

# Drought and Coastal Ecosystems: The NIDIS DEWS Carolinas Pilot Program

Kirsten Lackstrom<sup>1</sup>

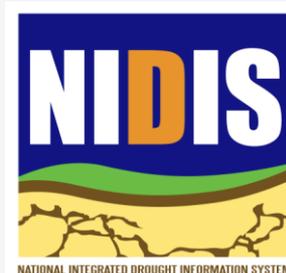
Amanda Brennan<sup>1</sup>, Lisa Darby<sup>2</sup>, Kirstin Dow<sup>1</sup>, Paul Conrads<sup>3</sup>

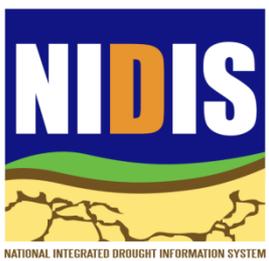
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<sup>3</sup>USGS, South Atlantic Water Science Center

Western States Drought Coordinators and Emergency Managers Meeting  
July 21-22, 2015





# Coastal Carolinas DEWS Pilot



- Drought is a significant stressor to coastal ecosystems, but
  - Ecological information is not integrated into drought monitoring and response, and
  - Drought/DEWS information is not integrated into coastal resource management



- “Ecological drought”
  - Water deficiency causing stress to plants, animals, ecosystems
- Drivers
  - Rainfall
  - Freshwater inflows
  - Tidal regimes

# CoCoRaHS Citizen Science Condition Monitoring Project

- Improve understanding of impacts
- Assess the usefulness of citizen science engagement as a means to monitor impacts and inform decisions
- Uses existing tools
- Sept 2013-June 2015
  - 47 volunteers
  - 1154 reports



**CoCoRaHS** COMMUNITY COLLABORATIVE RAIN, HAIL & SNOW NETWORK  
"Because every drop counts"

Home | States | View Data | Maps My Data Entry | Login

Welcome to CoCoRaHS! "Volunteers working together to measure precipitation across the nation."

**CoCoRaHS March Madness 2015**  
March 1-31, 2015  
How many new volunteers can you recruit in your state?

6,914 daily precipitation reports received today as of 3/12/2015 1:50 PM EDT

Daily Precipitation (inches x.xx)  
USA  
3/12/2015

0.0
Trace
0.00 - 0.31
0.32 - 0.62
0.63 - 1.55
1.56 - 3.73
3.74 - 5.60
5.61 - 6.23

**Main Menu**

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- Contact Us
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**Resources**

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- Hail Pad
- Distribution/Drop-off
- Help Needed
- Printable Forms
- The Catch
- Message of the Day
- Data Analysis
- CoCoRaHS Blog
- Web Groups

**JOIN COCORAHHS**

**TRAINING SLIDE-SHOWS**

**Things to know about...**

- Rain
- Hail
- Snow

# Regular Condition Monitoring

**Drought Impact Report Form**

**Station Number :** SC-RC-56  
**Station Name :** Columbia 0.5 NE

The significance of drought is tied directly to the impacts that it causes. Identifying and documenting impacts as they first appear and as they continue is essential for comprehensive drought monitoring. Please refer to the [CoCoRaHS training slide show](#) for reporting drought impacts.  
\* indicates required field

**Condition Monitoring**  
 Condition Monitoring Report

A **Condition Monitoring Report** allows a regular observer to describe normal conditions that are likely to change during drought, to create a basis for comparison. Please check Condition Monitoring Report if that's what you are submitting. If you aren't sure, please leave it unchecked. [More information on categories of drought impacts and reports.](#)

**Description**  
Please provide a description of how dry, normal or wet conditions are affecting you, your livelihood, your activities, etc. \*

**Report Categories**  
Please check at least one report category. If you check a category, please provide supporting information in the description. [More information on categories of drought impacts and condition monitoring reports.](#)

If an amount of money is associated with the impact, please consider providing that information in the box to the right of the category. Including a dollar amount means you agree to allow it to be used as a summary statistic.

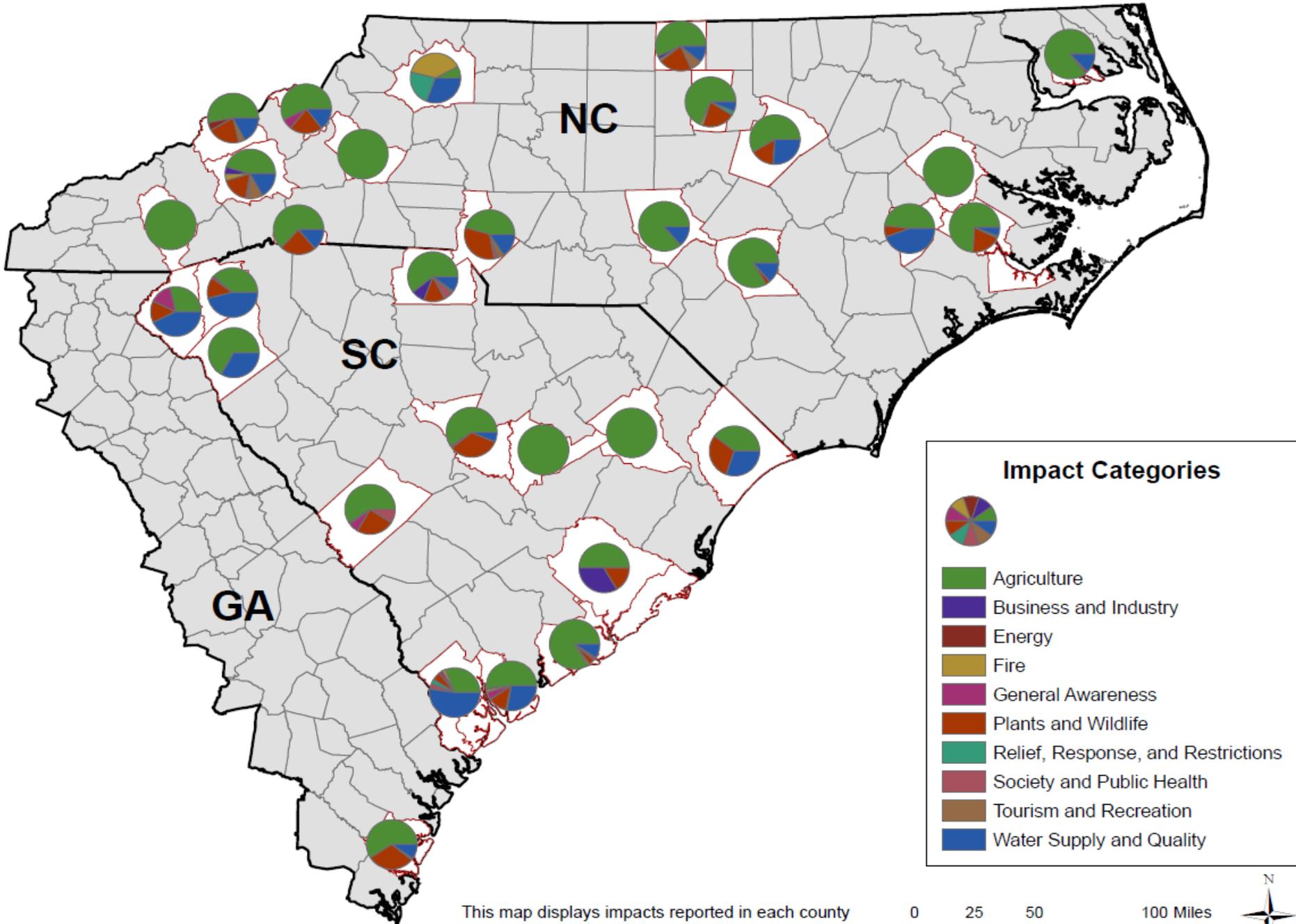
<input type="checkbox"/> Agriculture	\$	<input type="text"/>
<input type="checkbox"/> Business And Industry	\$	<input type="text"/>
<input type="checkbox"/> Energy	\$	<input type="text"/>
<input type="checkbox"/> Fire	\$	<input type="text"/>
<input type="checkbox"/> Plants And Wildlife	\$	<input type="text"/>
<input type="checkbox"/> Relief Response	\$	<input type="text"/>
<input type="checkbox"/> Society And Public Health	\$	<input type="text"/>
<input type="checkbox"/> Tourism And Recreation	\$	<input type="text"/>
<input type="checkbox"/> Water Supply And Quality	\$	<input type="text"/>

*“Dry dry dry! No significant precipitation since April 21 and above normal temperatures. Field crops are needing irrigation, and streams are well below normal levels. Tourists are enjoying the clear dry weather, tho hiking is dusty and sneezy! Pollinators are few and far between.”*

May 11, Buncombe County, NC

- All report content coded
  - Drought Impact Reporter categories
  - Weather, climate observations
  - Dry conditions
- Charts, graphs and maps created to aggregate and visualize coded content

# Coded Information by County



This map displays impacts reported in each county from September 2013 to November 2014.

# Evaluation Component

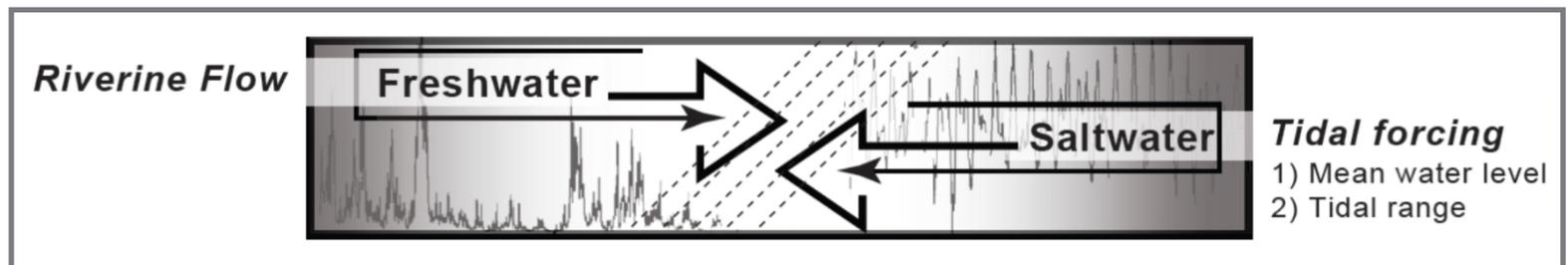
- Interviews with drought decision makers
  - Ongoing
- Value of reports
  - Provide context, early signs of drought
  - Verify quantitative indicators
- Usefulness, usability depends on:
  - Reliability of report(er)s
  - Spatial scale
  - Organizational context
  - Data aggregation
  - Drought conditions

*“We've been watching conditions quickly deteriorate in the western half of NC over the last few weeks and these have been invaluable sources of on-the-ground information. ... The wealth and detail of information in these reports is amazing.... Connecting the information in these reports with objective indicators such as streamflow levels or SPI really gives us a fuller picture of what's happening in parts of the state.”*

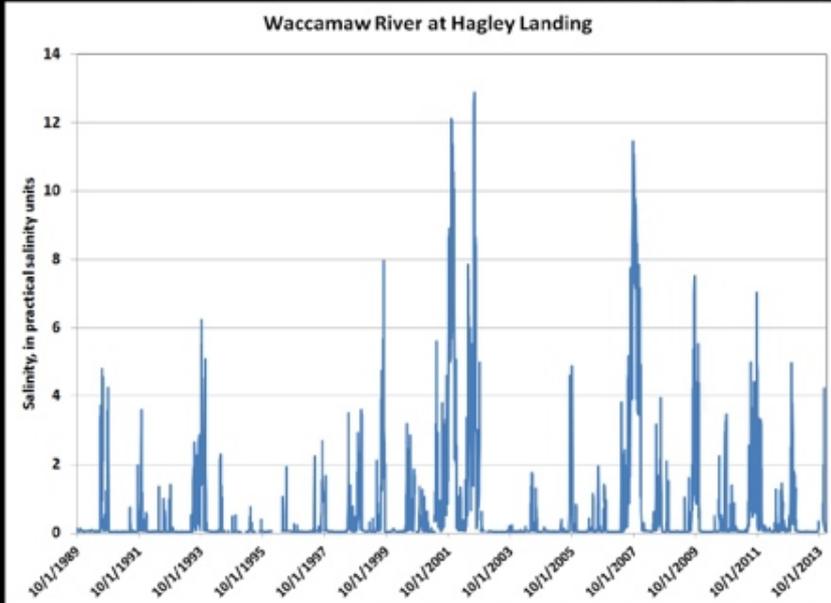
- NC Drought Management Advisory Council (NCDMAC) Representative ,  
April 8

# Coastal Drought Index (CDI)

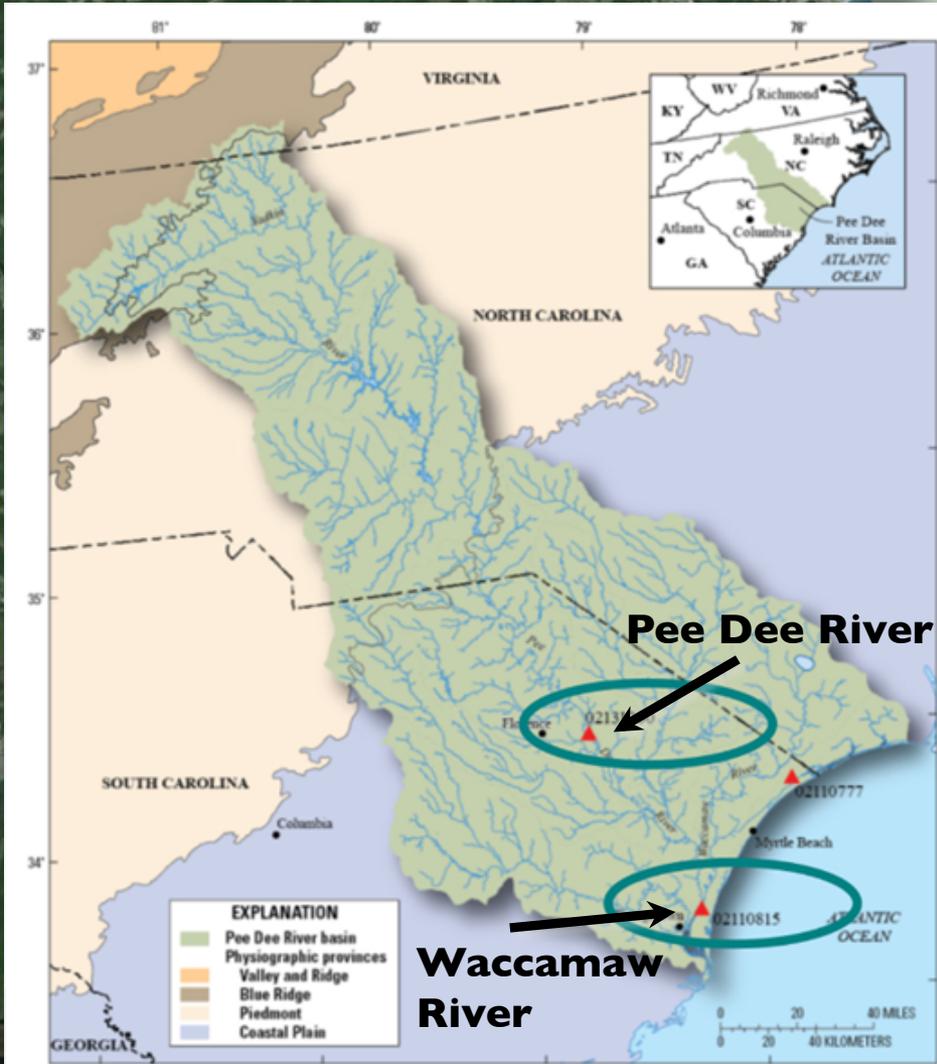
- Paul Conrads (lead)
  - USGS South Atlantic Water Science Center
- Salinity
  - Water utilities, refuge managers, fisheries
  - Freshwater-saltwater interface
  - Extremes (precipitation, streamflow, salinity)



# Can Salinity be Used as a Drought Index Variable?



Waccamaw River at Hagley Landing (02110815)  
 Long period of record  
 1989 to present  
 Daily mean salinity  
 ~8,000 data point



# Modify the Standardized Precipitation Index using Salinity for a Coastal Drought Index (CDI)

## Benefits:

- Computed for multiple time periods
  - 1-month, 3-month, - 6-month, etc.
  - Different time periods for different drought response variables
- Index for saltier *and* fresher conditions
- Real-time computation of the Coastal Drought Index

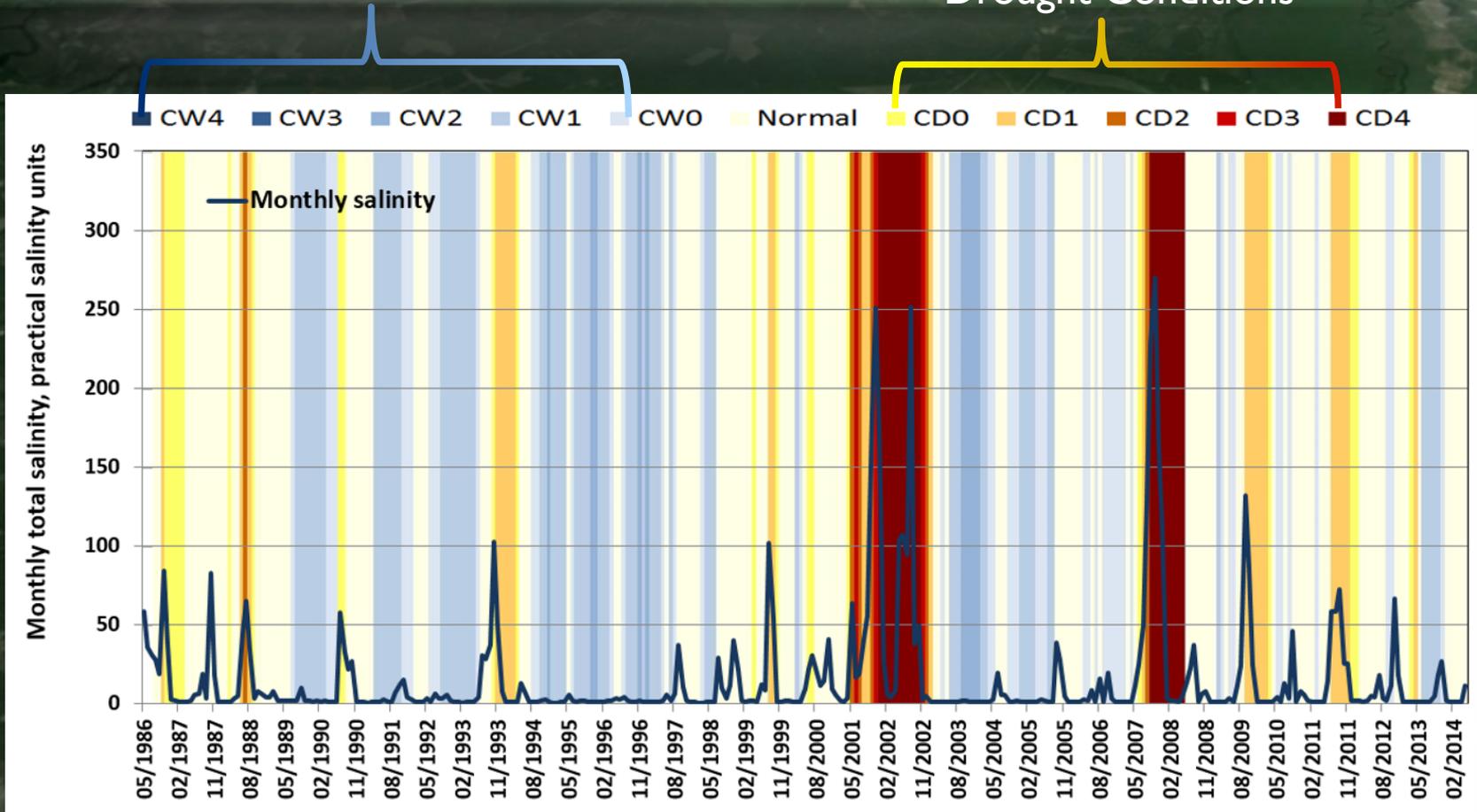
## Challenges:

- Number of long-term sites
- Missing records – estimating data gaps

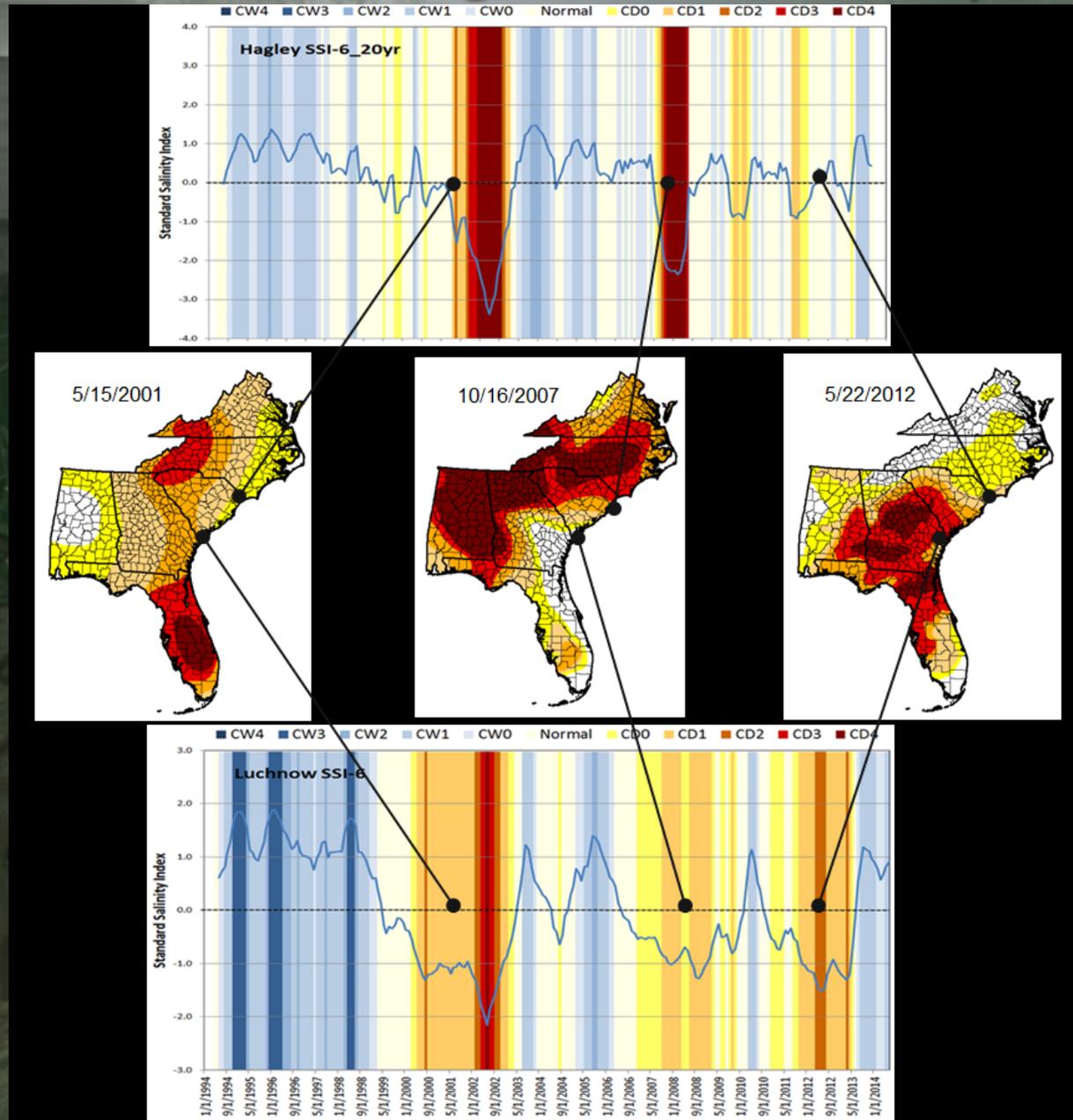
# 6-month CDI for Waccamaw River

Freshwater Conditions

Drought Conditions



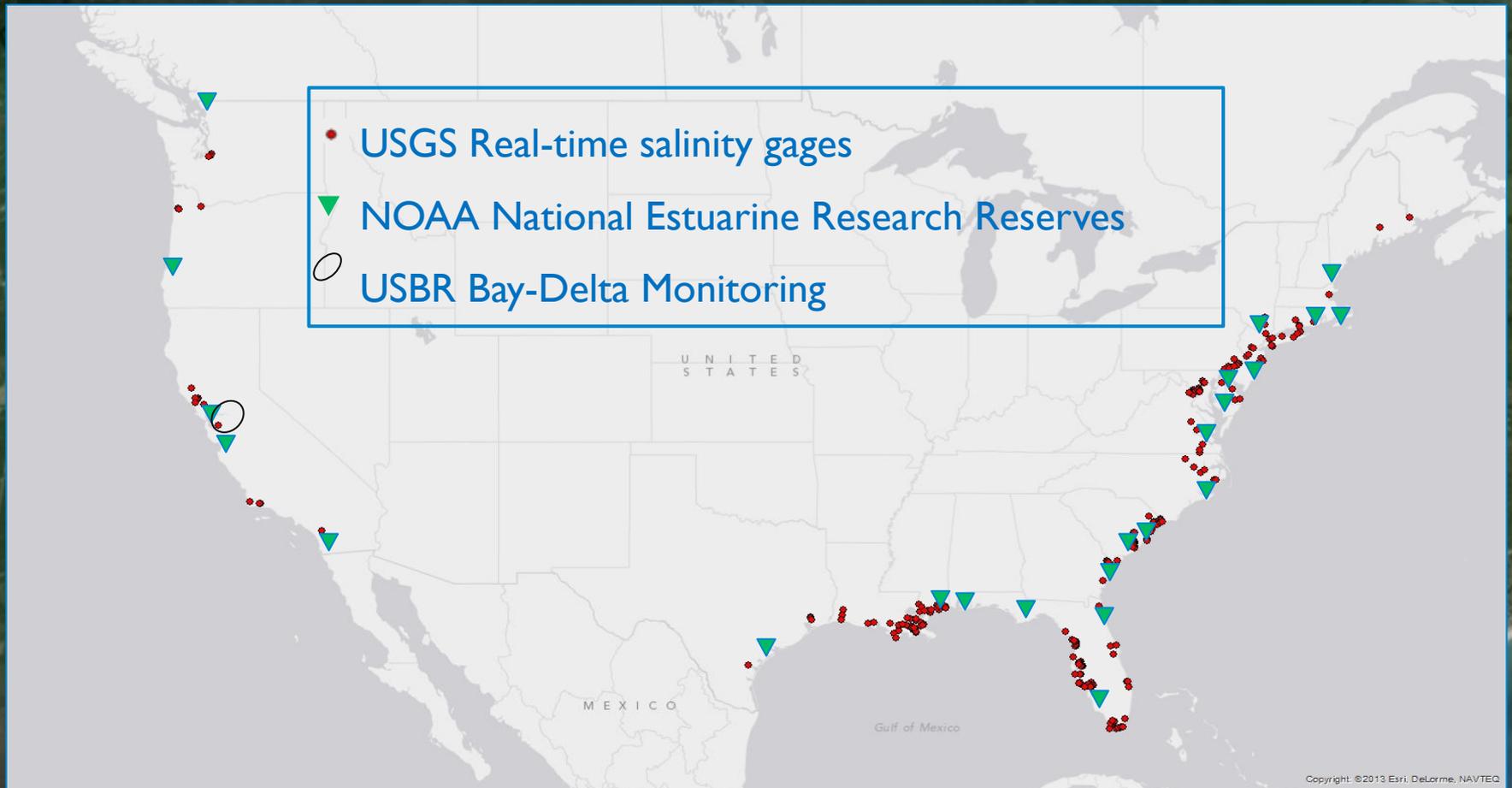
# Comparison with Drought Monitor Maps



# Next steps for the Coastal Drought Index (CDI)

- Real-time computation and dissemination
  - Operationalization
- Analyze the CDI with respect to coastal environmental response variables
  - Ecological indicators (NOAA SARP project)
  - *Vibrio*
  - Connect to resource managers and other decision makers
- Application to other locations

# Potential Real-time Data Sets for the Application of the CDI



For more information:

[http://www.drought.gov/drought/regional-programs/  
coastalcarolinas/coastal-carolinas-projects](http://www.drought.gov/drought/regional-programs/coastalcarolinas/coastal-carolinas-projects)

<http://www.cisa.sc.edu/coping.html>

CISA-CoCoRaHS Project webpage:  
[www.cisa.sc.edu/CoCoRaHS.html](http://www.cisa.sc.edu/CoCoRaHS.html)

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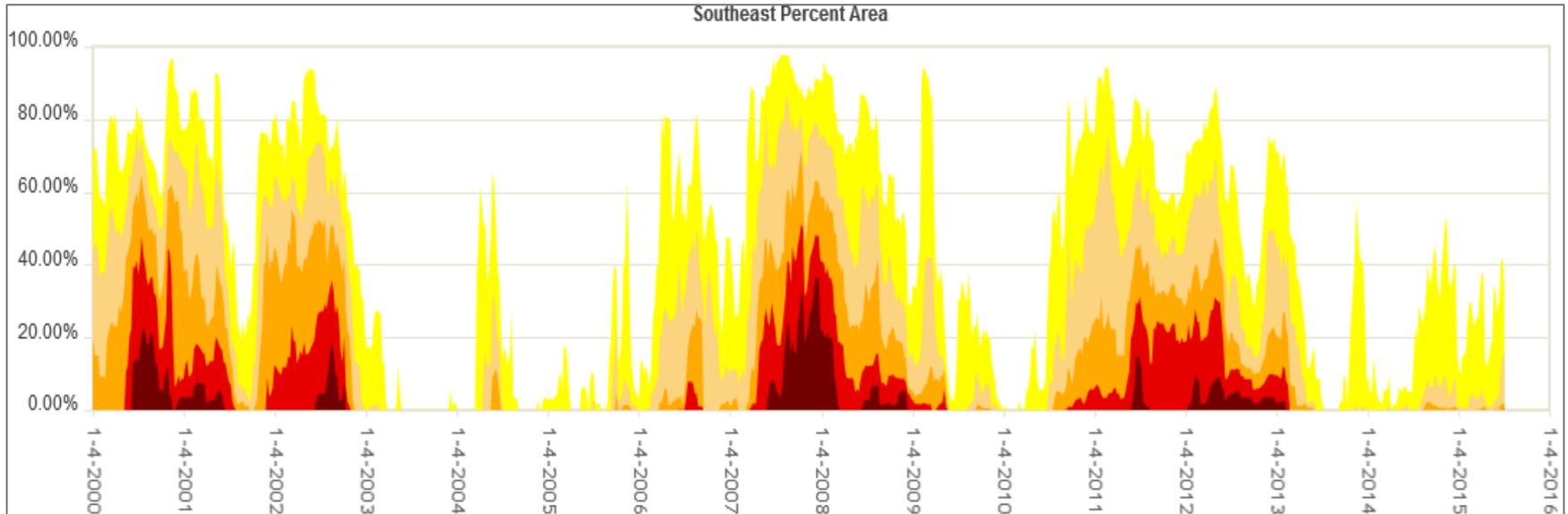
[Lackstro@mailbox.sc.edu](mailto:Lackstro@mailbox.sc.edu)

[www.cisa.sc.edu](http://www.cisa.sc.edu)



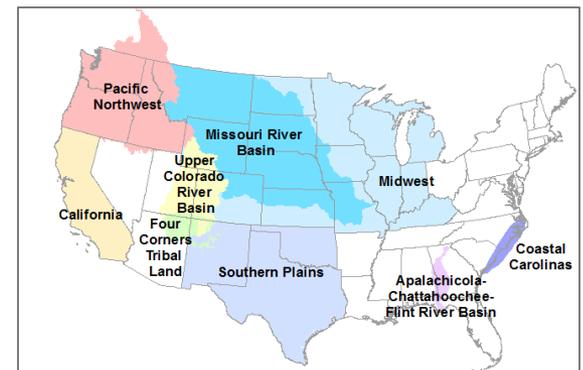
- Extra slides

# Drought in the Southeast



## Intensity:

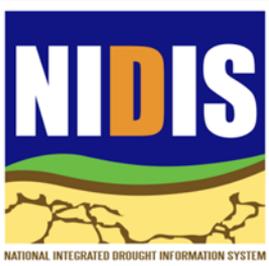
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought



Southeast U.S. (AL, FL, GA, NC, SC, VA)

Drought Conditions, Percent Area, 2000-present

Source: <http://droughtmonitor.unl.edu/MapsAndData/Graph.aspx>



# Coastal Carolinas DEWS Pilot Projects



Source: Dan Tufford

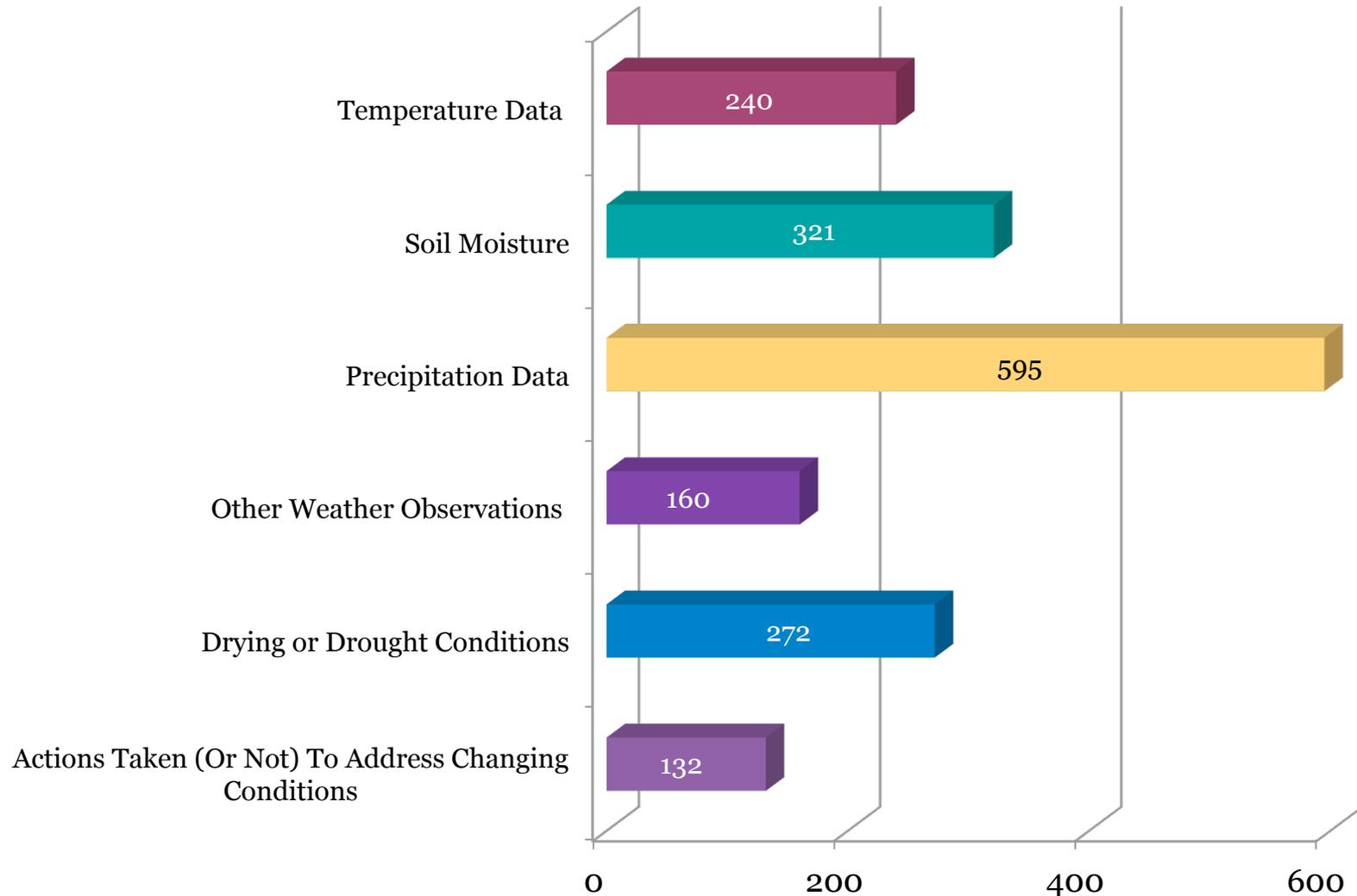


- Impacts
  - Onset and recovery
- Indicators and tools
  - Real-time salinity index
  - Ecological indicators of drought
  - Coastal zone fire risk (NC)
  - Blue crab fishery forecast (SC)
- Hydroclimate extremes atlas
  - Duration, frequency, intensity

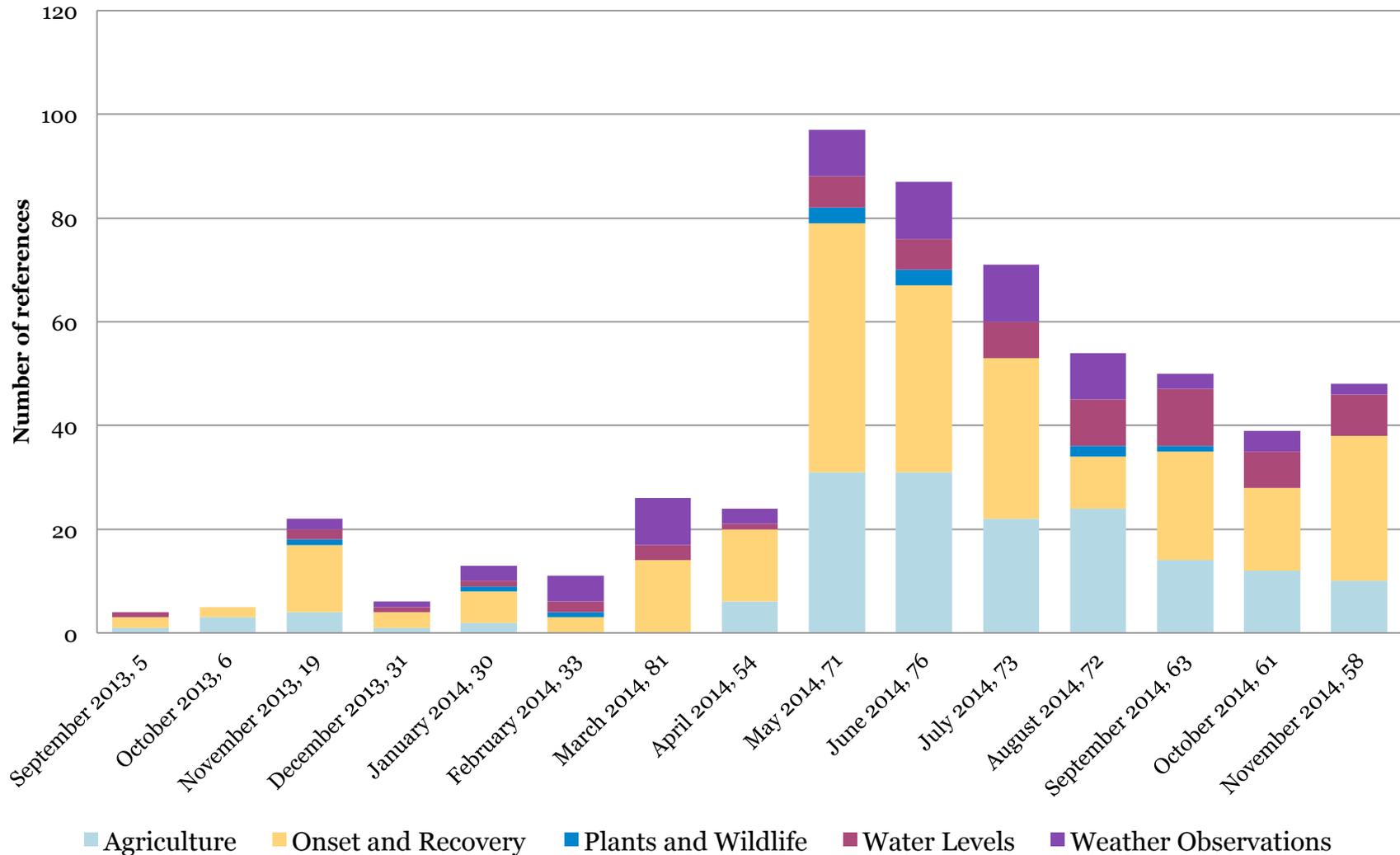
# NIDIS Coastal Carolinas projects

- Coastal drought index (CDI)
  - Based on USGS salinity and streamflow data
  - *Paul Conrads (USGS South Atlantic Water Science Center)*
- Indicators and indices of drought in southeastern coastal ecosystems
  - Work with refuge managers to characterize ecological drought
  - Relate ecosystem impacts to the CDI, develop triggers and thresholds
  - *Dan Tufford (CISA), David Chalcraft (East Carolina Univ.)*
- Assessment of drought indicators for coastal zone fire risk
  - Which drought index is the best indicator of fire risk in coastal organic soils?
  - *Ryan Boyles (NC State Climate Office)*
- Forecasting blue crab distributions using an individual-based population model (IBM)
  - Links freshwater discharge data with an IBM to forecast blue crab abundance and landings
  - *Michael Childress (Clemson University)*
- Atlas of Hydroclimate Extremes for the Carolinas
  - Baseline understanding, historical analysis of drought duration, frequency, intensity
  - *CISA team (USC, UNC-CH)*

# Other Report Content



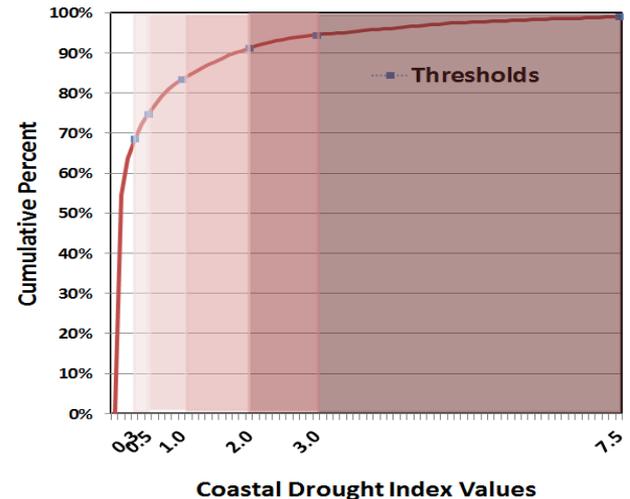
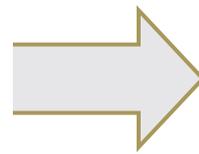
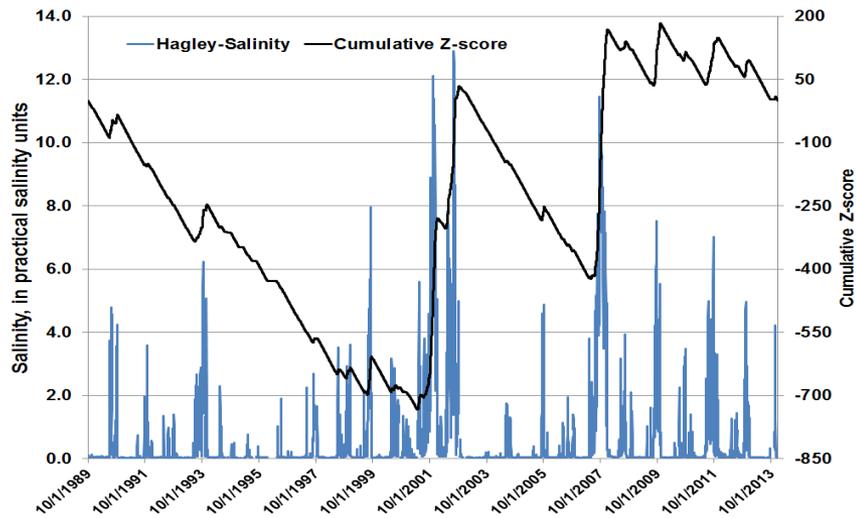
# References to Dry Conditions



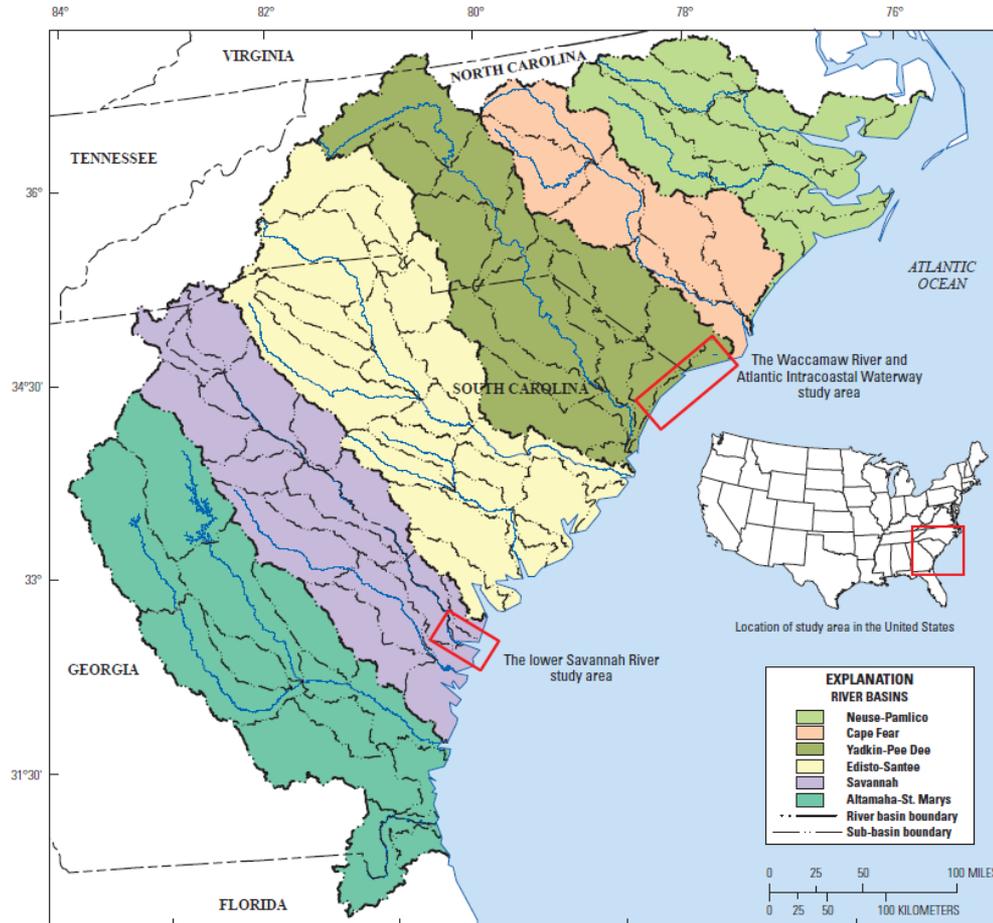
\* Numbers in x-axis labels indicate total number of reports submitted that month.

# Index Development Approach

1. Extract drought signal from the daily salinity time series
2. Compute frequency distribution
3. Use frequency distribution to set drought thresholds



# Regional Comparison



Base From ESRI® Data & Maps, 2009  
Hydrologic Unit Boundaries From US Department of Agriculture, 2009, 1:24,000  
Universal Transverse Mercator projection, NAD 83, Zone 17

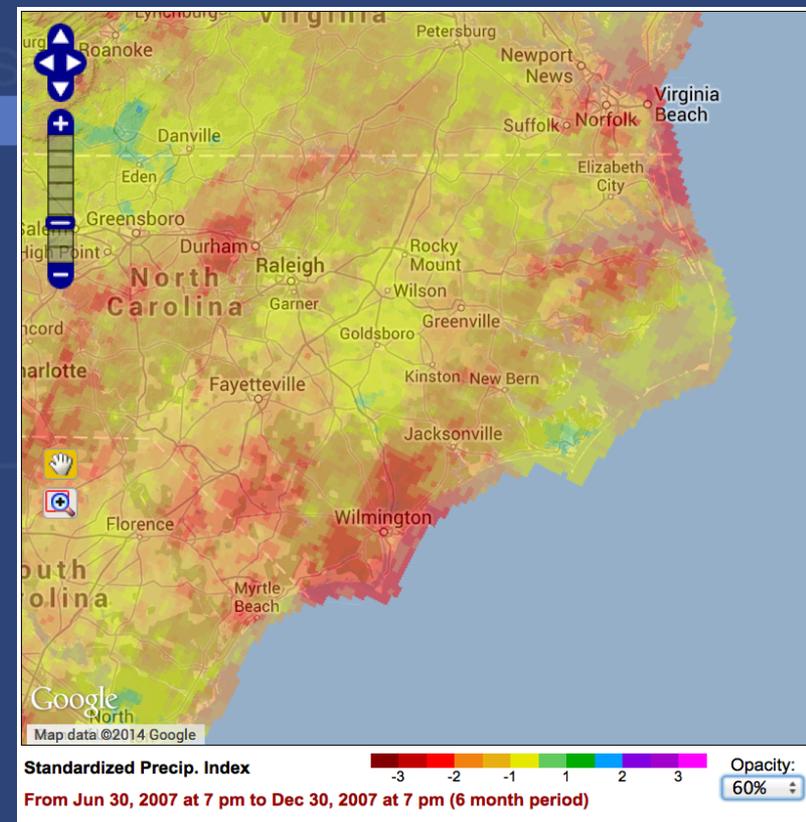
*Is the CDI a site-specific index or can it be used to make regional comparisons?*

In coastal organic soils, the soil itself burns under drought conditions.

Coastal land managers need to know “Which drought index is the best indicator of fire risk in coastal organic soils?” Previous work finds typical fire risk indicators don’t work well for these soils.

Recently, using radar-based MPE to produce drought indices.

Will compare MPE-based SPI, PDSI, SPEI, KBDI with fire event histories and multi-depth soil moisture probes in coastal organic soils.

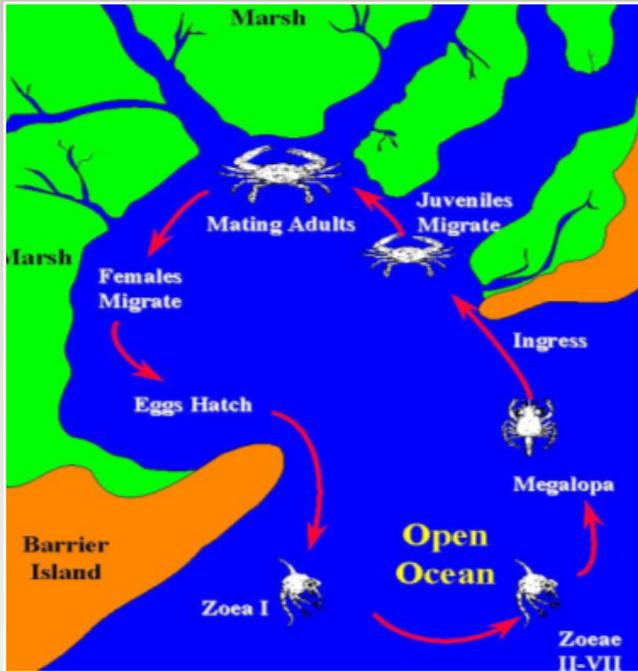


# Forecasting Blue Crab Distributions Using an Individual-Based Population Model

*Michael Childress (Clemson University)*

## Blue Crab

*Callinectes sapidus*



- Parameterize an individual-based population model of South Carolina blue crabs using empirical data from the ACE Basin NERR
- Link this IBM with real-time freshwater discharge data from the USGS to forecast future abundance, landings and economic value of blue crabs
- Distribute this forecast to fishermen, marine scientists and fisheries managers via web resources and social media

- Settlement = high salinity
- Maturation = low salinity
- Mating = low salinity
- Spawning = high salinity



Source: Michael Childress