urban environment. Traditional drainage systems for surface water runoff have been designed to transfer rainwater from where it has fallen to either a soak-away or a watercourse as rapidly as possible. This method increases the risks of flooding, environmental damage, and urban diffuse pollution; since runoff water usually carries contaminants including oils, heavy metals, pesticides, fertilizers, chemicals and other urban matter. Specifically designed urban tree pit systems can effectively and sustainably mitigate these challenges and significantly reduce the velocity and flow rate of surface water runoff in urban areas, contributing towards meeting the required discharge rates, while filtering out harmful pollutants and contaminants carried in surface water. This presentation uses GreenBlue Urban's 25 years of field experience, in conjunction with world-renowned researchers such as the University of Abertay Dundee and E2 Design Labs, to examine the opportunities available for integrating stormwater management into urban tree planting for truly sustainable urban landscapes.

Aftermath: Water Policy Implications of Florida v. Georgia
Bennett Bearden, William Andreen, & Nathaniel Broadhurst, The University of Alabama.

In 2013, Florida filed a motion in the U.S. Supreme Court for leave to file a complaint seeking an equitable apportionment of the ACF basin. Florida v. Georgia, No. 142 Orig. (filed Sept. 25, 2013). Florida sought to cap Georgia's overall depletive water uses. Alabama was not named in the lawsuit. The Court granted Florida's motion in November 2014 and appointed Ralph Lancaster, a Portland, Maine attorney, as Special Master. In early 2015, Georgia moved to dismiss the case for failure to join the United States as a party. Georgia argued that the United States had to be joined as a party because Florida could not be granted complete relief unless the United States, as the operator of a number of dams in the ACF basin, was bound by the final judgment. The Special Master denied Georgia's motion. The Special Master continually urged the parties to settle the case, but negotiations were protracted. Accordingly, he set a trial date in the case for October 31, 2016. After five weeks of trial, concluding on December 1, 2016, the Special Master again implored both sides to negotiate a settlement. Case Management Order No. 22, January 3, 2017, Doc. 634, specifically required Florida and Georgia to meet and confer about settlement and to consider, inter alia, a solution that might involve possible importation of water, via an interbasin transfer (IBT) from outside the ACF Basin. The negotiations, however, proved fruitless. On February 14, 2017 Georgia claimed a major victory in this long-running legal dispute when the Special Master issued his 70-page report to the United States Supreme Court, which concluded that Florida had failed to prove that new limits on Georgia's water consumption would provide Florida with the relief that it had sought. The Report of the Special Master in Florida v. Georgia raises some interesting water policy issues for Alabama. If Alabama ever ends up in an original action against Georgia or another state over water issues, a review of Supreme Court precedent suggests that having good data on water availability, use (withdrawals), and future demand, is important to winning those cases (Colorado v. New Mexico, 467 U.S 310 (1984)). Another more indirect takeaway from the Report is the danger posed by unrestrained agricultural irrigation. In Georgia's water withdrawal permitting system, farmers were made largely exempt from the regulations imposed on other consumptive users, and this clearly has had a significant impact on flows in the Flint River—especially during drought conditions. Further, analogies have been drawn between the sensitive Mobile Bay ecosystems and those in Apalachicola Bay, as well as similarities in the two areas' seafood industries. Thus, it is not out of the question to begin planning now in order to avoid a similar fate for Mobile Bay that has devastated Apalachicola's aquatic life and economic base. The aftermath of Florida v. Georgia further highlights the need for Alabama to develop a comprehensive state water management framework.

Evaluating Baseline Watershed Conditions and Identifying Restoration Opportunities Using Mobile Data Collection Software

David Bell, CH2M

Since September 2014, The Nature Conservancy (TNC) - Mississippi Chapter has implemented an innovative conservation program known as the Coastal Streams and Habitat Initiative. Working in partnership with the Mississippi Department of Environmental Quality (MDEQ) and the Pascagoula River Audubon Center, TNC developed an approach to address impaired watershed conditions from increased urbanization, reduced riparian buffers, streambank erosion and sedimentation and water quality impairments. TNC's efforts include coordinating with local stakeholders, development of Conservation Action Plans (CAPs), engaging in stream stewardship, collecting baseline monitoring data and developing detailed designs for future watershed improvement projects within nine small coastal streams in all three coastal counties (Hancock, Harrison, and Jackson). The work was funded by the National Fish and Wildlife Foundation's Gulf Environmental Benefit Fund, utilizing funds from the Deepwater Horizon oil spill of 2010. In 2016, as part of the baseline monitoring program, six coastal watersheds were identified for analysis of existing conditions as well as the potential to develop future stream restoration or watershed improvement projects. Those watersheds include, Watts Bayou, Magnolia Bayou, Coffee Creek, Oyster Bayou, Rhodes Bayou and Chicot Bayou. To accomplish the project goals, CH2M was contracted to conduct desktop analysis using ArcGIS software as well as perform mobile field data collection using the cloud-based ArcGIS Collector application. Over a period of three weeks in August the field teams assessed over 40 miles of streambank and marsh edge, evaluating riparian buffers, erosion, presence of invasive species, condition of stormwater infrastructure, sediment deposition, as well as collecting in situ water quality measurements. This presentation will summarize the results of the watershed assessment as well discuss the methods and numerous advantages of using GIS software in conjunction with a cloud-based mobile data collection application during field work.

AL Oyster Shell Recycling Program: Connecting people to their Coast
Mark Berte, Alabama Coastal Foundation

The Alabama Coastal Foundation, which will celebrate its 25th Anniversary next year, improves and protects Alabama's coastal environment through cooperation, education and participation. Last year, ACF established the Alabama Oyster Shell Recycling Program from a grant from the National Fish and Wildlife Foundation's Gulf Coast Conservation Grants Program. Participants in this session will learn about the genesis of the AOSR Program, the process used to educate restaurants, how the AOSR implementation plan was developed and executed, as well as the current status of collection/stewardship efforts. [PRESENTATION REVIEWER NOTE: As of June 19, the Program is five months ahead of schedule with over 2.7 million shells collected since the program started which translates to about 6.8 acres of reef or the weight of over 56 elephants.] Simply put, the AOSR Program collects oyster shells from local restaurants that use to consider them as trash. Instead, that important natural resource is collected three times a week from participating restaurants and taken to a site where they can cure for six months. Those shells are then put back into Alabama water where they can help new oysters grow because those shells are the preferred habitat of oyster babies (larvae) to settle on as juveniles (spat) to form new reefs. In addition to food value and being important to our local economy, oysters provide many other ecosystem services, such as: - Improving water quality: An adult oyster can filter 12 gallons of water per day. - Providing habitat: Oyster reefs provide habitat for other shellfish, fish, shrimp, crabs, birds and other animals. - Limiting erosion: Oyster reefs are natural breakwaters that protect shorelines. This Alabama Oyster Shell Recycling Program is being led by the Alabama Coastal Foundation which uses an inclusive environmental stewardship approach. To ensure the success of this project, ACF has created an Advisory Committee of restaurant owners, managers and chefs in addition to representatives from the Alabama Department of Conservation and Natural Resources, The Nature Conservancy, Mississippi-Alabama Sea Grant Consortium and the Mobile Bay Oyster Gardening Program. The AOSR Program is embedded into all of ACF's education and stewardship programs and the positive impact of this new program is taking place now and will continue to grow in the future.

Quantifying streamflow alteration in basins draining to the Gulf of Mexico
Brian Breaker, U.S. Geological Survey

Alteration of the hydrologic regime of tributaries to the Gulf of Mexico has been identified as a crucial component affecting the health of estuaries in the Gulf of Mexico. Hydrologic alteration can occur as a result of several anthropogenic activities including impoundment, surface-water withdrawal and return, changes to the landscape of watersheds (e.g. urbanization and agricultural activities), channelization, and diversion. These activities can affect characteristics of the flow regime of a stream including the magnitude, frequency, duration, timing, and rate of change of streamflow (Olden and Poff, 2003). In 2017, the U.S. Geological Survey began an analysis of hydrologic alteration of streams flowing to the Gulf of Mexico from the five Gulf States (Alabama, Florida, Louisiana, Mississippi, and Texas) to quantify the extent of hydrologic alteration and create a tool to assist water resource managers in measuring the potential impacts to the health of estuaries in the Gulf of Mexico when evaluating different surface-water use scenarios. Hydrologic alteration will be quantified throughout the study area using machine-learning algorithms (i.e. models). These models will use existing streamflow records for about 1400 streamgages located in current (altered) and reference (unaltered) basins, and will provide the tools necessary to estimate an altered and unaltered value for a given streamflow characteristic at gaged and ungaged locations. When complete, this analysis will support restoration efforts by identifying and prioritizing the most and least altered streams throughout the region. Spatial patterns and trends in streamflow characteristics will be related to estuary health. Information from the models will also be used to conduct network-optimization analysis to identify priority locations for new streamgage installation. In addition, an online-mapping tool will be created to provide information on spatial and temporal patterns of hydrologic alteration. Olden and Poff, 2003, Redundancy and the choice of hydrologic indices for characterizing streamflow regimes, River Res. Applic. 19: 101-121

Beach Restoration Design and Construction on Dauphin Island, Alabama
Beau Buhring, South Coast Engineers

The beaches of Dauphin Island have been rapidly eroding for years, some as much as 700 feet in recent decades, threatening a valuable maritime forest and freshwater lake habitat in an Audubon Bird Sanctuary. The East End Beach and Barrier Island Restoration Project was constructed between October 2015 and March 2016 to protect and preserve this habitat, restore eroding beaches and dunes, provide storm protection to other upland resources, and enhance an existing recreational beach. It was the first major engineered beach restoration project in the island's history. The 0.92 mile long project involved the dredging and placement of about 320,000 cubic yards of good quality sand on the southeastern Dauphin Island beaches. Sand for the restoration project, sourced from a borrow site 4.5 miles offshore, was identified after an exhaustive sand search and analyzed for compatibility with the native beach. Construction included the rehabilitation of eight rock groins into three new, nearshore, segmented breakwaters to help retain sand. The project increased the width of the restored beaches by about 200 feet on average and permanently added sand to Dauphin Island's East End beaches. This unique restoration project was named one of America's Best Restored Beaches in 2017 by the American Shore and Beach Preservation Association (ASBPA). This presentation will describe the coastal engineering design and analysis that made this project a success, including navigation of a challenging permitting process, the actual construction phase, and newly available monitoring data one year after construction.

How you can be apart of Alabama Dam Safety
Wade Burcham, Integrated Science & Engineering

There are many aging dams across the country, and Alabama has its fair share. Some of these dams have long since been forgotten - this despite their potential to cause severe damage, and in many cases, loss of life. As Alabama Water Resource Professionals, we are sometimes by default tasked with being the voice for the public regarding Dam Safety. This presentation aims to equip participants with helpful information for communicating risk to those who may have a lack of awareness, or may even be indifferent to the subject. Information about past dam failures, past attempts at a state dam safety program, as well as current efforts that are underway will be presented. Come learn about new resources on how you can be further equipped in regards to Dam Safety, and help build avenues to raise public awareness of this critical topic.

Increasing Flood Risk Awareness and Resilience through the Alabama Floodplain Management Program

Clay Campbell, Amec Foster Wheeler & **Wanda Ervin**, ADECA Office of Water Resources

Over the last 15 plus years, the Alabama Office of Water Resources (OWR) has updated the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRM) for all 67 counties in Alabama. As one of FEMA's Cooperating Technical Partners (CTP), OWR continues to update flood maps under FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) program. In recent years, more focus has been placed on strengthening community engagement, bettering communication, and improving the understanding of flood risk among local stakeholders. The OWR approach is to tailor the federal guidelines to enhance state and local flood risk management and mitigation initiatives. OWR has developed a series of tools and trainings that go beyond discussing traditional floodplain maps to help communities better recognize their flood risks and educate local stakeholders on how to best invest in sustainable mitigation actions. To assist with community engagement and outreach, OWR has developed a website that provides an audience of community officials, property owners, and other stakeholders the ability to view and download preliminary and effective flood information. The website currently contains regulatory and non-regulatory products developed during each Risk MAP project, including FIRMs, Changes Since Last FIRM (CSLF), depth and probability grids, and potential flood damages. Future plans for the website include the option to download newly effective hydraulic models. This website provides a more efficient means of reviewing preliminary data and retrieving effective data as well as determining areas for potential mitigation actions. OWR has completed several watershed Risk MAP projects and have many others underway. For each Risk MAP project, data has been or will be made available on the new website. However, OWR also provides other tools and training on a suite of risk-based products that can be utilized by communities to mitigate flood risk and increase flood risk awareness and resilience. These trainings include the well-received Risk MAP Tools Training, an in-person tutorial for local stakeholders on the Risk MAP database, as well as other products, that also aim to assist them in identifying flood risk change and areas of mitigation interest within their community. OWR also hosts a YouTube channel that contains pre-recorded tutorials on many of the Risk MAP products. OWR aims to add more tutorials in the future. Each of these trainings and tutorials are meant to increase the ability of a Community Official to communicate flood risk and encourage actions to reduce risk to life and property. The goal of this presentation is to demonstrate OWR's commitment to taking action to reduce flood risk in Alabama by providing community officials and other stakeholders with multiple resources beyond traditional flood risk products to help them increase flood risk awareness and resilience at the local level.

Weeks Bay Watershed Management Plan - Overview of Watershed Conditions and Water Quality

John Carlton, Double J Farms; **Mike Eubanks** & Emery **Baya**, Thompson Engineering

One of the tasks in preparation of the Weeks Bay Watershed Management Plan (WBWMP) was to assess watershed conditions, with particular emphasis on water quality. Section 3.0 of the plan provides a detailed review of the water quality programs and water quality standards applicable in the Weeks Bay watershed, and presents available water quality data. Because of the size of the watershed and budgetary constraints, collection of new water quality data was not part of the project. Over 40 scientific reports or sources of data relating to water quality were identified, the more comprehensive ones being used to provide an assessment of watershed conditions. Additionally, the Soil and Water Assessment Tool (SWAT) model was developed and calibrated for both Fish and Magnolia Rivers and utilized to estimate current and future sediment and nutrient loadings from approximately 235 subwatersheds and over 2,000 Hydrological Response Units. (Dr. Kalin with Auburn University performed this task and will present it separately.) The entire Weeks Bay watershed is comprised of four 12-digit Hydrologic Unit Codes (HUCs) draining an area approximately 27 miles long and 12 miles wide, or roughly 130,000 acres. Each of the four HUC-12 watersheds are discussed separately in the WBWMP. The lower reaches are in the Gulf Coast Flatwoods ecoregion and the upper riverine portions are in the Southern Pine Plain ecoregion with agricultural land uses, including silviculture, predominating the landscape. The climate is humid subtropical with abundant rainfall (~67 in/yr) and the area is frequently influenced by tropical cyclones. Assessing water quality was complicated by both too little data and too much data and the data sources are discussed in the Plan. Generally, the bay and mainstem of each river appear to be meeting the ADEM water quality standards most of the time, with water quality in Fish River being rated by Alabama Department of Environmental Management (ADEM) as GOOD and Magnolia River being rated as FAIR as recently as 2011. However, there are 4 segments listed on the 2016 ADEM 303(d) list as impaired due to fish consumption advisories related to mercury (Fish River, Cowpen Creek, Polecat Creek and Magnolia River) and one segment listed as impaired due to organic enrichment (Baker Branch). The source of mercury is thought to be atmospheric deposition and the source of organic enrichment is thought to be cattle grazing operations. It is also evident that pathogen levels frequently do not conform to the water quality standards, particularly following rainfall events and the ADEM pathogen Total Maximum Daily Load (TMDL) calls for a 68% load reduction from non-point sources in the Fish River watershed. To date, efforts to identify the source of pathogens by type (human, wildlife, or livestock) and location have been inconclusive. Water quality issues related to pathogens, dissolved oxygen, sediment, turbidity and nutrient loading (nitrogen and phosphorus) are also evident in the data reviewed for a number of tributaries throughout the Watershed. Although occasional water quality issues were reported for most all tributaries that have been sampled, the most prominent water quality impacts have been documented in Corn Branch, Pensacola Branch, Baker Branch, Cowpen Creek, Waterhole Branch and Turkey Branch (lower) in Fish River watershed, and Weeks

Creek and an unnamed tributary in the Magnolia River watershed. The impacts appear to be associated with both increasing urban development around the perimeter of the watershed and pervasive historical and on-going agricultural activities. Although classified by ADEM as an Outstanding National Resource Water, Weeks Bay proper is considered by all accounts to be eutrophic, with high nutrient loads from Fish and Magnolia Rivers frequently triggering increased algal activity and associated low dissolved oxygen levels. Because the Bay is shallow, these low dissolved oxygen and stratification events are usually short-lived, being overcome by wind action.

Using GIS and Story Maps for Watershed Management and Monitoring
John Cartwright, Mississippi State University

A collaborative effort at Mississippi State University has produced the Catalpa Creek Watershed Restoration and Protection Project. The effort involves over 30 faculty and administrators from MSU and 10 staff members from four agencies. During the first two years of the project a comprehensive Watershed Resource Management Plan and an Implementation Plan for Phase 1 of the project were developed. An initial effort of Phase 1 involves characterizing the watershed. Multiple researchers have been involved in gathering existing data, collecting new data, and formulating hydrologic and hydraulic models for the watershed. As a means of transferring this information between collaborators, stakeholders, and others associated with the effort we have implemented Esri's Story Maps. Story Maps (built upon ArcGIS Online resources) are interactive, web-based applications that combine geographic information with text and multimedia content. Utilization of Story Maps improves data accessibility across multiple platforms, improving data management and information transfer. By bringing Story Maps in to this project we are building a foundation that will provide a seamless transition from research to education and outreach as this project continues to develop across multiple phases.

High Definition Stream Survey of the Duck River, covering 120 miles in 8 days with only 2 people.
Brett Connell, Trutta Environmental Solutions

The High Definition Stream Survey of the Duck River is our longest survey to date and covered 120 continuous miles in 8 days with only 2 people. The Tennessee Dept. of Environment and Conservation, Tennessee Valley Authority, Columbia Power and Water, and the South Central Tennessee Development District have all funded different portions of the survey and is an example of how partnerships can lower the cost of surveys and increases the amount of data for everyone involved. The High Definition Stream Survey (HDSS) approach was created to rapidly gather continuous geo-referenced data in a single pass for a broad range of stream and streambank conditions by integrating GPS, video, depth, water quality and other sensors. Results from HDSS data can be used to determine the extent and distribution of instream habitat, locate areas that contribute to poor stream conditions, define the geomorphic condition for the stream, identify infrastructure impacts, document restoration results and provide a powerful "virtual tour" experience.

Developing New Groundwater Sources: Science or Serendipity?

Marlon Cook, Cook Hydrogeology, LLC

There are lots of similarities between exploring for oil and gas and exploring for groundwater. In both cases the desired fluid exists because of a combination of various natural processes, including climate, geography, geology, and chemistry. Discovery of both fluids in the subsurface has a long history involving varying degrees of scientific knowledge and serendipity. It is often said that the explorationist will take luck over science any time. However, as economic quantities of these valuable resources become more scarce, good science plays an ever increasing role. This paper summarizes four examples involving exploration for public groundwater supplies in four distinct hydrogeological provinces of Alabama.

Status and Trends of Streamflow Recession in Tennessee from Distributional Properties of Day-Over-Day Declines

Elena Crowley-Ornelas, **Rodney Knight**, & **William Asquith** U.S. Geological Survey,

Statistical properties of streamflow recession provide evidence of hydrologic processes such as groundwater and surface-water interactions. Bingham (1982, 1986) sought regional definition of generalized connectivity between surface-water and groundwater by calculating a persistent streamflow recession slope during winter low flows and then relating the recession slopes to surficial geology. The recession slope value is often referred to as the Bingham "geologic factor" or G-factor. The recession slope determined by Bingham's process was somewhat subjective because it was hand drawn based on the visual inspection of the stream hydrograph. The G-factor was derived through a hands-on graphical method for selected peak flows over a 20-year time period from U.S. Geological Survey (USGS) streamgages in Tennessee and Alabama. A streamflow recession curve, plotted on semi-log graph paper, was created by starting at peak discharge after a precipitation event until the line neared asymptotic with the x-axis. The number of days (x-axis) required for streamflow to decrease one log cycle (y-axis) was the index of streamflow recession for each station, or the G-Factor expressed in days per log cycle decline in flow. Boundaries for G-factors were determined using streamflow hydrographs and surficial geology. Basin-weighted values of the G-Factor have been shown statistically significant in statistical regionalization of various aspects of the flow regime (Bingham, 1982, 1986; Knight and others, 2012) in Alabama and Tennessee. Although G-factor values have been useful, the subjectivity and time-consuming manual method of the approach has made it problematic to calculate G-factors for newer records and different regions. The USGS has developed an automated process that calculates G-factors and has applied this method to more than 300 streamgages and more than 4 million days of streamflow at streams in or bordering Tennessee. Results from the automated process will be compared to the original G-Factor estimates to assess whether this new method is capturing the same hydrologic

process information. Additionally, graphics and maps depicting status and trends in streamflow and associations with Bingham's original work, will provide additional spatial analysis of pertinent hydrogeologic characteristics in the study area. Developing an automated process using existing data to calculate the G factor will make it possible to estimate the factor for larger areas as well as for discrete time periods. This new approach, if successful, will provide a tool to evaluate the extent of connectivity between surface-water and groundwater in a basin; the influence of groundwater withdrawals on baseflow; and could be an early indicator of potential drought effects.
Bingham, R H. 1986. "Regionalization of Low-Flow Characteristics of Tennessee Streams." Water-Resources Investigations Report. http://pubs.er.usgs.gov/publication/wri854191. Bingham, Roy H. 1982. "Low-Flow Characteristics of Alabama Streams." Water Supply Paper. http://pubs.er.usgs.gov/publication/wsp2083. Knight, Rodney R., W. Scott Gain, and William J. Wolfe. 2012. "Modelling Ecological Flow Regime: An Example from the Tennessee and Cumberland River Basins." Ecohydrology 5 (5): 613–27. doi:10.1002/eco.246.

Is the present a key to the past or is the past a key to the present: a look into the paleoflood record of the Tennessee River in Alabama

Lisa Davis, **Christopher Stewart** & **Natasha Dimova**, University of Alabama; **Gary Stinchcomb** & **Rachel Lombardi**, Murray State University; & **Steven Forman**, Baylor University,

Despite significant advances in meteorological and hydrological forecasting in the last 50 years, catastrophic floods constitute one of the most globally persistent natural hazards. The year 1931 marks the last time the U.S. did not experience a single flood-related fatality. At least 10 flood-related deaths occur per year in the U.S. Limitations in the instrumented flow records of rivers partly contributes to this problem. Instrumented discharge records rarely span more than 100 years, meaning they are too short to capture large floods, which tend to occur less frequently. Instrumented flow records only span the time of human occupation, which makes understanding variability of floods related to climate variability using these records more challenging. Because of these limitations, water researchers and managers are increasingly turning to natural archives of flood frequency and magnitude information, such as dendrochronology and sedimentary deposits from floods that are preserved in the landscape, in addition to the instrumented record. Paleoflood hydrology focuses on collecting and analyzing physical evidence of past floods that occurred before the instrumented record for flood risk assessment and understanding environmental change. Federal agencies working in the southwestern U.S., including the U.S. Geological Survey and U.S. Bureau of Reclamation, have used paleoflood hydrology to assess flood risk for dams, power plants, and public spaces for decades. Despite its longstanding and widespread application in other regions of the U.S., paleoflood analyses are rarely used to inform flood frequency and risk assessment in rivers of the eastern U.S. New federal guidelines (USGS Bulletin 17C: Guidelines for Determining Flood Flow Frequency) recommend incorporating paleoflood data in flood frequency estimations, making increased application and understanding of paleoflood analyses imperative. Our presentation will demonstrate some of the basic principles of paleohydrologic research and present preliminary findings of a paleoflood record we are developing for the middle Tennessee River (in the vicinity of Guntersville and Huntsville, AL), as part of a broader effort to develop paleoflood data for flood frequency analyses for the Tennessee River.

4-H AL Water Watch: Increasing Environmental Literacy and Watershed Stewardship through Youth-Focused Citizen Science
Mona Dominguez, 4-H AL Water Watch & **Sergio RuizCórdova**, AWW

The purpose of this presentation is to introduce the audience to the Youth-Focused Citizen Science Program, 4-H Alabama Water Watch (4-H AWW), to discuss outcomes of a recently completed 4-H AWW Project funded by the US EPA, to demonstrate how 4-H AWW can be incorporated into watershed stewardship efforts, and to explain how interested youth and educators can get involved with or support the program. The 4-H AWW Program was developed through a partnership of Alabama Water Watch (AWW) and Alabama 4-H. In 2015, 4-H AWW received funding from the EPA for a two-year project with the goal of building capacity within the Alabama Cooperative Extension System 4-H Alabama Water Watch Program to provide educators including teachers, volunteers, and 4-H agents with the training, materials, and support needed to increase environmental literacy for youth (ages 9 – 18) in Alabama. The project contributes to the long-term goal of 4-H AWW which to engage youth in watershed stewardship in their local communities and ultimately make informed and responsible decisions about the environment. The three major project objectives implemented to achieve this goal were: 1) Complete development of a 4-H AWW curriculum that will guide educators as they provide students with hands-on citizen science experiences focused on conducting water chemistry analysis and biomonitoring in their local waterbodies, including the development of an online water monitoring Citizen Science Data Simulation. 2) Train approximately 100 educators to utilize the curriculum at workshops facilitated in partnership with environmental centers throughout the state, and 3) Support participating educators as they implement the curriculum by helping them access monitoring materials, managing the database that stores water data, and managing the website where the data simulation and water data is accessed. As a result of the project, a new nine-module 300-page curriculum Exploring Our Living Streams: An Introduction to Watershed Stewardship, Stream Biomonitoring and Water Chemistry Monitoring (EOLS) was developed and printed, over 100 educators were trained and certified to implement EOLS with students, and stream biomonitoring supplies and water chemistry monitoring kits were distributed to 4-H County Offices for check-out by participating educators and students. During the project period, around 3,000 students have been reached by 4-H AWW. Students exposed to EOLS have increased knowledge and understanding of the water environment, pollution, and watershed stewardship. Students who become monitors gain skills related to testing water and data entry, analysis, and interpretation. 4-H AWW is being successfully implemented in a variety settings that include the formal classroom, specialty clubs during or after school, and even church groups. Watershed Management Plans addressing impaired waterbodies (funded by Section 319 Grants), have incorporated 4-H AWW as an educational activity that can also produce valuable water data used to evaluate project progress. Participants will learn how they can become part of the program and incorporate 4-H AWW into their watershed stewardship projects.

Scope and impacts of household raw wastewater discharges in three Alabama counties

Mark Elliott, **Parnab Das**, **Erdogan Aytekin**, **Yuehan Lu**, University of Alabama; **Kevin White**, University of South Alabama; & **Robert Jones**, Down to Earth, Inc,

A 2005 study of Bibb County, Alabama, showed that 15% of households not connected to sewer directly discharged raw sewage and 35% had septic systems that were failing (White and Jones, 2006). Discovery of this report from Bibb County and conversations with local stakeholders led our team to study the scope of the problem in nearby Alabama counties. Therefore, two nearby counties, Hale and Wilcox counties, with high rates of poverty (26.6% and 39.2%, respectively) and largely impermeable clay soils were chosen. The study uses two main methods (1) site-by-site inspections of a random sample of unsewered rural communities and (2) water sample analysis from impacted streams. Site inspection and water sampling data indicate very high rates of straight pipe discharge and substantial impacts of water quality in local streams and tributaries. In Wilcox County, approximately 60% of surveyed unsewered households had a visible straight pipe surface discharge of raw wastewater and only 7% of households had a permitted onsite wastewater treatment system. For the remaining 33%, inspection could not determine whether the discharge was above or below ground but there was no evidence of a septic system drainfield or a mound system (often this indicates that a straight pipe is buried and discharges to a hidden, overgrown area). This rate of straight pipe discharge would conservatively amount to over 500,000 gallons per day of raw sewage discharged to the ground in Wilcox County alone. In Hale County, site inspections revealed fewer households with visible straight pipes (6%) and more with permitted systems (35%). However, 59% of unsewered households had an unknown discharge and were unpermitted; many of these were likely buried straight pipes with a hidden surface discharge. Water sample analysis on Big Prairie Creek upstream and downstream of the town of Newbern indicates substantial runoff of raw wastewater into surface water. For example, samples collected post-drought in November 2016 yielded over 100,000 E. coli per 100 mL and a preliminary principle component analysis of multiple water quality parameters indicated that Big Prairie Creek consisted of over 5% sewage by volume following the drought. Although we have not investigated human health impacts, there is troubling evidence of possible health impacts associated with onsite wastewater failure. The most recent survey of soil-transmitted helminths (worms) in Alabama was over 20 years ago in Wilcox County; it revealed that 33% of children were positive for one or more helminths (Badham, 1993). A follow up study is being planned by the author of the 1993 report. Further investigation of health impacts from wastewater are needed throughout the Black Belt. This presentation will address the scope, impacts and possible solutions to onsite wastewater failures in rural Alabama.

Going with the flow - A novel, inexpensive method for collection of suspended sediment in the coastal environment

Emily Elliott & **Mark Elliott**, University of Alabama; **Elaine Monbureau**, **Glenn Walters**, **Antonio Rodriguez** & **Brent McKee**, University of North Carolina.

Identifying the source and abundance of suspended sediment transported within tidal creeks is essential for studying the connectivity between coastal environments (i.e., coastal watersheds and estuaries). The fine-grained suspended sediment load (SSL) makes up a substantial portion of the total sediment carried within the coastal environment and efficient sampling of the SSL is critical to our understanding of nutrient and contaminant transport, anthropogenic influence, and the effects of climate. Unfortunately, traditional methods of sampling the SSL, including instantaneous measurements and automatic samplers, can be labor intensive, expensive and often yield insufficient mass for comprehensive geochemical analysis. Within the coastal environment, especially estuaries, this issue is even more pronounced due to bi-directional tidal flow. This study tests the efficacy of a modified time integrated mass sediment sampler (TIMS) design for implementation within the tidal environment under bi-directional flow conditions. Our new TIMS design utilizes an 'L' shaped outflow tube to prevent back-flow during reverse flow conditions. These samplers are inexpensive to fabricate (<$300), require very little maintenance, and when deployed in mirrored pairs, can collect sediment uniquely in each direction of tidal flow. Laboratory analysis was conducted to characterize the flow and sediment trapping efficiency of the sampler, which indicated the bi-directional TIMS capture up to 96% of incoming particles across a range of flow velocities (0.3 to 0.6 cm s-1). The modified TIMS design was also tested in the field at two distinct sampling locations within the tidal zone. Single-time point suspended sediment samples were collected at high and low tide and compared to time-integrated suspended sediment samples collected by the bi-directional TIMS over the same four-day period. Particle-size composition from the bi-directional TIMS were representative of the array of single time point samples, but yielded greater mass, representative of flow and sediment concentration conditions at the site throughout the deployment period. This work proves the efficacy of the modified bi-directional TIMS design, offering a novel tool for collection of suspended sediment in the tidally-dominated portion of the watershed. Implementation of these devices within the Alabama coastal watershed could provide a simple, inexpensive tool for the characterization of the suspended sediment load within the system.

Management Recommendations for the Weeks Bay Watershed Management Plan
Michael Eubanks; Thompson Engineering, Inc.

A number of water quality and water quantity issues have been documented within the Weeks Bay Watershed (WBW) over the past several decades. Population growth and urban development, as well as some of the agricultural practices have continued to intensify problems in the Watershed. The Watershed includes all or portions of nine municipalities (Fairhope, Daphne, Spanish Fort, Loxley, Robertsdale, Silverhill, Summerdale, Foley, and Magnolia Springs) and associated unincorporated areas of Baldwin County, leading to a complex regulatory environment. By successfully addressing the co-related problems identified with population growth, urban development, and some agricultural practices within the Weeks Bay Watershed, the long-term health of the stream courses, Weeks Bay and Mobile Bay will be enhanced. Management Recommendations of the WMP include organizational initiatives, agricultural initiatives, water quality improvement initiatives, wetlands/riparian buffer initiatives, and shoreline/sea level rise initiatives: 1. Establish a Watershed Management Plan Implementation Team A WMP Implementation Team must be identified to carry forward the work necessary to prioritize site specific projects, work with the various inter-governmental entities within the watershed, and locate the necessary funding. 2. Develop Inter-Governmental County/Municipal Water Management Mechanism This recommendation would be to foster inter-governmental cooperation. An inter-governmental coordination mechanism would help address planning and zoning matters across the entire watershed. 3. Address Stormwater Management and Flooding Baldwin County and the municipalities are encouraged to regularly run flood prediction models, add a county GIS layer on which municipalities can list high potential development projects, conduct an inventory and assessment of stormwater detention systems. 4. Sustain Watershed Hydrology by Promoting Low Impact Development (LID) and Green Infrastructure (GI) Urbanization within the Watershed can minimize adverse impacts by adopting measures to sustain the watershed's hydrology by use of Low Impact Development (LID) and Green Infrastructure (GI). 5. Encourage Increased Agricultural BMPs Examples of agricultural BMPs that should be encouraged within the Watershed include: 1)Livestock exclusion from wetlands/streams; 2) Increased use of cover crops; 3) Improved nutrient management; and 4) Identify/Remediate high livestock areas where manure runoff is a pathogen source. 6. Address Watershed Water Quality Issues Recommendations dealing with water quality issues that have been identified through the WMP process include: • Identify instream erosional "hot spots" and prioritize and implement stream restoration. • Refine SWAT model results to identify and map "critical source areas" (CSAs) at the hydrologic response unit (HRU) level • Conduct a detailed turbidity source survey in tributaries with frequently elevated turbidity levels and develop detailed plans to reduce, minimize or eliminate the sources. • Conduct detailed pathogen source tracking and identification to develop detailed plans to remediate pathogen sources. • Develop a pathogen/flow relationship to support development of a public advisory system. • Develop an inventory of septic tanks that predate the existing ADPH inventory and design and implement an effort to fix leaking systems. • Identify and assess potential water quality impacts associated with biosolids and animal manure application sites. • Assess impacts of turf farms for runoff timing and volume, and pollutant loadings to streams. 7. Address Environment/Habitat Issues Poor condition wetland and riparian buffers in the watershed are associated mostly with agricultural and pasture lands. Identify restoration efforts in priority areas. Pursue strategic acquisition for high priority habitats. 8. Address Coastal Erosion and Sea Level Rise Issues Identify specific sites, at the parcel level in the lower reaches of the watershed, that are candidates for construction of living shoreline or other shoreline protection/restoration measures. Suitable sites would typically consist of areas that currently are (or anticipated in the future) exhibiting erosion or habitat loss. Promote programs to improve stakeholder awareness of SLR issuesM. 9. Develop Appropriate Monitoring and Adaptive Management Mechanisms the monitoring program should track the number of management measures that are implemented in each HUC 12 watershed and the degree to which they are implemented. 10. Continue Stakeholder and General Public Outreach and Education Community outreach and public education about the Weeks Bay Watershed has been and will continue to be extremely important to address conserving, protecting, and restoring this Watershed.

Updating Low-Flow Frequency and Flow-Duration Statistics in Alabama
Toby Feaster, U.S. Geological Survey

Alabama water-resource managers need up-to-date low-flow statistics for planning, management, and permitting decisions to help ensure adequate water for consumptive use, water-quality standards, recreation, and aquatic habitat protection. Low-flow statistics for Alabama have not been systematically updated in over 20 years, a period that includes 2 of the 10 driest years of total annual precipitation have occurred since 1895. As such, the U.S. Geological Survey began an investigation in 2014 to update low-flow frequency and daily duration statistics at 210 continuous-record streamgaging stations (stations) including both regulated and unregulated Alabama streams. Depending on the length of record available, annual minimum 1- and 7-day average flows with recurrence intervals of 2, 5, 10, 20, and 50 years were computed by using available data through March 2014. Additionally, daily flow durations for the 5-, 10-, 25-, 50-, 75-, 90-, and 95-percent probabilities of exceedance were computed. The investigation includes 87 Alabama stations for which 7Q10 estimates were previously published (1994) (daily mean flow data through climate year 1989 were used for the previous analysis), and for which additional data were collected. For those stations, a percentage change between the previous and current 7Q10 values was computed. The percentage change ranged from –61 to 108 percent with a mean difference of –0.2 and a median difference of 0.0. Of the 87 stations, 42 had a negative percentage change, 38 had a positive percentage change, and 7 had a zero percentage change. This investigation was jointly funded through the USGS Cooperative Water Program and the following non-Federal partners: Alabama Power; Alabama Farmers Federation; Alabama Association of Conservation Districts; Alabama Association of Resource Conservation and Development Councils; Alabama Department of Agriculture and Industries; Alabama Department of Conservation and Natural Resources—Division of

Wildlife and Freshwater Fisheries; Alabama Department of Economic and Community Affairs—Office of Water Resources Division; Choctawhatchee, Pea and Yellow Rivers Watershed Management Authority; Geological Survey of Alabama; and the University of Alabama—Water Policy and Law Institute. The results from this investigation will be documented in a U.S. Geological Survey Scientific Investigations Report and the low-flow and flow-duration statistics also will be available online through the U.S. Geological Survey StreamStats application.

Quantification of Functional Marker Genes for Denitrifying Microbial Populations in the Chandeleur Islands Impacted by the 2010 Gulf of Mexico Oil Spill

Nikaela Flournoy, **Caitlin Taylor**, **Patrice Crawford**, & **Patricia Sobecky**, University of Alabama; **Corianne Tatariw** & **Behzhad Mortazavi**, Dauphin Island Sea Lab

Estuarine, coastal, and barrier island ecosystems provide communities protection by reducing storm surges, dissipating wave energy, and economically through services such as fisheries, tourism, water catchment and water quality. As these ecosystems are deteriorating and threatened in this century, the services provided to humans are being valued monetarily to communicate their importance; i.e., property values on a Georgia barrier island increased with an additional meter of beach width, an acre of Louisiana wetland reducing wastewater treatment costs for a company by as much as $34,000. Events such as the 2010 Gulf of Mexico oil spill, the largest marine spill in history, act as catalysts to accelerate the deterioration and further the loss of these vital ecosystem services. The 2010 BP spill impacted the Chandeleur Islands, a chain of low-elevation barrier islands in Louisiana waters located forty miles south of Gulfport, MS. The island chain vegetation; i.e., Avicennia germinans (black mangrove) and native Spartina alterniflora (saltmarsh cordgrass) was heavily damaged as a result of the oil spill. As oil was deposited differentially (i.e., none to heavy), it was important to investigate the microbiology of oil-impacted areas as marsh vegetation is directly linked to microbe-driven ecosystem services such as denitrification, a nitrogen (N) cycle pathway. The objectives of this study were to characterize: i) the biodiversity of the microorganisms; ii) quantify denitrifying microbial populations using functional marker genes; and iii) measure rates of denitrification during a one-year period. Five eco-functional marker genes selected to represent denitrification were investigated; (1) narG for nitrate reductase (subunit G); (2) nirS for nitrite reductase; (3) norB for nitric oxide reductase; (4) nosZ for nitrous oxide reductase; and (5) nrfA, the cytochrome c552 terminal reductase of the formate-dependent pathway for nitrite reduction to ammonia. Three different marsh sites were selected for study based upon estimated amounts of prior oiling/oil coverage. The highest rates of denitrification were in September while the lowest rates were observed in February. The highest nirS abundance was detected for two of the three sites (Site 1 and 2) in September while Site 3 exhibited the highest abundance in November. Similarly, the highest abundances observed for norB and nosZ varied by site and by month. During the course of sampling over seven months in 2016 and 2017, weathered oil was detected in some of the marsh sediment cores and was chemically typed to Macondo oil. Ecosystem services such as denitrification, carried out only by microbes, act to remove nitrogenous wastes exported from freshwater systems

to marine systems. Studies such as this one are designed to characterize the barrier island microbial biodiversity and N cycle processes so as to better understand the long-term effects disturbances such as the 2010 oil spill pose to an ecosystem service that contributes to maintaining marine water quality. This is especially important in light of the fact that weathered oil continues to be observed seven years post spill.

Examples of Local Municipalities Working With Their Universities
Michael Freeman, Alabama Water Watch Association

In this presentation I will demonstrate two examples of collaborative work between a university and the local water works/municipality and how it can help both entities with permitting, testing, outreach and education within the MS4 process and beyond. I will also touch on how these examples can be replicated throughout the State of Alabama.

Extremophile Relationship to Geologic Setting in the Sulfur Springs Located at Blount Springs, Alabama
David Frings & **David Johnson**, Samford University

The geologic setting of the sulfur springs located at Blount Springs, Alabama creates an extreme environment that supports a variety of unique bacterial mats and marco-invertebrates. These extremophiles appear to metabolize the sulfur that is produced from the iron pyrite ($FeS2$) found in the Chattanooga Shale which forms the confining layer for the underlying limestone aquifer. The primary structure at the springs is a geologic window in the southwestern end of the Sequatchie anticline that exposes limestone of the Red Mountain Formation. The limestone aquifer supplies mineral rich water from a series of four springs that contain high levels of Sulphur. DNA analysis shows that the Blount Springs bacteria are similar to those that have been found in cave systems in New Mexico (Leachiguilla Cave) and northern Wyoming (Lower Cane Cave) that metabolize Sulphur, resulting in the release of hydrogen sulfide as a byproduct. The hydrogen sulfide has been shown to form sulfuric acid ($H2SO4$) in these western caves which chemically weathers the limestones. Similar processes may be at work in these Sulphur springs that are located in Blount County, Alabama.

Implementation Assessment for Water Resource Availability, Protection, and Utilization for the Choctawhatchee, Pea and Yellow Rivers Watersheds
Barbara Gibson, Choctawhatchee, Pea and Yellow Rivers Watershed Management Authority

The Choctawhatchee, Pea and Yellow Rivers Watershed Management Authority commissioned the Geological Survey of Alabama to conduct an assessment of water resources in the watersheds of southeast Alabama which could be utilized by all water users to determine current water availability and to plan future water development. The assessment included subsurface geologic and stratigraphic data collected by selected wells which may be used to determine the depth of each aquifer in the watersheds; the general water-bearing characteristics of individual geologic units; and the correlation of like geologic units penetrated by wells throughout the watersheds. Future groundwater availability was determined by analyzing water quality, groundwater recharge rates, and projected groundwater demand. Future demand was predicted based on population, industrial and agricultural growth projections for the next 50 years. Extensive surface water quality information was obtained and evaluated in addition to low-flow and maximum-flow information. Biological assessments were performed for all major sub-watersheds. This assessment was designed to supply pertinent information necessary for appropriate authorities to evaluate their present water source and to implement plans for future water-source development if needed.

Hydrologic Alteration and the Clean Water Act: Part II
Randall Haddock, Cahaba River Society

Hydrologic Alteration and the Clean Water Act: Part II The Clean Water Act calls on us to protect the physical, chemical, and biological integrity of our nations' waters. There is a growing recognition that changes in stream flow regimes, or "hydrologic alterations", are directly causing some streams to fail to support their designated uses. Here, we would follow-up a discussion on EPA's recent clarification about how states could more fully monitor, assess, and identify waters impaired due to hydrologic alteration with an urban watershed example of hydrologic alteration, including a description of statistical evidence for hydrologic alteration in Alabama's Cahaba River basin. Using a combination of information from EPA-approved siltation and habitat alteration TMDLs for Shades Creek and for the Cahaba River watershed and results from an analysis using The Nature Conservancy's 'Indicators of Hydrological Alteration' protocol, we will describe how the excessive siltation and habitat alteration already documented in the Cahaba River watershed may predominantly be due to hydrologic alteration. This conclusion should help guide management decisions to most effectively address the goals of these two Siltation and Habitat Alteration TMDLs. This perspective could also aide MS4s in designing more effective programs to meet their NPDES requirements. This information will be submitted to ADEM in the hope they will classify the Cahaba River as Hydrologically Impaired from its headwaters to Centreville in the April 2018 305(b) report to EPA.

EPA's Water Conservation & Efficiency Best Practices (formerly Region 4's Water Efficiency Guidelines)

Rosemary Hall Calli, EPA Region 4

A key function of a water utility is to ensure that it has adequate supply to provide water services to its domestic, commercial, and industrial customers. Because population continues to grow nationally, and at faster rates in some parts of the country, utilities often need to consider whether it is appropriate to develop additional supplies. Such supplies may be provided by greater withdrawals from surface water or groundwater, construction of reservoirs, or construction of desalination or water reclamation facilities. Any of these types of projects carries a cost. As water utilities consider options, it makes sense to ensure that they are effectively managing the water resources already under their control. More efficient use of water may avoid impacts to aquatic resources, provide greater ecosystem protection, and/or free up the water saved to serve additional needs. In December 2016, EPA released Best Practices to Consider When Evaluating Water Conservation and Efficiency as an Alternative for Water Supply Expansion (EPA-810-B-16-005) to help water utilities and federal and state governments carry out assessments of the potential for future water conservation and efficiency savings to avoid or minimize the need for new water supply development. The document can also be used by a utility or a third party to conduct assessments of how the utility is managing its water resources from a technical, financial, and managerial perspective. The document consists of six major practices, with suggested metrics to guide evaluations of progress. No single metric is intended to serve as a stand-alone test. Instead, the combined information on water conservation and efficiency implementation, with emphasis on planned measures, can inform reviews of a project's purpose and need, and analysis of alternatives. • The first practice involves conducting a water audit. The AWWA Free Water Audit Software© available from the American Water Works Association (AWWA) is used to complete a water balance and produce performance indicators for how well the basics of the water system are understood, including how much of the water distributed is authorized, metered, and/or billed. • Next, because leakage represents the largest real losses for most systems; the second practice focuses on assessing and addressing water loss minimization through leakage control. Metrics focus on measures of leakage tailored to system characteristics, identifying an economic level of loss, and measures (in place and planned) to assess and control water loss. • Metering of water, the third practice, allows for accurate accounting of water distributed, and can help identify unseen sources of leakage and prioritize abatement measures. When metered usage is communicated to customers, it also helps inform and incentivize how end uses are managed. • The fourth practice is an examination of water rate structure. Charges for water should reflect the full long-range costs (i.e., forward-looking, not historical) of operating and maintaining a water utility, as well as the scarcity and value of the resource. The rate structure should also encourage and reward conservation and efficient use. • End user water conservation and efficiency analysis, the fifth practice, begins with characterizing the system in terms of customer types and demand (e.g., single family residential, multifamily residential, commercial, institutional, industrial). This then allows for identification of demand drivers and demand reduction opportunities through targeted programs and incentives for end users. • The final practice is a written plan which includes definitive and measurable goals for optimizing system performance and ensuring efficient water use, with timelines for implementation. Footnote: The Best Practices were initiated as an update of the EPA Region 4 Guidelines on Water Efficiency Measures for Water Supply Projects in the Southeast, specifically for Clean Water Act Section 404 project review. The Best Practices document (# EPA-810-B-16-005) was released December 2016 as a national document broadly applicable to water programs and utility needs.

Bear Point Bayou – A Case Study in Urban Coastal Stream Restoration
Kit Hamblen, CH2M

The Bear Point Bayou Stream Restoration Project site is located on the University of South Mississippi (USM) Gulf Coast campus, north of US Highway 90 in Long Beach, Mississippi. The stream restoration project was identified as a part of The Nature Conservancy's Coastal Streams and Habitat Initiative for Mississippi, which is funded by the National Fish and Wildlife Foundation's Gulf Environmental Benefit Fund. Through this project, and others being performed as part of this Initiative, The Nature Conservancy (TNC) seeks to conserve key coastal streams in Mississippi by creating restoration opportunities that benefit the community and natural environment. The objective of the Bear Point Bayou Stream Restoration Project was to design and construct a stream restoration project with the goals of enhancing and restoring aquatic and riparian habitats along Bear Point Bayou; and managing erosion rates and improving stream bank integrity through bank grading, bank stabilization practices, and instream structure placement. In 2016, CH2M worked closely with TNC to develop the Bear Point Bayou Stream Restoration Project for approximately 2,400 linear feet of eroding stream channel with degraded habitat conditions. This presentation will highlight the challenges of implementing urban stream restoration projects in the Southern Coastal Plain ecoregion.

Common Mistakes in Applying Statistics to Water Quality Data – and How to Avoid Them
Jason Heberling, Heberling Environmental Consulting (HEC)

All too often statistical methods used in water quality analyses make assumptions that may not apply to the data sets collected. Commonly used methods of statistical analysis (such as ANOVA and t-tests) are parametric and are more powerful when the data fits a normal distribution. However, water and wastewater data generally does not match a normal distribution. Non-parametric statistical methods are often more useful for these analyses. In addition, water quality data sets are often skewed by outliers and non-detects. For water quality data, outliers and non-detects represent relevant data points and should not be discarded in an attempt to produce a normal distribution. Often such action results in false conclusions and in certain circumstances, arbitrarily discarding data is illegal. A special emphasis should be given to analyses based on data distribution and characteristics such as: normality, range of variances, and population size. The methods and approaches described and applied are selected according to information gathered from the technical literature, case studies, and pilot studies.

The Alabama Clean Water Partnership-Engaging Students for Clean Water
Ashley Henderson & **Sabrina Wood**, Alabama Clean Water Partnership

The Alabama Clean Water Partnership continues its successful engagement of students through several programs in the Alabama and Tallapoosa River Basins. These programs include the Blue Planet Defenders Environmental Club at elementary schools and a storm drain marking campaigns at a community college . The Alabama Clean Water Partnership along with MS4 Partner-the City of Montgomery, Montgomery Clean City Commission, Montgomery Public Schools and the Alabama Pulp and Paper Council have developed a six-month environmental club to engage students in underserved areas of Montgomery. The club meets for one hour a month and includes all fifth-grade students at the school of choice. Each month a hands-on activity teaches students about water and watersheds through various activities. The final club meeting includes a field trip to a local environmental park or nature center. After three successful years at four different schools, the ACWP has engaged approximately 250 students in watershed education in a long term meaningful way. Details of the program and obstacles to success will be presented along with ways to become involved or replicate this activity. The ACWP partnered with Central Alabama Community College in the Tallapoosa basin to mark storm drains on campus educating students, faculty, staff and visitors about stormwater issues. While partnering with the local college, the ACWP shared stormwater education to all students to encourage participation in the campaign. Central Alabama Community College students submitted beautiful artwork to be painted on storm drains throughout the campus. This project targeted young adults, which tends to be a difficult age group to educate. Details of the project and how to replicate or partner with the ACWP will be presented.

Establishing a Coastal Alabama Conservation Corps
Tom Herder, Mobile Bay National Estuary Program

Community engagement played a key role in the development of the Three Mile Creek Watershed Management Plan, including adaptation planning in low-lying, economically-challenged, traditionally-underserved communities facing frequent flooding events and increased threats related to climate change. Participants in the MLK Avenue Leadership Academy, cosponsored by the Mobile Bay National Estuary Program (MBNEP) and the Martin Luther King Jr. Avenue Redevelopment Corporation (MLKARC), participants working to improve community condition identified a need for the area's young adults to become more connected to the environmental assets. They proposed seeking opportunities to combine local environmental education with employment opportunities, and the idea of a Coastal Alabama Conservation Corps was born. In early 2016, MBNEP and MLKARC partnered to prepare a grant proposal to establish a Corps to put young, at-risk, urban adults to work implementing TMC WMP recommendations. Without a clear path to a workable budget, proposal submission was abandoned. In April, the National Fish and Wildlife Foundation's Developing the Next Generation of Conservationists provided another funding opportunity. MBNEP and MLKARC partnered with the Student Conservation Association (SCA), with 60 years of overseeing and funding similar initiatives and $100K in non-federal match, and a grant proposal for $250K was submitted in June and awarded in August for a six-month session of Coastal Alabama Conservation Corps. MLKARC assumed recruiting and screening ten 18 to 26-year-olds, public involvement responsibilities, and provision of space for Corps operations. SCA handled organizational infrastructure, safety training, payroll and benefits, and provision of two, trained SCA team leaders to supervise Corps members. MBNEP provided local program oversight, professional training oversight, funding, and grant administration as well as work schedule development. Local matching contributions included $25K each from Alabama Power and the Crampton Trust, $5K from Mobile Mayor Sandy Stimpson, and $2.5K each from County Commissioner Merceria Ludgood and City Councilmen Levon Manzie and Fred Richardson. Program objectives included providing training and environmental management employment to ten Corps members to apply marketable restoration techniques to implement smaller-scaled projects recommended in the Three Mile Creek Watershed Management Plan. Project outcomes were aimed at improving environmental stewardship and community ownership among minority, low-income, young adults; providing training and access to employment in an expanding Gulf restoration economy; and increasing local ownership of environmental assets of TMC through hands-on implementation of resource restoration and management activities to improve water quality and habitat condition. Team leaders arrived in leased SCA trucks in January, 2017, found housing, and occupied a store front on Broad Street provided by MLKARC. Six canoes and a trailer were secured for paddling into wooded wetlands surrounding the historic lower streamway of Three Mile Creek and One Mile Creek. Screened Corps members reported on February 3 for a nine-day, intensive training session in north central Florida. Staying in on-site dormitories with team leaders, they undertook training and received certification in chain saws, prescribed fire, wilderness and basic first aid and CPR, and canoeing. The CACC went to work on February 13. A Corps work week typically includes five eight-hour days implementing restoration measures, primarily control and eradication of invasive nuisance species from habitat-rich wooded wetlands, improving drainage in flood-prone neighborhoods, planting native plants as a component of restoration projects, and supplementing City and County efforts to manage environmental issues related to urban forestry. Each week includes four work days and one in advanced training; learning about coastal resource management, professional and communication skills, and environmental issues and developing speaking skills to carry the message of sound environmental stewardship to Mobile County Public Schools sixth grade classes through a curriculum-appropriate Watersheds 101 presentation. Members were paid $10 per hour with health benefits and at the conclusion of their term will be eligible for educational financial assistance through the AmeriCorps Vista program. Our first stab at an urban Conservation Corps in lower Alabama presented unforeseen challenges and rewards. Corps members demonstrated the feasibility of using relatively inexperienced young adults, willing to work in extreme environments wearing snake boots out of necessity, to implement WMP measures. Their success at public presentations to Mobile Public School System sixth graders providing a credible message of good environmental stewardship, surprised and satisfied funders, teachers, students, and the presenters themselves. The fruits of their ambition from this "launching pad" into higher education and the work force remain to be determined, but those who oversaw and committed time and resources to the program were rewarded with increased confidence in the abilities and potential of the Corps members who came on board to improve themselves, their communities, and their environment.

Stormwater User Fees in Alabama

Byron Hinchey, Amec Foster Wheeler

Stormwater utilities, or stormwater user fees, have been used as a dedicated funding source for stormwater management programs since the 1970's. More than 4,000 stormwater utilities are operational today, but we have been slow to embrace the concept in the "deep south". Stormwater utilities are prevalent in the border states of Florida, Georgia, and Tennessee. In Alabama, the Legislature at long last passed state-enabling legislation in 2014. However, the legislation was unusually prescriptive in how user fees must be billed and set very restrictive limitations on the amount that each property could be billed. We examine the concept of stormwater utilities, the use of stormwater utilities in the Southeast, and the opportunity, or lack thereof, to use this funding mechanism to successfully address our local stormwater management needs in Alabama.

Assessment of Groundwater Resources in Nanafalia Aquifer 2010-2016
Amye Hinson, Geological Survey of Alabama

The Geological Survey of Alabama (GSA) with support of the Governor's office and the Legislature recently completed an assessment of Alabama's groundwater resources in support of water policy development for the state. The purpose of the assessment was to generate spatial data based on hydrogeologic characteristics and information from water wells that may be used for future groundwater source planning and development as well as for the improvement of policies affecting the management, conservation, and protection of groundwater resources. The Nanafalia aquifer is a very productive aquifer in the Coastal Plain in Alabama and is used by many public water suppliers in southeast Alabama. Data for the assessment was collected from 2010 through 2016 to classify current groundwater resources in the Nanafalia Aquifer in Alabama , with the goal to (1) acquire and populate an acceptable groundwater well information database (Risk-Based Data Management System [RBDMS], (2) conduct an extensive field survey of wells to measure water levels for use in producing up-to-date potentiometric surface maps, (3) analyze geophysical logs to create geologic cross sections and geologic structure maps to physically define the depth of geologic formation tops, determine aquifer thickness and depth, determine the geologic composition of water-bearing strata, and to index wells to aquifers, and (4) create large-scale plates depicting geologic cross sections, formation structure, isopach maps, and potentiometric surface information. Extensive analysis of geophysical information and data resulted in the production of geologic cross sections, a net potential productive interval (NPPI) map, a potentiometric surface map, a geologic structure map, a groundwater production impact map, and groundwater recharge estimates for the Nanafalia aquifer in Alabama.

Past and Future Predicted Effects of Sea Level Rise and Human Activities on Habitats and Shorelines in Coastal Alabama's Weeks Bay Watershed
Scott Jackson, Ecology and Environment, Inc.

Although there are many potential impacts associated with climate change, some of the most pronounced and easily observed, are those related to sea level rise (SLR). While much uncertainty still exists over the rates at which sea level is expected to rise in the near future, apparent effects of sea level rise over the last 50-60 years are being observed already in some portions of Alabama's coastal watersheds. Observed and predicted future changes to coastal habitats and shorelines were analyzed as part of the Mobile Bay National Estuary Program's (MBNEP) Watershed Management Plan (WMP) for the Weeks Bay watershed in Baldwin County, Alabama. The analysis indicates that these habitats and shorelines in the watershed have been, and will likely continue to be impacted by both human activities and processes related to climate change, such as SLR. In order to assess changes to shorelines in the watershed over time, aerial photographs from 1955 were compared with aerial photographs from 2015. One of the most notable observations was land loss of emergent islands located near the mouths of the Fish and Magnolia Rivers. Some of these areas experience high levels of boat traffic and resulting wake, which can lead to shoreline erosion of the islands. Additional factors related to the size of these islands include the occurrence of flood events and tropical systems, which can cause increased flow and velocity leading to greater potential for bank erosion. The other most obvious shoreline change is the widening of multiple small tributaries of both the Fish and Magnolia Rivers, which do not appear to be affected by boat wake. These particular coastal streams are generally very short, run through marsh, and have very small watersheds. They are typically not wide or deep enough to be navigable by motorized boats. As such, erosion due to boat wake is most likely not the primary cause of the observed widening. Recorded data from the National Oceanic and Atmospheric Administration's (NOAA's) nearest long-term tidal gauge located at Dauphin Island, (approximately 17 miles southwest from the mouth of Weeks Bay), shows that mean relative sea level has risen 0.165 meters (6.5 inches) in the Mobile Bay area since the gauge was installed in 1966. Such a rise in mean relative sea level could explain why the smaller streams, which experience little to no risk of erosion from boat wake and no significant upstream land use changes in their micro-scale watersheds, have widened to such an extent in a relatively short period of time. NOAA and the U.S. Army Corps of Engineers (USACE) have predicted that sea level at the Dauphin Island station will likely rise somewhere between 0.34 and 2.15 meters (1 to 7 feet), by the year 2100. If the rate of sea level rises accelerates significantly, coastal environments may not be able to respond accordingly and will decrease in size or be submerged. As local sea levels increase, some marshes may migrate into neighboring low-lying areas, while other sections of marsh will be lost to open water or convert to an intertidal mudflat. In undeveloped or less developed coastal areas, ecosystems are more likely to be able to shift upward and landward with the rising water levels. Predicted effects of various SLR scenarios on future habitat distribution in the Weeks Bay watershed were analyzed using output generated by the Gulf Coast Prairie Landscape Conservation Cooperative (GCPLCC) from the Sea Level Affecting Marshes Model (SLAMM). The SLR scenarios chosen for analysis of the Weeks Bay Watershed were 0.5, 1.0, and 2.0 meters of relative mean SLR in the area from the initial year (2002) to the year 2100. In all three SLR scenarios, the largest proportion of habitat predicted to have a net reduction in acreage (via conversion to another habitat type or types) was the "Swamp" category, which constituted greater than 50 percent of total loss in all scenarios; and the "Regularly Flooded Marsh" category consistently showed the largest gains. However, as the SLR scenario was increased, this category's proportion of total habitat gained decreased as additional habitat categories, such as "Transitional Fresh Marsh," "Estuarine Open Water," and "Flooded Forest," began to increase.

Growing and Maintaining a Vibrant Watershed Group in North Central Alabama
Kevin Jenne, Choccolocco Creek Watershed; **John Loper** & **Thomas Loper**, The Loper Group; **Alan Fowler**, Geosyntec Consultants, Inc. & **Michael Price**, Genesis Project, Inc.

The Choccolocco Creek Watershed is a relatively new watershed group formed in 2011 to protect the waters of Choccolocco Creek located in northeast Alabama. Choccolocco Creek flows for approximately 65 miles from its headwaters in the Talladega National Forest southeast to its confluence with the Coosa River and receives inputs from a surrounding drainage basin that is approximately 500 square miles in size. The upper half of Choccolocco Creek is largely surrounded by undeveloped forestlands, and the lower portion is bordered by a combination of active agricultural lands and managed forestlands. Multiple tributaries provide surface water flow to Choccolocco Creek with several of these feeding the lower half of the creek. One of these tributaries, Snow Creek, flows for approximately six miles through highly developed urban and industrialized areas before entering Choccolocco Creek near its midpoint. In addition to the urban and industrial inputs from Snow Creek, the lower portion of Choccolocco Creek is the receiving waters for several permitted discharges, including two wastewater treatment plants and two industrial point sources. The agricultural lands bordering much of lower Choccolocco Creek are also potential sources for nonpoint pollutants, including nutrients. This presentation will focus on activities that are being conducted to grow and maintain the Choccolocco Creek Watershed recognizing that without diligent efforts, the initial enthusiasm and interest in a watershed group can wane as membership and volunteers discover that despite the benefits, it's hard work. The presentation will address important factors for growing and maintaining watershed groups including communication, organization, and fund raising. Communication is an influential factor for maintaining group momentum, and there are multiple tools available today that can be applied. Even with these tools, the messaging must be consistent and designed to highlight specific group events and successes. These successes, no matter how small, must be celebrated widely using the range of available communication tools. While many watershed groups begin as a loose affiliation of individuals and/or organizations bound by a common goal of protecting and/or restoring a watershed or waterbody, the most successful groups have become increasingly more organized over time. This includes developing a formal structure with defined roles and responsibilities and often includes governing boards and/or a board of directors. The presentation will provide an overview as to where the Choccolocco Creek Watershed is on this journey and describe upcoming plans. Finally, funding is central to the success of any organization, including watershed groups. It is important to recognize that despite how much volunteer labor a group may be able to muster, funding will be required to support projects. The presentation will describe how funding for this watershed group is being secured from a combination of sources including memberships, special events and grants.

Hydrologic Alteration and the Clean Water Act: Part I
Gerrit Jobsis, American Rivers; & **Randy Haddock**, Cahaba River Society

Changes in natural stream flow or "hydrologic alteration" can directly affect the physical, chemical and biological water quality of streams, lakes and wetlands. The results can have significant effects on designated uses protected by the Clean Water Act including aquatic life, recreation, cultural resources and drinking water. The identification of waters not meeting their designated uses due to hydrologic alteration can support efforts to address existing impairments and avoid new hydrologic alterations. In 2015, EPA issued national guidance to state and tribal water quality agencies that clarifies treatment of hydrologically altered waters under the Clean Water Act and encourages the agencies to more fully monitor, assess, and identify waters impaired due to hydrologic alteration. These waters should be reported to EPA and ultimately Congress under Category 4C of State Integrated Reports, also known as 305(b) reports. This workshop will provide an opportunity to learn about the effects of hydrologic alteration, EPA's guidance to states and tribes, and approaches for working with water quality agencies to identify and list hydrologically impaired waters in the biennial reports they are required to submit to EPA. Examples of streams in Alabama that should be classified as hydrologically impaired will also be provided.

Weeks Bay Watershed Hydrologic and Water Quality Modeling
Latif Kalin, Auburn University

The Mobile Bay National Estuary Program (MBNEP) is trying to develop watershed management plans for all HUC-12 watersheds around the Mobile Bay. This paper presents the watershed modeling efforts and the results for the Fish River and Magnolia River watersheds, which constitute the two main freshwater resources to the Weeks Bay, a sub-estuary of Mobile Bay. The presented watershed modeling effort is part of the "Fish River and Magnolia River Watershed Management Plan" project. The Soil Water Assessment Tool (SWAT) model was successfully applied to the Fish and Magnolia River watersheds. Although both watersheds are part of the Weeks Bay Watershed system, there are differences in their land use/cover (LULC), soil and topography. Therefore, separate models were developed for each watershed. The 2011 USDA National Agricultural Statistics Service crop layer was used as the representative LULC layer during model calibration and validation for flow, sediment, nitrogen, and phosphorous. Initially, manual calibration was used to have physically meaningful parameter ranges. At the next step SWAT-CUP (SWAT Calibration and Uncertainty Procedures) was used to fine tune those parameters using auto-calibration features. The calibration/validation period was 2005 to 2015. Model performances in general were very good during both calibration and validation periods. The calibrated model was run with the same LULC using daily climate data from 1986 to 2015 to generate 30 year-long model outputs. These 30-year model outputs revealed that the annual average TSS loadings from the outlets of the HUC-12 level Upper, Middle and Lower Fish River watersheds are 0.52, 0.56 and 0.48 t/ha, respectively. The annual TSS load to the Weeks Bay from the Fish River watershed is estimated to be 19,361 tons. The TSS loading from the Magnolia River watershed to the Weeks Bay is 1,371 tons, or 0.14 t/ha. It is clear that Fish River watershed is the dominant sediment provider to the Bay. Further, Fish River watershed is more susceptible to erosion than the Magnolia River watershed. Topography likely plays the bigger role in this, as Fish River watershed has a steeper terrain. The TN loadings from the outlets of each HUC-12 level units are 9.36, 10.52, 10.96 and 14.33 kg/ha, respectively, for the Upper Fish, Middle Fish, Lower Fish and Magnolia River watersheds. The North to South increase in TN loadings is associated with the increase in Agricultural land. The same numbers for TP are 1.24, 1.41, 1.60, 1.42 kg/ha, respectively. Again, there is the general increasing trend from North to South. Not surprisingly, the TSS, TN and TP loads are not generated evenly throughout the watersheds. As a matter of fact, only 10-14% of the total watershed area in the Fish River watershed is responsible for 50% of the TSS, TN, and TP loads generated from the whole watershed. In the Magnolia River watershed this percentage varies between 19% and 24%. We also looked at the past and future LULC impacts on flow and water quality. For that purpose, SWAT model was run with the 1992 LULC as well as two potential future LULC scenarios representing 2040(high growth and medium growth scenarios) . The same climate data from 1986 to 2015 were used. Average annual flows did not vary much, although low and high flows are expected to exhibit differences. Regarding TSS loading, there is an apparent increase in TSS loading to the bay moving from 1992 LULC to future LULC. The high growth scenario is expected to have the larger increase in sediment loading. TN had a different trend. Model results show that TN loadings were higher under the 1992 LULC compared to 2011. Future increase in residential lands in both watersheds are expected to lead to increase in TN loads. TP loads, on the other hand, appear to be lowest under the 1992 LULC, and future growth is expected to either not change or cause reduction in TP loadings to the bay.

How can we prepare Alabama for the era of water crisis?
Jonghun Kam, Princeton University

Alabama is now facing an era of water crisis because of more frequent water-related extreme events. In recent years, droughts and floods came together or close to each other (e.g., 2016–17 Southeastern U.S. Drought and 2017 Tropical Storm Cindy) and caused severe agricultural and economic losses. In this era, water resources management for multiple hazards becomes more challenging. To help build the resilience of the community to droughts and floods, a sub-seasonal to seasonal (S2S) forecasting system is developed, integrating the NOAA National Water Center (NWC) ensemble hydrologic forecasting and North American Multi-Model Ensemble (NMME) seasonal forecasting. For the sub-seasonal forecasting, the NOAA NWC hydrologic ensemble forecasting is customized to support flood response and preparedness planning at the state and city levels. For the seasonal forecasting, the NMME seasonal forecasting is utilized in simulating offline a land surface hydrologic model, the Variable Infiltration Capacity (VIC) and deriving multiple drought indices at the state level, including Standard Precipitation/Streamflow Index, and Soil Moisture Percentile. The proposed S2S forecasting system will be operated weekly and monthly for the purposes of responding to floods and droughts, respectively, via a web-based interface. Eventually, it will help build the resilience of the community to droughts and floods.

Application of AnnAGNPS to model an agricultural watershed in East-Central Mississippi for the evaluation of an on-farm water storage (OFWS) system
Ritesh Karki, Auburn University; **Mary Love M. Tagert**, **Joel O. Paz**, Mississippi State University; & **Ronald L. Bingner**, USDA-ARS National Sedimentation Laboratory, Oxford, MS

Annualized Agricultural Non-Point Source Pollutant Model (AnnAGNPS) is a watershed-scale, continuous simulation, physical model that has been widely used to simulate runoff, nutrients, sediment, and pesticides in agricultural watersheds. This study applied AnnAGNPS to simulate runoff, nutrients (total Nitrogen and total Phosphorus), and sediment from a 30.3 hectare agricultural watershed in East-Central Mississippi. AnnAGNPS was also used to evaluate an On-Farm Water Storage (OFWS) system as a Best Management Practice (BMP) for nutrient and sediment loading control from agricultural fields within this watershed and as a source of water for irrigation. An R2 of 0.85 and Nash-Sutcliffe Coefficient of Efficiency (E) of 0.82 in daily runoff estimation showed that the model can adequately simulate runoff from agricultural watersheds in East-Central Mississippi. In addition, an R2 of 0.88 and E of 0.67 for event-based sediment estimation and an R2 of 0.74 and E of 0.54 for monthly phosphorus estimation also showed that the model can satisfactorily simulate sediment and phosphorus. However, with an R2 of only 0.15 and E of -0.107, the model was unable to simulate nitrogen at a monthly scale, likely because of the lack of site specific and accurate input data. The evaluation of the OFWS system showed that the system was able to capture 220,000 m3 of runoff from the monitored watershed that can be stored and used for irrigation. AnnAGNPS estimated that the OFWS system also captured 46 tons of sediment and 558 kg of phosphorus during the monitoring period (September 2014 to March 2016), preventing downstream nutrient and sediment pollution.

Using Drone Images to Capture Channel Geometry for Hydrological Modeling
Thorsten Knappenberger & **Eve Brantley**, Auburn University

Hydrological models are important tools in stream restoration channel design and monitoring. Stream channel designs may include hydrological models with the goal to minimize shear stress and risk of fatal erosion and project failure. After impaired streams and reaches are restored the channel geometry is typically acquired through an intensive GPS survey. Based on the survey, hydrological models are processed and the as-built channel geometry is compared to the planned engineering design. Such GPS surveys are time consuming and only capture single points in a 3D landscape. An alternative is to use unmanned aerial vehicles, or drones, to capture aerial images and process them into 3D surfaces that then can be used in hydrological models. We identified 3 restoration projects in the D'Olive watershed and developed 3D surface models for each of the 3 restoration sites. We used an Inspire 1 (DJI, Shenzhen, China) UAV to capture the aerial images and processed them into 3D surface models using Pix4D (Pix4D Inc, San Francisco, CA). Shear stress was then modeled based on GPS survey data and based on UAV 3D surface models. GPS survey points and data derived from the 3D surface models correlated well with correlation coefficients of r=0.98. In-stream channel locations were captured more accurately with the GPS survey while the 3D surface models result in high resolution data on the banks. From our results, UAV drone images cannot replace GPS surveys. However, a hybrid of both approaches leads to highest surface quality. Critical points, especially in the channel where the water surface obscures the UAV images, still have to be acquired via GPS. High resolution aerial images can also be created from the UAV images. Those aerial images help hydrological modelers to understand the as-built conditions without having to visit the construction site. Future work will assess the suitability of UAV technology to monitor restoration sites over time capturing channel evolution and vegetation. In this study, only RGB images were processed. However, future data will also include multi-spectral images. With these data, it will be possible to assess vegetation growth and health. This provides a useful tool to identify and replant areas of low vegetation survival.

Establishing Comprehensive Volunteer Water Quality Monitoring
Jason Kudulis, Mobile Bay National Estuary Program

In coastal Alabama comprehensive watershed management planning is in full swing. In all, thirty one watersheds are targeted to get a plan, truly a massive and historic undertaking for coastal Alabama water resources. To guide planning efforts the EPA identifies nine key elements for inclusion, one of which is a monitoring component. Monitoring is vital to understanding the overall health of a watershed. It can be used to evaluate the success or failure of implemented planning strategies or determine where additional focus is needed. Often citizen driven volunteer monitoring programs are established to meet this critical need. However, organizing, funding, and retaining volunteer monitors to build a longstanding program can be a challenge. To address these obstacles and ensure support of both existing and future volunteer programs the Community Action Committee (CAC) of the Mobile Bay National Estuary Program has identified citizen monitoring as a priority and taken steps to allocate substantial resources including hiring a monitoring coordinator. Using partnerships, technology and Alabama Water Watch's EPA approved data collection methods the CAC has fashioned a framework to get new monitoring programs operational and outfitted for success. Additionally, the CAC serves as a hub for place-based grassroots organizations and monitoring entities to strengthen their individual group efforts and foster a unified volunteer monitoring community to advocate for water quality and wise stewardship. To date, the volunteer monitoring program model has led to the creation of new volunteer monitoring programs in the Fowl River Watershed and the Bon Secour/Skunk Bayou/Oyster Bay Complex.

Land-atmosphere coupling and soil moisture memory contribute to long-term agricultural drought
Sanjiv Kumar, Auburn University; **Matthew Newman**, NOAA ESRL PSD, NCAR; **Ben Livneh**, CU Boulder; **David Lawrence** & **Danica Lombardozzi**, NCAR

We assessed the contribution of land-atmosphere coupling and soil moisture memory on long-term agricultural droughts in the US. We performed an ensemble of climate model simulations to study soil moisture dynamics under two atmospheric forcing scenarios: active and muted land-atmosphere coupling strengths. Land-atmosphere coupling contributes to a 9% increase and 31% decrease in the decorrelation time scale of soil moisture anomalies in the US Great Plains and the Southwest, respectively. These differences in soil moisture memory are directly related to the length and severity of model drought. Consequently, long-term droughts are 10% longer and 3% more severe in the Great Plains, and 14% shorter and 20% less severe in the Southwest. An analysis of Coupled Model Intercomparsion Project phase 5 data show four fold uncertainty in soil moisture memory across models that strongly affect simulated long-term droughts and potentially attributable to the differences in soil water storage capacity across models.

Estimating nitrogen removal services of eastern oyster in Mobile Bay, Alabama
Quan Lai & **Zhang Yaoqi**, Auburn University; **Elise Irwin**, U.S. Geological Survey

Estimating and valuating services of an ecosystem is often demanding when there is a need to justify a restoration decision and to calculate the recovery of post dollar investment. Ecological restoration is often initiated as a means to cease or reverse the trend of degraded ecosystem and species loss caused by human-induced impacts. Eastern oysters have been acknowledged for their important contribution to human well-being by providing goods and services such as protecting shorelines from wave action, removing excess nutrients, increasing light penetration and providing shelter and food for fish, crustaceans and invertebrates. However, impacts from overharvest, disease and poor water quality have caused substantial declines of oyster reefs globally. In this study, we estimated nitrogen removal services provided by oyster reefs in Mobile Bay, Alabama. The oyster reefs were estimated to remove over 32,000 kg of Nitrogen per year through denitrification, and greater than 16,000 kg of Nitrogen per year through the burial of biodeposits into sediments. Almost 10,000 kg of Nitrogen can be removed per year from oyster harvest in the Mobile Bay, alone. By using the cost of removing nitrogen from an Alabama sewage water treatment plant, we estimated the economic benefit of the nitrogen removal services was upwards of $235,000 a year. These findings provide additional economic benefits to the overall estimation of oyster reef's ecosystem services in Alabama. These results can be used by decision makers or the public to estimate the economic return of oyster habitat restoration investments in Alabama waters.

Update on Grant Funded Comprehensive Steam Restoration Projects in the D'Olive Watershed, Baldwin County, Alabama
Paul Lammers, Mobile Bay National Estuary Program

The Mobile Bay National Estuary Program secured National Fish and Wildlife Foundation and Alabama Department of Environmental Management 319 grant funding to comprehensively restore degraded streams and wetlands to reduce sedimentation into D'Olive and Mobile bays. The D'Olive Creek Watershed Management Plan (2010) described factors underlying excessive erosion and sedimentation, identified most critically-degraded stream reaches, and recommended immediate restoration measures to prevent future degradation, reduce sediment sources, and prevent future degradation. The watershed's three principal tributaries (along with two unnamed tributaries) are included on the State's 303(d) list of Impaired Waters due to excessive sediment and habitat alteration. Stream restoration along the Eastern Shore of Baldwin County is not a trivial pursuit. With significant topographical relief, layers of erodible sand and clay, an average of five and a half feet of hard rain falling annually, and hardened urban landscape, this area represents "the perfect storm" of stormwater impacts, including flooding and flashiness, streambank erosion, wetlands degradation, and sedimentation. Already benefitting from sediment loading analyses provided by the Geological Survey of Alabama, MBNEP secured the services of a nationally-recognized stream restoration expert to guide the design, engineering, and management of projects being implemented simultaneously. Local engineering contractors also sought input from consultants to design restoration strategies capable of withstanding enormous sheer stresses to which the coastal streams of south Alabama are frequently subjected. With eight of 11 projects nearing completion and three more projects advancing through design phases, MBNEP will provide an update and share solutions developed to the challenges encountered in implementing the steam restoration projects.

Water-soluble carbohydrates sensing system using boronic acid modified poly(amidoamine) dendrimers
Xiaoli Liang & **Marco Bonizzoni**, The University of Alabama

Bodies of water often contains harmful compounds like organophosphorus from industrial farming and metabolites like carbohydrates from bacteria and plankton. Monitoring these components is essential to control water quality. Major challenges to sense analytes in water includes high cost, low sensitivity, complexity of the appropriate materials, and inconvenient construction of the functional devices. Therefore, developing simple analytical methods using materials that are commercially available or easy to prepare with good water solubility and high sensitivity is urgent. Our group developed aqueous analytical sensing systems for carbohydrates. Phenylboronic acids can be used as receptors in chemical sensors for carbohydrates. However, their binding affinity and solubility are usually poor in water. We improved these parameters by covalently connecting boronic acid moieties to the surface of a commercial available polymer: third-generation poly(amido)amine (PAMAM) dendrimers, to form a water-soluble PAMAM-boronic acid receptor (PAMAMba). We

first monitored the interaction of this modified boronic acid receptor with carbohydrate-like structure dyes such as 4–methylesculetin and alizarin Red S via absorbance and fluorescence spectroscopy. We then studied the interaction of the PAMAMba receptor with carbohydrates by setting up an indicator displacement assay based on those results. Addition of monosaccharides (e.g. fructose, glucose, galactose, ribose) and disaccharides (e.g. lactose, maltose, sucrose, trehalose) to the [PAMAMba • (dye)n] complexes allowed us to study the carbohydrates complexation to PAMAMba by following the displacement of the bound dyes. We demonstrated the use of these polymer-based sensors in a multivariate array sensing platform for the discrimination of carbohydrates in water as a proof of principle towards their broader applicability in physiologically and environmentally relevant conditions. This will allow us to generate a patterning system that can be used to sense different types of carbohydrates and other carbohydrate-like structures in water. These sensing efforts will be very helpful to monitor bacterial contamination of surface and deep waters by tracking the well-known carbohydrate metabolites of these species.

Faunal Habitat Linkages for Alabama Barrier Island Restoration Assessment at Dauphin Island

Clint Lloyd, Alabama Cooperative Fish and Wildlife Research Unit, & **Elise Irwin**, USGS.

Dauphin Island is a strategically significant barrier island along the northern Gulf of Mexico, serving as the only barrier island providing protection to much of the state of Alabama's coastal natural resources. The island has sustained impacts from both storms and the recent Deepwater Horizon oil spill, warranting evaluation of restoration options. This work will identify the most beneficial and effective restoration activities for Dauphin Island that, if implemented, would ensure long-term sustainability and resiliency of the state of Alabama's only barrier island, its habitats, the living coastal and marine resources it supports, as well as estuarine conditions in Mississippi Sound and the extensive coastal wetlands to the north. We have identified multiple objectives associated with long-term sustainability and resiliency of Dauphin Island. To evaluate the influence of restoration alternatives on conservation values we are developing a decision tool for the decision maker (Alabama Department of Conservation and Natural Resources) that will constitute a transparent assessment of the tradeoffs among the restoration strategies. A fundamental objective of this project is to maximize costal marine resources, particularly for the fauna that inhabit the island and the specific habitat types that these species utilize. Team members worked together to elicit faunal expertise and developed a list of species that utilize Dauphin Island. This list was used to estimate and rank general linkages of species to habitats. The rankings were then used in nonmetric multi-dimensional scaling (NMDS) ordination to identify similarities among faunal species based on estimated habitat usage. These habitat groupings will be used alongside geospatial models currently being developed to help quantify changes in habitat as a result of a suite of restoration alternatives. Through conceptual and predictive ecological modeling, reducing uncertainty can ultimately illuminate how these restoration alternatives contribute to the long-term sustainability of Dauphin Island as a barrier island.

Gradient-based Flood Map: A Science-Based Policy Alternative to the 100-year Flood Zone
Rachel Lombardi, University of Alabama

The 100-year flood is most commonly used in flood risk discourse because of the flood insurance rate maps (FIRM) created by the National Flood Insurance Program (NFIP). It is widely supported by literature that 100-year floods and associated flood maps create more confusion for the public than they effectively communicate risk. With 30 – 40% of flood insurance claims occurring outside of the 100-year flood zone, flood policy needs to be updated to a holistic representation of flood hazards. This paper proposes a science-driven policy alternative to 100-year flood maps called gradient-based flood risk maps which depict the flood inundation of all remote flood annual exceedance probabilities (0.01 or smaller) given the available hydrologic data for a region. A key factor in developing accurate maps of remote probability flood hazard is the inclusion of historic and paleoflood data in the flood frequency curve. Paleofloods are reconstructed using sedimentological evidence left by floods to reconstruct actual extreme events that have occurred in a river's geologic history. The inclusion of paleoflood and historic data can extend flood records thousands of years which allow hydrologist to determine remote probability floods without extrapolation beyond available data. The impact of using all available hydrologic data on flood maps and the feasibility of gradient-based map are demonstrated with case studies of several U.S. communities which have historically experienced extreme floods. These case studies show the key benefit of the gradient-based flood map is visual communication of a holistic view of flood hazard and allows property owners to make more informed decisions regarding flood risk.

Implementing a Modified HAND Method for Real-Time Continental Inundation Mapping
Ryan McGehee, Auburn University

The modified Height Above the Nearest Drainage (HAND) method is a terrain analysis method that can provide computationally efficient flood inundation approximations. We are demonstrating the complete methodology and providing our progress to date on a national implementation of the method. We expect to find significant improvements in our ability to approximate a more diverse range of hydrologic cases than the original HAND method while still being able to draw on its strengths. Ultimately, the modified HAND method has revolutionary potential for the field of water prediction and—with optimization—could be a breakthrough technology for flood forecasting and flood inundation mapping.

Medium range forecasting of reference evapotranspiration in continental U.S. using numerical weather predictions
Hanoi Medina, Auburn University

Forecasting evapotranspiration is one of the fundamental issues in water resources and irrigation management. Numerical weather prediction (NWP) forecasts can be used as model inputs for predicting medium range (1-10 days) reference evapotranspiration (ETo). This work compares the performance of raw and bias corrected medium range ETo predictions over nine climate regions in the continental U.S., using daily perturbed NWP forecasts, issued between May and August, from 2014 to 2016. The NWP are: the European Centre for Medium-Range Weather Forecasts (ECMWF), the National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS), and the United Kingdom Meteorological Office (UKMO). The study also ponders if the combination of single-model ensembles with overall similar levels of skill leads to a more skillful multi-model ensemble. ETo estimates based on quality-controlled U.S. Regional Climate Reference Network measurements, and computed with the FAO 56 Penman Monteith equation, are adopted as baseline. The result shows that the ECMWF has the best performance, followed by UKMO and GFS. The simple combination of the ECMWF and UKMO provided just slight, but yet significant, improvements in most performance statistics with respect to the best model. Errors in the incoming solar radiation forecasts are found to have a relatively high detrimental impact on the overall ETo uncertainty. From a practical perspective, our study of medium-range ETo forecasts provide useful information for water managers, farmers, and irrigation system operators.

Inland Navigation in Alabama
Larry Merrihew, Coalition of Alabama Waterway Associations Warrior Tombigbee

This presentation examines the value of the inland river systems of Alabama and the role of the Associations that monitor and promote this resource. The river systems of Alabama enhance the economic and environmental profiles of the State, and have helped change public and political opinions regarding the importance of the navigable rivers by involving the people in the discussions about the river systems. The presentation will also examine factors affecting the rivers from local, State, and National entities.

Coastal Marine Planning in Alabama
Christian Miller, Mobile Bay National Estuary Program

Coastal Marine Planning (CMP) is a comprehensive, adaptive, and ecosystem-based spatial planning process that analyzes current and anticipated uses of coastal areas and the marine environment to reduce environmental impacts and conflicts among users. The Alabama Department of Conservation and Natural Resources (ADCNR), via a grant from the National Oceanic and Atmospheric Administration - Office for Coastal Management, provided a grant to the Mobile Bay National Estuary Program (MBNEP) to develop and initiate CMP in the State of Alabama. The planning effort occurred in five phases, beginning in March of 2012 with the goal of improving the coordination of land and water uses along the Gulf Coast: I. Establish a Steering Committee, gather data, and identify gaps (FY 2012). II. Set vision and short- and long-term goals and objectives; gather data; and identify gaps (FY 2013) III. Expand network of stakeholders, prioritize and map uses and resources, begin to address goals and objectives; and gather data (FY 2014) IV. Develop decision support tool and gather data (FY 2015) V. Implement beta version of decision support tool, continue stakeholder input/education, and implement CMP (FY 2016) To guide CMP in Alabama a CMP Steering Committee was established and first met in March, 2012. The area approved by the Steering Committee set the CMP area as that which falls at and below the continuous 10-foot contour in Baldwin and Mobile counties, Alabama, and adjoining water bottoms extending 200 miles offshore into federal waters. The Steering Committee identified the following goals and objectives for CMP in Alabama: • Ensure sustainability of ecosystem services. • Minimize impacts of coastal activities on the environment. • Preserve economic viability of port activities. • Protect the interests of the State of Alabama. • Coordinate among agencies in future activities that pose conflicts of interest. • Develop a baseline of marine uses throughout coastal Alabama, and monitor over time. In order to achieve these goals, the committee developed the following objectives: 1. Inventory existing data sets that can inform CMP. 2. Define the geographic area for CMP. 3. Identify important habitats, resources, and uses that would benefit from improved management and coordination. 4. Develop a strategy for engaging the community in CMP. The initiation of CMP in Alabama presented many challenges, and continued engagement with stakeholders, including the Alabama Working Waterfronts Coalition, will be necessary to continue to advance CMP in Alabama. The perception of potential regulation of lands and water is a challenge in coastal Alabama, and participants were careful to refer to this effort as “marine planning” instead of other commonly-used terms including “marine spatial planning” or “coastal zoning” which elicit connotations of a regulatory methodology. The State’s approach to initiating CMP in Alabama was from a planning effort only. By allowing stakeholders to visualize potential conflicts of uses on a map, the focus shifted away from discussions of regulation to a more substantive discussion, which included potential use conflicts, data accuracy, and data types and sources. As such, this initial approach of mapping data for the expressed purpose of marine planning and understanding where conflicts of uses may arise might also help to solicit more acceptability for future CMP efforts in Alabama.

Development of Bivariate and Multivariate Coastal Drought Index- A comprehensive Drought Assessment Tool for Coastal Areas, Bays and Estuaries
Subhasis Mitra & **Puneet Srivastava**, Auburn University

Droughts in coastal areas has ecological impacts, affects socio-economic dynamics and public health. The interaction of freshwater-saltwater interface plays an important role in the economic and social dynamics along the coast and estuaries. In this study, we develop a bivariate and multivariate drought index that can quantify and indicate drought conditions in coastal, bays and estuaries by incorporating the meteorological, hydrological, and socio-economic droughts variables. The bivariate coastal drought index (BDI) was developed using the copula theory which included streamflow and salinity levels at the bay areas. Further, the entropy weighted Euclidean distance method was used to develop the multivariate coastal drought (MDI) index using precipitation, salinity and streamflow datasets. Both the BDI and MDI were able to capture the major drought events occurring in the region (2000, 2007 and 2011-2012). Analysis showed that both the BDI and MDI was able to indicate droughts conditions accurately based on multiple variables which previously developed univariate drought index failed to do for the coastal areas. MDI was able to detect drought earlier than BDI due to the incorporation of precipitation. Correlation analysis showed that both the BDI and MDI was highly correlated with the standardized univariate drought indices. One of the better features of the MDI was that it was able to capture the dynamics and trends of the variables involved and thus was a better indicator of droughts in the coastal regions. The coastal drought indices developed in the study can be used by the National Integrated Drought Information System (NIDIS) as drought indicators at coastal regions along the coastal regions, estuaries and bays in the US.

Tracking wastewater influence on oysters (Crassostrea virginica) in a freshwater dominated urbanized estuary
Haley Nicholson, Dauphin Island Sea Lab/University of South Alabama,

In freshwater dominated systems, major wastewater sources to urbanized estuaries can include wastewater treatment plants (WTP) and riverine discharge that can lead to oysters settling in wastewater affected areas, potentially affecting the ability to harvest adults. To define the relative influence of different wastewater sources on larval oysters, we measured oyster settlement rates and timing in the Mobile Bay/Mississippi Sound (MB/MS) system relative to WTP and riverine sources. We traced wastewater influence by measuring nutrients (NO3, NO2, NH4, TDN) in potential wastewater sources and N and C stable isotope (SI) ratios and indicator microorganisms (fecal coliforms, E. coli, male-specific coliphage) in WTP, riverine input sources, and oysters. Oyster spat settlement occurred only at higher salinity sites in MS with few spat collected at fresher MB sites, with peak settlement in mid-summer. WTP and riverine input sources had distinct nutrient, SI, and indicator microorganism signatures that could be traced to grow-out locations. Tissues were 1.2 to 2‰ enriched compared to suspended particles in the water and showed wastewater influence in northern MB near a major river mouth and WTP outfall. Similarly, nutrients and indicator microorganisms were highest in northern MB, with NO3 concentrations highest near the river mouth, and decreased down bay. Indicator microorganisms remained at background levels in MS except during rain events when microorganisms in water samples increased 30-60X. Overall, the river, rather than WTP, was the main source of indicator microorganisms and nutrients to this system. The combination of decreased anthropogenic waste input, dilution, nutrient uptake, and microbial decay down bay may have contributed to limit wastewater influence at oyster settlement locations. Currently, oysters in this system settle in areas less affected by wastewater, but that may be vulnerable to future urbanization and associated changes in freshwater flow and wastewater inputs.

Bridging Water Policy and Aquatic Species Conservation: What We Have Learned From a Two-Inch Fish

Patrick O'Neil & **Anne Wynn**, Geological Survey of Alabama; **Jeff Powell** & **Jennifer Grunewald**, U.S. Fish and Wildlife Service

The Trispot Darter is a rare fish found only in a few tributaries of the upper Coosa River system in Alabama, Georgia, and Tennessee. Originally described from Alabama collections made in the late 1940s, the species had not been found in Alabama for over 50 years until its rediscovery in 2008. It occupies a variety of stream sizes but spawns in ephemeral headwater channels. Recent studies of its spawning habitat revealed intricate relationships between the local distribution and survival of this species to groundwater hydrogeology, climate, soils, land cover, and land management. This species reproduces in seasonally wet headwater channels where flow is sustained through the winter and spring by recharge from saturated soils and shallow aquifers. Additionally, the Trispot Darter undertakes a Herculean spawning migration by moving upstream through water falls, stream blockages, and shallow pools to eventually reach its spawning ground. Policies affecting water quantity and water quality in Alabama are directly related to the viability of this species in several ways. Maintaining groundwater connections with spawning areas during the breeding season is critical to providing a minimum flow for reproduction and growth; maintaining sustainable instream flows in the nonbreeding streams is necessary for long-term survival; assessment and improvement of instream flow barriers such as road crossings and culverts that inhibit upstream migration movements is needed; and the use and improvement of best management practices for agriculture, forestry, and expanding urban areas within the range of the Trispot Darter is important for maintaining water quality.

Macroinvertebrate Community Response to Drought Years in Regulated and Unregulated Reaches of the Tallapoosa River, Alabama
Kristie Ouellette, **Ely Kosnicki**, **Tom Hess**, & **Clint Lloyd**, Alabama Cooperative Fish and Wildlife Research Unit; & **Elise Irwin**, U.S. Geological Survey

Hydropeaking is a common practice for hydroelectric facilities, even though it is well known to reduce downstream riverine community complexity. The extreme fluctuations in river stage, flow and temperature as a result of hydropeaking greatly alters the natural flow variation and creates stressful environmental conditions for the aquatic communities downstream of the impoundment, especially native species that thrive in natural flow conditions. R.L. Harris Dam is a hydropower facility located in the upper-central Tallapoosa River basin that has been the subject of an adaptive flow management project since 2005. Macroinvertebrates have been collected since project inception in spring and fall seasons to investigate effects on communities that are subject to both river regulation and natural variation in hydrology. A subsample from each year was randomly selected and macroinvertebrates were identified to the lowest possible taxon level. Non-metric multidimensional scaling (NMDS) was used to ordinate samples over Wisconsin double standardization of square root abundance macroinvertebrate space using Bray-Curtis Similarity Index. Selected metrics of richness, functional feeding groups, and habit were analyzed using ANOVA. The macroinvertebrate communities differ between the regulated and unregulated portions of the river, and these results are consistent through all years analyzed thus far. Overall, regulated reaches support fewer predators and scrapers, and more non-insect taxa, gatherers, and multi-voltine swimmers. Our results support an increase in community complexity in all reaches during drought years, although this could also be a result of increased detection probability due to drought conditions. Macroinvertebrate community composition of regulated reaches most resembled those of unregulated reaches during the drought years. This is potentially a result of fewer releases during drought years, which is supported by the presence of sensitive species closer to the dam as well as an increase in shredders and case-builders during the drought years. While reach and water year explain some of the variation in macroinvertebrate communities, it is highly important to consider the legacy effect of previous water years when proposing flow plans based on current water conditions.

Disinfection of Liquid Human Waste through Photoelectrochemical Process
Qing Peng, University of Alabama; & **Jeffrey Glass**, Duke University

Sustainable methods that can disinfect liquid human waste (LHW) into reusable water before discharging into the environment are urgently needed to address water and energy challenges. Photoelectrochemical (PEC) processes are a promising method to address this challenge by utilizing inexhaustible solar energy to reclaim water from LHW and generate/store energy. I will present the preliminary data showing PEC process as a viable process to reclaim LHW. The possibility of generating chlorine oxidative species through PEC with LHW as the electrolyte for disinfection will be

shown. The effect of the supporting electrolyte, light scattering/absorption, and biofouling of the PEC electrode surface on the disinfection process will be discussed. Our results show the promise of the PEC strategy for reclaiming water from LHW, along with challenges to be overcome for practical implementation of this method.

Hydrologic classification of Alabama rivers based on cluster analysis of dimensionless signatures

Sarah Praskievicz & **Cehong Luo**, University of Alabama

Classification of rivers is useful for a variety of purposes, such as generating and testing hypotheses about watershed controls on hydrology, predicting hydrologic variables for ungaged rivers, and setting goals for river conservation and management. Many existing river classification systems are top-down (based on a priori class definitions) and sometimes arbitrary. In this research, we present a bottom-up (based on machine learning) river classification designed to investigate the underlying physical processes governing rivers' hydrologic regimes. The classification was developed for the entire state of Alabama, based on 248 United States Geological Survey (USGS) stream gages that met criteria for length and completeness of records. Five dimensionless hydrologic signatures were derived for each gage: slope of the flow duration curve (indicator of flow variability), baseflow index (ratio of baseflow to average streamflow), rising limb density (number of rising limbs per unit time), runoff ratio (ratio of long-term average streamflow to long-term average precipitation), and streamflow elasticity (sensitivity of streamflow to precipitation). We used a Bayesian clustering algorithm to classify the gages, based on the five hydrologic signatures, into distinct hydrologic regimes. We then used classification and regression trees (CART) to predict each gaged river's membership in different hydrologic regimes based on climatic and watershed variables. Using existing geospatial data, we applied the CART analysis to classify ungaged streams in Alabama, with the National Hydrography Dataset Plus (NHDPlus) catchment (average area 3 km2) as the unit of classification. The results of the classification can be used for meeting management and conservation objectives in Alabama, such as developing statewide standards for environmental instream flows, and the classification methodology can also be extended nationwide. Such hydrologic classification approaches are promising for contributing to process-based understanding of river systems, by focusing on the physical controls that are common across different rivers rather than on what makes each river unique.

Challenges, perspectives and understandings regarding wetland function – a comparative case study

Rasika Ramesh, **Latif Kalin**, **Mehdi Rezaeianzadeh**, & **Chris Anderson**, Auburn University; **Mohamed Hantush**, US EPA

Rapid coastal development has led to loss/alteration of wetlands, streams, and headwater areas that buffer coastal waterways from pollution. Headwater streams are particularly vulnerable to alteration and disappearance as a result of urban expansion and agriculture. This study aims to assess functioning of headwater slope wetlands: groundwater-fed forested wetlands that occur in headwater areas of first order streams and are abundant in the Alabama-Mississippi Coastal Plain. However, headwater wetlands are less studied, especially in the Gulf Coastal Plain. To address this knowledge gap, three headwater wetlands along a gradient of urban modification in Baldwin County, AL were chosen for this study. Modeling this system presents unique challenges pertinent to a low gradient coastal plain system including high water tables, significant groundwater interactions and dealing with very small watersheds (being headwater areas). Models such as the Soil and Watershed Assessment Tool (SWAT) and WetQual (watershed and wetland scale models respectively) were used to conduct a modeling based inquiry into the functioning of these wetlands. The results of this study reinforce the influence of residence time in wetland nutrient mitigation. These insights were contrasted with that derived from a similar modeling based inquiry of a small restored wetland in a dominantly agricultural watershed whose runoff flows to an estuary in Chesapeake Bay in Maryland. This study is significant for two reasons: (1) it expands our understanding of the diversity of nutrient mitigation ability among different kinds of wetlands (2) it expounds on the many challenges that have to be met in order to model such complex systems.

Minimum streamflow requirements necessary for streambed inundation using graphical and mathematical methods for Alabama streams

Claire Rose, **Rodney Knight**, **Patrick O'Neil**, & **Scott Gain**, U.S. Geological Survey of Alabama

Water is critical to the survival of aquatic biota; however, little has been done to quantify the minimum water depth in a stream that can still provide adequate habitat for the support of aquatic biological communities. Much research in this field has focused either on connections between various streamflow measures and aquatic habitat or linkages between habitat and the biological health of a river. There is little physical evidence that instream flow standards based on indices such as the 7Q10, developed with regard to waste assimilation, are minimally protective to aquatic biota. Aquatic resource management would benefit from a better tool for understanding the interactions between streamflow, channel morphology, and streambed in connection to biological health to establish scientifically-defensible flow requirements. In particular, understanding minimum flows needed to fully inundate streambeds would provide an empirical basis for ecologically meaningful instream flow standards. The USGS, in cooperation with the Geological Survey of Alabama, evaluated streamflow, channel morphology, and habitat availability at 36 stream gage sites in four physiographic regions of Alabama for the purpose of developing a mathematical approach to target a range of streamflows that correspond to the maximum bed inundation threshold.

The objective of that analysis was to determine (1) if streamflow and channel geometry could be linked in a discernible manner, and (2) the potential to develop regional tools for predicting critical-flow thresholds. Visual and mathematical methods were applied to the 36 sites individually to determine the streamflow necessary for minimally inundating the streambed at each site. The number of sites was expanded by two-fold to strengthen the robustness of the dataset. The purpose of the expansion was to increase statistical significance in determining streamflow correspondence with regional and physiographic characteristics. Specifically, sites were located as to allow for stronger evaluation for regionalization of the method according to physiographic region and geologic unit type and potential prediction of streamflow necessary for inundating the streambed. The analysis included daily value streamflow time series, streamflow measurement data (cross-section data), game and non-game fish community data, available habitat data, and stream cross-sectional surveys. This investigation will be used to answer questions regarding maximized physical habitat at low flow, predicting streamflow by region, geology, and other physiographic boundaries, and to determine correlation between the health of the aquatic biota and streamflow necessary for inundating the streambed.

Primum Non Nocere – Fundamentals of Ecological-Driven Remediation
John Schell, TEA, Inc., **John Loper** & **Thomas Loper**, The Loper Group, Inc.,
Michael Price, Genesis Project, Inc., **Alan Fowler**, Geosyntec Consultants, Inc.

The decision to remediate a hazardous waste site is based in part on perceived risks to ecological receptors. Benchmarks adorned in a high level of uncertainty beget errors in decision making. Similarly, overstating the precision of blunt tools used in assessing ecological risks provides decision makers with a false sense of confidence in conclusions reached through this assessment process. The result can sometimes be unnecessary remediation and a futile attempt at restoration - an attempt to put things back the way humans perceive they should be. Understanding the challenges in trying to truly restore what nature has built over long periods of time, decision makers need to be confident that there is real substantial ecological harm prior to "curing" the harm with intrusive remediation. We have learned from decades of experience that remediation of sediment sites is not always a zero-sum game: the benefits from remediation equal (or exceed) the destruction incurred from the remedial action. This is certainly not true in the short term and numerous case studies illustrate it is not true in the long term. As scientists, we need to consider all the data established by the relevant constellation of benchmarks and improve our ability to determine when an effects threshold has truly been breached and injury has occurred. An important, and often overlooked component is understanding, and where possible quantifying, the consequence of intrusive "remedies". Some of the relevant consequences include habitat destruction, community disruption (wildlife and human), impacts to cultural geography and the potential loss of species that are threatened, endangered or classified as extinct. Webster's defines a remedy as "a medicine, application, or treatment that relieves or cures a disease or injury; something that corrects or counteracts." Does an intrusive remedial action in an aquatic environment relieve or correct an ecological injury? The answer requires a two-step process: first, establish there is an injury; and second, have confidence that the "remedy" will correct or counteract the cause of the injury. The evidence required to establish an injury constitutes a "Health Check List" and includes information on habitat (aquatic, riparian, terrestrial), chemistry (pH, conductivity, pollutants), and the benthic piscine avian and mammalian communities (structure, dominance). The entirety of the dataset needs to be considered in the decision-making process, with an understanding and appreciation for the uncertainties and variability inherent in the different assessment tools. The Anniston PCB Site provides a case study for the application of a systematic approach to determine harm or injury and the need for invasive action. Data are available on chemical concentrations in sediment, water and biota, as well as habitat quality and structure of the benthic and piscine communities. These data will be discussed in terms of the need for remediation and the difficulties in achieving acceptable restoration of the ecosystem should intrusive remediation occur.

Non-Lethal Estimation of Proximate Body Composition of Channel Catfish Using Bioelectrical Impedance Analysis

Julie Sharp, Alabama Cooperative Fish and Wildlife Research Unit, Auburn University, **Elise Irwin**, U.S. Geological Survey, Auburn University

Assessment of body composition serves as an accurate measure of fish condition. Fat content is known to be a reliable indicator because animals with more stored fat, or energy, are more capable of successful reproduction and survival. Physiological and biochemical techniques are used to measure composition but require time and fiscal resources for laboratory analysis, eliminating use for rare and endangered species or long-term monitoring. Alternatively, bioelectrical impedance analysis (BIA) is a non-lethal technique used to estimate body composition, such as fat, protein, and water, from measurements of resistance and reactance. While models have been developed for only a few species of fish, development of a BIA model for Channel Catfish, *Ictalurus punctatus*, is desirable because of the species' economic importance and needs to measure condition in the field. Accurate BIA requires initial model development which was accomplished by correlating reactance and resistance to %DW. Species specific relations between %DW and proximate composition estimates were established with simple conversion equations. The influence of electrode location on impedance measurements was assessed to determine which result in the most accurate body composition predictions. Lastly, the effect of temperature was analyzed to develop correction equations which will lend the models to use in the field.

What Difference Does a Year Make? The Influence of Drought Periods on Low Flow Statistics and Water Quality Trends
Lynn Sisk, TTL, Inc.

Droughts in recent years have had dramatic impacts on the amount of water flowing in rivers and streams in Alabama. A review of measured stream flow reveals how these relatively short term droughts have changed the estimated seven-day, ten-year low flow (7Q10) for streams with differing numbers of years of measured flow. For streams with longer periods of record, a single year of drought may have less impact on the estimated annual 7Q10 than its impact on a stream with fewer years of measured flow. However, the severity of the drought also plays a role in determining how a seasonal or annual drought may influence the estimated 7Q10 for a stream. In this same way, drought periods can influence the estimation of water quality trends in rivers and streams and skew estimates of annual pollutant loadings and water quality in streams. This presentation will examine how past droughts in Alabama have influenced estimates of 7Q10 stream flow and water quality.

Keeping Lagoons EPA Compliant
Wade Stinson, Wastewater Compliance Systems

The most common method for treating domestic wastewater in small communities is wastewater treatment lagoon. As the population in the rural areas continues to increase, and as discharge standards become increasingly stringent, the challenge of removing contaminants from wastewater has become increasingly important. As a result, these lagoon systems that do not meet discharge requirements are generally replaced with expensive mechanical treatment plants. What alternatives are available for communities with lagoons facing ever increasing discharge regulations? This presentation explores varying innovations that can be applied to a typical lagoon system to maintain compliance for next one to two permit renewing cycle, include cleaning, circulation, screening, optimize existing aeration, fixed film technologies, curtains, covers and disinfection.

Creating a Clean Water Future for the Weeks Bay Watershed
Roberta Swann, & **Christian Miller**, Mobile Bay National Estuary Program.

A number of water quality and water quantity issues have been documented within the Weeks Bay Watershed (WBW) over the past several decades. Population growth and urban development, as well as some of the agricultural practices, have continued to intensify problems in the Watershed's four principal Hydrologic Unit Code (HUC 12) subwatersheds: Upper Fish River, Middle Fish River, Lower Fish River, and Magnolia River. Since 1998, a number of stream segments in the WBW have been placed on Alabama's 303(d) list due to a variety of pollutants of concern. The WBW is a large area (approximately 130,000 acres), containing a large network of streams (approximately 362 miles) within central Baldwin County. The Watershed includes all or portions of nine municipalities (Fairhope, Daphne, Spanish Fort, Loxley, Robertsdale, Silverhill, Summerdale, Foley, and Magnolia Springs) and associated unincorporated areas of Baldwin County. Increased volume and velocity of stormwater runoff, as well as some agricultural practices, have exacerbated concerns over water quality degradation, e.g., bacterial pollution, nutrient over enrichment, sedimentation, and flooding within the Watershed. To respond to these concerns, the Mobile Bay National Estuary Program (MBNEP) and the Baldwin County Soil and Water Conservation District (BCSWCD) facilitated efforts to address issues in the Weeks Bay Watershed. This involved award of a contract in January 2016 to Thompson Engineering, Inc. (Thompson), along with sub-consultants Ecology and Environment, Inc. (E&E), Barry A. Vittor and Associates, Inc. (BVA), Bob Higgins and Associates, Hand-Arendall LLC, and Latif Kalin for preparation of a comprehensive Weeks Bay Watershed Management Plan (WMP). Development of the WMP, made possible through funding by the National Fish and Wildlife Foundation's Gulf Environmental Benefit Fund, has been guided by the goals, objectives, and expectations contained in the MBNEP's 2013 – 2018 Comprehensive Conservation Management Plan (CCMP). This planning process, guided by the MBNEP and watershed stakeholders, charts a conceptual course for improving and protecting the things people most value about living along the Alabama coast (water quality, fish, environmental health and resilience, access, culture and heritage, shorelines). In addition to meeting requirements for watershed planning specified by EPA's "Nine Key Elements", the focus in preparation of the WMP has been to provide a strategy to conserve or restore those habitat types that are most stressed: freshwater wetlands; streams, rivers and riparian buffers; and intertidal marshes and flats. The overall goal is to help Weeks Bay Watershed stakeholders develop a plan that recommends specific and tangible management measures to protect, conserve, and preserve the unique qualities of the area and recognize and encourage stewardship of the Watershed's resources in a cooperative way. Weeks Bay is recognized through designation as a National Estuarine Research Reserve (NERR) since 1986 and as an Outstanding National Resource Water (ONRW), one of only three within the State of Alabama since 1992. The Magnolia River is recognized as an Outstanding Alabama Water (OAW) since receiving that designation in 2009. Early in the watershed management planning process it became very obvious to the Thompson team that two valuable entities exist within this watershed and should be specifically recognized – the Weeks Bay National Estuarine Research Reserve and the Weeks Bay Foundation. This WMP outlines a holistic approach to address the issues and concerns identified for the land and water areas of the WBW. The purpose of this WMP is to guide watershed resource managers, policy makers, community organizations, and citizens to protect the chemical, biological, and cultural integrity of the WBW, and specifically its waters and habitats supporting healthy populations of fish, shellfish, and wildlife and providing recreation in and on these waters of coastal Alabama. To accomplish these broad goals, this WMP identifies a range of measures that can be applied to more efficiently manage urban development and agricultural practices within the WBW. By successfully addressing the co-related problems identified with population growth, urban development, and some agricultural practices within the WBW, the long-term health of the stream courses, Weeks Bay and Mobile Bay will be enhanced. Preparation of the WMP was accomplished through a collaborative effort that was guided by the Thompson team and the Stakeholders Working Group (SWG). The focus of this team was to elicit strong stakeholder participation. The SWG includes about 25 representatives from the cities, the county, state and federal agencies, homeowners, agricultural interests, developers, and engineers. The SWG continued to meet bimonthly with the Thompson Engineering team throughout the development process, having a total of 10 meetings over the course of the WMP development.

Finding and nurturing public support: what cultural rhetorics can contribute to public debates on environmental initiatives and clean water policies
Cindy Tekobbe, The University of Alabama.

Any number of public polls and opinion studies tell us that Americans are politically and culturally polarized. A Pew 2014 study of the opinions of 10,000 people demonstrates that citizens are by and large frustrated with their governments and have little trust for government-sponsored initiatives. But it also demonstrates what most people could tell you from their experience at the family holiday dinner table – people are more likely to believe or support notions that match their preconceived opinions and values. This mistrust and entrenched ideology can make a challenge of finding broad support for even common-sense public policy. While rhetoric as a discipline is most commonly recognized as the art of persuasion, it is also the art of understanding how people engage in knowledge-making practices. In order to persuade an audience, the writer or speaker must craft a “knowing” in the audience that the speaker’s position is one they too should take up. A speaker crafts this knowing by constructing for the audience: definitions, proofs, and passion. For example, to persuade an audience to vote for a bond initiative to improve the quality of water in local waterways, the speaker might make a moral argument. The speaker could then construct a knowing that clean water is a moral choice by emphasizing the necessity of safe drinking water and by igniting passionate beliefs that children should have safe water. However, given the political polarization in public discourse, a mistrust of public speakers, and a tendency to only support ideas that align with preconceived notions, the tried and true rhetorical practices of persuasive speaking and writing may be less effective than they have been in the past. Alternatively, the discipline of cultural rhetorics approaches knowledge-making through the sharing of personal stories. Cultural rhetoricians position the storytellers of first-hand and lived experiences as primary knowledge-makers, rather than relying on the traditional persuasive public speaker to be the conveyer of knowledge to a receptive audience. A cultural rhetorician working in water policy might approach gaining support for a local clean water bond initiative by inviting speakers to share their childhood stories of drinking clean water from local springs or safely swimming in local rivers. Speakers might share stories of the importance of a local creek to their family who has lived near its banks for generations. The exchange of these lived experiences can help construct a publicly held memory of the significance of a waterway to the community, or humanize the issue of clean local water by making the policy initiative relatable to the everyday lives of community members. In this presentation, the speaker will briefly define and describe the field and practices of cultural rhetorics. Then, the speaker will discuss some of the water quality issues in their own community. Next, they will share a few examples of local community-based water cleanup and water quality preservation initiatives. Finally, the speaker will propose strategies for implementing cultural rhetorics to garner or expand community support for water quality initiatives.

A Paleohydroclimate Perspective on Alabama Water Policy

Matthew Therrell, **Glenn Tootle**, **Bennet Bearden**, **Emily Elliot**, University of Alabama,

The historic socioeconomic damage caused by hydroclimate extremes such as drought and flooding is well documented in the Southeastern U.S. and recent events such as flooding in Louisiana and the Carolinas and drought and wildfire in the southern Appalachians highlight the significant and ongoing hazard posed by hydroclimate variability to the natural and built environment. Determining the long-term natural variability of streamflow as well as the frequency and magnitude of extreme hydrologic events is important not only in terms of thoughtfully managing the water resources of the state but also in terms of providing context for understanding hazards to life, property and infrastructure, and ecological impacts. The paleo record of hydroclimate is limited in the Southeast in general and particularly so in Alabama. However the available records clearly show that the observed record of hydroclimate (e.g., streamflow) does not adequately represent the range of natural variability and therefore any water resource policy that does not take the paleo record into account will not stand the test of time. Water resource managers in the Southeast should heed the lessons of the Western states and not only promote the development of paleo records in the region but also use these valuable archives to inform and guide water policy.

Ecosystem review and analysis for the weeks bay watershed management plan

Tim Thibaut, Barry A. Vittor & Associates, Inc.

The Baldwin County Wetland Advanced Identification Map (ADID, 2005) was the ground base for the assessment of Weeks Bay Watershed wetlands. The ADID map was modified through remote sensing techniques, using existing spatial datasets and ArcGIS. The datasets included MBNEP/ADCNR State Lands Division true color orthoimagery (2015), NAIP true color orthoimagery (2015), Baldwin County 1-ft LiDAR contour data (2002), NRCS Grady soils data, and National Hydrology Dataset (NHD) flowlines. A total of 278 field check points were visited in January 2017 to corroborate wetland locations and identify areas where wetlands were added, eliminated, or adjusted in the base map. The modified ADID map has 12,367 acres of wetlands, with 89.7% in the palustrine shrub/forested category. The ecological condition of wetlands and riparian buffers was investigated through landscape scale assessment, using the modified ADID map, NHD flowlines, and the National Land Cover Dataset (2011). The proportion of natural (forested) land cover within a 300-ft upland buffer was used to predict the quality of adjacent wetlands. For riparian buffers, natural (wetlands and upland forest) cover within a 100-ft-wide corridor bordering both sides of study area ditches, streams, and rivers was assessed. Non-natural land cover categories include barren land, hay/pasture, cultivated crops, developed-open space, and low-medium-high intensity developed. Wetland and riparian buffers were assessed for each of the 169 NHD catchments comprising the watershed. Catchments with natural land cover comprising between 100 and 75% of their total buffer acreage were scored as good quality, 74 to 51% as fair quality, and 50% or less as poor quality. Wetland buffers in the Upper Fish River HUC12 are mostly in good condition. Middle Fish River has 43% of its catchments with fair condition wetland buffers, around one third in good condition and nearly 25% in poor condition. The Lower Fish River HUC12 has a majority of catchments with wetland buffers in good condition, but most of the total buffer acreage is only in fair condition. Wetland buffers in the Magnolia River HUC12 are mostly in poor condition, including 51% of the catchments and 58% of the total buffer acreage. Riparian buffers in Upper Fish River have the highest proportion of catchments in good condition (76%), followed by Middle Fish River (66%), Lower Fish River (55%), and Magnolia River (50%). Most of the riparian buffer acreage in the Magnolia River HUC12 is in poor condition, due to narrow or non-existent buffers along drainageways and ditches that traverse agricultural land. Buffer restoration opportunities in these locations should be analyzed prior to implementation, to avoid inadvertent creation of nutrient loading sources. Poor condition wetland and riparian buffers are present to some extent at the upper margins of all four sub-watersheds. In general, the main stem of Fish River has intact wetland and riparian buffers. Future development in the watershed should proceed with a heightened awareness of the value of maintaining these areas in a natural state. Priorities for acquisition and conservation in the watershed include tidal wetlands. Tidal marsh systems are considered high quality habitat due to their level of ecosystem services provision, including habitat for fisheries and species of high conservation concern. Total estuarine emergent acreage in the watershed is 507 acres, with these systems located in the lower reaches of the Fish River HUC12, which includes most of Weeks Bay, and the lower Magnolia River HUC12. The total area of tidal marshes within existing conservation easements is 176 acres. Alabama Natural Heritage Program (ALNHP) data includes switchgrass tidal fringe at two locations on the Magnolia River. This community type is considered a habitat of extreme rarity in Alabama (S1). Tidal pond cypress, also an S1 habitat, has documented occurrences in the area of lower Eslava Branch and near Weeks Creek. The ALNHP data also include an area of streamside white-cedar swamp (S1) in the Upper Fish River HUC12, associated with Turkey Branch near Highway 90. Longleaf pine-turkey oak woodland (S2) occurs near Fish River in the Middle Fish River HUC12, south of CR 48. These rare habitats should be investigated to verify their occurrence and document their extent and ecological condition, prior to consideration of establishing conservation easements for their protection. Invasive exotic plants are widespread in the watershed. Establishing a public-private collaboration program for management of invasive exotic flora and fauna, and for inventorying important habitats and species on private lands, would be of significant value for long-term conservation and management.

Multi-decadal Decline of Alabama Streamflow

Glenn Tootle, **Matt Therrell**, **Bennett Bearden**, **Emily Elliott**, **Jonhun, Kam**,
University of Alabama

Unprecedented population growth combined with environmental and energy demands have led to water conflict in the Southeastern United States. The states of Florida, Georgia and Alabama have recently engaged in litigation on minimum in-stream flows to maintain ecosystems, fisheries and energy demands while satisfying a growing thirst in metropolitan Atlanta. A study of Southeastern United States (Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina and Tennessee) streamflow identified a declining pattern of flow over the past ~25 years with increased dry periods being observed in the last decade. When evaluating calendar year streamflow for (56) unimpaired streamflow stations, a robust period of streamflow in the 1970's was followed by a consistent decline in streamflow from ~1990 to present. In evaluating 20-year, 10-year and 5-year time periods of annual streamflow volume, the past decade reveals historic lows for each of these periods. Potential climatic drivers which could be associated with this decline were examined with a particular focus on streamflow gages in and adjacent to the State of Alabama.

Have the local government entities involved in water resources management evolved over the period 1990 to the present day? Have their changing roles influenced the development of water policy in the state?

Mary Wallace-Pitts, University of Alabama

The need for an integrated water policy in Alabama has long been recognized - the AWRSC report of 1990 (i) identified deficiencies related to planning and management and concluded the "actions must be taken immediately to develop a framework for managing water resources". Almost 25 years later the Alabama Water Agencies Working Group (AWAWG) recognized the importance of natural hydrologic boundaries and recommended that future management should be based, at least in part, on their location (ii). However, today little data exists to inform decision makers with respect to selection of the appropriate local governance entity or entities to implement the water policies being developed for the state (iii) . The literature is clear with respect to the need for an appropriate framework within which to implement successful policies. According to Peters (iv) an appropriate framework ensures that that the "rights and assets" of all stakeholders can be protected while also protecting public assets for the long-term. This framework should also include the necessary political/legal and institutional structures. To address this deficiency the AWAWG created a Local/Regional Focus Area Panel (v) (FAP) charged with recommending a "structure and strategy" for planning and implementation, with a view to determining the appropriate institutional framework. This research is designed to compare the entities in existence in 1990 and their role with those present today. Through an analysis of institutional evolution through time and a comparison with other local, regional and national frameworks an appropriate framework for Alabama will be proposed.
Endnotes: i Alabama Water Resources Study Commission (AWRSC), 1990, Water for a

Quality of Life ii Alabama Water Agencies Working Group (AWAWG), 2014, Mapping the Future of Alabama Water Resources Management: Policy Options and Recommendations iii Pitts, 2016, AWRA Conference Proceedings 2016, What is the Appropriate Institutional Framework for the Implementation of Water Policy in Alabama? http://www.aaes.auburn.edu/wrc/wpcontent/uploads/sites/108/2016/09/Wallace_2016ALWRA.pdf iv Peters, Doerte; 2009 Policies and Legal Framework; http://www.sswm.info/ v AWAWG, 2014, Mapping the Future of Alabama Water Resources Management: Policy Options and Recommendations

Reconstructing sediment inputs, water quality and phytoplankton communities in Wolf Bay, Alabama from the sediment record
Matthew Waters, **Alex Metz**, & **Ben Webster**, Auburn University

The connectivity between inland water systems and coastal environments occurs in bays where salt and fresh waters are mixed forming a dynamic environment. Given the large influx of materials, water quality is of concern in bay systems, however, these areas can be extremely productive and provide suitable habitat for economic gain such as fisheries and aquaculture. While models and monitoring efforts can serve important roles, historic data is generally lacking and is needed to better understand natural conditions as well as changes to the ecosystem from historic perturbations. Paleolimnological tools can be applied to sediment cores collected in bay areas to provide historic influxes of materials as well as changes to the primary producer community. Here, we report on the analysis of a 1.3 m sediment core from Wolf Bay, Alabama. The core included two distinct sections comprised of modern organic sediments (0 to 0.5 m) over a shell hash layer (0.6-1.3 m) representing a historic period of oyster beds. Results from paleolimnological measurements including nutrients (C, N, P), photosynthetic pigments and organic matter show two distinct ecological states in the bay's history. Drivers of ecosystem change are believed to be linked to human disturbance in upstream and local watersheds.

Mapping and Analysis of Sedimentation in a Suburban Lake
Bret Webb, University of South Alabama

This presentation will describe the results of mapping and analysis of nearly 60 years of sediment accumulation in a suburban, man-made lake. Comprehensive mapping of lakebed elevations was performed in the artificial impoundment of the Lake Forest subdivision during May and June of 2016. Nearly 90% of the precipitation that falls within the D'Olive Creek Watershed flows through this recreational amenity lake prior to reaching Mobile Bay. The goal of this mapping was to determine how much sediment had accumulated in the lake since it was created, by way of a dam, in the early 1970s and where the accumulation had mostly occurred. Additionally, some shallow sediment cores were obtained from creek deltas within the lake and were analyzed for grain size and composition. Due to limited access to the waterbody, a novel method was required to perform the lake survey: a high-resolution ADCP was mounted to a kayak, which afforded easy access to very shallow and densely vegetated water. Spot elevations on land and in very shallow water were obtained via walking surveys using RTK GNSS receivers. Over 12,000 discrete elevation measurements were obtained during the study. These present-day elevations were compared to a 1958 topographic survey, which was painstakingly digitized for the purpose of performing a comparative analysis of lakebed elevations. The results of the comparative analysis revealed that over 300,000 cubic yards of sediment had accumulated over 78% of the lake area since construction of the dam. Also, the lake surface area decreased by approximately one-third, from 61 to 43 acres, over that same period of time. As a result, the lake has lost somewhere between 45% and 60% of its flood storage (below the crest of the dam spillway), though its construction was not for flood mitigation. The sediment grain size analysis revealed that the upper 12 in to 16 in of sediment are coarse, well-sorted sands having a texture and color similar to what is found along what remains of Mobile Bay's sandy shorelines. As a result of the sediment impoundment upstream of the dam, those shorelines have been deprived of one of their only remaining sources of bay shoreline materials: creek flood deposits. The results of this study are being considered in ongoing restoration and enhancement feasibility studies of the lake, including the potential to relocate and reuse some of the accumulated sediments.

Accessible County Level Water Resource Fact Sheets: Experiences from Your Neighbor
Vincent White, U.S. Geological Survey

Accessible water-resources data and analysis are essential for the proper management of a community's water resources. Knowledge of water availability, quality, development potential, and the impact of development is necessary for water-resources planning and protection. Water-resources information for Louisiana and many other states are presented in a variety of technical reports, each with a particular geographical scope and topical focus. Information in these reports often includes the whole state or a multi-county area. Basic information on surface water, ground water, and water quality in a single county of interest often has to be gleaned from several reports, many of which may be in limited circulation and difficult to locate. Many stake-holders and decision-makers are often not in a position with respect to resources and time-required to research and synthesize the available literature. Furthermore, difficulties in acquiring and analyzing data runs the spread from an apparent or actual absence of information for a county to an information overload induced by reports conducted using different terminology in slightly different study areas in different decades. Concise summaries are needed to provide the information needed to make decisions about current and future development which meets the needs of local stakeholders of all segments and avoids the excesses of under-information and over-information. The Water Resources of Louisiana Parishes project is about 70 percent finished achieving this goal with the publication of an online and hard-copy fact sheet for each of Louisiana's 64 parishes (equivalent to a county). These 64 publications, which are generally 6 pages in length, provide summaries of groundwater and surface-water availability, water quality, current and historical water usage, and an extensive list of references for readers looking for more in-depth treatments of the topic. Adjunctive beneficiaries of this project include scientists unfamiliar with a local area and social-environmental justice. Scientists will be provided a tool to quickly gain a general picture of the state of affairs in regards to water resources in a particular area as well as an already prepared list of references for further study. A second benefit of the project is the advancement of environmental justice. According to EPA: "Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies...It will be achieved when everyone enjoys the same degree of protection from environmental and health hazards and equal access to the decision-making process to have a healthy environment in which to live, learn, and work." Science is essential for sound decision making and high-quality unbiased science in general is expensive. Communities on the lower end of the socioeconomic spectrum may not have as many scientific resources available due to a lack of interest or the inability to pay for it. USGS Water Resources fact sheets provide at least a certain level of accessible and free knowledge for every community–regardless of demographic or economic factors–at parish-scale resolution for the entire state.

Alabama Dam Safety: Inventory Update and Beyond

Jeff Zanotti, Amec Foster Wheeler; **Wardell Edwards**, Alabama Office of Water Resources

Alabama is the only state in the nation without a Dam Safety Program. This potentially limits Alabama regarding the conditions and locations of the state's aging dam infrastructure. In 2008, Alabama's Office of Water Resources (OWR) began creating a statewide inventory of dams by using Geographic Information System (GIS) analytical tools and datasets to both locate and estimate hazard potential. Through yearly goals and lessons learned along the way the statewide inventory for all 67 counties was completed this year. This inventory is a positive step forward in establishing a base to make informed decisions regarding dam safety. The end goal of the inventory is to supplement the National Inventory of Dams (NID) and maintain a statewide database that can be utilized by our state and local governments for emergency management and mitigation purposes. The proficiency of the GIS applications allowed us to locate new dams as well as identify spatial inaccuracies of the current NID database. With all 67 counties of Alabama now analyzed, a statewide database has been compiled for assessment, mapping, and planning. The potential hazard classifications were based on a combination of volume, height, and downstream identifiable hazards. This presentation will demonstrate the ways GIS can be used to communicate dam risk and hazard mitigation. The compilation of statistics, facts, and hazard assessments gleamed from the use of this database, will go a long way in discussions on the state and local level for the next steps in securing overall dam safety for the state's citizens, property, and well-being.

Poster Presentations
(alphabetical order by author's last name)

ID	Author	Title
1	**Mohammad Al-Hamdan**	Developing a Dynamic SPARROW Water Quality Decision Support System Using NASA Remotely-sensed Products
2	**Palki Arora**	Effect of Subsurface Application of Broiler Litter on Phosphorus Losses
3	**Elizabeth Bankston**	Verifying that Coliscan Easygel Colony Color Corresponds to Expected Color Results
4	**Shuo Chen**	Effects of Agricultural Land Use on the Sources and Reactivity of Dissolved Organic Matter (DOM) in Subtropical Streams
5	**Sandra Cutts**	An Evaluation of Organically Bound Tritium (OBT): The Savannah River Site
6	**Parnab Das**	Surface Discharge of Raw Wastewater from Unsewered Homes in Central Alabama
7	**Karl DeRouen Jr.**	Drought, Access to Improved Water and Conflict: A case study
8	**Jamekia Durrough-Prichard**	Availability of Groundwater Resources for the Highland Rim in Alabama
9	**Deepa Gurung**	Floodplain Inundation Dynamics of Sipsey River, Alabama
10	**Xiaole Han**	Hillslope-stream Connectivity Via Subsurface Stormflow on Headwater Hillslope in Southeast China
11	**Brendan Higgins**	Coupling Anaerobic Digestion with Algae Cultivation for Advanced Treatment of Agricultural Wastewaters
12	**Amye Hinson**	Geological Survey of Alabama Real Time Water Level Network
13	**Michael Ihde**	Discrimination of Metal Cation Mixtures in Water
14	**Mariam Khanam**	The Effect of River Bathymetry on Riverine Flood Simulations
15	**Matt Koerner**	Development of an In-stream Manipulation Experiment to Determine Micro-scale Interactions Between Freshwater Mussels and Sediment
16	**David Koon**	Alabama Cooperative Extension System's Efforts to Educate Homeowners on Smart Water Use
17	**Rachel Kuntz**	The Lethal Effects Caused by Local Untreated Stormwater of Daphnia Populations Compared to Stormwater Treated Through Bioretention Media
18	**Shelby Lauzon**	Worms Living in Toxic Hydrogen Sulfide
19	**Taylor Ledford**	The Impact of Nutrient Loading on Nitrogen Removal in a *Juncus roemerianus* and *Spartina alterniflora* Dominated Saltmarsh in the Northern Gulf of Mexico
20	**Yang Lu**	Electrospun Carbon/Iron Nanofibers with Enhanced Heat and Chromium(VI) Removal Properties of Water Treatment
21	**Cehong Luo**	The Needs of the River: Examining potential impacts of external drivers on environmental instream flows on the Cahaba River
22	**Kritika Malhotra**	Fingerprinting and Modeling Sources of In-stream Sediments in a Southern Piedmont Watershed

ID	Author	Title
23	**Mariel McConville**	The Eukaryotic and Prokaryotic Biota of Blount County, AL Sulfur Spring
24	**April Nabors**	Evaluating the Removal of TOC and Resulting DBP's Using Filter Aids
25	**Gabriel Proano**	High Surface Area Biofilter Media Fabrication Using Additive Manufacturing for Moving Bed Bioreactors in Wastewater Treatment Process
26	**James Rivers**	Identifying Past Trends in Hydrologic and Hydroclimatic Extremes in Coastal Alabama Watersheds
27	**Jarrett Roland**	Center Pivot Irrigation Water Use in the Wiregrass Region of Alabama
28	**Mary Rubisch**	Tidal-flow Wetlands with Feedback Control for Management of Nitrogen in Aquaculture Wastewater
29	**Michael Salisbury**	Analysis of D'Olive Creek Watershed: Identifying the local drivers that have led to stream degradation and how they compare to the drivers of the Fly Creek Watershed
30	**Walker Skeeter**	Are Intense Precipitation Events Increasing in the Southeastern USA?
31	**Kimberly Stowers**	Historiometric Analysis: A toolbox for improving water management efforts
32	**Md Tazmul Islam**	Physical Based Global Bedload Flux Analysis in Large Rivers
33	**Derek Tollette**	The Effects of Crude Oil on Northern Gulf of Mexico Salt Marsh Nitrogen Cycling
34	**Charles Waid**	Stream Restoration Impact on Stream Stability and Water Quality in Moores Creek, Alabama
35	**Caitlin Wessel**	Impacts of Microplastics in the Water Column on Oysters
36	**Evan Wujcik**	Fabric/MWCNT Nanosensor for Ultra-Portable Copper Ion Detection in Drinking Water
37	**Yifei Xu**	The Anions in the Citric Acid Cycle: Tackling the differentiation of minimally diverse species using hyperbranched polymeric receptors

For further information, please see the conference website:
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