



Core Research Staff

Dr. Seth W. Bigelow

Assistant Scientist, Forest Ecology

Dr. Lindsay R. Boring

Director, Forest Ecology

Dr. Steven T. Brantley

Assistant Scientist, Ecohydrology

Dr. L. Michael Conner

Scientist, Wildlife Ecology

Dr. Stephen W. Golladay

Associate Scientist, Aquatic Ecology

Dr. L. Katherine Kirkman

Scientist, Plant Ecology

Dr. Paul V. McCormick

Scientist, Aquatic Ecology

Dr. Lora L. Smith

Associate Scientist, Herpetology

Core Conservation Staff

James B. Atkinson, Jr.

Natural Resources Manager

Dr. Steven B. Jack

Conservation Ecologist, Silviculture/Forest Ecology

Brandon Rutledge

Conservation Monitoring Biologist

Scott Smith

Assistant Natural Resources Manager

Core Education Staff

David W. Hicks (Retired 2015)

Scientist, Hydrology

Kevin McIntyre

Education Coordinator

Mark Melvin

Conservation Management/Education Technician

Core Support Staff

Glenn Bailey

Network Manager

Jean Brock

GIS & Information Technology Manager

Bryan Cloninger

Central Analytical Lab Technician

Becky Gay

Business Administrator

Scientific Advisory Committee

Dr. Jerry F. Franklin (1988-2013),

Founding Member (2013-present)

Professor of Ecosystem Management, College of Forest

Resources, University of Washington

Mr. Robert Larimore (2010-present)

Chief, Environmental Management Division, Fort Benning

Dr. Gene E. Likens, Chair (1988-2012),

Founding Member (2012-present)

Distinguished Senior Scientist, Ecologist,

Founding Director and President Emeritus,

Cary Institute of Ecosystem Studies

Dr. Robert J. Naiman (1994-2015), Chair (2013-2014)

Professor, School of Fisheries, University of Washington

Mr. Brian Richter (2013-present)

Director, Global Freshwater Strategies,

The Nature Conservancy

Dr. Nova Silvy (2010-present)

Regents Professor, Department of Wildlife and Fisheries

Science, Texas A&M University

Dr. James M. Vose (2013-present), Chair (2015-present)

Project Leader, Center for Integrated Forest Science,

Southern Research Station, U.S. Forest Service

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Mission & Values

The Joseph W. Jones Ecological Research Center at Ichauway seeks to understand, to demonstrate, and to promote excellence in natural resource management and conservation on the landscape of the southeastern Coastal Plain of the United States.

The Jones Center was founded on a long-standing ethic of conserving land and water resources. Ichauway is maintained as the tangible expression of this natural resource management philosophy. Central to this philosophy is the conviction that management and research inform each other and are partners in their contribution to knowledge. One of the Center's most important products is people who combine a rigorous understanding of ecological principles with proficiency in natural resource management.

To understand the natural systems of the southeastern Coastal Plain, the Center assembles information from respected practitioners and the scientific literature and conducts targeted research to expand the knowledge of the field. Through a rigorous and creative research program, the Center aspires to improve management and stewardship of resources of the southeastern Coastal Plain and also to contribute to natural resource science at the national and international levels.

To demonstrate excellence in natural resource management, the Center manages Ichauway to protect and enhance the diversity of natural communities and their component species. The practical and economic aspects of proper stewardship are fundamental considerations of this work.

To promote excellence in natural resource management and conservation, the Center develops and conducts education and outreach programs for natural resource professionals, undergraduate and graduate students, interns, and land owners and managers. The Center serves as a science-based resource for public officials, policymakers, and the public.





From the Director



This 2014-2015 Biennial Report provides informative updates on our research, education, and conservation programs, highlighting many key achievements by our staff, students, and collaborators. During these past two years we have added new key staff, expanded research and education programs, and honored the retirement of our former Woodruff Foundation President and board member, Pete McTier, as well as our former Foundation Secretary/Treasurer, Lee Tribble. We also added some beautiful expansions to our research facilities. Dr. James Vose, forest ecologist with the U.S. Forest Service's Southern Research Station, has been recently appointed Chair of the Jones Center Scientific Advisory Committee.

The addition of two new research scientists, Dr. Steven Brantley and Dr. Seth Bigelow, is expanding our research program on longleaf pine ecosystems with emphasis upon ecohydrology and adaptive silviculture. These scientists increase our potential for more integration of our forest ecology program with research on watersheds and wildlife. Both individuals

are broadly trained and have demonstrated strong interdisciplinary research approaches. This brings our number of full-time research scientists up to seven, and we have increased our highly valued outside colleagues and cooperators to 75.

We continue to leverage our investments in research and conservation with our ability to demonstrate results in the field through our diverse education and outreach events at Ichauway. During the past two years we have served 1,310 visitors, with average duration of stay exceeding two days each. These classes and field experiences serve university students, natural resource managers, land owners, and other constituents spanning water resources, wildlife, and forestry. We still offer our four university field courses in the spring of each year, and our staff continues to make great contributions with long-term education and outreach efforts. This especially includes the Georgia Prescribed Fire Council, America's Longleaf Restoration Initiative, events related to conservation of imperiled species, and special programs for state and federal natural resource agencies on topics focused on watersheds, and on protection of air quality using best prescribed fire practices.

We acknowledge the strong core support of our programs from the Robert W. Woodruff Foundation which permits us to maintain the high quality and long-term continuity of programs. We thank them for their visionary commitment of Ichauway's exceptional resources to serve our conservation, research, and education programs.

Dr. Lindsay R. Boring, Director

Highlights 2014-2015

- » Dr. Mike Conner, along with collaborators from the University of Florida, received a National Science Foundation grant to link studies of animal movement to the environmental data available from the recently established National Ecological Observatory Network (NEON) platform. This research project will use fox squirrels as a model species to demonstrate how recent animal tracking technology can be linked to the highresolution NEON data to better understand animal movement in response to their surroundings.
- » The Center was awarded \$698,052 in externally-funded research and outreach projects during 2014 and \$645,240 during 2015. Of those amounts, \$140,808 (2014) and \$25,000 (2015) funded other institutions' collaboration on these projects. Sixteen externally-funded projects were continued from awards prior to 2014.
- » Dr. Kay Kirkman authored a textbook on the diverse ecosystems found in the state of Georgia. *Natural Communities of Georgia* was published by the University of Georgia Press and has received very positive reviews. The book serves as the definitive reference and guide to the natural history of Georgia's natural communities and is being utilized as a textbook for several university-level courses.
- » The Center continued to provide leadership and support for regional and national collaborative conservation initiatives. Kevin McIntyre served as Chair of the Longleaf Partnership Council, a collaborative effort to implement a range-wide conservation plan for longleaf pine, in which we have been involved for several years. Mark Melvin served as Chair of the Georgia Prescribed Fire Council, of which the Center was a founding member.
- » Approximately 1,310 natural resource professionals and university students participated in Jones Center education and outreach activities during 2014-2015 as part of 72 educational programs that included field tours, short courses, workshops, and professional conferences. In addition, approximately 650 visitors from the region attended our Open House event.
- » Thirty-four graduate students from six cooperating universities conducted their research at Ichauway during 2014-2015 as part of our cooperative graduate student program. Three individuals participated in the Center's conservation apprentice program during this time. As of 2015, 109 graduate students have completed advanced degrees under co-advisement with our cooperators.
- » The Center's restoration program for the federally-endangered red-cockaded woodpecker (RCW), which began with only one bird in 1999, continues to achieve new levels of success. As of 2015, there are approximately 80 birds, which account for 32 active clusters with 25 breeding pairs. Moving out from our original site in the northeastern portion of Ichauway, artificial clusters were established in new areas across the property. Importantly, in recent years, RCWs have excavated natural cavities on Ichauway and are successfully nesting in those.
- » Research staff hosted four visiting scientists from four universities and agencies during one- to two-week residencies at Ichauway during 2014-2015 and collaborated with 71 other scientists and cooperators.
- » Research staff published 21 articles in peer-reviewed journals in 2014 and 26 in 2015. Center staff also produced five technology-transfer and other publications in 2014 and two in 2015.
- » In 2015, the Center dedicated a new addition to the research building. These facilities improvements provided a new, enlarged auditorium for seminars and meetings; new technological capacity for remote conferencing; and a more efficient layout of office space for scientists and information technology staff. The interior of the addition was finished using heartwood from longleaf pine salvage harvested from Ichauway by our conservation staff.



Overview of Research, Education, & Conservation Programs

The Joseph W. Jones Ecological Research Center at Ichauway is a research and conservation site of regional, national, and international significance. Ichauway's 29,000 acres contain almost 18,000 acres of mature longleaf pine woodlands, 4,000 acres of young restoration plantings of longleaf pine, numerous geographically isolated wetlands, 25 miles of rivers and streams, and 3,000 acres of field habitat. Most of Ichauway is used for research and educational demonstrations. This land base is complemented by 50,000 square feet of research and education facilities and a full-time staff of 84.

Research

Research programs at the Jones Center focus on two broad themes: the ecology, restoration, and management of the longleaf pine ecosystem; and water resources, wetlands, and aquatic ecosystems of the southeastern Coastal Plain. These areas of focus reflect the Center's location and the information needs of the region. Ichauway is located in the heart of the historic range of longleaf pine. The longleaf pine ecosystem is one of the most biologically diverse in North America and, with less than 5% of the original extent remaining, increasingly a focus



of conservation efforts. Southwest Georgia is also a hydrologically unique karst region that serves as the major recharge area for one of the nation's most prolific and heavily-used aquifers, the Upper Floridan aquifer.

We balance basic research of these systems with applied work of relevance to the natural resource management and conservation communities. Much of the Center's research is integrated under five long-term projects that incorporate components of terrestrial, aquatic, and wildlife research in an interdisciplinary approach. Research collaborations include new technologies such as eddy flux towers and remote sensing.

Information generated from our research

program is disseminated through peer-reviewed journal articles; technology-transfer products; popular publications; and by participation in local, regional, state, and national scientific meetings. Our approach to research is based on collaboration between scientific staff and information users. Our work seeks to address important natural resource management questions so that policymakers and land owners can utilize science to support the development of sound resource management plans and policies.

Conservation

The Center's conservation program is responsible for the stewardship and management of the Ichauway land base. It also serves as a technical information resource for Center staff and visitors and as a demonstration of sound resource management in the region.

Integration of research and natural resource management at the Jones Center presents a unique opportunity for these programs to inform one another. Information from our research programs can be scaled up to an operational level for implementation and demonstration on Ichauway. These management applications provide valuable feedback and generate additional questions for researchers.

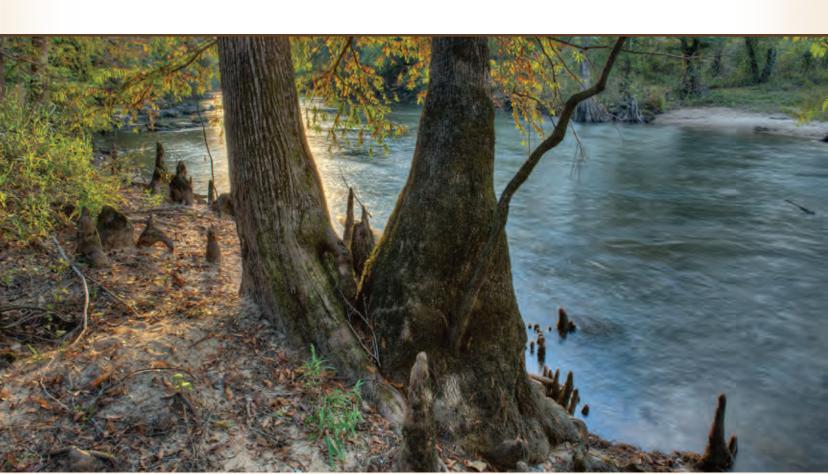
The Center's conservation program incorporates a diverse range of activities into a management model that balances multiple values in the context of a deeply-rooted land ethic. Land management activities include an extensive prescribed fire program, conservation-based forest management, and restoration of the longleaf pine ecosystem across the Ichauway landscape. Our wildlife program includes game management for species such as bobwhite quail and white-tailed deer as well as management and monitoring of nongame and endangered species characteristic of the longleaf pine ecosystem, such as the red-cockaded woodpecker and gopher tortoise.

Education & Outreach

Information from our scientific research, as well as knowledge generated from our conservation and land management programs, are shared with a diverse constituency including natural resource management agencies, policymakers, private land owners, conservation organizations, and university classes. These audiences visit Ichauway for field tours, short courses, and workshops, while Center staff also work collaboratively at other sites in Georgia and across the Coastal Plain of the southeastern U.S.

Our primary constituents include practicing natural resource professionals and those actively involved in making decisions that influence the management of natural resources. Our work with university students helps prepare the next generation of professionals. Through our outreach efforts, the Center influences conservation and management at a range of scales. Center staff are actively engaged in collaborative partnerships at the state, regional, and national level, complementing our work onsite at Ichauway.

Approximately 109 students from regional research universities have completed advanced degrees through our cooperative graduate education program, and 23 students are actively pursuing degrees at this time. Key cooperating institutions include the University of Georgia, University of Florida, University of Alabama, and six other nationally-ranked programs. The development of well-trained professionals through our cooperative graduate program is one of the Center's most important contributions. This program provides a unique legacy that continues to influence the management and conservation of natural resources through the course of these individuals' careers in conservation, research, and education.





Long-Term Research Projects

Wildlife

Principal Investigators: L.M. Conner, L.L. Smith, and L.K. Kirkman Lead Technicians: Gail Morris, Jen Howze, and Lisa Giencke

Wildlife research at the Jones Center is primarily focused on two areas: predator-prey relationships and wildlife-habitat interactions. The existing predator community in the southeastern U.S. has been altered by a number of factors. These factors include the elimination of apex predators (e.g., cougars and red wolves), the reduction of sport hunting and trapping of medium-sized mammalian predators (mesopredators), as well as changes in the landscape (e.g., fragmentation) that favor certain mesopredators and concentrate prey, rendering them more susceptible to predation. Much of the historic research on predator-prey interactions was driven by game management considerations and was focused at the species level rather than at the community level. In addition, little research was of sufficient duration to fully understand the long-term effects of predator management efforts. A major focus of the Center's wildlife program is a long-term research project that addresses community-level predator-prey dynamics over long temporal scales.

The "predator exclusion" project, in place for over 12 years, is now the longest running study of its kind in the U.S. This experiment excludes mesopredators from four 100-acre fenced exclosures and is designed to measure the impacts of mesopredators on selected prey (avian ground and shrub nests, gopher tortoise nests and hatchlings, small mammals) and on alternative predator species (snakes, birds of prey). We are also investigating the potential for trophic cascades as a result of mesopredator exclusion and interactions between habitat management (e.g., hardwood removal and prescribed fire) and predation.

Early findings of the study revealed that one of the greatest impacts from mammalian predators was on nests of the gopher tortoise, a species of conservation concern. This has led to ongoing research into long-term changes in the demography of tortoise populations in the absence of mammalian predators as well as relationships between habitat structure and predation rates. This work also demonstrated that red imported fire ants were a primary predator of shrub-nesting birds, which has led to additional projects that are currently underway that explore community-level impacts of fire ants on small mammals and herpetofauna.

Additional research topics emerged from these early results and other observations, with more detailed results forthcoming. Recent white-tailed deer research has supported early observations by documenting higher densities of does in exclosures during fawning season. This work found significantly higher fawn survival within exclosures and a negative relationship across Ichauway between doe weight and coyote abundance. Modeling efforts suggested that the exclosures contribute substantially to our overall deer population, essentially doubling the number of fawns per doe in the 4,000 acres surrounding exclosures.

Ecologists have long recognized the top-down role of large predators within ecosystems. When large carnivore populations decline, smaller carnivores and large herbivores may flourish and fundamentally alter the ecosystem, a form of "trophic cascade." Data collected as part of the predator exclosure study suggested that coyotes impacted behavior of deer, thus altering vegetative composition and structure. Recent results have shown that within exclosures, deer grazed more heavily on legumes and other forbs, which grow lower to the ground and require more effort to locate. In the control plots outside of the exclosures, deer preferentially browsed on oak saplings, presumably because this allowed them to be more vigilant for coyotes. These dissimilar foraging strategies have resulted in differences in abundance for both legumes and oaks between the control plots and the exclosures. Collectively, coyotes may fill the ecological role of the now locally-extinct red wolves and cougars; coyotes impact deer populations through both direct predation and by altering foraging behavior.

Our work with wildlife-habitat interactions is focused on how wildlife species respond to habitat structure in



natural longleaf pine forests as well as responses to manipulation of that structure through active management. We work at a range of scales, from stand level to landscapes, with particular focus on species of conservation concern and management interest. Current research in this area is largely devoted to understanding wildlife-vegetation associations, developing models to predict habitat suitability for various species of interest, and attempting to quantify when species can be expected to occur following various restoration activities.

In 2014-2015, Center wildlife scientists received a grant from the Gulf Coastal Plain and Ozarks Landscape Conservation Cooperative to study

wildlife-habitat interactions. This project analyzed a range of existing data from wildlife research and conservation monitoring conducted on Ichauway and related that to habitat structure data from our permanent vegetation plots to develop habitat models for several species of wildlife associated with longleaf pine forests. Center scientists and collaborators from the University of Florida also received a grant from the National Science Foundation to link high resolution movement data from Sherman's fox squirrel with high resolution remote sensing from our NEON site.

Because of our long history working with the gopher tortoise, the Center is regarded as one of the leading authorities on this species in the Southeast. Center scientists continue to contribute to the development of the Candidate Conservation Agreement (CCA) for the gopher tortoise. The CCA is a cooperative effort among state, federal, non-governmental, and private organizations to implement proactive gopher tortoise conservation measures that will hopefully mediate the need for listing of the eastern population of this species under the Endangered Species Act. In 2014-2015, Center staff worked under contract with the state of Florida to assess gopher tortoise populations on 33 of their most significant sites for this animal. This project utilized new population survey methodology that was developed at the Center and refined through working with the Georgia Department of Natural Resources on conservation lands in Georgia.

The Center's wildlife program continues to explore scientific questions related to wildlife populations in longleaf pine ecosystems while also addressing applied wildlife issues of importance to the management and conservation community. This work underscores the importance of Ichauway as a long-term study site and the value of the Center's work in furthering wildlife conservation and management.

Water Resources

Principal Investigators: S.W. Golladay, P.V. McCormick, and S.T. Brantley Lead Technicians: Nathalie Smith, Brian Clayton, Evan Rea, and Stribling Stuber

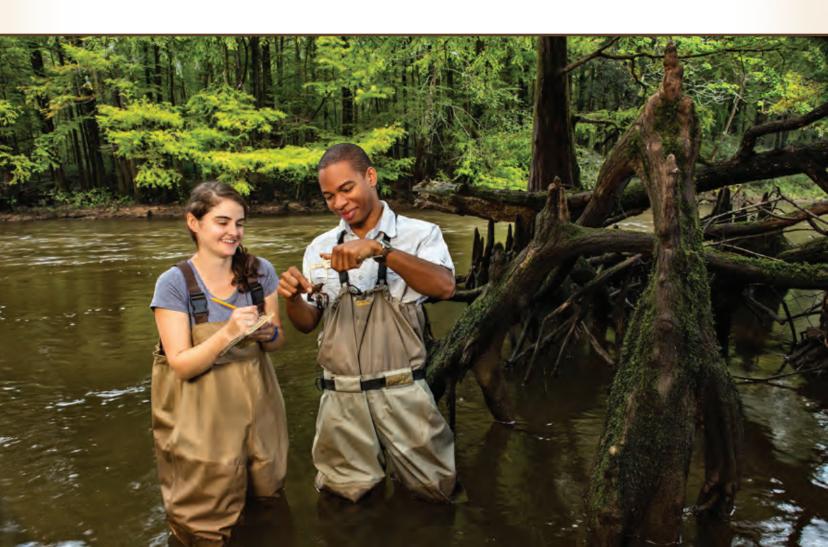
The waters of the Apalachicola-Chattahoochee-Flint (ACF) Basin are a shared resource between Alabama, Florida, and Georgia that support the needs of municipalities and agriculture while providing instream flow for healthy streams and rivers as well as the ecological and economic needs of Apalachicola Bay. The Center's water resources research program seeks to better understand the relationship between human land use, water withdrawals, and the health of streams, rivers, and aquifers in the ACF Basin. Reliable supplies of clean water are essential for human health and well-being, and our work provides a scientific foundation for informed decisions about water resource management and policy.

The Center maintains a long-term research and monitoring program to understand trends in water quality and

ecological conditions in the lower Flint River Basin, including surface water, groundwater, and springs. This work has shown long-term increases in nitrate concentration in groundwater discharging into the Flint River, raising concerns about fertilizer and waste water discharges and their long-term consequences for regional water supplies. Ongoing studies of Lake Seminole suggest that it mitigates nutrient runoff from upstream land use, discharging higher quality water than it receives. In 2014-2015, we supplemented observational data with a manipulative study to further understand the roles that hydrilla, an invasive aquatic plant, and two exotic mollusks play in influencing water quality. Analyses were also completed to better understand the ability of lake sediments to capture excess nutrients and metal contaminants.

Environmental flows research in the lower Flint River Basin seeks to better understand the impact of increased human water demand on stream health. The environmental flow regime is the seasonal and interannual variation in stream flow necessary to maintain healthy aquatic life. Irrigation withdrawals in the basin have reduced stream flows during the growing season, especially during droughts, resulting in loss of aquatic habitat, changes in water quality, and stress to aquatic life. Center scientists have demonstrated long-term seasonal declines in flows relative to rainfall over recent decades as irrigation demands have risen. These analyses have been augmented with stream surveys to quantify habitat loss caused by flow declines. Long-term research has documented concurrent declines in freshwater mussel populations and supported the designation of critical habitat for certain species of mussels and fish in the lower Flint River. Recent studies have documented alterations in invertebrate and fish community structure across gradients of flow alteration. The ultimate goals of this work are to understand how stream biota respond to and recover from unnaturally low flow events and to identify potential flow thresholds that cause long-term harm to stream health.

The Center is currently developing a new research program that seeks to understand how altered flow regimes relate to changes in land cover and how alternatives for future watershed management might contribute to flow





restoration. This effort involves three projects that will link evapotranspiration, groundwater levels, and stream flow. First, we will construct stand-level water budgets for both restored and fire-suppressed longleaf pine and compare these to known values for other land uses, such as hardwood forests and row crop agriculture, to better understand how land use allocation affects the overall water budget at a landscape scale. Second, we will estimate the relative importance of groundwater versus surface water inputs as sources of stream flow. Finally, we will use this understanding of evapotranspiration and groundwater/surface water exchanges to model stream flow regimes under hypothetical land cover and climate scenarios.

Water is a finite resource that must be managed to meet the multiple demands of society and to protect the environmental services that healthy streams and rivers provide. The Center's work in water resources provides an important scientific foundation to support the development of policies that balance human and environmental needs. A new emphasis on functionally linking land use to water quality and quantity will further demonstrate that good land management is good watershed management.

Dynamics of Frequent-Fire Longleaf Pine Ecosystems Principal Investigators: L.R. Boring, S.T. Brantley, L.M. Conner, and L.K. Kirkman Lead Technicians: Scott Taylor, Stribling Stuber, Gail Morris, and Lisa Giencke

Perhaps the most significant biological attribute of Ichauway, the extensive second-growth longleaf forests provide a rich opportunity for research. With an open, mature canopy of trees in the 90-100 year age class and older, as well as over 11,000 acres of wiregrass-dominated understory that was never cultivated for agriculture, these forests are uniquely suited for the study of reference longleaf pine ecosystems. Since the Center's research programs began, the basic and applied ecology of longleaf pine ecosystems has been a priority. This line of research is our oldest long-term project and initially explored fundamental topics that were poorly understood in native longleaf forests, such as basic patterns of ecological productivity and biodiversity. Subsequent studies have researched the complex feedbacks between fire regimes, water and nutrient resources, above and belowground productivity, and community responses in longleaf pine ecosystems. Findings from these studies have been central to our current understanding of longleaf ecosystem structure and function, and have informed the growing regional interest in longleaf restoration and management.

We continue to maintain these long-term reference research sites that span a moisture gradient from wet to dry in order to study the ecological effects of long-term fire suppression and recovery from suppression. The fire restoration treatment examines the effects of reintroducing burning to sites across the soil moisture gradient that have developed a ten-year successional midstory of oaks and shrubs. Changes in the plant and faunal communities are being measured along with soil and litter/fuel responses. A collaborative project with the University of Georgia is comparing bark beetle communities within these sites and treatments and will examine potential changes in forest health and potential susceptibility to bark beetle attack.

Several years ago, interest in carbon dynamics of forests increased greatly due to concerns about climate change and rising levels of atmospheric carbon dioxide. A focused study of carbon dynamics in longleaf forests was a natural outgrowth of this project, with much of the foundational work already in place to begin detailed research on this information gap. This study has used three eddy flux covariance towers and a continuous stream of automated soil carbon dioxide measurements to compare a gradient of wet to dry longleaf sites on Ichauway. This research continues with a working agreement among the Jones Center, the University of Alabama, and the U.S. Forest Service Southern Research Station. This work continues to refine our knowledge of carbon allocation, variability with climate, and carbon dioxide emissions from prescribed burning.

New research at these sites is focused on tree physiological responses to fire suppression and fire reintroduction as well as interactions between fire regime and soil moisture. Tree responses to both chronic stress (e.g., competition for water and nutrients among pines and oaks with fire suppression) and episodic stress (e.g., fire

reintroduction) are being examined at the leaf, tree, and stand levels. Leaf-level stress is currently being measured using gas exchange, chlorophyll fluorescence, and leaf chemistry. New studies are under development to examine whole-tree physiological responses to stress using sap-flow probes and to examine differential allocation of carbon to growth and defense through measurements of resin flow. This research will contribute to a better understanding of stand-level resistance and resilience to climate change and provide a foundation for additional opportunities to study forest health and function in longleaf ecosystems. For example, sap-flow measurements are being used to construct water budgets for longleaf pine at stand and landscape scales. As these studies continue over the long-term, results will inform us of the interactions between stand-level stress and effects of drought and climate change on longleaf ecosystem function and health.

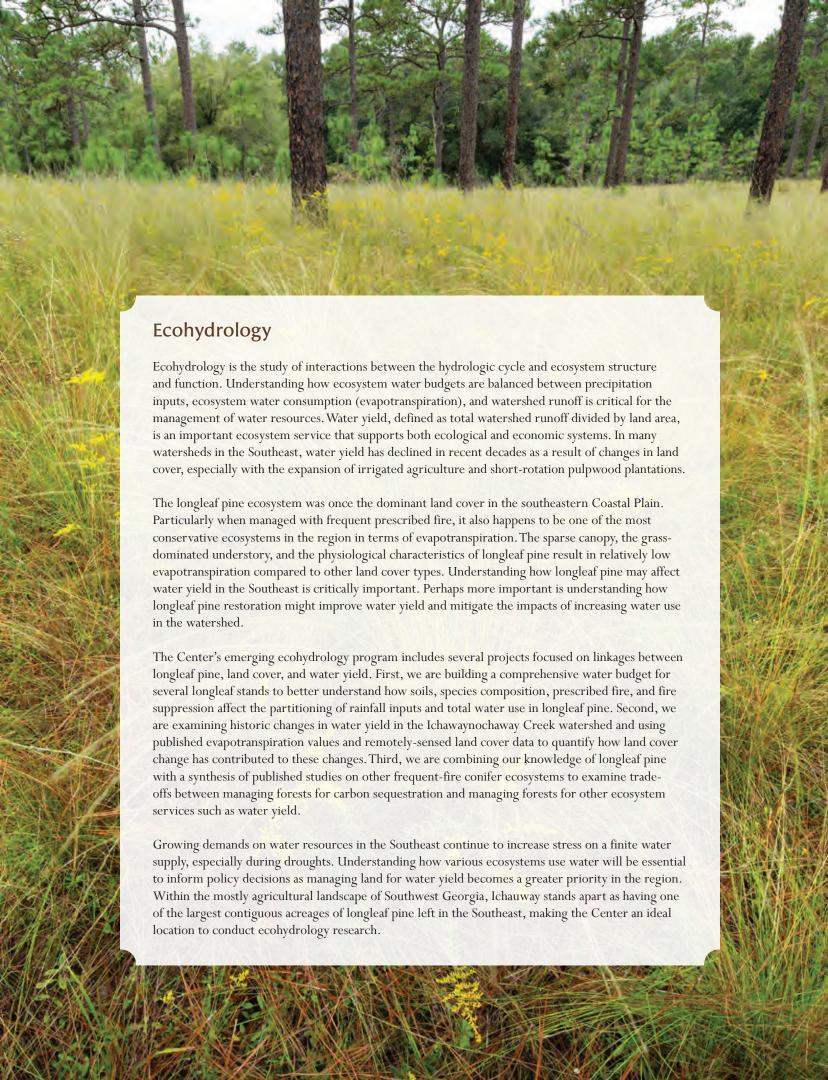
As one of the Center's original long-term research projects, elements of this work have now been in place for twenty years and results to date have filled many gaps in our knowledge of the basic ecology of longleaf pine ecosystems. This foundational understanding has allowed us to address key research priorities, such as carbon dynamics, emissions from prescribed burning, and effects of fire suppression in a more scientifically rigorous manner, demonstrating the value of long-term research. The future provides a wide range of research opportunities to better understand longleaf pine ecosystems, such as species dynamics in response to climate change, potential shifts in fuels and fire regimes, changes in faunal communities impacted by fire suppression, interactions of carbon and nitrogen cycles, longleaf pine ecohydrology, and potential contributions to groundwater.

Ecological Forestry & Restoration of Longleaf Pine Ecosystems Principal Investigators: S.B. Jack, L.K. Kirkman, R.K. McIntyre, L.L. Smith, and L.M. Conner Lead Technicians: Mary Frances Nieminen, Lisa Giencke, Jen Howze, and Gail Morris

Restoration and management of longleaf pine ecosystems in the southeastern U.S. is a regional conservation priority. Public and private land owners and managers are drawn to longleaf pine for the multiple amenities the forest type provides, including wildlife habitat, high-quality timber products, aesthetics, and recreational value. A major regional conservation initiative seeks to double the existing acreage of longleaf pine through the efforts of a diverse coalition of private and public sector stakeholders. Although the current focus of most longleaf restoration efforts across the Southeast is primarily on tree establishment on new acres, there is growing recognition of the importance of an ecosystem approach to longleaf management and restoration. True ecosystem restoration will require a long-term, holistic approach that includes all elements of the ecosystem, and this underscores the need for increased understanding of regional and site-specific differences and the influence of scale and initial conditions on restoration trajectories.

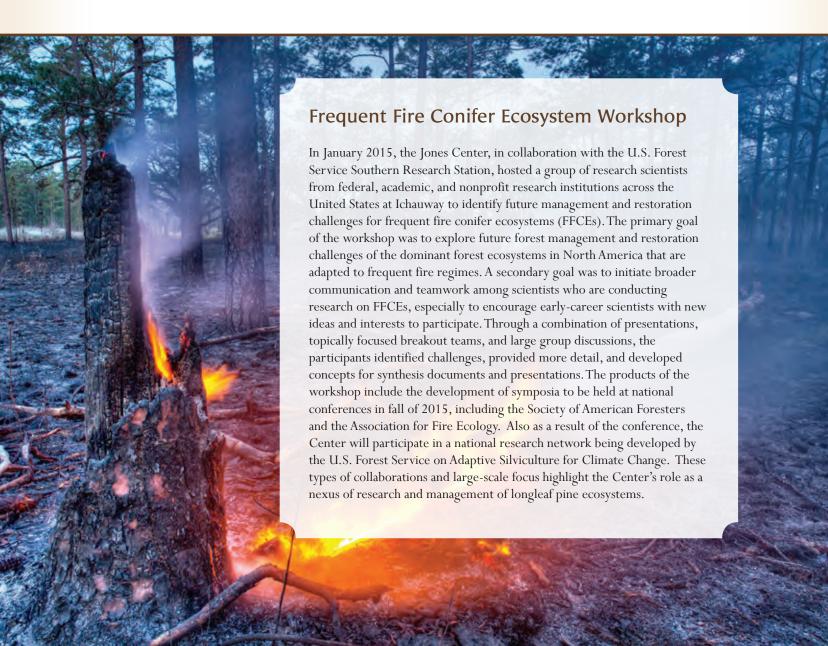
The Center is well-positioned to help answer many emerging restoration and management questions given the extensive mature longleaf forests and young longleaf plantations on Ichauway, the substantial body of research from the Center that has increased understanding of how these forests function, and the exemplary management of longleaf ecosystems on Ichauway. The goal for this project is to meet the challenge of providing sound management information supported by a strong scientific understanding of ecological processes. Two focal areas of this long-term project are: 1) managing existing longleaf forests for multiple values using an ecological forestry approach and 2) management practices to restore recently established longleaf plantations to multi-aged forests with diverse plant and animal communities.

This project brings together several study components including native ground cover restoration, phased conversion of off-site pine species to longleaf, intermediate stand manipulations such as thinning and management of hardwood competition, wildlife responses to restoration, and ongoing maintenance of mature longleaf forests. These different aspects are united by a common element: each can play an important role in maintaining or moving a given stand or tract toward the desired structure and function of multi-aged, open pine-grasslands maintained by frequent fire.



Ecological forestry is an approach to forest management that uses natural disturbances and ecological processes as a guide to silvicultural prescriptions and desired forest structure. Our ecological forestry research in natural, mature longleaf forests addresses the following: 1) How do natural disturbances in longleaf pine ecosystems shape forest structure and how do managed disturbances, such as harvest, compare to those patterns?; 2) What are the relationships between patterns of overstory retention, prescribed fire, and forest demographics?; and 3) How rapid is the recovery of the system, particularly the understory plant community, after disturbance from harvesting? To address these questions, measurement plots (4 ha) were installed with different canopy harvest treatments, including control (no cut), single-tree selection, and two gap-based harvest treatments. Harvest treatments were conducted in 2009 following the collection of pre-treatment data, with subsequent research efforts concentrated on documenting and measuring the impacts and recovery following harvest. Variables measured include soil compaction, cone predation, demography of longleaf pine regeneration and hardwood sprouts, and understory plant recovery following harvest. In addition to the core research questions, these treatment plots provide a good platform for additional research studies and collaborations.

A second major area of focus for this project is longleaf ecosystem restoration, whether from a starting point of afforestation on former agricultural land or the use of techniques such as underplanting longleaf seedlings in existing plantations of other pine species to gradually move the canopy composition toward longleaf dominance over time. In both of these instances, restoration practices typically begin by planting nursery-grown



seedlings, with the ultimate goal of a multi-aged, fire-maintained longleaf forest with the diverse ground cover and wildlife communities for which longleaf forests are well-known. While there has been much progress in artificial regeneration techniques for the tree itself, much less is known about establishing a diverse ground cover plant community in these developing longleaf pine stands. Similarly, there are significant questions about how focal wildlife communities will respond in these plantations, especially as structure changes during the stand development process; most existing knowledge has been gathered from mature natural longleaf forests, and few longleaf plantations are old enough to fully characterize responses of wildlife and plant communities to structural changes during different temporal stages of stand development. We initiated a long-term, large-scale experiment to address several topics including: 1) How do management actions affect the direction and rate of changes in stand and landscape conditions, and how do these trajectories vary at different scales?; 2) What is the relative effect of past management practices, compared to the direct effect of present actions, on future stand and landscape condition?; and 3) How do wildlife communities respond to the changing conditions at different scales, and how well can we "direct" these responses?

The extraordinary second-growth forests of mature longleaf pine and native ground cover found on Ichauway, as well as the varying stages of longleaf restoration across the property, provide both a living laboratory and an outstanding demonstration site for this ecosystem. As interest in longleaf conservation and restoration continues to grow across the Southeast, our efforts and land base put us in a unique position to develop new information through research and outreach to inform management and conservation of this ecosystem.

Geographically Isolated Wetlands in the Coastal Plain Landscape Principal Investigators: L.K. Kirkman, L.L. Smith, S.W. Golladay, and S.T. Brantley Lead Technicians: Lisa Giencke, Jen Howze, Brian Clayton, Nathalie Smith, and Stribling Stuber

Geographically isolated wetlands (GIWs) are wetlands that are completely surrounded by uplands and lack obvious connections to adjacent aquatic ecosystems. While GIWs may appear to be isolated for part or all of the year, they are not functionally isolated. They provide many of the same services and functions as other types of wetlands and headwater streams, contributing to hydrologic and ecological processes within watersheds, as well as helping to regulate the export of water and pollutants from their watersheds to downstream waters. Commonly embedded within a matrix of fire-maintained longleaf pine ecosystems in the southeastern Coastal Plain, GIWs are important habitat for numerous plant and animal species that rely on them for part or all of their life cycle, including many species of conservation concern.

A greater range of connectivity exists among GIWs, uplands, and streams than commonly recognized. This continuum of hydrologic and habitat connectivity contributes to delivery of ecosystem services at a watershed scale. In regions with a large abundance of GIWs, such as the Dougherty Plain of Georgia, the collective importance of numerous wetlands is often overlooked relative to the larger regional watershed. Similarly, wetland complexes within the longleaf pine ecosystem have been undervalued for their vital role in maintaining regional biodiversity. Throughout the Dougherty Plain, the intensity of agricultural land use has altered the degree and nature of linkages among wetlands, uplands, and streams; modified vegetative structure of habitat within and around wetlands; and increased nutrient and pesticide loading in wetlands. Such changes affect the roles that GIWs play in water storage, water quality, and wildlife habitat.

The apparent physical separation of GIWs from stream networks has led to a gap in their regulatory protection under the U.S. Clean Water Act. Cumulative impacts due to the large-scale changes in timing, magnitude, and flow of water, nutrients, and organisms are significant, but poorly understood and quantified. This information is needed to inform management and policy to protect and enhance wetland functions and watershed integrity within a human-dominated landscape.

This study framework is designed to enhance the understanding of GIW functions and services and inform future

policies for wetland conservation. This study integrates investigations of the functional role of wetlands in the region, specifically to: 1) provide new information on linkages of isolated wetlands to the regional watershed and jurisdictional waters, 2) relate wetland ecosystem services to human health and well-being, 3) determine the relationship between wetland condition and ecosystem services across a gradient of wetland alteration, and 4) provide guidance for GIW management in agricultural landscapes to recapture their functional value.

In 2014-2015 our research centered on major ecological functions of GIWs and land use impacts to these functions. These studies build on over 20 years of investigations of the species assemblages of plants, amphibians, and aquatic insects in reference GIWs on Ichauway and measures of hydrologic responses of individual wetlands to precipitation. In addition, we have examined the agricultural land use impacts on wetlands in the Dougherty Plain. Hydrologic research is currently focusing on the identification of subsurface/groundwater connections of GIWs to surface water and the surrounding terrestrial landscape as well as quantification of the episodic movement of storm water among GIWs. These studies also aim to quantify landscape-scale water storage capacity and determine the capacity for sequestration of nutrient and pesticide contaminants. Finally, we are comparing water budgets of fire-suppressed and frequently burned GIWs within a longleaf pine landscape.

Current and future habitat studies are designed to determine the impacts of habitat fragmentation on dispersal of semi-aquatic organisms in GIWs, such as amphibians, and to assess wildlife as potential hosts for mosquito-borne diseases. In particular, these studies will assess wildlife as potential vectors of pathogens among aquatic systems and determine how alterations of water quality influence invasive species presence.

Proposed management and restoration studies will examine the resilience of wetland structure and function following abandonment of agriculture and restoration through the USDA Wetland Reserve Program. We will also be



conducting experimental manipulations of wetlands within agricultural settings to enhance ecosystem functions as potential mitigation or conservation incentive efforts.

Conservation

There is a long history and tradition of exemplary management of the natural resources at Ichauway dating back to Robert Woodruff's acquisition of the property in the late 1920s. The unique landscape, extensive natural, second-growth longleaf pine forest with large tracts of intact native understory found on Ichauway today is the result of this careful stewardship over multiple decades, and the property is widely known across the Southeast as one of the finest remaining examples of this rare forest type and as a model for exemplary land management. The founding of the Jones Center over 20 years ago launched a new chapter in the stewardship of the property in which science and management are more fully integrated and collaborative. The Center's conservation staff is responsible for the day-to-day natural resource management on Ichauway and cooperates with the scientific staff to incorporate new research findings into ongoing management.

The conservation program at the Jones Center has professional staff with expertise in resource management (including prescribed fire), wildlife biology, and forestry. This group is responsible for a wide range of projects, such as forest management, silviculture, and restoration; habitat management for game species, such as bobwhite quail and white-tailed deer, as well as a host of non-game species; conservation of endangered, threatened, and special concern species, such as red-cockaded woodpeckers and gopher tortoises; long-term habitat monitoring and monitoring of faunal communities; and control of invasive, non-native plant and animal species. Their work includes ongoing activities, such as using prescribed fire as a management tool, maintenance of the property's roads and fire breaks, and targeted efforts to restore or improve forest or wildlife habitat based on sound science. In addition to resource management activities, significant effort is expended in support of the Center's research and education programs.

Highlights of activities over the last two years include the following:

Prescribed fire is the most important tool for managing and maintaining the longleaf pine ecosystem and its associated wildlife. The Center maintains a model prescribed fire program that sustains the longleaf ecosystem and also minimizes wildfire danger. In 2014, Center staff burned approximately 12,450 acres, and in 2015 approximately 12,120 acres were burned for management, research, and education objectives. The long history of prescribed fire on Ichauway continues to provide a platform for research studies and demonstrates the critical role of fire in maintaining the values of longleaf forests.

Efforts to control exotic plant species in 2014-2015 were again focused on herbicide treatment of Japanese climbing fern. This prolific vine-like fern spreads rapidly by spores and is becoming increasingly problematic in the Southeast and seems to establish most readily in lower, wetter areas and subsequently spreads into uplands. Current treatments are focused primarily along roadways and in drainages, with some follow-up treatments on areas sprayed in previous years. Treated areas are monitored to determine the need for additional treatments as well as to better understand recovery of the understory plant community. The first occurrences of cogongrass, a very aggressive, noxious grass species, on Ichauway were found in 2015 at two locations. Both spots were small and were treated with herbicide by personnel from the Georgia Forestry Commission through a cooperative program. These infestations will be monitored for any resprouting, and field workers were shown the plants so they can help identify any occurrences in the future.

We also continue to monitor and aggressively remove feral hogs on Ichauway. Only 11 hogs were removed in 2014, but in 2015 over 40 hogs were removed by trapping and active chase following sightings. The fluctuating numbers suggest that our control efforts can be successful in keeping hog numbers at manageable levels, but the presence of hogs is also a cyclical process depending on many different factors (including management actions on adjacent properties).

Restoration efforts for the endangered red-cockaded woodpecker (RCW) on Ichauway had continued success in 2014-2015. The long-term population goal is more than 30 active clusters with at least 30 potential breeding groups to ensure a viable and stable population. In 2014, there were 26 active clusters and 21 breeding pairs that hatched 32 chicks. The population continued to increase in 2015, with 32 active clusters, 25 breeding pairs, and 41 chicks hatched. The population currently (fall of 2015) is approximately 80 birds. In 2014, six new recruitment clusters were established north of Highway 91, and three of these clusters were active during the 2015 nesting season. Much of our past success with this program is attributable to careful stewardship, including the installation of artificial nest cavity boxes. In recent years, however, the RCWs have begun to excavate their own cavities, and in 2015, two of the nests were in these excavated natural cavities.

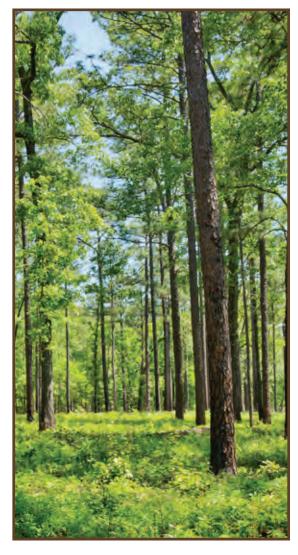
The Center continues to practice active forest management on Ichauway. In the natural, second-growth longleaf and mixed pine stands, an adaptation of the Stoddard-Neel system of individual tree selection harvest is implemented. The significant acreage of longleaf plantations that were established in the 1990s as part of our restoration efforts are now approaching an age where a first thinning operation is appropriate. These young plantations are thinned in a manner similar to other plantations (removing every third or fourth row with some thinning between), and native ground cover plants are often seeded into these plantations following the harvest operations for restoration objectives. In 2014, we thinned 345 acres of young longleaf plantations both as part of a research project and also for operational objectives, generating significant revenue due to locally and temporarily high prices for pulpwood at the time of the sale.



Education

The Jones Center's education and outreach programs target natural resource professionals and university students enrolled in natural resource programs. These audiences represent the best opportunity for application of new information generated from the Center's research and conservation programs. In 2014-2015, approximately 1,310 visitors participated in 72 events, such as short courses, workshops, and field tours at Ichauway. Approximately two-thirds of these individuals were professionals and one-third were students. In addition to education and outreach programs held at Ichauway, Center staff are engaged in collaborative partnerships at state and regional levels. Our graduate education and conservation apprentice programs continue to produce highly skilled young professionals who carry the Ichauway legacy through their careers in natural resource research, management, and conservation.

Since the founding of the Center in the early 1990s, a primary area of focus has been the ecology, management, and restoration of the longleaf pine ecosystem. Historically neglected in both research and management because of its perceived shortcomings economically, there is renewed interest in longleaf pine from both the public and private sectors. The Center's long-term commitment to understanding both the science and management of this ecosystem puts us in a unique position to contribute to the growing interest in longleaf as a conservation priority at regional and national levels. Center staff served in the collaborative group that developed the rangewide conservation plan for longleaf pine, America's Longleaf Restoration Initiative, and continue to work



with the ongoing implementation effort for the plan, the Longleaf Partnership Council. This is a collaborative partnership of federal and state natural resource agencies, non-governmental conservation organizations, and the private sector working to achieve the goals of the rangewide plan, which include doubling the current acreage of longleaf pine and improving the condition of existing longleaf forests. These efforts are viewed as a national model for regional collaborative conservation partnerships and as a result of their success, longleaf pine was recognized in 2014 by the U.S. Department of Agriculture as one of eight Critical Conservation Areas in the United States. Center staff also contributed to multiple local implementation teams for the rangewide conservation plan for longleaf pine. These teams are collaborative groups conducting on-the-ground longleaf restoration in targeted priority areas across the Southeast.

The high quality examples of the longleaf ecosystem found on Ichauway, as well as our exemplary management and restoration programs, provide an extraordinary setting for onsite educational programs. Our ecological forestry workshops continue to be one of our primary longleaf outreach programs, with two workshops held in 2014-2015. Center staff also worked with the National Fish and Wildlife Foundation to synthesize current knowledge of longleaf economics and economic considerations of large-acreage land owners' decisions about undertaking longleaf restoration on their properties. In 2015, the Center held its third longleaf pine management

and restoration Maymester course for the University of Georgia and the University of Florida.

Prescribed fire is an essential management tool for many southeastern ecosystems, particularly longleaf pine, and is therefore a significant element of the Center's education and outreach program. The Center conducts onsite training and demonstration and participates in several regional and national collaborative partnerships. Onsite training programs provide hands-on experience with prescribed fire for Jones Center personnel and university students through our employee prescribed fire course and our Maymester prescribed fire course offered through the University of Georgia. In addition, demonstration burns are conducted on Ichauway for strategic visiting groups, many of whom have never had experience with prescribed fire.

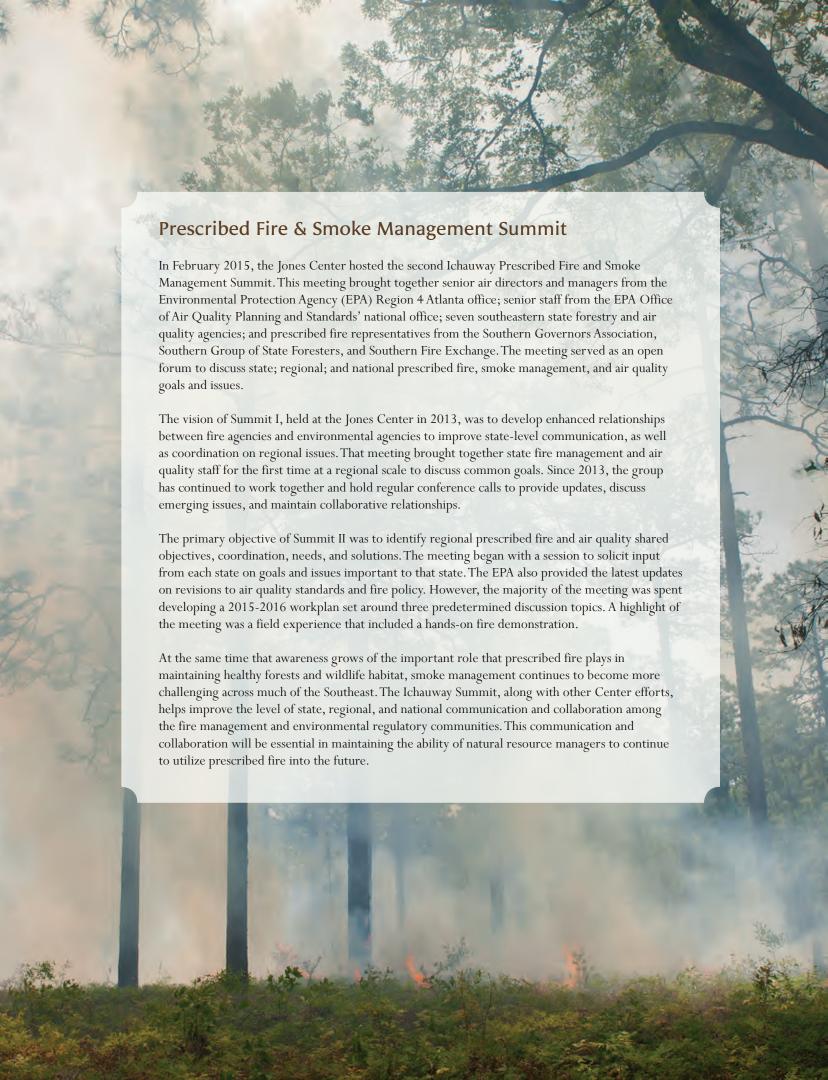
In 2014-2015, Center staff continued to serve in leadership roles in the Georgia Prescribed Fire Council, the national-level Coalition of Prescribed Fire Councils, and the Southern Fire Exchange. These efforts promote prescribed fire with a diverse audience that includes natural resource professionals, policy makers, and the general public and highlight the valuable role prescribed fire plays in protecting human health and maintaining healthy forests. Following on the success of a similar effort two years ago, in 2015 the Center convened a second workshop for air quality regulators and fire chiefs from seven of the eight southeastern state agencies, as well as Region 4 Environmental Protection Agency administrators and national policy-writers. Center staff also served as instructors for the Georgia Forestry Commission's certified prescribed burner course. The Center also continued work with the Cohesive Strategy, a national fire plan led by the Wildland Fire Leadership Council, a working group of federal agency fire management leaders, as this effort wrapped up the development phase and moved into implementation.

Outreach in water resources during 2014-2015 contributed to efforts to resolve water appropriation issues in the Apalachicola-Chattahoochee-Flint (ACF) Basin through work with the ACF Stakeholder process. Center staff served on the ACF Stakeholder Executive Committee and Technical Oversight Committee through 2014. During this period, data collection, model development, and assessment of conservation alternatives were used to develop a Sustainable Water Management Plan, released in late spring 2015. Staff members provided technical and editorial review of the document and have contributed to the writing of several sections of the Sustainable Water Management Plan.

Jones Center staff completed a collaborative partnership to improve agricultural water use efficiency in the lower Flint River Basin. This effort was organized through a Conservation Innovation Grant from the Natural Resources Conservation Service. A technical report on the status of mussel habitat and populations was provided to the Lower Flint Soil and Water Conservation District and Georgia Nature Conservancy. Center staff continue to collaborate on agricultural water use issues through ongoing partnerships with USDA-sponsored Regional Conservation Cooperative Partnerships based in the lower Flint River Basin.

Center staff continue rare species advisement and education efforts in partnership with the Georgia Department of Natural Resources and the U.S. Fish and Wildlife Service. The Center hosts an annual ACF Mussel Workshop, which provides training for academic, agency, and consulting biologists on methods of mussel identification and survey. Participation in this or similar training is now a requirement for obtaining mussel collecting and observation permits. Center staff also contribute to habitat conservation planning efforts and serve as reviewers for proposed species listings.

The Center was a sponsor of the biennial Georgia Water Resources Conference in 2015. Jones Center staff served on the steering committee, which developed the conference structure and program during 2014. The Center's water resources program continues its stakeholder outreach efforts through participation in Georgia Adopt-A-Stream, Georgia River Network, Georgia Aquarium Creeks to Coast Teacher Workshops, and presentations to community service groups.





Visiting Scientists

Dr. Joel Brown, University of Illinois at Chicago (2014)

Dr. Mary Freeman, U.S. Geological Survey/University of Georgia (2014)

Dr. Elizabeth Gleim, Emory University (2014)

Dr. Michael Stambaugh, University of Missouri (2015)

Other Collaborating Scientists & Graduate Co-Advisors

Dr. Carla Atkinson, University of Alabama

Dr. Doug Aubrey, University of Georgia/Savannah River Ecology Laboratory

Dr. Analie Barnett, The Nature Conservancy

Dr. James Beasley, University of Georgia/Savannah River Ecology Laboratory

Dr. Michael Binford, University of Florida

Mr. Mike Black, Shortleaf Pine Initiative

Dr. Krista Capps, University of Georgia

Dr. Ronald Carroll, University of Georgia

Dr. Steven Castleberry, University of Georgia

Dr. Michael Chamberlain, University of Georgia

Dr. Richard Chandler, University of Georgia

Dr. Matt Cohen, University of Florida

Dr. Alan Covich, University of Georgia

Mr. John Cox, Lolly Creek Ecological Land

Management and Restoration

Dr. Irena Creed, University of Western Ontario

Ms. Colette DeGarady, The Nature Conservancy

Ms. Carol Denhof, The Longleaf Alliance

Dr. Ankur Desai, University of Wisconsin

Dr. Michael Dietze, Boston University

Dr. Paul Duffy, Neptune and Company

Mr. Neal Edmondson, Georgia Forestry Commission

Mr. Troy Ettel, The Nature Conservancy

Dr. Jerry Franklin, University of Washington

Mr. Glen Gaines, U.S. Forest Service (Retired)

Dr. Kamal Gandhi, University of Georgia

Dr. Dale Gawlik, Florida Atlantic University

Mr. Rick Gillam, U.S. Environmental Protection Agency

Dr. Bob Gitzen, Auburn University

Dr. Heather Golden, U.S. Environmental Protection Agency

Dr. Jim Guldin, U.S. Forest Service

Dr. Craig Guyer, Auburn University

Dr. Jeff Hepinstall-Cymerman, University of Georgia

Mr. Kevin Hiers, Sewanee

Mr. John Holman, Forest Soils Consultant

Dr. Rhett Jackson, University of Georgia

Dr. Eric Jokela, University of Florida

Mr. Kyle Jones, U.S. Forest Service

Ms. Melanie Kaeser, U.S. Fish and Wildlife Service

Dr. Benjamin Knapp, University of Missouri

Dr. Jennifer Knoepp, U.S. Forest Service

Dr. Charles Lane, U.S. Environmental Protection Agency

Dr. Hank Loescher, National Environmental

Observatory Network

Dr. Marguerite Madden, University of Georgia

Dr. John Maerz, University of Georgia

Dr. Daniel Markewitz, University of Georgia

Mr. Glenn Martin, AECOM

Dr. Katherine Martin, U.S. Forest Service

Mr. Barrett McCall, Larson & McGowin

Dr. Robert McCleery, University of Florida

Dr. Jessica McGuire, Georgia Department of Natural Resources

Dr. Anna McKee, U.S. Geological Survey

Dr. Karl Miller, University of Georgia

Dr. Chelcy Miniat, U.S. Forest Service

Dr. Lisa Muller, University of Tennessee

Dr. Joe Nairn, University of Georgia

Dr. Joseph O'Brien, University of Georgia

Mr. Ken Parker, Georgia Forestry Commission

Mr. Michael Prevost, White Oak Forestry

Dr. Todd Rasmussen, University of Georgia

Mr. John Seymour, Roundstone Native Seed

Dr. Greg Starr, University of Alabama

Dr. Christina Staudhammer, University of Alabama

Dr. Paul Stoy, Montana State University

Mr. Rob Sutter, Enduring Conservation Outcomes

Dr. James Vose, U.S. Forest Service

Mr. Clay Ware, U.S. Fish and Wildlife Service

Dr. Robert Warren, University of Georgia

Dr. Matthew Waters, Valdosta State University

Dr. David Wear, U.S. Forest Service

Dr. Michael Yabsley, University of Georgia

Mr. Mike Zupko, Wildland Fire Leadership Council

Externally Funded Research

Boring, L.R. Long-term ecosystem inventories: Assessing availability and scalability of C and N data for ecosystem models to inform scope of future proposals. Strategic Environmental Research and Development Program (U.S. Department of Agriculture - Forest Service). 2014-2016. \$65,701. Received in 2014, \$17,919. Received in 2015, \$49,585.

Conner, L.M. Breeding bird response to longleaf pine restoration. National Wild Turkey Federation. 2011-2016. \$35,700. Received in 2014, \$11,900. Received in 2015, \$6,953.

Conner, L.M. Collaborative research: EAGER-NEON: NEON sites as a platform for transformative wildlife research. National Science Foundation. 2015-2017. \$167,148. Received in 2015, \$90,000.

Conner, L.M. Development and evaluation of an unbaited camera survey technique for estimating relative abundance and demographic parameters of white-tailed deer. Georgia Department of Natural Resources (University of Georgia). 2014-2018. \$145,140. Received in 2014, \$14,926. Received in 2015, \$27,040.

Conner, L.M. Effects of hydrology, hunting, and predation on white-tailed deer dynamics in South Florida. Florida Fish and Wildlife Conservation Commission (University of Georgia). 2014-2018. \$249,449. Received in 2014, \$20,919. Received in 2015, \$87,643.

Conner, L.M. Gray fox spatial movement tracking. Department of Defense. 2013-2016. \$86,812. Received in 2014, \$61,600. Received in 2015, \$6,916.

Conner, L.M. Movement ecology of female wild turkeys during nesting and brooding seasons on Silver Lake Wildlife Management Area. Georgia Department of Natural Resources (University of Georgia). 2014-2017. \$153,400. Received in 2014, \$1,181. Received in 2015, \$73,253.

Conner, L.M. Prescribed fire and ecology of turkeys, coyotes, and deer. Georgia Department of Natural Resources (University of Georgia). 2012-2014. \$91,466. Received in 2014, \$5,311.

Conner, L.M., L.L. Smith. Using wildlife habitat models to evaluate management endpoints for open pine woodland and savanna. U.S. Fish and Wildlife Service (Mississippi State University). 2014-2016. \$132,104. Received in 2014, \$44,489. Received in 2015, \$82,340.

Golladay, S.W. Dominant invasive species in Lake Seminole, GA. Department of the Interior (Valdosta State University). 2014-2015. \$6,145. No funds received in 2014. Received in 2015, \$6,145.

Golladay, S.W. Instream assessment of stream habitat and mussel populations adjacent to AAWCM sites in the lower Flint River Basin. The Nature Conservancy - Georgia. 2012-2014. \$59,687. Received in 2014, \$6,899.

Golladay, S.W., R.J. Mitchell. A Workshop on Conservation and Natural Resource Management in an Uncertain Future: Using the Southeastern U.S. as a Model for Managing Change. National Science Foundation. 2012-2015. \$49,000. No funds received in 2014. Received in 2015, \$16,092.

Golladay, S.W., R.J. Mitchell. A Workshop on Conservation and Natural Resource Management in an Uncertain Future: Using the Southeastern U.S. as a Model for Managing Change. U.S. Department of Agriculture - Forest Service. 2012-2014. \$15,000. Received in 2014, \$4,863.

Kirkman, L.K. Evaluation of longleaf pine ground cover ecotype seed sources. R. Howard Dobbs Jr. Foundation. 2012-No End Date. \$65,000. Received in 2014, \$9,618. Received in 2015, \$21,221.

Kirkman, L.K. Population survey and analysis for federally-listed or petitioned plants and the threatened Gulf sturgeon. U.S. Fish and Wildlife Service. 2012-2015. \$85,000. Received in 2014, \$11,300. Received in 2015, \$1,789.

Kirkman, L.K., L.L. Smith. Isolated Wetlands Workshop. Environmental Protection Agency. 2013-2015. \$14,000. Received in 2014, \$2,622. No funds received in 2015.

Kirkman, L.K., L.M. Conner, R.K. McIntyre. Longleaf Pine Understory Restoration III. National Fish and Wildlife Foundation. 2007-2014. \$196,500. Received in 2014, \$86,507.

McIntyre, R.K. Longleaf Economics Workshop. National Fish and Wildlife Foundation. 2013-2014. \$50,320. Received in 2014, \$29,105.

McIntyre, R.K., S.B. Jack. Collaborative management and restoration of longleaf pine in lowcountry South Carolina. The Nature Conservancy - South Carolina. 2013-2014. \$24,375. Received in 2014, \$12,735.

McIntyre, R.K., S.B. Jack. Collaborative management and restoration of longleaf pine in lowcountry South Carolina. The Nature Conservancy - South Carolina. 2014-2016. \$16,875. No funds received in 2014. Received in 2015, \$9,133.

Mitchell, R.J., L.R. Boring. Building forest management into Earth system modeling: scaling from stand to continent. National Science Foundation. 2013-2016. \$170,872. Received in 2014, \$85,663. Received in 2015, \$15,904.

Mitchell, R.J., L.K. Kirkman, L.M. Conner, L.L. Smith. Developing dynamic reference models and a decision support framework for southeastern ecosystems: an integrated approach. Strategic Environmental Research and Development Program. 2009-2015. \$1,351,138. Received in 2014, \$64,761. Received in 2015, \$18,691.

Smith, L.L. Gopher tortoise surveys and population evaluation. Florida Fish and Wildlife Conservation Commission. 2014-2016. \$300,000. Received in 2014, \$148,033. Received in 2015, \$109,558.

Smith, L.L. Gopher tortoise surveys and population evaluation. U.S. Fish and Wildlife Service. 2012-2014. \$40,000. Received in 2014, \$12,092.

Smith, L.L. Surveys of Barbour's map turtle and alligator snapping turtle in Georgia. Georgia Department of Natural Resources. 2013-2015. \$64,917. Received in 2014, \$43,955. Received in 2015, \$20,962.



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