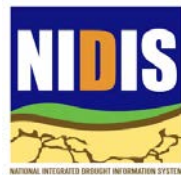# Coastal Salinity Index (CSI)

NOAA Eastern Region Climate Services Webinar
October 29, 2020

Matt Petkewich, U.S. Geological Survey
Kirsten Lackstrom, Carolinas Integrated Sciences and Assessments

Motivation
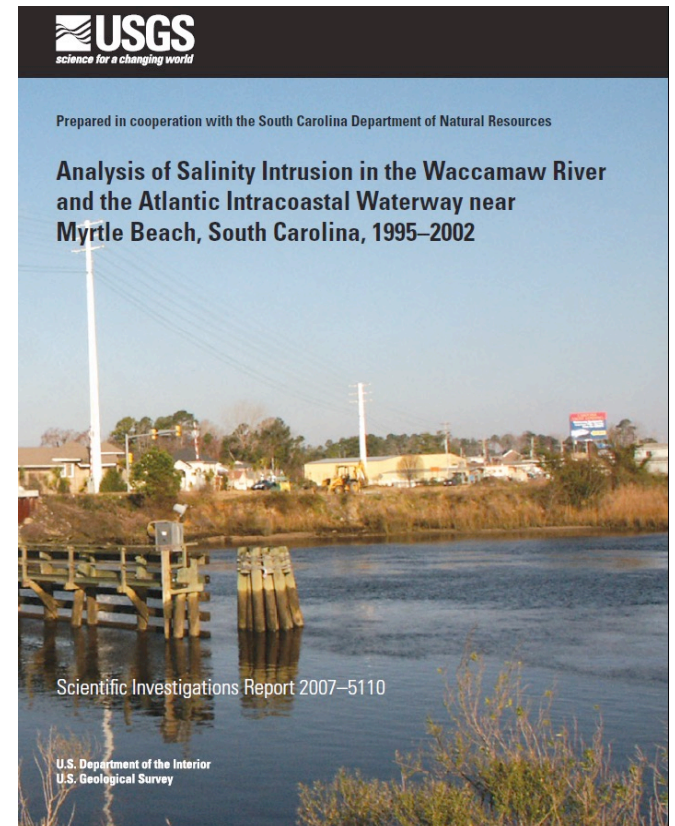

Fisheries

Source: Michael Childress/Clemson

Habitat Change

Source: Chandler Green/CISA

Municipal and Industrial Intake Closures

≋USGS
science for a changing world

Prepared in cooperation with the South Carolina Department of Natural Resources

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

Scientific Investigations Report 2007–5110
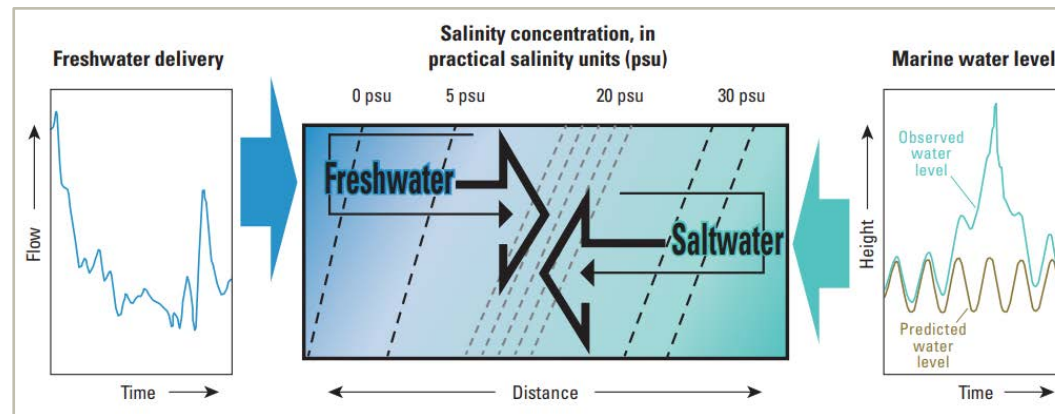
U.S. Department of the Interior
U.S. Geological Survey

Overview

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

- Precipitation
- Drought
- Flood/tropical storms
- GW discharge
- ET
- Streamflow regulation
- Water extraction (agriculture, industry, PW supply)

- Tides
- Winds
- Tropical storms
- Sea-level rise

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

Source: Conrads, P.A., Rodgers, K.D., Passeri, D.L., Prinos, S.T., Smith, C., Swarzenski, C.M., and Middleton, B.A., 2018, Coastal estuaries and lagoons – The delicate balance at the edge of the sea: U.S. Geological Survey Fact Sheet 2018-3022, 4 p. https://doi.org/10.3133/fs20183022.

Approach and methods

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

[Brackets and parentheses in the ranges indicate inclusion (brackets) or exclusion (parentheses) of a value in the listed range. CSI, Coastal Salinity Index; CD, coastal drought; NA, not applicable; CW, coastal wet; ∞, infinity]

| Coastal salinity classification	Description	Color	Range	CSI threshold value	Cumulative percentage
CD4	Exceptional salinity conditions		(∞, −2]	−2	2
CD3	Extreme salinity conditions		(−2.0 to −1.6]	−1.6	5
CD2	Severe salinity conditions		(−1.6 to −1.3]	−1.3	10
CD1	Moderate salinity conditions		(−1.3 to −0.8]	−0.8	20
CD0	Abnormal salinity conditions		(−0.8 to −0.5]	−0.5	30
Normal	Normal salinity conditions		(−0.5 to 0.5]	NA	70
CW0	Abnormal freshwater conditions		(0.5 to 0.8]	0.5	80
CW1	Moderate freshwater conditions		(0.8 to 1.3]	0.8	90
CW2	Severe freshwater conditions		(1.3 to 1.6]	1.3	95
CW3	Extreme freshwater conditions		(1.6 to 2.0]	1.6	98
CW4	Exceptional freshwater conditions		(2, ∞)	2	100

- Similar approach to the Standardized Precipitation Index (SPI)
- Indicates drought and wetter conditions over multiple time periods (1- to 24 months)
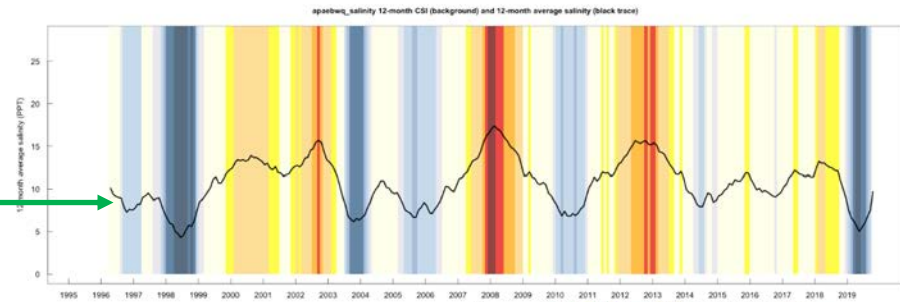- >18 years period of record
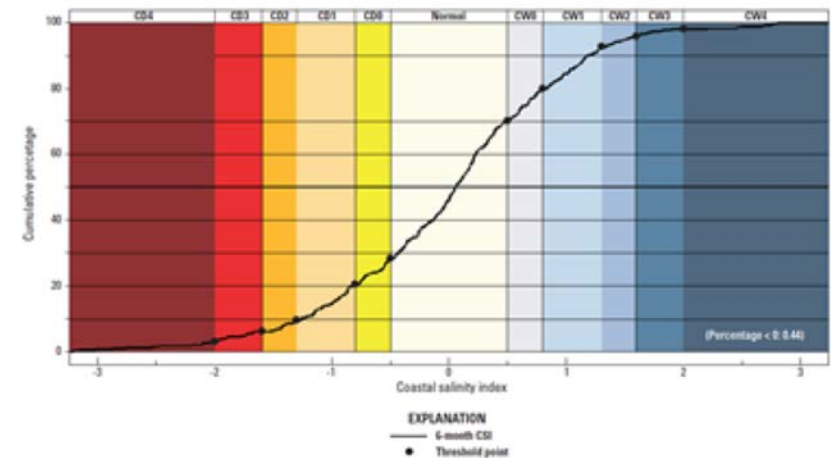
Source: Petkewich, M.D., Lackstrom, K., McCloskey, B.J., Rouen, L.F., and Conrads, P.A., 2019, Coastal Salinity Index along the southeastern Atlantic coast and the Gulf of Mexico, 1983 to 2018: U.S. Geological Survey Open-File Report 2019-1090, 26 p., https://doi.org/10.3133/ofr20191090.
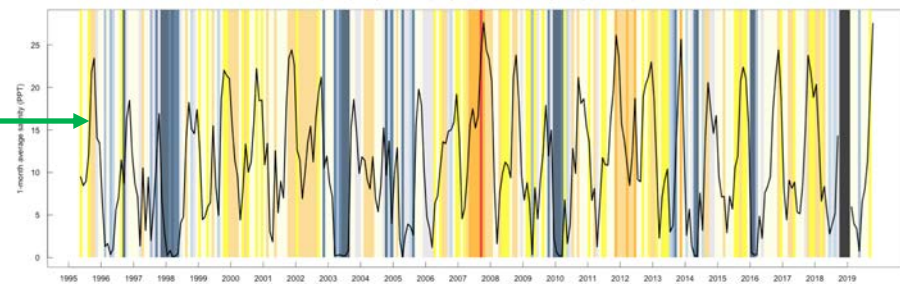
Example graphs

The black line for the CSI-24 shows the 24-month average salinity
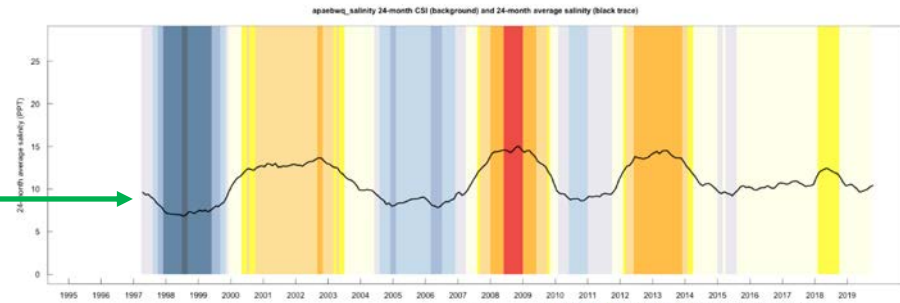
For the CSI-12, the 12-month average salinity is shown

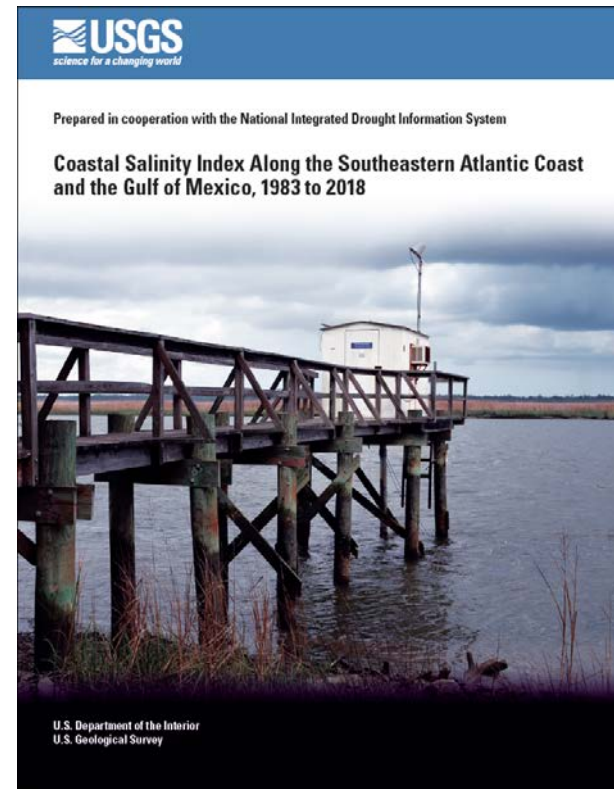For the CSI-1, the 1-month average salinity is shown

East Bay Bottom Station, APAEBWQ
Apalachicola National Estuarine Research Reserve

EXPLANATION: CD, coastal drought; CW, coastal wet; Period of record: 05/1995 - 10/2019

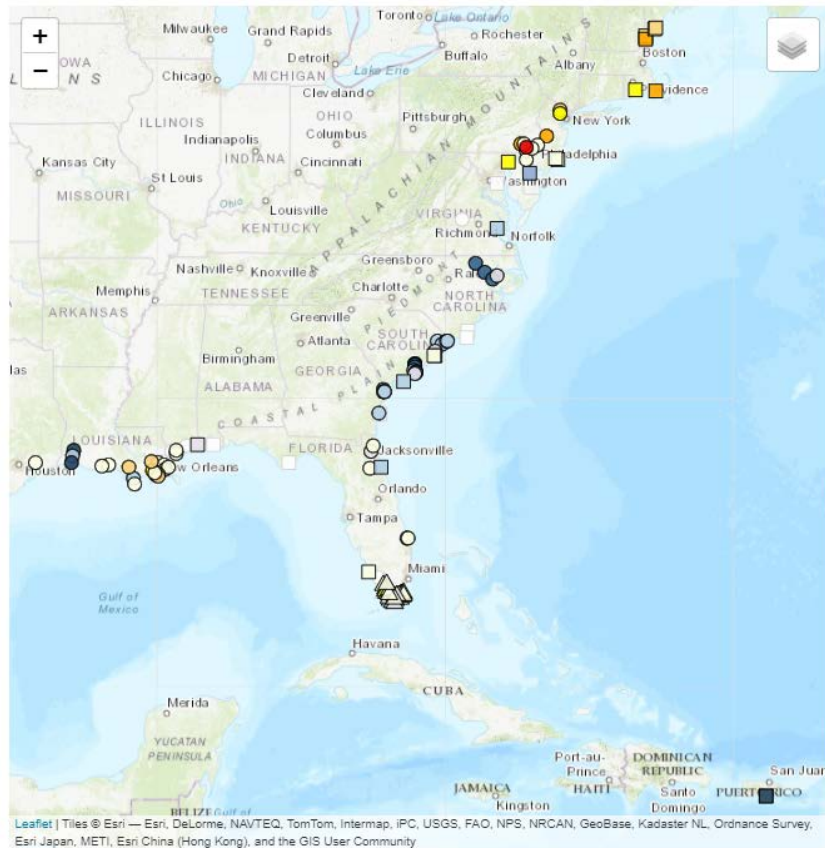CD4 | CD3 | CD2 | CD1 | CD0 | Normal | CW0 | CW1 | CW2 | CW3 | CW4 | Missing

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
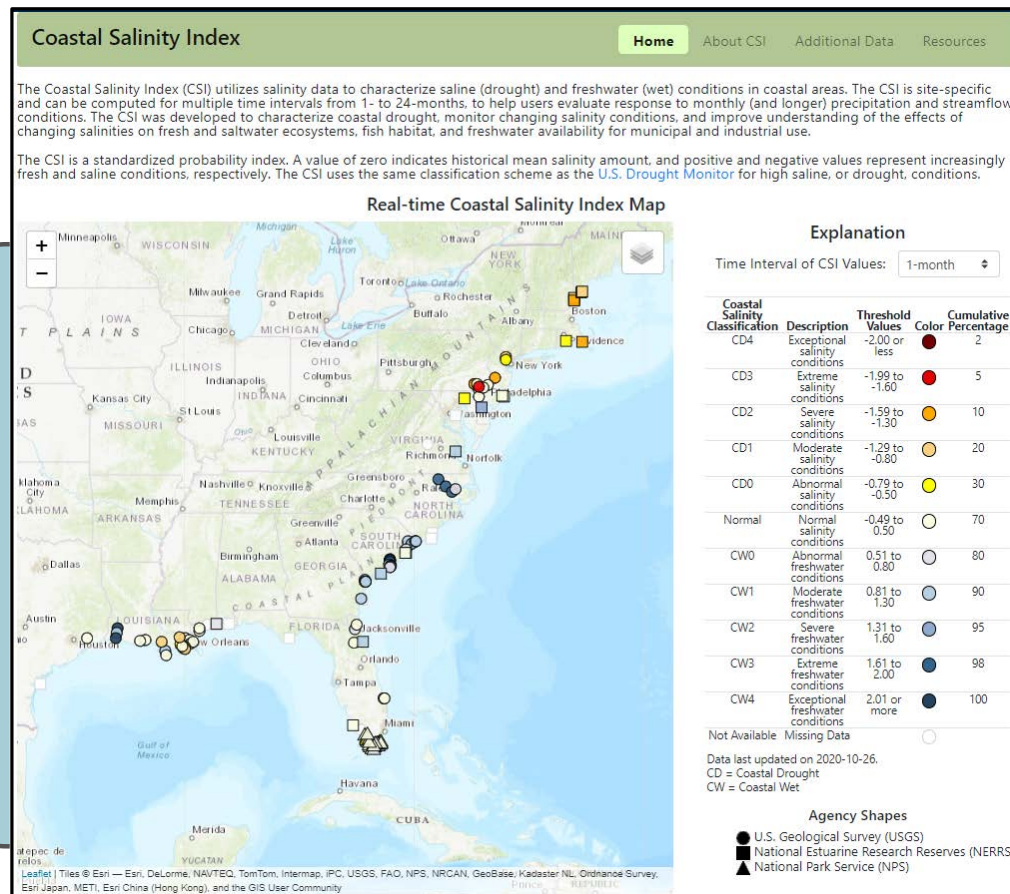

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Prepared in cooperation with the National Integrated Drought Information System

Coastal Salinity Index Along the Southeastern Atlantic Coast and the Gulf of Mexico, 1983 to 2018

U.S. Department of the Interior
U.S. Geological Survey

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**

Landing/Home Page (1)

Coastal Salinity Index   Home   About CSI   Additional Data   Resources

The Coastal Salinity Index (CSI) utilizes salinity data to characterize saline (drought) and freshwater (wet) conditions in coastal areas. The CSI is site-specific and can be computed for multiple time intervals from 1- to 24-months, to help users evaluate response to monthly (and longer) precipitation and streamflow conditions. The CSI was developed to characterize coastal drought, monitor changing salinity conditions, and improve understanding of the effects of changing salinities on fresh and saltwater ecosystems, fish habitat, and freshwater availability for municipal and industrial use.

The CSI is a standardized probability index. A value of zero indicates historical mean salinity amount, and positive and negative values represent increasingly fresh and saline conditions, respectively. The CSI uses the same classification scheme as the U.S. Drought Monitor for high saline, or drought, conditions.

Real-time Coastal Salinity Index Map

Explanation

Time Interval of CSI Values: 1-month

Coastal Salinity Classification	Description	Threshold Values	Color	Cumulative Percentage
CD4	Exceptional salinity conditions	-2.00 or less		2
CD3	Extreme salinity conditions	-1.99 to -1.60		5
CD2	Severe salinity conditions	-1.59 to -1.30		10
CD1	Moderate salinity conditions	-1.29 to -0.80		20
CD0	Abnormal salinity conditions	-0.79 to -0.50		30
Normal	Normal salinity conditions	-0.49 to 0.50		70
CW0	Abnormal freshwater conditions	0.51 to 0.80		80
CW1	Moderate freshwater conditions	0.81 to 1.30		90
CW2	Severe freshwater conditions	1.31 to 1.60		95
CW3	Extreme freshwater conditions	1.61 to 2.00		98
CW4	Exceptional freshwater conditions	2.01 or more		100
Not Available	Missing Data			

Data last updated on 2020-10-26.
CD = Coastal Drought
CW = Coastal Wet

Agency Shapes
● U.S. Geological Survey (USGS)
■ National Estuarine Research Reserves (NERRS)
▲ National Park Service (NPS)

Leaflet | Tiles © Esri — Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

User-selected CSI time interval
(default = 1-month CSI)

CSI Classification Table

Interactive Map
(see station pop-ups on next slide)

Station Legend

Landing/Home Page (2)

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)

Coastal Salinity Index Gages

Click or hover mouse over rows to identify corresponding icons on the map. Click on column headers to sort columns; shift-click to sort by multiple columns. Use boxes below headers to search or filter through data.

Station ID	Station Name	Agency	State	CSI Value (1-mo)	Station Data Page	Input Salinity Data	Output CSI Data	CSI Monthly Graphs
Search...	Search...	Select agency	Select state	Filter data...				
02035000	JAMES RIVER AT CARTERSVILLE, VA	USGS	VA	Not available	View station page	Download input data	Download CSI data	View graphs
cbvtcwq	Taskinas Creek	NERRS	VA	0.87	View station page	Download input data	Download CSI data	View graphs
08067252	Trinity Rv at Wallisville, TX	USGS	TX	-0.5	View station page	Download input data	Download CSI data	View graphs
marscwq	Ship Channel	NERRS	TX	Not available	View station page	Download input data	Download CSI data	View graphs
02110704	WACCAMAW RIVER AT CONWAY MARINA AT CONWAY, SC	USGS	SC	1	View station page	Download input data	Download CSI data	View graphs
02110755	AIW AT BRIARCLIFFE ACRES AT N. MYRTLE BEACH, SC	USGS	SC	0.93	View station page	Download input data	Download CSI data	View graphs
02110760	AIW @ MYRTLEWOOD GOLF COURSE @ MYRTLE BEACH, SC	USGS	SC	0.8	View station page	Download input data	Download CSI data	View graphs
02110770	AIW AT GRAND STRAND AIRPORT N. MYRTLE BEACH, SC	USGS	SC	1.15	View station page	Download input data	Download CSI data	View graphs
02110777	AIW AT HIGHWAY 9 AT NIXONS CROSSROADS, SC	USGS	SC	1.25	View station page	Download input data	Download CSI data	View graphs
021108125	WACCAMAW RIVER NEAR PAWLEYS ISLAND, SC	USGS	SC	0.66	View station page	Download input data	Download CSI data	View graphs

About the CSI Page

Coastal Salinity Index
Home | **About CSI** | Additional Data | Resources

About the Coastal Salinity Index

Section	Description
∨ Motivation	Why was the CSI developed?
∨ Methods	How is the CSI calculated?
∨ CSI Classifications	CSI Classification Table
∨ How to Read Stacked Graphs	Example CSI stacked graph with explanations
∨ Use Cases	In progress
∨ Future Work	<1-month intervals; additional datasets
∨ Data Disclaimers	Provisional and final data
∨ Contact	Project team information
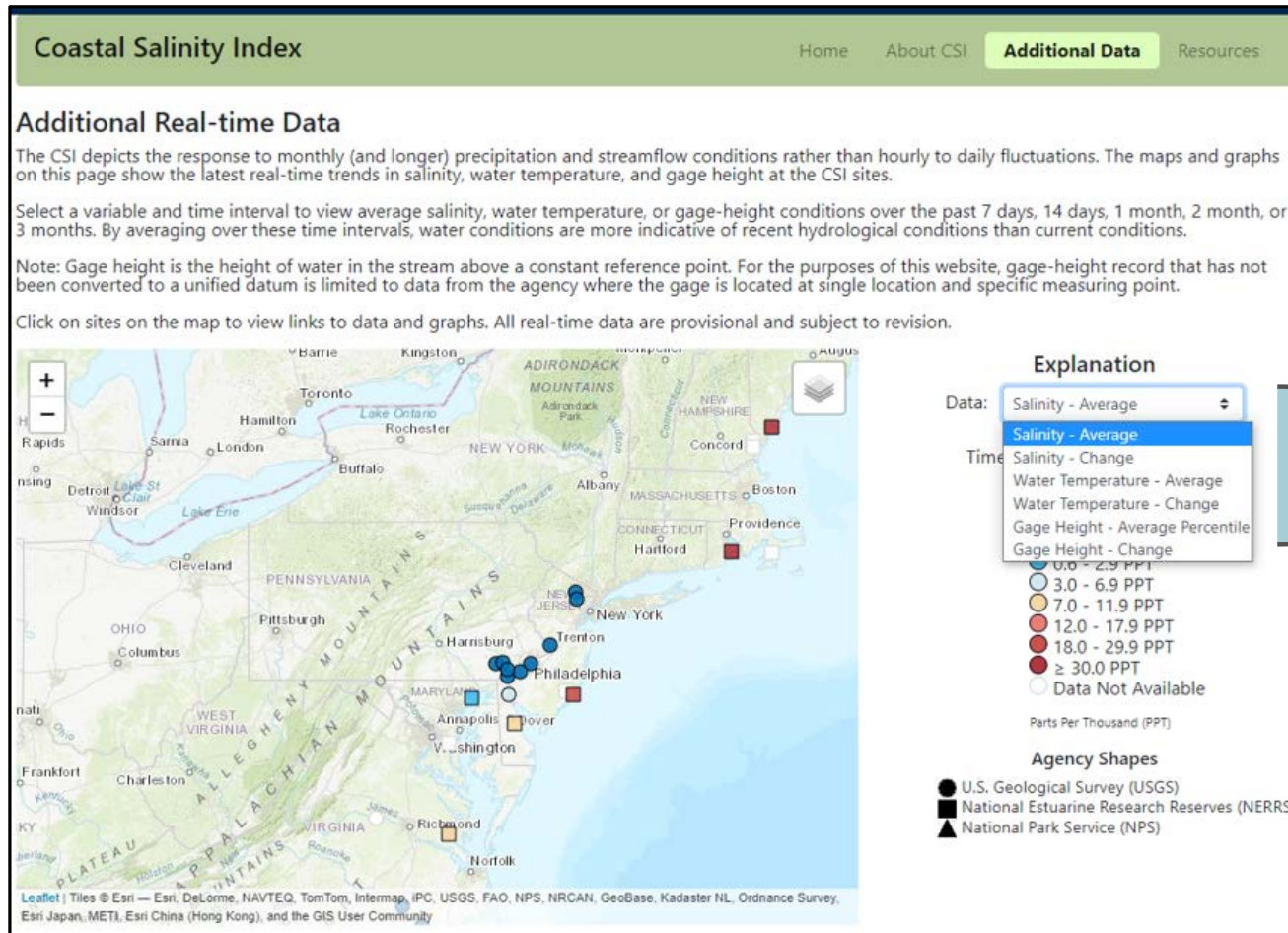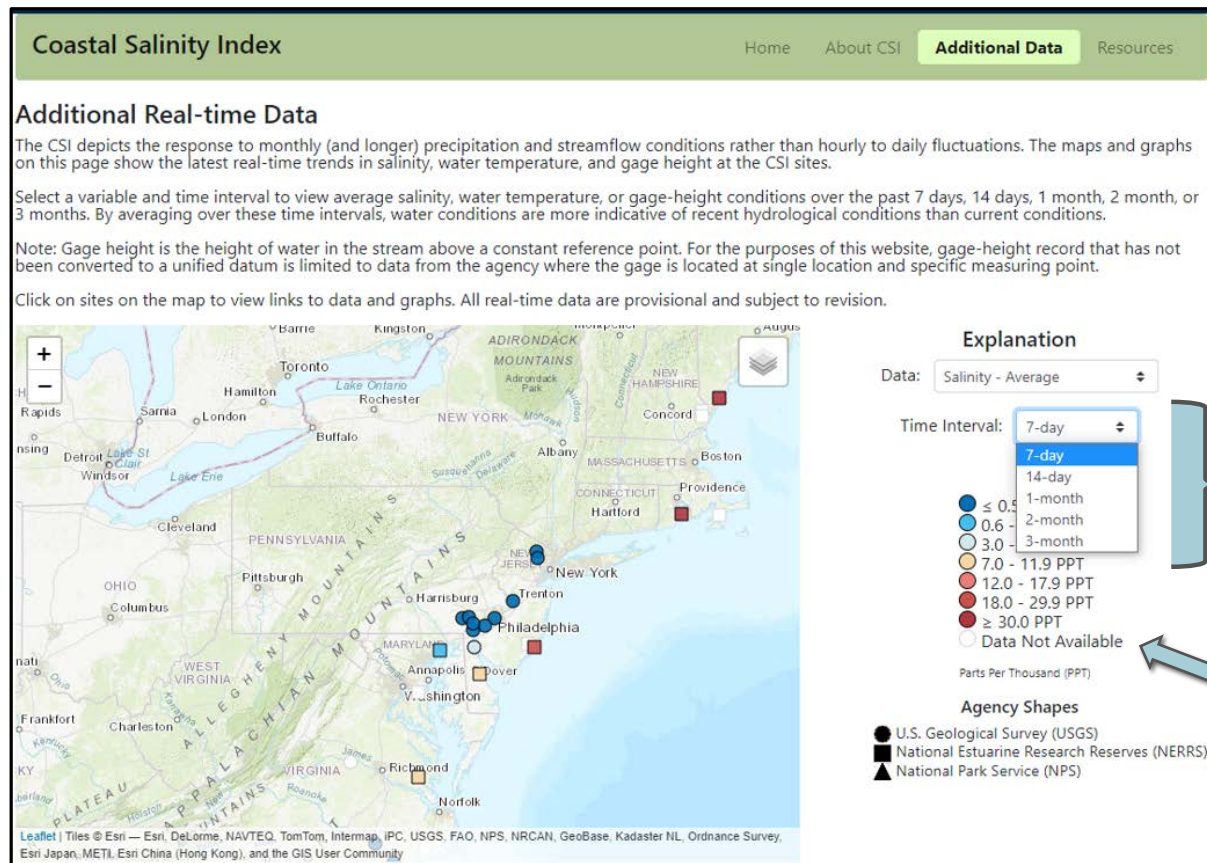
Click on each sub-page heading to access content

Additional Real-Time Data (1)

Additional Real-Time Data (2)

Additional Real-Time Data (3) - Salinity 7-Day Average Example

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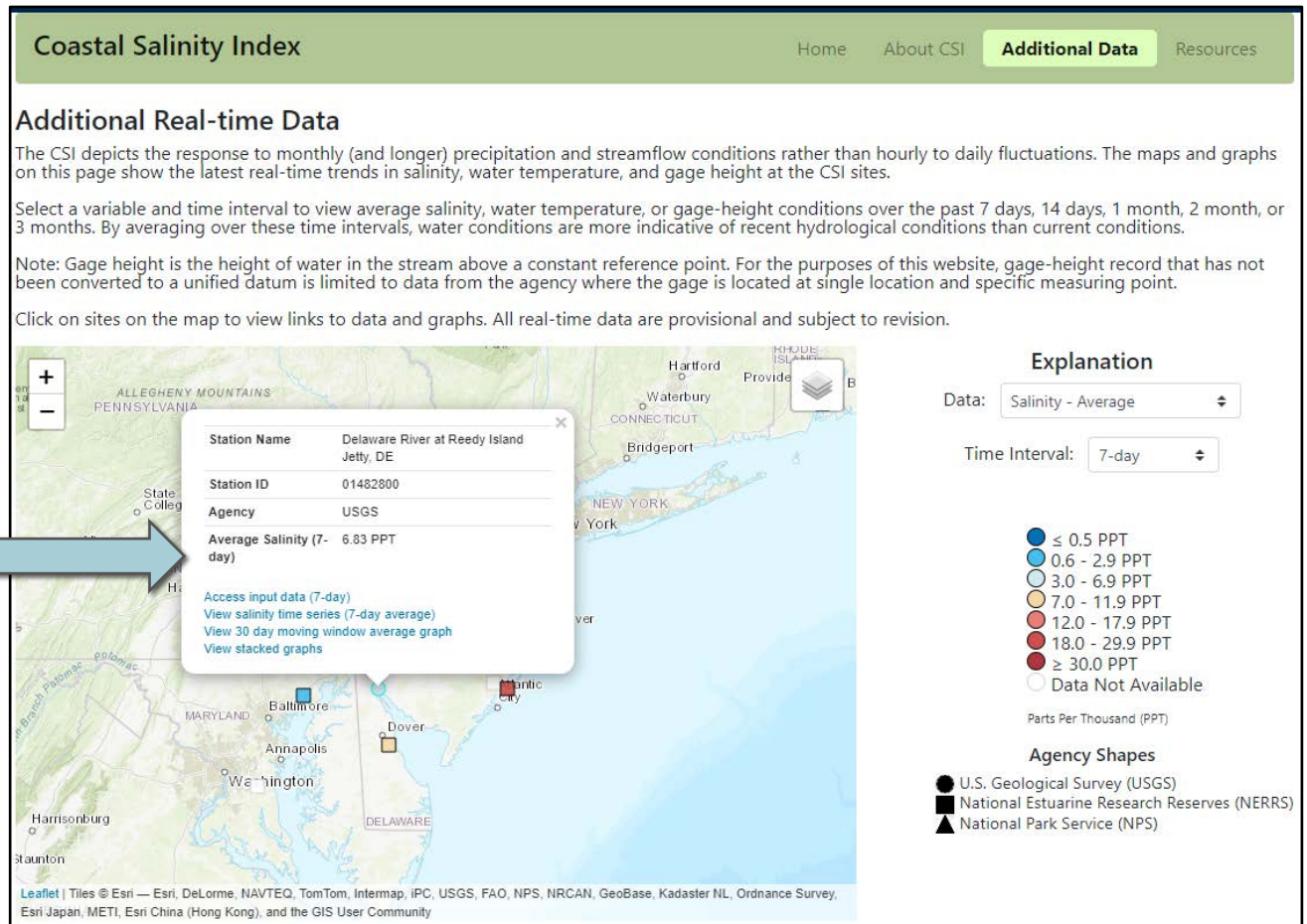
Additional Real-Time Data (4) - Water Temperature 7-Day Change Example

Additional Real-Time Data: Graphs (1)
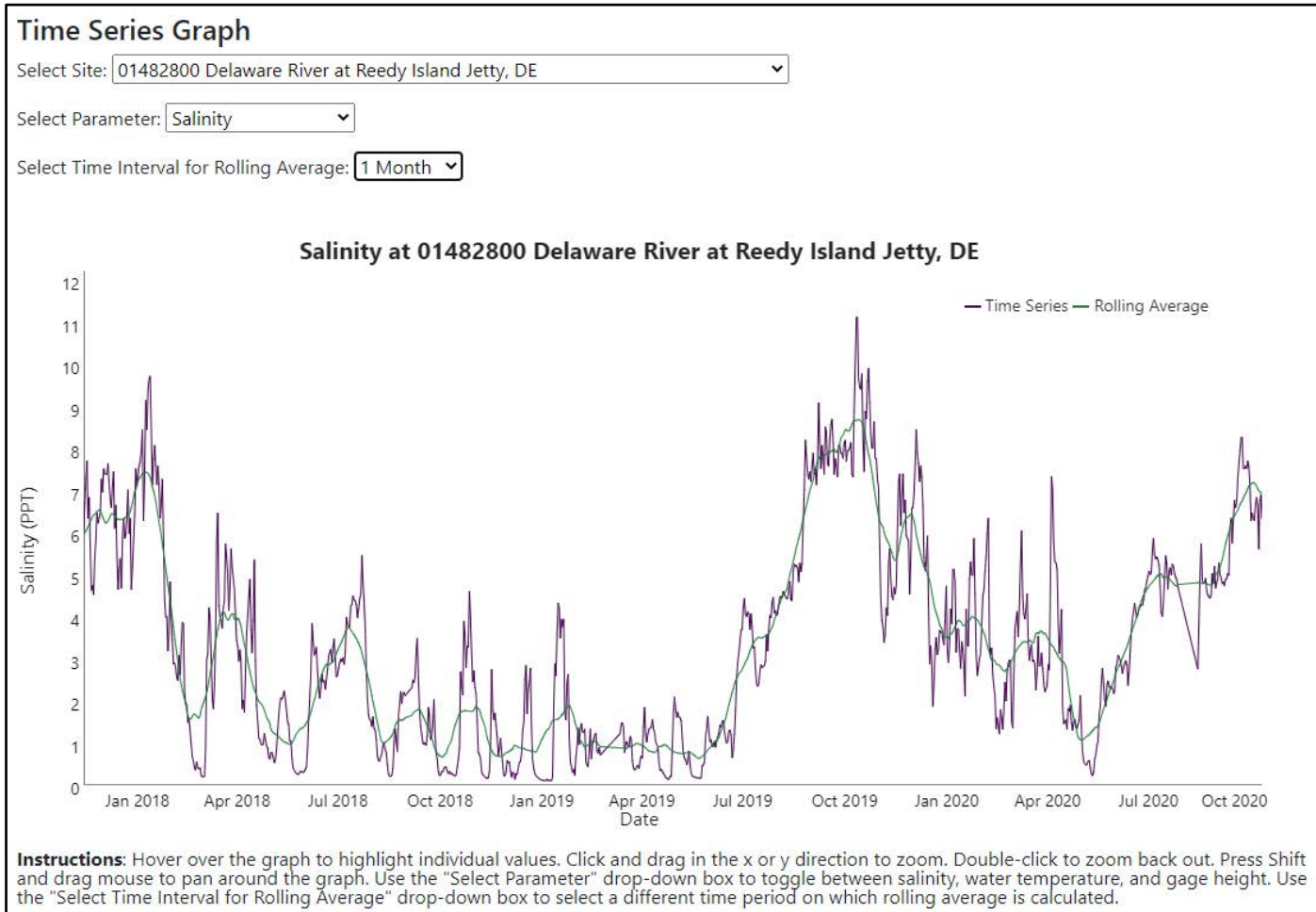
Additional Real-Time Data: Graphs (2)
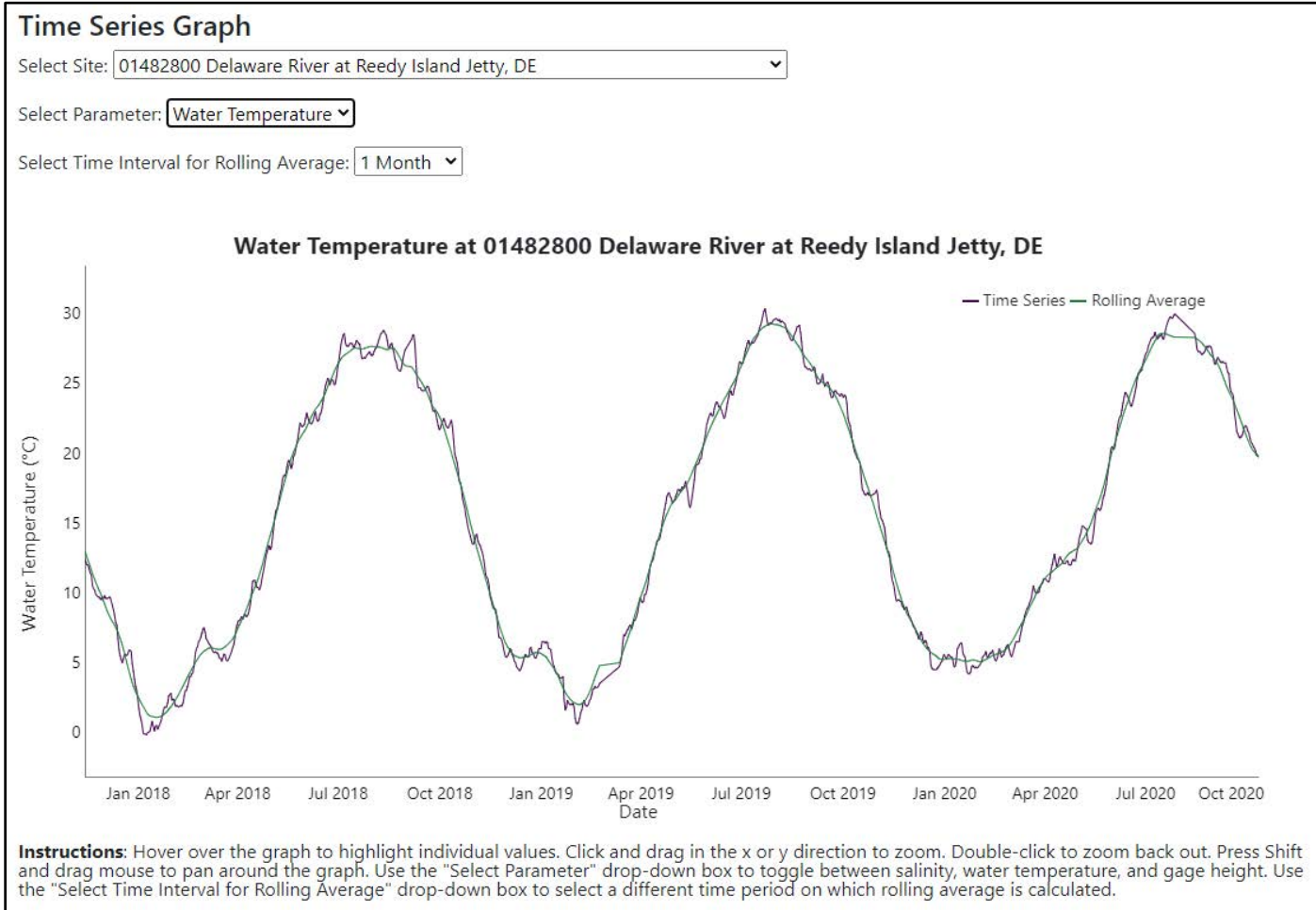
Additional Real-Time Data: Graphs (3)
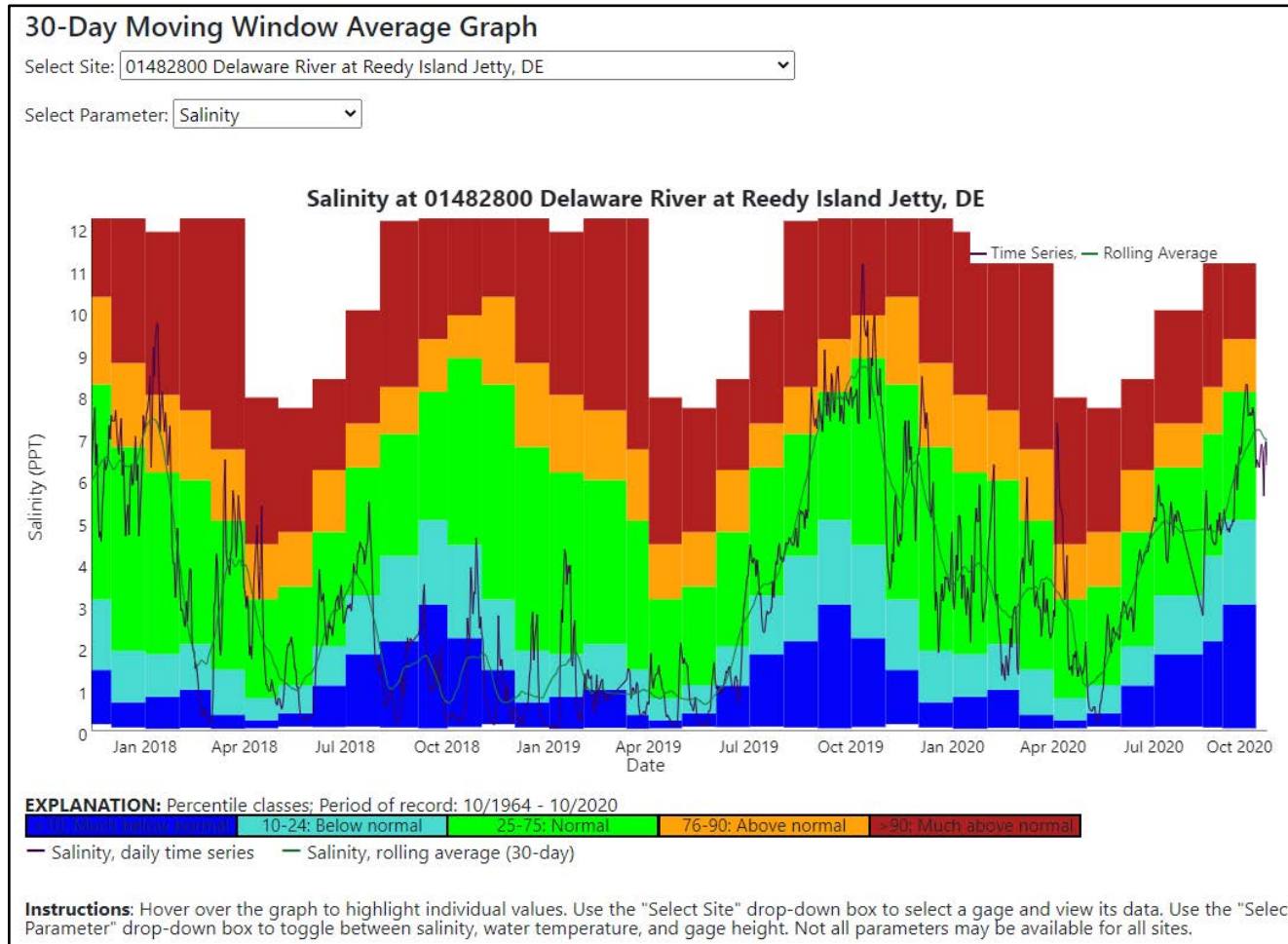
Additional Real-Time Data: Graphs (4)

Resources Page

Thank you

CSI website link (current website)
https://www2.usgs.gov/water/southatlantic/projects/coastalsalinity/home.php

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

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