Coastal Drought Monitoring Knowledge Assessment Workshop

USGS Real-Time Salinity Drought Index

Center for Coastal Environmental Health and Biomolecular Research
Charleston, SC

January 7, 2014

Executive summary

WORKSHOP AGENDA
9:00 AM
WELCOME, LOGISTICS, AND INTRODUCTIONS
GEOFF SCOTT (NOAA/CCEHBR), KIRSTIN DOW (CISA), AND LISA DARBY (NOAA/NIDIS)

PRESENTATIONS
9:20 AM
INTRODUCTION TO THE NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM (NIDIS)
LISA DARBY (NOAA/NIDIS)

9:40 AM
OVERVIEW OF THE NIDIS-CAROLINAS COASTAL ECOSYSTEMS DROUGHT EARLY WARNING PILOT
KIRSTIN DOW (CISA)

9:50 AM
CHALLENGES IN MONITORING COASTAL DROUGHT AND THE POTENTIAL FOR SALINITY INDICES
KIRSTEN LACKSTROM (CISA)

10:30 AM
OVERVIEW OF THE DEVELOPMENT OF THE USGS REAL-TIME SALINITY DROUGHT INDEX
PAUL CONRADS (USGS, SOUTH CAROLINA WATER SCIENCE CENTER)

EXAMPLE APPLICATIONS
11:00 AM
CONNECTING ECOLOGICAL LINKAGES TO THE USGS REAL-TIME SALINITY DROUGHT INDEX
DAN TUFFORD (CISA)

11:20 AM
HEALTH, WATER AND ENVIRONMENTAL QUALITY: THE IMPORTANCE OF REAL-TIME SALINITY DATA FOR VIBRIO MODELING AND OTHER ISSUES
GEOFF SCOTT (NOAA/CCEHBR)

11:40 AM
FORECASTING BLUE CRAB DISTRIBUTIONS USING AN INDIVIDUAL-BASED POPULATION MODEL
MICHAEL CHILDRESS (CLEMSON)

FACILITATED DISCUSSION
1:00 TO 2:30 PM
ROBERT WEBB (NOAA) - FACILITATOR

NEXT STEPS
2:30 TO 3:00 PM
LISA DARBY (NOAA) AND PAUL CONRADS (USGS)

The United States Geological Survey (USGS) is developing a new coastal drought index (CDI) based on real-time salinity and streamflow data, as part of the National Integrated Drought Information System (NIDIS) Carolinas Coastal Ecosystems Drought Early Warning Pilot. This new index is intended to provide critical site-specific information regarding occurrences of salt water intrusions when streamflows are low. The initial target audiences for the index are those who live and work along the Carolina coasts, but lessons learned in the development of this index should be transferable to other locations with real-time salinity and streamflow measurements.

The USGS and NIDIS held a workshop in Charleston, S.C. in January of 2014 to introduce the index to stakeholders and to obtain input about user needs for salinity information along the coast, to aid in the development of this tool.

Workshop goals

- ♦ Identify the challenges and opportunities to use salinity indices in monitoring coastal drought conditions and provide guidance to NIDIS on how to advance the use of salinity indices in managing coastal drought.
- ♦ Assess current coastal drought monitoring capabilities and develop recommendations for using salinity indices in coastal drought monitoring.
- ♦ Introduce to potential users a new USGS coastal drought index, currently under development. This new index will be based on real-time salinity measurements.
- ♦ Provide examples of how this coastal drought index may be used for the NIDIS Carolinas Coastal Ecosystems Drought Early Warning Pilot.
- ♦ Understand the relevance of drought and salinity issues for other agencies by identifying related activities, needs, and opportunities for future work.

Paul Conrads of the USGS South Carolina Water Science Center presented a preliminary CDI report. This CDI was based on a 60-day moving weighted average of salinity data combined with a 15-day time derivative of salinity measurements. His team computed a time series of the CDI values (daily values over 24 years) along with a frequency distribution of the values. The frequency distribution curve was then used to select thresholds to define coastal drought intensity levels. Thresholds were selected to define the frequency distribution curve with a limited number of points. Approximate CDI values were set for potential ecological changes, such as the shift of freshwater to brackish tidal marshes. Resulting CDI levels were plotted with the measured salinity for the period January 1, 2000 to December 31, 2012 (see Fig. 3 in the full report).

Choosing the appropriate CDI values as thresholds is an important part of the research supporting the development of this index, and is in the beginning stage. Dr. Dan Tufford of Carolinas Integrated Sciences & Assessments presented his team's proposal for linking the CDI to ecological impacts. He plans a needs assessment focused on coastal ecological resources, leading to an understanding of drought concerns, sensitivities, and triggers and thresholds for decision-making.

Presentations about potential uses of a CDI based on real-time salinity measurements rounded out the workshop, with Drs. Geoff Scott (Center for Coastal Environmental Health and Biomolecular Research) and Michael Childress (Clemson University) highlighting the importance of salinity information related to shellfish health.

Next steps include (1) USGS performing additional analyses of available measurements to guide the selection of the best sites to prototype the index and (2) NIDIS assisting in establishing collaborations with the National Estuarine Research Reserve system.

Fifteen experts (14 of whom attended the workshop) have volunteered to be a part of an advisory board to aid the USGS in refining the CDI.

Meeting summary

Introduction to the workshop

After a brief welcome to the Center for Coastal Environmental Health and Biomolecular Research (CCEHBR) from the Director, Geoff Scott, Lisa Darby of NIDIS presented some background about the National Integrated Drought Information System's (NIDIS) purpose, highlighted NIDIS activities in 2013, and reviewed workshop goals.

Presentations

Overview of the NIDIS-Carolinas Coastal Ecosystems Drought Early Warning Pilot

KIRSTIN DOW, CISA

Kirstin Dow of the Carolinas Sciences & Assessments (CISA) set the stage for the salinity index workshop by giving some background on the NIDIS pilot drought early warning system (DEWS) in the coastal Carolinas.

In the spring of 2010, CISA began to identify needs for a pilot DEWS for both North and South Carolina. They organized two stakeholder workshops to identify DEWS needs and produced two informative reports. One report focused on drought and water issues for urban water systems in North Carolina, and the other report covered drought impacts and stresses on coastal ecosystems. (Both assessment reports are available on the CISA website: http://www.cisa.sc.edu/resourcesReports.html.)

Based on the findings of the two stakeholder workshops, CISA performed additional investigations into the issues of drought in coastal ecosystems by producing a State of Knowledge Report, The Impact of Drought on Coastal Ecosystems in the Carolinas (Gilbert et al., 2012), which can also be found on the CISA reports page. This report outlines what we know and what we do not know about drought in coastal ecosystems, along with recommendations for future research needs.

After considering what was heard at the stakeholder meetings regarding drought information needs in the Carolinas, and our general lack of knowledge regarding drought in coastal ecosystems, it was decided that the NIDIS DEWS would focus on coastal ecosystems in the Carolinas. This is a departure from other NIDIS pilots in that we are not focusing on a single river basin, but on a special category of drought impacts and issues.

To kick off the Carolinas Coastal Ecosystems Pilot, a stakeholder meeting was held in Wilmington, N.C. in summer 2012, and four potential pilot project topics were identified:

- Evaluation of Drought Indicators & Indices
- Public Health & Water Quality
- Drought Forecasts & Communications
- Drought Impacts Reporting

A FULL SUMMARY OF THIS WORKSHOP CAN ALSO BE FOUND ON THE CISA REPORTS PAGE: HTTP://WWW.CISA.SC.EDU/RESOURCESREPORTS.HTML

Challenges in Monitoring Coastal Drought and the Potential for Salinity Indices

KIRSTEN LACKSTROM, CISA

Kirsten Lackstrom talked about the challenges and opportunities for drought monitoring in coastal ecosystems, including CISA's work in improving the collection of drought impact information through a citizen science effort they are leading for the pilot Carolinas Coastal Ecosystems DEWS.

Drought impact reporting challenges include:

Limited understanding

- Drought is difficult to measure spatially (area affected) and temporally (onset and recovery)
- There is no unified roster or database of drought events or losses
- Data about the full range of impacts for many sectors and regions does not exist

Drought impact reporting opportunities include:

- Connecting drought impacts and drought indicators. Particular sectors use specific indices:
  > Agriculture (PDSI, CMI)
  > Hydrology, water supply (streamflows, SPI, SWSI)
  >Fire (KBDI)

The success of the work presented at this workshop depends on linking drought impacts with the new salinity index. This work provides an opportunity to define drought for coastal ecosystems by considering:

- Drivers: Precipitation, freshwater inflows, sea level, water management
- Key stressor/indicator: salinity, movement of the saltwater-freshwater interface
- Opportunity to use data from existing USGS (and other agency) specific conductance/salinity gages

Opportunities also include the discovery that many groups or sectors have found that salinity information is important to them.

- Salinity is a shared concern among many stakeholders, agencies, organizations
  > Management plans and assessments, e.g., North Carolina ecological flows report, Albemarle-Pamlico National Estuary Partnership (APNEP) Comprehensive Conservation and Management Plan
  > Local decision makers, resource users and managers: Lessons learned from CISA stakeholder interviews will inform the pilot DEWS
  > Researchers, academic community
- Challenges
  > Fostering connections between groups
  > Integration with drought management activities
- Priorities discussed at previous NIDIS-Carolinas workshops
  > Identify which variables, thresholds, and impacts are most important to monitor and assess (e.g. chemical, physical, biological, socio-economic)
  > Determine appropriate temporal- and spatial-scales
- Existing monitoring programs –some examples:
  > Long Term Ecological Research (LTER) Network
  > National Estuarine Research Reserve System

> National Estuary Program
> National Park Service Inventory & Monitoring Program
> National Wildlife Refuge System Inventory & Monitoring Initiative

♦ Transferability to other sectors and regions: Public health, recreation and tourism, water infrastructure

Through a series of interviews performed by CISA staff, it was found that while people along the coast are concerned about drought, they prefer to use their own local knowledge over standard, more formalized, drought information, such as standard drought indices.

Overview of the Development of the USGS Real-time Salinity Drought Index

PAUL CONRADS, USGS, SOUTH CAROLINA WATER SCIENCE CENTER

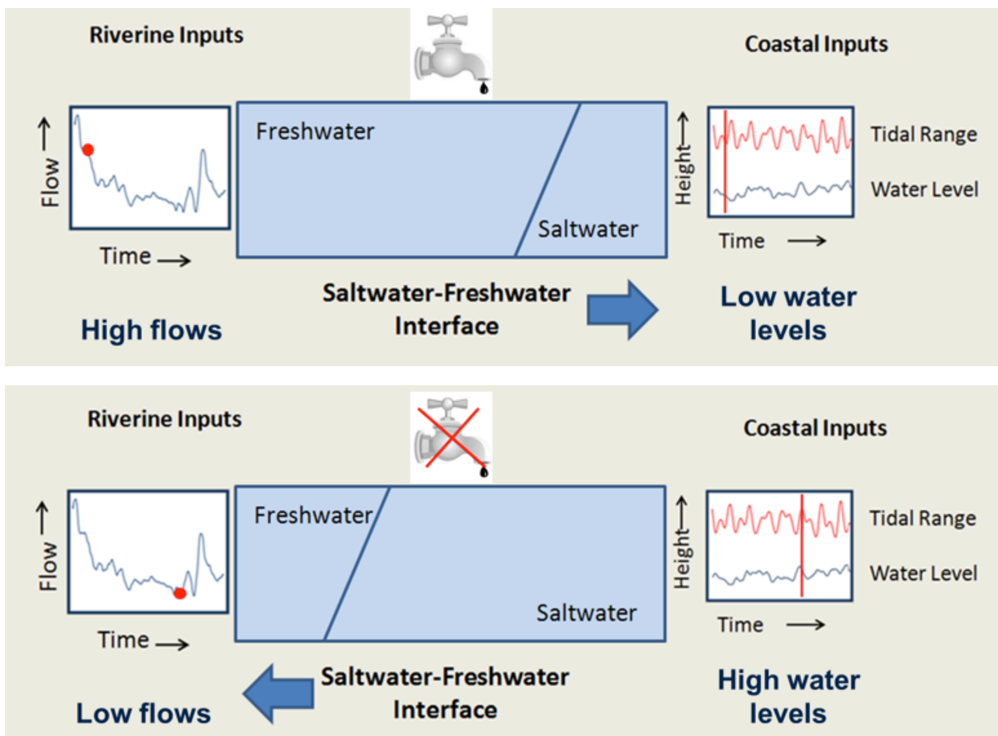


FIGURE 1
SALTWATER-FRESHWATER INTERFACE. HIGH FLOW (TOP PLOT) AND LOW COASTAL INPUTS VS. LOW FLOW (BOTTOM PLOT) AND HIGH COASTAL INPUTS.

Paul Conrads introduced his preliminary work on the new Coastal Drought Index (CDI), which is based on real-time USGS salinity data. Paul first reviewed the saltwater-freshwater interface, demonstrating that as low river flows develop due to drought, saltwater from the ocean intrudes inland (Fig. 1). Paul also made the point that estuaries are never steady-state and are constantly bombarded with changing streamflow and coastal water-level conditions, complicating our ability to assess their health and status. To further complicate matters, the response of ecology of an estuary to changing conditions may be delayed by days, months, or years.

To give some background on how river flow and salinity relate to each other, Paul presented a time-series plot that shows river flow, salinity and U.S. Drought Monitor categories averaged over the Yadkin-Pee Dee River Basin (Fig. 2). Note how the peaks in salinity align with low river flow and the extreme (D3) or exceptional (D4) drought categories of the U.S. Drought Monitor.

USGS Real-Time Salinity Drought Index

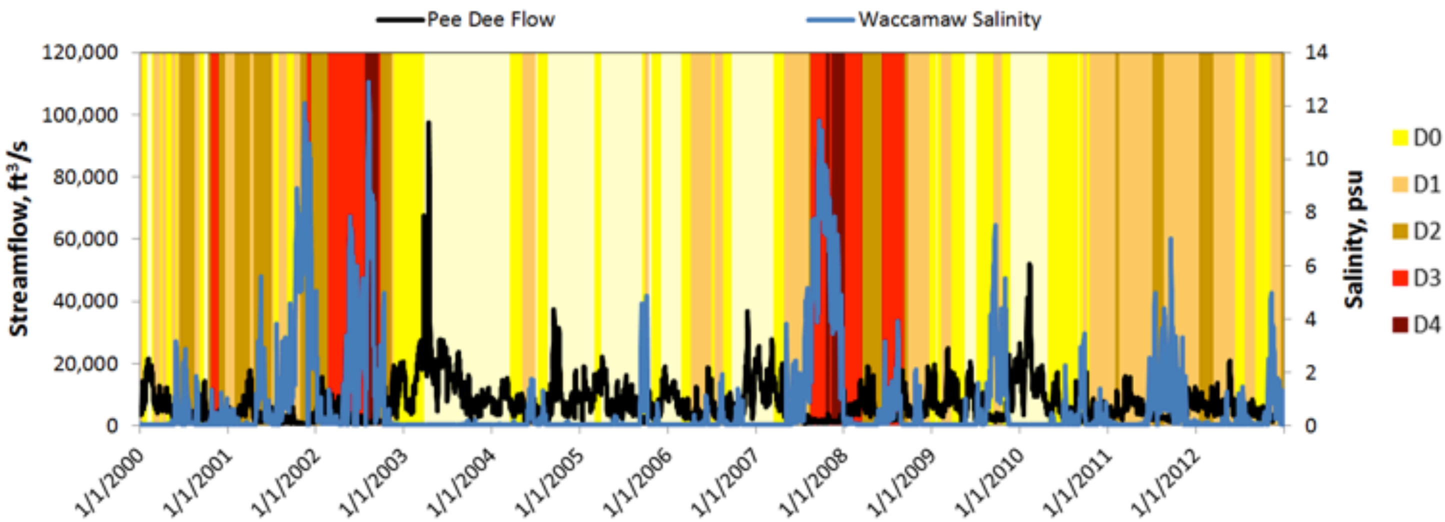


FIGURE 2
STREAMFLOW, SALINITY AND U.S. DROUGHT MONITOR CATEGORIES AVERAGED OVER THE YADKIN-PEE DEE RIVER BASIN.

Before delving into the nuts and bolts of his preliminary calculations on the new Coastal Drought Index, Paul reviewed some basics about drought indices. He listed the following criteria for a drought index, along with considerations for the new salinity index:

- ♦ Appropriate time scale for the problem
  - > Responses to salinity changes – there are multiple time scales
  - > Short-term impacts (e.g., municipal water intake, pathogen transport) vs. long-term impacts (e.g., tidal marsh conversion)
- ♦ Quantitative measure of large-scale long-continuing conditions: Limited studies/data on ecological response to coastal drought
- ♦ Applicable to the problem: Importance of the saltwater/freshwater interface position
- ♦ Historical data for computation: Long-term data records available
- ♦ Computable on a near-real time basis: Many real-time salinity gaging sites (taken from Friedman 1957 and Heim 2002)

Other considerations include

- ♦ Will the index be a generalized regional index or a site-specific index?
- ♦ The need to account for different estuary types, such as tidal sloughs or tidal rivers
- ♦ Regulated vs. unregulated rivers (regulation does have an impact on salinity)
- ♦ Choosing the appropriate temporal scale

In our case, the newly developed index will be a site-specific index and will need to be correlated with local environmental responses

- ♦ Differentiating aspects of the salinity signal: Periodic, episodic, chronic:
- ♦ Index classes clearly defined: Correlate to environmental response
- ♦ Physics of the index is understandable
- ♦ Real-time computation of coastal drought index

Paul then ran through possible mathematical methods for computing a coastal drought index, and showed example calculations, including:

- ♦ Running averages and percentiles

- Single mass curves
- Cumulative Z-scores
- Time derivatives

For his preliminary Coastal Drought Index (CDI), Paul chose to work with a combination of average salinity and a time derivative:

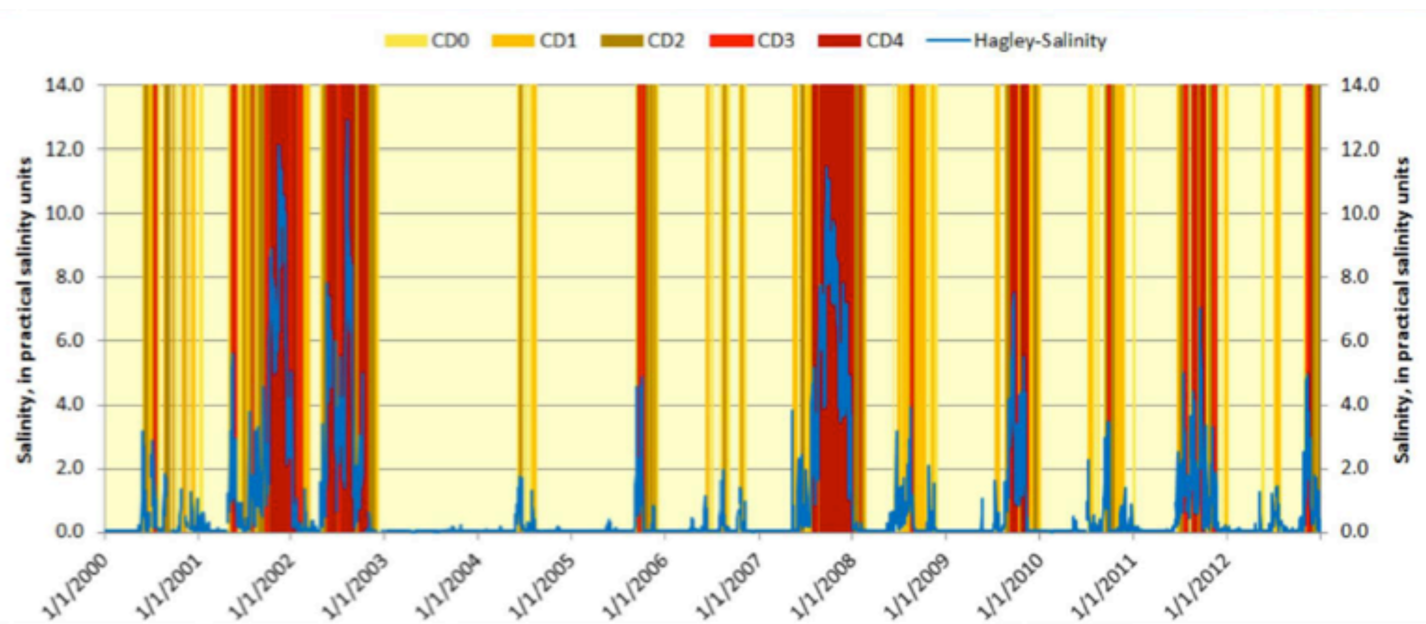
- 60-day moving weighted average salinity + 15-day time derivative
  - > Note that the use of a moving average introduces a time scale into the analysis.
  - > Using a time derivative provides information about both the beginning and ending of a drought period, both of which are difficult to determine in many instances.
- Compute frequency distribution of the CDI values
- Choose threshold values from the distribution

The selection of the threshold values for the index will involve some research, and is a large component of the development of this index, such as relating the salinity values to ecological impacts (addressed in the next presentation by Dan Tufford). However, Paul did present a preliminary prototype CDI where he computed a time series of the index (daily values for 24 years) and then computed a frequency distribution of CDI values. The frequency distribution curve was then used to select thresholds to define the coastal drought levels. The thresholds were selected to define the frequency distribution curve with a limited number of points and setting points at approximate values where there are potential ecological changes (such as the shift of freshwater to brackish tidal marshes). The resulting CDI levels were plotted with the measured salinity for the period January 1, 2000 to December 31, 2012 (fig. 3).

Final thoughts on the preliminary CDI:

- CDI can refine timing issues of upstream U.S. Drought Monitor changes (compare figures 2 and 3)

FIGURE 3
EXAMPLE PRELIMINARY COASTAL DROUGHT INDEX (COLORS) WITH SALINITY MEASUREMENTS SUPERIMPOSED.



- ♦ Time derivatives can address onset and recession of drought timing
- ♦ Include elements from other analyses, for example, cumulative Z-scores
- ♦ Cascade computation with logic statements
- ♦ Determine the best way to handle missing data

Linkages to the USGS Real-time Salinity Drought Index

DAN TUFFORD, CISA

There are two phases to this project:

- ♦ Needs assessment: Dave Chalcraft – East Carolina University
- ♦ Salinity index development and test: Dan Tufford – University of South Carolina and Paul Conrads – USGS South Carolinas Water Science Center

As mentioned previously, relating the new Coastal Drought Index to drought impacts, including environmental responses to drought conditions, is key to the success of this new index. Dan's project will be a major effort in establishing thresholds for the index.

Dan also made the point that high salinity values near the coast can create upland stresses and impacts, not just aquatic problems.

The needs assessment phase of this work will cover a broad assessment of coastal ecological resources (aquatic and upland, including inland to the extent of tidal freshwater). There will be structured interviews of local stakeholders. The study will evaluate ecological drought concerns and sensitivities, and seek to understand triggers and thresholds. The study will include existing or new indices.

In the process of linking the new Coastal Drought Index to ecological impacts or outcomes, the PIs will work with National Wildlife Refuges (NWR), National Estuarine Research Reserves (NERRs), and the CCEHBR, looking for acute and long-term changes.

Salinity effects that will be assessed include seasonal stress, ecosystem conversion and range expansion, and freshwater intakes.

Beyond the needs assessments and stakeholder interviews, Dan's project will also support adaptation planning for resource managers, with the Waccamaw NWR, Savannah NWR, North Inlet/Winyah Bay NERR, and the SC Nature Conservancy as potential partners. A risk assessment in response to increased health risks will take place, and future climate scenarios will be incorporated into the adaptation planning.

Example Applications for a real-time salinity index

Ecological and Human Health Threats Related to Drought in Coastal Ecosystems

GEOFF SCOTT, CCEHBR

Health impacts of drought include (CDC, 2010):

- ♦ Compromised water quantity and quality (e.g. increased effluent dominated streams)
- ♦ Compromised food and nutrition
- ♦ Compromised air quality (increased particulates, Harmful Algal Blooms [HABs])
- ♦ Diminished living conditions (temperature)
- ♦ Increased recreational risks (e.g. Naegleria fowleri)
- ♦ Increased disease incidence for infectious (e.g. E. coli & Salmonella), chronic (e.g. asthma) and vector-borne/zoonotic disease

The impacts of upstream drought and water withdrawals on the health and survival of downstream estuarine oyster populations can be harmful, for instance, in Apalachicola Bay (Petes et al., 2012). In particular,

- ♦ Increased salinity
- ♦ Increased temperature
- ♦ Altered pH
- ♦ Increased periods of dry deposition and pollution loading when it does rain

Geoff also discussed how climate change could affect estuaries, including salinity increases due to sea-level rise. Biota do respond to increases in water temperature and salinity (among other variables), bringing potential risks to seafood safety through reduced water quality (altered microbes and HABs) and quantity.

For instance…

Vibrios and Climate Change

- ♦ Several Vibrio species (including V. cholerae, V. parahaemolyticus, and V. vulnificus) occur naturally and ubiquitously in U.S. coastal waters
- ♦ Increasing prevalence of Vibrios associated with warmer waters have been noted in Northern Atlantic waters, including occurrences of V. vulnificus, and in the Pacific NW.
- ♦ Most alarming example: 2004 shellfish-associated outbreak of V. parahaemolyticus in Prince William Sound, Alaska, where it had never been found before and waters were thought to be too cold to sustain it. Clearly associated with warmer waters and impacted 62 people. Also appeared to be more virulent.

Vibrio Infections in the U.S.

- ♦ Between 1996 and 2001, the incidence of Vibrio infections increased by more than 80%.
- ♦ More importantly, despite a significant decline (30-45%) in the incidence of most bacterial foodborne infections in the United States in 2004, the incidence of Vibrio infections increased by 47% over the baseline period of 2001-2002.
- ♦ The CDC estimates that 8000 Vibrio infections and approximately 60 deaths related to Vibrio infections may occur annually in the United States.
- ♦ Vibrio infections are acquired through consumption of contaminated raw or undercooked shellfish such as oysters, clams, mussels, or crabs.
- ♦ Exposure of wounds to contaminated sea water, injury caused by contaminated seashells, and shark and alligator bites are potential alternative sources of infection.

Eutrophication/HAB problems in North Carolina and surrounding areas

- ♦ Estimated restoration costs for Falls Lake Reservoir - >$200M
- ♦ Similar problems - Neuse, Yadkins & other NC watersheds
- ♦ Restoration cost Chesapeake Bay - > $1-3 Billion

Conclusions – Ecosystem impacts of drought:

- ♦ Increased temperature and salinity and altered pH may affect the survival of marine organisms
- ♦ Altered water delivery and increased pollution loading during subsequent rain events due to increased dry deposition period

- ♦ Increased amount of effluent dominated streams during drought may increase pollution loads
- ♦ Interactions of pollution, temperature, salinity and pH
- ♦ Altered degradation rates and partitioning of pollutants during drought
- ♦ These altered ecosystem conditions may enhance microbes and increase HAB events

Drought and human health

- ♦ Increased microbial and HAB threats during drought may affect drinking water safety, food quality and reduce recreational activities
- ♦ The linkages between climate change including drought and shifting patterns of health threats and outcomes are complicated by factors such as wealth, distribution of income, status of public health infrastructure, provision of preventive and acute medical care, and access to and appropriate use of health care information.
- ♦ The severity of future health impacts will be influenced by adaptive strategies to limit and adapt to climate change.

Access to real-time salinity data, calibrated to ecosystem impacts, is needed for modeling studies that can provide people with important information regarding water quality and seafood safety during times of drought and post-drought heavy rainfall events.

Forecasting Blue Crab Distributions using an Individual-based Population Model

MICHAEL CHILDRESS, CLEMSON UNIVERSITY

South Carolina crab landings (i.e., pounds harvested) have declined by 40% since 1998

- ♦ The steepest decline corresponded to the extended drought period from 1999- 2002
- ♦ Overall landings are positively related to freshwater discharge

The life-cycle for blue crabs is linked to salinity levels:

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

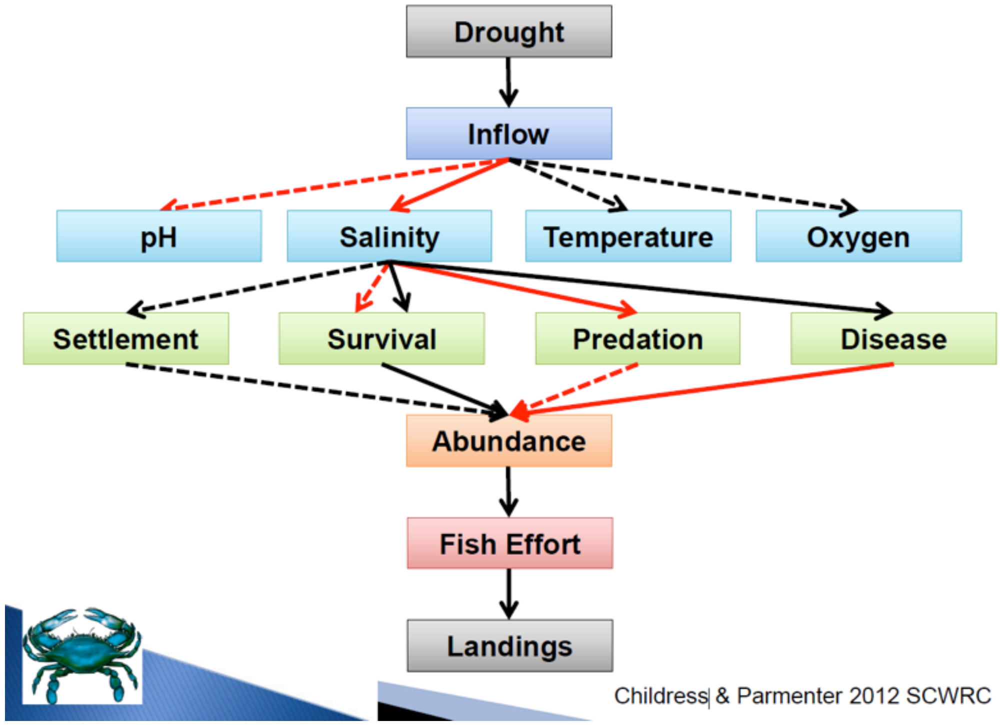
Objectives of Michael's study

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

Important model variables include (Fig. 4):

- ♦ Temperature and dissolved oxygen
- ♦ Temperature sine curve from ACE NERR data @ St. Pierre Creek
- ♦ Dissolved oxygen calculated based on temperature – DO relationship

FIGURE 4
KEY VARIABLES IN THE BLUE CRAB MODEL



- Added correction factor by river

Discharge and salinity

- Discharge sine curve from USGS station 02175000 – Givhans Ferry, Edisto River
- Corrected by monthly deviation from historical mean discharge
- Multiplied by logistic curve to represent spatial salinity gradient

Michael has completed modeling studies for the Combahee, Ashepoo, and Edisto Rivers.

- Model captures the drought of '99 -'02
- Model population declines during drought
- Model population high during summer when flow is low
- Negative correlation between crab number and flow

Modeled blue crab landings vs. actual blue crab landings in South Carolina

- Model forecasts steep decline during '99 - '02 drought
- Model fails to forecast increased landings '10 -'12
- Model predicts 25.8% of observed landing variation. This is twice the predictive power of using river discharge alone

Conclusions:

- Crab landings are positively correlated with river discharge
- River discharge is negatively correlated with marsh salinity
- Salinity has positive & negative effects on crabs: Low salinity decreases survival & increases predation; high salinity decreases survival & increases disease
- This new index will be useful for identifying times of increased high-fresh

water flow events (as indicated by below-normal salinity) as well as high-salinity, low-flow events.

Points made in the discussion following the presentations:

- Should we call the index a "Coastal Ecosystem Services Drought Index?"
- Keep in mind that impacts due to high salinity values will broaden beyond the coast, stretching into the upper reaches of the rivers.
- How much change over how long of a period before drought impacts are felt?
- It would be interesting to compare gages along the same river.

Facilitated discussion

ROBIN WEBB, NOAA

How might the incorporation of an enhanced coastal drought index such as a USGS salinity drought index fit into your agency's mission?

U.S. Fish & Wildlife Service: The salinity index could better inform the timing for fish passage (immigration/emigration). Could contribute to a biotic index for Diogenes fish, such as sturgeon, indicating where and when they are moving. This index could be good for threatened and endangered species.

SCDNR: Concern was expressed about comparable uses of the index across rivers and river types

SC Sea Grant: This index will be useful for indicating drought and no drought.

Mission Aransas NERR: This will be a useful tool for NERRs

In Corpus Christi – the news focuses on reservoirs (how full are they), not estuaries. This would be a useful tool for educating the public about low-flow impacts.

CCEHBR: The index could be useful to the industrial and drinking water sectors for salt water intrusion events.

USACE: There's a viable role for the Corps. Can't address all issues; watersheds in SC are all very different.

SCDNR: NERRs want to use products with a consistent methodology

What management decisions could be informed by access to a real-time coastal drought index such as the USGS Salinity drought index?

TNC: The index could be used to assess freshwater flow, disease, predators, and oyster restoration

Apalachicola NERR:

- The index could be beneficial for Apalachicola Bay; could apply to many organisms
- Using the index to pinpoint the duration of the event is important due to cumulative environmental stress
- Seasonality and rate-of-change are also important

SCDNR: The state uses 7 indices already; could use the new index, but we need the associated impacts

Florida A&M: Please expand the index into Florida, particularly the east coast. Consider underground issues (brackish groundwater).

Next steps

Paul Conrads will continue the analyses to determine the best sites and methodology for producing a prototype coastal drought index.

Dr. Dwayne Porter suggested Paul could potentially collaborate with him since he manages data for the NERRs.

Lisa Darby will send the workshop report to Erica Seiden (Acting Chief of NOAA's Estuarine Reserves Division) so she will be aware of what happened at the workshop and will work with Dr. Seiden about the possibility of Paul Conrads giving a presentation to NERR scientists.

Volunteers for an advisory committee for Paul:

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