

## WRRI Newsletter

ISSN 0549-799X

Number 384 October-December 2013

### John Fear Joins WRRI, Sea Grant

by Katie Mosher

John Fear is now deputy director of the Water Resources Research Institute of the University of North Carolina and of North Carolina Sea Grant.

"John's experience in relevant WRRI and Sea Grant research areas, as well as his successes in building long-term, positive partnerships across North Carolina and the region, will help us address current efforts and our strategic planning," notes Susan White, executive director for WRRI and Sea Grant. "We are pleased to have him join our team."

Fear's focus will be developing and executing research portfolios for the two interinstitutional programs that work with academic, agency, business and community partners across the state. Both programs are headquartered at North Carolina State University.

For nine years, Fear worked as research coordinator for the N.C. Coastal Reserve program within the N.C. Division of Coastal Management. The Coastal Reserve includes the N.C. National Estuarine Research Reserve, a state-federal partnership. There he participated in numerous fresh-water initiatives including efforts to remove invasive phragmites in the freshwater marshes of Currituck Banks, and water quality-monitoring projects in Currituck Sound and Phelps Lake.

"I look forward to joining the outstanding team at WRRI and Sea Grant. I have admired their great body of work for years and am excited about the opportunity to contribute toward the continued growth and success of both programs," Fear adds.

He holds a doctorate in environmental sciences and engineering from the University of North Carolina at Chapel Hill's School of Public Health. A North Carolina



*WRRI and Sea Grant deputy director,  
John Fear. Photo courtesy John Fear.*

native, he also has a bachelor's degree in biology and chemistry from UNC-CH and served as a postdoctoral fellow at its Institute for Marine Sciences.

He has served on the North Carolina Sea Grant Advisory Board and was a member of the steering committees for ocean policy and inner coast studies led by Sea Grant and the N.C. Coastal Resources Law, Planning and Policy Center.

Fear currently is on the core management team for the N.C. Sentinel Site Cooperative, a multiagency partnership established as part of a National Oceanic and Atmospheric Administration effort to provide coastal communities and resource managers with information on potential impacts of sea-level rise on coastal habitats.

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### WRRI Annual Conference set for March

The annual conference of the Water Resources Research Institute of the University of North Carolina System will be March 19th and 20th at North Carolina State University's McKimmon Center in Raleigh.

The conference will focus on issues, solutions and opportunities related to North Carolina's water resources. Students, researchers and environmental professionals are invited to attend, as are representatives of nonprofit environmental organizations, governmental agencies, businesses and industries involved in water-related issues.

The N.C. Water Resources Association Annual Symposium also takes place in conjunction with the conference. This year's event — titled Local Governments as Keystone Water Resource Managers — will explore the role that communities play in managing and shaping the future of water resources in North Carolina.

Symposium panelists will discuss this local management capacity, and will compare and contrast local management with other administration models. Concurrent sessions of oral presentations will focus on a full suite of water resource issues relevant to our state.

For early rates, register by March 14th. For details, visit [go.ncsu.edu/wrriac](http://go.ncsu.edu/wrriac).

# Changes at DENR, hydrocarbon exploration and budgets were themes of this year's NC Water Resources Congress meeting

John Skvarla, secretary of the North Carolina Department of Environment and Natural Resources, recently offered the North Carolina Water Resources Congress his perspective on changes for his agency's operations and philosophy.

The congress, which promotes partnerships among local, state, and federal governments to invest in infrastructure and water management improvements, met at North Carolina State University's McKimmon Center on Oct. 31.

Representatives of the U.S. Army Corps of Engineers Wilmington District, N.C. Division of Water Resources, and the N.C. Division of Soil and Water Conservation also provided updates on their programs. Other presentations included descriptions of oil and gas mining, coastal shoreline protection, and river and watershed restoration.

## Keynote

"I think there is a new DENR," Skvarla said during his presentation. "I think we are customer-centric. I think we are there to help you through the maze."

Going with the water theme of the meeting, the secretary compared state government to a broken water pipe. Up until now, Skvarla said, the solution to meet budgetary needs has been "'Let's raise taxes and buy more pumps.' Except nobody has bothered to inspect that water pipe in the last 20 years and, guess what? There's a giant break."

According to Skvarla, DENR is currently involved in approximately 1,550 lawsuits. He referenced these as well as the estimated 950 independent information technology systems within state government as examples of the system's inefficiency. "That's a break in the pipe folks. Let's fix it. Let's address those issues," he said.

Moving from economics to the environment, Skvarla stressed that the science guiding the department is not skewed by politics.

"My position is what my scientists tell me because they are the experts," Skvarla said. "Once they have convinced me they are fully versed on all sides of the argument, then I will do what they tell me to do. Because our first job is to protect the environment and our second is to do it in an economically efficient way."

## Agency Briefings

Christine Brayman, deputy for programs and project management for the U.S. Army Corps of Engineers' Wilmington District, listed the dredging of Wilmington Harbor and completion of the lock-and-dam fish passage on the Cape Fear River as among major freshwater projects completed this year. Upcoming projects include working with Princeville to manage flood risk, as well as finalizing a memorandum of agreement with DENR that will give the state and local governments the ability to dredge inlets, rivers and lakes.

Tom Reeder, N.C. Division of Water Resources director, discussed authorizations and funding for water resources development projects. "All the things we really need to have, we got funding for last year," Reeder said.

New additions to the DENR water program portfolio include the dredging memorandum of agreement with U.S. Army Corps of Engineers, multiple storm-damage reduction projects and the National Resources Conservation Service's Environmental Quality Incentives Program — a state-federal partnership that seeks to control sediments in waterways by conducting stream restoration

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ISSN 0549-799X

Number 384

October-December 2013

This electronic newsletter is published by the Water Resources Research Institute of the University of North Carolina. It is financed in part by the Department of the Interior, U.S. Geological Survey, as authorized by the Water Resources Research Act of 1964. You may sign up to receive the electronic newsletter via an electronic listserv by sending an email to [water\\_resources@ncsu.edu](mailto:water_resources@ncsu.edu).

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and stream-bank stabilization on agricultural lands.

Reeder concluded with a note about DWR's use of hydrological modeling. He said that division modelers will soon incorporate data from the Ecological Flows Science Advisory Board assessment into their models. This will ensure that future planning will take into account water necessary for aquatic ecosystems. DWR is also in the process of creating a set of new, integrated watershed planning models that will look at water quality as well as quantity, he said.

Pat Harris, director of N.C. Division of Soil and Water Conservation, gave an update that included discussion of the division's flagship program, the N.C. Agriculture Cost Share Program, that has saved more than 7.3 million tons of soil from entering the state's waterways since 1983.

That program was established by the North Carolina General Assembly to reduce the input of agricultural nonpoint source pollution to the state's waterways. It gives financial and technical assistance to soil and water conservation districts for the voluntary installation of best management practice, or BMPs, she explained.

Other programs she mentioned include the Community Conservation Assistance Program, designed to improve water quality through the installation of BMPs on lands not directly involved with agriculture production, and the Agricultural Water Resources Assistance Program that identifies opportunities to increase water-use efficiency, availability and storage on farms.

### **Oil and Gas exploration**

Kenneth Taylor, North Carolina's state geologist, and Walt Haven, Oil and Gas program manager in the N.C. Division of Energy, Mineral and Land Resources, spoke about oil and gas exploration and development and the regulations required for such extraction in North Carolina.

Taylor gave an overview of oil and



*DENR Secretary, John Skvarla, gave keynote address. Photo: Rhett Register*

gas exploration in the state beginning with the first oil well drilled near the Hatteras lighthouse in 1925. Since then, only 127 other oil and gas exploration wells have been drilled in the state.

About 200 million years ago, as the supercontinent Pangaea began to fragment, the equator ran through what is now Raleigh, Taylor noted. At that time, rifts, looking very similar to Africa's Rift Valley, existed in the region. The Deep River Basin and Dan River-Danville basin, located in the middle and northwestern parts of the state respectively, filled with organic material. Now deeply buried, these rifts are the places in the state where hydrocarbons are most likely to be found, he added.

Haven said that if the industry does come to the state, exploration would probably begin in the Deep River Basin.

The Mining and Energy Commission, Haven said, is working to develop a regulatory framework for a statewide oil and gas program. The commission, established by the General Assembly in 2012, is in the process of creating rules for permitting, construction, abandonment and siting of wells. The panel also is creating standards for drilling units, environmental sampling, water use, waste management, and

chemical disclosure, as well as hydraulic fracturing.

Describing what drilling would look like on the ground, Haven showed an image of 130-foot tall oil derrick and said, "The scale of drilling is going to be larger than water well drilling ... at the time this happens, it is not going to be a secret."

He ended by addressing the question: Does fracking cause groundwater contamination?

"Based on the scientific peer-reviewed information we have," he said, "we do not have evidence showing water wells being contaminated with hydraulic fracturing fluid."

Haven said the greater risk might be on the surface, such as from spills caused by traffic accidents.

"My personal belief," he said "is that from an environmental release standpoint, I think it is most likely to be surface spills or releases."

### **Other presentations**

Other presentations included a discussion by Frank Yleverton of the U.S. Army Corps of Engineers Wilmington District and Dawn York of Dial Cordy and Associates on the creation of rock-ramp fish ladders at Cape Fear Lock and Dam #1 and #2. These were built to allow shad and sturgeon to get beyond the dams to their traditional breeding grounds. The project was built by the U.S. Army Corps of Engineers as mitigation for work they were doing in Wilmington Harbor.

David Woodie, from Mecklenburg County Land Use and Environmental Services Agency, also walked the group through extensive steam restoration efforts in the Charlotte-Mecklenburg Stream Restoration Program.

To learn more about the N.C. Water Resources Congress and view presentations from this year's meeting, go to: [ncwrccongress.org](http://ncwrccongress.org)

For a recent story on the Cape Fear lock-and-dam project visit: [www.ncseagrant.org](http://www.ncseagrant.org) and search for "silver spawners"

## DOT addresses nutrients

Andy McDaniel and Ryan Mullins, engineers with the North Carolina Department of Transportation Highway Stormwater Program, were guest speakers at the NCWRA forum and luncheon on December 9.

The pair described the department's Guided Reduction of Excess Environmental Nutrients, or GREEN Program, an initiative that seeks to reduce nutrient loading from the department's road and non-road facilities by combining department assets with university research.

According to McDaniel, all of the department's 200 facilities and more than 80,000 miles of state-maintained roads fall under one NPDES permit. That permit requires the department to implement a minimum number of stormwater best management practice retrofits, also called BMP retrofits, every year.

McDaniel said the nutrient load coming off of roadways is similar to that coming off of roofs. Both contain relatively small amounts of nutrients from atmospheric deposition.

The small amounts are a problem, McDaniel said, because part of meeting nutrient reduction rules in the Falls Lake and Jordan Lake systems includes making a percentage reduction of nutrients in the runoff.

"Percentage reductions are good," said McDaniel, "because they are equitable, but there is a point at which more removal is difficult."

In his portion of the presentation, Mullins described the GREEN Program's use of university research to guide the application of BMP retrofits and other nutrient-load reduction measures. So far, he said, 35 projects with University of North Carolina system researchers have been completed. From 2005 to 2010, the department spent \$5.7 million on research.

Many of the projects seek to characterize the runoff coming from different BMP retrofits. Other projects tweak existing BMPs or design new ones. Mullins described roadside BMP retrofit projects that employ bio swales, bio embankments, many forms of filtered media, catch basins and a host of other BMPs.

"One size does not fit all," Mullins said concerning the matching of BMP retrofits to the limited space available in many roadside easements.

McDaniel ended the presentation by describing two projects that the DOT-university partnership is developing: a checkpoint dam and a technique for tilling embankments.

Checkpoint dams use a series of pools filled with engineered media to encourage filtration and infiltration of water. McDaniel said these cascading pools are good for inclines and might be especially well suited for bridge embankments. Unfortunately, they are also very expensive.

A less-costly BMP retrofit that the partnership is looking at is the tilling of roadway embankments. This involves dressing sides of hills to absorb more nutrients. Researchers are testing various methods for tilling and adding soil amendments to slow runoff and promote infiltration.

"If we focus in on developing programs that acknowledge the importance of nutrients, that are designed to enhance nutrient removal, and combine that with research," McDaniel said, "we hope these will yield higher performing BMPs in the future."

To learn more about DOT research go to: [connect.ncdot.gov/projects/planning/Pages/ResearchAnalysis.aspx](http://connect.ncdot.gov/projects/planning/Pages/ResearchAnalysis.aspx)

To learn more about NCWRA visit: [www.ncwra.org](http://www.ncwra.org)



*Andy McDaniel (top) and Ryan Mullins (below), engineers with NCDOT, spoke about initiatives to manage nutrients in the linear environment of the state's roadways. Photos: Rhett Register*



## WRRI project identifies hog waste in North Carolina water bodies

North Carolina is second only to Iowa in the number of pigs it farms. A recent WRRI-funded project tests a method for identifying swine waste contamination in the lower Cape Fear River watershed, an area where nearly half of the pigs in the state are raised.

Current water-monitoring techniques show only the presence or absence of feces, not their origin. But a technique tested by Dr. Bongkeun Song and fellow scientists may enable researchers to pinpoint the type of animal from which the waste is coming — pig, cow, dog or human.

"This method, which is called bacterial source tracking, will enhance water quality monitoring in North Carolina watersheds by identifying and quantifying the source of contamination," Song says.

Feces can carry disease-causing microbes such as Cryptosporidium, Giardia, Salmonella and Escherichia coli. The waste also contains nutrients, such as nitrogen and phosphorus that are already over-abundant in many of North Carolina's waterways.

Current water quality monitoring techniques enumerate coliform bacteria, a group of bacteria that are found in the intestines of warm-blooded animals, to look for potential fecal contamination. The tests take water samples, grow coliform bacteria and count their numbers. According to researchers, this coliform test, while easy to use, has some drawbacks.

"Coliform bacteria such as E. coli are able to grow and reproduce in the environment, outside of the body. We want an indicator species that is short-lived in the environment," says Ann Arfken, a former graduate student in Dr. Bonkeun's lab and one of the authors of the report.

Instead of E. coli or another coliform bacteria, the scientists used bacteria from the genera *Bacteroides* and *Prevotella* to look for fecal contamination. Like coliforms, *Bacteroides* spp. and *Prevotella* spp. are present in the gut of most warm-blooded animals and in their feces. Unlike coliforms, *Bacteroides*-*Prevotella* bacteria cannot live for long outside of its host or reproduce in the riverine environment. This means that if they are present, they have come from the waste of an animal, not a population that lives in the waterway.

Using *Bacteroides*-*Prevotella* also allows scientists to determine what species the waste came from. Some of the bacteria's traits, including the length of a section of one of its genes, are dependent upon the bacterial host. Using a technique developed by other scientists, Song and his group examined fragments from a gene called 16S rRNA.

The researchers analyzed samples from the waste ponds of 18 concentrated animal feeding operations, or CAFOs, that are the predominant type of hog farm in the state. Their analysis provided them with a genetic signature of pig waste in North Carolina.

They then tested five sites in the Black River watershed and four sites in the Northeast Cape Fear River watershed every other month from May 2009 to May 2010. Collaborator Dr. Mike Mallin's research team simultaneously collected fecal coliform bacteria samples, nutrient samples, and physical data including water temperature, turbidity, conductivity and rainfall data.

The team found hog-specific *Bacteroides*-*Prevotella* 16S rRNA genes at all of the sampling sites. A few of the sites tested positive for

the genes throughout the yearlong sampling period while others showed them only intermittently.

The researchers found no overall trends correlating the physical factors they noted with the presence or absence of the bacteria. In some locations, they did see correlations between finding the bacteria and rainfall. Temperature played a role in others. Proximity to swine waste lagoons was a factor in some locations as well.

The final report from this project concludes: "These results provide molecular evidence that swine waste is leaving CAFOs and entering public waterways; thus present management techniques are insufficient to keep such waste on-site."

The report recommends that the bacterial source tracking should be continued at sites that consistently tested positive for the genes.

Song and Arfken have used results from the study to improve the technique and increase its resolution. They hope to eventually develop ways to quantify the amount of hog waste in the river, not just say whether it is present or absent.

"You can compare in the river 'this site has more contamination than this site,'" says Arfken, "but it is really hard to say how much contamination that really is."

To read the report and see its recommendations, visit: [go.ncsu.edu/70248](http://go.ncsu.edu/70248)

## WRRI and Sea Grant jointly fund wetlands restoration research

Opaque plastic covers a greenhouse in west Raleigh where soft-stemmed bulrush sway in the breeze coming in through open windows. The bulrush, a tall spiky plant common to North Carolina wetlands, grow in a series of large wooden planters filled with soils Mike Burchell and Tiffany Messer have brought back from a proposed wetlands restoration site in Hyde County.

The system, called a mesocosm, acts as a representative environment that researchers can study to answer questions about how the larger environmental system works at the restoration site.

The project, which will analyze the nitrogen uptake potential of restored wetlands, is among the first to be jointly funded by North Carolina Sea Grant and the N.C. Water Resources Research Institute.

“The freshwater work done by WRRI dovetails nicely with the coastal concerns that Sea Grant focuses on,” says Susan White, executive director of Sea Grant and WRRI. “Results from this project will have broad applicability in both freshwater and saltwater environments.”

By recreating a little slice of Hyde County in a lab in Raleigh, Burchell, an ecological engineer with the North Carolina State University’s Department of Biological and Agricultural Engineering, and Messer, a doctoral student, can measure how the wetlands process nitrogen in levels similar to those found in agricultural runoff. Elevated nitrogen levels in water bodies can lead to algal blooms whose decay removes oxygen that fish and shellfish need to survive.

“You can’t do this kind of data analysis on a site that is four hours away,” Messer says. “We can’t go



*Maggie Rabiipour (left) and Tiffany Messer (right) inspect sensors used to monitor bulrush-covered mesocosms in a Raleigh lab. Photo: Rhett Register.*

every day to get samples.” The lab also allows the researchers to control all of the parameters that factor into a wetland absorbing nitrogen, something that would be impossible in the field.

Above the bulrush planters hangs a latticework of clear aquarium tubing. The plants are given water that mimics agricultural runoff the restored wetlands will receive. Periodically, a sensor system automatically sips water samples through the tubes from each of the mesocosms. The system measures the water’s contents and stores the information for Messer to download. From the data, she can determine how much of the nitrogen is being removed from the water.

Plants love nitrogen. That’s why it is used for fertilizer. But it is not the bulrush that neutralizes all of the nitrogen fertilizer in the water. The organisms that often do the heavy lifting are the bacteria that reside around the root structures of the plants in the soil. Under the right conditions, these bacteria use nitrogen instead of

oxygen. The result is the breakdown of active fertilizer in the water into solidly bonded, inactive nitrogen. Results from this process, called denitrification, bubble up from the soil to join the inert nitrogen gas that makes up 78 percent of our atmosphere.

Wires dangle from probes inserted into the soil to test for the redox potential — a measurement of how likely the bacteria will be to convert the fertilizer. Messer and her assistant, undergraduate Maggie Rabiipour, collect data from them and also check pH, dissolved oxygen and temperature in each of the mesocosm systems.

By December, Messer had run 11 rounds of tests on the mesocosms and planned five more. The preliminary results are encouraging in terms of nitrogen absorption at the restoration site — a farm that borders the Alligator River National Wildlife Refuge.

“It appears that the wetlands will be able to reduce nitrogen concentrations to a level that will not be a problem for the refuge,” she says.

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## Nitrogen's fate

The projects also answer broader questions about how nitrogen flows through wetlands.

"Everyone knows that wetlands remove nitrate. I knew that when I was getting my Ph.D. But where's it going?" Burchell asks.

Nitrogen fertilizer moving into a wetland could be used by plants or bacteria in the soil, escape into the air, or dissolve in water. Thus, Messer and Burchell devised a tracer study that uses a rare form of nitrogen to map the fate of nitrogen as it moves through a wetland.

After injecting the nitrogen-15 isotope into the mesocosms, the pair took samples of all of the places it could have gone — air, water, soil and plants. They sent the samples to a U.S. Geological Survey lab and the Duke Environmental Stable Isotope Lab and are waiting for the results as of January 2014.

"I now understand why more people haven't done this study," Burchell says. "It is a lot of work and it is expensive. But we've persevered through this. Our preliminary analysis has shown that most of the nitrogen loss is from complete denitrification from nitrate to nitrogen gas."

That is a good thing because the denitrification process has a few intermediate forms of nitrogen, such as nitrous oxide, that are potent greenhouse gases.

Despite the effort involved, results from piecing together the route nitrogen takes once it enters a wetland will help engineers estimate how much nitrogen a wetland can absorb in restoration projects in North Carolina and beyond.

"This project is using science to make the most accurate prediction about what will happen to nutrients

when water is diverted from agricultural land to restored wetlands," says Sea Grant water quality specialist Barbara Doll. "Their efforts will further advance the science of nitrogen fate and transport in coastal wetland systems."

This is an excerpt. For the full article, visit: [www.ncseagrant.org](http://www.ncseagrant.org)

## White joins NC Sedimentation Control Commission

WRRI director Susan White recently was appointed to the Sedimentation Control Commission. The 11-member group adopts rules, sets standards and provides guidance for implementation of the N.C. Sedimentation Pollution Control Act of 1973.

The act was written to prevent sediments — coming mainly from construction sites and road maintenance — from entering rivers and streams. According to the U.S. Geological Survey, excess sediment in streams can harm aquatic life, increase water-treatment costs, make the water less useful for recreation, clog channels and intakes, and destroy habitat. It is also one of the most pervasive forms of water pollution.

SCC commissioners work with municipalities to create sediment control plans. Most of the members of the commission are appointed by the governor and serve three-year terms. The exception is a permanent seat reserved for the director of the Water Resources Research Institute.

To learn more about the SCC visit: [portal.ncdenr.org/web/lr/erosion](http://portal.ncdenr.org/web/lr/erosion)

## Hans Paerl on NPR and WUNC



*Hans Paerl samples algae on China's Lake Taihu. Photo courtesy Hans Paerl.*

Most science is communicated by journals. But increasingly, scientists are going to other media to share their research. Hans Paerl, a researcher at the University of North Carolina at Chapel Hill, recently appeared on two well-known radio talk shows to discuss his work with toxic cyanobacteria blooms.

"There's a lot of interest in toxic cyanobacteria blooms and how to control them," says Paerl, "as they are on the increase and affecting the world's freshwater resources."

According to Paerl, toxins produced by cyanobacteria have long-term health effects including links to liver disease and neurological degeneration. He adds that increase in the blooms is liable to affect drinking water, aquaculture and irrigation.

Currently Paerl is studying eutrophication in Lake Taihu, China's third-largest freshwater lake. For many of his projects closer to home, such as his ongoing research on eutrophication and algal blooms in North Carolina's Neuse River estuary, WRRI has been a partner.

To listen to Paerl's discussion with Ira Flatow on NRP's Science Friday visit:

[www.sciencefriday.com/segment/10/25/2013/climate-change-aids-toxic-slime-s-advance.html](http://www.sciencefriday.com/segment/10/25/2013/climate-change-aids-toxic-slime-s-advance.html)

To hear his conversation with Frank Stasio on WUNC's The State of Things go to:

[wunc.org/post/danger-toxic-algae-north-carolina](http://wunc.org/post/danger-toxic-algae-north-carolina)

## Upcoming Events

### **Spring 2014 Erosion and Sedimentation Control Planning and Design Workshops**

**March 3, 2014,**  
Jane S. McKimmon Center,  
Raleigh, N.C.

**April 3, 2014,**  
The Crossing at Hollar Mill,  
Hickory, N.C.

7.5 PDHs\* will be offered for professional engineers and land surveyors, and 7.5 CEUs\* will be offered to landscape architects  
(\*contingent on board approval)

More information at:  
[www.ncsu.edu/wrri/code/events.htm](http://www.ncsu.edu/wrri/code/events.htm)

### **North Carolina Low Impact Development Summit**

**March 26-27, 2014**  
Raleigh Convention Center  
Raleigh, NC

A committed partnership between the state, N.C. Coastal Federation, N.C. State University, development professionals, local governments and private engineering firms is engaged in developing new standards and tools to simplify the use of Low Impact Development as a voluntary and cost effective option for stormwater management. Please join us March 26-27, 2014, at the Raleigh Convention Center as we share these new tools and the great work of our partnership.

Visit

<http://events.r20.constantcontact.com/register/event?oeidk=a07e8rp52lg03dfe3c4&llr=zt44nadab>  
for details

### **2014 WRRI Annual Conference and NCWRA Symposium**

**March 19-20, 2014**  
Jane S. McKimmon Center  
Raleigh, NC

The conference will highlight the latest water research, management, and policy in North Carolina through a series of concurrent presentations, themed panel discussions, and posters. This year's NCWRA symposium, "Local Governments as Keystone Water Resource Managers," will explore the unique and critical role that local governments play in managing water and in shaping the future of our water resources in North Carolina. We will showcase water projects that exemplify leadership and innovation at the local level.

Registration now open and draft agenda available at: [go.ncsu.edu/wrriac](http://go.ncsu.edu/wrriac)

### **Carolinias Climate Resilience Conference**

**April 28-29, 2014**  
Hilton Charlotte University Place  
Charlotte, NC

The impacts of current climate variability and the evidence of climate change are continuing to grow and with it our understanding of the challenges we face in adapting to those changes. Building resilience – the ability to adjust easily to or recover from a stress or change – is an important step in preparing to successfully address the current and future pressures. The Carolinas Climate Resilience Conference seeks to assist by providing a platform to share experience and knowledge of opportunities, tools, resources, local initiatives and expertise.

Visit  
<http://www.cisa.sc.edu/ccrc/>  
for details