

National Integrated Drought Information System

## Coastal Carolinas Drought Early Warning System Meeting Summary Report

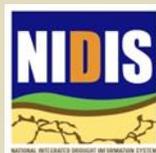
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Wilmington, North Carolina



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## Table of Contents

Introduction to the Coastal Carolinas DEWS .....	2
Background .....	2
Coastal Carolinas DEWS Strategic Planning Meeting.....	3
Overview of the Coastal Carolinas DEWS .....	5
Drought in the Carolinas .....	5
About NIDIS and the Coastal Carolinas DEWS Strategic Plan .....	5
The Coastal Carolinas Drought Early Warning System (DEWS) Program.....	5
Fire Weather Monitoring and Coastal Fire Risk Assessment in North Carolina .....	5
Forecasting the South Carolina Blue Crab Fishery .....	6
The Coastal Salinity Index .....	6
Priorities and Needs for the Coastal Carolinas DEWS.....	7
Highlights from the Small Group Discussions .....	7
Voting Activity: Meeting Participants Consider and Refine DEWS Priorities.....	9
Proposed Actions for the Coastal Carolinas DEWS .....	11
Fire and Forestry Working Group .....	11
Agricultural and Conservation Lands Working Group .....	12
Salinity and Ecological Indicators of Drought Working Group.....	13
Coastal Resource Management Working Group .....	14
Next Steps .....	14
Appendix A. Coastal Carolinas DEWS Meeting Agenda .....	16
Appendix B. Opportunities for Coordination and Collaboration .....	18

## Introduction to the Coastal Carolinas DEWS

### WHAT IS NIDIS?

The National Oceanic and Atmospheric Administration's (NOAA) National Integrated Drought Information System (NIDIS) program was first authorized by Congress in 2006 (Public Law 109-430) with an interagency mandate to coordinate and integrate drought research, building upon existing federal, tribal, state, and local partnerships in support of creating a national drought early warning information system.



### WHAT IS A DEWS?

A DEWS utilizes new and existing partner networks to optimize the expertise of a wide range of federal, tribal, state, local and academic partners in order to make climate and drought science readily available, easily understandable and usable for decision makers and to improve the capacity of stakeholders to better monitor, forecast, plan for and cope with the impacts of drought.

NOAA's National Integrated Drought Information System (NIDIS) supports the development and implementation of a Drought Early Warning System (DEWS) in the coastal Carolinas. NIDIS is comprised of a network of regional drought early warning systems throughout the United States, where, in accordance with Congressionally authorized Public Laws (P.L. 109-430 and P.L. 113-86), NIDIS is working closely with federal, tribal, state and local interagency and intergovernmental partners to improve drought early warning capacity and resilience.

### Background

The Coastal Carolinas DEWS was initiated in 2012 with a focus on the coastal regions of North Carolina and South Carolina. Both states experience considerable climate variability, including drought, heavy precipitation, tropical storms, ice storms, and severe heat. In terms of drought, the region has recently experienced drought events in 1998-2002, 2007-2009, 2010-2013, 2015, and 2016. Several of these events have exposed drought vulnerabilities, including those particular to coastal regions. These include impacts associated with changes to water quality conditions, such as increasing salinity levels and fluctuations, and the availability and timing of freshwater to support unique estuarine and coastal ecosystems. Drought monitoring and planning often center on agriculture, forestry and fire management, and water supply rather than on ecological resources. Ecosystems also need to be addressed where increasing population and water demands interact with drought to stress freshwater resources.

The Coastal Carolinas DEWS focuses on addressing needs and challenges associated with drought impacts on coastal resources. Coastal Carolinas DEWS objectives are to:

- Improve understanding of the unique vulnerabilities and impacts of drought in coastal areas.
- Develop tools, information, and other resources that will help managers and decision makers integrate drought- and coastal resource management activities.
- Provide a forum for a diverse group of federal, state, and local stakeholders that represent all economic sectors to strategize and develop appropriate, relevant, useful, and readily available drought, climate, weather, and water-related information.

Many entities have assisted NIDIS with the launch and development of the Coastal Carolinas DEWS. They include university partners from the Carolinas Integrated Sciences & Assessments (CISA) program at the University of South Carolina, Clemson University, and East Carolina University. Agency partners include the North Carolina and South Carolina State Climate Offices, North Carolina Sea Grant, South Carolina Sea Grant Consortium, and the USGS South Atlantic Water Science Center. Projects have addressed drought monitoring, collection of drought impacts information, research and development of tools to improve understanding of drought's effects on coastal resources, and communications and outreach activities. The [Coastal Carolinas DEWS Program Progress Report](#) provides an overview of activities and accomplishments through 2015.

Through interactions with a variety of stakeholders, these projects have revealed the importance of understanding the connections between drought and 1) high precipitation events, which can significantly affect the duration and severity of drought, and 2) heat waves, which can exacerbate the onset and impacts associated with drought. Ongoing and new Coastal Carolinas DEWS activities should address the need to improve early warning capacity and resilience to both drought and high precipitation events throughout the coastal Carolinas region and to consider how temperature plays a role in the severity of drought impacts.

More information about the [Coastal Carolinas DEWS](#) is available on the NIDIS [drought.gov](http://drought.gov) website.

## Coastal Carolinas DEWS Strategic Planning Meeting

NIDIS sponsored a planning meeting on June 2, 2016, in Wilmington, North Carolina to gather stakeholder input on the development of a Coastal Carolinas DEWS Strategic Plan. The meeting convened partners to:

- Refine priorities and major tasks for the Coastal Carolinas DEWS
- Inform the content of the Coastal Carolinas DEWS Strategic Plan
- Foster an information-sharing network around coastal drought issues

NIDIS and CISA staff led the planning process for the Coastal Carolinas DEWS meeting in spring 2016. A first step was to invite and organize a meeting working committee to help with: identifying meeting invitees, formulating and refining the meeting agenda, participating in the meeting, and providing feedback on products, such as the meeting report and the Coastal Carolinas DEWS Strategic Plan.

### Meeting Committee Members

*Courtney Black*, National Integrated Drought Information System (NIDIS)  
*Ryan Boyles*, State Climate Office of North Carolina, NC State University  
*Paul Conrads*, US Geological Survey – South Atlantic Water Science Center  
*Kirstin Dow*, *Amanda Farris*, *Kirsten Lackstrom*, CISA  
*Steve McNulty*, USDA Southeast Regional Climate Hub  
*Hope Mizzell*, State Climatology Office, SC Department of Natural Resources  
*Susan White*, North Carolina Sea Grant College Program  
*Maria Whitehead*, South Carolina Chapter, The Nature Conservancy

The one-day event convened twenty-nine federal, state, and academic partners in addition to other stakeholders. Participants represented a range of interests and expertise, including drought monitoring,

salinity dynamics and monitoring, fire-weather monitoring and response, coastal resources management, and agricultural and conservation land management.

The agenda, provided in Appendix A. Coastal Carolinas DEWS Meeting Agenda, was designed to facilitate information sharing and dialogue among participants. Small-group discussions centered on identifying the drought early warning information needs of decision makers, reviewing and refining priorities for the Coastal Carolinas DEWS, and generating specific activity ideas for inclusion in the Coastal Carolinas DEWS Strategic Plan.

The remainder of this report summarizes information presented at the meeting and highlights the key themes that emerged through the discussions.

### **Meeting Participants**

Carolinas Integrated Sciences & Assessments  
Clemson University  
Department of Interior/Southeast Climate Science Center  
Environmental Protection Agency/Region 4  
National Integrated Drought Information System  
National Weather Service  
North Carolina Coastal Reserve  
North Carolina Department of Health and Human Services  
North Carolina Forest Service  
North Carolina Sea Grant  
North Carolina Sentinel Site Cooperative  
North Carolina State University/State Climate Office of North Carolina  
South Carolina Department of Natural Resources/  
ACE Basin National Estuarine Research Reserve  
Southeast Regional Climate Center  
The Nature Conservancy  
University of North Carolina at Chapel Hill  
University of North Carolina at Wilmington  
University of South Carolina  
USDA Forest Service  
USDA Southeast Regional Climate Hub  
USGS South Atlantic Water Science Center  
Water Resources Research Institute of the UNC System

## Overview of the Coastal Carolinas DEWS

Presentations about drought in the coastal Carolinas, the NIDIS program, and specific projects undertaken as part of the Coastal Carolinas DEWS were provided as an overview to the program. Presentations and handouts detailing the Coastal Carolinas DEWS projects undertaken since 2012 are available on the [meeting website](#).

### Drought in the Carolinas

Rebecca Ward, Extension Climatologist with North Carolina's State Climate Office, presented the history of drought in the coastal Carolinas and the current drought status. Ward illustrated the unique problems that the areas in the coastal Carolinas face: dependence on upstream flow, use of aquifers, and the related vulnerabilities of barrier islands, longleaf pine forests, and marsh ecosystems. She also provided precipitation forecasts for 2016 summer and fall.

### About NIDIS and the Coastal Carolinas DEWS Strategic Plan

Courtney Black, NIDIS Regional Drought Information Coordinator, gave a presentation about NIDIS and the development of the Coastal Carolinas DEWS Strategic Plan. She provided background about NIDIS, the public laws underpinning the program, and the components of a drought early warning system. Black also discussed the benefits of a DEWS strategic plan which include identifying drought-related priorities and activities in the region, creating a coordinated regional network to generate support, and leveraging resources to assist with the expansion of activities and dissemination of information related to the DEWS.

### The Coastal Carolinas Drought Early Warning System (DEWS) Program

Kirsten Lackstrom, CISA Research Associate, presented an overview of the Coastal Carolinas DEWS goals and activities since 2012. These include: projects to develop indicators and tools to monitor coastal drought conditions and forecast potential impacts (described below); two CISA-led activities, the [Atlas of Hydroclimate Extremes for the Carolinas](#) and the [Citizen Science Condition Monitoring project](#); and over 50 presentations and engagements with different stakeholder audiences about these efforts. The Atlas of Hydroclimate Extremes will be a web-based resource that provides visual and quantitative information on the patterns of drought and extreme events and related impacts. The Citizen Science Condition Monitoring project engages citizen scientists to submit daily precipitation measurements and weekly reports about local weather and climate conditions and impacts through the [Community Collaborative Rain, Hail and Snow \(CoRoRaHS\) network](#). This project supports continuous monitoring of conditions, rather than one-off reporting of impacts, to help better assess drought onset, intensification, and recovery. While these projects were initiated with a focus on coastal drought, their scope has expanded to address broader drought monitoring and communications needs across North Carolina and South Carolina.

### Fire Weather Monitoring and Coastal Fire Risk Assessment in North Carolina

Ryan Boyles, Director of North Carolina's State Climate Office, spoke about fire weather monitoring and coastal fire risk assessment in North Carolina highlighting how drought conditions elevate fire risks. To better assess fire risk, his office collaborated with the North Carolina Forest Service in the development of the [NC Fire Weather Intelligence Portal](#), which generates fire danger information based on broad risk indicators. As an additional step to assess fire risk in the unique organic soils common in coastal regions, Boyles, Corey

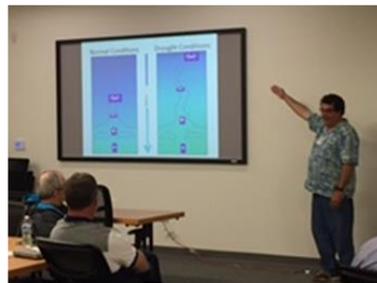
Davis, and Rebecca Ward compared soil moisture data with other potential measures of organic fire risk. Results confirm that existing risk indicators do not accurately forecast fire in coastal soils. To overcome challenges in coastal fire risk assessment, Boyles proposed addressing the needs for additional monitoring sites in eastern North Carolina and data from remotely-sensed soil moisture.

### Forecasting the South Carolina Blue Crab Fishery

Michael Childress, Associate Professor with Clemson University’s Department of Biological Sciences, presented his development of a model and decision support tool for forecasting the blue crab fishery in the Ashepoo-Combahee-Edisto (ACE) Basin of South Carolina. High salinity conditions induced by drought contribute to the upstream movement of blue crabs. His results from modeling salinity, crab disease, and other factors, suggest that blue crabs have the highest survival at intermediate salinities. Results also suggest a 2- to 3-year time lag in drought impacts on crab landings and that prolonged droughts may have cumulative effects that delay the recovery of crab landings. To advance and expand use of the forecasting tool, Childress suggested incorporating the Coastal Salinity Index (see below), future river discharge projections, and data from other regions into the blue crab landings model.

### The Coastal Salinity Index

Paul Conrads, Surface Water Specialist with the USGS South Atlantic Water Science Center, spoke about the development of the Coastal Salinity Index (CSI). This project emerged from the 2012 Coastal Carolinas DEWS stakeholder workshop discussions regarding the question, “Can a drought index be developed for the coast?” Developed using methodologies similar to the Standardized Precipitation Index (SPI), the CSI characterizes drought conditions in coastal systems using real-time and historical salinity datasets. Conrads demonstrated how the index can be correlated with environmental response variables, used for regional comparison, and applied to various types of estuaries. Future directions for the CSI in early drought warning include the development of a complete software package, continued investigation of relationships between the CSI and other coastal response variables, and applications to other coastal sites.



## Priorities and Needs for the Coastal Carolinas DEWS

Following the background presentations, participants broke into small groups to identify and discuss what they considered to be ongoing needs related to coastal drought and priorities for the Coastal Carolinas DEWS. As part of these discussions, each small group brainstormed and developed a set of 8-10 recommended DEWS priorities for the full group to consider. Participants then reconvened to report back on the small group sessions and introduced their priorities. After the report back, participants “voted” for what they considered to be the top three priorities for the Coastal Carolinas DEWS. Highlights from the small group discussions, including suggestions for priorities and activities, are provided below and followed by results of the voting exercise.

### Breakout groups discussed DEWS needs and priorities, focusing on the following:

*Who and/or what is being affected (or has been affected) by coastal drought, to include increasing salinity and lack of freshwater?*

*What are the key needs related to understanding the unique vulnerabilities and impacts of drought on coastal ecosystems and other coastal resources?*

*What are the key needs related to the development, provision, and use of information related to coastal drought that will help managers and decision makers integrate drought- and coastal resource management?*

*What are the key needs related to the facilitation of communications, collaboration, and coordination around issues and activities related to coastal drought?*

## Highlights from the Small Group Discussions

### Who and/or what is being affected (or has been affected) by coastal drought?

- Coastal drought directly affects ecological resources and systems, such as salt marshes, barrier islands, and wetlands, as well as agricultural and forestry lands and other managed areas on the coast. Direct effects include increasing salinity, saltwater intrusion, lack of fresh water, and adverse soil moisture conditions.
- These conditions contribute to other impacts such as *Spartina* dieback, increased fire risks, decreased carbon sequestration, and changes to water and soil quality which lead to a variety of subsequent impacts.
- Water managers must respond to complex issues such as cones of depression in groundwater aquifers and address multiple (non-consumptive and consumptive, upstream and downstream) water resource needs and uses.

### What are the key needs related to understanding the impacts of coastal drought?

- **Tools and approaches to improve the monitoring and assessment of drought impacts**, to include salinity, water quality (impacts from low and high flows, effects on municipal water treatment), soil moisture, and human health (vector-borne diseases, algal blooms, air quality). Improved assessments and awareness of the direct and indirect effects of drought are expected to increase the effectiveness of resource managers, including refuge managers, forest managers, agricultural producers, and other water users and managers.

- Conduct projects to link different indicators and to understand the connections between drought duration, severity, and impact thresholds
  - Document and assess how different industries and sectors respond to drought
  - Assess the impacts from, and previous responses to, historically significant droughts
  - Identify vulnerable populations
  - Develop a plan for drought impacts data collection for implementation when a drought does occur
- **Better overall understanding of regional water budgets and management options**
    - Conduct projects to identify connections and relationships between drought and other water and land use activities (e.g., stormwater management)
    - Conduct policy research to develop more robust water management options to prepare for and respond to drought

### What are the key needs related to the *development, provision, and use of information related to coastal drought?*

- **Development of coastal drought information**
  - Increase coastal drought monitoring networks
  - Expand and enhance the existing network of CoCoRaHS and condition monitoring observers; enlist citizen scientists and volunteers, such as river and water quality monitoring groups, or different types of coastal resource management activities, such as those at state and national parks
  - Expand soil and fuel moisture monitoring data and networks and other indicators that would be useful for fire managers
  - Develop better long range annual forecasts to inform planting and other agricultural decisions
  - Assess what information would be of most value for long-term planning decisions and processes
- **Provision of coastal drought information**
  - Identify existing datasets, information, and long-term monitoring networks that could be leveraged and integrated to provide information more relevant to coastal drought
  - Provide other types of drought-related information that is salient for resource managers and decision makers, such as salinity measurements and water and air quality monitoring data
  - Provide longer-range climate information, e.g., seasonal and ENSO outlooks
  - Determine how frequently to provide information, including what dissemination mechanisms are most effective and efficient with different users and audiences
- **Use of coastal drought information**
  - Investigate the use of a standard set of indicators to characterize coastal drought conditions
  - Assess the types of information that would have the most long-term value at different time scales (seasonal v. long-term droughts, short-term response v. long-term planning)
  - Provide training and outreach to obtain feedback on existing drought resources and tools in development, in order to refine ongoing development and use of those products (e.g., the CSI and Fire Weather Intelligence Portal)

## What are the key needs related to *improving communications, collaboration, and coordination around coastal drought*?

- **Communicating drought impacts information to a variety of audiences**, including resource managers, community planners, the public, and transient populations that move through the coast.
  - Promote proactive rather than reactive responses to drought when they occur through the development of a long-term drought communications strategy and efforts
  - Develop a more cohesive way to provide drought information, such as a single portal for coastal drought information
  - Leverage local media and other communications tools (e.g., webinars, social media) to reach local audiences and agencies that might not be familiar with coastal drought issues
  - Leverage other opportunities focused on water-related education and outreach, for example partnerships with extension programs and environmental educators, to increase awareness and disseminate information about drought among broader audiences
  - Deploy email and push notifications to send drought alerts
  - Use social science research to improve communication methods and develop greater trust with diverse audiences

## Voting Activity: Meeting Participants Consider and Refine DEWS Priorities

Based on their discussions, each break group generated a list of Coastal Carolinas DEWS priorities for the full group to consider in a voting activity. The objective was to have participants begin to further refine and prioritize the types of actions that would be most important for the Coastal Carolinas DEWS. Each participant “voted” for their top three priorities for the DEWS. The full set of ideas was categorized according to the three themes discussed in the small groups: understanding impacts; developing, providing, and using information; and communications, collaboration, and coordination. However, participants could distribute their votes across the categories in whatever manner they chose (i.e., vote for one priority under each category, or vote for three priorities in the same category).

Table 1 summarizes the results from the voting activity, showing three tiers of priorities – highest, medium, and lowest. Most ideas generated by the breakout groups focus on a project or action. However, two ideas in the “high priority” tier emphasize the process of engaging decision makers and managers in the Coastal Carolinas DEWS program. These priorities focus on the application of co-production and decision-analytic approaches in the development and implementation of activities. While collaboration is an inherent part of any DEWS, a “co-production” approach can be used to help further build interdisciplinary and joint knowledge around coastal drought issues. The development and implementation of specific projects should include scientists and climate information providers; decision makers who use drought information; and the agencies, organizations, and other stakeholders who are affected by coastal drought. Through sustained and focused dialogue among groups, it is more likely that new information produced through the Coastal Carolinas DEWS program will be used to respond to and plan for coastal drought impacts and issues as well as promote more proactive approaches to managing drought.

Table 1. Voting Activity Results: Coastal Carolinas DEWS Priorities

<b>Highest priority</b>
<i>Communications, Collaboration and Coordination</i>
Apply the co-production model; involve the public or decision makers throughout the scientific process
<i>Impacts (increase understanding and awareness)</i>
Increase public health activities; investigate impacts of coastal drought on issues such as wildfire risk, smoke health impacts, algal toxins
Investigate and identify water quality impacts of reduced stream flow
Move toward a decision analytic approach to define indicators and impacts of concern
<i>Information (development, provision, use)</i>
Identify key areas for salinity monitoring and a mechanism to accomplish
Provide one place or portal to find relevant information and data
<b>Medium priority</b>
<i>Communications, Collaboration and Coordination</i>
Communicate CoCoRaHS condition reports at local, state, and national levels
Connect with coastal city decision makers
Develop push notifications to agriculture and land managers who install and use water risers to alter hydrology
Identify and work with targeted audiences and develop communication strategies for each project and/or product
Identify potential collaborators such as the US Army Corps of Engineers, extension agents, and environmental educators
Improve translation of scientific information to decision makers
Understand how different users and sectors could use and apply information from previous droughts (for example, the 2002 and 2007 events)
Understand the context of impacts and decisions- who are the primary information users?
<i>Impacts (increase understanding and awareness)</i>
Investigate and identify drought impacts on oyster populations
Investigate and identify drought impacts on salt marsh ecosystems, especially Spartina
Investigate and identify links between current indices and marine fisheries at local, regional, and national scales and the relationships between the life history and the time lag effects of drought
<i>Information (development, provision, use)</i>
Deploy soil moisture probes for deep measurement and ovens for drying fuels to determine fuel moisture for fires
Develop better annual forecasting with inclusion of El Niño and La Niña
Examine existing indicators and develop new indicators that can be used to monitor conditions
Identify other datasets that are already packaged or available
Incorporate biotic terrestrial ecosystem impacts on water use and yield into streamflow variability
Synthesize data rather than gathering more data; integrate existing tools
Utilize data and information for seasonal drought

Lowest priority
<b><i>Communications, Collaboration and Coordination</i></b>
Develop proactive communications strategies and approaches now for use in future droughts
Involve the local media in the communication of drought information to the general public
<b><i>Impacts (increase understanding and awareness)</i></b>
Convey impacts to those who do long-term planning
Investigate and identify ecosystem impacts connected to drought duration and severity
Investigate and identify coastal drought impacts on forest productivity and carbon sequestration
Investigate and identify links between marine and freshwater across space and temporal scales
<b><i>Information (development, provision, use)</i></b>
Apply SPEI in agriculture-related drought monitoring
Conduct a more formal needs assessment
Determine how frequently to provide information in order to best inform management decisions
Develop a better water budget that includes climate, land and precipitation
Improve soil moisture data
Integrate storm water management and urban land use into drought efforts

## Proposed Actions for the Coastal Carolinas DEWS

This section highlights potential actions that participants developed in further detail to assist in meeting the Coastal Carolinas DEWS goals. Meeting participants divided into four breakout groups to develop proposals for specific actions that could be considered for implementation as part of the Coastal Carolinas DEWS program. Individuals were organized into the following working groups according to their interests and expertise:

- Fire and forest management
- Agricultural and conservation land management
- Salinity and ecological indicators of drought
- Coastal resource management

Participants were asked to consider the priorities identified in the previous sessions of the meeting in developing actions that would address DEWS goals. Such actions related to understanding drought impacts; drought information development, provision, and use; and communications, collaboration, and coordination. While some of the proposed actions may be feasible in the short-term (1-2 years), others will likely require longer time horizons. In addition, they identified existing tools, resources, and activities that could be leveraged and potential partners and stakeholders. Appendix B. Opportunities for Coordination and Collaboration includes a list of all proposed actions, with possible partners and stakeholders.

### Fire and Forestry Working Group

#### Proposed Action: Expand the Fire Weather Intelligence Portal

The [Fire Weather Intelligence Portal](#), developed by the State Climate Office of North Carolina, provides users with the ability to monitor past, current, and forecasted weather and fire risk conditions in a comprehensive

manner. Initially created in 2010 with North Carolina data, the USDA Southeast Regional Climate Hub (SERCH) recently funded the Portal's expansion across the US Forest Service's Southern Region, which spans from Virginia to Texas.

This working group recommended additional enhancements to the Fire Weather Intelligence Portal, particularly activities pertinent to the Coastal Carolinas DEWS' focus on coastal drought and ecosystems. Needs and priorities include more detailed assessments of wildfire risks in coastal areas; the deployment of multi-depth soil moisture probes to expand the monitoring network; and incorporation of new analyses and data syntheses into the portal. Risk assessments would consider the unique conditions of coastal soils and wildfire impacts on air quality and human health. Ongoing engagement with resource managers and other stakeholder groups is also a priority to improve fire-related communications strategies and inform other resource management and planning decisions during drought events (i.e., use of control structures to manage water resources).

### **Proposed Action: Communicate Health Impacts Related to Fire**

This action would supplement Fire Weather Intelligence Portal activities through focused attention on improving the understanding and communication of health impacts related to fire. The goal would be to expand the existing Portal tool to include information and resources regarding health risks and foster communication and collaboration between the fire community and health agencies.

The NC Climate Ready Program would lead these activities, leveraging funding from CDC grants and other drought and health opportunities. The SC Environmental Health Tracking program, housed at the SC Department of Health and Environmental Control, is another potential partner. Engagement with vulnerable populations would support the development of specialized strategies to reduce community impacts.

## **Agricultural and Conservation Lands Working Group**

### **Proposed Action: Develop an Integrated Hydrological Modeling and Impacts Assessment Tool**

Complex resource management issues would benefit from the integration of existing and new tools. Participants recommended the development of a tool that would build upon current and planned activities by integrating freshwater and saltwater monitoring with hydrological flow data. The tool could also include hydrological impact assessments, land use scenarios, and information from citizen scientist efforts (such as the Condition Monitoring project).

The goals of this action would be to help potential users consider coastal drought questions in the context of other resource management decisions and improve overall hydrological monitoring. For example, land managers could use the tool in their planning to compare the hydrological demands of a loblolly pine forest versus longleaf pine forest. The creation of the tool could draw upon existing resources (for example, the [WASSI Model](#)) and might be fairly straightforward (for example, calculating flow regime and precipitation). Other activities (for example, impact assessments, scenario development, and incorporation of citizen science information) would require longer-term effort and development of broader partnerships.

### **Proposed Action: Expand Condition Monitoring in Coastal Areas**

Expanding the [Citizen Science-Condition Monitoring project](#) on the coast could improve understanding of coastal drought impacts. Goals include increasing the number of project participants and condition

monitoring reports and augmenting existing reports, which often focus on general impacts to agriculture and water resources, with coastal-specific information. Priority activities would involve identifying and reaching out to organizations that may already be actively collecting related data (e.g., coastal parks, refuges, and recreational areas) with the expectation that adoption of condition monitoring might be greater where there are opportunities to mainstream it into current activities. Ongoing engagement (trainings, regular communications) with citizen science volunteers and participating organizations would be necessary to support this activity as many groups may not be familiar with drought issues or condition monitoring.



## Salinity and Ecological Indicators of Drought Working Group

### Proposed Action: Apply the CSI to Coastal Resource Management Decisions in the Carolinas

Improved understanding, and monitoring, of freshwater/saltwater dynamics was a key need identified by meeting participants. This activity will continue the development of the Coastal Salinity Index (CSI) to characterize and monitor drought conditions in the coastal Carolinas. Priorities for advancing the use of the CSI include computing and disseminating the CSI in real-time and working with coastal resource managers to apply the CSI and assess the linkages between salinity and ecological responses.

Activities would involve computing the CSI for different sites and creating a software package and open source website for users to access the CSI. Collaborations with coastal resource managers and agencies holding salinity and/or ecological response datasets would augment existing monitoring efforts, allow further documentation and investigation of salinity and saltwater intrusion impacts, and lead to improved understanding of the connections between freshwater management and coastal conditions. Findings from the application and testing of the CSI would then be used to further refine the tool and its use. Over the longer term, these efforts could support the development of a “salinity alert” system to support timely response to coastal drought conditions.

### Proposed Action: Develop CSI Information for Drought Monitoring Committees

This action would build upon other efforts to apply and use the CSI in coastal resource monitoring and management, focusing on generating information that conveys salinity and/or freshwater conditions in a format that is accessible and useable by a variety of decision makers involved in state-level drought monitoring and response. The target audiences for this project would include the NC Drought Management Advisory Council, the SC Drought Response Committee, and the water utilities, river/reservoir managers, and

state and federal agency representatives that serve on these committees. Short-term priorities would include working with the committees to identify the best ways for displaying and disseminating the CSI, and other salinity data, and assess use of the CSI in statewide drought monitoring activities. As potential CSI users might represent other sectors or the general public, activities could also include the development of educational materials to increase awareness of coastal drought and encourage impact reporting.

## Coastal Resource Management Working Group

### Proposed Action: Investigate Connections between Drought and Mosquito Populations

Mosquito population dynamics affect the recreation and tourism industries critical to coastal areas. The goal of this action would be to identify the extent to which there is a correlation between dry conditions and mosquito populations in both freshwater and saltwater environments. Specific activities might include modeling and forecasting mosquito populations, identifying types of mosquito borne illness, and determining the baseline for mosquito borne disease incidence.

Activities might be able to leverage funding and projects targeted at addressing the Zika virus. Findings from this project could help inform pesticide use by resource managers. Participation of resource managers and health departments in this activity will be critical in developing and disseminating information about mosquitos and health to wider audiences.

### Proposed Action: Produce a Coastal Water Budget

Meeting participants identified a need for a better overall understanding of regional water budgets and management options. Priorities include identifying the connections between drought and other water and land use activities (stormwater management, for example) and working with decision makers to develop robust water management options to prepare for and respond to drought.

The creation of a coastal water budget could be used to inform drought policy, planning, and modeling efforts in the coastal Carolinas. A comprehensive budget would integrate data regarding groundwater, streamflow, evapotranspiration, and precipitation, as well as upstream water usage. The budget would allow decision makers to anticipate how land use change and industrial, agricultural, and municipal water consumption patterns and trends might impact water resources in coastal areas. Conducting a needs assessment, and obtaining input from key stakeholders, prior to launching the project would be imperative to guiding project development and ensuring its effectiveness with target audiences.

The USGS National Water Census Study in the Coastal Carolinas is an important, existing activity to build upon. Many other organizations currently conduct relevant work and could provide or serve as resources for the development of a coastal water budget. Examples include the US Army Corps of Engineers, reservoir operators, the Cape Fear River Monitoring Program, Waterkeeper organizations, the NC Urban Water Consortium, Rural Center, WRRI, the Environmental Finance Center at UNC, Councils of Government (COGs), and public utilities.

## Next Steps

Through the course of the meeting discussions, participants identified many other activities and organizations related to coastal drought. Organizations currently involved in coastal drought-related activities include

research, water resources management and planning, education and training, and communications. While the presence of many interests and activities can challenge coordination, actively pursuing partnerships and collaborations would provide opportunities to leverage existing resources to address coastal drought needs and priorities (see Appendix B. Opportunities for Coordination and Collaboration).

The group discussed the best tools and mechanisms to share information and promote ongoing communication and collaborations around the Coastal Carolinas DEWS program. There was general agreement that quarterly calls would help facilitate information sharing and maintain momentum. Most meeting participants indicated that they would be interested in participating on these calls.

Information obtained during this meeting will be used to guide the development of the 2-year Strategic Plan for the Coastal Carolinas DEWS. NIDIS and CISA will continue to engage with meeting attendees and other agencies and partners in the Carolinas to obtain feedback and additional input.

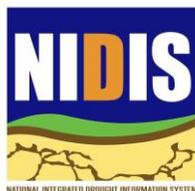
The Strategic Plan will provide a framework of priority actions that will guide the development and implementation of the Coastal Carolinas DEWS. The Plan will outline the partners involved in implementing the DEWS and key milestone dates. Additional actions and partners may be added to the Plan as the DEWS develops. The Strategic Plan will be available on the [NIDIS Drought Portal](#).

The Coastal Carolinas DEWS Strategic Plan is intended to serve as a “road map” for drought early warning activities in the Carolinas.

The plan will be available on the drought.gov website when it is completed.



## Appendix A. Coastal Carolinas DEWS Meeting Agenda



### Coastal Carolinas Drought Early Warning System (DEWS) Meeting

Thursday, June 2, 2016

Center for Marine Science, University of North Carolina Wilmington, Wilmington, NC

#### Meeting Objectives

- *Refine priorities and major tasks for the Coastal Carolinas DEWS*
- *Inform the content of a Coastal Carolinas DEWS Strategic Plan*
- *Foster an information-sharing network around coastal drought issues*

#### Meeting Agenda

- 8:15 Registration (continental breakfast provided)
- 8:45 Welcome and Introductions  
*Courtney Black, NIDIS, and Kirsten Lackstrom, CISA*
- 9:00 Session One: Overview of the Coastal Carolinas DEWS
- Drought status and history in the coastal Carolinas  
*Rebecca Ward, State Climate Office of North Carolina*
  - About NIDIS and the Coastal Carolinas DEWS Strategic Plan  
*Courtney Black, NIDIS*
  - Overview of the Coastal Carolinas DEWS goals and activities  
*Kirsten Lackstrom, CISA*
  - Drought indicators for coastal zone fire risk  
*Ryan Boyles, State Climate Office of North Carolina*
  - Forecasting the South Carolina blue crab fishery  
*Michael Childress, Clemson University*
  - The Coastal Salinity Index  
*Paul Conrads, US Geological Survey-South Atlantic Water Science Center*
- 10:15 Break
- 10:30 Session Two
- Q&A about NIDIS and the Coastal Carolinas DEWS program
  - Needs and priorities for the Coastal Carolinas DEWS  
*Facilitators: Kirstin Dow, Amanda Farris, Kirsten Lackstrom*

- o Small group discussions regarding needs related to coastal drought
- o Report back from small groups and large group activity regarding priorities

12:00 Working Lunch

12:45 Session Three

- Large group discussion about priorities
- Tasks and activities to advance the Coastal Carolinas DEWS
  - Facilitators: Courtney Black, Kirstin Dow, Amanda Farris, Kirsten Lackstrom*
  - o Small group discussions to identify and elaborate on priority activities
  - o Breakout groups: fire and forest management, conservation and agricultural lands, salinity and ecological indicators, coastal resource management

2:45 Break

3:00 Session Four: Wrap-up and next steps

*Courtney Black, NIDIS*

- Report back from small groups and large group discussion regarding proposed actions
- Final discussion regarding next steps for developing and implementing the Coastal Carolinas DEWS Strategic Plan

4:00 Adjourn

### Meeting Steering Committee Members

*Courtney Black*

National Integrated Drought Information System (NIDIS)

*Ryan Boyles*

State Climate Office of North Carolina, NC State University

*Paul Conrads*

US Geological Survey – South Atlantic Water Science Center

*Kirstin Dow, Amanda Farris, Kirsten Lackstrom*

Carolinas Integrated Sciences & Assessments (CISA)

*Steve McNulty*

USDA Southeast Regional Climate Hub

*Hope Mizzell*

State Climatology Office, SC Department of Natural Resources

*Susan White*

North Carolina Sea Grant College Program

*Maria Whitehead*

South Carolina Chapter, The Nature Conservancy



## Appendix B. Opportunities for Coordination and Collaboration

The organizations and entities listed in the table below were identified as potential Coastal Carolinas DEWS stakeholders and/or partners during small group discussions. This is not intended to be a definitive list but rather a starting point as the Coastal Carolinas DEWS program continues to reach out to communities, organizations, and sectors affected by or working on coastal drought issues.

Meeting participants also provided general suggestions for additional sectors and groups that might be interested in the Coastal Carolinas DEWS program as stakeholders or contributors. The Coastal Carolinas DEWS program will consider ways to engage with these stakeholders as the strategic plan is developed and implemented. These groups include:

- Councils of Government and other regional planning agencies
- Reservoir managers
- State and national aquariums, forests, parks, and reserves in coastal areas
- State environmental and health agencies
  - NC Department of Environmental Quality
  - NC Department of Health and Human Services
  - SC Department of Health and Environmental Control
  - SC Department of Natural Resources
- Tourism and recreation businesses
- USGS Cooperators
- Volunteer river and water quality monitoring groups
- Water and wastewater utilities



Table 2. Proposed Actions: Coastal Carolinas DEWS

<b>Proposed Action</b>	<b>Objective</b>	<b>Possible Partners and Stakeholders</b>
<b>Expand the Fire Weather Intelligence Portal (FWIP)</b>	Enhance the FWIP by conducting more detailed assessments of coastal wildfire risks and incorporating new analyses into the portal	State Climate Office of NC, NC Forest Service, The Nature Conservancy, USDA SERCH, wildlife refuges, university-based researchers and projects, state and federal agencies
<b>Communicate Health Impacts Related to Fire</b>	Expand the FWIP to improve understanding and communication of health impacts related to fire	NC Climate Ready Program (NC Department of Health and Human Services), SC Department of Health and Environmental Control
<b>Develop Integrated Hydrological Modeling and Impacts Assessment Tool</b>	Develop tool that integrates freshwater and saltwater monitoring with hydrological flow data	USDA SERCH, USGS, university researchers, state agencies, citizen scientists, resource managers
<b>Expand Condition Monitoring in Coastal Areas</b>	Increase number of project participants in coastal areas, to improve and increase reporting of coastal drought conditions	CISA; organizations such as The Nature Conservancy, NC Coastal Federation, Audubon, and “Friends of” groups
<b>Apply the CSI to Coastal Resource Management Decisions in the Carolinas</b>	Continue to develop the CSI to characterize and monitor drought conditions in the coastal Carolinas	USGS, National Estuarine Research Reserve System (NERRS), Department of Defense coastal installations, US Army Corps of Engineers, water utilities, university-based researchers, other state and federal agencies
<b>Develop CSI Information for Drought Monitoring Committees</b>	Generate CSI information that is accessible and usable by a variety of drought decision makers	USGS, state drought response committees, state climate offices, university-based researchers
<b>Investigate Connections between Drought and Mosquito Populations</b>	Identify the extent to which there is a correlation between dry conditions and mosquito populations in both freshwater and saltwater environments	Centers for Disease Control, state and county health departments, State Climate Offices
<b>Produce a Coastal Water Budget</b>	Improve understanding of regional water budgets, water availability, and management options	USGS, US Army Corps of Engineers, water utilities, water monitoring programs, university-based researchers, local and regional agencies