

BOTTOMLAND and SWAMP FORESTS SYMPOSIUM



**October 31 through
November 2, 2017**

**Hilton Riverfront Hotel
Wilmington, NC**



NC STATE EXTENSION FORESTRY

Go.ncsu.edu/Bottomland-Symposium

Symposium Overview

This symposium is a forum for research and issues surrounding bottomland and swamp forest systems. The presentations and tour will highlight the outcomes of 3 years of research by the North Carolina Forest Service, and the USDA Forest Service and NC State University Department of Forestry and Environmental Resources. The invited speakers represent the most timely research and practices on bottomland and swamp forests in the Southeastern U.S. Their contributions include assessments of these forest types, best management practices for harvesting and water quality, and the potential for restoration efforts on both natural and human influenced sites. We are most grateful for their willingness to participate in this symposium and share the important data and experiences in these bottomland and swamp forest types. The Symposium planners present this forum as a contribution to the health and sustainability of this special ecosystem in North Carolina and beyond. Thank you for your participation as it is also your personal contribution to this important effort.

Symposium Coordinators

NC Forest Service Symposium Planning Committee:

Jim Slye, Sean Brogan, Tom Gerow, AJ Lang, Barry New, Hans-Christian Rohr

Symposium Logistics:

Kelley McCarter, North Carolina State University, Extension Forestry
Kerrie Cave, North Carolina State University, Office of Professional Development

Special Thanks To

All of the presenters and panelists who are sharing their knowledge at this symposium and to Dr. William Stahle, University of Arkansas for being our keynote speaker and special session presenter;

Dr. Robert "Bob" Kellison, NC State University Professor Emeritus in recognition of his career-long leadership and many contributions in research, teaching, and extension on hardwood and bottomland forest silviculture;

November 2nd Field Tour Presenters: Jim Slye, Bill Pickens, Erin Levine and Ron Myers (NC Forest Service), William Conner (Clemson University), Mike Aust (Virginia Tech), David Robinson and John Deans (Corbett Timber Company);

NC State University undergraduate student researchers, Josiah Marshall and Michael Bottorff for their hard work with the NC Forest Service to carry on the research associated with this symposium;

USDA Forest Service for essential research funding that made this symposium possible.

Symposium Supporting Organizations

North Carolina Forest Service
USDA Forest Service
North Carolina State University, Extension Forestry
USDA NIFA Renewal Resources Extension Act
North Carolina State Parks

Symposium Agenda

TUESDAY, OCTOBER 31, 2017 – TECHNICAL PRESENTATIONS, EXHIBITS, POSTER SESSION

- 12:00 – 1:00 Poster Set-up – Authors should check in with AJ Lang, NC Forest Service
- 1:00 – 1:10 Welcome: Barry New, Technical Development Program Head, NC Forest Service
- 1:10 – 1:30 Symposium Overview: Sean Brogan, Forest Management and Development Division Director, NC Forest Service and Jim Slye, Forest Health Specialist, NC Forest Service
- Technical Session I: Moderator, Dr. Mark Megalos, NC State University Extension Forestry
- 1:30 – 2:30 A Panel of Southern States: Forest Management Challenges in the Bottomlands and Swamps of Florida, Georgia, and North Carolina. Fifteen-minute presentations from each panelist with the final 15 minutes of question/answer from the audience.
- Jeff Vowell, Assistant Director, Florida Forest Service
 - John Colberg, Forest Water Quality Program Coordinator (retired), Georgia Forestry Commission
 - Jim Slye, Forest Health Specialist, NC Forest Service
- 2:30 – 2:45 Current Policy Discussions and Partnership Efforts in North Carolina's Bottomland Forests
Tim Foley, Policy Director, Southern Group of State Foresters
- 2:45 – 3:15 Refreshment Break and Poster Set-up and Discussions
- 3:15 – 3:45 History of Bottomland Hardwood Research in the South
Dr. Robert Kellison, Professor Emeritus, NC State University
- 3:45 – 4:15 US Forest Service Center for Bottomland Hardwood Research
Dr. Emile Gardiner, Research Forester and Team Leader, USDA Forest Service, Southern Research Station
- 4:15 – 5:00 Water Quality/Regulatory Issues Affecting Wetlands
Tom Gerow, Water Resources Staff Forester, NC Forest Service
- 5:00 Conclusion of Day 1 Technical Session
- 5:30 – 7:30 Social at Riverview Terrace, Hilton Hotel
- 6:00 – 6:45 Optional Session: Ancient Taxodium Natural History and Decdroclimatology
Dr. David W. Stahle, J. William Fulbright College of Arts and Sciences, University of Arkansas

WEDNESDAY, NOVEMBER 1, 2017 – TECHNICAL PRESENTATIONS, LUNCHEON, POSTERS

8:00 – 8:15 Call to Order and Moderator: Barry New, Technical Development Program Head, NC Forest Service

Technical Session II: Moderator, Barry New, Technical Development Program Head, NC Forest Service

8:15 – 8:45 FIA Data/Extent of the Resource
Mark Brown, FIA Analyst, Southern Research Station, USDA Forest Service

8:45 – 9:30 Ecology of Bottomland/Swamp Hardwoods
Dr. Emile Gardiner, Research Forester, Center for Bottomland Hardwood Research, USDA Forest Service

9:30 – 9:45 Refreshment Break and Poster Display Discussions

9:45 – 10:45 Effects of Timber Harvesting on Cypress and Tupelo Regeneration
Dr. W. Michael Aust, Professor of Forestry, Virginia Tech

10:45 – 11:15 Bottomland/Swamp Forest Restoration and Artificial Regeneration
Dr. William Conner, Professor, Belle Baruch Center for Coastal Ecology and Forest Science, Clemson Univ.

11:15 – 12:00 A Survey of 25 Swamp Forest Harvests in the North Carolina Coastal Plain
Jim Slye, Forest Health Specialist, NC Forest Service

12:00 – 1:15 Luncheon Presentation: Ancient Bald Cypress at Black River, North Carolina
Dr. David W. Stahle, J. William Fulbright College of Arts and Sciences, University of Arkansas
Lunch Provided. Moderator: Jim Slye, NC Forest Service

Technical Session III: Moderator, David Halley, True North Forest Management Services

1:30 – 3:00 Stakeholder Panel: Looking at Bottomlands from Different Perspectives
Opening comments by David Halley will be followed by ten-minute presentations from each panelist with all questions held to the end of the panel session.

- Enviva – Ben Larson, Director of Sustainability
- The Nature Conservancy – Jeff Marcus, NC Longleaf Pine Restoration Director
- Meherrin River Forest Products – Don Bright, President
- Audubon – Curtis Smalling, North Carolina Director of Bird Conservation
- Private Landowner – Hardy Parker, Duplin County, NC

3:00 – 3:30 Refreshment Break and Poster Display Discussions

Technical Session IV: Moderator, Barry New, Technical Development Program Head - NC Forest Service

3:30 – 4:00 Ecological Forestry Practices for Bottomland Forests of the Southeastern U.S.
Amanda Mahaffey, Northeast Region Director, The Forest Guild

4:00 – 4:45 The Ecological and Economic Values of Bottomland and Swamp Hardwoods
Dr. Fred Cabbage, Professor of Forest Economics, NC State University

4:45 – 5:00 Wrap Up / Symposium Adjourns / Poster Removals

5:15 Field Tour Logistics Meeting (those pre-registered to attend the field)

THURSDAY, NOVEMBER 2, 2017 – FIELD TOUR

For those pre-registered to attend the field tour, please participate in the tour logistics meeting on Wednesday, November 1 at 5:15 PM in the Cape Fear Ballroom at the end of the Symposium. Tour participants should dress for the anticipated weather conditions and chance of precipitation, especially as relates to the use of waterproof footwear.

The following is a generic tour agenda. A detailed handout will be provided during the field tour.

6:45 AM Grab 'n Go breakfast at Hilton lobby is available to consume at hotel or in vans
7:45 AM Vans load on Water Street in front of the parking lot at Hilton Hotel (sorry, no caravanning)
8:00 AM Vans and support vehicles depart Hilton Hotel (sharp)
Mid Day Lunch service provided in three shifts at Singletary State Park
4:00 PM Approximate time of arrival back at Hilton Hotel

Participants should select one of the vans provided and stay with that vehicle for the entire day.

Below is the list of stops and topics that will be covered during the tour.

1. Cape Fear River Bottomland	Challenges in Natural Regeneration. Natural and man-made hydrological changes and their impacts on the natural regeneration of bottomland forests.
2. Singletary Lake State Park	Overview of Carolina Bays. A brief presentation highlighting this unique land feature. (lunch break)
3. Colly Swamp Blackwater Stream System	Artificial Regeneration of Cypress. Enrichment of natural regeneration by planting cypress seedlings.
4. Bladen Lakes State Forest	First Terrace Bottomland Hardwood Stand. Alternative silvicultural practices and their influence on regeneration and plant/animal communities.

Bottled water available all day from NC Forest Service trucks. Restroom facilities available at each stop.

Biographies of Invited Speakers and Panelists

(Alphabetical order by last name)

Mike Aust received his Ph.D. from NCSU and has been a faculty member in the Department of Forest Resources and Environmental Conservation at Virginia Tech since 1989. Mike's teaching activities at Virginia Tech include Forested Wetlands, Forest Soils and Hydrology, Forest Boundaries, and Roads, and Forest Field Experiences. His research activities focus on the development and implementation of forestry BMPs to minimize the effects of forest operations on soil productivity and water quality. Mike is a Certified Forester and member of the Society of American Foresters, Society of Wetland Scientists, and Soil Science Society of America.

Don Bright is President of Meherrin River Forest Products. Meherrin River manufactures hardwood lumber with locations in Virginia and North Carolina, most recently adding a third location in Macon, North Carolina. Don Bright received his BS degree in Forestry from Virginia Tech with emphasis on Forest Products Marketing and Management. Don was Vice President of Morgan Lumber Company, a Southern Yellow Pine lumber producer, before incorporating MRFP in 2011. He owns timberland in Virginia to include upland hardwood, pine plantation and Cypress bottomland. Don has a passion for forest stewardship and wildlife management. He is currently serving his 6th year on the Virginia Governor's Board of Forestry. Don and his wife, Kimberly, and two children reside in Clarksville, VA.

Mark Brown is a Resource Analyst with the Southern Research Station of the US Forest Service at the Forest Inventory and Analysis (FIA) work unit in Knoxville, Tennessee. Mark is responsible for the FIA publications regarding forest trends in the States of North Carolina and Florida. Regionally, he is responsible for reporting trends in the South's cypress population as well as that for the South's mangrove population. Mark received undergraduate and graduate degrees from the University of Georgia and Clemson University, respectively.

John Colberg works with Rockdale County, Georgia as a Forester and Certified Arborist. John performs inspections related to the County's Tree Ordinance and other urban forestry services. During his 30 years with Georgia Forestry Commission, he served as a Field Forester, District Water Quality Coordinator, Regional Forest Water Quality Specialist, and the final 4-1/2 years as the GFC's agency coordinator of its Forestry Water Quality/BMP Program, retiring in 2015. The County also owns approximately 2,000 acres which he manages as county greenspace, where cutting and other normal forestry operations are carried out. John earned his BS in Forest Management at Auburn in 1985 and currently resides in Buford, GA.

William Conner is Professor, Forestry and Environmental Conservation Department and Assistant Director of the Baruch Institute of Coastal Ecology and Forest Science at Clemson University, Clemson, SC. In addition to his research and teaching relating to forest wetland ecology at Clemson, Dr. Conner is a Fellow of the Society of Wetland Scientists and the Clemson Institute of Parks and member of the Society of Ecological Restoration along with other national and international natural sciences organizations. He served on the Governor's Coastal Wetland Forest Conservation and Use Science Working Group from 2004-2005. His important work, at both Clemson and LSU, have helped shape the way cypress and tupelo forests are managed and conserved in the Southern US.

Fred Cabbage is Professor, Department of Forestry and Environmental Resources, North Carolina State University. He has co-authored more than 400 research papers and 500 speeches on analysis of global timber investments, natural resource policy, market based conservation programs and sustainability certification, and agroforestry; and teaches natural resource policy and forest economics. He was a Service Forester in Kentucky for 2 years; a professor at University of Georgia for 10 years; an economist and Research Work Unit Project Leader with the Forest Service for 5 years; Department Head at NC State for 10 years; and for the past 13 years, a professor at NC State. He received undergraduate and graduate degrees at Iowa State University and the University of Minnesota, respectively. Fred is the 2017 national President of the Society of American Foresters.

Tim Foley is the Policy Director for the Southern Group of State Foresters (SGSF), representing the forestry policy interests of 13 states from across the South as well as Puerto Rico and the US Virgin Islands. In this role, he supports the mission of state forestry agencies in sustaining the economic, environmental and social benefits of the South's forests by working with Congress, federal agencies, and partners to generate policy that supports southern forests and forest landowners. Prior to joining SGSF, Tim worked for the US Forest Service in many roles including timber management, environmental planning, budget development, and with the USFS International Programs area providing technical assistance on forest carbon assessment to countries in West Africa. Tim holds a Masters of Environmental Management from Duke University and an undergraduate degree in Environmental Policy from Colby College in Waterville, ME.

Emile Gardiner is a Research Forester with the Southern Research Station of the US Forest Service at the Center for Bottomland Hardwoods Research in Stoneville, Mississippi. Emile serves as the Team Leader for Regeneration and Reproductive Biology Research. His academic training and research experience have focused on seedling ecophysiology and regeneration silviculture of bottomland hardwoods. His research contributes to the development of practices that benefit rehabilitation of natural hardwood stands and restoration of forest on former agricultural land for a variety of landowner objectives.

Tom Gerow, Jr. is the Water Resources Staff Forester with the North Carolina Forest Service in the state office in Raleigh. Tom joined the Forest Service in 2002 and through his time with the agency has been a staff specialist on all matters related to water quality & forestry, including nonpoint source pollution; BMPs; stream restoration; training & education; and in his current job is the agency's lead staff person on water-quality & wetlands rules, policies, and guidance. Tom has served as Chairman and Secretary of the Water Resources Committee for the Southern Group of State Foresters. Prior to his state service, Tom worked 7 years for the Georgia-Pacific Corporation across 3 states while assisting with management of the company's timberland and overseeing timber harvesting operations. Tom attained a BS in Forest Management from N.C. State University in 1994, is a North Carolina Registered Forester, a member of the Society of American Foresters, and the North Carolina Forestry Association.

Ben Larson has worked on sustainable biomass for over ten years. Beginning with the Union of Concerned Scientists (UCS), he advocated for US federal renewable energy and climate policy that included sustainable biomass, and developed compromise with forest owners, biomass power generators, and the environmental community over how sustainable forest biomass could be included in policy. After receiving his master's in Forestry from the Yale School of Forestry, Ben worked as a consultant with Environmental Defense Fund (EDF) on practical ways that the pellet industry can be more sustainable. At the National Wildlife Federation (NWF), Ben managed bioenergy and SE Forestry programs, which focused on habitat and biodiversity conservation, and partnered with Enviva on two projects related to identifying and protecting high conservation-value forests. At Enviva, Ben is director of sustainability, managing partnerships related to biomass sustainability and climate benefits.

Robert "Bob" Kellison is a Professor of Forestry, NC State University (Emeritus). Among other duties at NC State University, Dr. Kellison directed the Hardwood Research Cooperative with members consisting of forest industry and state agency member organizations with landholdings from Maryland to Delaware, south to central Florida, and west to Arkansas. Following his retirement from NC State University in 1995, Dr. Kellison worked for Champion International, and later International Paper. He concluded his formal employment by directing the Institute of Forest Biotechnology for four years. Industrial and governmental organizations in North and South America, Europe, Asia, Africa and Pacific Region still seek his advice on hardwood silviculture and various forest management topics.

Amanda Mahaffey is the Northeast Region Director of the Forest Stewards Guild. She holds a B.A. and Master of Forestry from Yale University and a Master of Music from the University of Southern Maine. She has over a decade's worth of experience in forestry and environmental management, including industrial forest management, wetland delineation, timberland transactions, woodland owner outreach, regional conservation partnership coordination, and fire. In 2016, Ms. Mahaffey co-authored a report on ecological forestry for bottomland hardwood forests of the Southeast, and she continues to be engaged in regional initiatives in bottomland forest conservation and management.

Hardy Parker is a resident and private landowner in Duplin County where he has managed his family's farms and timberland for more than 30 years. His management of timberland includes a "hands-on" approach for all aspects from planting through harvesting. Hardy was a member of the North Carolina Forestry Advisory Council from 2006 - 2012. He is currently a member of the North Carolina Department of Agriculture Commissioner's Circle (2012 - present).

Jim Slye is a forest health specialist with the North Carolina Forest Service (NCFS). His 22+ years of work with bottomland hardwoods in different areas of the southeastern coastal plain. Most recently, as Assistant Regional Forester – Forest Management for the NCFS Coastal Division, he provided silvicultural guidance to agency personnel. In addition, his work has involved assessment of regeneration on harvested bottomland sites and involvement with various working groups associated with bottomland hardwood management. Previously, Jim taught Forest Management Technology at Wayne Community College where instruction included identification, silvics, and silviculture of bottomland hardwoods. Jim began his career in forest industry procurement and land management, including procurement for a hardwood sawmill sourcing material from bottomland hardwood sites. As part of his industrial duties, he was also involved in hardwood log and tree grading. Jim possesses a BS in Forest Management from NC State University.

Curtis Smalling is the Director of Conservation with Audubon of North Carolina. He is currently responsible for the Working Lands, Coast, and Bird Friendly Communities programs for Audubon North Carolina. He is a member of several species working groups including the Cerulean Warbler Technical Working Group, International Wood Thrush Conservation Alliance, and the International Golden-winged Warbler working group including working on these species and others on their wintering grounds in Nicaragua. He is a contributing author or editor for several books and publications. Curtis is a 1985 magna cum laude graduate of Appalachian State University with a Bachelor of Arts in Biology and in 1996 received a Master of Arts in Appalachian Studies. A life-long bird watcher, Curtis began watching birds with his grandfather, who was very interested in Purple Martins. He resides in Boone, NC with his wife of 35 years, Mary, and has three children and a granddaughter.

David W. Stahle is a Distinguished Professor in the Department of Geosciences and Director of the Tree-Ring Laboratory at the University of Arkansas, Fayetteville (www.uark.edu/dendro). He received his Ph.D. in Physical Geography at Arizona State University in 1990. He was elected a Fellow of the American Association for the Advancement of Science in 2015. He has published over 100 articles on the development of climate-sensitive tree-ring chronologies from the United States and Latin America, the reconstruction and analysis of past climate, and on the social and environmental impacts of past climatic extremes. He is the founder and director of the Ancient Cross Timbers Consortium and is now developing the Ancient Bald Cypress Consortium to promote research, education, and conservation of the last remaining old-growth bald cypress and bottomland hardwood forests that survive in the southeastern United States.

Jeff Vowell is Assistant Director with the Florida Forest Service. Jeff oversees the Forest Management Bureau, which manages 1.2 million acres of timberland for wood supply, recreation and wildlife. The agency provides technical forestry assistance to private landowners; the Forest Protection Bureau, responsible for fire control on over 26 million acres of wildland; the Logistics and Support Bureau, responsible for all facilities and equipment in the agency; and the Field Operations Bureau, responsible for implementation of all program areas. Jeff also has oversight responsibilities for the agency's Forest Hydrology program, which manages the silviculture BMPs, and related regulatory aspects of forestry in Florida. The Florida BMP Technical Advisory Committee recently developed the Forestry Wildlife BMPs for Imperiled Species. Jeff Vowell earned a B.S. degree in Forest Management and a Masters degree in Hydrology. He has worked as a procurement forester for private industry and has been with the Florida Forest Service since 1987.

Abstracts of Poster Presentations

Poster #1 BUFFER RESTORATION, NUTRIENT OFFSET AND CARBON SEQUESTRATION ON A FORMER BOTTOMLAND HARDWOOD SITE IN CRAVEN COUNTY, NORTH CAROLINA

Douglas Frederick¹ and Scott Frederick²

¹Professor, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC 27695

²President, Soil, Water and Environment Group, Raleigh, NC 27607

Abstract –There is a North Carolina market for Neuse River buffer, nutrient offset credits and, a national market for carbon credits produced by restoring native forests on drained, former bottomland hardwood sites in the Neuse River Basin. Marginal agricultural lands, planted to native tree species can contribute to increased acreage of high-value, diverse bottomland hardwoods beneficial for water quality, wildlife habitat and carbon sequestration. Clearing and ditching for agriculture over the past 100 years have negatively affected the Neuse River Basin, which is a severely threatened river system. These activities have obliterated many of the historical streams and forested wetlands. This project involved planting over 250,000 native trees and shrubs in 2008 on 386 acres of former agriculture fields for the purpose of creating mitigation credits and improving water quality through bank stabilization, stream shading, increasing nutrient uptake, sediment filtering, sequestering atmospheric carbon and improving wildlife habitat. Intensive plantation forestry techniques were used to achieve success. The site was monitored for tree survival, growth and changes in hydrology over 9 years. Planted tree survival was over 90% and growth has been excellent. Based on tree growth, carbon sequestration was determined for current biomass production and for a rotation of 70 years. This successful bottomland hardwood restoration project is providing multiple benefits and services in a severely impaired watershed and may be a template for future restoration projects in the Neuse River Basin and other watersheds in North Carolina.

Poster #2 BOTTOMLAND HARDWOOD AND SWAMP FOREST RESTORATION IN EASTERN NORTH CAROLINA

Douglas Frederick¹, E. Carlyle Franklin¹, and Scott Frederick²

¹Professor and Professor Emeritus, Respectively, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC 27695

²President, Soil, Water and Environment Group, Raleigh, NC 27607

Abstract –There is a need and opportunity to restore thousands of acres of former, forested wetlands on the Coastal Plain in eastern North Carolina, currently used for agriculture that are marginal investments for farmers because of periodic flooding. This restoration project demonstrates that marginal agricultural fields, with hydric soils, can be restored to functioning forest ecosystems through modification of hydrology, planting native, late – successional trees and shrubs and monitoring critical functional variables. This may be the highest and best use for these marginal fields and can contribute to increasing the area of bottomland hardwood and swamp forested wetlands in eastern North Carolina. Forty - eight acres of ditched and drained agricultural fields in Tyrrell County, NC were planted in 1996-97 with 12 native hardwood tree and shrub species, Atlantic white cedar and bald cypress. Lateral ditches were plugged and plantings were stratified by soils and vegetation type. Competition was controlled for 5 years. Survival, growth of planted trees, hydrology and functional performance were assessed in 2017. Planted tree survival was greater than 70% in the Nonriverine Swamp, Nonriverine Wet Flat Hardwood and Atlantic White Cedar Types and, natural wetland hydrology was restored. Based on project site sampling and aerial assessment in adjacent Albemarle Sound, water quality on site and exiting the site was significantly improved through planted tree and shrub cover, water interception, filtration and sediment reduction.

Poster #3 NATURAL WATER ISOTOPIC TRACERS FOR ESTIMATING SURFACE WATER STORAGE AND WATER UTILIZATION EFFICIENCY OF A FORESTED WETLAND

Yuch-Ping Hsieh¹, Glynnis C. Bugna², and Johnny M. Grace III³

¹Professor (corresponding author), Center for Water Resources, College of Agriculture and Food Sciences, Florida A&M University, Tallahassee, Florida, 32307.

²Research Associate, Center for Water Resources, College of Agriculture and Food Sciences, Florida A&M University, Tallahassee, Florida, 32307.

³General Engineer, USDA Forest Service-Southern Research Station, Center for Forest Watershed Research, Tallahassee, Florida, 32307.

Abstract –Hydrological processes and water balances of a forested wetland are critical factors related to the wetland ecosystem functions and services. Our understanding of the hydrological processes and balances in forested wetlands is limited mainly due to the tedious and expensive monitoring processes of the traditional methods. Natural water isotopic tracers; however, provides us a simpler alternative method for monitoring hydrological processes and water balances in a forested wetland. We initiated this study to develop a procedure that uses natural stable water isotopic tracers in the estimation of surface water storage and water utilization efficiency of a forested wetland. We report here the feasibility of this approach by a theoretical analysis and an example from an ephemeral wetland (Ponds 55) in NW Florida.

Poster #4 SULFUR CHEMISTRY OF UPLAND AND EPHEMERAL WETLAND SOILS AND ITS INDICATION TO SOIL SUBMERGENCE HISTORY

Yuch-Ping Hsieh¹, Glynnis C. Bugna², and Johnny M. Grace III³

¹Professor (corresponding author), Center for Water Resources, College of Agriculture and Food Sciences, Florida A&M University, Tallahassee, Florida, 32307.

²Research Associate, Center for Water Resources, College of Agriculture and Food Sciences, Florida A&M University, Tallahassee, Florida, 32307.

³General Engineer, USDA Forest Service-Southern Research Station, Center for Forest Watershed Research, Tallahassee, Florida, 32307.

Abstract –Ephemeral wetlands are ecologically and hydrologically important to many forested ecosystems in North Florida. Monitoring hydrologic and redox conditions of an ephemeral wetland have been quite tedious and costly with the traditional methods. We initiated this research to identify a simpler and effective means to determine the hydrological and redox conditions of an ephemeral wetland using sulfur chemistry as an indicator. We used the multi-element scanning thermal analysis (MESTA) technology to characterize the sulfur chemistry and other parameters of the sediments in an ephemeral wetland (Ponds 55) in NW Florida. MESTA, which can directly analyze both organic and reduced inorganic sulfur, has opened up a convenient option for us to understand soil sulfur, which has not been studied as much as other major essential elements in soils. Through comparison of non-submerged upland soils and submerged wetland soils, we can see a distinct sulfur component in the latter that were not found in the former. This unique submerged soil sulfur component is more thermally stable (>425 °C) than the sulfur component found in the non-submerged sediments (300-400 °C). This unique submerged soil sulfur component persisted at least 120 days after being exposed to the air. We speculate that this thermally stable sulfur component is the product of the reaction between hydrogen sulfide (product of microbial sulfate reduction) and organic matter. This thermally stable sulfur component, therefore can be an indicator to the inundation and redox history of soils surrounding an ephemeral wetland.

Poster #5 IN SITU GROUNDWATER DENITRIFICATION IN A RIPARIAN ZONE OF A SHORT-ROTATION WOODY CROP EXPERIMENTAL WATERSHED

Johnson B. Jeffers¹, C. Rhett Jackson¹, Benjamin M. Rau², Catherine M. Pringle³, and Cody T. Matteson¹

¹ Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602

² USDA Forest Service, Savannah River Forestry Sciences Lab, Aiken, SC 29803

³ Odum School of Ecology, University of Georgia, Athens, GA 30602

Abstract –Water quality monitoring in an experimental short-rotation woody crop (SRWC) watershed in the Upper Coastal Plain of South Carolina has shown increased concentrations of nitrate (NO_3^-) in groundwater but no evidence of increased NO_3^- in riparian groundwater or surface waters. Forested riparian areas established as streamside management zones (SMZ) are known to act as buffers to surface water bodies by mitigating nutrients. Quantifying denitrification by measuring dinitrogen (N_2) and nitrous oxide (N_2O) concentrations along groundwater flow paths could help determine if the current width of SMZs is sufficient for this intensive forestry management practice. A network of piezometers has been established in the Fourmile Experimental Watershed at the Department of Energy – Savannah River Site. Water samples were collected monthly and analyzed for nutrient and dissolved gas concentrations. Preliminary data showed greater concentrations of N_2O than N_2 in groundwater. The ratios of N_2O to combined end products of denitrification ($\text{N}_2\text{O} / \text{N}_2\text{O} + \text{N}_2$) ranged from 0.33 to 0.99. Mean $\text{N}_2\text{O} + \text{N}_2$ concentrations were greater in groundwater samples in the SRWC plot and along the SMZ boundary than along the ephemeral stream within the riparian zone. Correlations between water chemistry parameters and N_2 concentrations are indicative of known biogeochemical driving factors of denitrification. Continued monthly sampling will be coupled with analysis of nutrient concentrations (NO_3^- , NH_4^+ , TN, DOC) to help determine transport and processing of NO_3^- and production of dissolved gases within the groundwater system.

Poster #6 HYDROLOGIC LINKAGES BETWEEN FLOODPLAIN WETLANDS AND ADJACENT AGRICULTURAL LANDS

Cody T. Matteson¹, C. Rhett Jackson², Susan B. Wilde³, Darold Batzer², James Shelton³, Johnson Jeffers¹

¹ Graduate Research Assistant, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, Georgia, 30602.

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Abstract –Depending on dominant flow pathways, wetlands can provide biogeochemical processing in agricultural settings. Field-to-stream water quality gradients were evaluated across a forested alluvial swamp and through a ditched wetland swale on the same site. During 2016 and 2017, water samples were collected from shallow piezometers and surface water were analyzed for total oxidized nitrogen (TOxN), total phosphorus (TP), and microbial abundance. In the alluvial swamp, toeslope nutrient concentrations in shallow groundwater and surfacewater are elevated relative to background levels, with median values of 13.25 mg//TOxN and 47.60 μg //TP. Shallow groundwater and surfacewater concentrations are substantially lower only a few meters into the floodplain wetland and lower still (0.13 mg//TOxN and 29.67 μg //TP) at discharge points to an adjacent creek. TOxN levels entering and exiting the ditched swale do not mitigate as efficiently, median values of 3.91 mg//TOxN reduce to 1.45 mg//TOxN, while TP input and reduction exceed the alluvial swamp by starting at 141.67 μg //TP at the inflow and discharging into a river at 57.40 μg //TP. Higher proportions of *Cyanobacteria*, Turbidity indicators, and *Diatom* communities are observed in the ditched swale, and input areas of the alluvial swamp. ANOVA tests of TOxN ($P < 0.001$) and TP ($P = 0.9$) change across the alluvial swamp suggest effective processing of TOxN. While P values for TOxN and TP in the ditched swale, yield $P = 0.9$ for TOxN and $P = 1.0$ for TP indicating reduced efficiency of mitigation. Though pollutant additions have been similar into both wetland types, water quality improvements are distinct in the alluvial swamp.

Poster #7 UNDERSTANDING WATER USE DYNAMICS OF WATER EXCESS AND DROUGHT AT A FOREST MUNICIPAL LAND APPLICATION SITE IN EASTERN NC

Nancy E. Gibson¹, Elizabeth G. Nichols²

¹Graduate Research and Teaching Assistant, Department of Forestry and Environmental Resources, North Carolina State University, Raleigh, NC, 27606

²Professor (corresponding author), Department of Forestry and Environmental Resources, NC State University, Raleigh, NC, 27606

Abstract –There are 86 municipal wastewater land application sites in North Carolina, the largest of which is operated by the City of Jacksonville. This facility treats primary-treated municipal wastewater by irrigation onto 2332 acres of mixed loblolly pine hardwood forest. My research will address how the Jacksonville site functions hydrologically across different weather events from drought to water excess for the last 17 years. The site is currently instrumented with 11 data loggers to understand groundwater level dynamics in irrigated areas. Current data including biweekly surface water discharge measurements, precipitation data, and irrigation data as well as recorded historical precipitation, irrigation, and quarterly groundwater measurements will be used to develop a water balance model of the forest over the last 17 years. In the last two years, the land treatment site has received a combined 146 inches of rain and 64.36 inches of irrigation due to higher than normal precipitation events. The water balance model will increase our understanding of forest response to extreme water and drought at the site. Hydrological relationships are expected to vary spatially with the heterogeneity of soils across the site. How the hydrologic function of this particular forest impacts annual tree growth and pine harvest yields as total biomass and board feet is informative to management of these sites and to appropriate forest compositions for forest regeneration.

Poster #8 QUANTIFYING THE EFFECTIVENESS OF STREAM CROSSING BEST MANAGEMENT PRACTICES IN THE COASTAL PLAIN OF VIRGINIA

Chandler L. Dangle¹, W. Mike Aust¹, M. Chad Bolding¹, and Scott M. Barrett²

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Forestry best management practices (BMPs) are regulated by the Clean Water Act through individual state programs to protect water quality and prevent erosion during and after timber harvests. This study was developed to compare and contrast BMP implementation at stream crossings by region and road type in Virginia, and to also quantify the effectiveness of the BMPs by developing hypothetical upgrades and determining their respective costs. 150 stream crossings (75 truck, 75 skidder) used in silvicultural operations within the past year, from the mountains, piedmont and coastal plain of Virginia were assessed for BMP implementation. Erosion rates for approaches to the stream were modeled using the USLE-Forest methodology. Ratings were developed to categorize crossings as BMP-, BMP-standard, or BMP+. Costs for upgrading the crossing to a higher BMP category were estimated by adjusting cover percentage and approach lengths. This poster focuses primarily on stream crossings sampled in the coastal plain of Virginia, where challenges regarding forested wetland operations abound. Sixty-one percent of stream crossings in the coastal plain have been classified at BMP-standard, with an average erosion rate of 3 TAY; 28% of crossings have been classified as BMP+, with an average erosion rate of <1 TAY; and 11% of crossings have been classified as BMP-, with an average erosion rate of 7 TAY. Initial results indicate that erosion rates are reduced 2X on haul roads and 4.5X on skid trails as crossings are upgraded from the BMP- to the BMP-standard category, most commonly achieved with an advantageous cost-benefit ratio.

**Poster #9 ENCOURAGING BIRD-FRIENDLY FOREST MANAGEMENT ON PRIVATELY-OWNED
BOTTOMLAND FORESTS**

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Abstract –An estimated 200 bird species utilize Bottomland Hardwood Forests as breeding (49 species), migration, and overwintering habitat (2). Eighty-six percent of North Carolina's 18 million acres of forestland is privately-owned (1). Eighty-eight percent of these landowners do not have a forest management plan (3). Emphasizing bird conservation techniques that require small habitat changes to produce valuable results may make management less intimidating to landowners, foster a new audience emphasizing the importance of forest planning, and ultimately conserve imperiled habitat for many priority bird species.

The Forest Landbird Legacy Program (FLLP) was established as an avenue to connect landowners with technical and financial assistance to manage their forest in bird-friendly ways. Audubon North Carolina is able to directly reimburse the landowner for up to 75% of habitat restoration expenses. FLLP also ensures goal longevity and family forest legacy by establishing 10-year agreements.

Current action steps include: 1) Delineating best management practices for North Carolina forest landbirds, 2) Identifying priority areas of contiguous hardwood forests, 3) Recognizing and working with private landowners in areas of high importance to restore mature forest conditions that maximize structural diversity, 4) Training land management professionals in bird-friendly forest management.

Results thus far include three workshops with 150 professionals trained, nearly 30 agreement-holding landowners, and many more prospects. Outreach efforts continue to expand and include cooperation with partners: US Fish and Wildlife Service, NC Forest Service, NC Wildlife Resources Commission, and Natural Resources Conservation Service.

Citations:

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To protect, manage and promote forest resources
for the citizens of North Carolina.

Vision

We envision a North Carolina with healthy trees and forests that provide essential environmental, economic and social benefits served by a professional workforce recognized as a leader in forest protection, emergency response, resource management and environmental education.

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Steve Troxler, Commissioner