Florida Bay Algal Blooms
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Pelican Key Basin
Mark Parry – ENP
September 22, 2016
Algal Blooms
Operational Definition

A phytoplankton bloom is a rapid increase in the population of aquatic microscopic algae or cyanobacteria, such that one or two forms dominate the community and reproduce to extraordinary cell densities.
Algal Blooms in Florida Bay
Cyanobacteria Primary Component

**Synechococcus**
- Globally distributed & highly productive
- Single cells; cylindrical/spherical (0.6 to 35 µm)
- Phycoerytherin
- Can use inorganic and organic sources of N/P
- Toxins- None reported*

<table>
<thead>
<tr>
<th>Plankton Category</th>
<th>Size (µm)</th>
<th>Plankton Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femto</td>
<td>0.02-0.2</td>
<td>Viruses</td>
</tr>
<tr>
<td>Pico</td>
<td>0.2-2.0</td>
<td>Bacteria</td>
</tr>
<tr>
<td>Nano</td>
<td>2.0-20</td>
<td>Cyanobacteria</td>
</tr>
<tr>
<td>Micro</td>
<td>20-200</td>
<td>Diatoms Dinoflagellates</td>
</tr>
<tr>
<td>Meso</td>
<td>200-2000</td>
<td>Zooplankton</td>
</tr>
</tbody>
</table>

*Boyler et al, 2008
Chlorophyll-a Measurement

Chlorophyll-a Proxy (μg/L)

Methods

• Spectrophotometry
• High Performance Liquid Chromatography
  ✓ Laboratory Fluorometry
  ✓ In-situ fluorescence with optical probe (YSI EXO)
EPA Method 445

• Sample Water Collection
  Cell Filtration
  Chlorophyll Extraction

• Measure fluorescence on benchtop instrument

FBISC v SFWMD Chlorophyll-a Analysis Comparison

$r = 0.98$
Algal Blooms in Florida Bay
Area of Interest

Florida Bay Zones
(1) Eastern Basins
(2) Northern Central Basins
(3) Western Bay
(4) Southern Central Basins
Algal Blooms in Florida Bay
Area of Interest

Primary Areas affected by the Seagrass die-off in 2015
<table>
<thead>
<tr>
<th>Year</th>
<th>Florida Bay</th>
<th>Seagrass</th>
<th>Die-off</th>
<th>Peak Chl-a</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990's</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>IRENE</td>
<td></td>
<td></td>
<td>22 to 36</td>
</tr>
<tr>
<td>2005-2007</td>
<td>Synthesis Report</td>
<td>December 2008</td>
<td>Eastern Bay (Barnes Sound)</td>
<td>10 to 15</td>
</tr>
<tr>
<td>2013-2014</td>
<td>Dissertation Dan Hoer 2015</td>
<td>S Central Bay (Mystery basin)</td>
<td></td>
<td>20 to 33</td>
</tr>
</tbody>
</table>
# Algal Blooms in Florida Bay
## Historical Reports

<table>
<thead>
<tr>
<th>2015-2016</th>
<th>2016-2017</th>
<th>2017-2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Florida Bay</strong></td>
<td><strong>August 2016</strong></td>
<td><strong>September 2017</strong></td>
</tr>
<tr>
<td><strong>Seagrass Die-off</strong></td>
<td><strong>Rankin Lake Bloom</strong></td>
<td><strong>Hurricane IRMA</strong></td>
</tr>
<tr>
<td>N Central Bay to Atlantic</td>
<td></td>
<td>Coastal Bights/N Central Bay</td>
</tr>
<tr>
<td><strong>Peak Chl-a µg/L</strong></td>
<td><strong>50 to 64</strong></td>
<td><strong>218 &amp; 185</strong></td>
</tr>
</tbody>
</table>
Dissolved Oxygen was hypoxic in Rankin Lake at initiation but bloom water was saturated thereafter.

https://worldview.earthdata.nasa.gov
Central Bay Algal Bloom
October 2016  Satellite Imagery (EOS Terra)

CYANOBACTERIA
- Picoplankton
  single cells, colonies, clusters and bacteria-like cells
- Nanoplankton
  similar to picoplankton and Synechococcus-like cells

DINOFLAGELLATES:
- Pyrodinium bahamense
- Ceratium hircus
- Karenia longicanalis
- Prorocentrum spp

https://worldview.earthdata.nasa.gov
Central Bay Algal Bloom
October 2016

**CYANOBACTERIA**
- $10^9$ cells/L Picoplankton
- $10^8$ cells/L Nanoplankton

**DINOFLAGELLATES**
- $10^2$ cells/L of *Pyrodinium*
- $10^2$ cells/L of *Ceratium*
- *Karenia brevis* - Not Present
Central Bay Algal Bloom
November 2016  Satellite Imagery (MODIS)

**CYANOBACTERIA**
(cell count decreased)
- Picoplankton
- Nanoplankton
- Unidentified Cyanobacteria

**DINOFLAGELLATES**
(cell count/diversity increased)
- Unidentified Flagellates
- *Karenia longicanalis*
- *Heterocapsa spp*
- *Prorocentrum spp*
- *Prorocentrum micans*
- *Gyrodinium spp*
- *Karlodinium spp*

https://worldview.earthdata.nasa.gov
Central Bay Algal Bloom
Late November 2016

CYANOBACTERIA
• $10^8$ cells/L Picoplankton
• $10^7$ cells/L Nanoplankton
• $10^6$ cells/L Unidentified

DINOFLAGELLATES:
• $10^5$ cells/L Dinoflagellates (unidentified) most <10 µm; unarmored
• $10^4$ cells/L of *Heterocapsa*
• $10^3$ cells/L of *Karenia longicanalis*
• *Karenia brevis* - Not Present
# Algal Blooms in Florida Bay

## Peak Concentrations

<table>
<thead>
<tr>
<th>BASIN</th>
<th>DATE</th>
<th>CHL µg/L</th>
<th>SECCHI (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JOHNSON KEY</td>
<td>11/04/16</td>
<td>64</td>
<td>20</td>
</tr>
<tr>
<td>SNAKE BIGHT</td>
<td>12/20/16</td>
<td>55</td>
<td>30</td>
</tr>
<tr>
<td>TWIN KEY</td>
<td>09/22/16</td>
<td>54</td>
<td>40</td>
</tr>
<tr>
<td>RANKIN LAKE</td>
<td>12/14/16</td>
<td>50</td>
<td>35</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td><strong>02/08/17</strong></td>
<td><strong>1.2</strong></td>
<td><strong>CTB</strong></td>
</tr>
</tbody>
</table>

*Clear to bottom*
Algal Blooms in Florida Bay
Hurricane IRMA
September 2017
Florida Bay
Water Quality Sampling Sites
Florida Bay
Post IRMA Chlorophyll-a

August 2017 Chlorophyll

September 2017 Chlorophyll

POST IRMA

218 185
Florida Bay
Post IRMA Chlorophyll-a

January 2018
Chlorophyll ug/L

September 2018
Chlorophyll ug/L
Florida Bay
Coastal Bights to Reef Tract Connection

First Algal Bloom
October 22, 2016

Post IRMA Algal Bloom
November 26, 2017

Recurrent Algal Blooms
March 22, 2018
Conclusion

• The extreme responses of cyanobacterial blooms to recent perturbations in Florida Bay (in terms of biomass and spatial extent) may indicate degraded resilience of the ecosystem.

• The connection of central coastal Everglades conditions to the Middle Keys reef tract can be clearly seen during recent cyanobacterial bloom events.