An aerial satellite photograph of a wetland area, likely the A.R.M. Loxahatchee National Wildlife Refuge. The image shows a large, dark, irregularly shaped area in the upper left, which is a body of water. The surrounding land is a mix of green and brown, indicating different types of vegetation and possibly agricultural fields. A white outline highlights a specific, roughly rectangular area in the lower right quadrant of the image, which appears to be a dense forest or a specific wetland feature. The text is overlaid on the image in a white, sans-serif font.

Spatial and temporal
trends in water quality at
the A.R.M. Loxahatchee
National Wildlife Refuge:
A water quality index for
assessing long-term
restoration

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Rebekah Gibble, PhD, ARM Loxahatchee NWR



Hypothesis

- ▶ Water quality parameter status in combination with individual ecological thresholds can be used to track ecosystem status

Goal

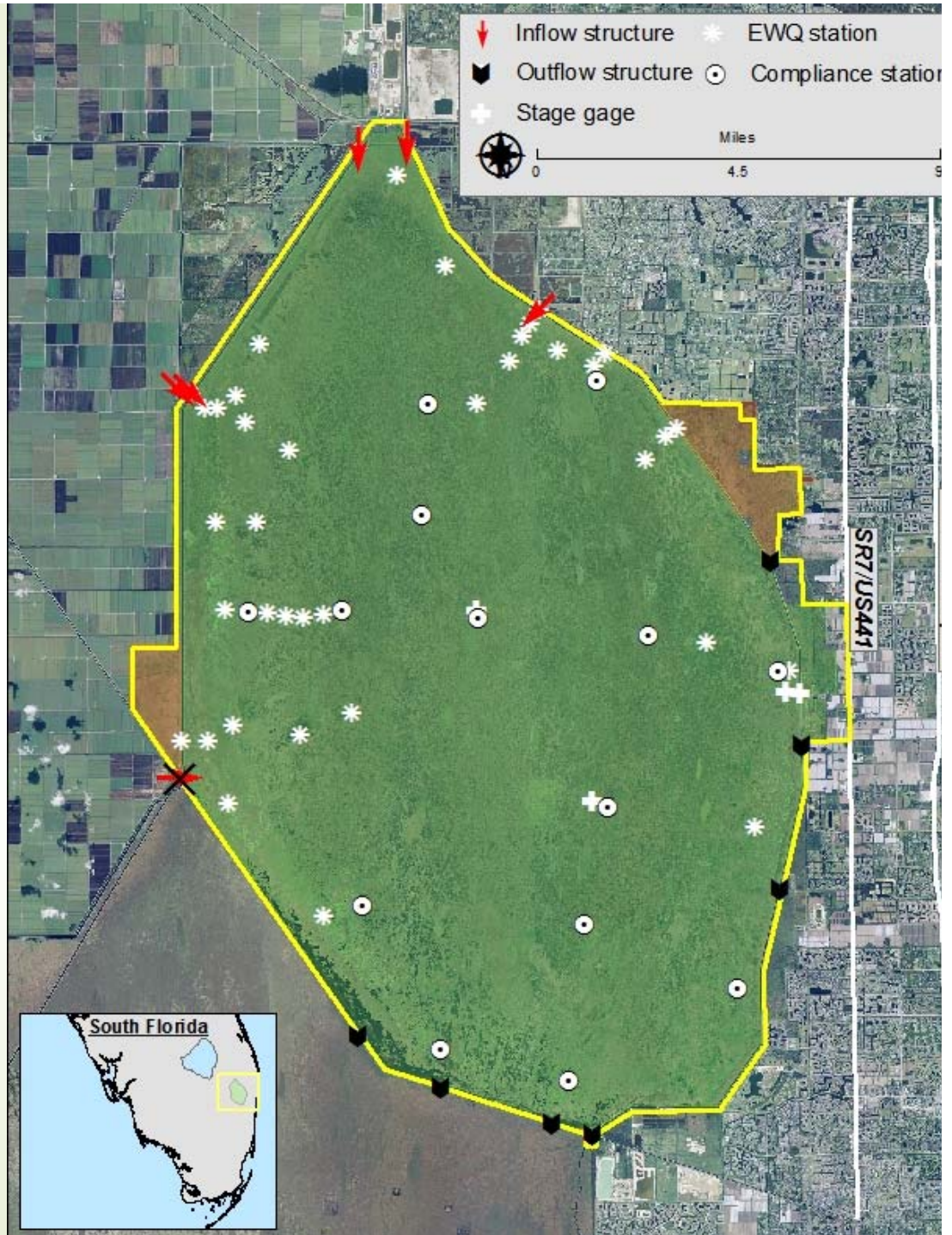
- Develop a simple water quality index using the Enhanced Water Quality (EWQ) monitoring network on the Refuge
- Use the index to assess system status

Image source: sofia.usgs.gov

Data

Analytical POR:

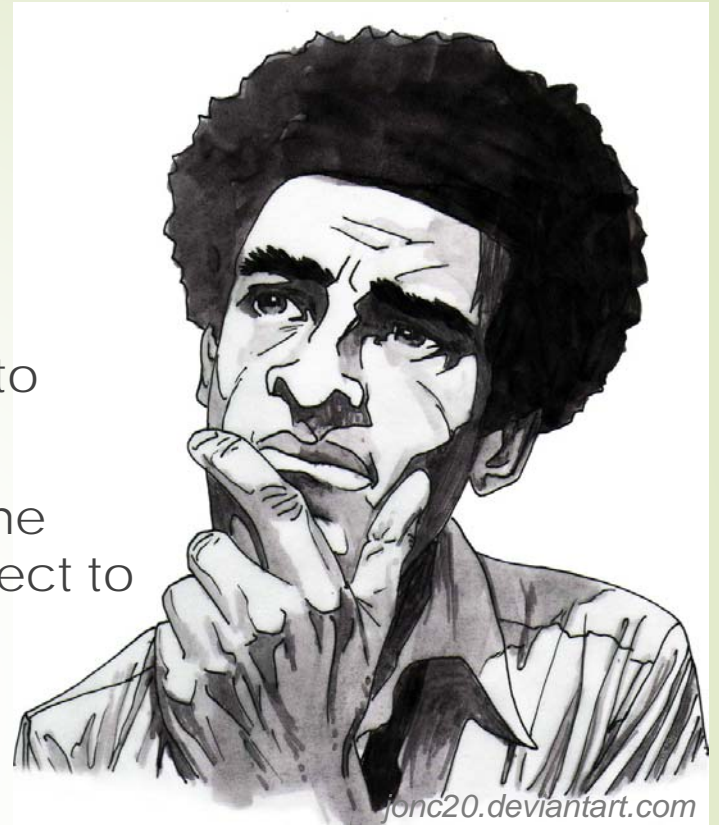
- Calendar Year (CY) 2004 – 2014
- Period for comparison:
 - CY04-07
 - CY08-11
 - CY12-14



Analyses

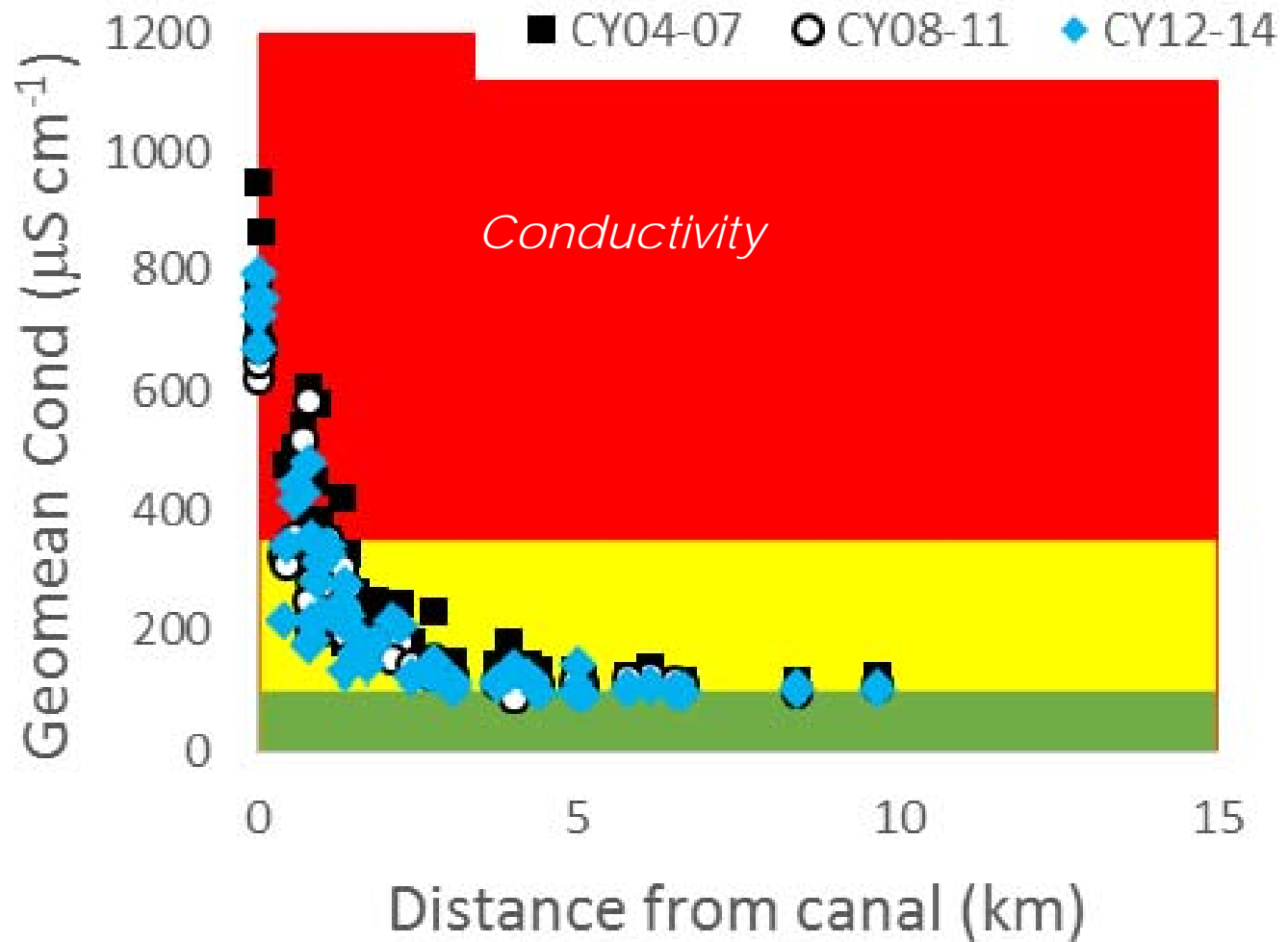
- ▶ Surface water trends:
 - ▶ Canal and marsh:
 - ▶ Long-term trends:
 - ▶ P, Cond, SO₄, DO
 - ▶ Hydrologic variability removed through regression against stage
 - ▶ Residuals for each station and parameter tested for statistical trends
 - ▶ $\alpha < 0.1$
- ▶ Water quality index mannKen R trends

Analyses (cont.)

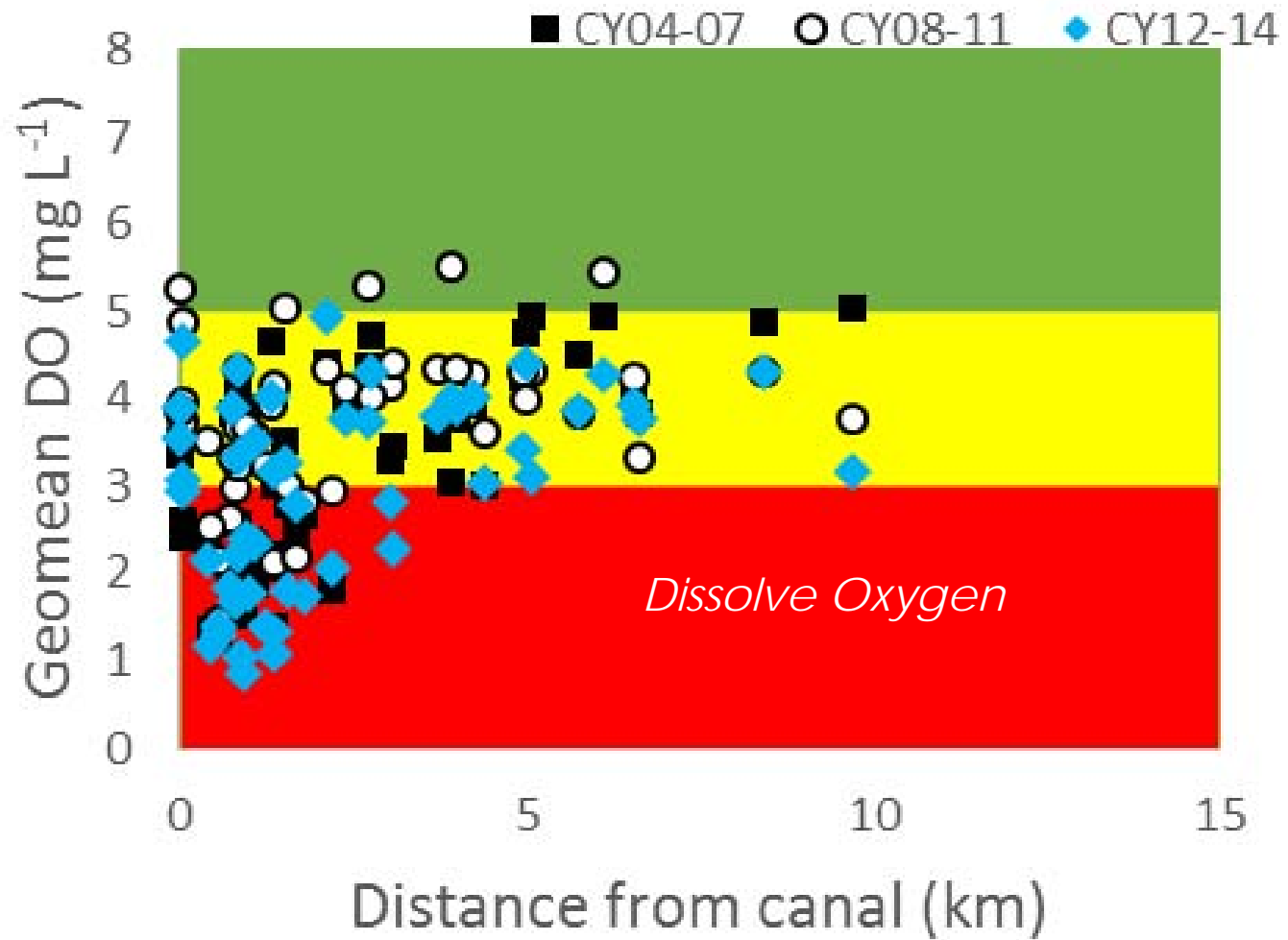


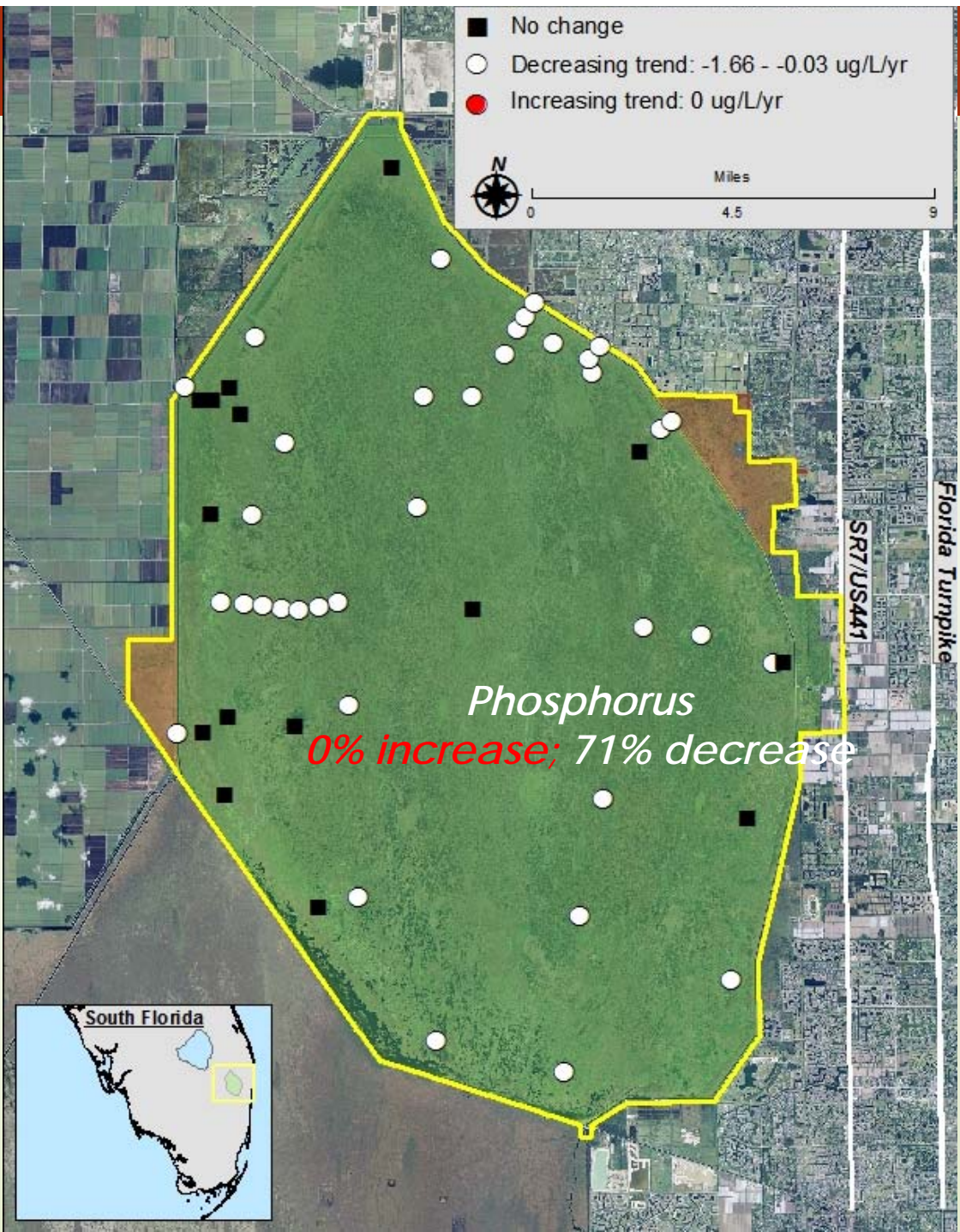
- ▶ WQ index development:
 - ▶ Combine P, DO, Cond, and SO_4 together to generate an index
 - ▶ Values from 0 to 2 were attributed to the water quality at each station with respect to parameter specific thresholds
 - ▶ P: ≤ 7 ppb (CD target for Refuge marsh), ≤ 10 ppb (EPA), > 10 ppb
 - ▶ DO: ≤ 3 ppm (EPA poor no life support), ≤ 5 (EPA poor, supports non-juvenile), and > 5 (EPA supports life)
 - ▶ Cond: ≤ 100 (close to rainfall driven), ≤ 350 (Periphyton community stays intact), > 350 (Desmides and sensitive diatoms die-off and replaced)
 - ▶ SO_4 : ≤ 1 ppm (Corrales 2011, no MeHg), ≤ 20 (Corrales 2011, promotes MeHg), > 20 (Corrales 2011, no MeHg)
 - ▶ Index ranges 0 to 8, with 0 = seriously degraded and 8 = no significant degradation
 - ▶ Trends by stations assessed

Long-term spatial pattern



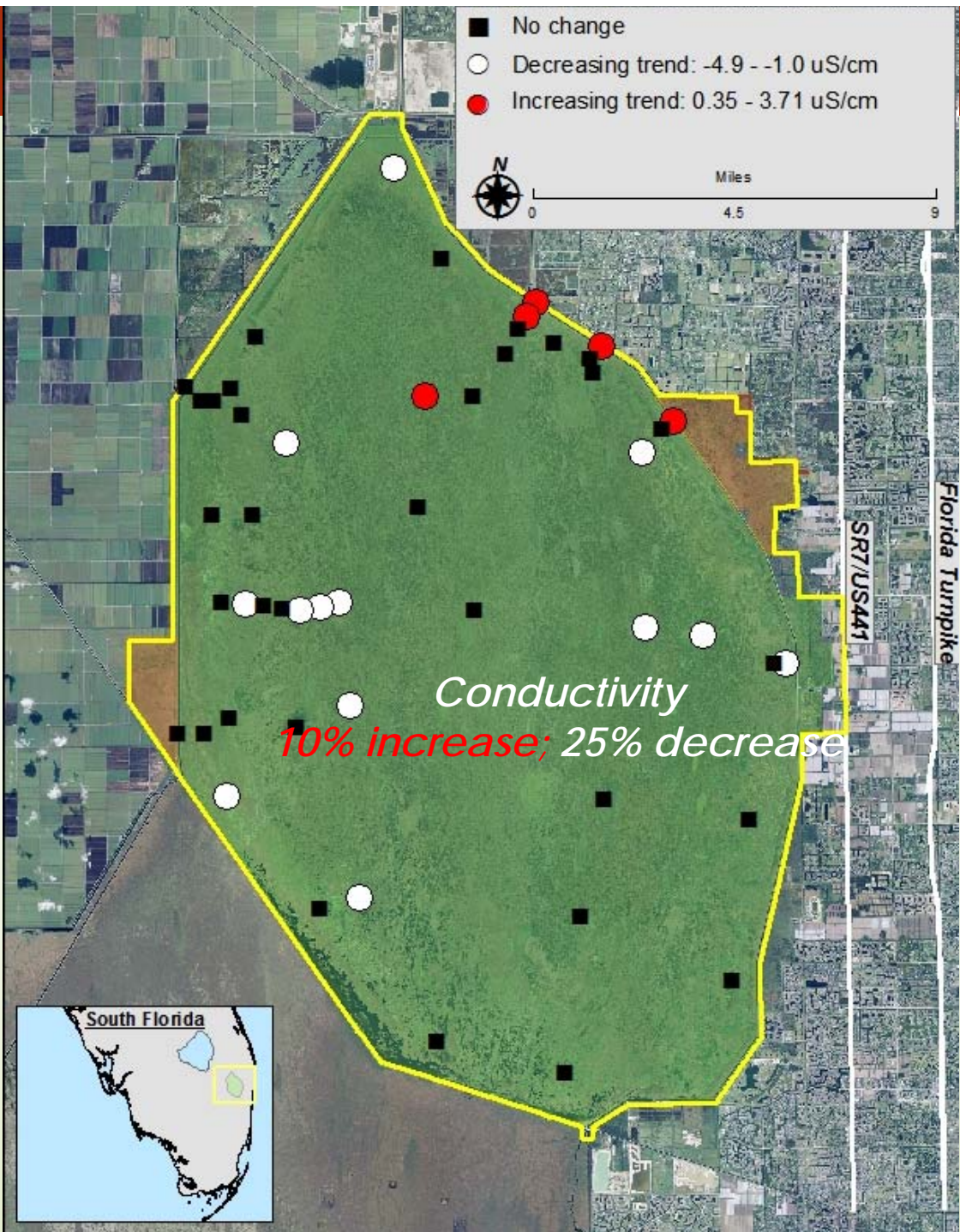
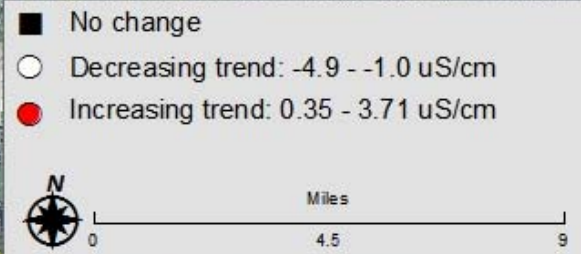
Long-term spatial pattern





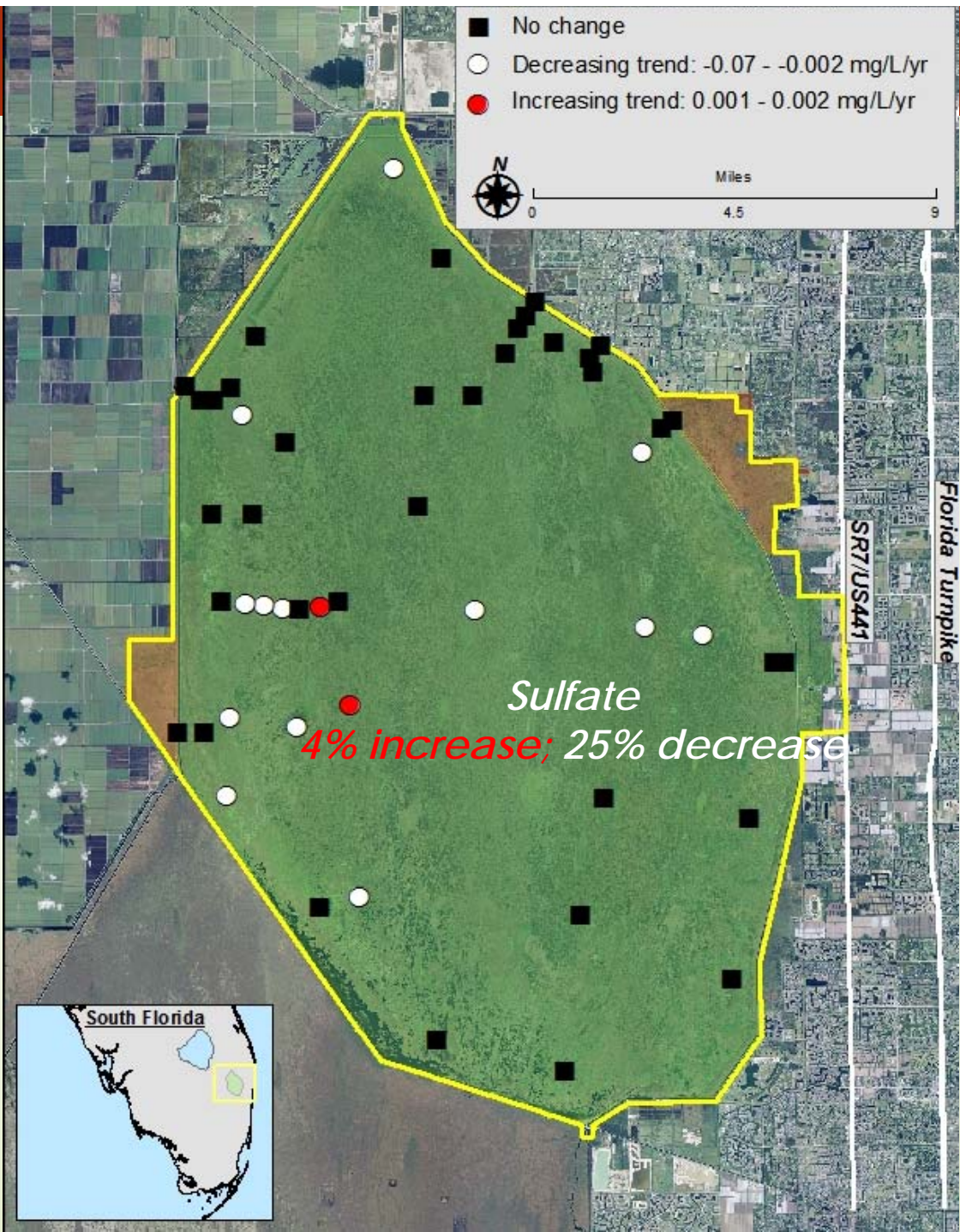
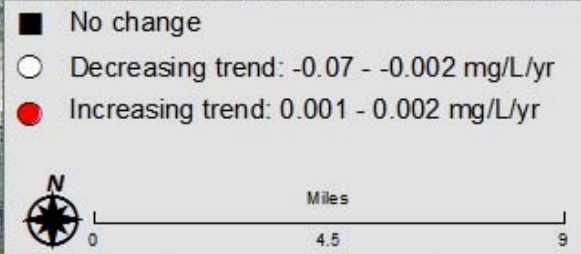
Phosphorus
0% increase; 71% decrease

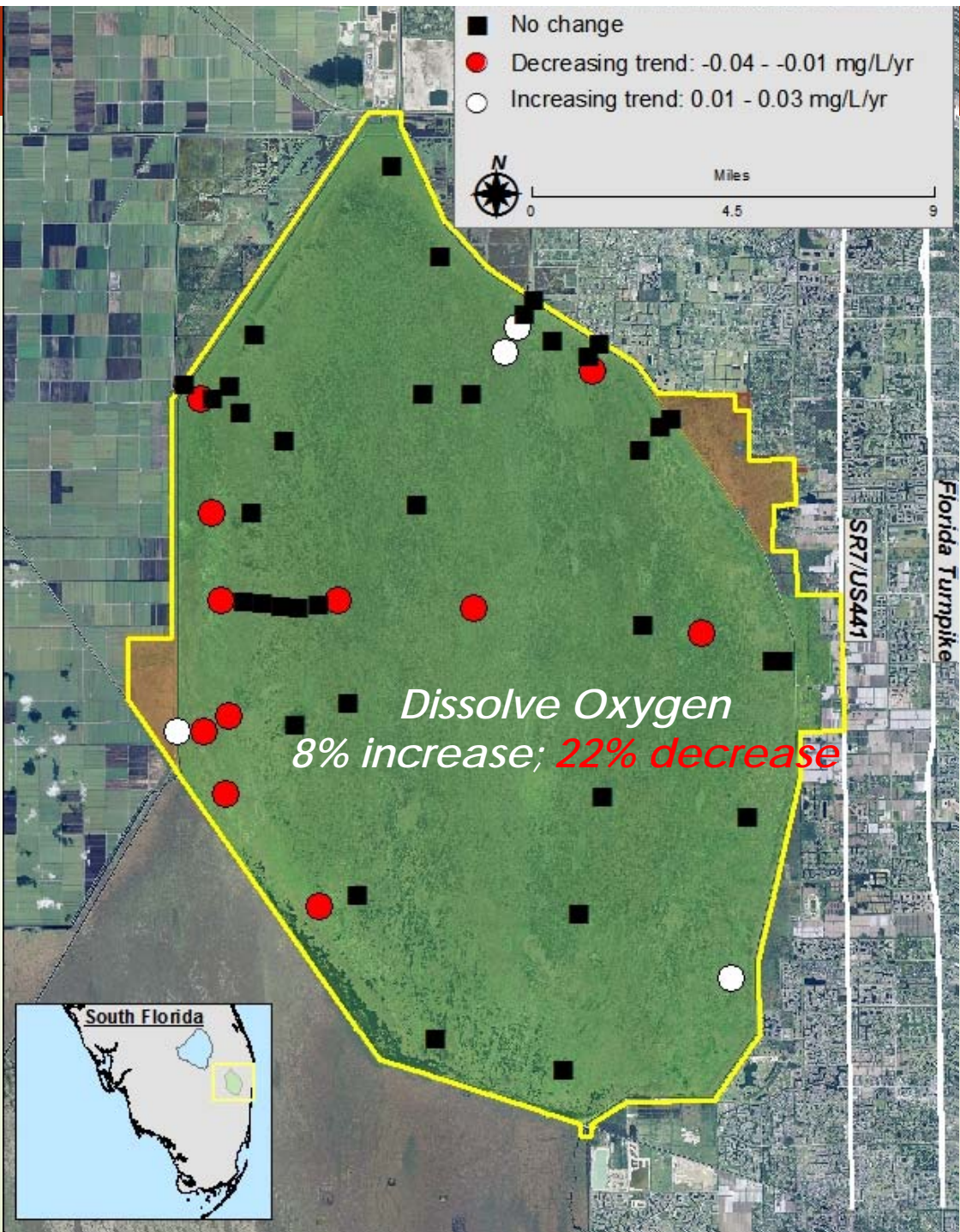
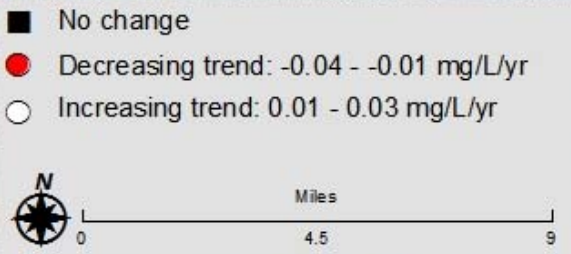




Conductivity
10% increase; 25% decrease





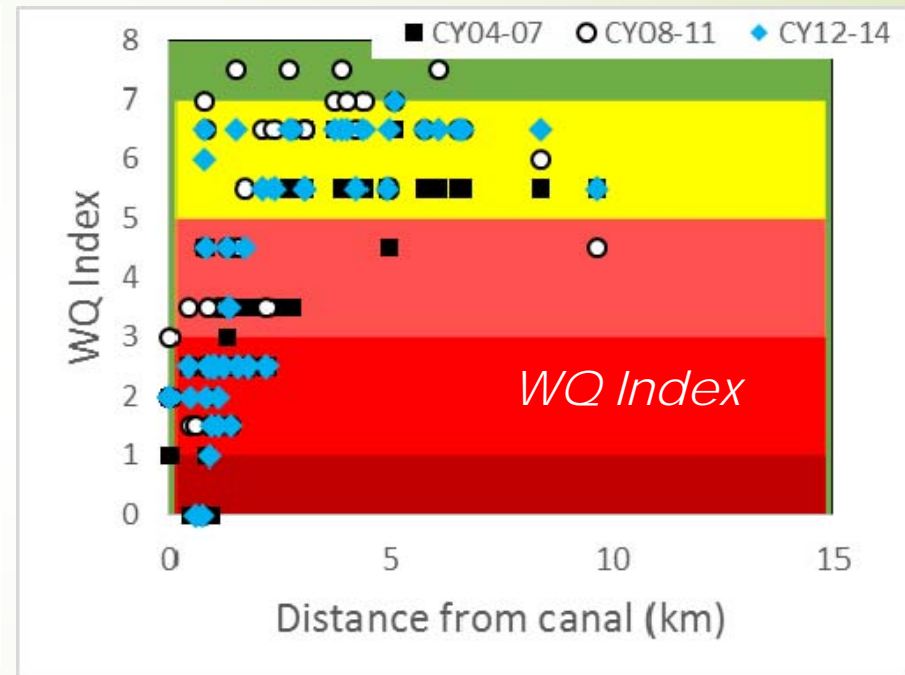


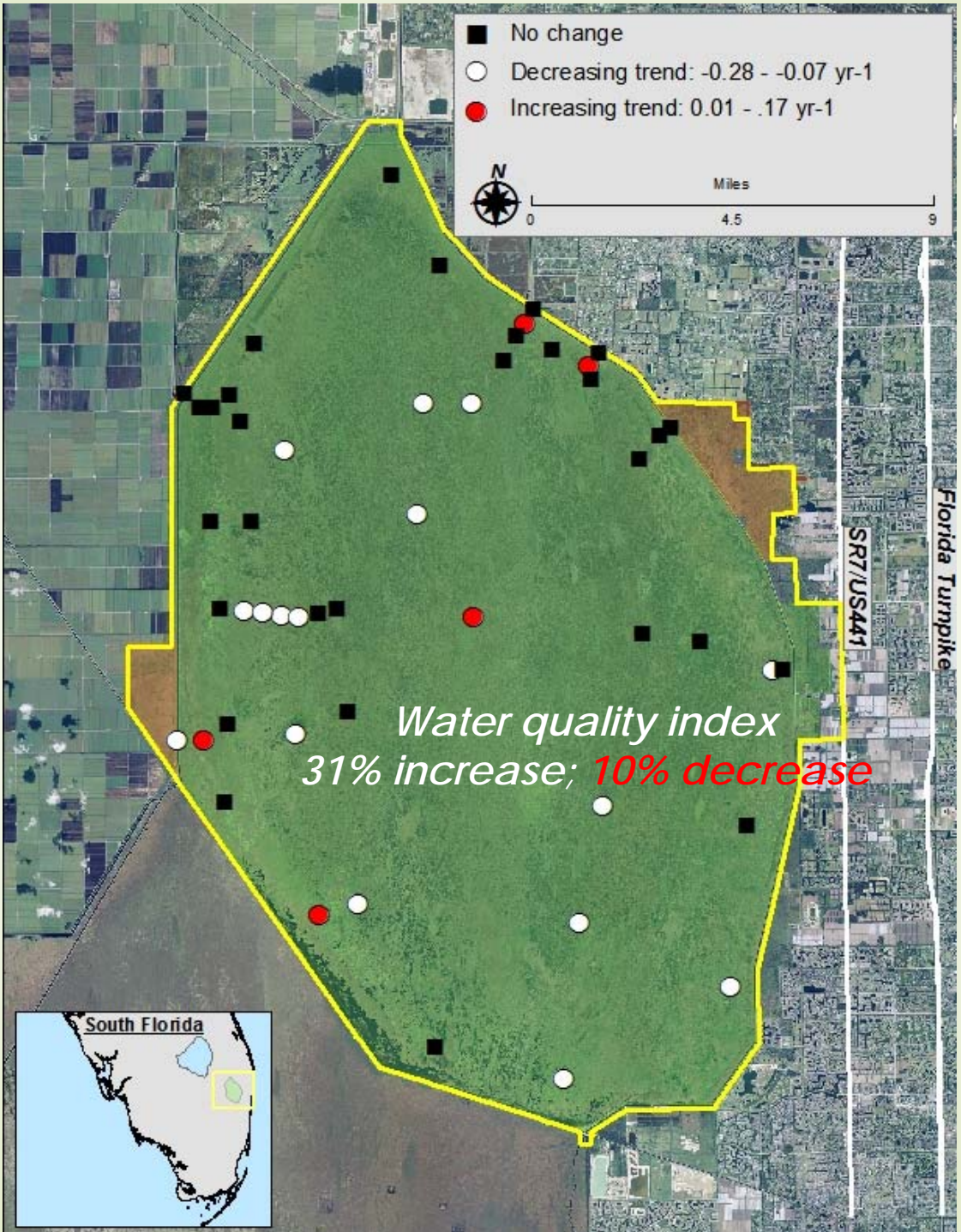
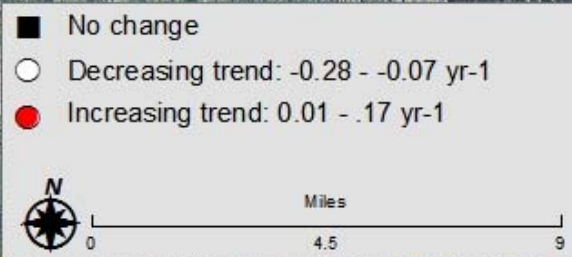
Dissolve Oxygen
 8% increase; 22% decrease



Water quality index

Index value	Descriptor
8	No significant degradation
6-7	Evidence of degradation
4-5	Degraded
2-3	Considerably degraded
0-1	Seriously degraded





Water quality index
 31% increase; 10% decrease



Take home points

- ▶ Downward trends in all parameters, but substantial decreases in DO across the Refuge
- ▶ Water quality index shows many stations above considerably degraded status after about 2.5 km into the marsh interior
- ▶ Index shows areas of improvement and problem spots (i.e., downstream STA1E)



Next steps

- ▶ Link WQ index with vegetation status and hydrologic spatial patterns
- ▶ Determine if WQ index can be used as an early warning indicator – compare with periphyton metrics
- ▶ Test WQ index formulation for other areas of the Everglades (e.g., Everglades National Park, WCA2 and WCA3)
- ▶ Incorporate index into structured decision making



Resources

- ▶ Reports on the Enhanced Water Quality Program:
 - ▶ http://sofia.usgs.gov/lox_monitor_model/
- ▶ Data request:
 - ▶ Donatto Surratt
 - ▶ donatto_Surratt@nps.gov
 - ▶ 561.735.6003
- ▶ Funding support:
 - ▶ Critical Ecosystem Studies Initiative (CESI)
 - ▶ Find out more at:
<http://www.nps.gov/ever/learn/nature/cesi.htm>
- ▶ Disclaimer: The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any agency of the U.S. government.