Coastal Salinity Index (CSI)

NOAA Eastern Region Climate Services Webinar
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Matt Petkewich, U.S. Geological Survey
Kirsten Lackstrom, Carolinas Integrated Sciences and Assessments
Motivation

Source: Michael Childress/Clemson

Fisheries Municipal and Industrial Intake Closures

Source: Chandler Green/CISA

Habitat Change

Analysis of Salinity Intrusion in the Waccamaw River and the Atlantic Intracoastal Waterway near Myrtle Beach, South Carolina, 1995–2002


Overview

- Indicator of salinity changes and location of the freshwater-saltwater interface
- Focus of the NIDIS Coastal Carolinas Drought Early Warning System (DEWS)

Societal, economic, ecological effects
- Vegetation tolerance (habitat, storm-surge protection)
- Fisheries (fish, crabs, oysters)
- Drinking water intakes
- Industrial water intakes
- Algal blooms
- Tourism/Recreation

Approach and methods

- Similar approach to the Standardized Precipitation Index (SPI)
- Indicates drought and wetter conditions over multiple time periods (1- to 24 months)
- >18 years period of record

Table 1. Coastal salinity classifications, descriptions, and threshold values.

<table>
<thead>
<tr>
<th>Coastal salinity classification</th>
<th>Description</th>
<th>Color</th>
<th>Range</th>
<th>CSI threshold value</th>
<th>Cumulative percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD4</td>
<td>Exceptional salinity conditions</td>
<td>dark red</td>
<td>(∞, -2]</td>
<td>-2</td>
<td>2</td>
</tr>
<tr>
<td>CD3</td>
<td>Extreme salinity conditions</td>
<td>dark red</td>
<td>(-2.0 to -1.6]</td>
<td>-1.6</td>
<td>5</td>
</tr>
<tr>
<td>CD2</td>
<td>Severe salinity conditions</td>
<td>dark yellow</td>
<td>(-1.6 to -1.3]</td>
<td>-1.3</td>
<td>10</td>
</tr>
<tr>
<td>CD1</td>
<td>Moderate salinity conditions</td>
<td>light yellow</td>
<td>(-1.3 to -0.8]</td>
<td>-0.8</td>
<td>20</td>
</tr>
<tr>
<td>CD0</td>
<td>Abnormal salinity conditions</td>
<td>yellow</td>
<td>(-0.8 to -0.5]</td>
<td>-0.5</td>
<td>30</td>
</tr>
<tr>
<td>Normal</td>
<td>Normal salinity conditions</td>
<td>light grey</td>
<td>(-0.5 to 0.5]</td>
<td>NA</td>
<td>70</td>
</tr>
<tr>
<td>CW0</td>
<td>Abnormal freshwater conditions</td>
<td>light grey</td>
<td>(0.5 to 0.8]</td>
<td>0.5</td>
<td>80</td>
</tr>
<tr>
<td>CW1</td>
<td>Moderate freshwater conditions</td>
<td>light grey</td>
<td>(0.8 to 1.3]</td>
<td>0.8</td>
<td>90</td>
</tr>
<tr>
<td>CW2</td>
<td>Severe freshwater conditions</td>
<td>dark grey</td>
<td>(1.3 to 1.6]</td>
<td>1.3</td>
<td>95</td>
</tr>
<tr>
<td>CW3</td>
<td>Extreme freshwater conditions</td>
<td>dark grey</td>
<td>(1.6 to 2.0]</td>
<td>1.6</td>
<td>98</td>
</tr>
<tr>
<td>CW4</td>
<td>Exceptional freshwater conditions</td>
<td>dark grey</td>
<td>(2, ∞]</td>
<td>2</td>
<td>100</td>
</tr>
</tbody>
</table>

Example graphs

The black line for the CSI-24 shows the 24-month average salinity.

For the CSI-12, the 12-month average salinity is shown.

For the CSI-1, the 1-month average salinity is shown.

East Bay Bottom Station, APAEBWQ
Apalachicola National Estuarine Research Reserve
Products and resources (2017-2019)

- **CSI R-package**
  - GitHub
- **Historic CSIs** along the Gulf and SE Atlantic coasts
  - USGS ScienceBase Catalog
- **Real-time CSIs**
  - 17 stations in NC, SC, and GA; USGS South Atlantic Water Science Center website
  - 12 stations in South Florida; USGS Coastal Everglades Depth Estimation Network (EDEN) website

https://doi.org/10.3133/ofr20191090
USGS Community for Data Integration project (2020)

- Identify and integrate new salinity datasets
  - USGS
  - National Park Service (Everglades)
  - National Estuarine Research Reserve System (NERRS)
- Enhance existing website and user interface to accommodate new CSIs
- Develop CSI R-scripts for use in ecological analyses
User-selected CSI time interval (default = 1-month CSI)

CSI Classification Table

Station Legend

Interactive Map (see station pop-ups on next slide)
Station pop-ups allow user to:

- link to station page (originating agency)
- download input salinity data (.csv files)
- download CSI values (.csv files)
- access CSI graphs

Links are also available in the Station Table.
Landing/Home Page (3)

Link to:
- Station information (agency website)
- Input salinity data (.csv files)
- Output CSI values (.csv files)
- CSI graphs

CSI Station Table
Sortable and Searchable (by multiple parameters)
### About the Coastal Salinity Index

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<td>How is the CSI calculated?</td>
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<td>CSI Classifications</td>
<td>CSI Classification Table</td>
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<td>How to Read Stacked</td>
<td>Example CSI stacked graph with explanations</td>
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<td>Provisional and final data</td>
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<td>Data Disclaimers</td>
<td>Project team information</td>
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</table>

Click on each sub-page heading to access content.
Additional Real-Time Data (1)

The Coastal Salinity Index (CSI) depicts the response to monthly (and longer) precipitation and streamflow conditions rather than hourly to daily fluctuations. The maps and graphs on this page show the latest real-time trends in salinity, water temperature, and gage height at the CSI sites.

Select a variable and time interval to view average salinity, water temperature, or gage-height conditions over the past 7 days, 14 days, 1 month, 2 month, or 3 months. By averaging over these time intervals, water conditions are more indicative of recent hydrological conditions than current conditions.

Note: Gage height is the height of water in the stream above a constant reference point. For the purposes of this website, gage-height record that has not been converted to a unified datum is limited to data from the agency where the gage is located at single location and specific measuring point.

Click on sites on the map to view links to data and graphs. All real-time data are provisional and subject to revision.
Additional Real-Time Data (2)

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**Time Intervals**
- 7-day
- 14-day
- 1-month
- 2-month
- 3-month
Additional Real-Time Data (3) - Salinity 7-Day Average Example

Additional Real-time Data
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Station Data
Input data
Time series
CSI stacked graphs
Additional Real-Time Data (4) - Water Temperature 7-Day Change Example

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Additional Real-Time Data: Graphs (1)

Time Series Graph
Select Site: 01482800 Delaware River at Reedy Island Jetty, DE
Select Parameter: Salinity
Select Time Interval for Rolling Average: 1 Month

Salinity at 01482800 Delaware River at Reedy Island Jetty, DE

Instructions: Hover over the graph to highlight individual values. Click and drag in the x or y direction to zoom. Double-click to zoom back out. Press Shift and drag mouse to pan around the graph. Use the "Select Parameter" drop-down box to toggle between salinity, water temperature, and gage height. Use the "Select Time Interval for Rolling Average" drop-down box to select a different time period on which rolling average is calculated.
Additional Real-Time Data: Graphs (2)

**Time Series Graph**
Select Site: 01482800 Delaware River at Reedy Island Jetty, DE
Select Parameter: Water Temperature
Select Time Interval for Rolling Average: 1 Month

**Water Temperature at 01482800 Delaware River at Reedy Island Jetty, DE**

Instructions: Hover over the graph to highlight individual values. Click and drag in the x or y direction to zoom. Double-click to zoom back out. Press Shift and drag mouse to pan around the graph. Use the "Select Parameter" drop-down box to toggle between salinity, water temperature, and gage height. Use the "Select Time Interval for Rolling Average" drop-down box to select a different time period on which rolling average is calculated.
Additional Real-Time Data: Graphs (3)

30-Day Moving Window Average Graph
Select Site: 01482800 Delaware River at Reedy Island Jetty, DE
Select Parameter: Salinity

Salinity at 01482800 Delaware River at Reedy Island Jetty, DE

EXPLANATION: Percentile classes: Period of record: 10/1964 - 10/2020
- 0%-10: Below normal
- 10%-25: Normal
- 25%-75: Above normal
- 75%-100: Much above normal
Salinity, daily time series
Salinity, rolling average (30-day)

Instructions: Hover over the graph to highlight individual values. Use the "Select Site" drop-down box to select a gage and view its data. Use the "Select Parameter" drop-down box to toggle between salinity, water temperature, and gage height. Not all parameters may be available for all sites.
Additional Real-Time Data: Graphs (4)

CSI Monthly Graphs
Select Site: 01482800 Delaware River at Reedy Island Jetty, DE
Select Time Frame: 12-month

Average 12-month CSI and Salinity at 01482800 Delaware River at Reedy Island Jetty, DE

EXPLANATION: CD, coastal drought; CW, coastal wet; Period of record: 10/1964 - 10/2020

Instructions: Hover over the graph to highlight individual values. Use the "Select Site" drop-down box to select a gage and view its data. Use the "Select Time Frame" drop-down box to select a different time interval on which the CSI and salinity rolling average is calculated. Click here to learn how to read stacked graphs.
Resources Page

CSI tools and resources

Publications

Project partners, supporters, and funders
Thank you

CSI website link (current website)

CSI R-package
https://github.com/USGS-R/CSI

USGS South Atlantic Water Science Center
Contact Matt Petkewich at mdpetkew@usgs.gov