Indian River Lagoon: Perfect storm or new norm

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Questions

• What is the lagoon?
• What is a shared challenge?
• How are we doing?
• What happened?
• What have we learned?
What is the lagoon?

• Valuable
  (East Central Florida and Treasure Coast Regional Planning Councils)

How much $7,640,311,564
Total Annual Economic Value
What is the lagoon?

- Complex
  - 3 receiving waterbodies
  - long (156 mi)
  - shallow (~3' on average)
  - wind and tide driven (not a river)
  - segmented (flushing wks to mos)
  - sensitive
  - diverse
    - ecology
    - politics
    - challenges
What is a shared challenge?

- Total Maximum Daily Load (TMDL)
- Basin Management Action Plans
  - adaptive approach to uncertainty
  - seagrass a key indicator
How are we doing?

- Good management
- Good luck

Vero WWTP discharge ↓
Drought

IRFWCD discharge ↓
Mini-drought
‘04 hurricanes surge and flushing


Mapping years

Seagrass area (acres)
0 30,000 60,000 90,000

(Historic coverage)

~42% loss
~12% gain
~15% gain

‘04 hurricanes flushing
TS Fay flushing
How are we doing?

• 2012–2013 manatee UME  
  (115 mortalities due to undetermined causes in 2013)

• 2013 dolphin UME  
  (Mar–Aug ⇒ $3 \times - 6 \times$ higher mortality than 9 year mean)

• 2016 fish kill in Banana River Lagoon  
  (estimated $> > 100,000$ mortalities)
What happened?

Initially two phytoplankton (microalgal) blooms

Superbloom in the north – record magnitude and duration

Other bloom in CIRL – lower magnitude and long duration
What happened?

2012 brown tide
(Aureoumbra lagunensis)
What happened?

Aureoumbra lagunensis
Mouth Banana Creek; 9/6/13; photo by T. Miller

Takayama tasmanica
IRL across from Turkey Creek; 9/20/13; photo by T. Miller

Pyrodinium bahamense
Banana River; 8/28/13; photo by D. Scheidt

Other?
IRL east shore by 528 Cswy; 9/6/13; photo by T. Miller
Satellite Modeled Chlorophyll

Chl a (µg/L)

- < 40
- 41 - 60
- 61 - 80
- 81 - 100
- 101 - 120
- 121 - 140
- > 140

The St. Johns River Water Management District prepares and uses this information for its own purposes, so it may not be suitable for other uses. Maps of chlorophyll-a concentrations represent the results of applying statistical models to surface reflectance captured by the sensor. These estimates are accompanied by uncertainty that can be increased by variability in water clarity, depth, atmospheric conditions, and the composition of algal assemblages. For example, estimates for shallow, nearshore areas are likely affected by light reflecting off the bottom. Image downloaded from earthengine.google.com.
What happened?

Eutrophication progression scheme

Increased nutrient delivery

Enhanced growth phytoplankton and macroalgae

Increased shading and benthic respiration

Seagrass loss

Adapted from C.M. Duarte (1995)
What have we learned?
St. Johns River Water Management District

13 stations

- Diatom
- Dinoflagellate
- Cyanobacteria
- Nanoeukaryote
- Brown tide
- Other

Percentage of samples with bloom

Year and number of samples

2002: 50
2003: 56
2004: 52
2005: 78
2006: 124
2007: 139
2008: 99
2009: 139
2010: 164
2011: 181
2012: 145
2013: 160
2014: 168
2015: 168
2016: 168

Superbloom
- Players have changed
- Smaller
  (> 200 side-by-side across “.”)
- Turn over faster
- Other challenging behavior

Newer dominants

- Pyrodinium bahamense
- Dino-flagellates
- Filamentous cyanobacteria
- Pico-cyanobacteria
- Chlorophyte
- Mixed nano-flagellates
- Aureoumbra lagunensis

Diatoms
Use different types of N (also P)
Bypass microbial loop
Less loss

Use organic forms
Faster cycling
Compete well

Relative preference index
> 1 ⇒ preferred

Graph courtesy of J Papcek and P Inglett
“Fix” N (pull it out of thin air)

+ correlations w/
# of picocyanobacteria
°C

− correlations w/
[N]
[N]:[P]

[N] ↓ or [P] ↑ ↑ ⇒ 
N fixation ↑

0.28-0.35 g N/m³/wk

Graph courtesy of J Papcek and P Inglett
Mean % cover of seagrass (1994 – 2017)

Compressed scale | Monthly →
(bi-annual sampling)
Mean % cover of seagrass and drift macroalgae (1994 – 2017)

Compressed scale | Monthly → (bi-annual sampling)
Mean % cover of seagrass and drift macroalgae and mean chlorophyll concentrations (1994 – 2017)

Seagrass % cover
Drift % cover
Chlorophyll a

Compressed scale | Monthly → (bi-annual sampling)
What have we learned?

- **Legacy loads ⇒ internal load**
  (especially ammonium used by brown tide)

- **Drift algae ⇒ key role in cycling**
  (loss/lack of growth made nutrients available)

- **Small phytoplankton ⇒ make their own N**
  (fix nitrogen under certain conditions)

- **Small phytoplankton ⇒ use organic N and P**
  (e.g., amino acids)

- **Small phytoplankton ⇒ more efficient blooms**
  (growth rates and nutrient uptake)
Take-home messages

• Nutrients ⇒ chlorophyll = the issue
• Nutrient budget = “complex”
• New sources of chlorophyll = “bad actors”
• Value in information from ≥ 1 level below level of management
Take-home messages

• Events matter

• Restoration underway and planned
  – SJRWMD projects and cost share
  – IRL Council grants
  – Brevard County sales tax

• It took us a while to get here …
  it’ll take us a while to get where we want to go
Thank you