

COASTAL CAROLINAS DROUGHT EARLY WARNING SYSTEM STRATEGIC PLAN

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2017 – 2018 Strategic Plan



Document prepared by the National Integrated Drought Information System (NIDIS) in partnership with key stakeholders including Carolinas Integrated Science Assessments (CISA).

Coastal Carolinas DEWS Strategic Plan 2017 - 2018

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COASTAL CAROLINAS DROUGHT EARLY WARNING SYSTEM

The National Integrated Drought Information System and Drought Early Warning Systems

In 2006, Congress authorized the National Integrated Drought Information System (NIDIS) with a mandate for interagency coordination and integrated drought research that builds upon existing federal, tribal, state, and local partnerships to create a national drought early warning system (DEWS). NIDIS is working toward this goal by developing a network of regional DEWS (see map, below). These regional DEWS utilize existing networks to make climate and drought science readily available, easily understandable, and usable; and to improve regional capacity to respond to and cope with drought.

A regional DEWS is supported by stakeholders, comprised of relevant partners and community members across the region, including universities, the private sector, and federal, tribal, state, and local entities. Stakeholders participate in the NIDIS consultation process, and they support NIDIS priorities by leveraging existing resources, programs, and partnerships. This relationship ensures a robust, “ground-up” regional DEWS that is well-networked and responsive to the specific needs of each region. NOAA and the NIDIS program did not establish the DEWS and do not control or manage the DEWS functions or operations; rather, the DEWS constitute the continuation, and leveraging, of existing partnership networks.

WHAT IS NIDIS?

The National Oceanic and Atmospheric Administration’s (NOAA) National Integrated Drought Information System (NIDIS) was authorized by Congress in 2006 (Public Law 109-430) with an interagency mandate to develop and provide a national drought early warning information system, by coordinating and integrating drought research, and building upon existing federal, tribal, state, and local partnerships.

WHAT IS A DEWS?

A Drought Early Warning System (DEWS) utilizes new and existing networks of federal, tribal, state, local, and academic partners to make climate and drought science accessible and useful for decision makers; and to improve the capacity of stakeholders to monitor, forecast, plan for, and cope with the impacts of drought.



The Coastal Carolinas

DEWS

North Carolina and South Carolina experience considerable climate variability, including drought, heavy precipitation, tropical storms, ice storms, and severe heat. The region experienced extreme- to exceptional drought events in 1998-2002 and 2007-2009, and moderate- to severe conditions from 2010-2013. These events exposed existing and emerging drought vulnerabilities in this rapidly growing region, including those particular to coastal regions. These include impacts associated with changes to water quality conditions, such as increasing salinity levels, and the availability and timing of freshwater to support estuarine and coastal ecosystems.

The Coastal Carolinas DEWS was launched in 2012 with a focus on the coastal regions where stakeholders had indicated that there was a substantial need to better understand the implications of drought on coastal resources.¹ This DEWS focuses on ecological resources where increasing human water demands also interact with drought, stressing freshwater resources and vulnerable sectors of the economy. Many of the activities associated with this DEWS, from condition monitoring to better understanding the health impacts of drought, have a state-level footprint, benefitting the non-coastal areas of the Carolinas as well.



Coastal Carolinas DEWS Region

Note: While the yellow shading denotes the Coastal Carolinas DEWS region, where the majority of DEWS actions focus, activities may extend beyond the shaded area when needed.

Purpose of the Coastal Carolinas DEWS

The Coastal Carolinas DEWS is a collaborative federal, state, and local interagency effort to improve drought early warning capacity and long-term drought resilience throughout the region. Local stakeholder-driven needs around data

¹ The eastern boundary of the Coastal Carolinas DEWS is the eastern boundary of the Middle Atlantic Coastal Plain and Southern Coastal Plain ecoregions. Ecoregions were derived from mapping conducted by J.M Omernik, Omernik (1987), and from mapping performed in collaboration with EPA regional offices and other federal agencies, state agencies and neighboring North American countries. More information may be obtained at the following website: <https://www.epa.gov/eco-research/ecoregions>.

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collection and monitoring; research; planning for climate extremes; and communication, education, and outreach present opportunities for designing collaborative early warning activities.

Specific goals of the Coastal Carolinas DEWS include:

- 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.
- Enhance interactions between the research community and decision makers on the latest weather, climate, and drought science.

THE COASTAL CAROLINAS DEWS STRATEGIC PLAN

Plan Purpose and Development

The Coastal Carolinas DEWS Strategic Plan (Plan) outlines priority tasks and activities that build upon existing stakeholder networks to improve drought early warning capacity and long-term resilience in the coastal areas of North and South Carolina. This is a “living document” to which additional actions and partners may be added as needs and opportunities arise. The Plan includes a list of current partners (in Appendix A), outcomes, and key milestones for present activities as well as indicating areas where NIDIS is seeking additional partners or working to finalize details of some activities.

Dedicated partners across the Coastal Carolinas region contributed to the development of the Plan, including federal, state, academic and local entities, and in particular the Carolinas Integrated Science and Assessments (CISA), a NOAA Regional Integrated Science Assessment (RISA) team. A workshop was held in Wilmington, NC, in June 2016 to receive input on priority needs and actions to be addressed through this Plan. Participants included 29 federal, state and academic partners in addition to other key stakeholders with a diverse range interests and expertise. Their interests included drought monitoring, salinity dynamics and monitoring, fire-weather monitoring and response, coastal resources management, agricultural and conservation land management, and public health. Information obtained from this [2016 Plan Development workshop](#), as well as a [2012 Coastal Carolinas DEWS Scoping Workshop](#) to initiate the DEWS, and lessons learned to date through implementing the Coastal Carolinas DEWS, have all informed this Plan.

Coastal Carolinas DEWS Priorities and Activities

The Coastal Carolinas DEWS prioritizes the following aims necessary to building drought early warning capacity and long-term drought resilience throughout the Coastal Carolinas region:

- **Priority 1 – Foster Stakeholder Collaboration, Coordination, and Relationship Building** – The foundation for an effective DEWS is built upon cultivating a culture of interagency collaboration, coordination, and information sharing. Related actions include coordinated calls as well as meetings and workshops to facilitate informed discussion on drought among federal, state, and local agencies.

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- **Priority 2 – Improve Drought Early Warning Outreach and Communication** - Improved communications and outreach on drought and drought-related climate events contribute to raising awareness and sustaining vital relationships among science providers and decision makers. Related actions include improved communications on the U.S. Drought Portal's (www.drought.gov) Coastal Carolinas DEWS webpage, and development and implementation of a Coastal Carolinas DEWS communication plan.
- **Priority 3 – Improve Coastal Drought Monitoring and Use of Drought Indicators and Indices** – Improvements to monitoring systems and expanded use of drought indicators and indices in the region will support decision-making in land and water management as well as fisheries research, monitoring, and management. NIDIS and stakeholders will improve coastal drought monitoring and address advancements to existing drought indicators like coastal zone fire risk indicators, the Coastal Salinity Index (CSI), and the blue crab fishery model.
- **Priority 4 – Expand Understanding of Coastal Drought Impacts and Vulnerabilities** - This priority aims to strengthen the collection and dissemination of drought impact information with a focus on drought-related health impacts. Related actions include conducting new studies on drought health related impacts and further investigating the level of interest and resources available to study other drought-impact related topics proposed by stakeholders in the region.
- **Priority 5 – Incorporate Coastal Drought Tools into Resource Management** – This priority focuses on climate and hydrologic studies and tools that directly inform resource managers and decision-makers. Related actions may include utilizing web-based tools, modeling, and studies to identify connections between drought and other water management and land use activities that inform resource planning and decision-making.

For each priority, some of the associated activities outlined this plan have been started, while others may be initiated over the next two years, depending on designated leaders and funding sources. The corresponding schedule summarizes the approximate timeframe for each activity's implementation (Appendix B). Milestone dates are based on the following quarters, designated by seasons: Winter (Jan, Feb, Mar); Spring (Apr, May, Jun); Summer (Jul, Aug, Sep); and Fall (Oct, Nov, Dec).

Additionally, some of the activities are funded while other activities will require efforts to acquire funding. Funding sources may include NIDIS and DEWS partners. As the Coastal Carolinas DEWS continues to develop, it will be important to continue to identify and leverage resources and available funding among DEWS partners.

Coordination with NIDIS Working Groups

Vital to the mission of NIDIS are its six Working Groups, each focused on a different component of NIDIS activities within and across agencies and throughout the country. These six areas of focus are: (1) education and public awareness, (2) monitoring and observations, (3) predictions and forecasting, (4) interdisciplinary research and applications for risk assessment, (5) planning and preparedness, and (6) the U.S. Drought Portal for improving accessibility to usable drought risk information. More information on these Working Groups is provided in the [NIDIS Implementation Plan December 2016](#)

[Update.](#)

Coordination, communication, and transferability of information and actions between the NIDIS Working Groups and the DEWS is essential the overall process of building an integrated drought information system. The NIDIS Program Office maintains a network of regular communication and exchange of information between these entities to ensure meaningful engagement and effective collaboration on priorities and activities. Appendix C illustrates how each of the activities in this Plan correlates with the Working Group(s).

Priority 1 – Foster Stakeholder Collaboration, Coordination, and Relationship Building

The Coastal Carolinas DEWS seeks to develop a robust network of federal, state, and local stakeholders dedicated to building drought early warning capacity and long-term resilience in a coordinated manner. Associated activities include routine conference calls with Coastal Carolinas DEWS stakeholders to provide input on Coastal Carolinas DEWS decisions.

Activity 1.1 Participate in Partnership Conference Calls with Federal Agencies

Federal agencies throughout the Southeast region (AL, MS, GA, FL, NC, SC, and VA) hold monthly, informal conference calls to exchange information about activities and projects that address climate resiliency within the region, including drought resiliency. NIDIS and Coastal Carolinas DEWS partners will continue to engage in this process, leveraging information and resources from the Apalachicola-Chattahoochee-Flint (ACF) DEWS where beneficial and applicable. Partners include the Environmental Protection Agency (EPA) (current lead in organizing the calls), CISA, U.S. Department of Interior (DOI) Southeast Climate Science Center (CSC), North Carolina Water Resources Research Institute, Sea Grant programs of North Carolina and South Carolina, the DOI South Atlantic Landscape Conservation Cooperative (SA LCC), NOAA's Southeast Regional Climate Center (SERCC), U.S. Department of Agriculture (USDA) Southeast Regional Climate Hub (SERCH), and the National Park Service (NPS).

Activity 1.1 Outcomes

- NIDIS Program Office provides routine reports back to the Coastal Carolinas DEWS stakeholder group on relevant coastal drought and climate-related activities discussed during the call. [Winter 2017 – Fall 2018]

Activity 1.2 Coordinate with Federal Climate Services Providers in the Region

Multiple federal agencies provide routine climate services, conduct weather-related research, and communicate the state of knowledge around weather and climate with audiences across the Carolinas. These climate service providers include DOI's Southeast CSC, the USDA's SERCH, and NOAA's SERCC, who contribute in various ways to improving drought monitoring, planning, and resources management. These providers are active Coastal Carolinas DEWS partners, and regularly connect with NIDIS to identify opportunities to collaborate, leverage resources, reduce redundancy, and coordinate relevant activities. NIDIS will convene regular calls and deliver routine correspondence to connect with these climate service providers and exchange information as well as identify opportunities for collaboration and leveraging of resources.

Activity 1.2 Outcomes

- Routine correspondence between NIDIS and the federal entities described above on collaboration, leveraging resources and coordinating Coastal Carolinas DEWS relevant activities. [Spring 2017 - Fall 2018]

Activity 1.3 Develop Inventory of Drought Activities in the Coastal Carolinas

Federal, state, and local entities throughout the Carolinas are actively engaged in a variety of climate and drought-related efforts that can benefit resource managers, planners, and other decision makers affected by or interested in coastal drought. CISA is developing a drought resources inventory to obtain information on existing and planned activities and projects related to drought early warning and drought resilience. These activities may specifically address the Carolinas along the coast or be of larger regional scope, yet provide benefit to the coastal region.

NIDIS will make the completed inventory publicly available on the U.S. Drought Portal, and it will be used by DEWS stakeholders and decision makers as a reference tool, and will be updated regularly. The ongoing engagement to document efforts and update the table and Plan will provide opportunities for information exchange, collaboration, and leveraging of other activities and resources.

Activity 1.3 Outcomes

- First draft of drought-related projects and activities inventory in the Coastal Carolinas DEWS. [Summer 2017]

Priority 2 – Improve Drought Early Warning Outreach and Communication Capacity

During drought and other drought-related climate events (e.g., high precipitation events that offer lessons about the impacts of drought), increased drought and climate communication and outreach to stakeholders is paramount. These efforts include a Coastal Carolinas DEWS centralized communication hub (U.S. Drought Portal) that provides information on climate tools and resources, communication and outreach to stakeholders, and forums to foster discussion on how drought early warning outreach and communication can be improved. NIDIS and stakeholders may also pursue additional tools to improve drought early warning communication, like special webinars, presentations, and social media.

Activity 2.1 Update and Maintain the Coastal Carolinas DEWS Information on the U.S. Drought Portal

NIDIS will work with its partners to update and maintain the [Coastal Carolinas DEWS page](#) on the U.S. Drought Portal. This site provides up-to-date information on DEWS activities (e.g. workshop dates and summaries, research, outreach activities, applicable links to climate data). Additional information will be added to the U.S. Drought Portal as it becomes available, to include: details about innovative studies, drought vulnerability studies, best management practices, success stories, and insights from coastal managers working to incorporate drought information into management strategies.

NIDIS will convene a group of stakeholders to review and provide feedback on how to strengthen the Coastal Carolinas DEWS section on the U.S. Drought Portal, using Google analytics for the U.S. Drought Portal to inform the discussion. Suggested improvements may include the selection of specific drought and risk management tools to post on the site that are useful for stakeholders and ideas on how DEWS

actions and other relevant information and activities in the region can be presented. Partners may include NCEI, CISA (primary provider of content in the past), NC and SC state climatologists, and subject matter experts from the NIDIS Drought Portal Working Group.

Activity 2.1 Outcomes

- Routine enhancements to the Coastal Carolinas DEWS webpage, to include timely updates, relevant content, and visual improvements in layout and formatting. [Winter 2017 – Fall 2018]

Activity 2.2 Develop Coastal Carolinas DEWS Communications and Outreach Plan

A coordinated approach to communication and outreach among DEWS stakeholders will improve the quality and efficiency in which drought and climate-related information is delivered to stakeholders. This activity entails the development and implementation of a Coastal Carolinas Communication and Outreach Plan (Communications Plan) and an assessment of what products, messages, and communication mechanisms would best meet the variety of stakeholder and sector-specific needs for coastal drought early warning information. This assessment will cover tools and resources to enhance preparedness and planning efforts in the region. CISA will synthesize previously completed Coastal Carolinas DEWS work to determine coastal drought information use and needs. Along with NIDIS, CISA will lead the development of a Communications Plan that coordinates the most effective methods and products available to disseminate drought information and resources. This Plan will also identify new products to improve communication. NIDIS will leverage and/or supplement related information developed by climate and coastal information providers in the Carolinas, such as the SCO NC's Climate Blog; websites, listservs, newsletters, social media, and other products disseminated by Coastal Carolinas DEWS partners.

NIDIS and CISA will work with regional partners to develop the Communications Plan. Partners may include SERCC, State Climate Office of NC, SC State Climatology Office, NOAA's National Ocean Service (NOS), NOAA's National Weather Service (NWS), USDA SERCH, U.S. Geological Survey (USGS), NC Water Resources Research Institute, SC and NC Sea Grant programs, NOAA's National Estuarine Research Reserves (NERRS) coastal training programs, the SC Coastal Information Network, member(s) from the NC Drought Management Advisory Council (DMAC), and others.

Activity 2.2 Outcomes

- Synthesis report to collate information from previous Coastal Carolinas DEWS assessments of information use and needs. [Summer 2017]
- Recommendations for a Coastal Carolinas DEWS Communications Plan. [Summer 2017]
- Development and dissemination of new drought information communications products identified during the development of the Communications Plan. [Fall 2017 – Fall 2018]

Priority 3 – Improve Coastal Drought Monitoring and Use of Drought Indicators and Indices

Typical drought indicators often fail to capture the conditions and impacts experienced in coastal areas. Coastal Carolinas DEWS partners seek to develop and understand drought indicators and indices tailored to coastal ecosystem dynamics. This priority aims to build on existing efforts and indicators, such as coastal zone fire risk indicators, the CSI, and the blue crab fishery model.

Activity 3.1 Assess how to Enhance Coastal Drought Monitoring and Use of Drought Indicators and Indices in the Coastal Carolinas

CISA will synthesize previously completed Coastal Carolinas DEWS work in the region regarding the use of existing drought indicators and recommendations for both enhancing existing tools and developing new projects to improve drought monitoring in coastal areas. The report may also assess how drought indicators may be linked to coastal drought impacts and incorporate findings from related research in the area.

These recommendations will be presented to the Coastal Carolinas DEWS stakeholders as part of a process to develop a plan to further address needs related to the use of drought indicators and other tools in resource monitoring and management. Partners will include CISA and other federal and state agencies.

Activity 3.1 Outcomes

- Synthesis report to collate information from previous Coastal Carolinas DEWS assessments of information use and needs. [Fall 2017]
- Recommendations to enhance existing Coastal Carolinas DEWS activities for consideration in the development of a Coastal Carolinas DEWS Drought Monitoring and Indicators Plan. [Fall 2017]

Activity 3.2 Assess and Expand Coastal Zone Fire Risk Indicators for Fire Monitoring and Management Decisions

The complex terrain, drainage, and composition of organic soils make it difficult to assess fire risk in coastal regions. When existing drought indices miss the magnitude and timing of periods with heightened fire risk, this can have important implications for activities such as planning prescribed burns or allocating resources to potentially at-risk locations. Investigation and development of organic fire risk indicators is necessary to improve monitoring and management for fire risk in the region.

As follow up to the “Coastal Zone Fire Risk Assessment” project conducted in 2014-2015, the State Climate Office of North Carolina (SCO NC) will lead an expanded effort to:

- improve the monitoring of soil moisture;
- enhance the [Fire Weather Intelligence Portal](#) to better address coastal fire conditions and risks;
- assess coastal zone fire risk indicators; and
- help resource managers use new coastal zone monitoring data and information for drought management and planning decisions.

Specific activities include:

- Engage with resource managers on the Coastal Zone Fire Risk Project - a collaborative initiative will be developed to determine specific tasks and activities where a group will meet periodically to provide guidance on the project and obtain user feedback on data products and outcomes.
- Data collection - Identify and assess potential sites, and then deploy soil moisture probes at

multiple locations across coastal NC to collect data without interruption. In the short term, a parameter such as Estimated Smoldering Potential could be calculated using the soil moisture data to provide useful operational guidance about fire or smoke risk in those areas with organic soils. In the longer term, the soil moisture data may be analyzed and related to data from other depths, as well as time-lagged precipitation values, local groundwater data, or other readily available environmental data that could help estimate organic fire risk and smoldering potential in the absence of sensors in the ground. This process will be coordinated with the National Soil Moisture Network and potentially be linked to the Soil Climate Analysis Network (SCAN) and U.S. Climate Reference Network (USCRN) stations along the coast if it moves from an experimental phase to an operational phase.

- Link data to the Fire Weather Intelligence Portal - As soil moisture data is being collected, it will be displayed on existing tools such as the SCO NC's Fire Weather Intelligence Portal.
- Conduct data analysis - The organic soil moisture data will be compared with other widely available datasets, including remotely sensed soil moisture data, with the goal of identifying a dataset that captures the variations and extremes of organic soil moisture.

Partners may include SCO NC (lead), NWS, NC Forest Service, the Nature Conservancy, U.S. Fish and Wildlife Service (USFWS), NC State Parks and Recreation, USDA SERCH, and CISA.

Activity 3.2 Outcomes

- Annual project report to include concise description of tasks and summary of findings, partners involved, and next steps. [Summer 2018 – completion of project]
- Engagement plan with project partners and stakeholders. [Fall 2017]
- Identification and assessment of potential site, deploy soil moisture probes and data collection. [Summer - Fall 2017]
- Inclusion of new datasets to the Fire Weather Intelligence Portal and documentation of enhancements. [Winter 2018 – completion of project]
- Analysis of soil moisture data. [Summer 2018 – completion of project]
- Final project report, with findings and recommendations for coastal zone fire risk monitoring, also posted and promoted on the U.S. Drought Portal. [Winter 2021]

Activity 3.3 Advance Development and Use of the Coastal Salinity Index

Droughts affect coastal areas uniquely because of changes in salinity resulting from decreases in freshwater inflows and precipitation. The CSI emerged from stakeholder discussions at the 2012 Scoping Workshop. Using real-time and historical salinity data sets and methodologies similar to the Standardized Precipitation Index (SPI), the CSI characterizes drought conditions in coastal systems. The CSI is computed for various time scales to capture short- and long-term conditions. The continued application and enhancement of the CSI is in the interest of many agencies and organizations that manage and/or monitor water and other coastal resources.

The USGS will lead efforts described below:

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- Develop software package for the computation of the CSI. USGS partners will collaborate to develop, test, and build a software package that analyzes data, fills data gaps, computes the index, and plots data.
- Compute the CSI for other locations. Develop and provide a more extensive data set and information to 1) increase the opportunity for the real-time use of the CSI (Activity 3.2), 2) to evaluate and optimize the distribution function used to compute the CSI, and 3) link the CSI to proximal ecological data sets (see Activity 3.4 below).

Partners may include: USGS Science Centers (lead) including the South Atlantic Water Science Center (SAWSC), the Caribbean-Florida Water Science Center (CFWSC), Lower Mississippi Gulf Water Science Center (LMGWSC), St. Petersburg Coastal and Marine Science Center (SPCMSC), the USGS Southeast Regional Office, the USGS Office of Water Information (OWI); NERRS; NC Sea Grant; SC Sea Grant Consortium; CISA; Auburn University; University of Florida; NPS; and state agencies such as the SC Department of Health and Environmental Control (SCDHEC) and the SC Department of Natural Resources (SCDNR).

Activity 3.3 Outcomes

- Develop software package for the computation of the CSI. [Summer 2017 – Fall 2017]
- Compute the CSI for other locations. [Winter 2018]
- Summary report written by the CSI partners summarizing the findings of computing the CSI at other locations, with a prioritized list of candidate new monitoring stations. [Spring 2018]

Activity 3.4 Apply the CSI to Coastal Resource Management Decisions

The CSI was developed to inform coastal resource managers on coastal drought conditions and to improve understanding and monitoring of freshwater/saltwater dynamics. This activity builds off Activity 3.3 by advancing the use and application of the CSI for drought and coastal resource management.

Activities specific to this task include:

- Analyze the CSI with respect to datasets of environmental response variables. Such analysis is critical for demonstrating the linkage between coastal drought and affected environmental resources, economic sectors, and communities.
- Assess use and application of CSI with resource managers by working closely with resource managers to apply and test the utility of the CSI. This activity will help to augment existing monitoring efforts and facilitate the documentation and investigation of salinity and saltwater intrusion impacts.
- Establish and implement a CSI working group to foster communication and coordination among interested Coastal Carolinas DEWS stakeholders to help improve the CSI and its use in resource monitoring and management. Activities may include identifying datasets, reviewing analyses, and testing and using the CSI.

Partners may include representatives from CISA (co-lead), USGS (co-lead), ACE Basin National Estuarine Research Reserve (NERR), Clemson University, NC Sea Grant, NC WRI, North Inlet-Winyah Bay NERR, SC DNR, SC Sea Grant Consortium, Southeast Coastal Ocean Observing Regional Association (SECOORA), The Nature Conservancy, University of South Carolina, and USFWS.

Activity 3.4 Outcomes

- Assess usability of CSI with resource managers. This activity will include engagement with managers, developing a plan for evaluating use of CSI in resource management decisions, implementing the plan, and summarizing activities, findings, and next steps in annual project reports. [beginning in Fall 2017, with plan implementation extending until completion of the project]
- Establish and implement a CSI working group, including quarterly webinars and/or in person meetings. [Winter 2016/Spring 2017 - completion of the project]

Activity 3.5 Expand the South Carolina Blue Crab Fishery Model

Drought can have both positive and negative effects on blue crab populations. There is a need to further understand how future variation in river discharge will impact commercial blue crab landings. Clemson University has developed a model and decision support tool for forecasting the SC blue crab fishery. Modeling exercises coupled with the decision support tool have shown that high salinity conditions, induced by drought, contribute to the upstream movement and decreased survival of blue crabs. Laboratory and field experiments suggest that blue crabs have the highest survival at intermediate salinities. The model suggests a 3-year time lag in drought impacts on crab abundance, which was independently confirmed by a comparison of the Little Back River CSI with the SC commercial crab landings.

This activity expands the geographic range of this model to include CSIs for key rivers along the Atlantic seaboard with commercial blue crab landings from Maryland to Florida. This will allow the creation of a regional drought forecast tool for one of the most important commercial fisheries in the U.S, of immediate interest to agency managers and researchers. Activities include (1) identification of key rivers along the Atlantic seaboard with sufficient time-series salinity data to calculate the CSIs, (2) estimation and verification of the CSI for each river, (3) compilation and standardization of commercial blue crabs landings data by state and region, and (4) analysis of time-lag variation and optimal model selection to create a robust Atlantic Blue Crab Drought Forecast tool. Partners may include USGS (SAWSC), SCDNR, CISA, and SC Sea Grant Consortium.

Activity 3.5 Outcomes

- Interim report including selection of rivers with salinity data and calculation of their CSI. [Summer 2018]
- Interim report including blue crab landing data for the Atlantic region. [Fall 2018]
- Final report including the Atlantic Blue Crab Drought Forecast Tool with short (3 year) and long (10 year) forecasts for blue crab commercial landings. [Summer 2019]

Priority 4 – Improve Understanding of Coastal Drought Impacts and Vulnerabilities

Developing a comprehensive understanding of how drought impacts the Coastal Carolinas is a critical

component for better planning and response to drought. The acquisition of drought impact information during a drought, in combination with relevant monitoring data and applicable modeling studies, can be useful in evaluating the drought vulnerability of ecosystems and coastal communities. This priority focuses on actions to improve the collection and dissemination of drought impact information and develop a better understanding of how drought impacts public health.

Activity 4.1 Implement and Expand the Citizen Science Condition Monitoring Project

In early 2013, CISA began the [CoCoRaHS-Condition Monitoring project](#) to advance drought impact monitoring and reporting by integrating on-the-ground impacts information provided by citizen scientists into drought monitoring and decision making processes. To date, Community Collaborative Rain, Hail and Snow (CoCoRaHS) network volunteers submit regular status reports about the condition of their local environment and communities. Regular reporting, rather than intermittent drought impact reports, can help to create a baseline for comparison of change through time and to improve understanding of the onset, intensification, and recovery of drought.

This activity includes (1) project operations and (2) activities to increase the number of project participants and condition monitoring reports in the Coastal Carolinas.

Project operations include ongoing communications and outreach with volunteers, engagement with drought decision makers through interviews and surveys, and analyzing use and relevance of condition monitoring reports for drought monitoring.

To increase the number of project participants and condition monitoring reports in the coastal region of the Carolinas, NIDIS and partners will engage organizations actively collecting drought-related data (e.g., coastal parks, refuges, and recreational areas) to encourage their participation and connection to their pre-existing efforts. Ongoing engagement (trainings, regular communications) with new citizen science volunteers and participating organizations will also support the Coastal Carolinas DEWS as many groups may not be familiar with drought issues or condition monitoring.

Partners in this effort include CISA (lead), CoCoRaHS partners, the National Drought Mitigation Center (NDMC), and the NC and SC SCOs. Additional partners may include organizations such as the NWS Forecast Offices, state and regional CoCoRaHS coordinators, the NC and SC Sea Grant programs, the Nature Conservancy, NC Coastal Federation, Audubon, and “Friends of” groups.

Activity 4.1 Outcomes

- Communications and outreach materials for project volunteers through a monthly newsletter, blog posts, quarterly conference calls, and email exchange. [Winter 2017 – completion of project]
- Identify appropriate groups or organizations to recruit volunteers. [Winter-Summer 2017]
- In-person and webinar trainings. [Winter-Spring 2017]
- Targeted project materials for recruitment and training. (e.g., project information sheet, training slideshows). [Winter-Spring 2017]
- Preliminary findings and recommendations from analysis of condition monitoring content and other feedback activities (e.g. surveys and interviews). [Summer 2017]

Activity 4.2 Investigate Relationship between Drought and Health Vulnerabilities

This activity involves the development of a white paper to document the state of knowledge regarding drought and health connections focusing on topics relevant to the Coastal Carolinas DEWS. High precipitation events may also be addressed within the context of how those events influence drought conditions and health impacts. The Centers for Disease Control (CDC) currently provides overview information and an infographic on this topic on its [website](#).

The white paper will investigate topics suggested at the 2012 Scoping Workshop and 2016 Plan Development Workshop, as well as others identified through literature searches, including:

- Effects and potential mitigation actions associated with water quality degradation on vulnerable coastal communities during a drought (e.g., degradation of drinking water supply, salt water intrusion, HABs, *Vibrio* risks, etc.).
- Relationships between drought, air quality, and public health impacts, and how this information may be shared with affected coastal populations (e.g., public service announcements, partner communication vehicles).
- Connections between drought and vector-borne disease and risks (e.g., effects on mosquito populations, West Nile Virus risks, etc.).

The white paper will synthesize the existing state of knowledge through a literature review in addition to surveys and interviews to catalogue existing resources and activities in the region and to identify vulnerabilities, gaps, and barriers related to drought and human health. Findings from, and information gathered through, this activity will be used to develop informational materials (e.g., 2-pagers, website content, webinar presentations) that can be disseminated through partners' websites and networks. These materials will communicate the health impacts from drought to a wide audience of drought decision makers and planners, local health officials, and the public. Partners may include CDC, CISA, NC Institute for Climate Studies (CICS-NC), NC Health and Human Services (NC DHHS) Division of Public Health, NDMC, SERCC, and SC Department of Health and Environmental Control (SC DHEC).

Following development of the white paper, NIDIS, Coastal Carolinas DEWS stakeholders, and climate health specialists will integrate the findings into the DEWS and determine resources and support to develop a drought and public health-related project.

Activity 4.2 Outcomes

- White paper summarizing findings related to the topics listed above. [Fall 2018]
- Informational materials to communicate the health impacts of drought posted to the U.S. Drought Portal and shared with regional stakeholders. [Fall 2018 – completion of project]

Priority 5 – Incorporate Coastal Drought Tools into Resource Management

The Coastal Carolinas DEWS aims to develop tools, information, and other resources that will help managers and decision makers address drought- and coastal resource management challenges. This priority focuses on development of the modeling studies and tools that directly inform resource managers and help them identify connections between drought and water management and land use activities.

Activity 5.1 Inform Drought Management and Planning through an Atlas of Hydroclimate Extremes

Stakeholders across the Carolinas want to better understand how the onset, duration, and cessation of drought affect management choices; how drought indicator data is linked to drought impacts; and how new tools and information can improve awareness of drought and foster proactive planning for drought risks.

In response to these needs, CISA initiated the development of the Atlas of Hydroclimate Extremes for the Carolinas in 2014. The Atlas is an online resource (available and promoted on the CISA website and linked to the U.S. Drought Portal) for drought response committees, water resource managers, and other decision makers who plan for and manage hydroclimate risks. Statistical measures of regional risks and impacts related to hydroclimate extremes can help inform drought planning, preparedness, and communications and outreach efforts across the Carolinas. Specific information connects statistical analyses and graphics with text, photos, and other media to tell the story about precipitation anomalies in the Carolinas. It includes information on the frequency, duration, and intensity of drought and high rainfall events; conditions necessary to support drought recovery; and impacts associated with hydroclimate extremes. Station-specific and climate division-level data allows coastal stakeholders to access the information most pertinent to their region. Through user feedback activities, the team will educate users about the region's drought and pluvial climatology and learn what thresholds of anomalously wet or dry periods matter most to decision makers as well as best methods for displaying precipitation statistics to broad audiences. CISA will use the Atlas as a tool to foster and support communications and planning that address hydroclimate risks and impacts in the Carolinas. Partners include CISA (lead), the NC and SC SCOs, and SERCC.

Activity 5.1 Outcomes

- Version 1.0 of the web-based digital atlas available to the public. [Spring 2017 - Summer 2017]
- Report with final results and recommendations from user feedback. [Summer 2017]

Activity 5.2 Evaluate Water Availability and Use to Meet Societal and Ecological Needs in Southeastern Atlantic Coastal Basins of the Carolinas

Ongoing and projected increases in permanent and tourist population, extreme natural events (droughts/hurricanes/earthquakes), and potential changes in climate will place additional stress on the societal and ecological systems competing for water resources in many coastal communities, particularly in the Myrtle Beach–Grand Strand, South Carolina and Wilmington, North Carolina metropolitan areas.

The USGS is leading a water availability study in the Coastal Carolinas as a part of the National Water Census USGS research program. The study evaluates how potential changes in population growth, land-use, and climate will impact aquifer water levels and the frequency, duration, and magnitude of streamflow and salinity intrusion near water-supply intakes. Existing regional groundwater, surface water and ecological response models will be expanded and enhanced to provide decision support tools to investigate the impact of historic, current, and future groundwater and surface-water withdrawal and climate change scenarios on societal and ecological water demands.

Decision support systems (DSS) similar to the [PRISM-2 DSS](#), which allow resource managers to evaluate changes in salinity intrusion from the changes in streamflow and sea-level due to climate change, will be developed from the groundwater and surface-water and ecological response models of the study area to address water-resource issues of concern to the stakeholders. These enhanced models and associated DSSs will provide new data and tools that can be used by managers to plan future surface-water allocations and groundwater development and withdrawals as stakeholders evaluate potential consequences on ecology and susceptibility of the aquifers to saltwater contamination. Partners include USGS (lead), NC State University, and Southeast CSC.

Activity 5.2 Outcomes

- Individual DSSs will be developed for aquifer and ecological response to various surface-water and groundwater withdrawals and land-use scenarios resulting from a range of population growth projections and climate change/sea-level rise scenarios. Upon determining stakeholder needs and preferences, the DSSs could take the form of a queryable database library, an interactive desktop GIS interface, or two/three-dimensional graphical representation of modeled results, which will also feed back to the U.S. Drought Portal. [Winter 2017 – Winter 2019].
- All DSSs and user interfaces will allow users to select areas of interest or gauged locations and retrieve predictions of aquifer water levels and quality (in select areas), salinity or ecological conditions based on a predefined library of modeled water-withdrawal, ecological-flow requirement, and(or) climate change/sea-level rise scenarios. [Winter 2017 – Winter 2019].

Activity 5.3 Leverage Existing Studies and Tools to Further Improve Hydrologic Modeling and Water Budget Estimates

By leveraging existing drought-related studies and tools that address improved hydrologic modeling and water budget estimates, complex resource management challenges can be better addressed. This can be seen from the following examples:

- The results of the USGS study in Subtask 5.2 can be transferred to other rapidly growing coastal metropolitan areas that are either currently dealing with similar water availability conflicts or will be in the future.
- The [USDA Water Supply Stress Index Model \(WaSSI\)](#) is a web-based tool to project the effects of land use change, climate change, and water withdrawals on river flows, water supply stress, and ecosystem productivity.
- Enhancement to the [PRISM-2 DSS](#) tool would allow it to be used to evaluate potential changes in salinity, water level, and water temperature from projected water-use and climate change scenarios at water-supply intakes and on tidal freshwater forested marshes and temperature effects (along with salinity) on the occurrence of Vibrio bacteria.

Stakeholders recommend the continued development of tools and studies that build upon current activities by integrating freshwater and saltwater monitoring with hydrological flow data and water budget estimates. Desired focal points for modeling and study include: hydrological impact assessments, land use scenario assessments, refined coastal water budgets, local groundwater and surface water interactions and the incorporation of information from citizen scientist efforts, such as the CoCoRaHS Condition Monitoring project described in Activity 4.1.

This activity focuses on the improvement and refinement of existing modeling/tool development efforts to address priority water and land management questions. NIDIS and partners will consult with decision-makers in the region to identify priority management questions which will inform the refined project scopes for existing modeling/tool development. Stakeholders have expressed a need to build a comprehensive, regional understanding of how low inflows impact coastal resources.

Components of the study could include: (1) operating rules and policies for different river basins, (2) differences between in stream/ downstream needs relative to operating upstream rules, (3) existing “water budgets” for water availability and water use, (4) thresholds such as “At what low flows should actions be taken?”(5) “What are the impacts at a given threshold or action level?”, and (6) drought communication strategies related to modeling results.

Partners may include USGS, USDA SERCH, CISA, USACE, reservoir operators, the Cape Fear River Monitoring Program, Waterkeeper organizations, the NC Urban Water Consortium, Rural Center, WRRRI, the Environmental Finance Center at UNC, Councils of Government (COGs), and public utilities, other university researchers, state agencies, and citizen scientists.

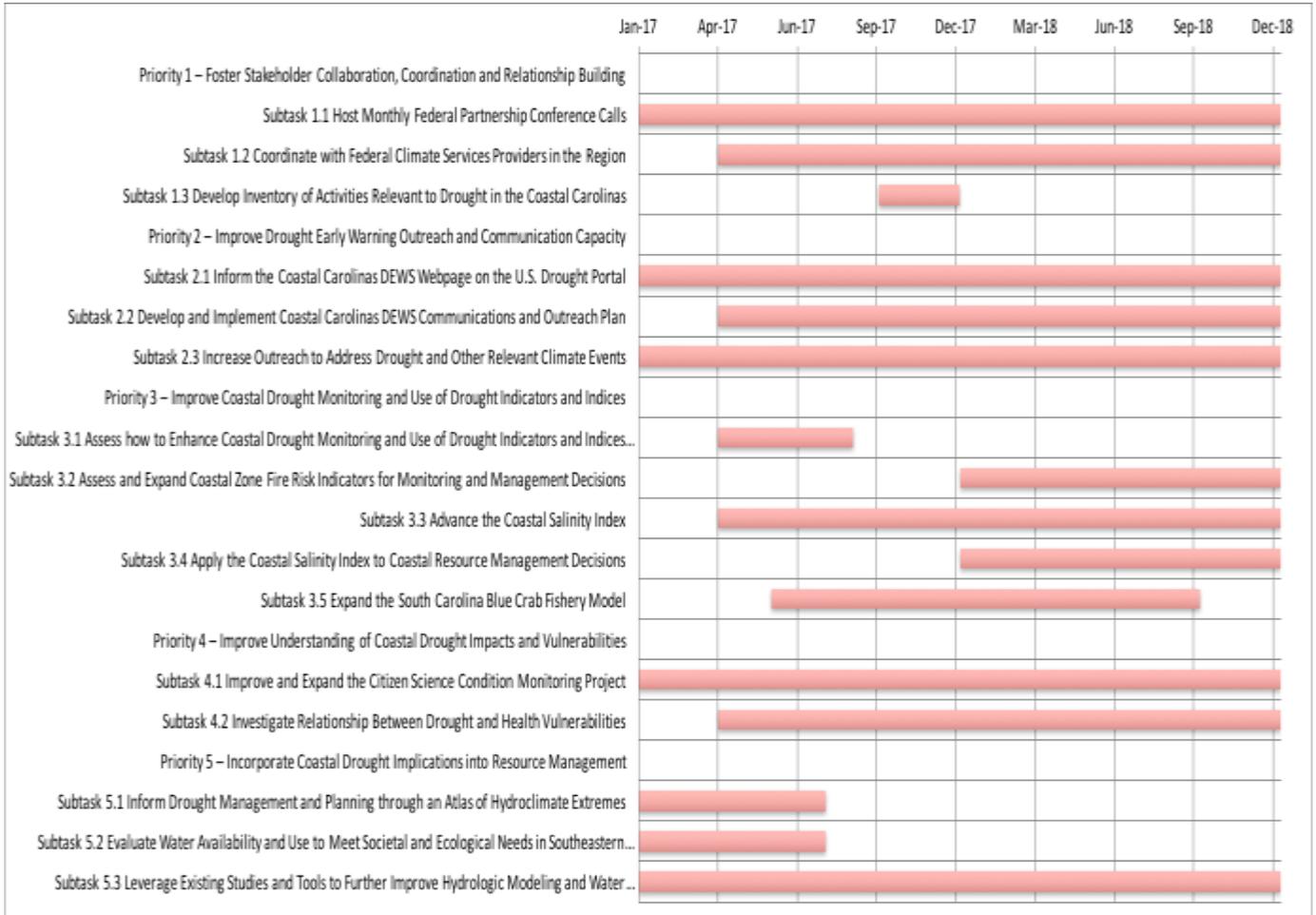
Activity 5.3 Outcomes

- Portfolio of tools used to address land, forest, and other resource manager questions. [Fall 2018 – Fall 2020]
- Report synthesizing project scope, methodologies, results, key findings, and next steps to inform resource management decision-making in the Coastal Carolinas DEWS. [Fall 2018 – Fall 2020]

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SCHEDULE

Coastal Carolinas DEWS Strategic Plan Milestones



APPENDIX A -- DEWS PARTNERS IN DEVELOPMENT OF THE STRATEGIC PLAN

The development and implementation of this Plan reflects the knowledge and experience of dedicated individuals, organizations, and partners. Collaboration is the key to improving drought early warning capacity and long-term resilience through implementation of the Coastal Carolinas DEWS. This list of partners is not exhaustive and will evolve as new regional partnerships are formed.

Table A – Partnerships

Partner Agencies and Organizations
Carolinas Integrated Sciences and Assessments
Clemson University
Environmental Protection Agency
National Drought Mitigation Center
National Oceanic and Atmospheric Administration
National Weather Service
National Center for Environmental Information
National Ocean Service
National Estuarine Research Reserves
Southeast Regional Climate Center
North Carolina Sea Grant
North Carolina Coastal Reserve
North Carolina Department of Health and Human Services
North Carolina Forest Service
North Carolina Sentinel Site Cooperative
North Carolina Water Resources Research Institute
State Climate Office of North Carolina
South Carolina Department of Natural Resources
South Carolina State Climatology Office
South Carolina Sea Grant Consortium
U.S. Department of Agriculture
Southeast Regional Climate Hub
U.S. Department of Interior
Southeast Climate Science Center
U.S. Geological Survey

APPENDIX B – NIDIS WORKING GROUPS

Coordination, communication, and transferability of information and actions between the NIDIS Working Groups and the Coastal Carolinas DEWS is essential the overall process of building a collaborative information system. The table below highlights how each of the priority activities in the Plan correspond with the individual Working Groups. As the Coastal Carolinas DEWS and Working Groups continue to develop, activities among Working Groups will be leveraged and coordinated.

Table B – Coastal Carolinas DEWS and NIDIS Working Groups

Activity	NIDIS Working Groups					
	Education and Public Awareness	Monitoring and Observations	Predictions and Forecasting	Interdisciplinary Research Applications for Risk Assessment	Planning and Preparedness	U.S. Drought Portal
Priority 1 – Foster Stakeholder Collaboration, Coordination and Relationship Building						
Activity 1.1 Host Monthly Federal Partnership Conference Calls					X	
Activity 1.1 Host Monthly Federal Partnership Conference Calls					X	
Activity 1.2 Coordinate with Federal Climate Services Providers in the Region					X	
Activity 1.3 Develop Matrix of Activities Relevant to Drought in the Coastal Carolinas					X	
Priority 2 – Improve Drought Early Warning Outreach and Communication Capacity						
Activity 2.1 Inform the Coastal Carolinas DEWS Webpage on the U.S. Drought Portal	X					X

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Activity 2.2 Develop and Implement Coastal Carolinas DEWS Communications and Outreach Plan	X	X	X	X	X	X
Activity 2.3 Increase Outreach to Address Drought and Other Relevant Climate Events	X	X	X		X	X
Priority 3 – Improve Coastal Drought Monitoring and Use of Drought Indicators and Indices						
Activity 3.1 Assess how to Enhance Coastal Drought Monitoring and Use of Drought Indicators and Indices in the Coastal Carolinas		X		X	X	
Activity 3.2 Assess and Expand Coastal Zone Fire Risk Indicators for Monitoring and Management Decisions		X		X		
Activity 3.3 Advance the Coastal Salinity Index		X	X	X		
Activity 3.4 Apply the Coastal Salinity Index to Coastal Resource Management Decisions		X		X	X	
Activity 3.5 Expand the South Carolina Blue Crab Fishery Model		X	X	X		
Priority 4 – Improve Understanding of Coastal Drought Impacts and Vulnerabilities						
Activity 4.1 Improve and Expand the Citizen Science Condition Monitoring Project		X				

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Activity 4.2 Investigate Relationship between Drought and Health Vulnerabilities		X			X	
Priority 5 – Incorporate Coastal Drought Implications into Resource Management						
Activity 5.1 Inform Drought Management and Planning through an Atlas of Hydroclimate Extremes	X				X	
Activity 5.2 Evaluate Water Availability and Use to Meet Societal and Ecological Needs in Southeastern Atlantic Coastal Basins of the Carolinas		X	X	X		
Activity 5.3 Leverage Existing Studies and Tools to Further Improve Hydrologic Modeling and Water Budget Estimates		X	X	X		

APPENDIX C - ACRONYMS

ACF	Apalachicola-Chattahoochee-Flint
CDC	Centers for Disease Control
CFWSC	Caribbean-Florida Water Science Center
CICS-NC	Institute for Climate Studies
CISA	Carolinas Integrated Science and Assessments
CoCoRaHS	Community Collaborative Rain, Hail and Snow
CSC	Climate Science Center
CSI	Coastal Salinity Index
DEWS	Drought Early Warning System
DMAC	Drought Management Advisory Council
DOI	Department of Interior
DSS	Decision support systems
EPA	Environmental Protection Agency
LMGWSC	Lower Mississippi Gulf Water Science Center
NERRS	National Estuarine Research Reserves
NC	North Carolina
NC DENR	North Carolina Department of Environment and Natural Resources
NC DHHS	North Carolina Health and Human Services
NDMC	National Drought Mitigation Center
NIDIS	National Integrated Drought Information System
NOAA	National Oceanic Atmospheric Administration
NOS	National Ocean Service
NPS	National Park Service
NWS	National Weather Service
OWI	USGS Office of Water Information
SA LCC	South Atlantic Landscape Conservation Cooperative
SAWSC	South Atlantic Water Science Center
SC	South Carolina
SCAN	Soil Climate Analysis Network
SCDNR	South Carolina Department of Natural Resources
SCO	State Climate Office
SCO NC	State Climate Office of North Carolina
SCDHEC	SC Department of Health and Environmental Control
SCDNR	SC Department of Natural Resources
SERCC	Southeast Regional Climate Center
SERCH	Southeast Regional Climate Hub
SPCMSC	St. Petersburg Coastal and Marine Science Center
U.S.	United States
USCRN	United States Climate Reference Network
USDA	United State Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
USNPS	U.S. National Park Service
WaSSI	Water Supply Stress Index Model