Development of a Real-time Coastal Drought Index

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Coastal Drought

The Impact of Drought on
Coastal Ecosystems in the Carolinas

Executive Summary January 2012

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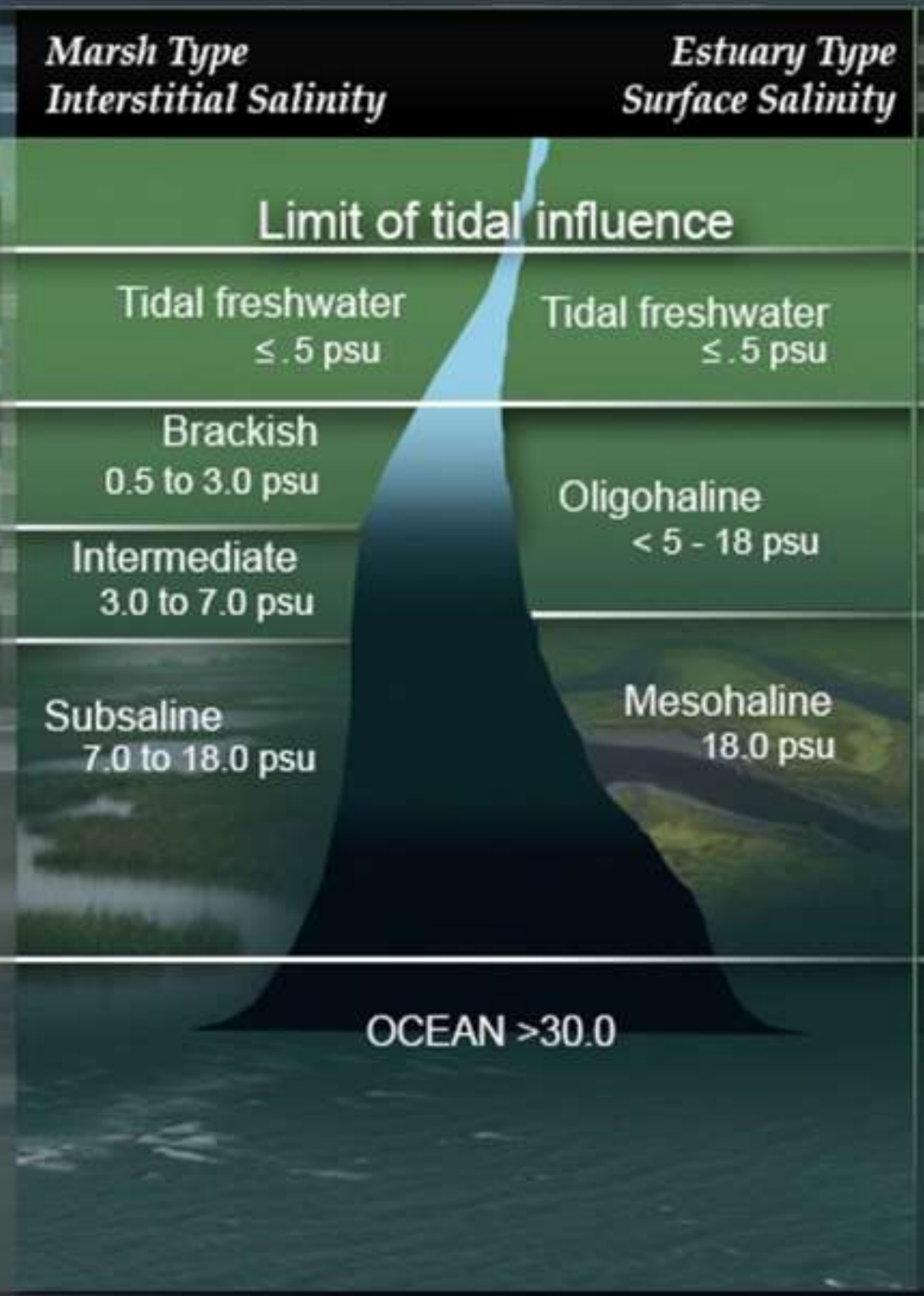
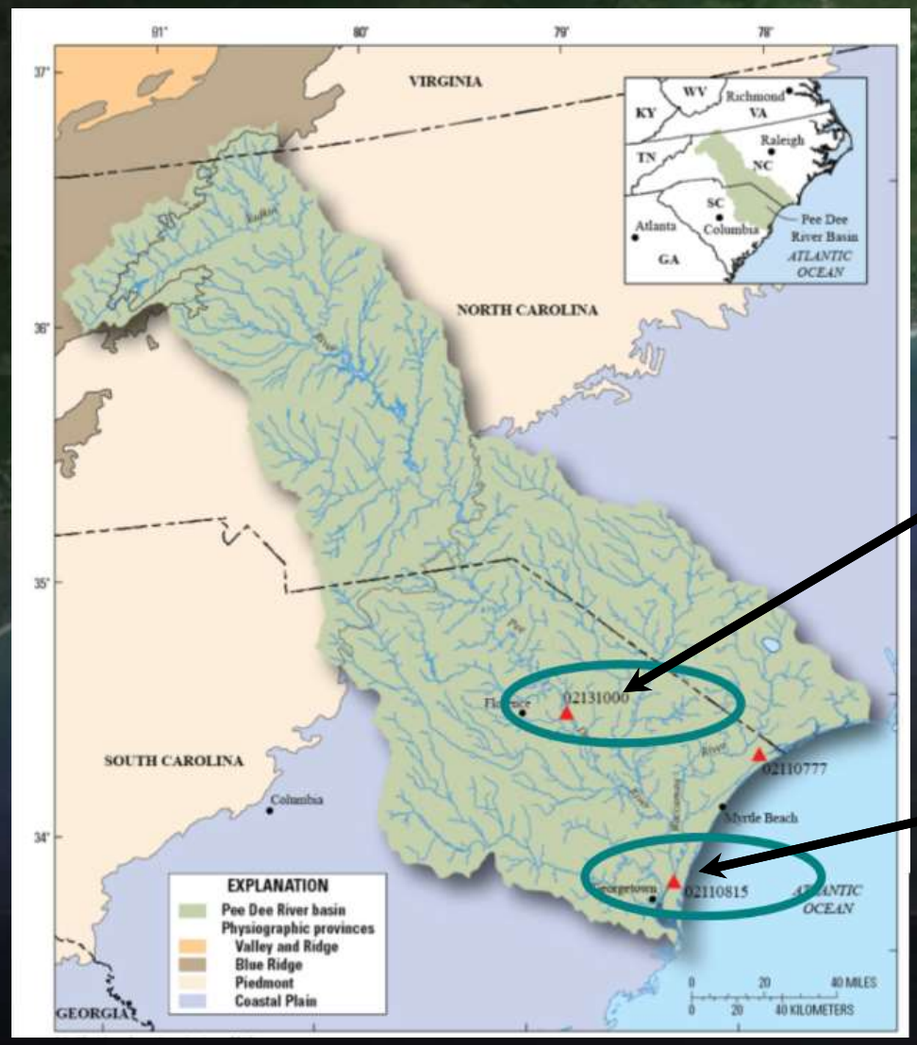
- Effects on:
  - Tidal marsh
  - Shellfisheries
  - Vibrio pathogen transport
- Largest stressor –salinity

Question –
Can a drought index be developed for the coast?

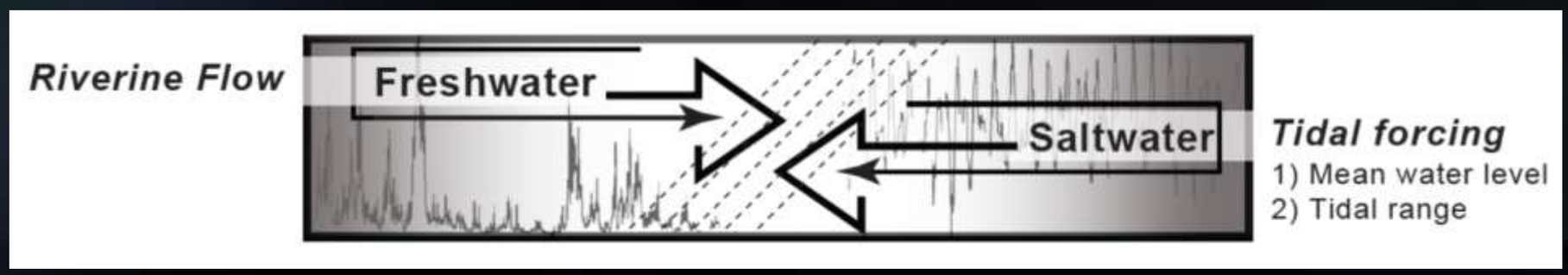


Can Salinity be Used as a Drought Index Variable?

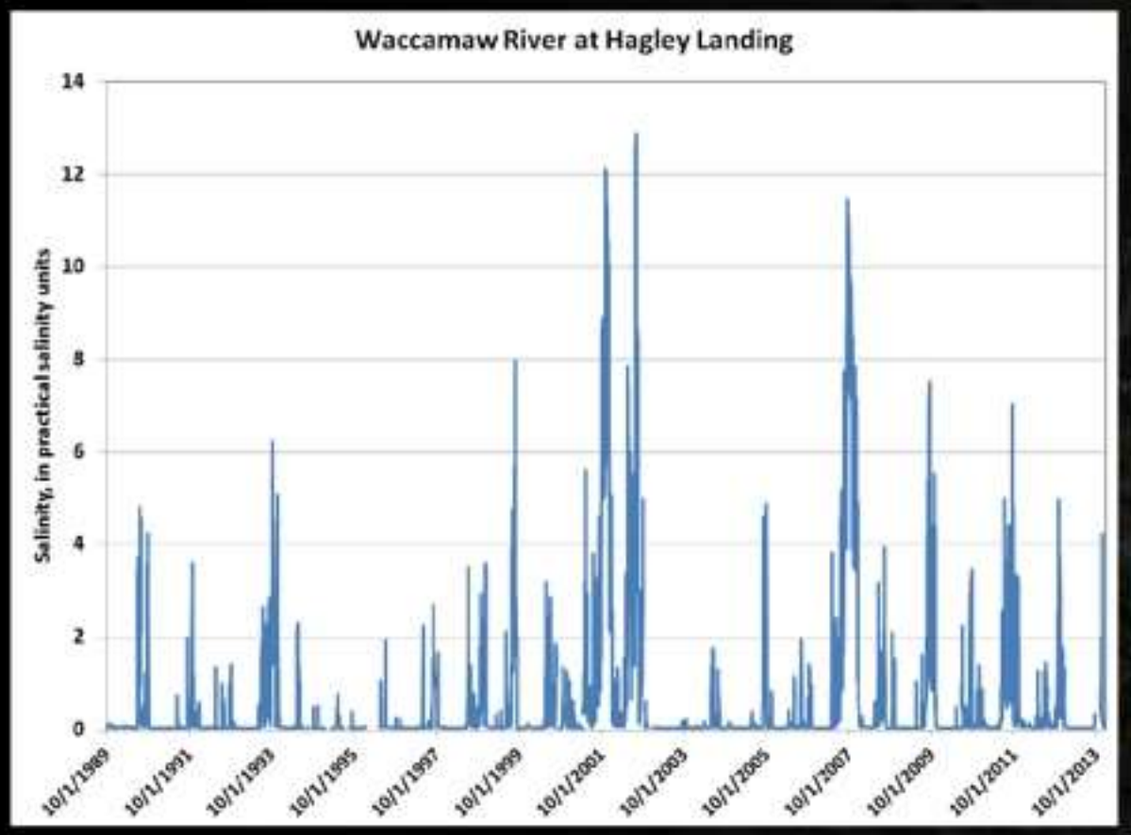


Pee Dee River

Waccamaw River

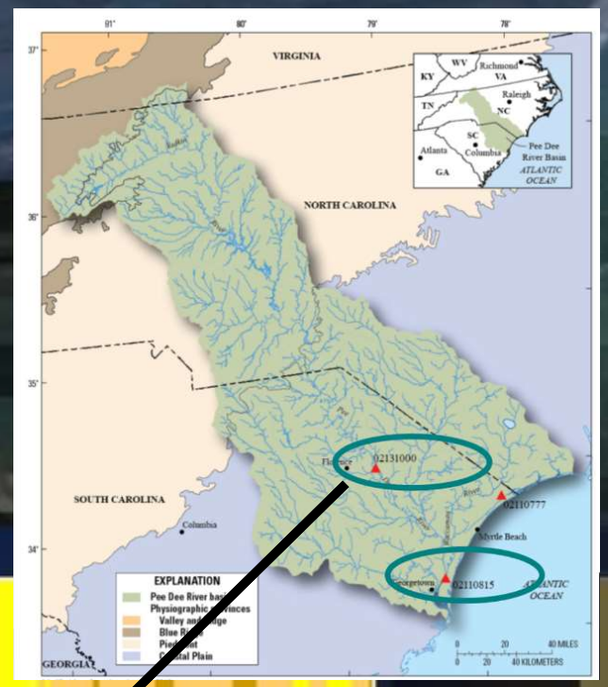


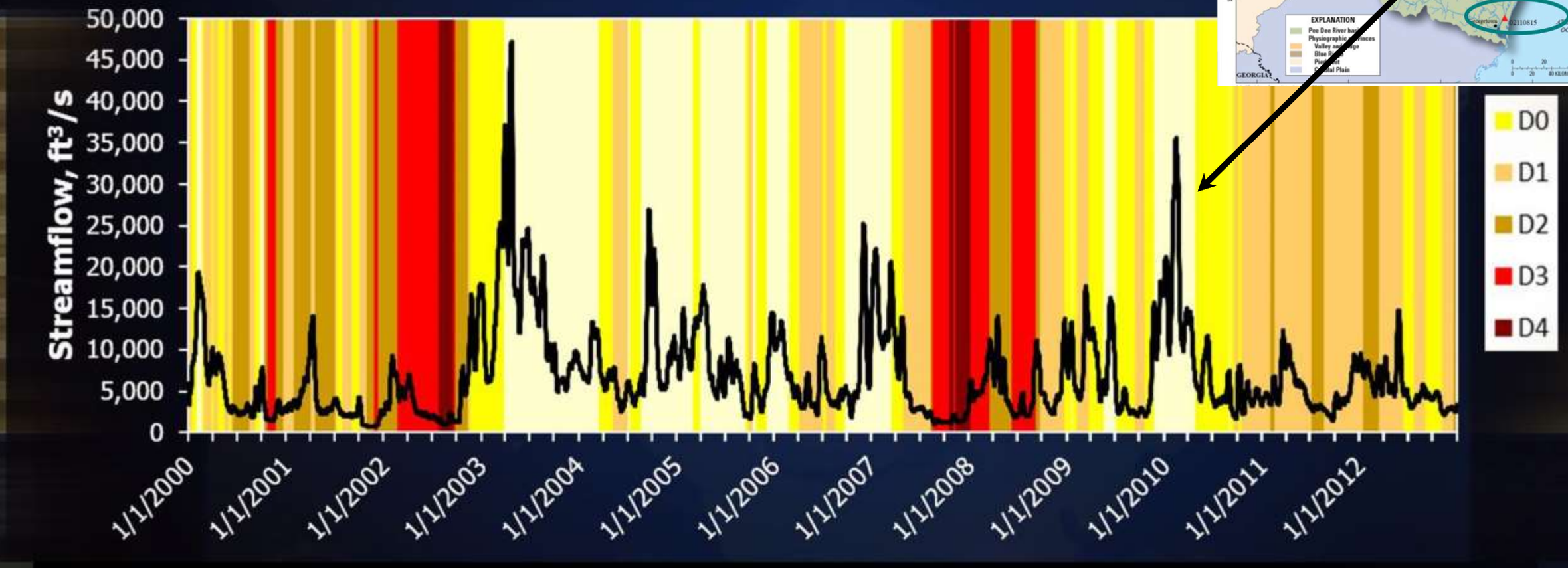
Long-term Salinity Data



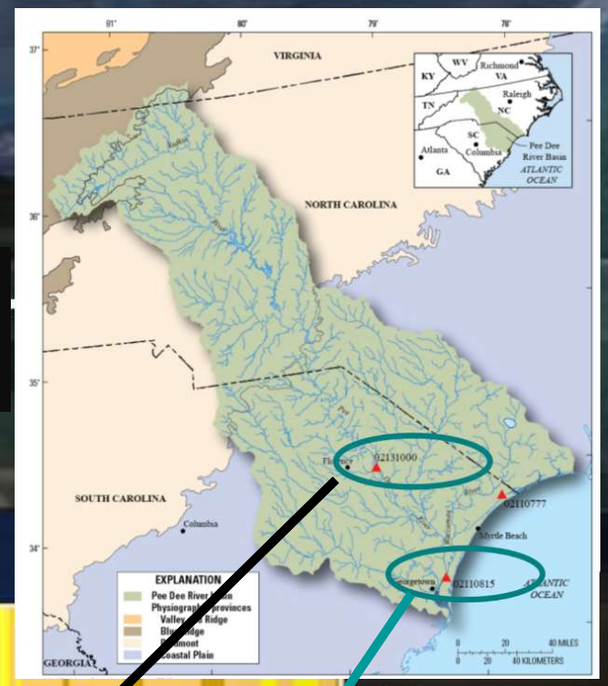
Waccamaw River at Hagley Landing (02110815)
Long period of record
1989 to present
Daily mean salinity
~8,000 data point

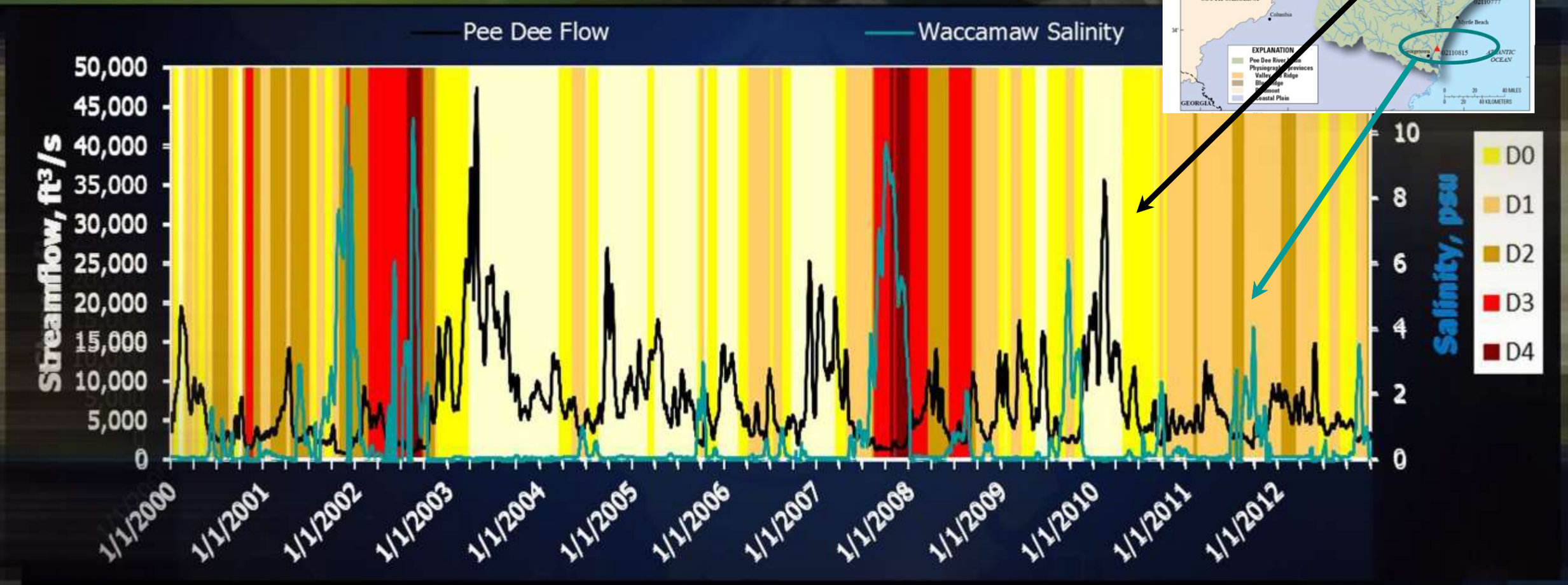
Flow and Drought Index





Flow, Salinity, and Drought Index

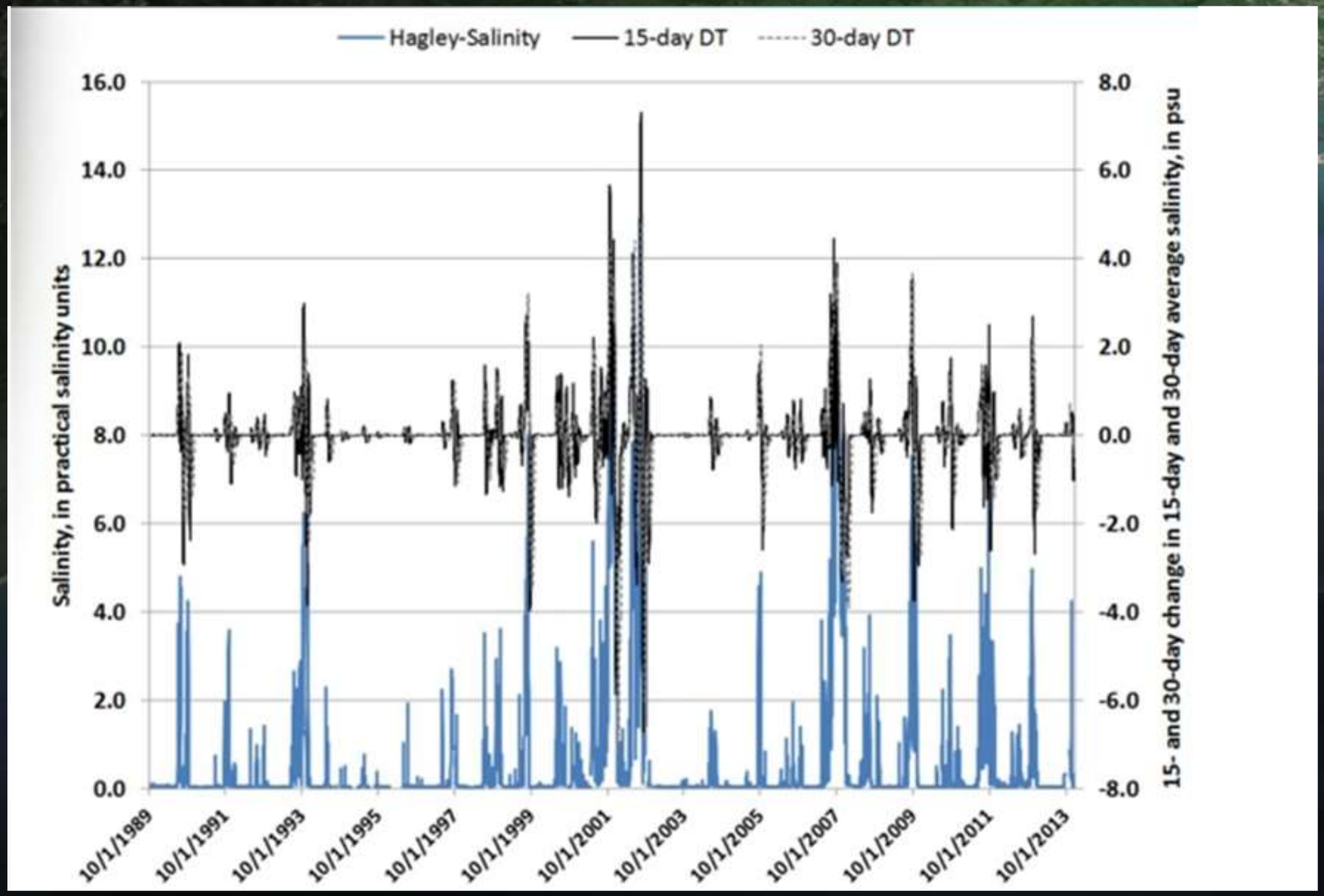




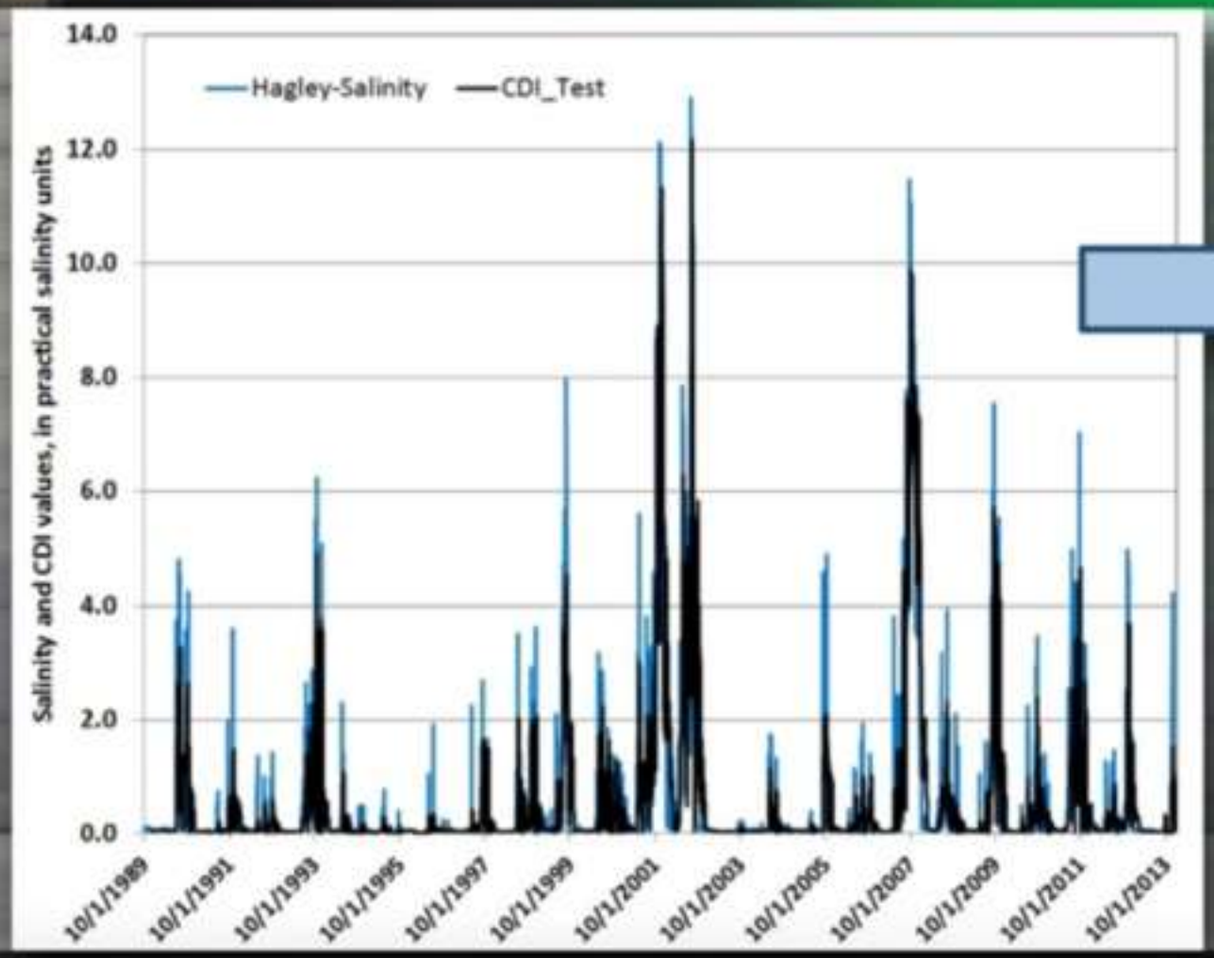
Index Development Approach

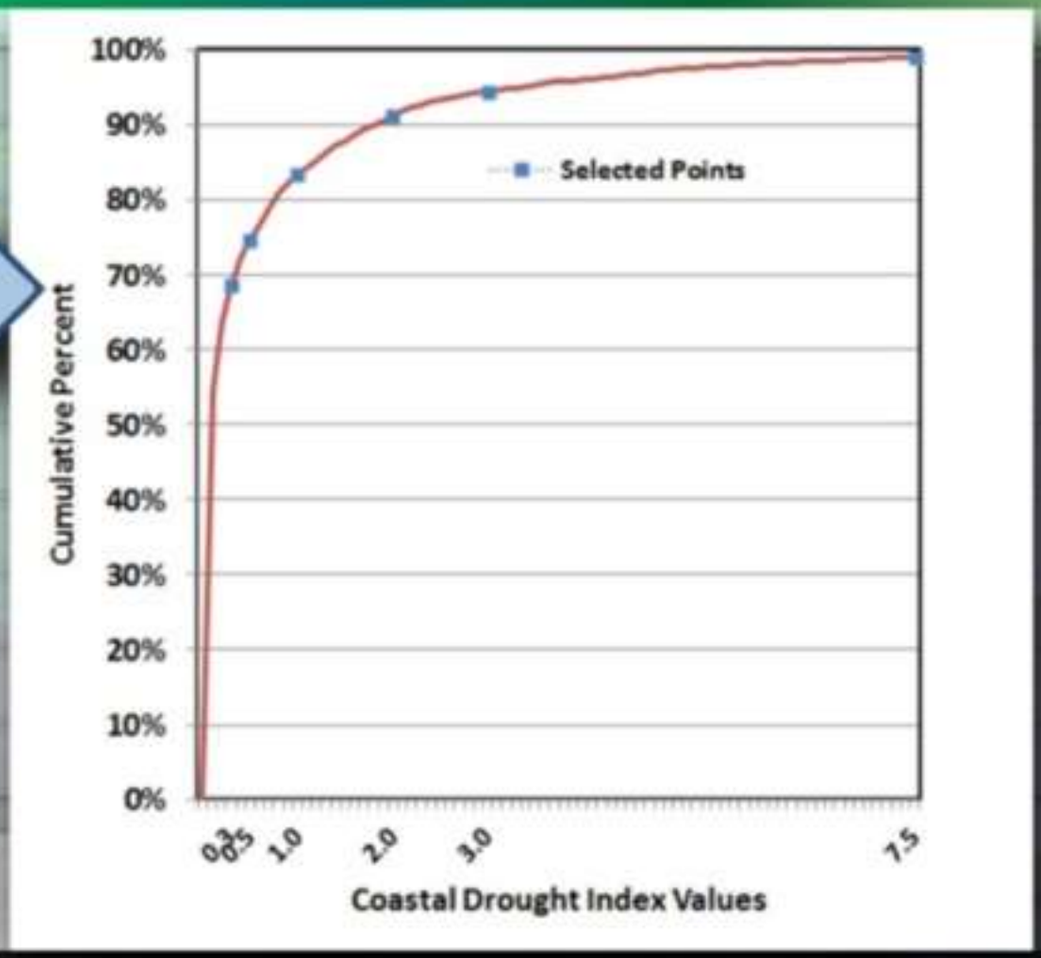
1. Signal process salinity times series to extract drought information,
2. Create “coastal drought” salinity time-series,
3. Compute frequency distribution, and
4. Use frequency distribution to set drought thresholds

Signal Processing



Preliminary Coastal Drought Index (CDI) Time Series & Frequency Curve



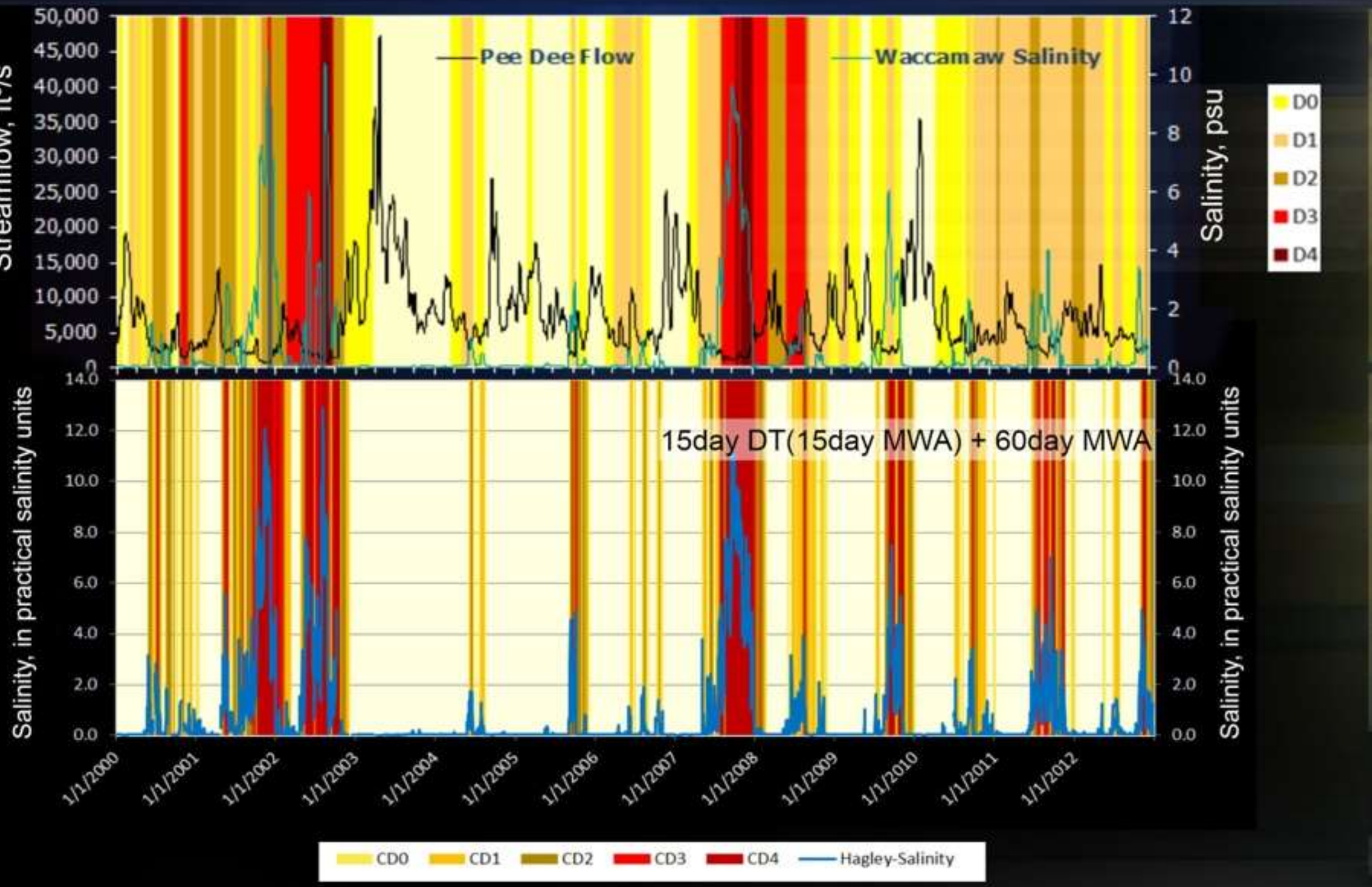


Preliminary

CDI = 60-day MWA salinity + 15-day DT

- Computed frequency distribution of CDI values
- Pick threshold values from distribution

Salinity, Flow and Drought Monitor Declarations



Issues to Address

- Pinball effect
- Concern for “wet” conditions
- Time scales between the CDI and environmental and ecological response variables

Standardized Precipitation Index (SPI)

- Similarity of SPI and cumulative Z-scores
- Normalize precipitation with probability distribution
- Index values are standard deviation from the median
- Index for dry and wet conditions
- SPIs comparable for different locations

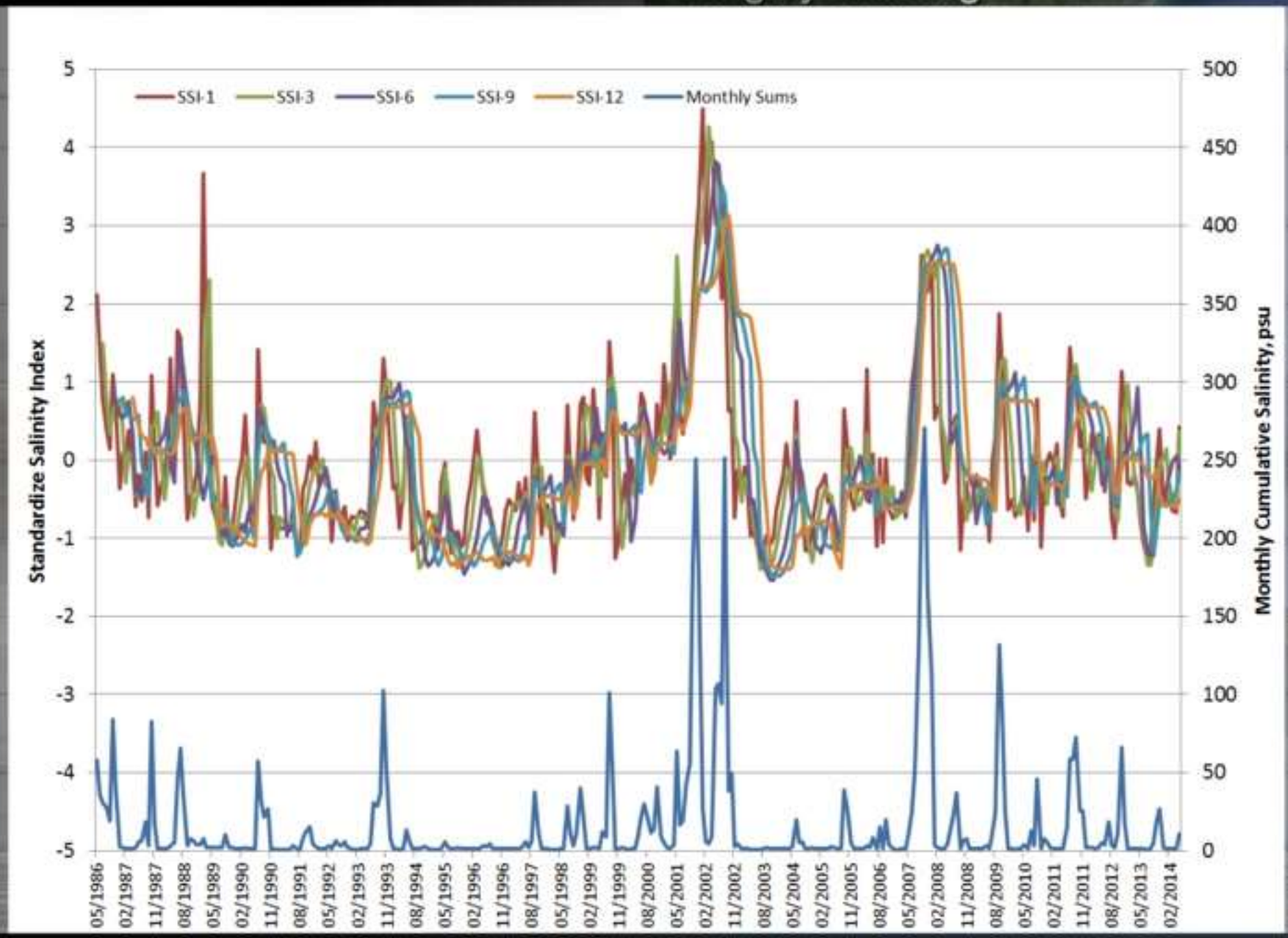
Benefits of computing a *Standardize Salinity Index*

- Compute for multiple time periods
  - 1-month, 3-month, 6-months, etc.
  - Difference time periods used for different drought response variable
- Index for fresher and saltier conditions
- Real-time computation of SSI
- Challenges
  - Limited number of long-term sites
  - Missing record – estimating data gaps

Monthly values

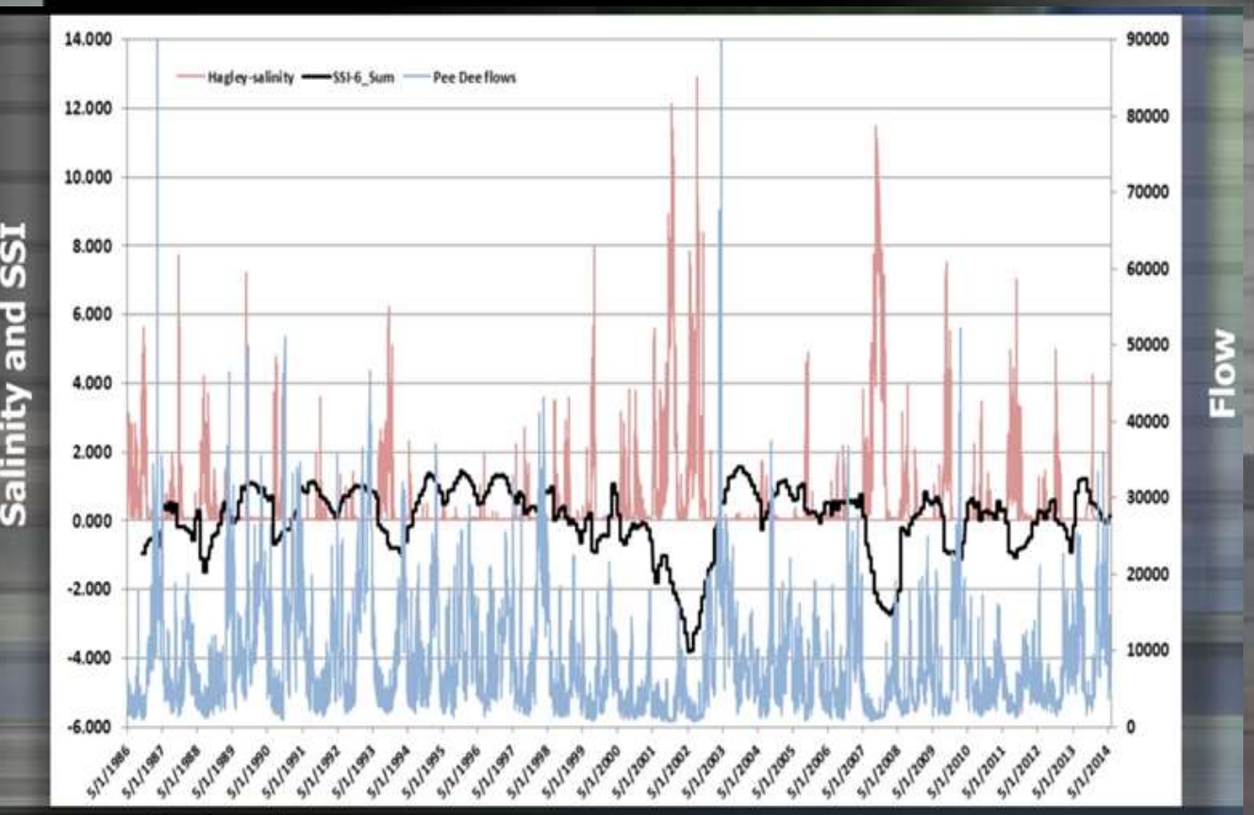
Positive SSIs – saltier conditions

Negative SSIs – fresher conditions

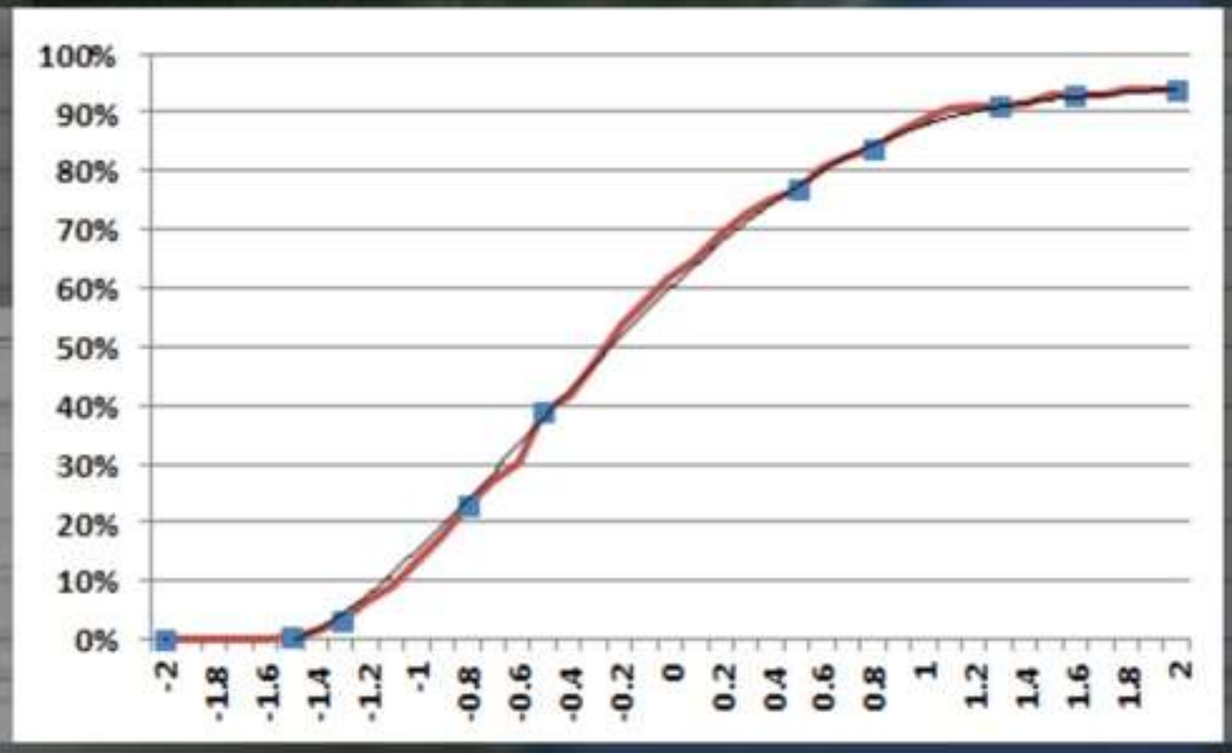


Issues with "positive" drought values

Transform SSI values into Drought Declarations



Daily values
Positive SSIs – fresher conditions
Negative SSIs – saltier conditions



Declaration	Decsription	SSI Threshold
W4	Exceptional wet	2
W3	Extreme Wet	1.6
W2	Severe Wet	1.3
W1	Moderate Wet	0.8
W0	Abnormally Wet	0.5
N0	Normal	0
D0	Abnormally Dry	-0.5
D1	Moderate Drought	-0.8
D2	Severe Drought	-1.3
D3	Extreme Drought	-1.6
D4	Exceptional Drought	-2

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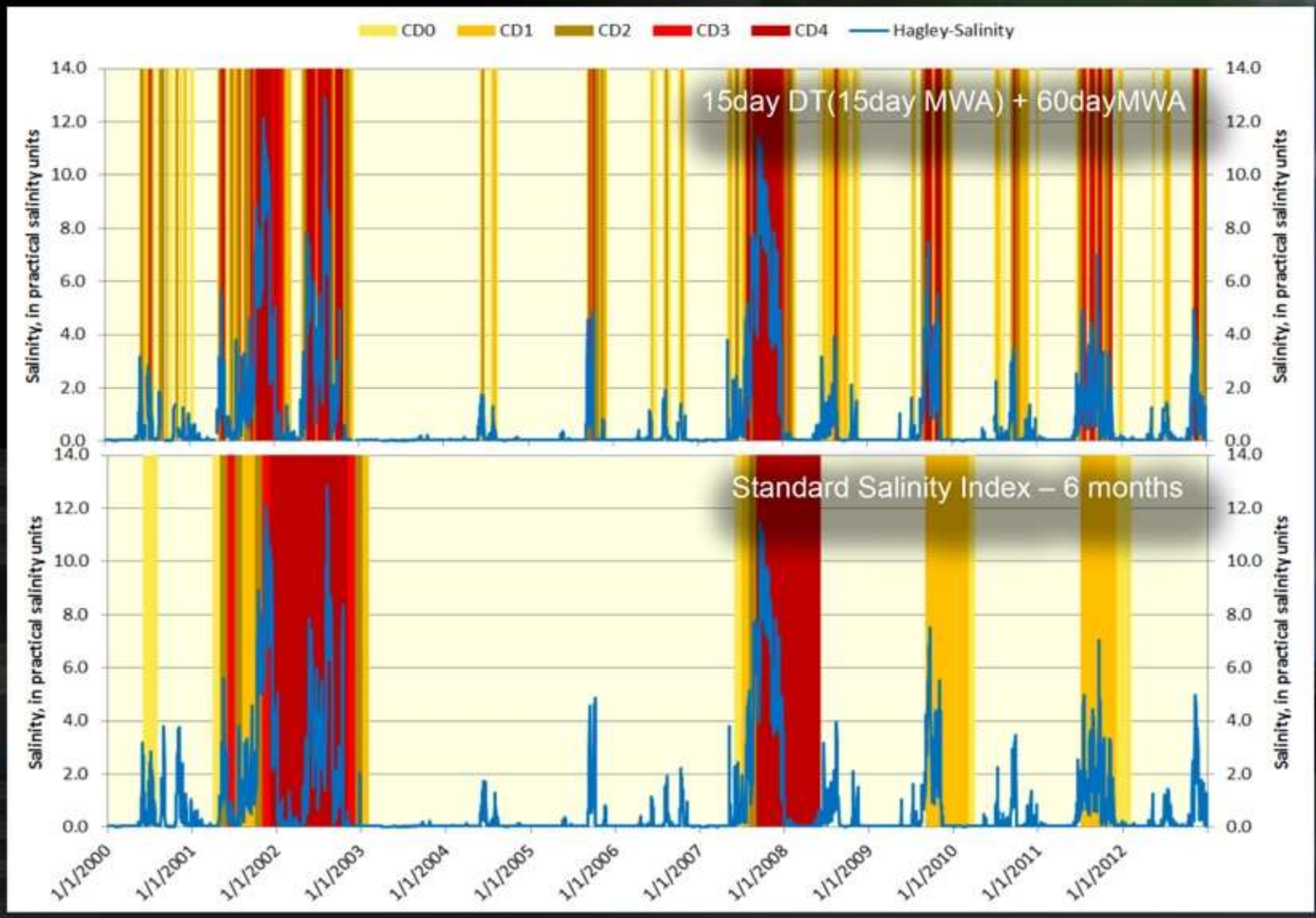


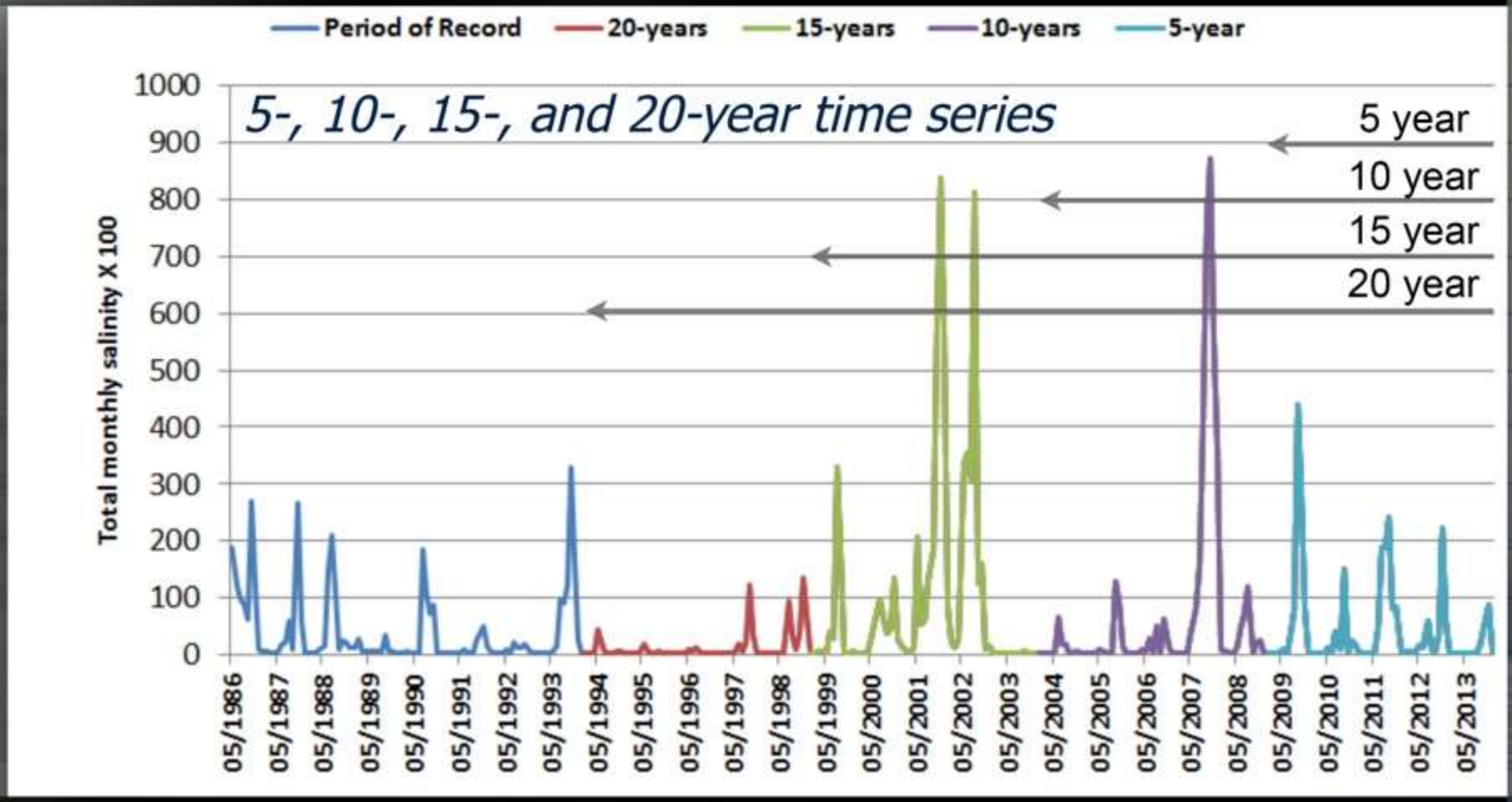
SSI doesn't have the "pinball machine" effect as compared to the preliminary CDI

USGS

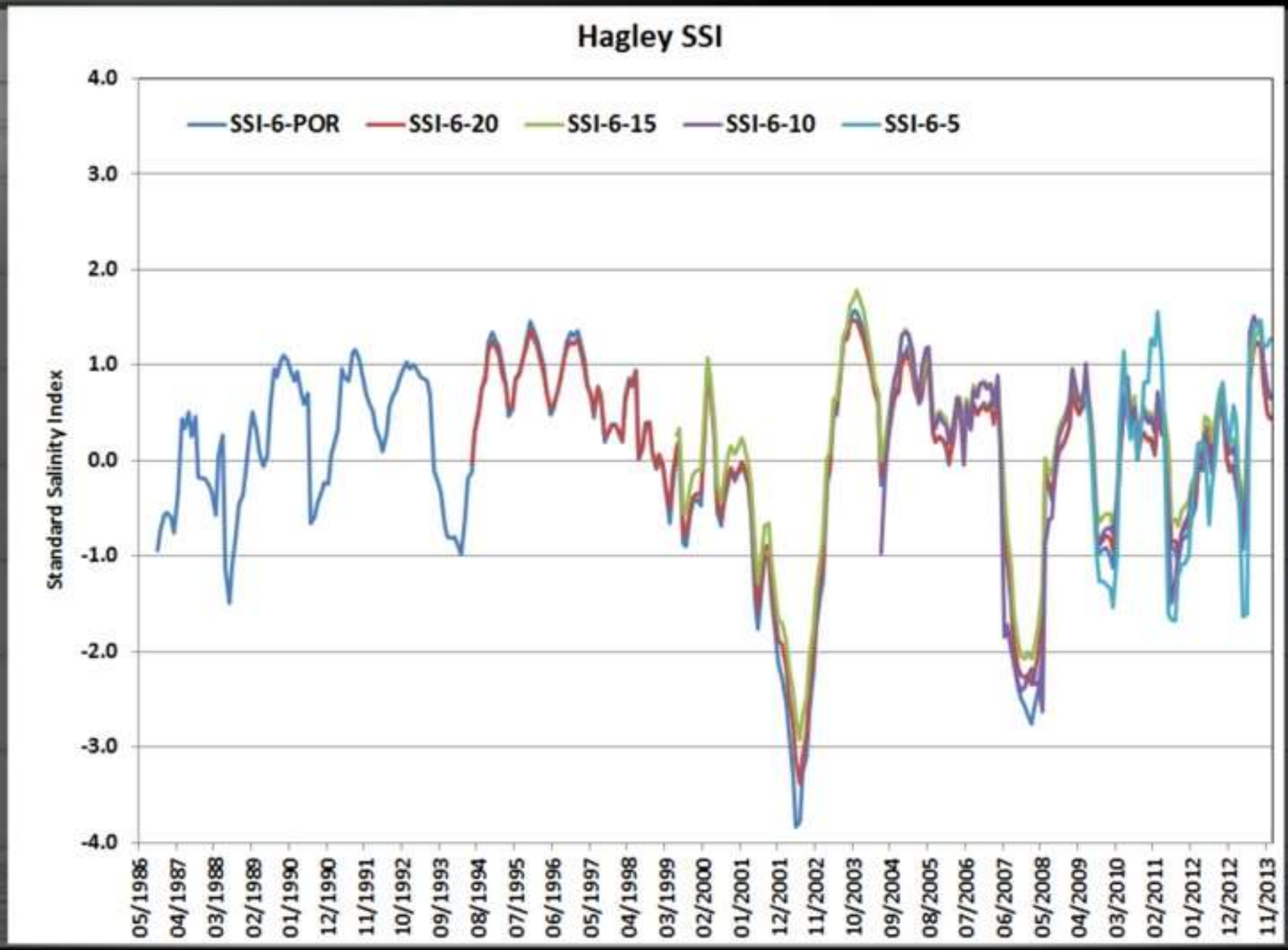
Other CDI issues

- Period of record
- Estuary types
- Regional comparisons

What are the effects of using different time periods?



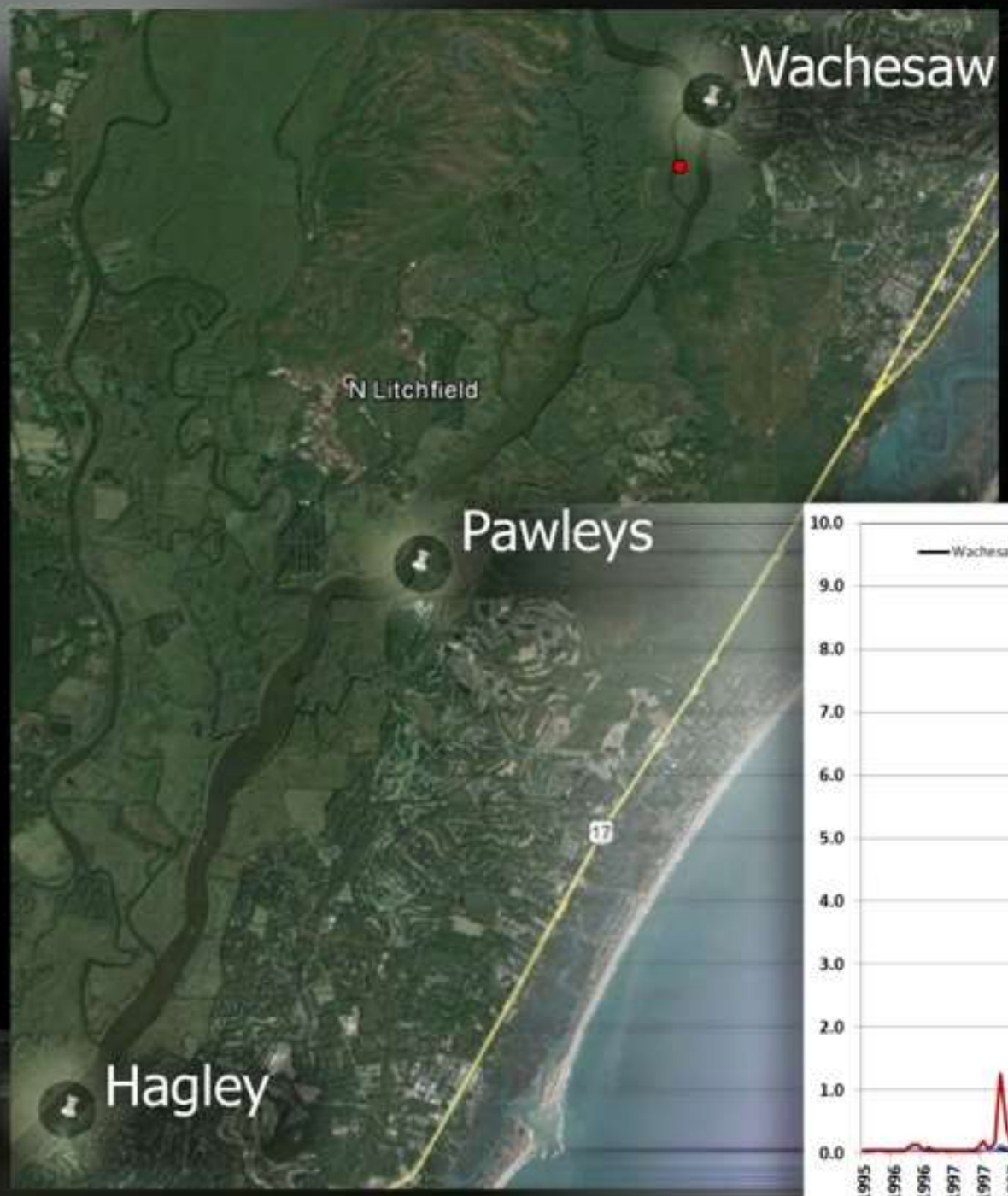
Range of historical record for 10-year data set is > that the other longer time series.



Results for 10-year and longer very similar.
The 5-year didn't have the range of conditions as the other datasets.

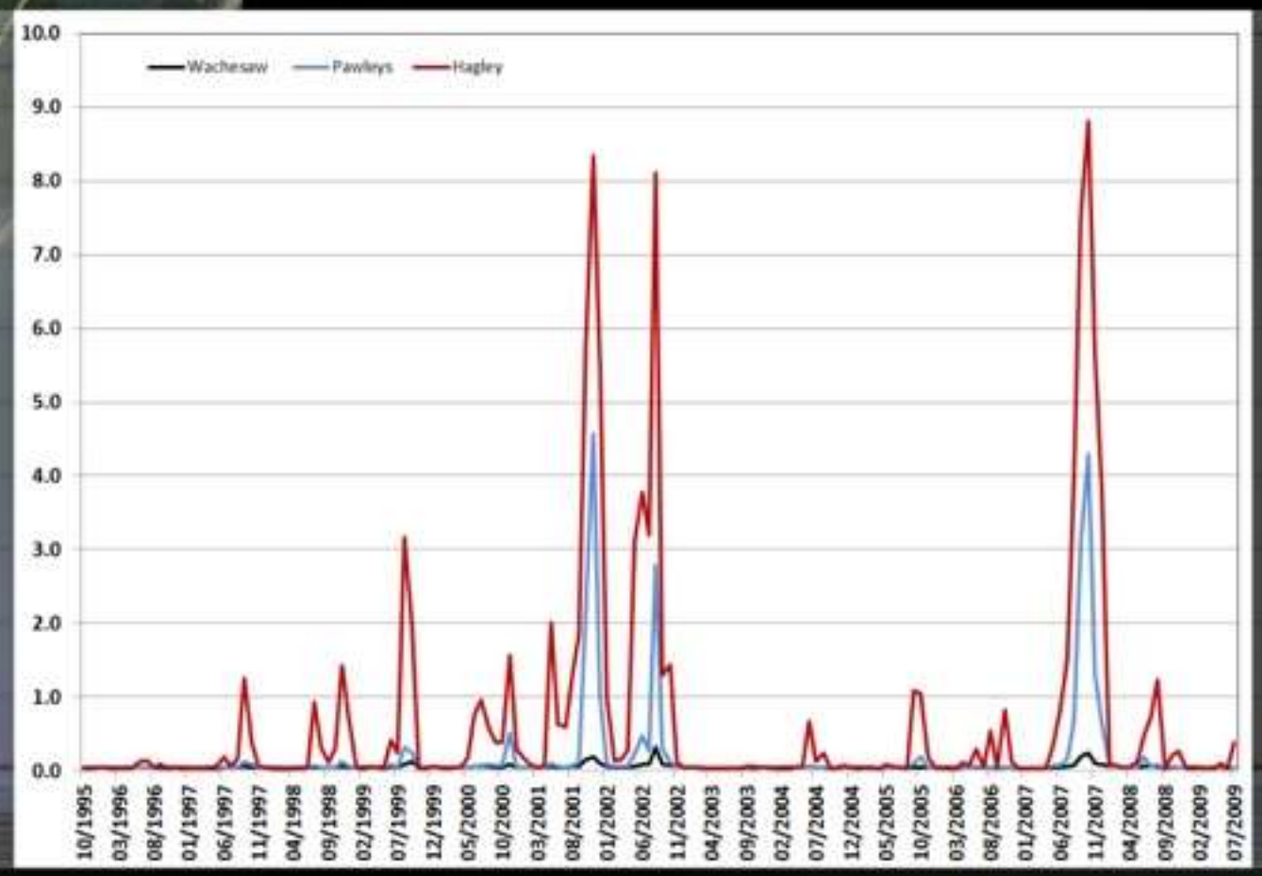
USGS

How do the SSIs from different sites on the same river look?



~14-years of measured and simulated data

October 1995 – July 2014



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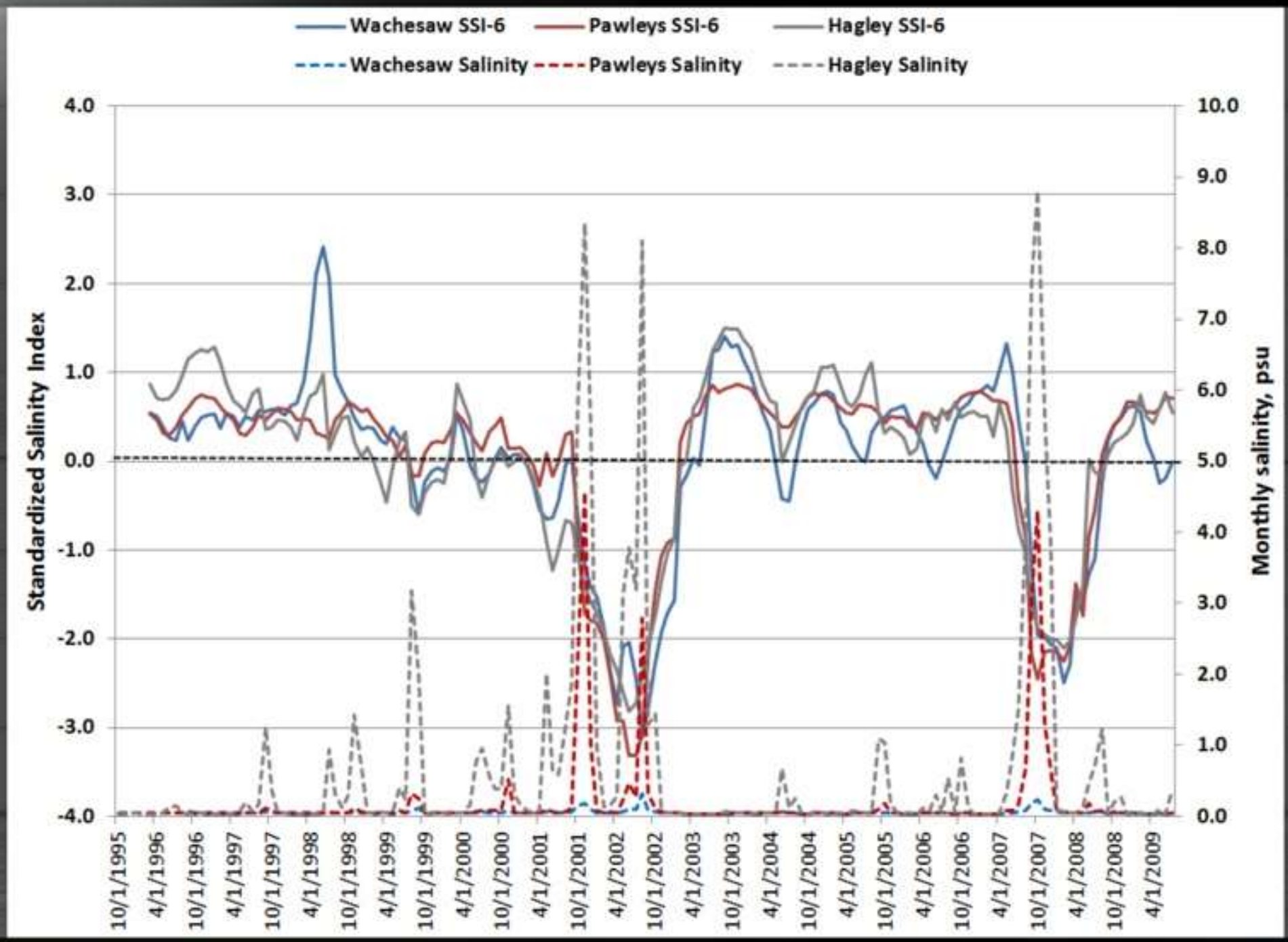
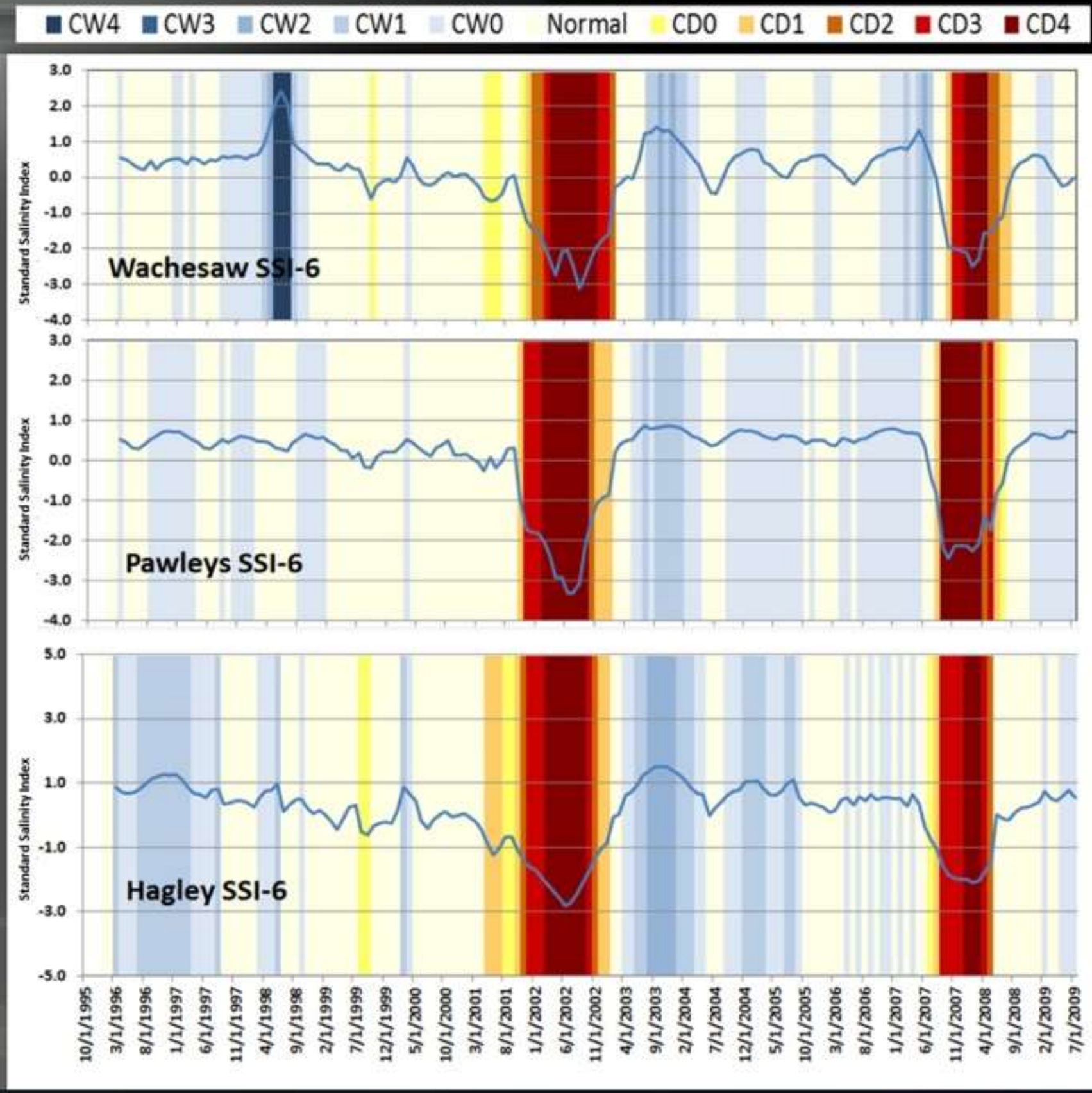
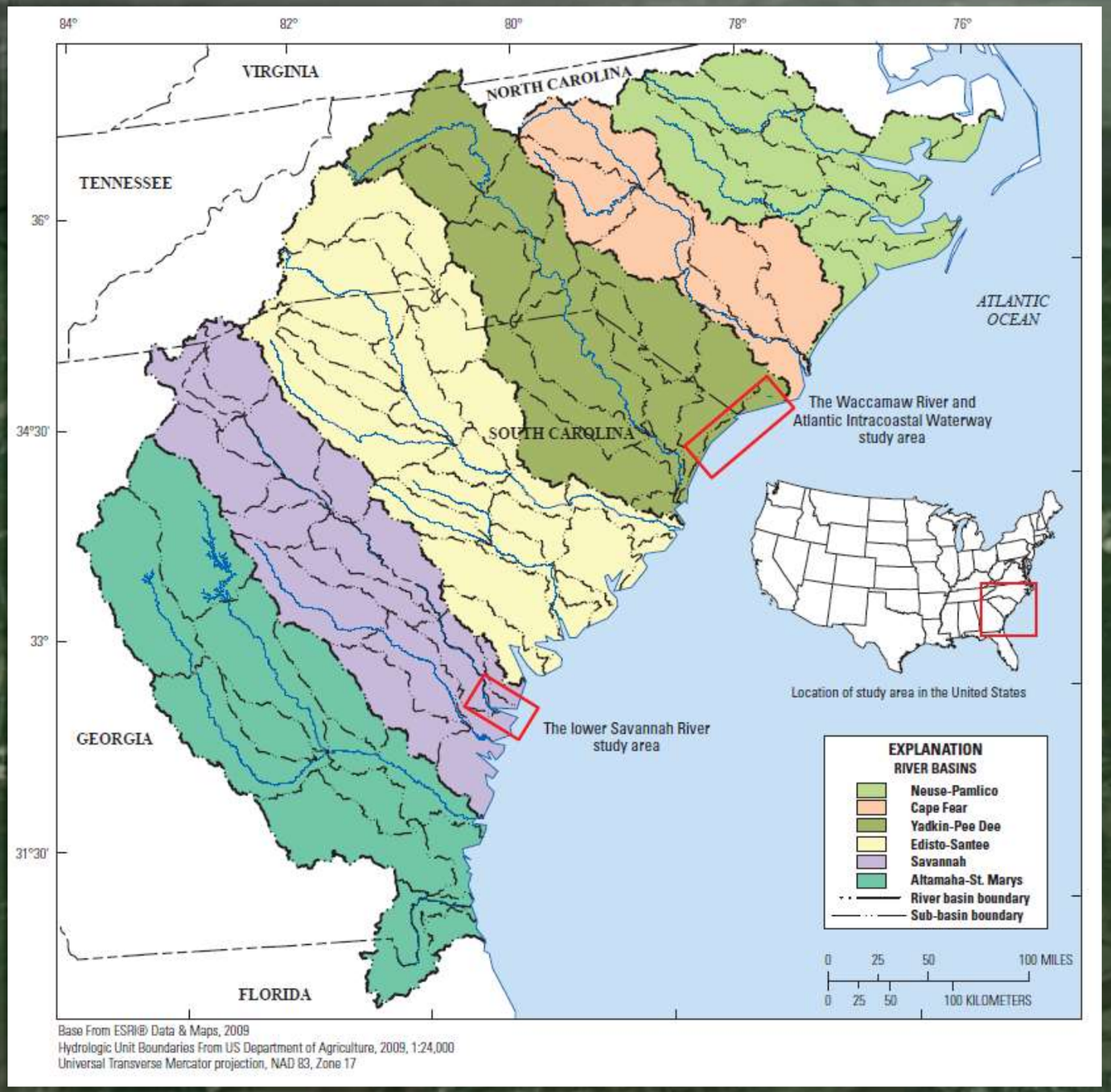
Waccamaw River SSI-6s



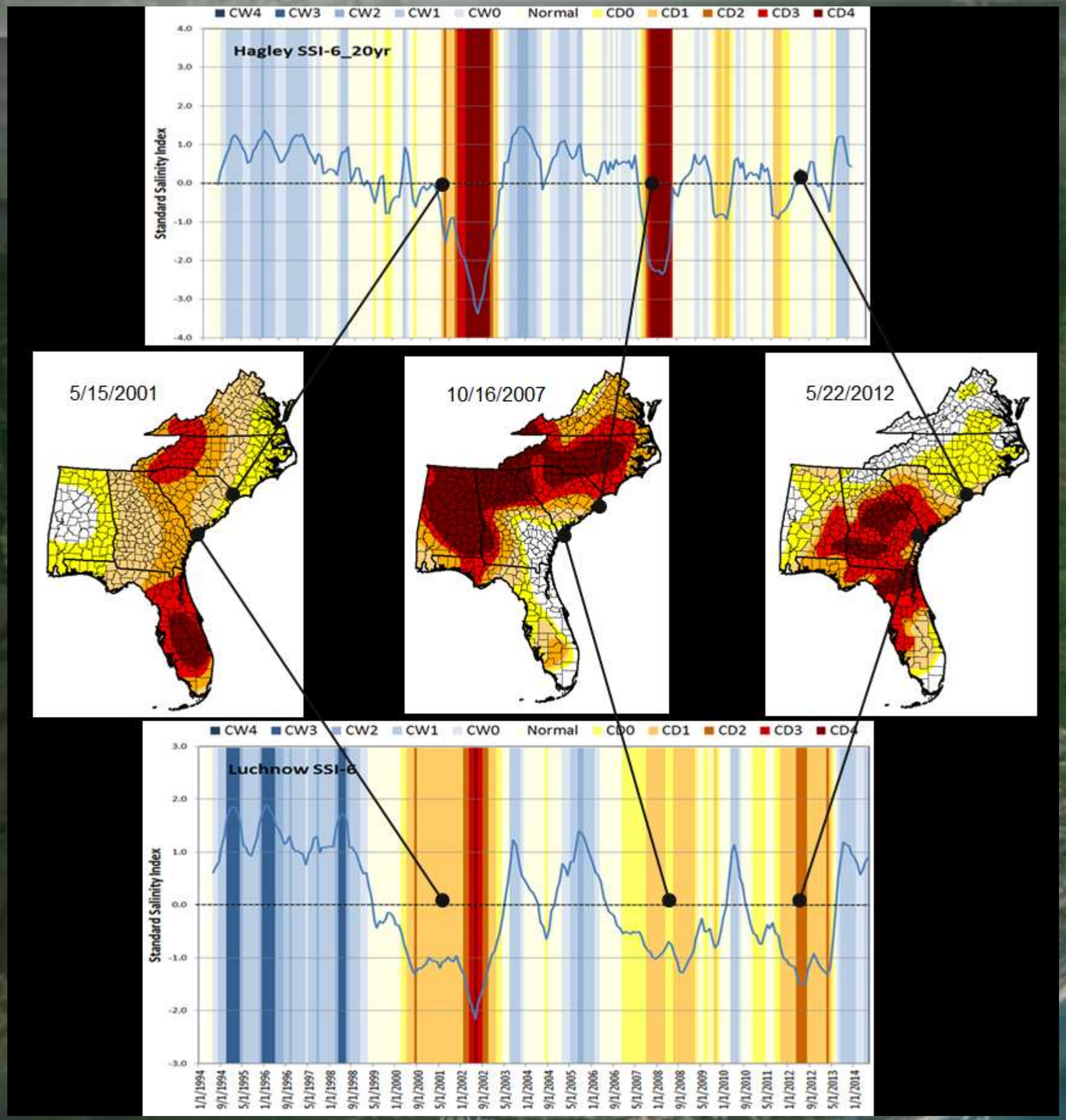

CW4
CW3
CW2
CW1
CW0
Normal
CD0
CD1
CD2
CD3
CD4
Standard Salinity Index
Wachesaw SSI-6
Pawleys SSI-6
Hagley SSI-6
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
5.0
-5.0
10/1/1995
3/1/1996
8/1/1996
1/1/1997
6/1/1997
11/1/1997
4/1/1998
9/1/1998
2/1/1999
7/1/1999
12/1/1999
5/1/2000
10/1/2000
3/1/2001
8/1/2001
1/1/2002
6/1/2002
11/1/2002
4/1/2003
9/1/2003
2/1/2004
7/1/2004
12/1/2004
5/1/2005
10/1/2005
3/1/2006
8/1/2006
1/1/2007
6/1/2007
11/1/2007
4/1/2008
9/1/2008
2/1/2009
7/1/2009

Regional Comparison

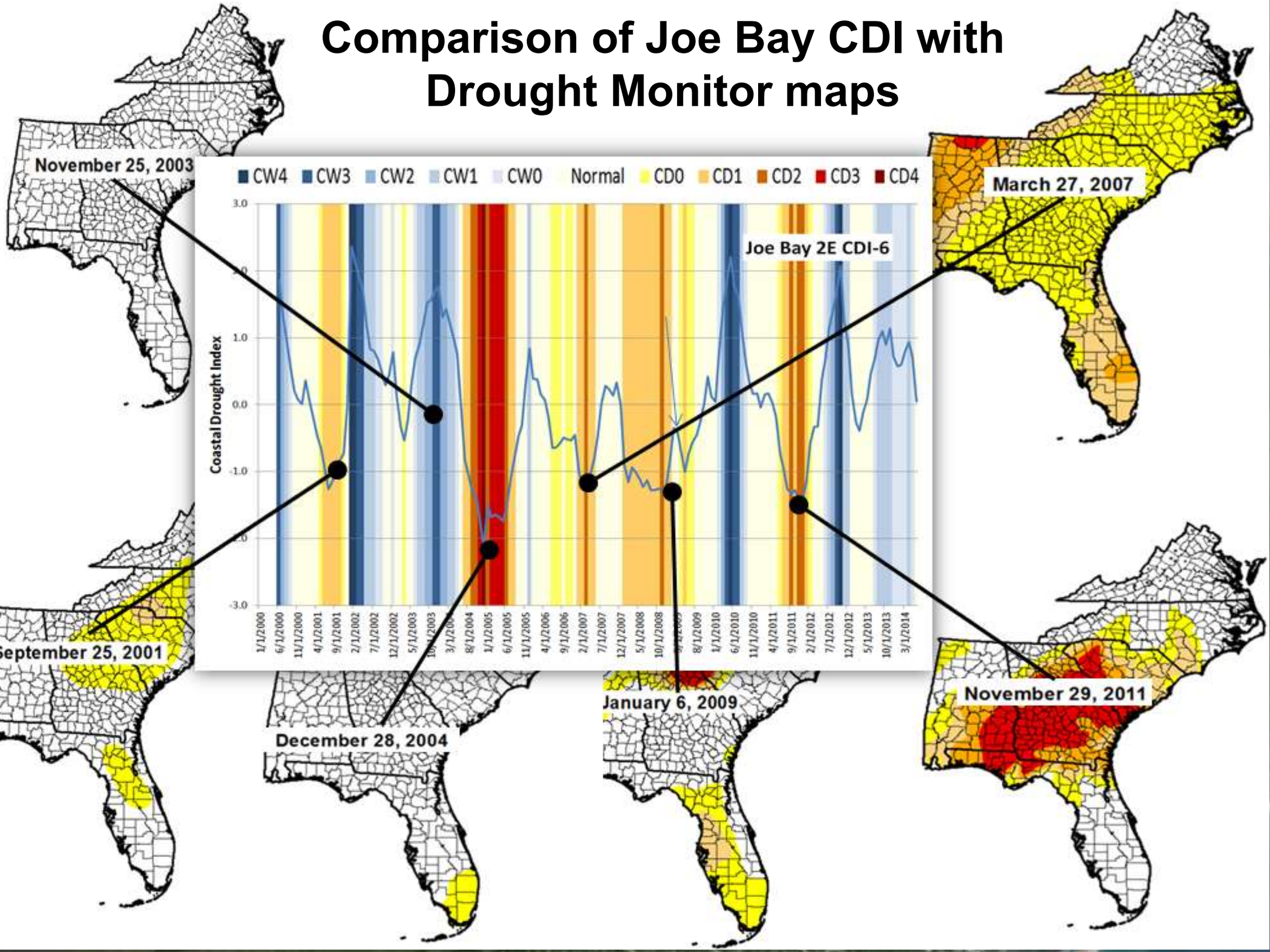


Is the CDI a site specific index or can it be used to regional comparisons?

Comparison with Drought Monitor Maps

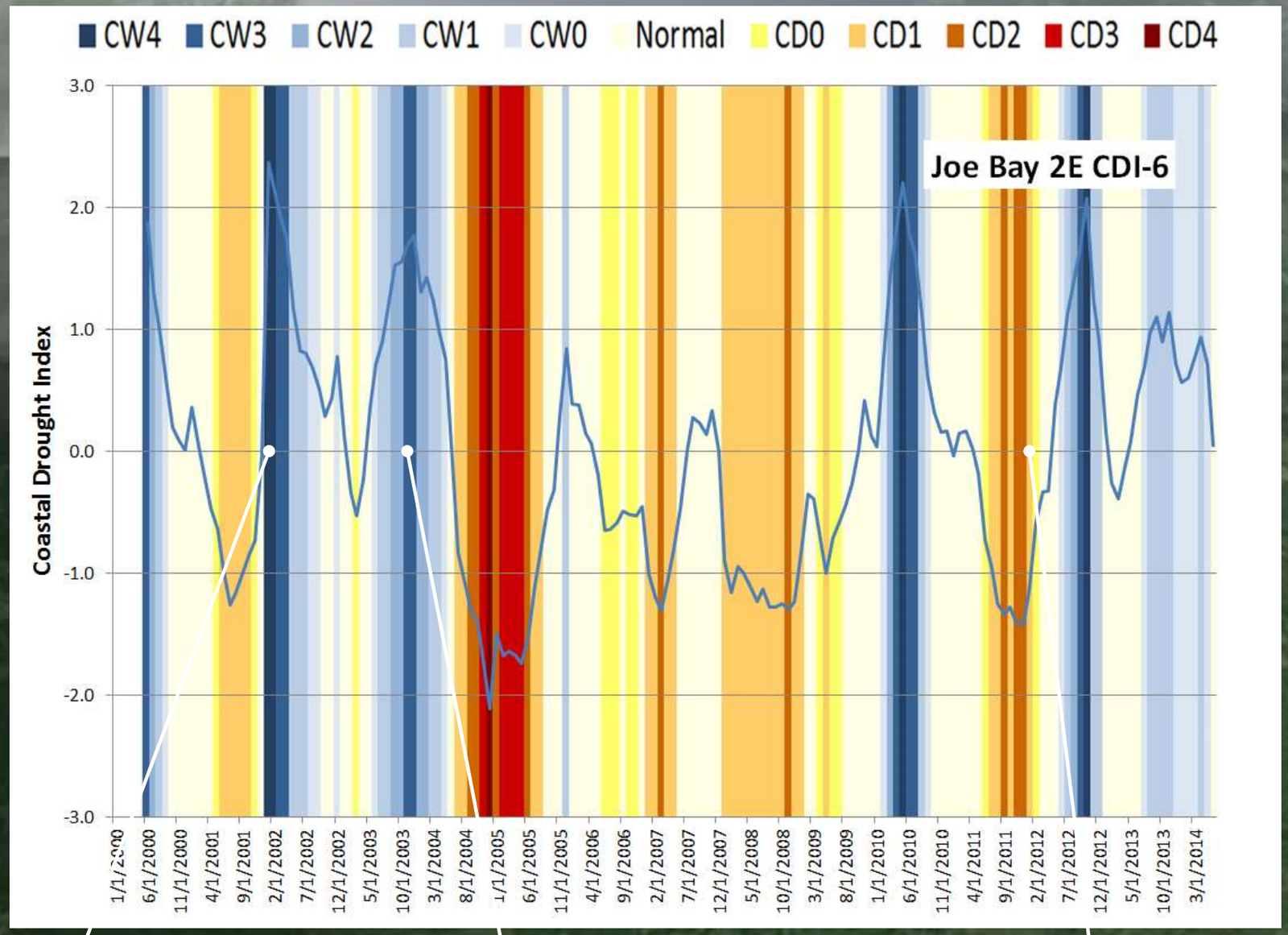


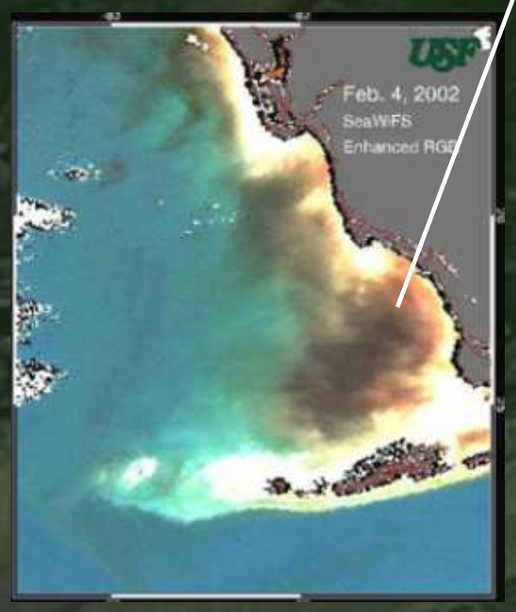
Comparison of Joe Bay CDI with Drought Monitor maps

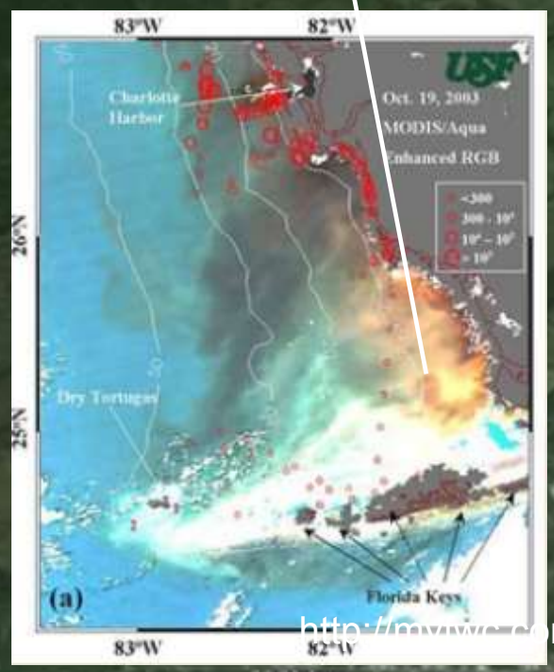


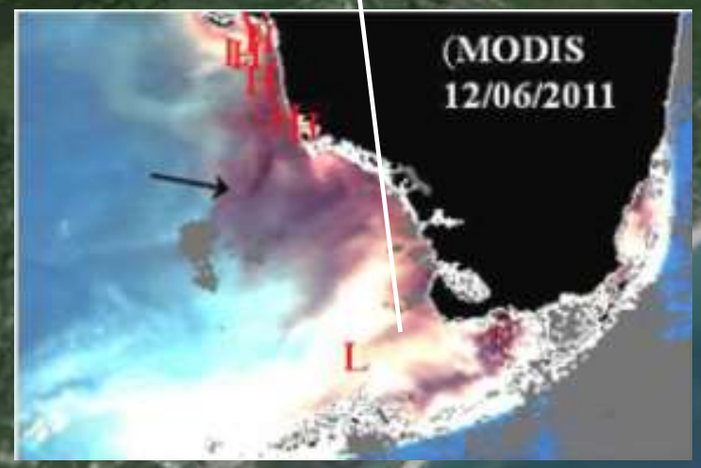
Dark water events in Southern Florida

Size of the 2011 event much smaller than the one 10 years earlier









http://myfwc.com/research/redtide/monitoring/historical-events/dark-water/

Summary

- CDI can be used for drought and wet conditions
- Not a site specific CDI
- May be able to use different periods of salinity record
- Can be used to compare sites
- Based on established SPI computation that readily understood and accepted in the drought community

Questions?

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