Reducing Septic Tank Pollution in Charlotte County: Background Research and Scope of Work

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Critical Issues Facing Florida's Estuaries and Coastal Waters

- Nutrient, microbial and contaminant pollution
- Harmful algal blooms
- Loss of seagrass and coral reef habitat
- Decline of fisheries
- Emerging diseases and mortalities in wildlife (corals, manatees, dolphins, sea turtles, pelicans, fish, shellfish) and humans

Septic Tanks: An "Unseen" Source of Sewage Pollution in Florida's Waters

- Approximately one-third of households in Florida rely on septic tanks

- Soils in much of Florida are unsuitable for septic tanks (porous sands or karst limestone, low organic content, high water tables)

- Contaminants include nitrogen, phosphorus, OWCs (pharmaceuticals, hormones, etc.), bacteria, viruses

- Estimated N-load from septic systems in Florida is substantial:

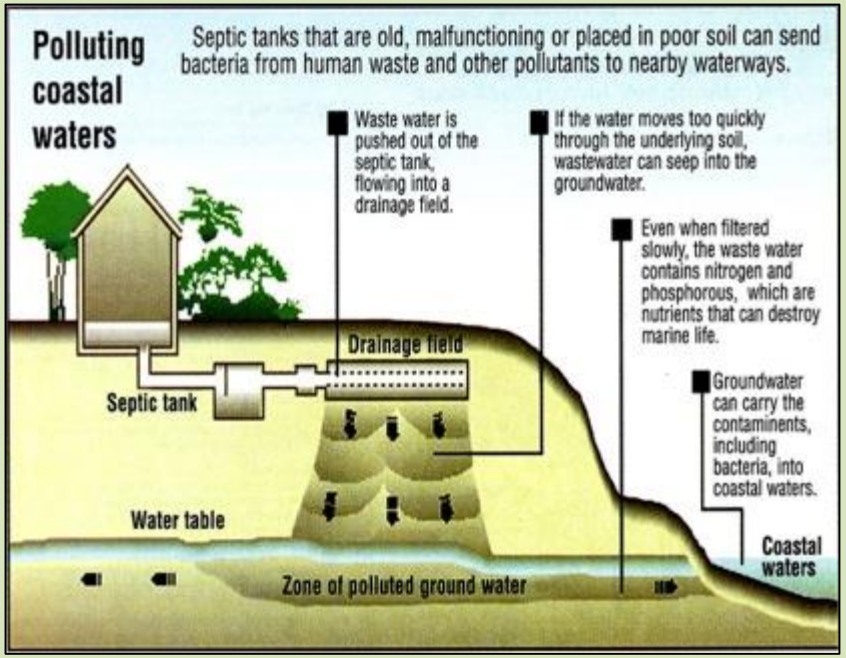
Fertilizer: 1.4×10^{11} g-N/yr

Septic systems: $2.4 - 4.9 \times 10^{10}$ g-N/yr

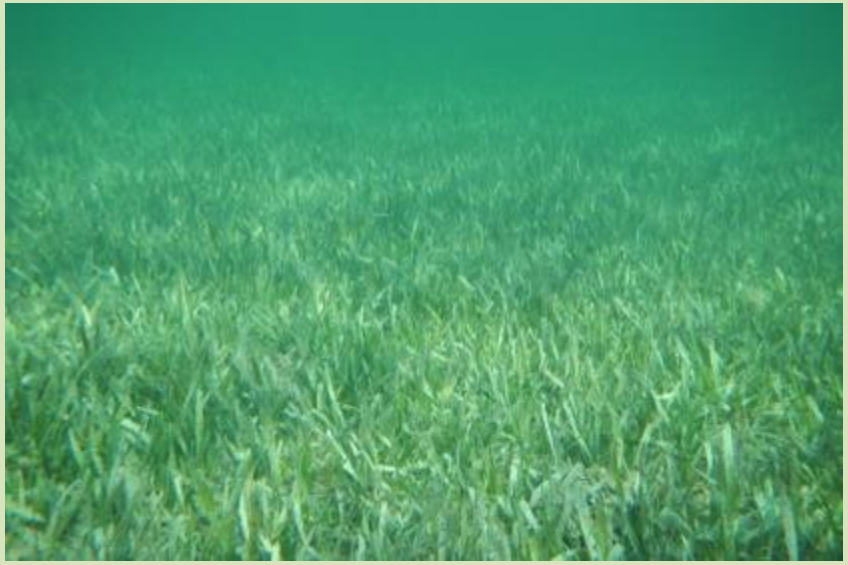
Atmospheric inputs: $5.9 - 9.4 \times 10^{9}$ g-N/yr

Reclaimed water: $1.2 \times 10^{8} - 2.6 \times 10^{10}$ g-N/yr

(Badruzzman et al. 2012)



Florida Keys (Monroe County) Septic Tank Study



- Monroe County designated an “Area of Critical State Concern” in 1974

- ~ 30,000 septic tanks, 80% located in high density subdivisions within a short distance to surface waters (< 25 m)

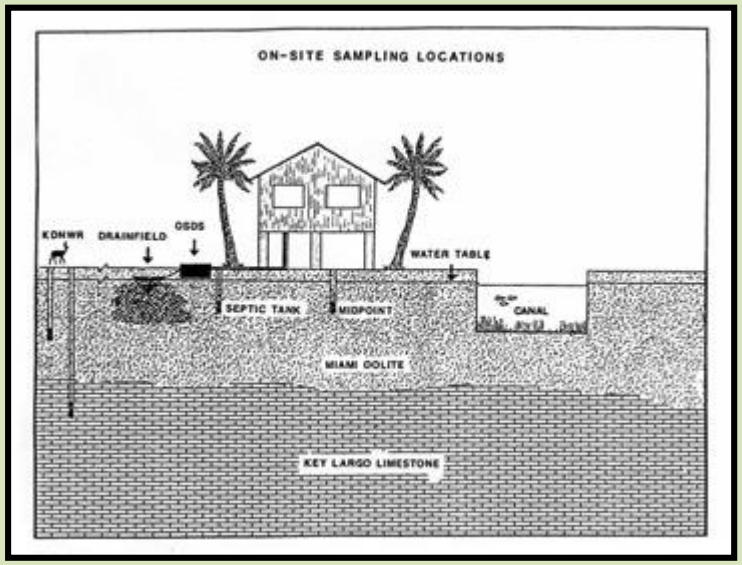
- High water tables and limestone (karst) substrata with low organic content present poor soil conditions

- Nutrient sensitive seagrass and coral reef ecosystems in nearshore waters

- Increasing urbanization and tourism have brought more people to the Florida Keys in recent decades

- Despite designation of the Florida Keys National Marine Sanctuary in 1990, the Keys now has the lowest coral cover in Caribbean

Results of Septic Tank Study: 1986-1987



- 5,000-fold enrichment of groundwaters with reactive forms of nitrogen -- ammonium and nitrate

- Ammonium was the dominant N form, indicating "failing" septic tank systems

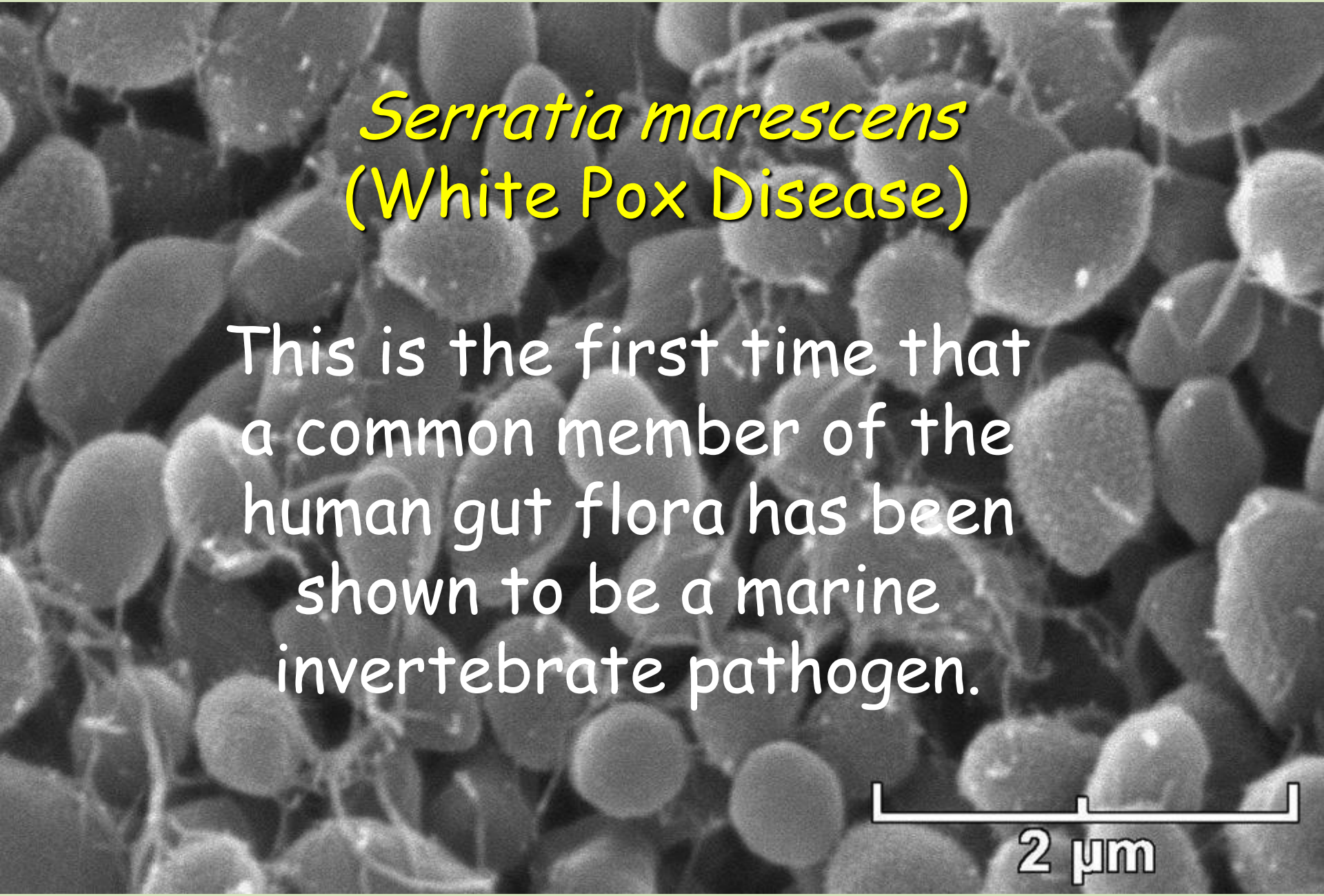
- 400-fold phosphorus enrichment, resulting in high N:P ratios in groundwater (selective P removal)

- Groundwater flow measurements showed importance of "tidal pumping"

- Rain events caused transient surges of contaminated groundwater into surface waters

- Nutrient concentrations of groundwaters were higher in dry season, while those of surface waters were higher in the wet season

Ecological Impacts of Sewage Pollution in the Florida Keys

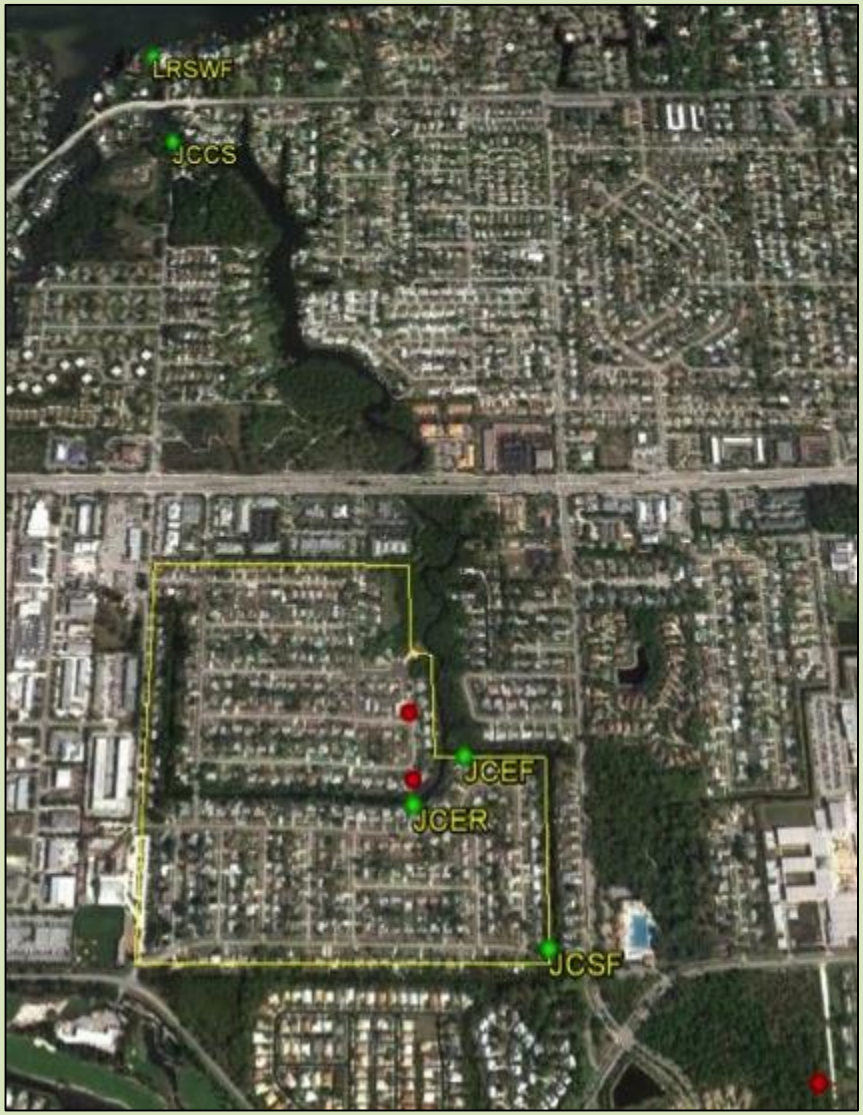


Serratia marescens (White Pox Disease)

This is the first time that a common member of the human gut flora has been shown to be a marine invertebrate pathogen.

Good News: Central Collection and AWT in the Keys

Jupiter Creek Septic Tank/Water Quality Study for Loxahatchee River District: 1995



Results of Jupiter Creek Study

- Interaction of groundwaters and Jupiter Creek influenced by tidal pumping, elevated groundwater tables in wet season

- "Failing" septic tanks caused ammonium buildup in groundwaters and Jupiter Creek

- $\delta^{15}N$ values ($^{o}/_{oo}$) in shallow groundwaters and Jupiter Creek > + 3 ($^{o}/_{oo}$) , characteristic of sewage

- Higher fecal coliforms in wet season compared to dry season in both groundwaters and Jupiter Creek

- High concentrations (> 1,000 µg/kg) of coprostanol, a fecal sterol, present in "black mayonnaise" sediments

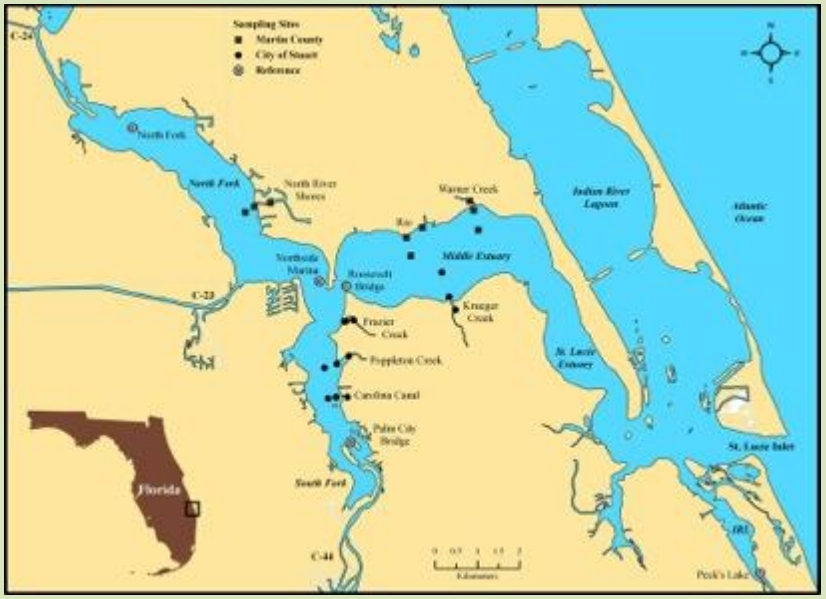
Lee County Phase I Study in 2004: What is Causing Blooms of Red Drift Algae?

$\delta^{15}N$ values ranged +5.7 to +7.1 ‰ in blooms along beaches in Lee County in 2004, sewage implicated

Lee County Phase II Study 2005: Development of Massive Red Tides (*Karenia brevis*) and "Dead Zone"

$\delta^{15}N$ values ranged +6.8 to +9.5 ‰ in this bloom in 30 psu water off Sanibel Island, September 7, 2005; sewage implicated again

Martin County Septic Study Phase I: 2005-2006



- Sampled in June & November 2005, March 2006
- Freshwater discharges caused low salinity and DO, high nutrients, turbidity, coliforms
- Highest turbidity, nitrate, and TN in South Fork (C-44); ammonium and phosphate highest in North Fork (C-23, C-24)
- Highest nutrients and coliforms near residential areas with high densities of septic tanks
- Toxic *Microcystis* blooms in Manatee Pocket in 2013 had high $\delta^{15}N$ values (+ 8.6 $^{o}/_{oo}$) in the range of sewage nitrogen

Changing Land-Use and Eutrophication in the Indian River Lagoon (IRL)

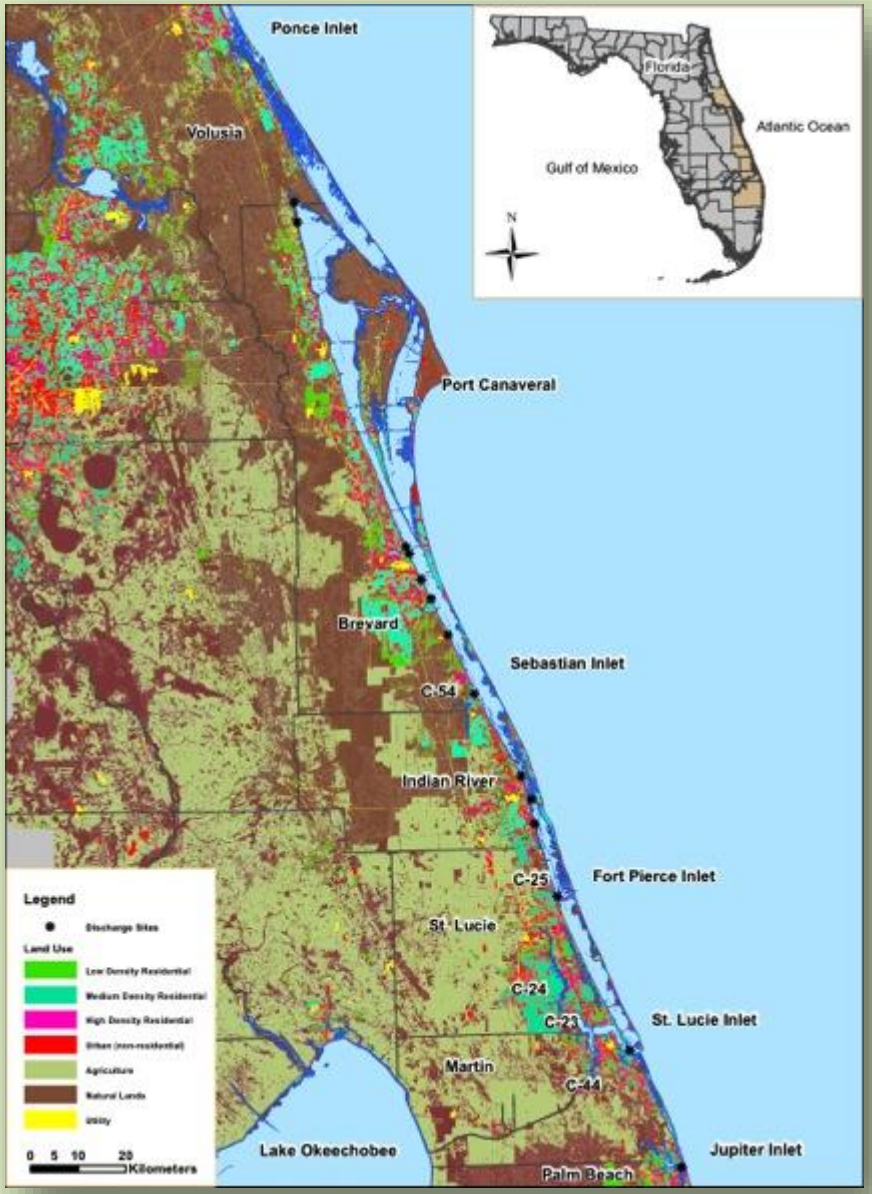
- Land-Use

urban	39%
agriculture	24%
forest	4.5%
wetland	12.1%
range	20.8%

- IRL Act eliminated sewage outfalls;
  but, ~ 300,000 septic tanks remain in IRL basin;

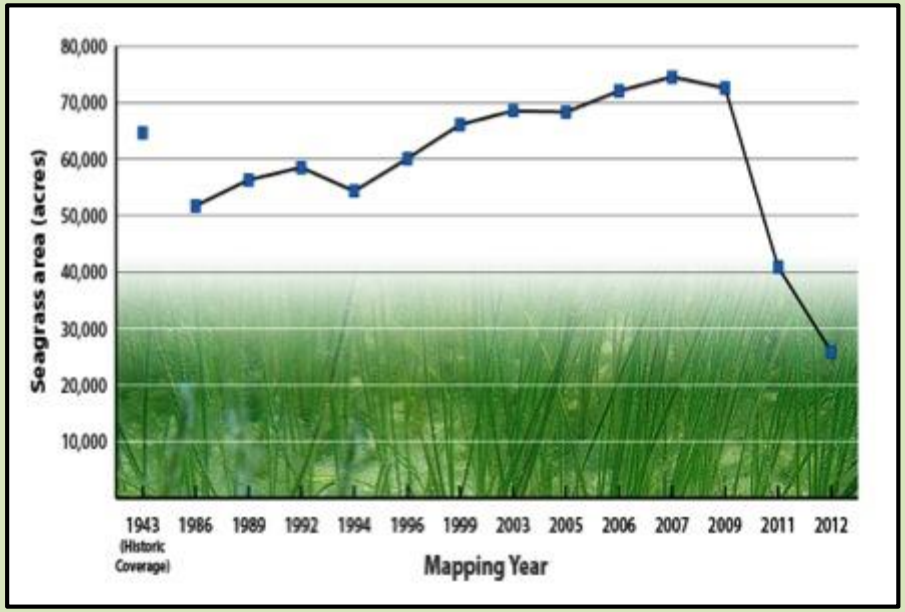
- Eutrophic Condition
  - Moderate to high nitrogen input
  - High susceptibility (low flushing)
  - Substantial expression of eutrophy
  - Algal blooms likely to worsen

From: Bricker et al. 2007 National Estuarine Eutrophication Assessment, NOAA, Silver Springs, MD



Ecosystem Responses to Eutrophication in the IRL

- Increasing seagrass epiphytes, macroalgae, and phytoplankton
- "Super Bloom" followed multi-year drought in 2011
- Brown Tide in 2012
- Unprecedented seagrass die-off
- Wildlife, fish, shellfish mortality in IRL

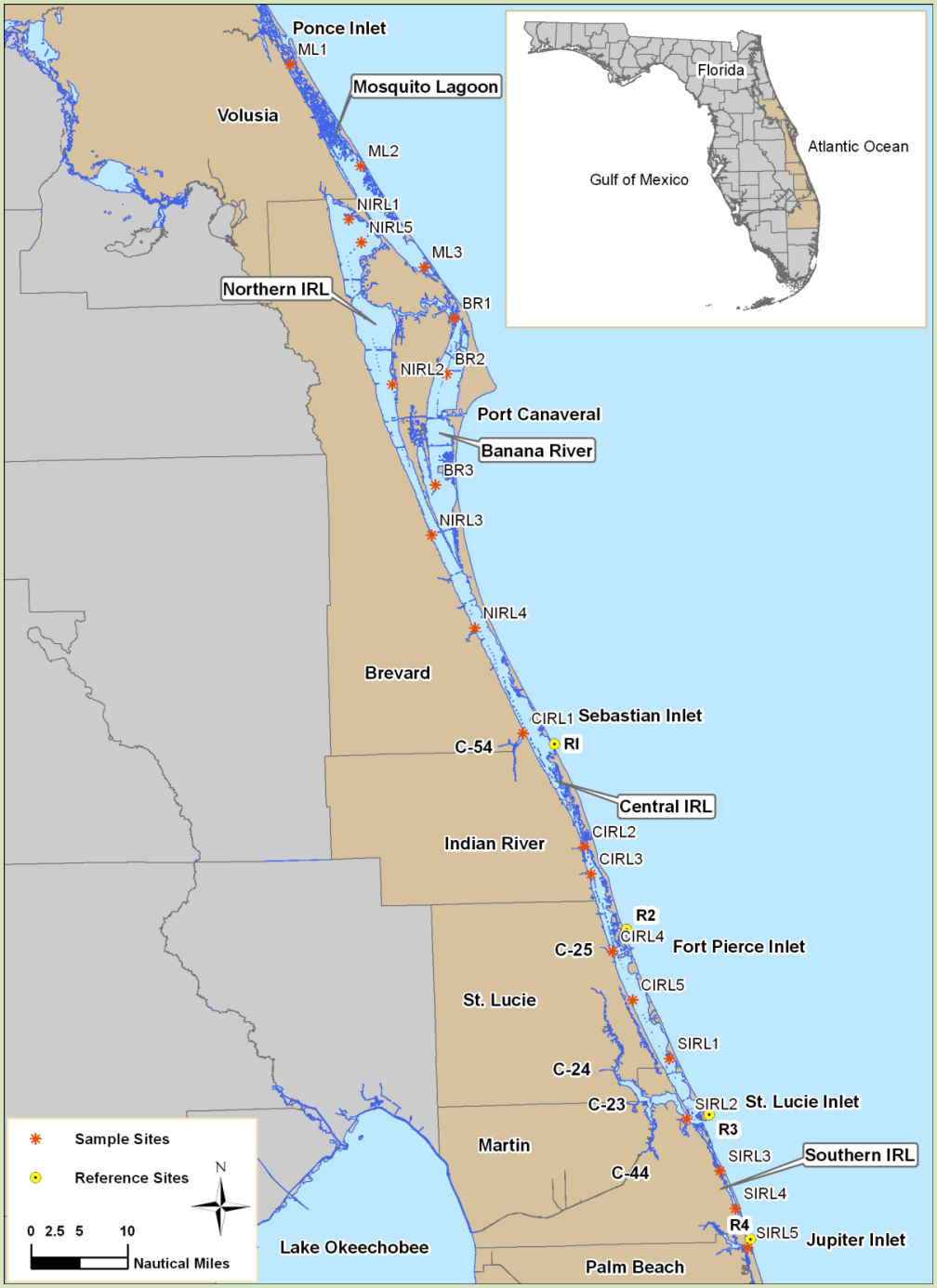


IRL-Wide Study 2011-2012

20 IRL Sites + 4 Reference Sites

- Objectives: Use multiple lines of evidence (dissolved nutrients, C:N:P and $\delta^{15}N$ in macroalgae) to assess spatial/temporal patterns in nutrient pollution, N- vs. P-limitation of algal growth, and N sources fueling eutrophication in the IRL.

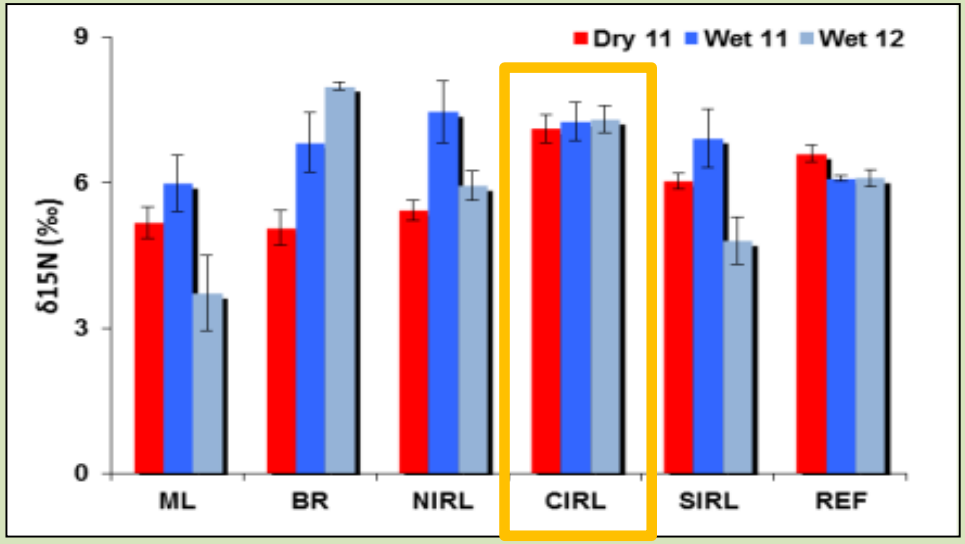
- Goal: Improve water quality in the IRL by providing high-quality, user-friendly data to resource managers and policy-makers.



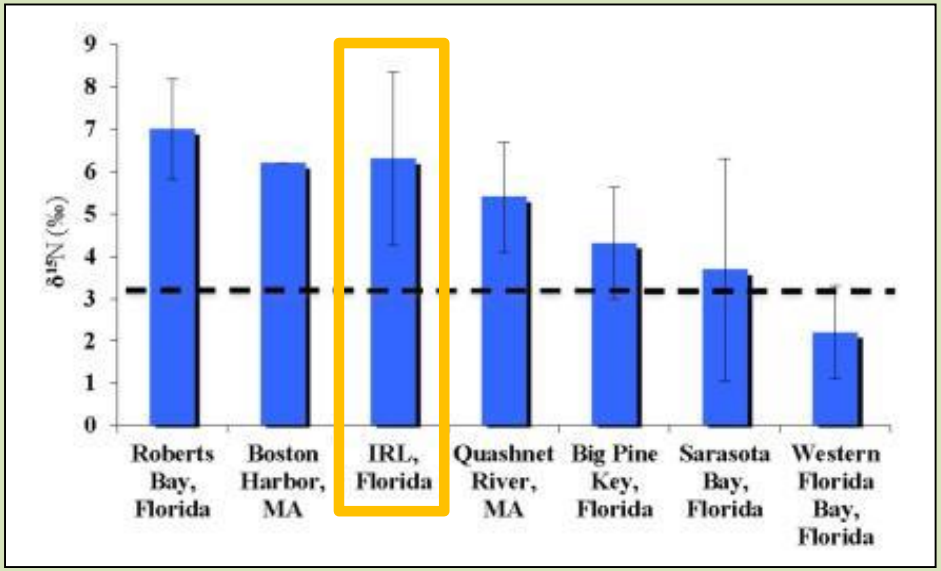
Macroalgae as Bio-Observatories in the IRL

Gracilaria tikvahiae 	***Caulerpa prolifera*** 
Hypnea musciformis 	*Hypnea spinella* 
Caulerpa mexicana 	*Laurencia filiformis* 
Acetabularia schenckii 	*Acanthophora spicifera* 

Stable N Isotopes in Macroalgae Identify Sewage N Source



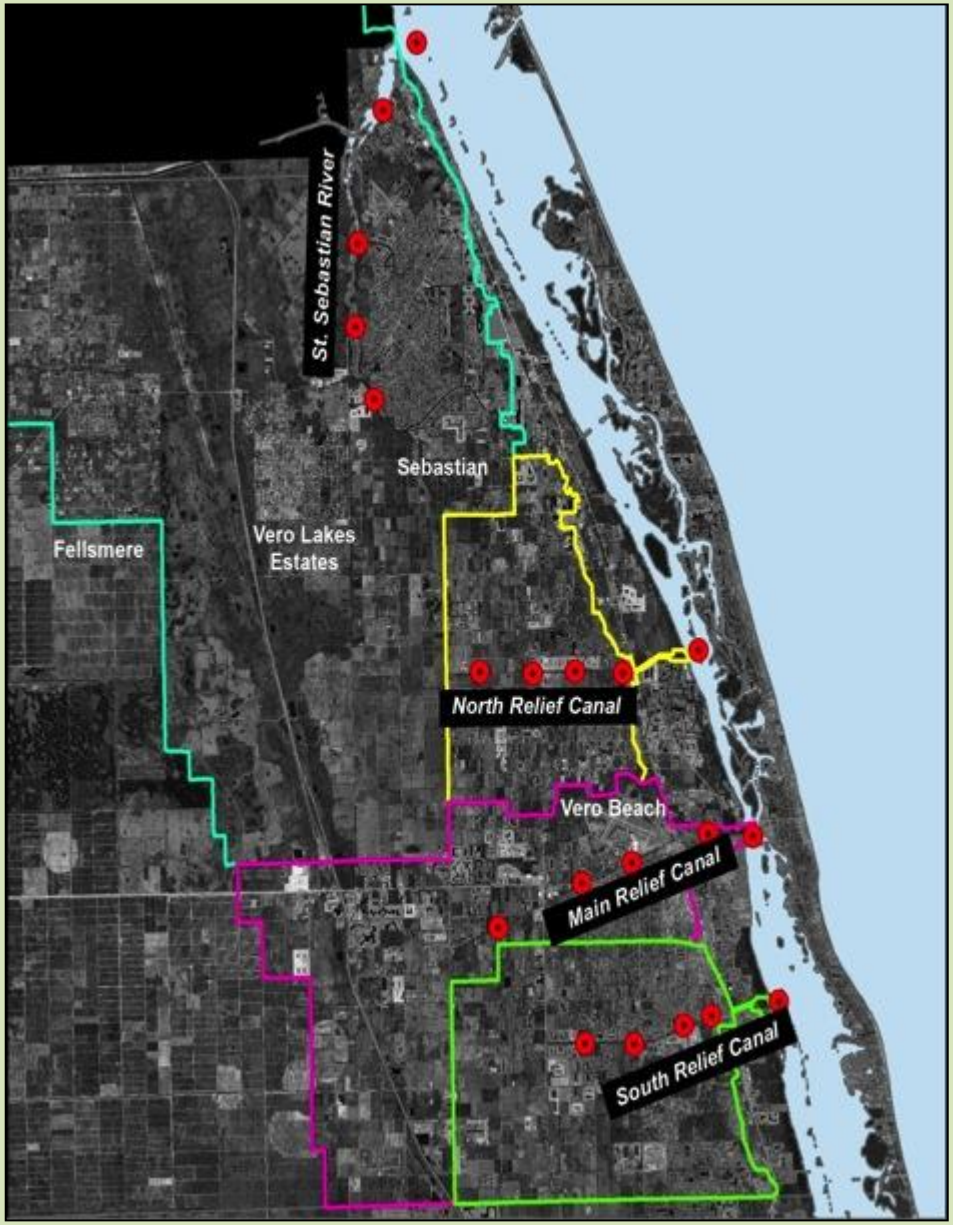
Source	$\delta^{15}N$ Level
OSTDS effluent	+3 to +5
Treated wastewater	+5 to +28
Upwelling	+2
Nitrogen fixation	0
Atmospheric N	-3 to +2
Fertilizers	-2 to +2
Everglades peat	0 to +2



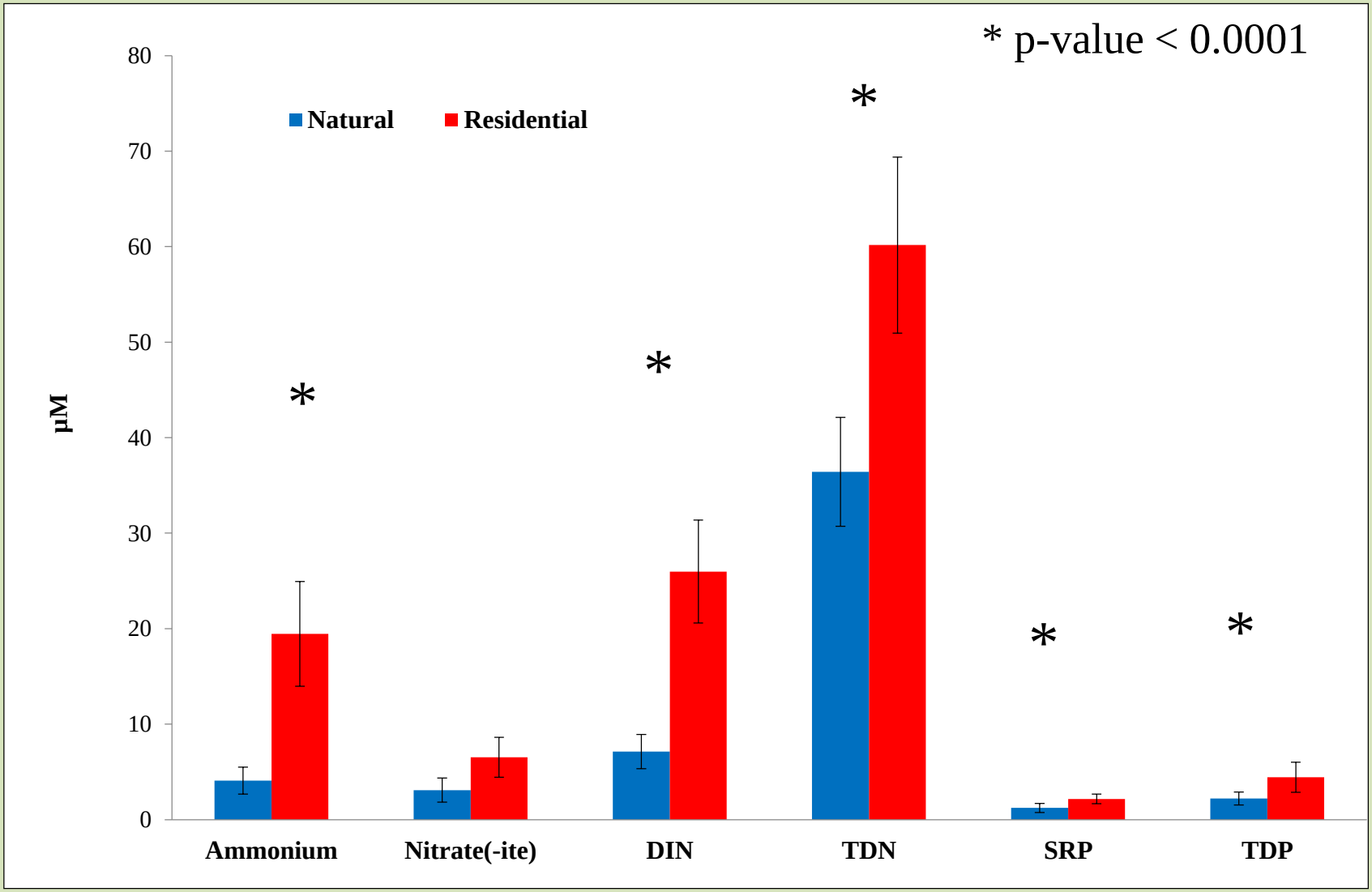
- $\delta^{15}N$ in IRL averaged + 6.3 $^{o}/_{oo}$
- $\delta^{15}N$ in IRL comparable to other areas with known sewage contamination

Indian River County Septic Study: 2013-2014

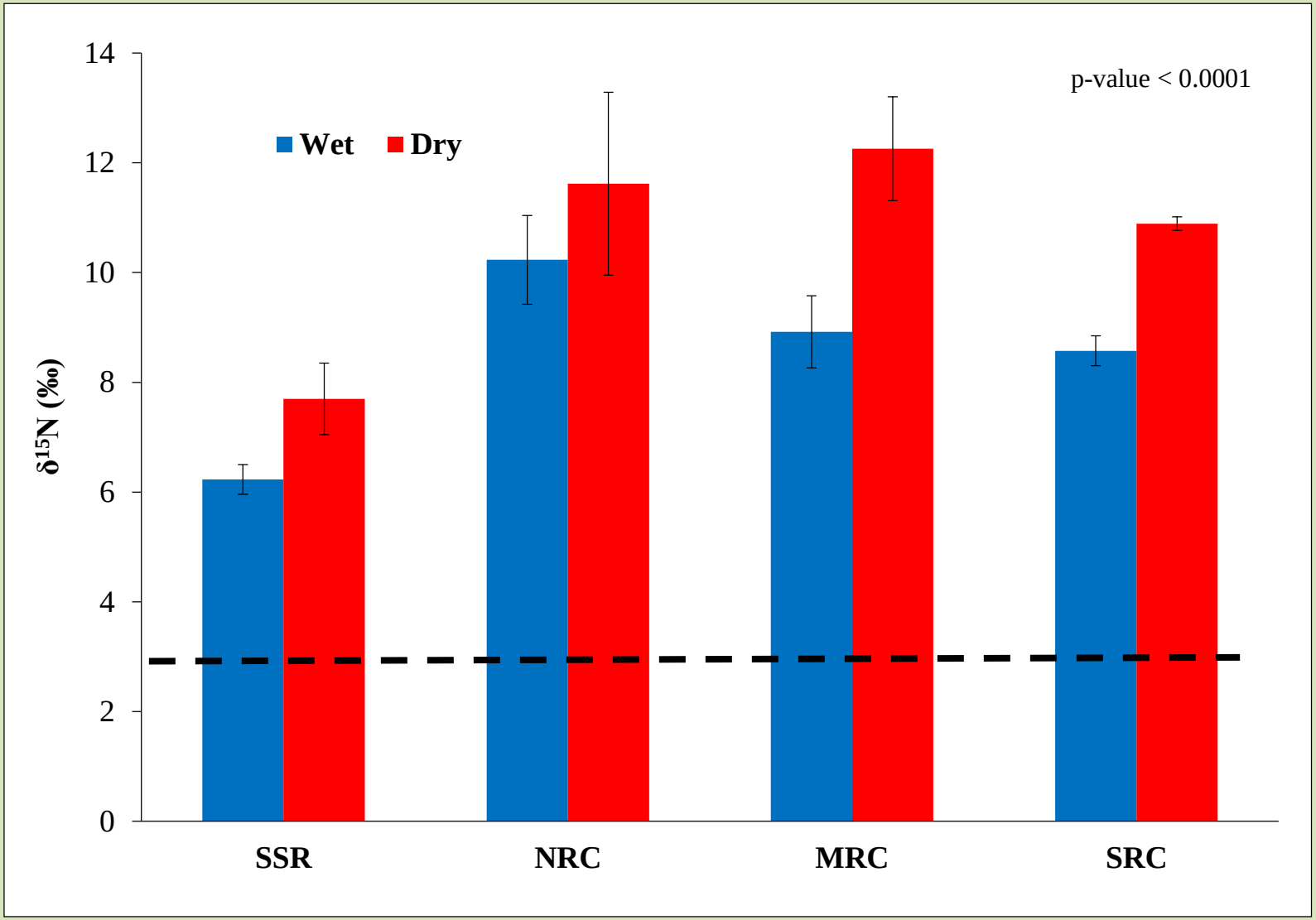
- October 2013 (wet season)
- March 2014 (dry season)
- Surface water
- Groundwater
- Reference Sites



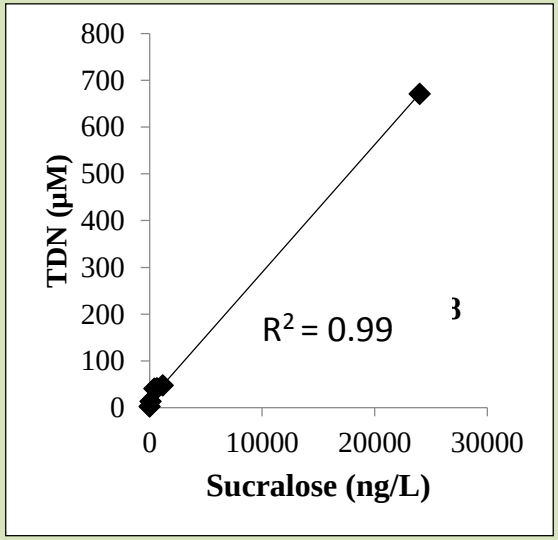
Dissolved N and P Levels in Natural vs. Residential Areas

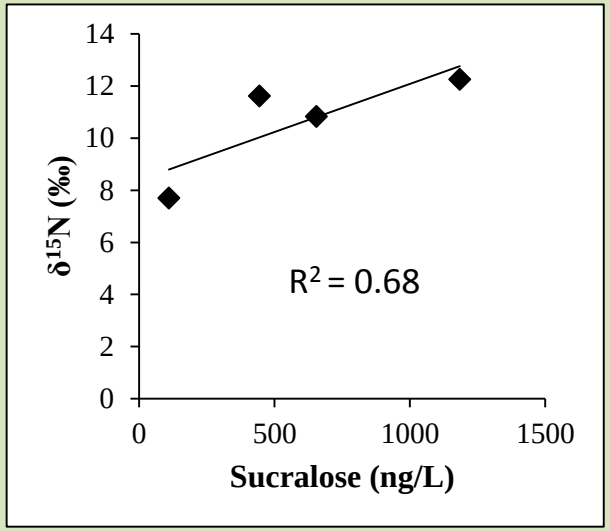


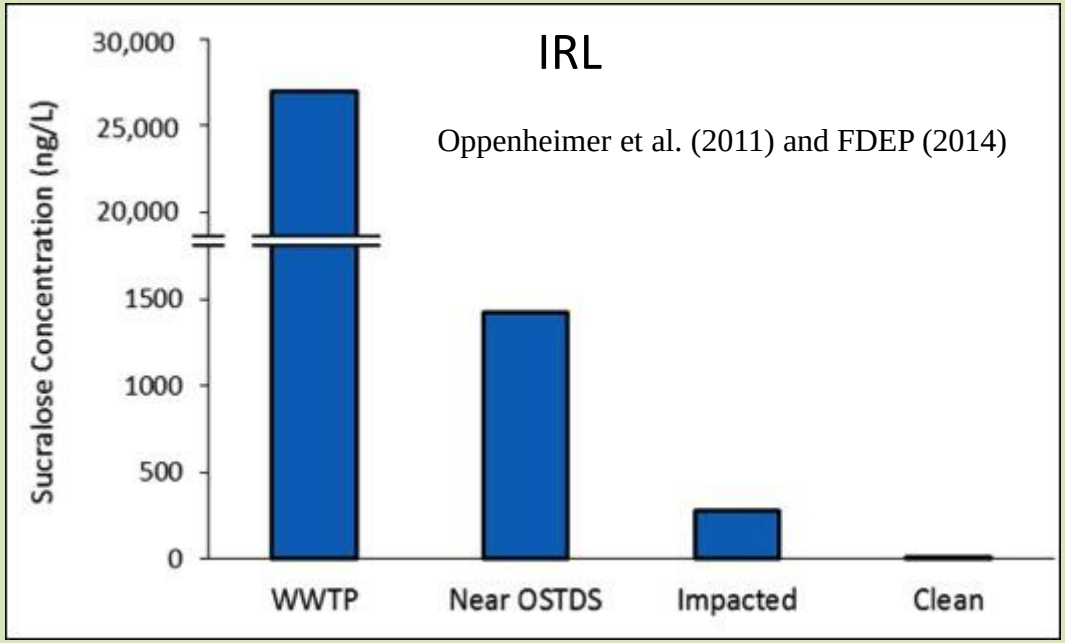
Macrophyte $\delta^{15}N$



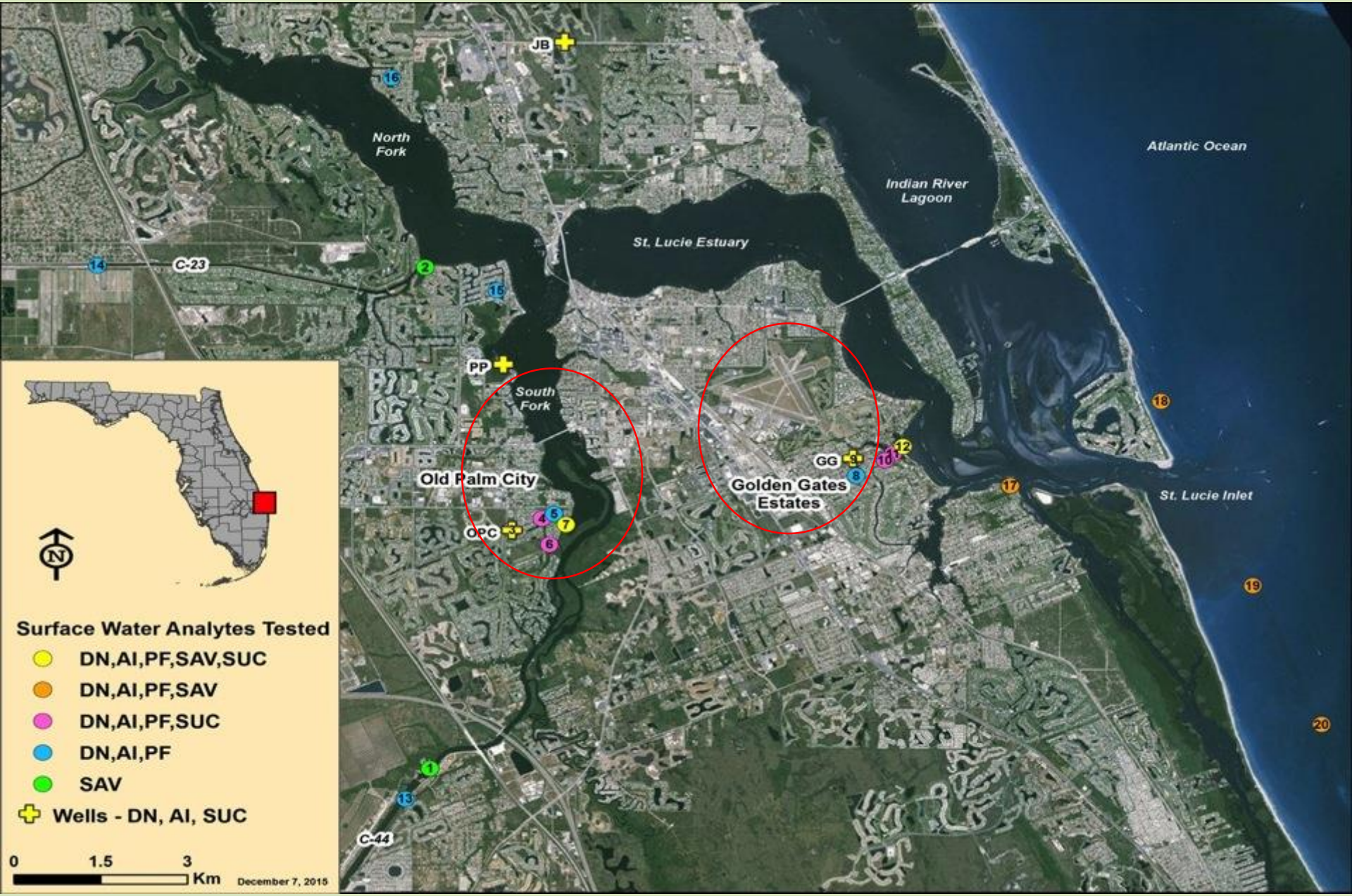
A Human Tracer: Sucralose



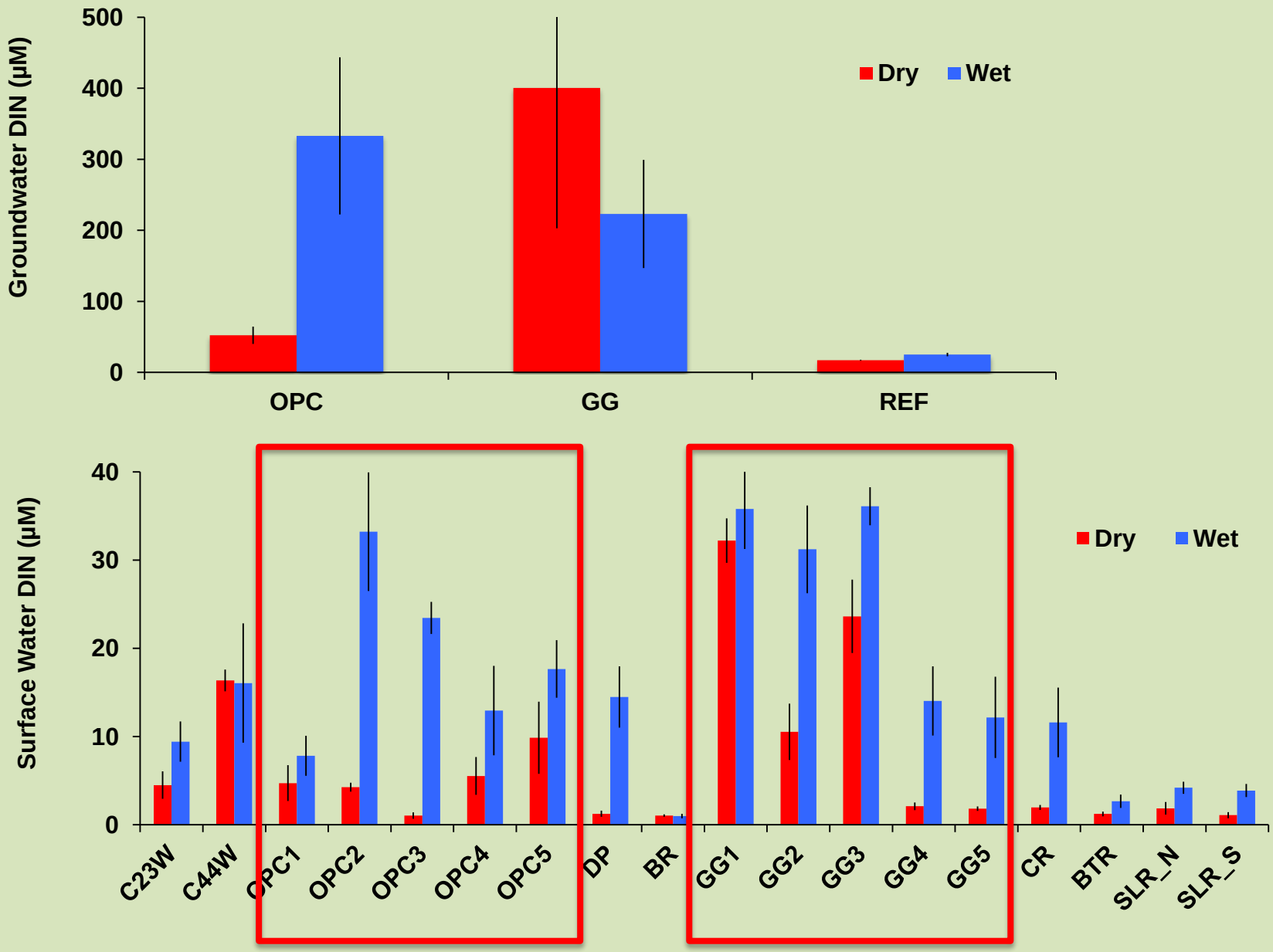




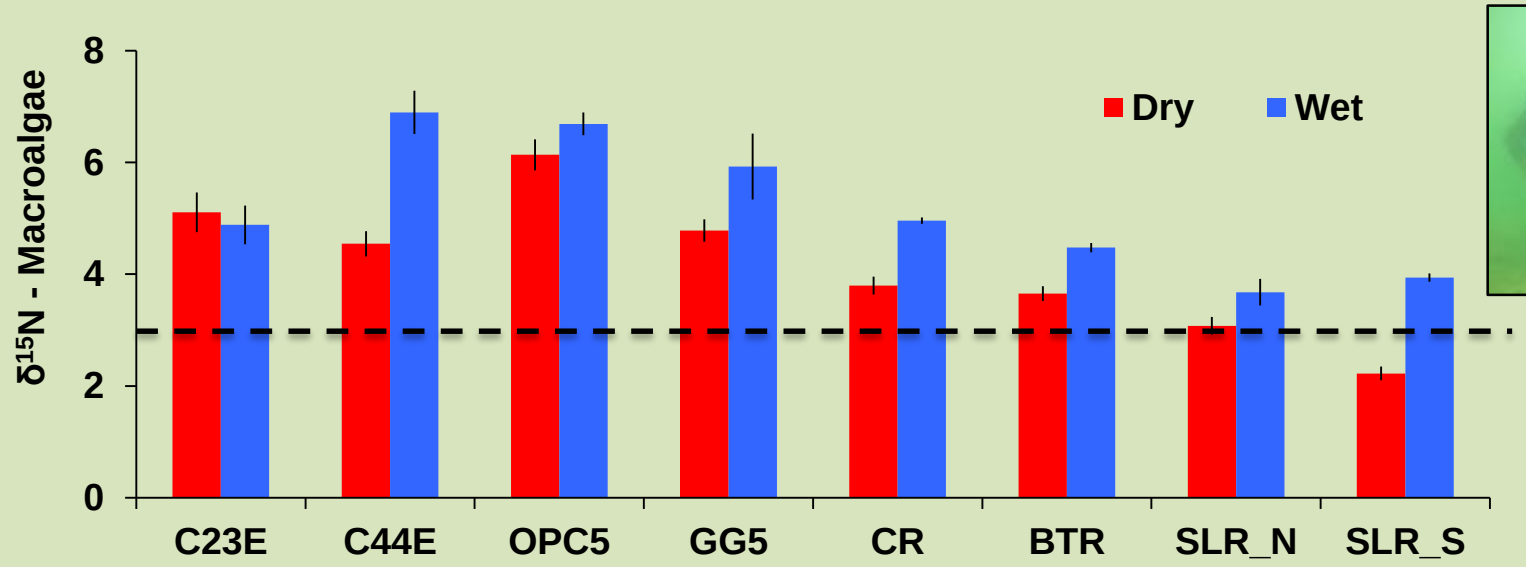
Martin County Septic Study Phase II: 2015



Dissolved Nutrients – Dissolved Inorganic Nitrogen

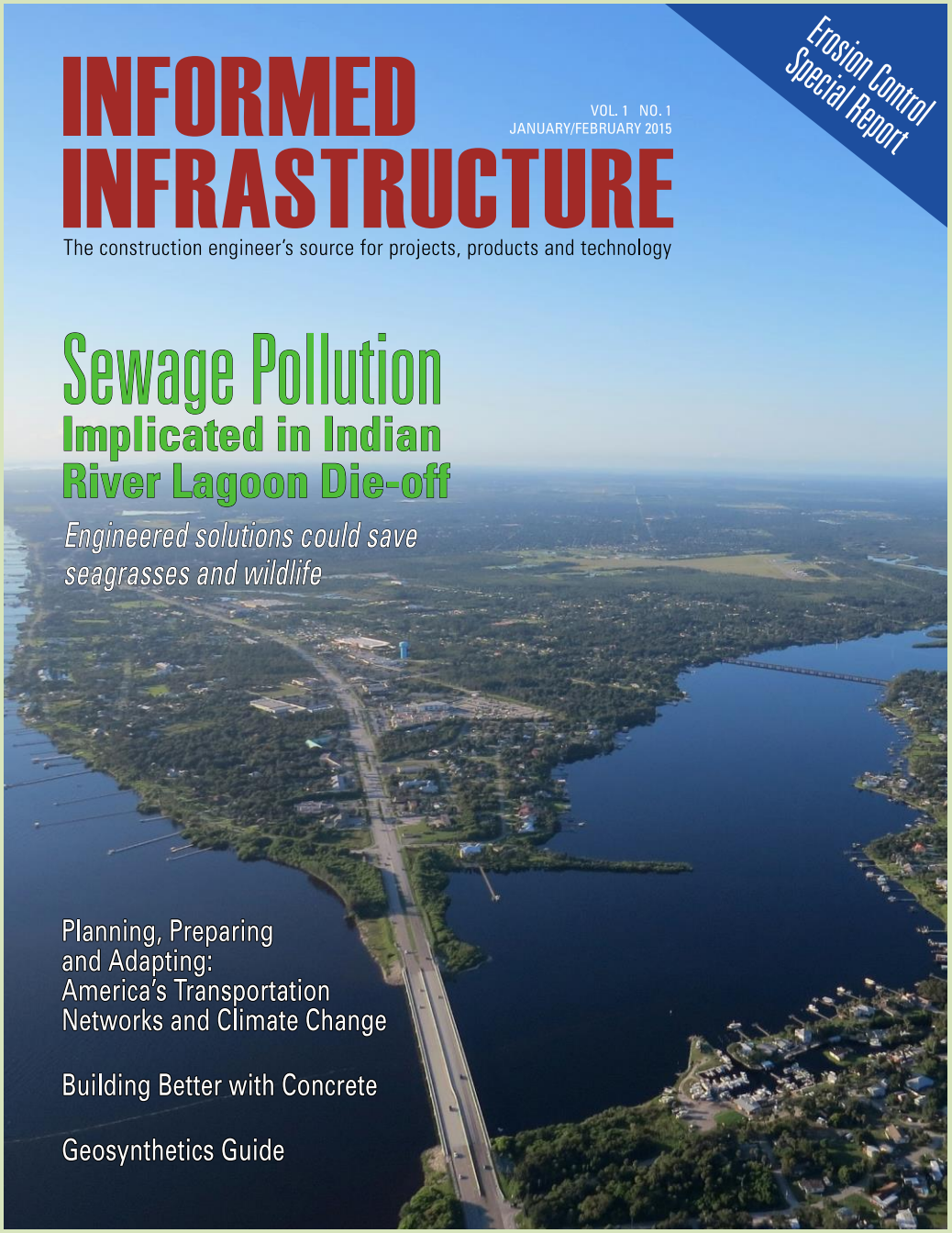


Sewage Pollution Indicator – $\delta^{15}N$ Macroalgae



Nearshore reefs:
high abundance of algae, urchins, and boring sponges

Sewage Pollution Indicator – Sucralose



Moving Forward

- Septic tanks do not protect Florida's extensive aquatic resources

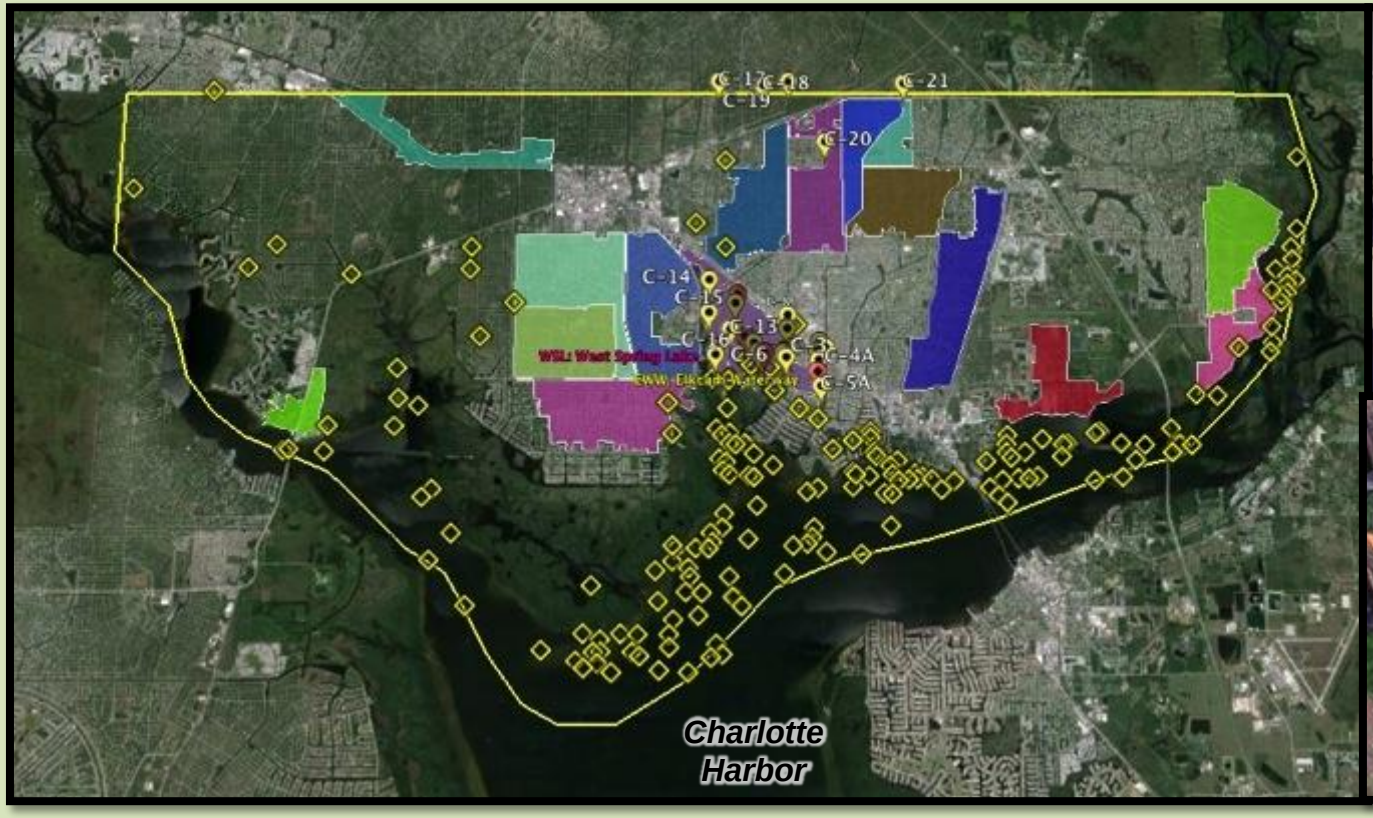
- This is an inadequate infrastructure problem on watersheds of many sensitive waterbodies

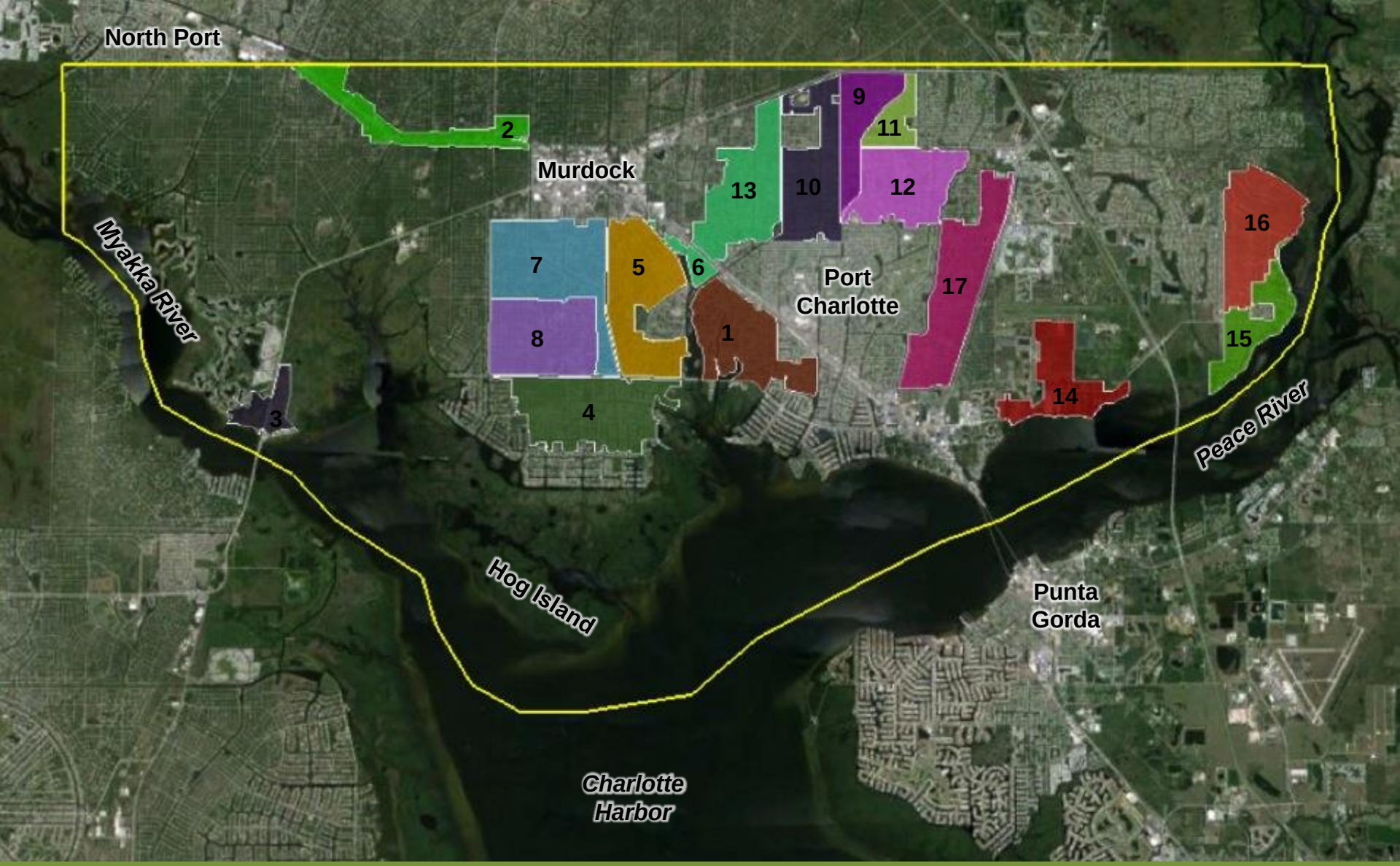
- Need pro-active planning process to prevent problem from worsening

- Septic tank reductions as part of BMAPs for "nitrogen credits"

Charlotte County PHASE I: Design of a Long-Term Water Quality Sampling Program

1. Datamine and Synthesize Existing Data
2. Reconnaissance Field Trips, QA/QC sampling across study area
3. Identify Long-Term Monitoring Stations and Outline Sampling Design
4. Identify Laboratories & Volunteer Networks to Collect & Analyze Samples





1. Spring Lake Pilot
2. US41
3. El Jobean/Myakka
4. Ackerman/Countryman
5. Crestview West
6. Crestview East
7. Como/Auburn North
8. Como/Auburn South
9. Morningstar/Haverhill East
10. Morningstar/Haverhill West
11. Elkcam/Fordham North
12. Elkcam/Fordham South
13. Dorchester
14. Decosters
15. Harbor Heights South
16. Harbor Heights North
17. Niagra Waterway

PHASE II: Implement Long-Term Sampling to Document Pre-Post Construction Conditions in the Watershed, Myakka and Peace Rivers, and Charlotte Harbor

1. Dissolved Nutrient Concentrations – surface and groundwater
2. Sucralose Concentrations – surface and groundwater
3. Microbial (Enterococcus and Coliform) Counts in surface water
4. Stable N Isotope Signatures and C:N:P in submerged vegetation
5. Molecular DNA Source Tracking in Sediments





Questions?