Nutrients and Water Quality in the Indian River Lagoon

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"The fundamental driving force is the accumulation of nitrogen and phosphorus in fresh water on its way to the sea."

Clean Coastal Waters: Understanding and Reducing the Effects of Nutrient Pollution.
(NRC, 2000)
Nutrient Pollution

“The most pervasive and troubling pollution problem currently facing U.S. coastal waters.”

Human Development, Land-Use and Eutrophication in the IRL

- **Land-Use**
  - urban: 39%
  - agriculture: 24%
  - forest: 4.5%
  - wetland: 12.1%
  - range: 20.8%

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

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

20 IRL Sites + 4 Reference Sites

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

2. Improve water quality in the IRL by providing high-quality, user-friendly data to resource managers and policy-makers.
Indian River County Sites

CIRL 1 = St. Sebastian River Mouth
CIRL 2 = Main Relief Canal
CIRL 3 = South Canal
Reference Site 1 = Ambersand Wormrock Reef
1. Collect water and macroalgae and document field conditions

2. Remove epibionts from algae, rinse, dry, grind, and analyze for natural abundances of stable N & C isotopes and C:N:P contents

3. Filter water and analyze for dissolved nutrients
2011 Chlorophyll $\alpha$ (µg/l)

July 2011
2011 TDP (μM)

ML

BR

NIRL

CIRL

SIRL

REF

ML

BR

NIRL

CIRL

SIRL

REF

5.1 SSRM
2.26 MRC
2.16 SC
## Common Macroalgae in IRL

<table>
<thead>
<tr>
<th><strong>Gracilaria tikvahiae</strong></th>
<th><strong>Caulerpa prolifera</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Gracilaria tikvahiae" /></td>
<td><img src="image2" alt="Caulerpa prolifera" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Hypnea musciformis</strong></th>
<th><strong>Hypnea spinella</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Hypnea musciformis" /></td>
<td><img src="image4" alt="Hypnea spinella" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Caulerpa mexicana</strong></th>
<th><strong>Laurencia filiformis</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="Caulerpa mexicana" /></td>
<td><img src="image6" alt="Laurencia filiformis" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Acetabularia schenckii</strong></th>
<th><strong>Acanthophora spicifera</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image7" alt="Acetabularia schenckii" /></td>
<td><img src="image8" alt="Acanthophora spicifera" /></td>
</tr>
</tbody>
</table>
P-limited (High APA)

ML
BR
NIRL
CIRL
SIRL

2011 C:P

Dry
Wet

0 250 500 750 1000 1250 1500 1750 2000 2250

> 250 P-limited

284 SSRM
206 MRC
204 SC
188 MRC
230 SC
2011
\( \delta^{15}N \ (\text{o/oo}) \)
Comparison of $\delta^{15}$N in Macroalgae From Sewage-Impacted Coastal Waters in Florida and Massachusetts

- 9.04 ± 0.28 Wet Season
- 7.05 ± 1.52 Dry Season
## Summary of Nutrient Levels in Indian River County

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CIRL (St. Sebastian River to Midway Road)</th>
<th>IRL-Wide (ML, BR, NIRL, CIRL, SIRL)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dissolved Nutrients:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salinity: Dry 2011</td>
<td>+</td>
<td>Average</td>
</tr>
<tr>
<td>Salinity: Wet 2011</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chl a: Average</td>
<td>Lower than BR and NIRL</td>
<td></td>
</tr>
<tr>
<td>Salinity: Average</td>
<td>Lower than ML, BR, NIRL</td>
<td></td>
</tr>
<tr>
<td>DIN: Dry 2011</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>DIN: Wet 2011</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>SRP: Dry 2011</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>SRP: Wet 2011</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>TDN: Dry 2011</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>TDN: Wet 2011</td>
<td>Lower than ML, BR, NIRL</td>
<td></td>
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<tr>
<td>TDP: Dry 2011</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>TDP: Wet 2011</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>TDN:TDP: Dry 2011</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>TDN:TDP: Wet 2011</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Macroalgae:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C:N: Dry 2011</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>C:N: Wet 2011</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>C:P: Dry 2011</td>
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<td>-</td>
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<tr>
<td>C:P: Wet 2011</td>
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<td>-</td>
</tr>
<tr>
<td>N:P: Dry 2011</td>
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<td>-</td>
</tr>
<tr>
<td>N:P: Wet 2011</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$\delta^{15}$N: Average</td>
<td>Lower than NIRL</td>
<td></td>
</tr>
<tr>
<td>$\delta^{15}$N: Wet 2011</td>
<td>+</td>
<td>+</td>
</tr>
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</table>
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OSDS Polluted Canal

Looe Key NMS
Jupiter (Jones) Creek Septic Study for Loxahatchee River District
Jupiter (Jones) Creek Septic Study for Loxahatchee River District

1. Continuous, net positive groundwater discharge to Jones Creek that contribute to the base flow of the system.

2. Groundwater flow varied as a function of tide – higher flow during low tide. Range: 1.0 – 2.5 cfs (high tide) to 3.1 – 7.5 cfs (low tide).

3. Septic Tank Effluent contaminated groundwaters to levels in violation of State standards and suggest subsurface transport of contaminants into Jones Creek via the uppermost zones of the surficial aquifer.

4. All monitoring wells were in violation of standards for fecal coliform bacteria (counts > 4 colonies/100 ml) during both the wet and dry season when counts ranged up to 30,000 colonies/100 ml.

5. Highest fecal coliform counts and concentration so f color, BOD, COD, and nutrients (TN, TP NH4+, NO3-, SRP) were documented in monitoring wells closest to the septic drainfields.

6. Consistently high fecal coliform counts occurred in the shallowest well of the study and adjacent to Jones Creek, suggesting Septic Tank Effluent transport into Jones Creek via the uppermost zones of the surficial aquifer.

7. All recorded nitrate concentrations exceeded the State health advisory for nitrate of and most exceeded the State Primary Drinking Water Standards.

8. Water quality data within Jupiter Creek showed chronic violations of State surface water quality standards and high concentrations of sedimentary coprostanol in upper Jones Creek and high 15N/14N ratios (up to 28.86 o/oo in shallow wells) confirmed direct inputs of septic tank effluent from human wastewater sources.
Impacts of Hurricanes on Nutrient and Microbial Pollution: St. Lucie Estuary, Southeast Florida
1. High fecal and total coliform counts in violation of FDEP and EPA standards were observed in tidal creeks and canals adjacent to dense urban land uses that relied on septic tanks for on-site sewage disposal.

2. The microbial concentrations generally increased from downstream (closest to the SLE) to upstream (most inland) within most urbanized tidal creeks and canals.

3. Localized surface-water fecal contamination from septic tanks was apparent at sites in both Martin County and the City of Stuart.

4. Most violations of coliform standards were associated with lower salinities, underscoring the role of the C-44 freshwater discharges in exacerbating septic tank-derived, microbial fecal pollution in the SLE.
IRL Septic, Groundwater, Wastewater, and Microbial Studies


