

# Indian River Lagoon



# What is the lagoon?



- **Valuable**

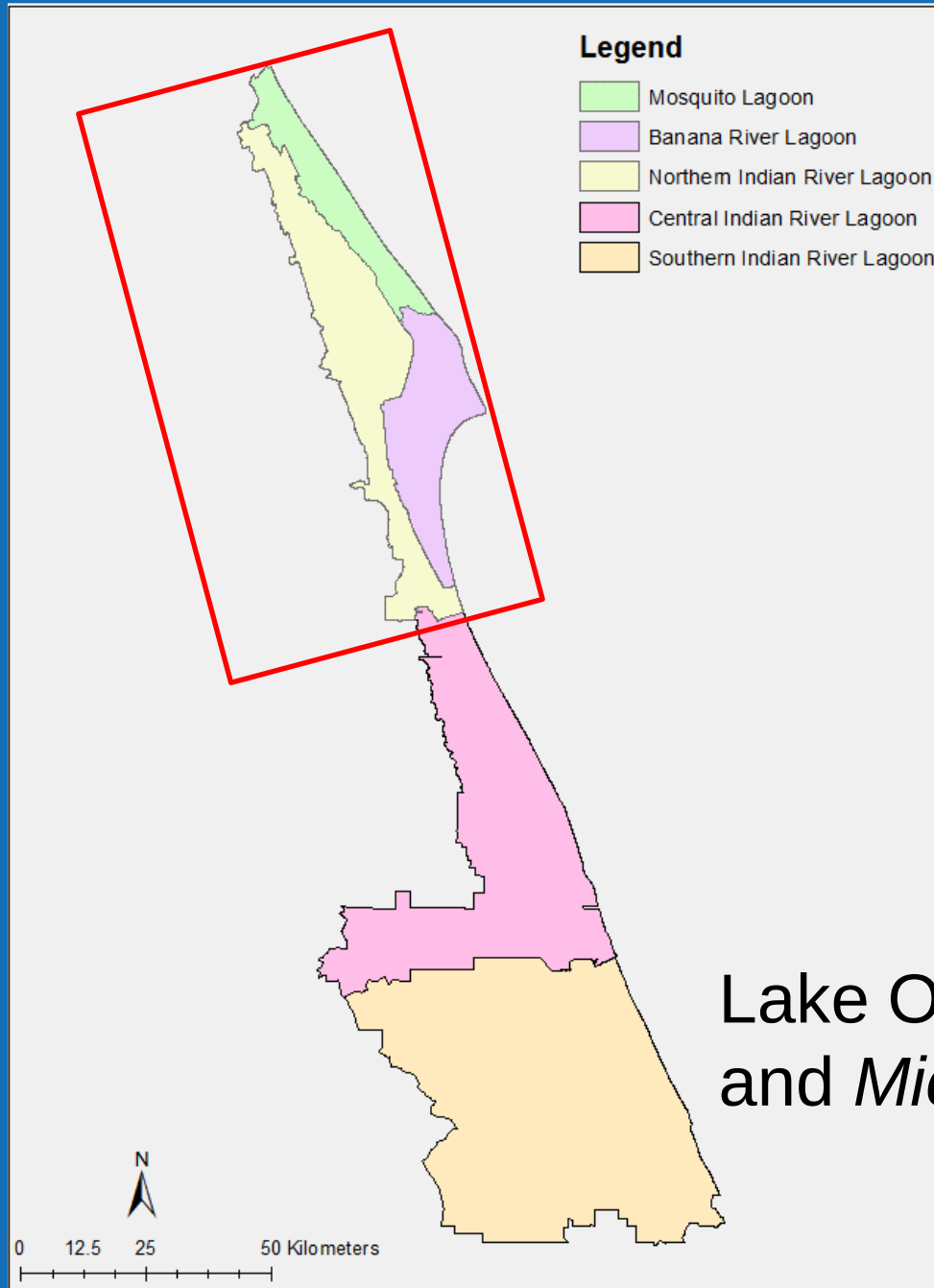
(East Central Florida and Treasure Coast Regional Planning Councils)



- **Complex**
  - 3 receiving waterbodies
  - long (156 miles)
  - shallow (~3' on average)
  - not a river  
(wind and tide driven)
  - segmented  
(flushing weeks to months)
  - sensitive
  - diverse
    - ecology
    - politics
    - challenges



# St. Johns River Water Management District

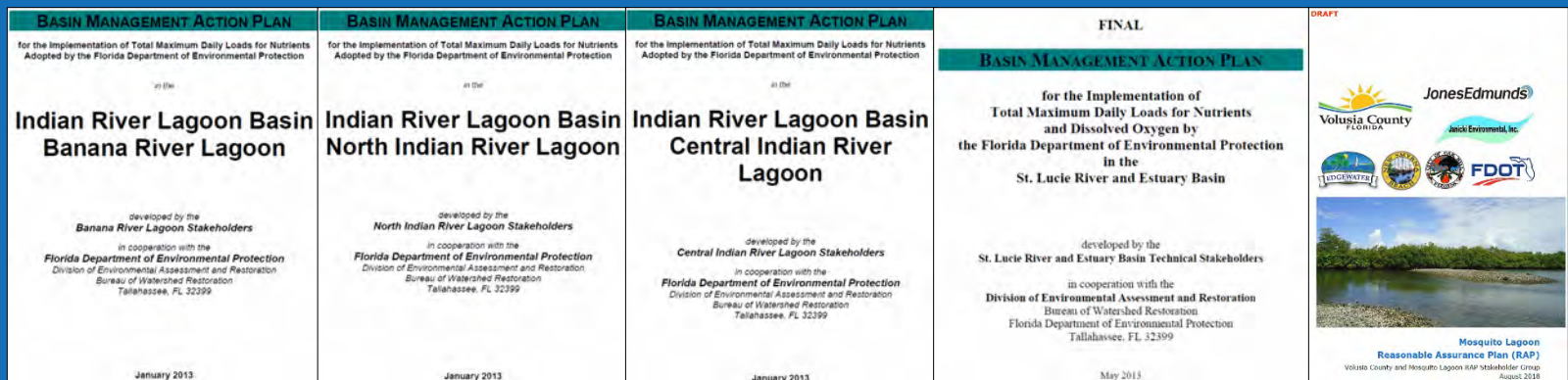


Lake O discharges  
and *Microcystis*



**What is a shared challenge?**

- Excess nutrients (N and P)
- Total Maximum Daily Load (TMDL)
- Basin Management Action Plan (BMAP) or Reasonable Assurance Plan (RAP)
  - adaptive approach to uncertainty
  - seagrass a key indicator



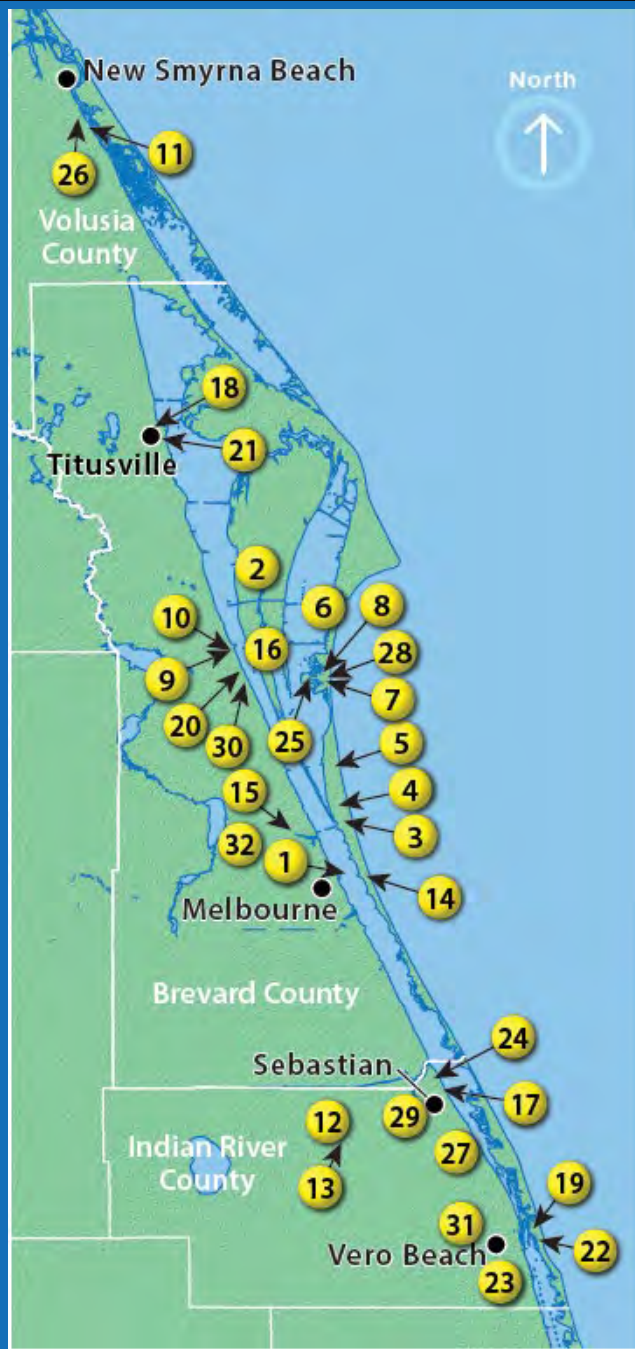
**What are we doing?**



# St. Johns River Water Management District



# St. Johns River Water Management District



## Brevard SOIRLPP

<https://www.brevardfl.gov/SaveOurLagoon>

### Save Our Lagoon Project Plan

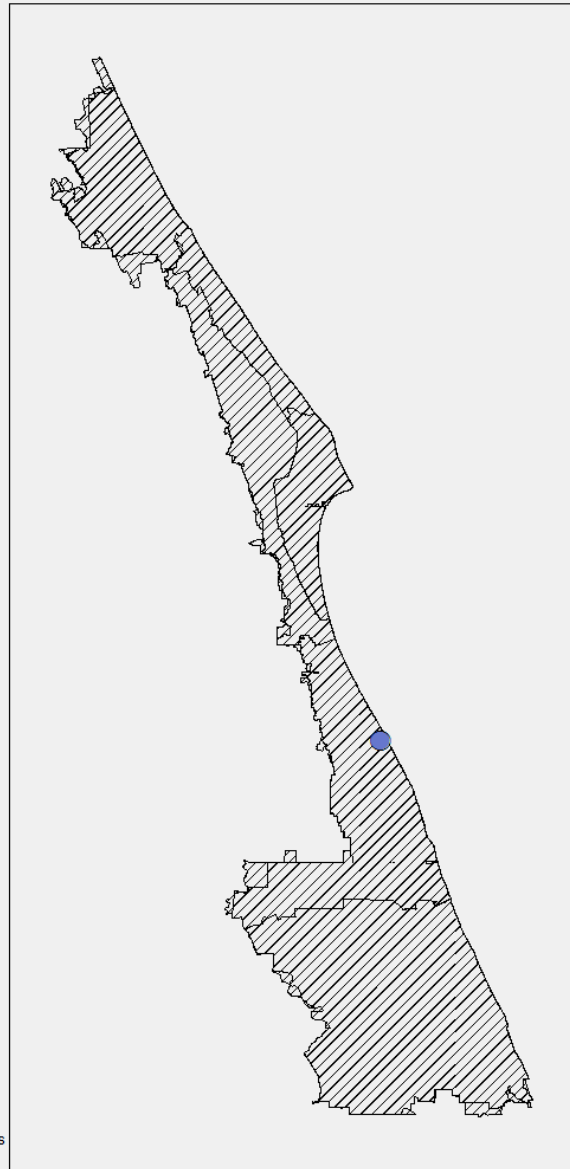


IRLNEP CCMP

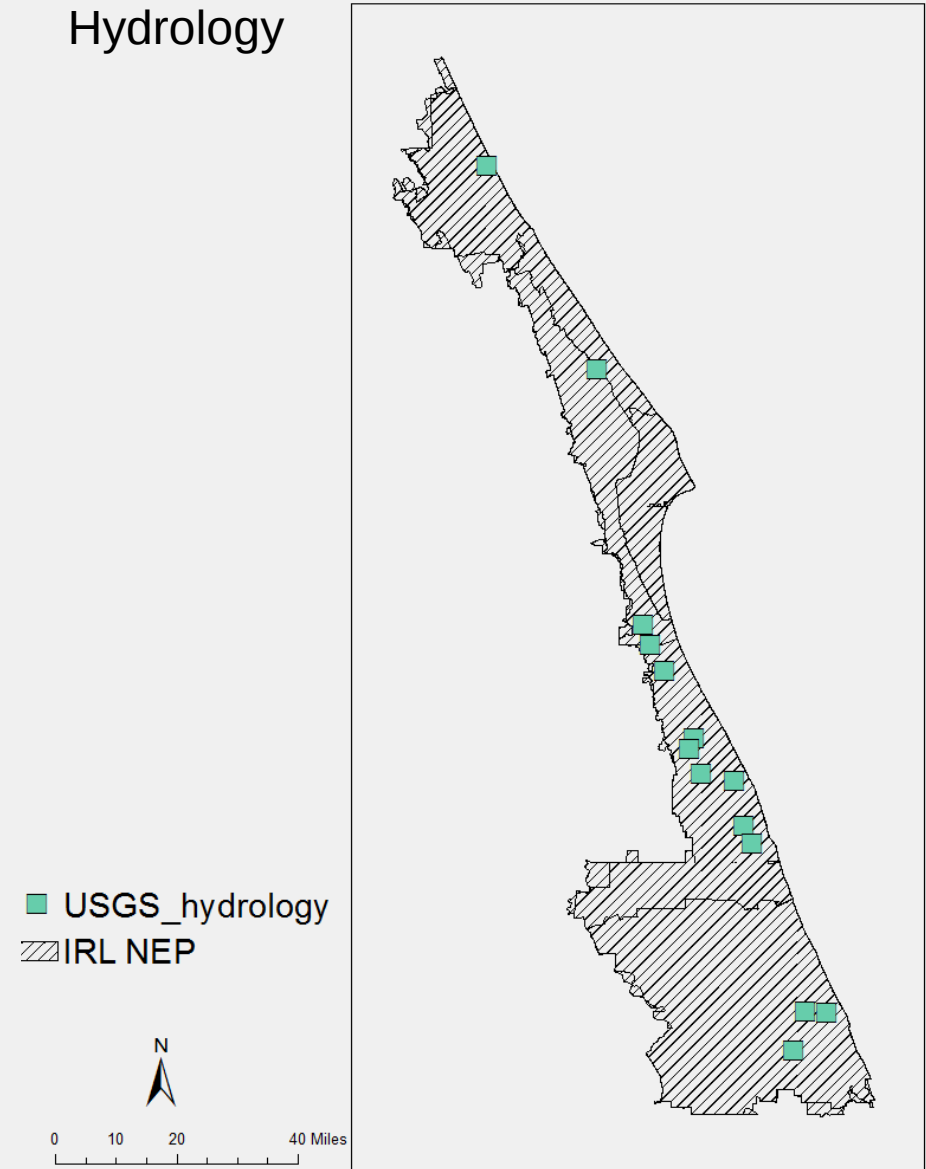
<http://www.irlcouncil.com/ccmp-comments.html>

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## Atmospheric deposition

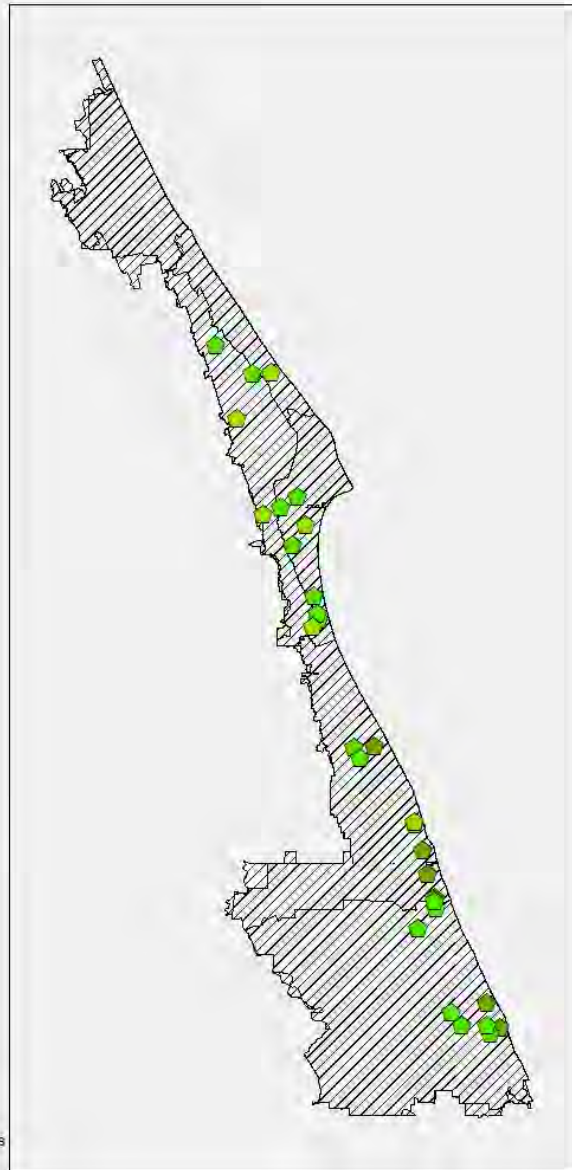


## Hydrology



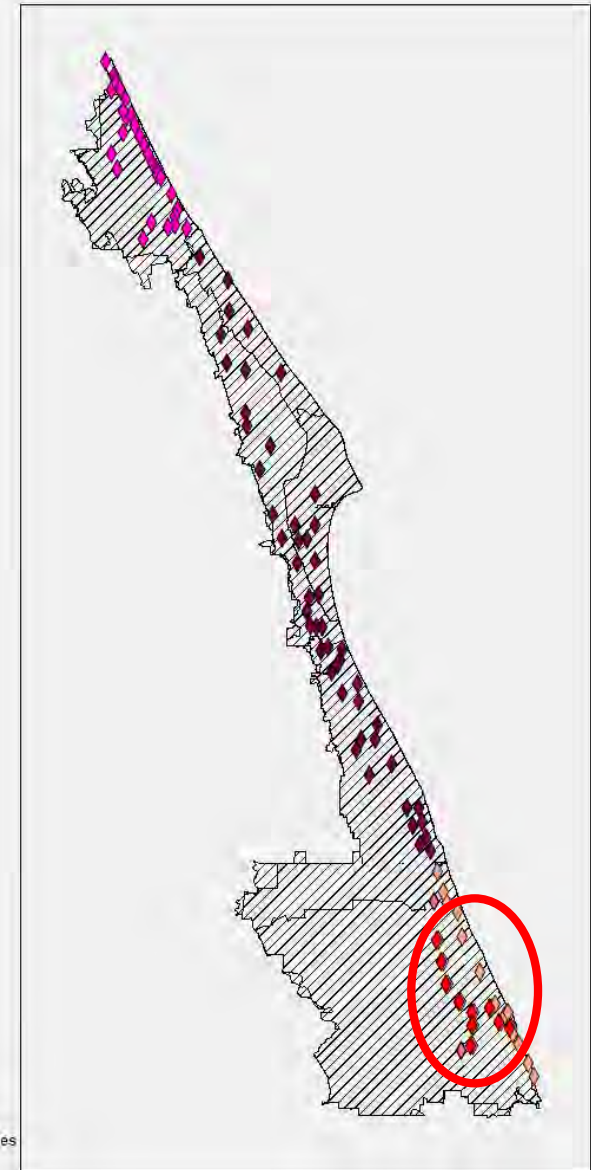
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“Continuous”  
water  
quality

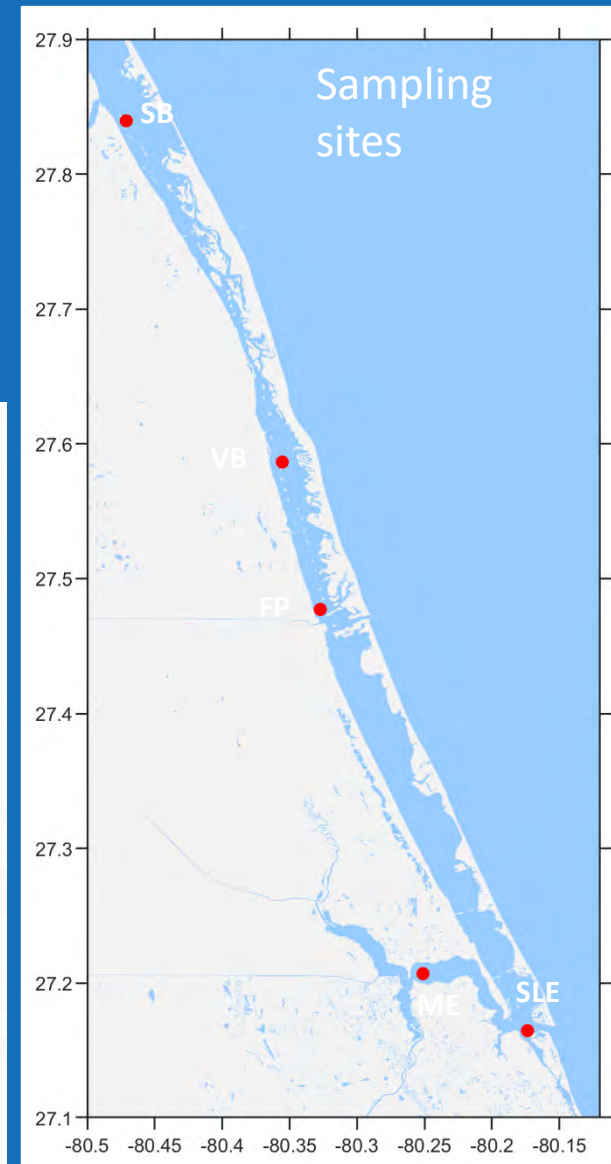
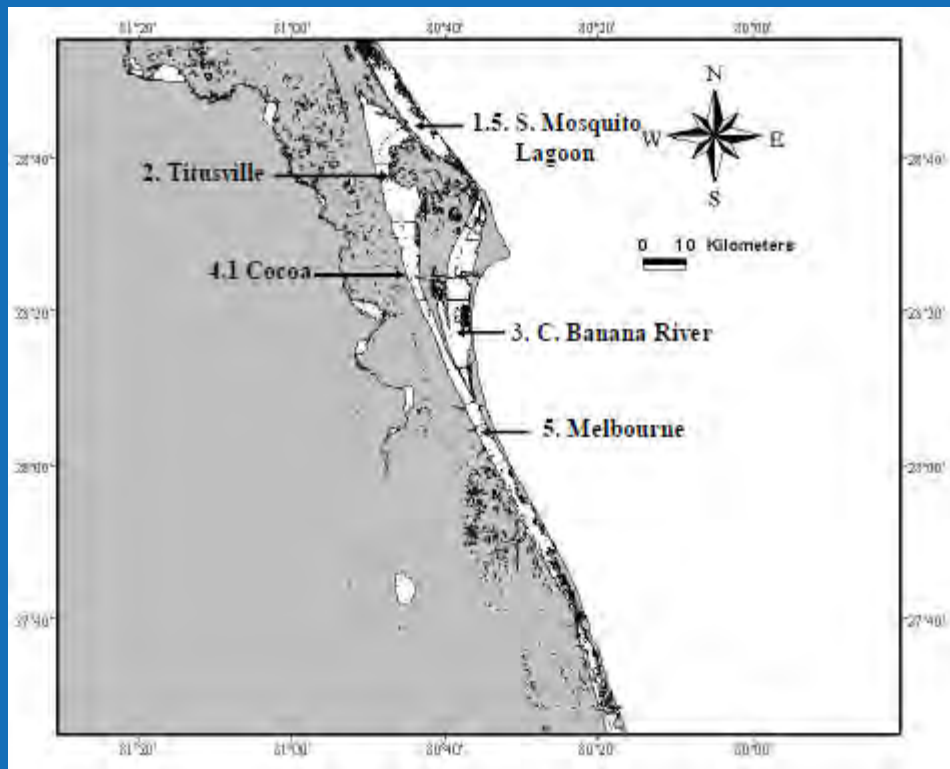


Monthly  
water  
quality

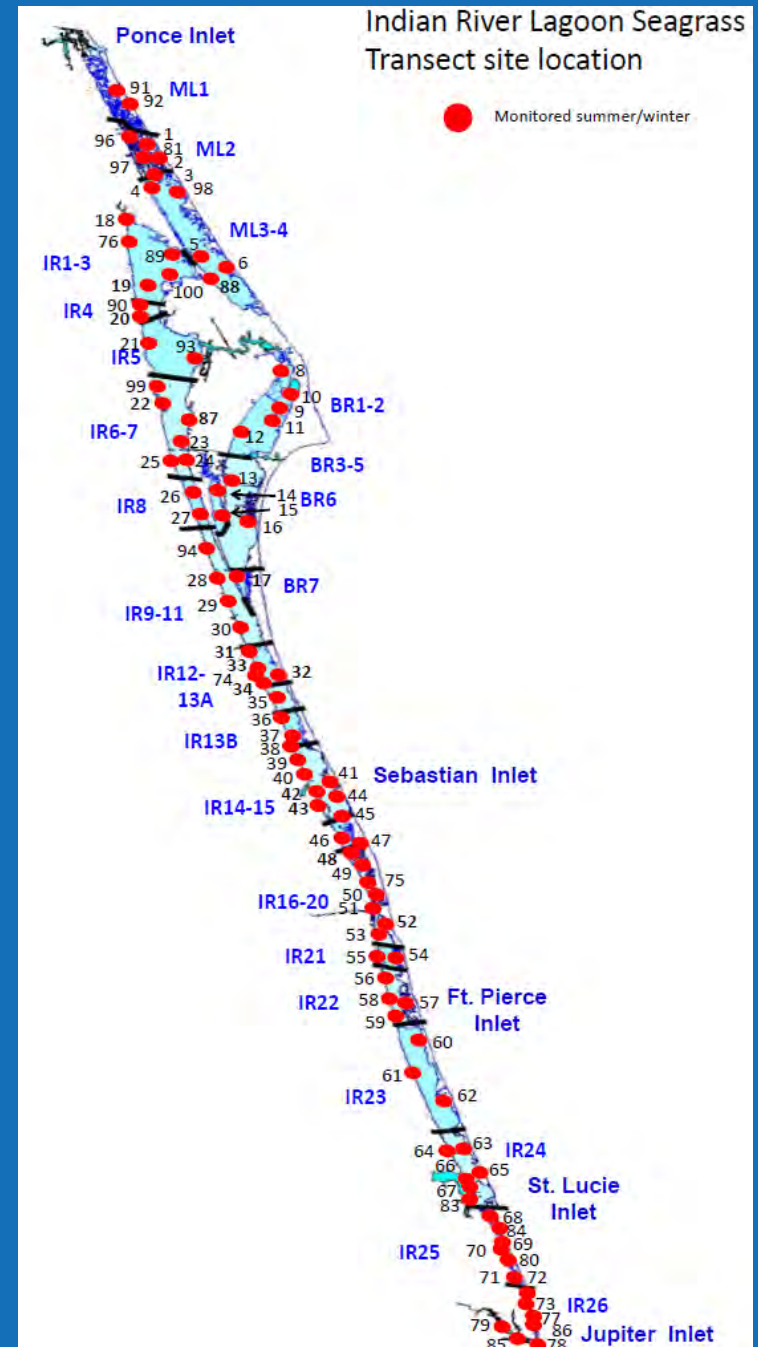
- ◆ Volusia
- ◆ SJRWMD
- ◆ SFWMD\_w
- ◆ FDEP
- ▨ IRL NEP



- **Phytoplankton**
  - fortnightly, IRLNEP
  - weekly, FWRI, HAB focus



- Seagrass
  - transects, summer and winter
  - maps, each 2 years



- Fisheries independent monitoring, FWC



Figure IR17-01. Map of the northern Indian River Lagoon sampling area. Zones are labeled A–F, and H.

**How are we doing?**

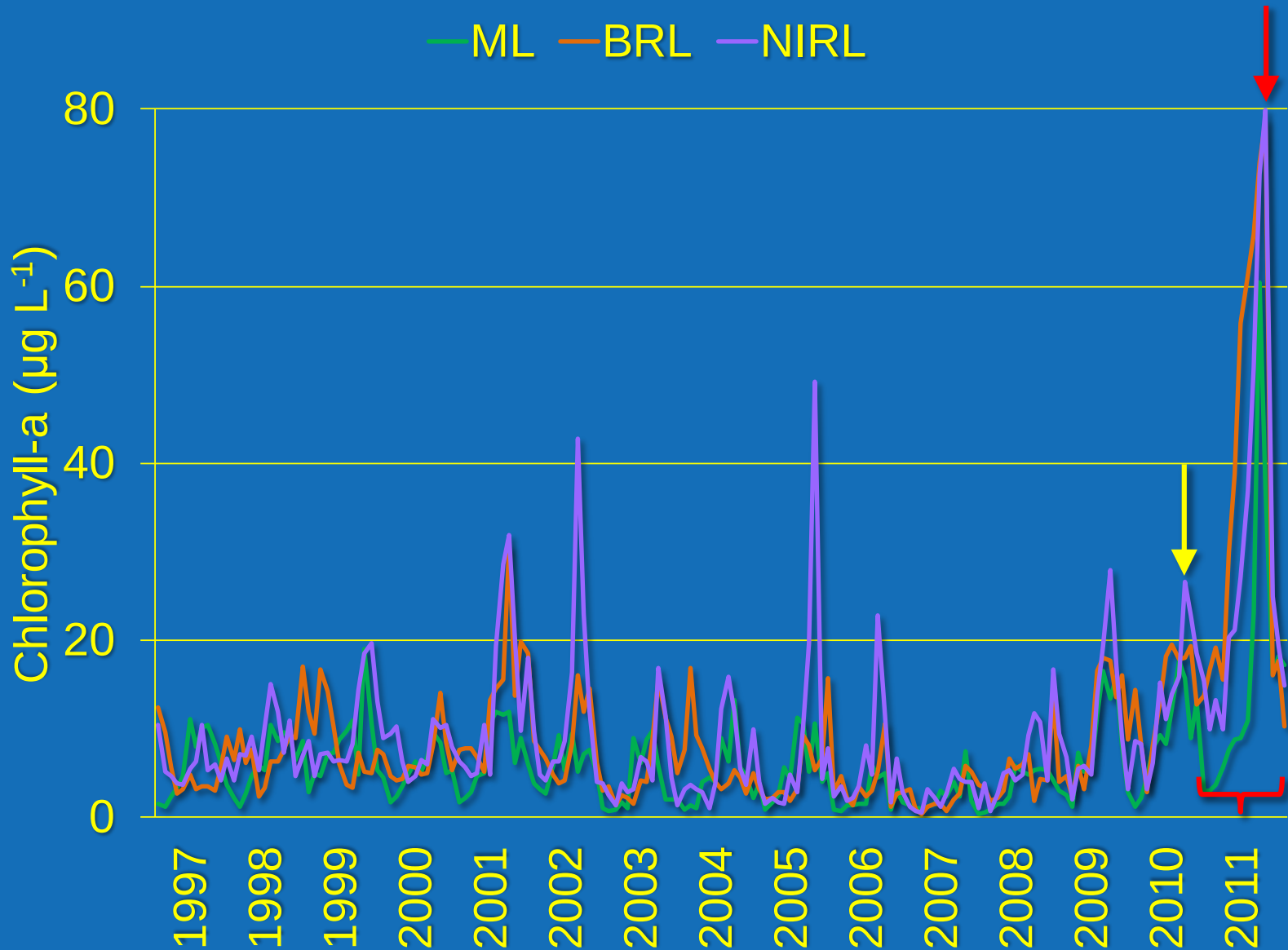


# St. Johns River Water Management District

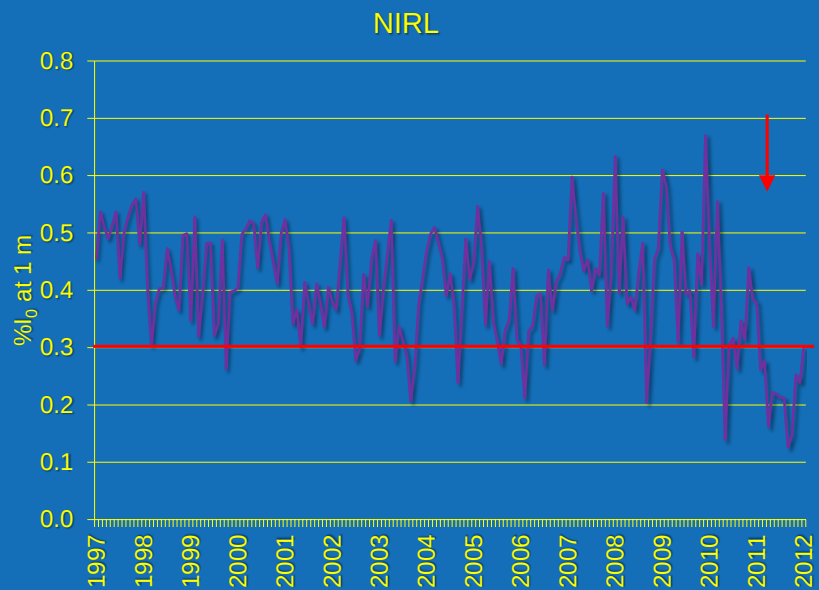
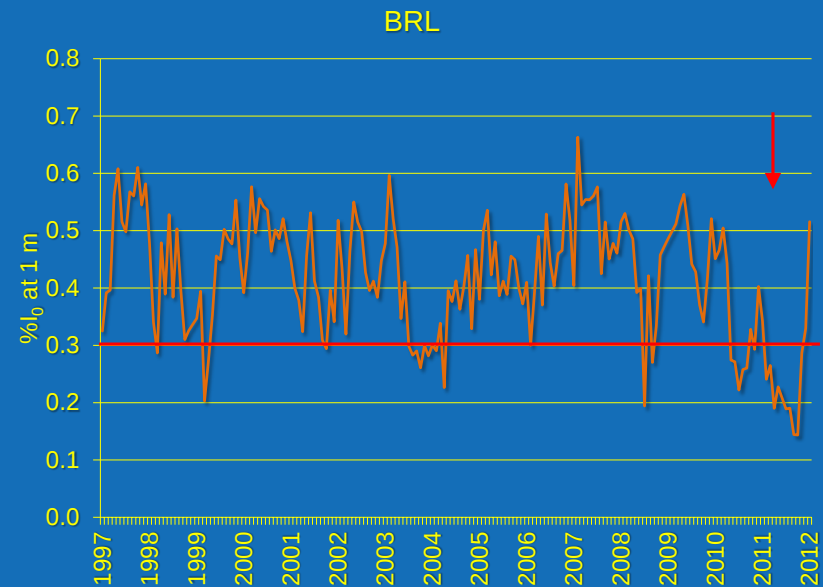
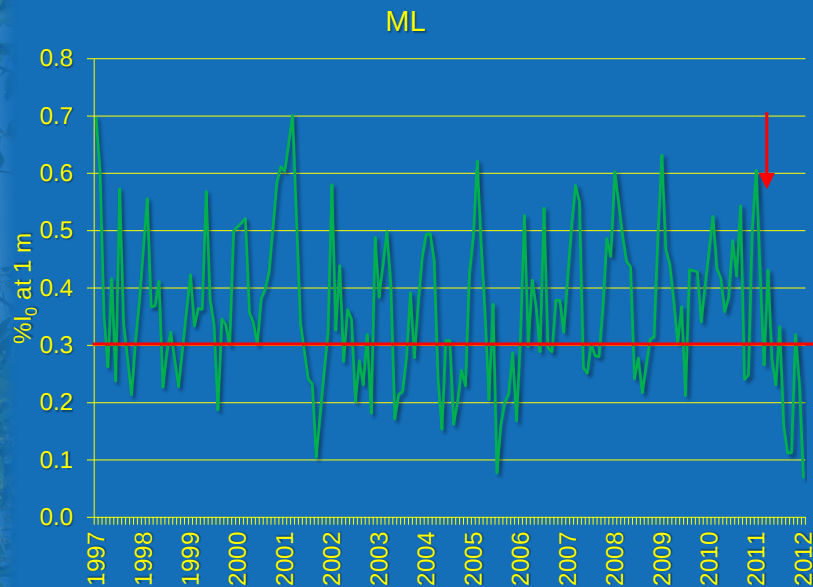
## Indian River Lagoon seagrass



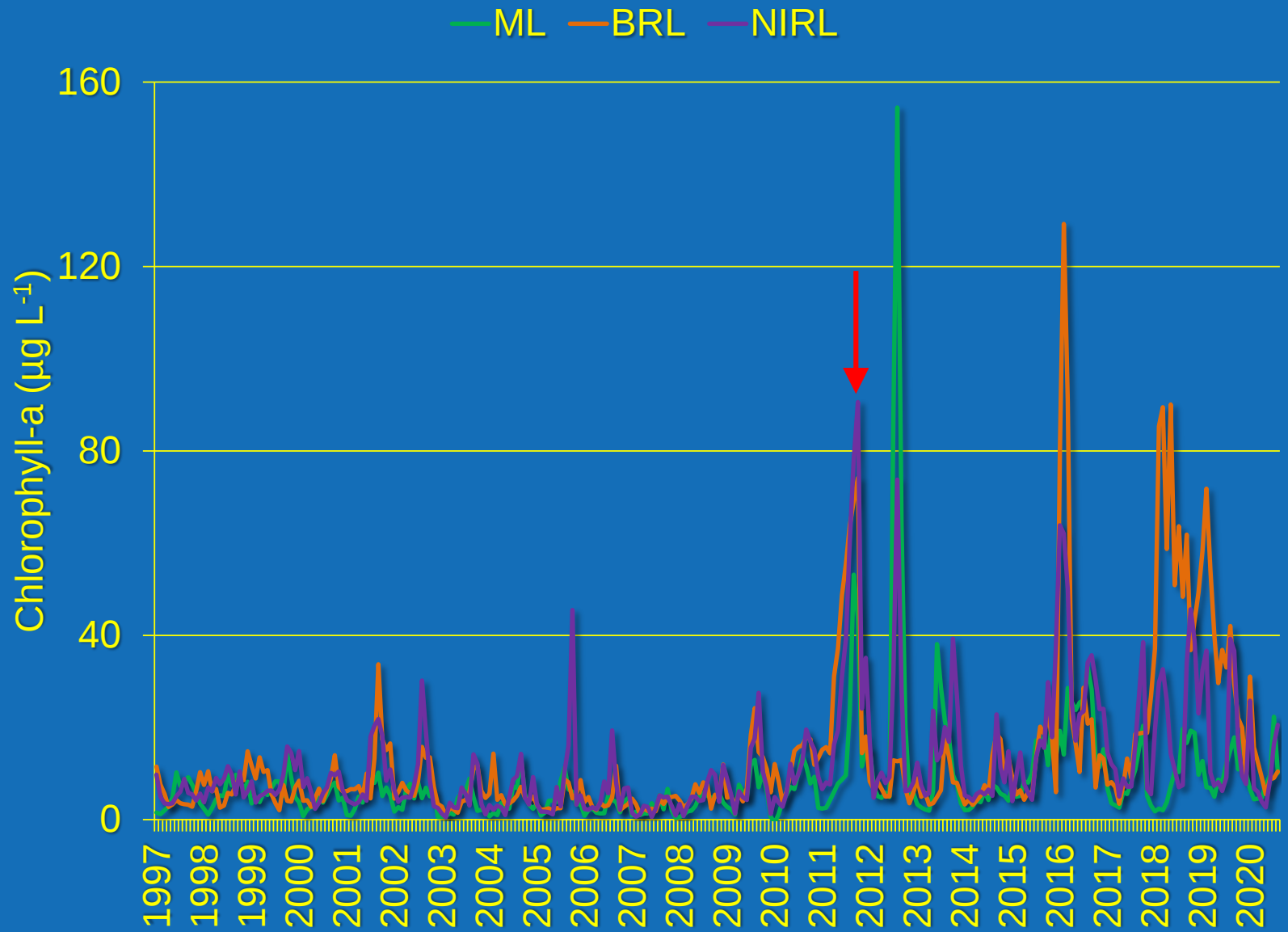
# St. Johns River Water Management District



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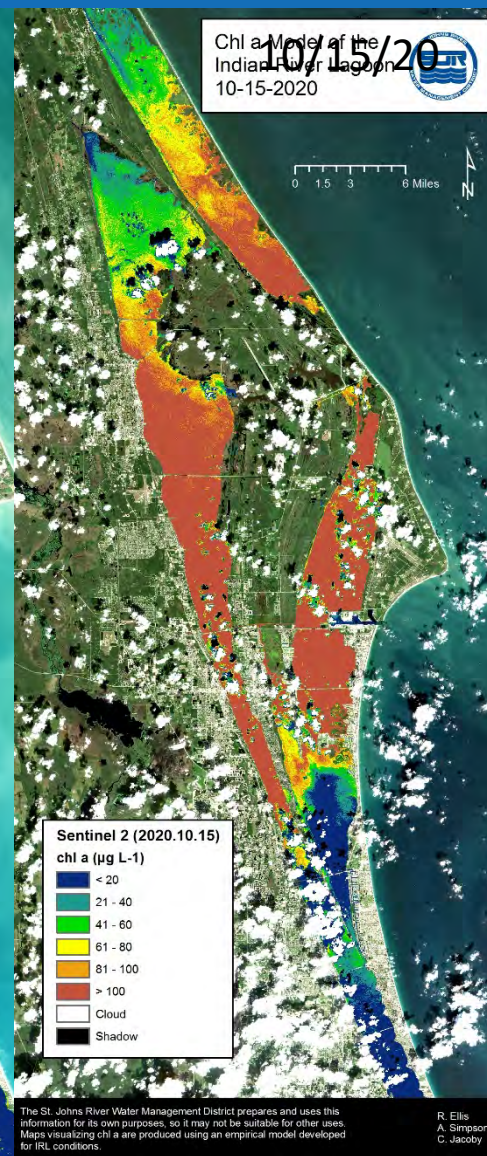
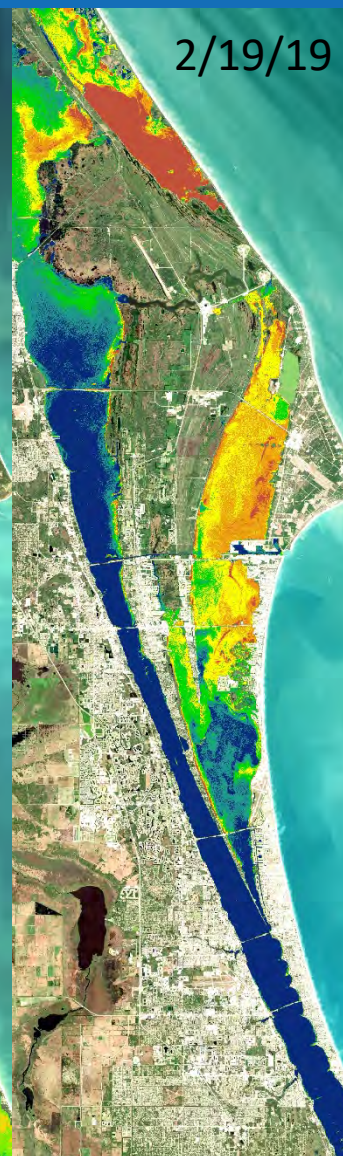
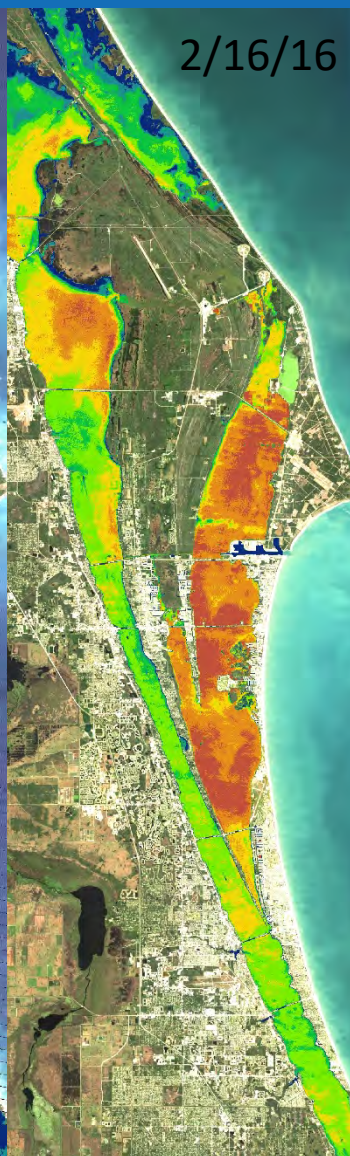
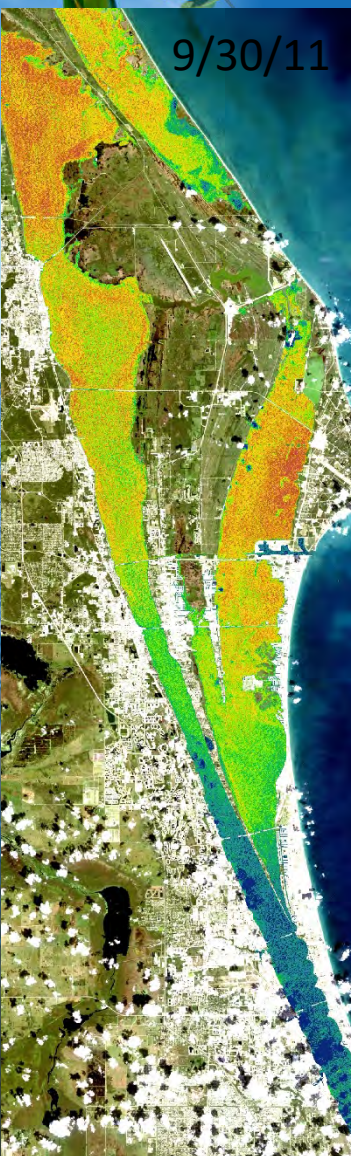


# St. Johns River Water Management District

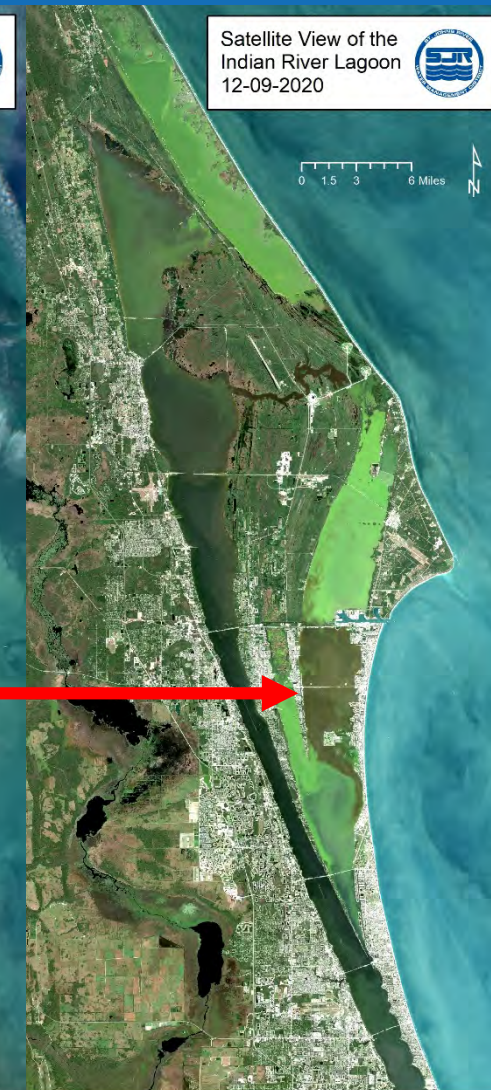
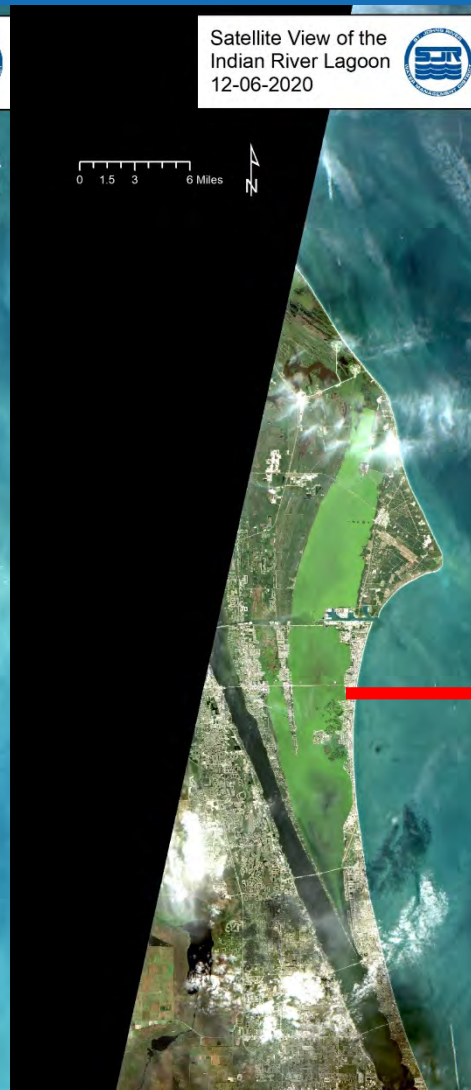
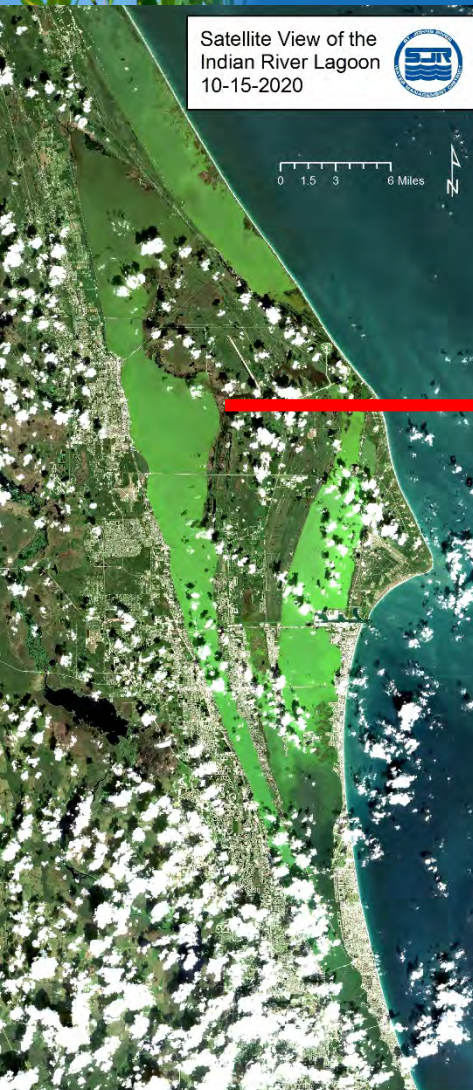


# St. Johns River Water Management District

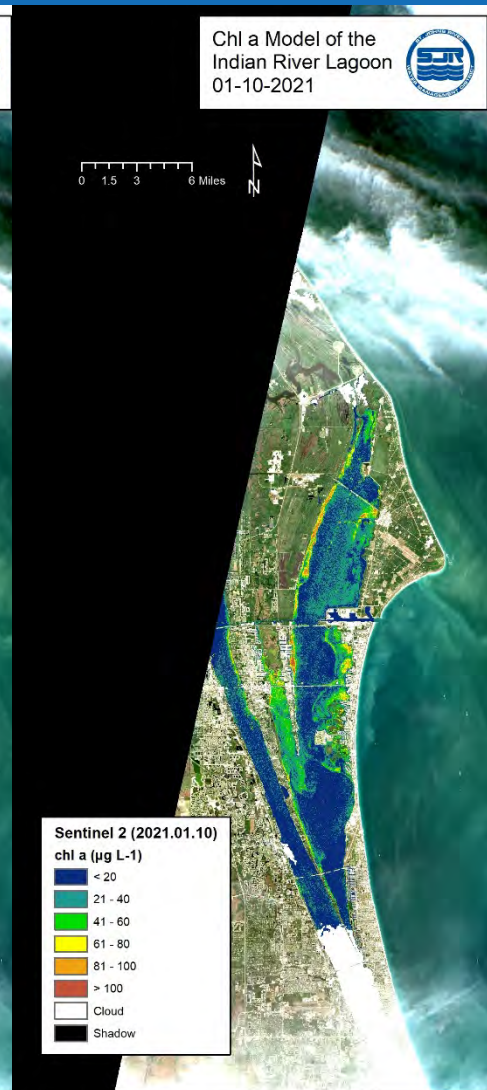
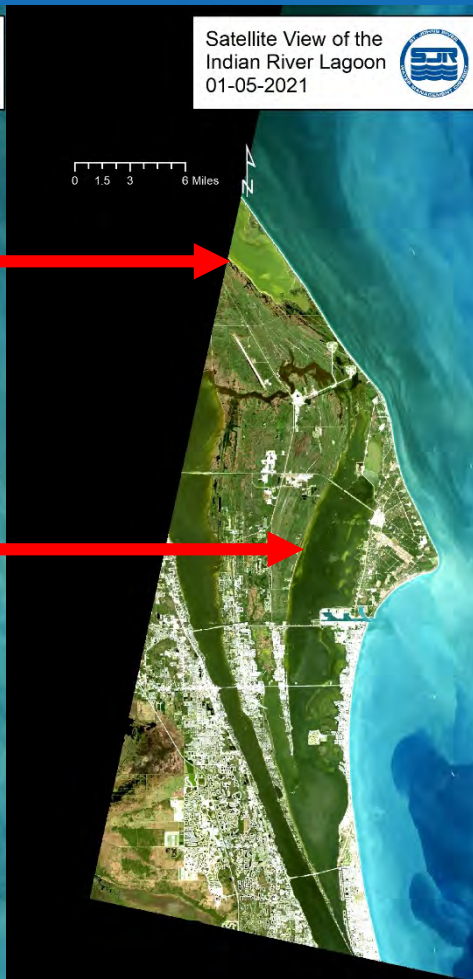
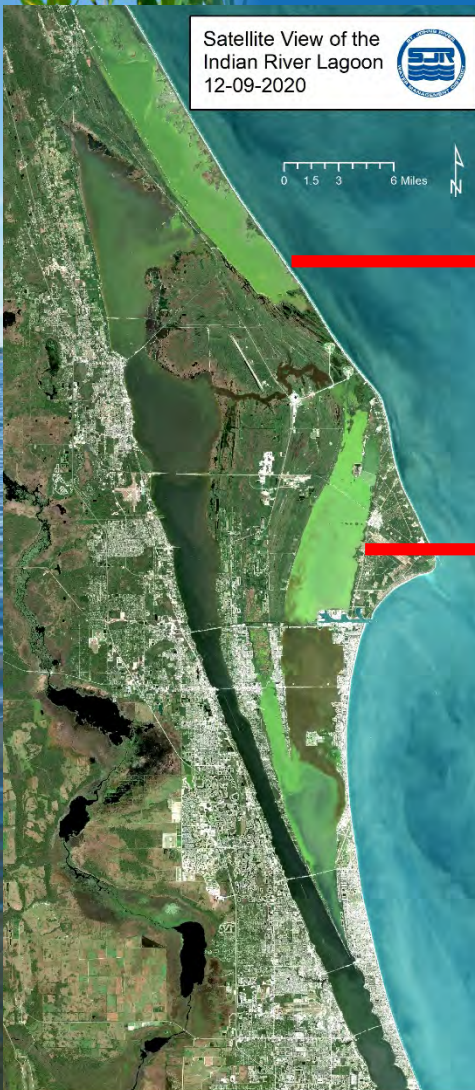
## Recent bloom



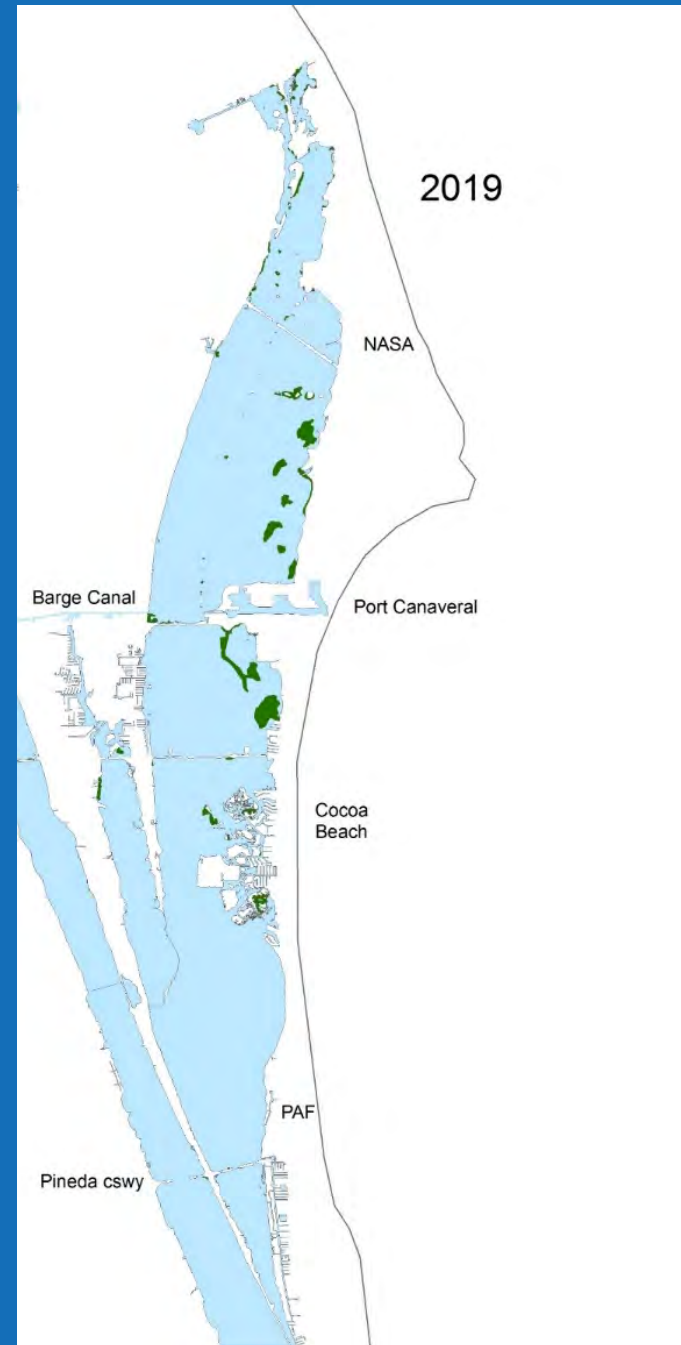
## • Recent bloom



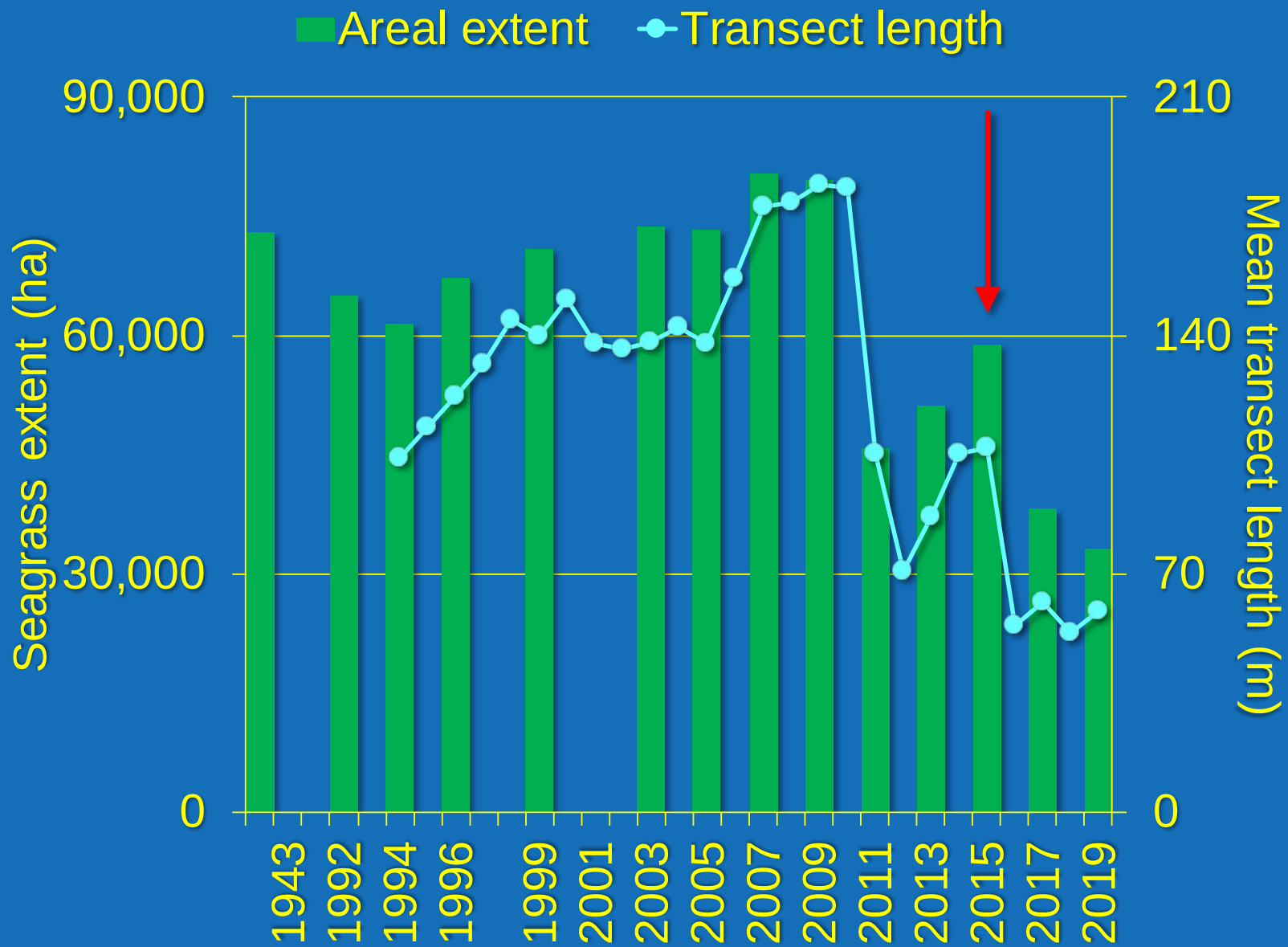
## Recent bloom



- Changes from 1992 to 2019

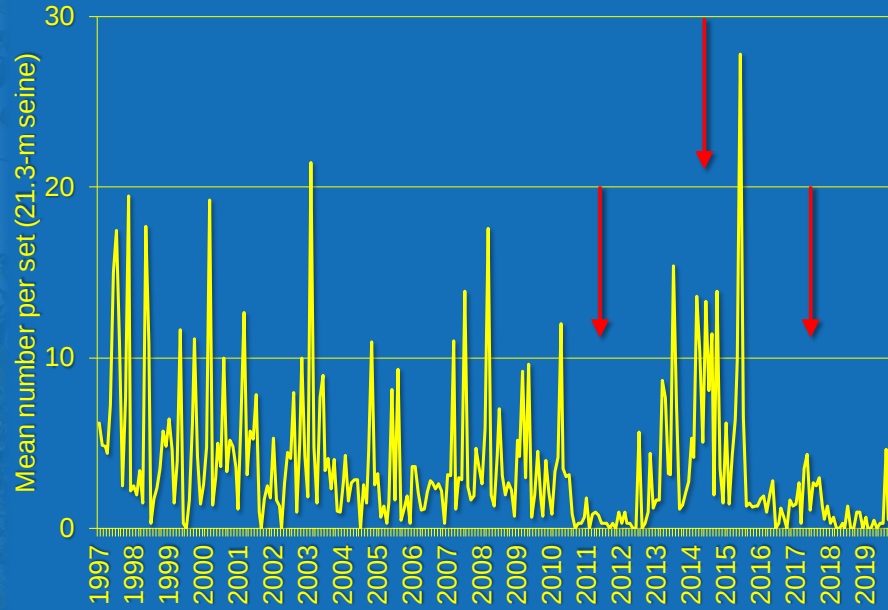


# St. Johns River Water Management District

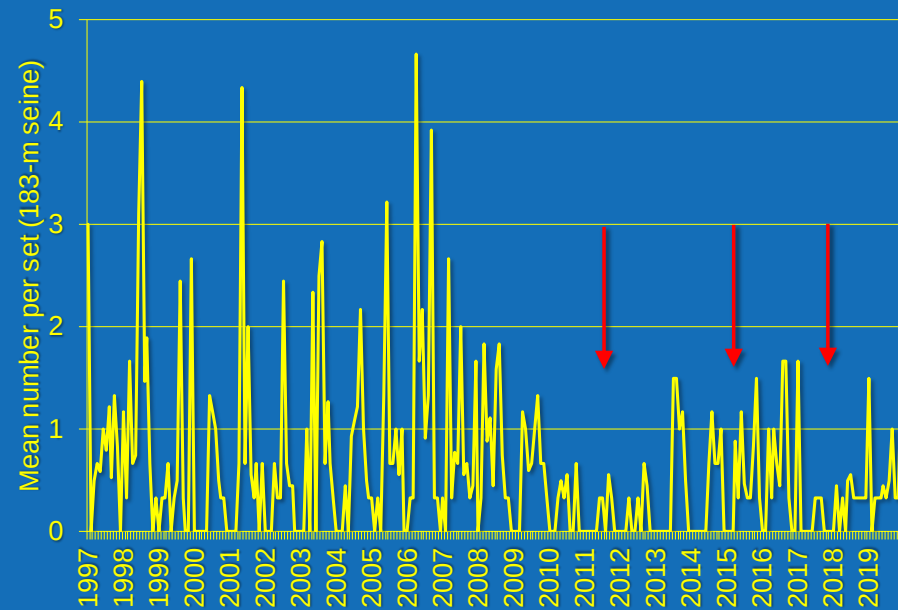


# St. Johns River Water Management District

Code goby



Snook



- 
- **2012–2013 manatee UME**  
(115 mortalities due to undetermined causes\* in 2013)
  - **2013 dolphin UME**  
(Mar–Aug  $\Rightarrow$  3 $\times$  – 6 $\times$  higher mortality than 9 year mean)
  - **2016 fish kill in Banana River Lagoon**  
(estimated  $\gg$  100,000 mortalities)

**What happened?**



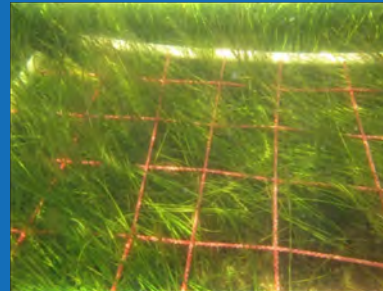
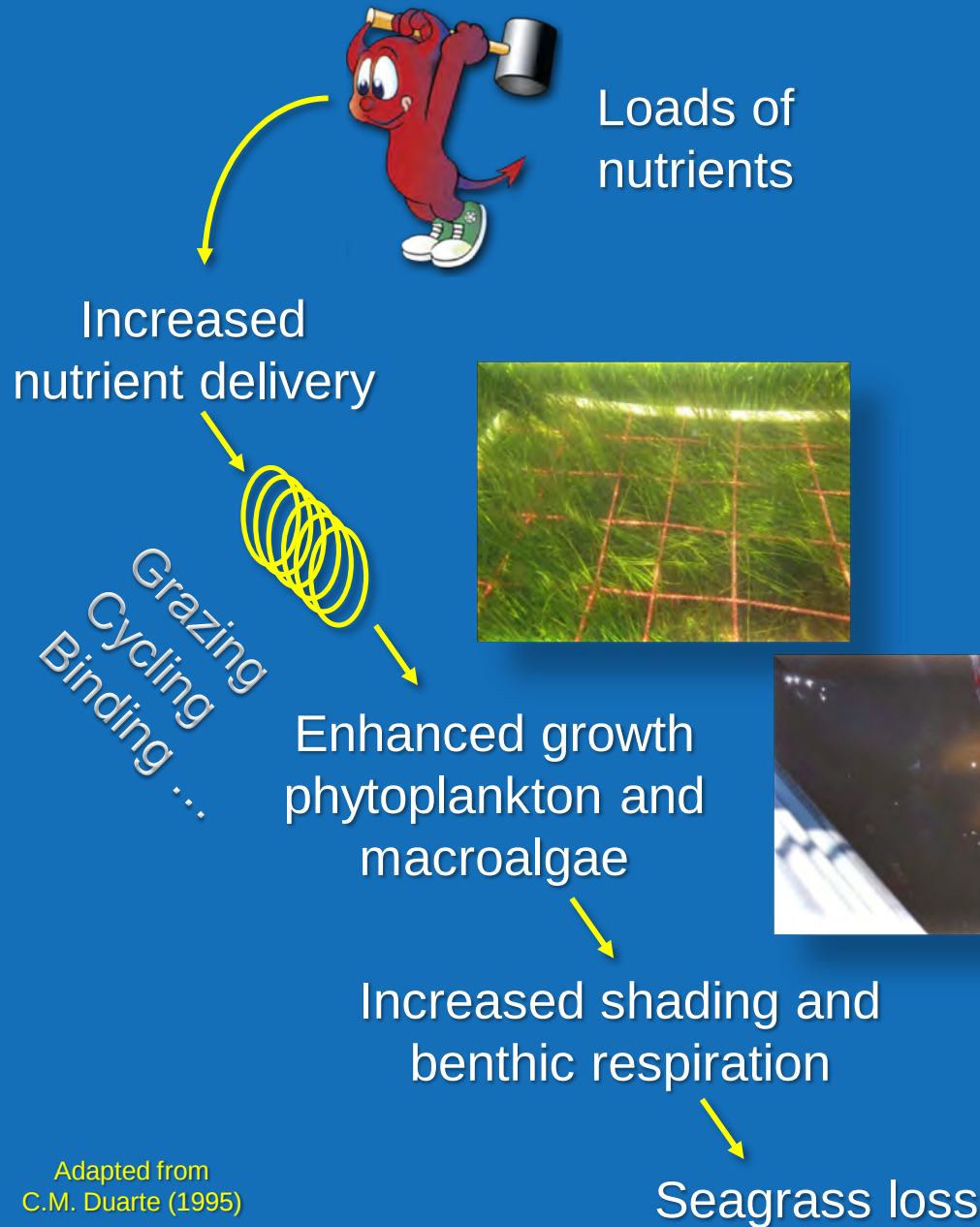
# St. Johns River Water Management District



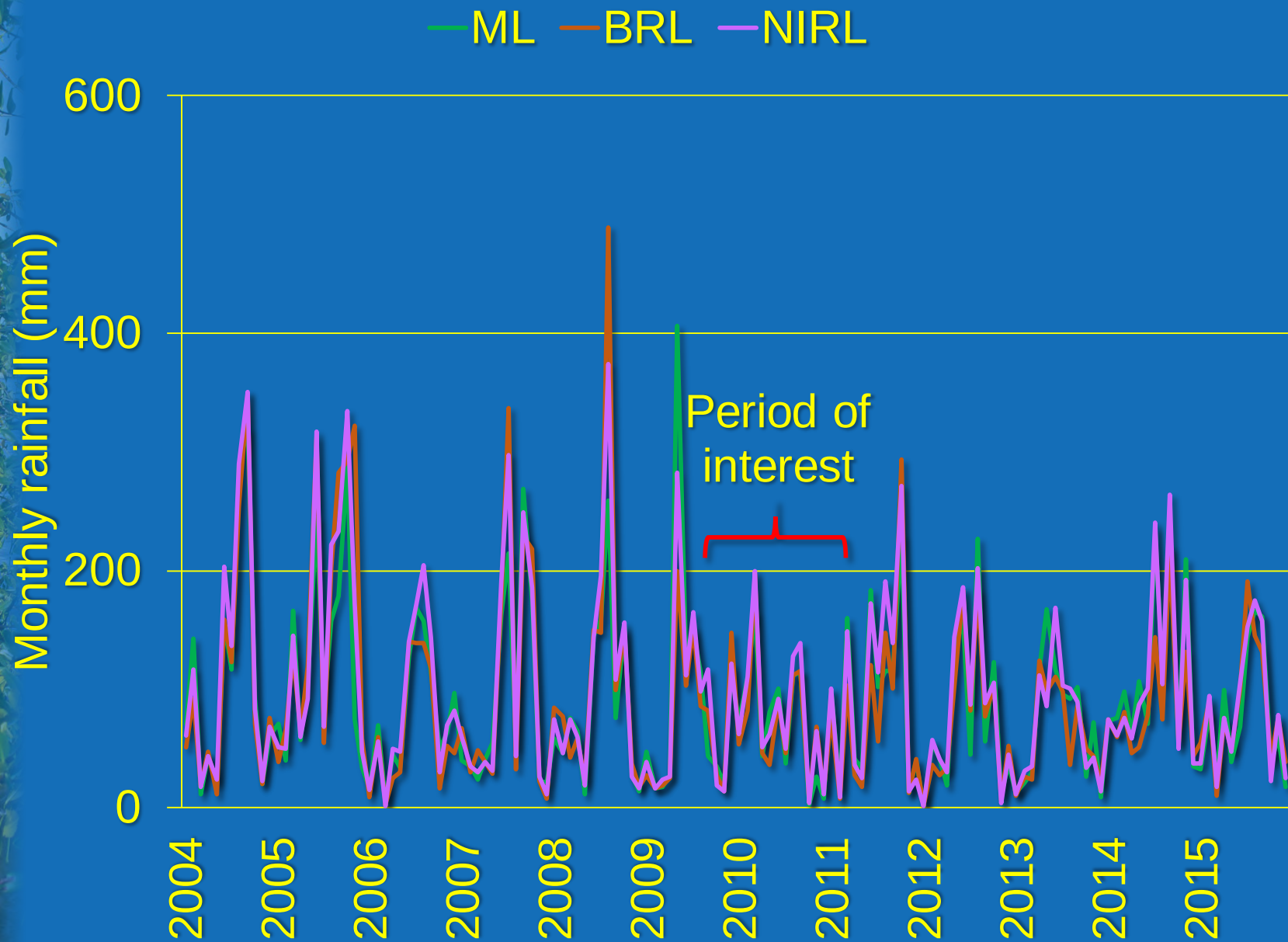
*Florida Tech*



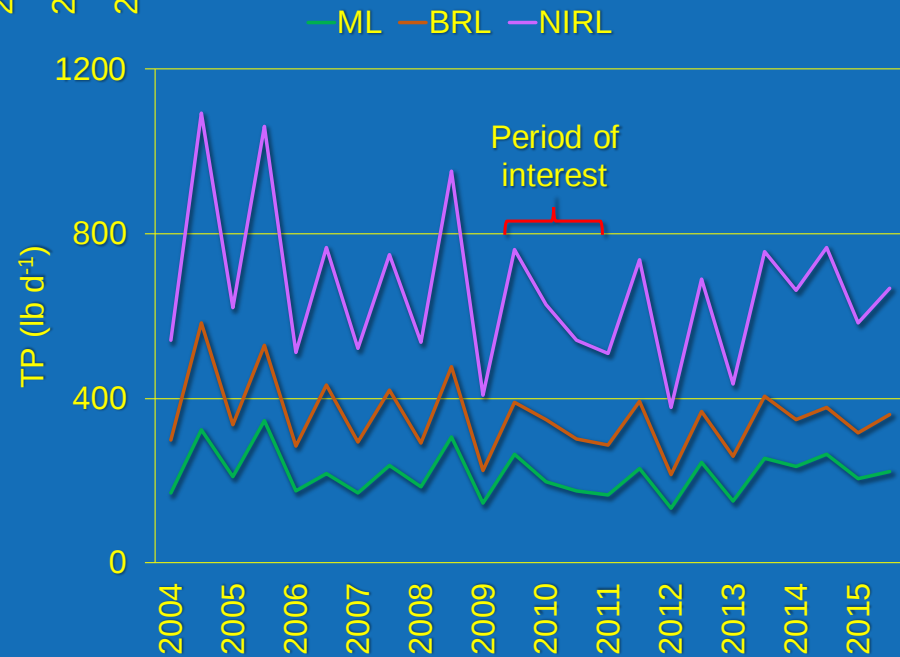
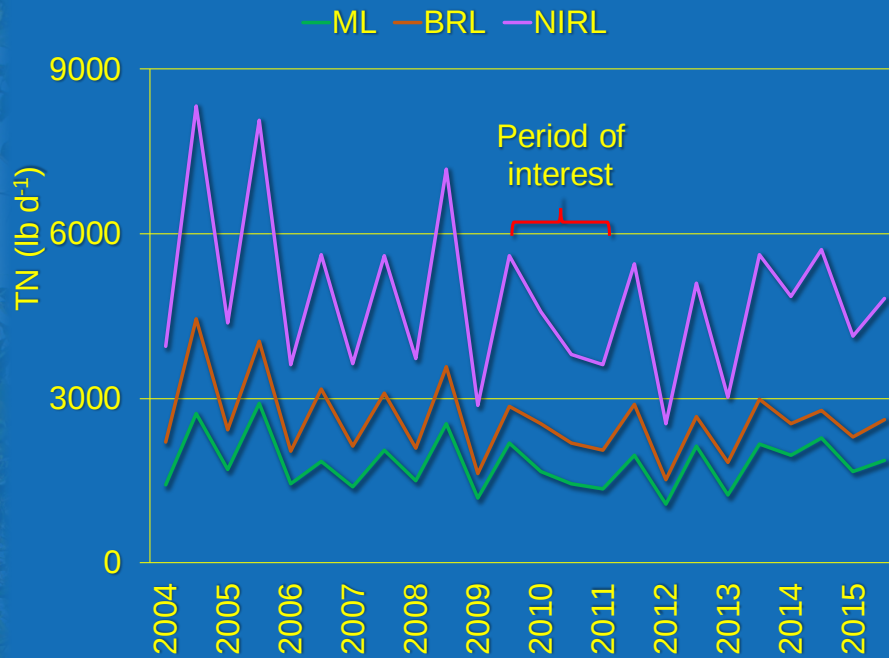
Eutrophication  
progression  
scheme



# St. Johns River Water Management District

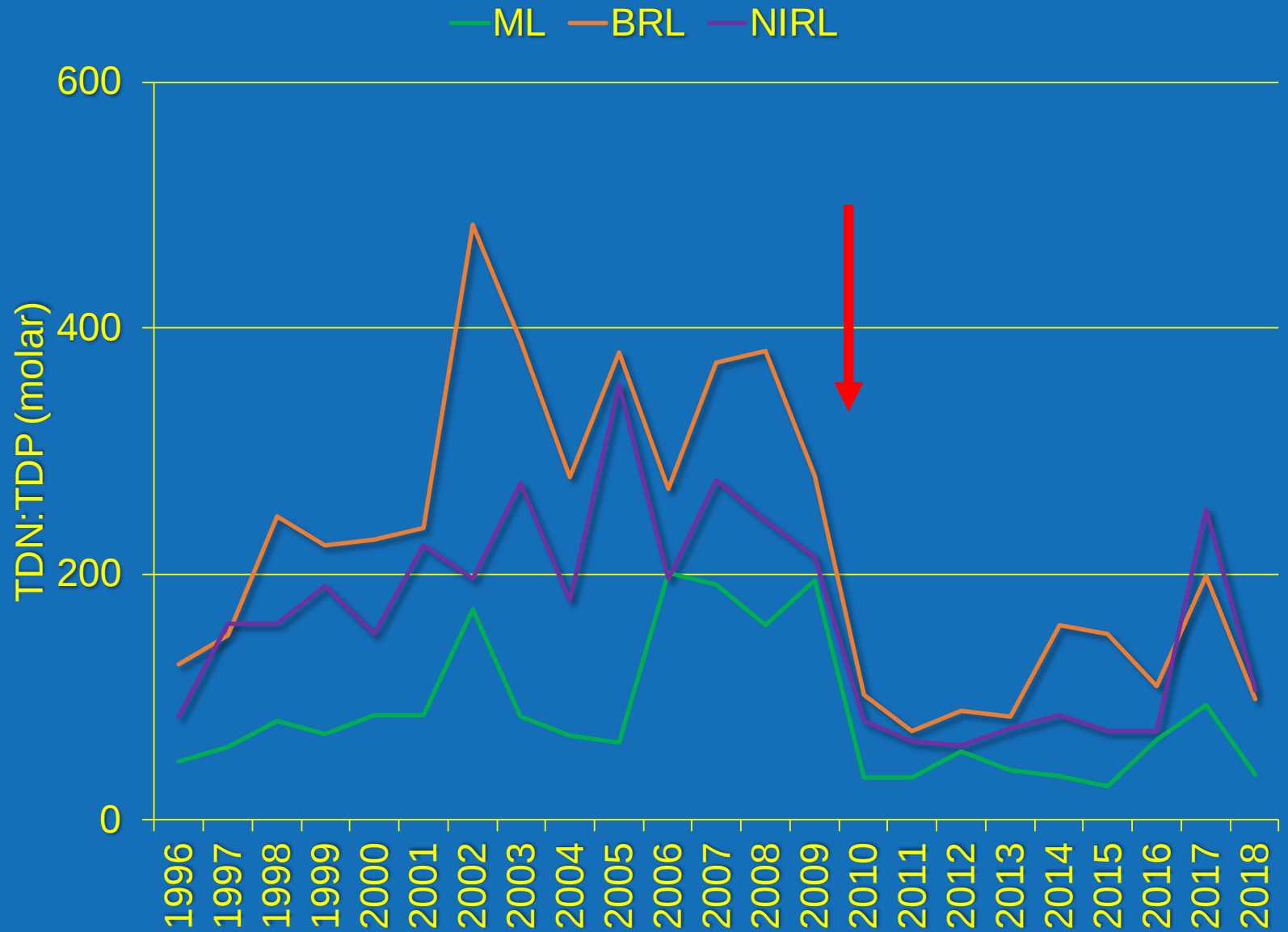


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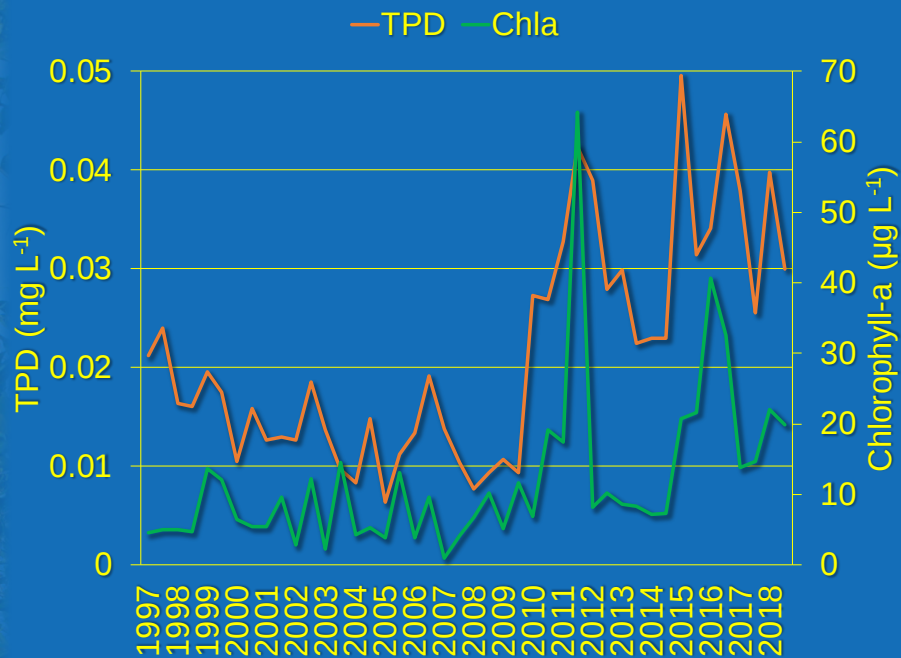


HSPF model

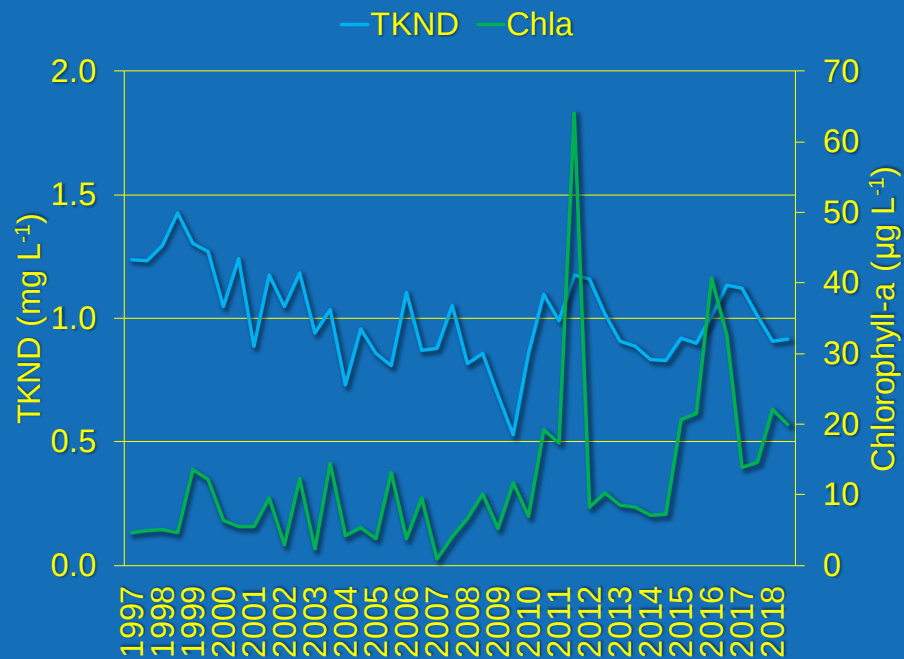
# St. Johns River Water Management District



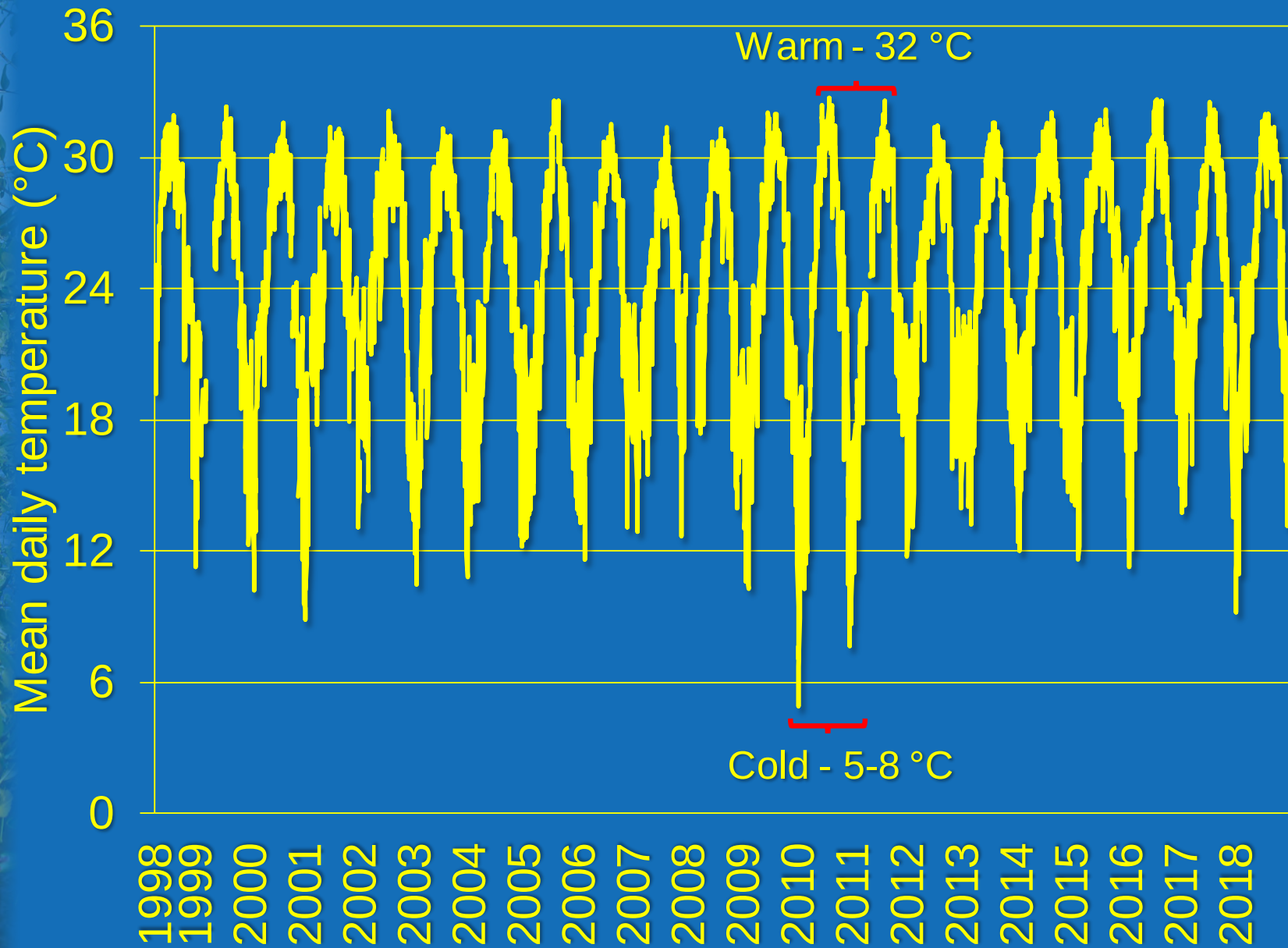
# St. Johns River Water Management District



NIRL  
IRLI10  
south of NASA causeway



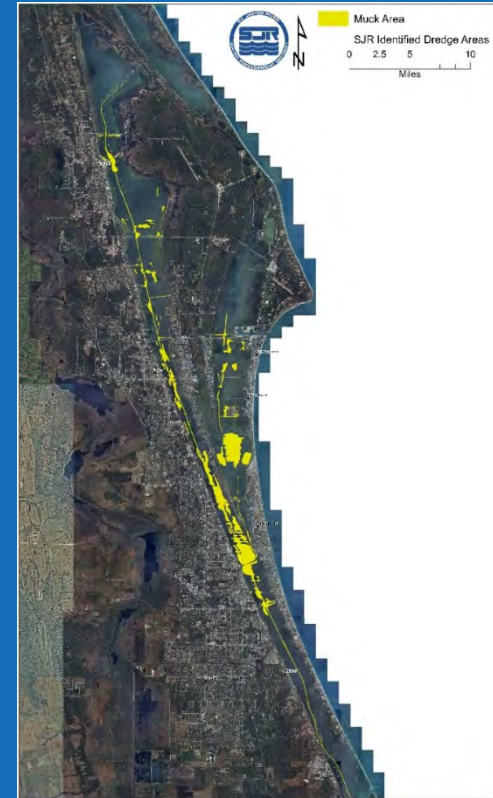
# St. Johns River Water Management District





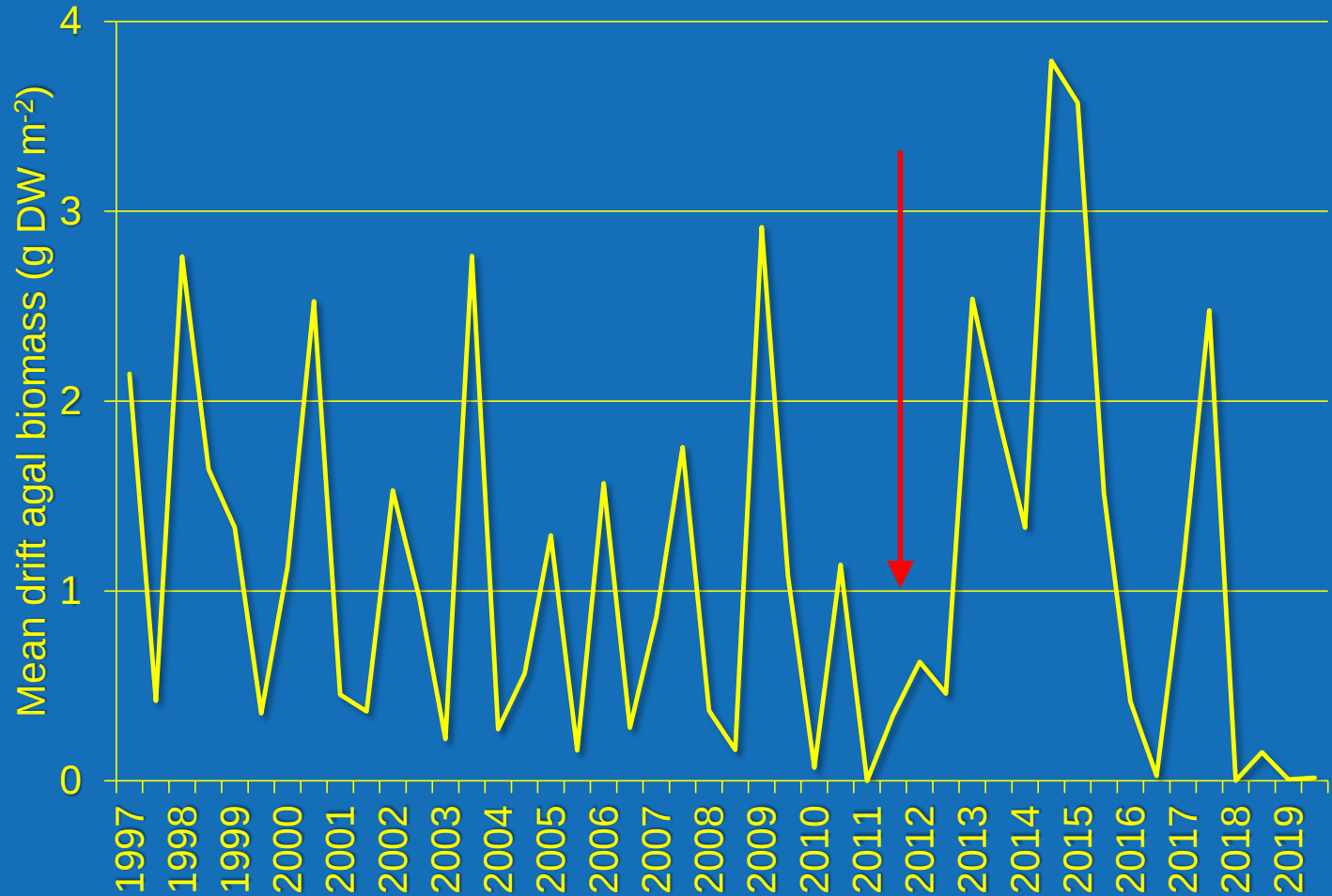
- Internal source = cold kill (Jan 2010)?
- NASA contractors  $\Rightarrow$  400 tons of fish
- Assume 4% N and 0.4% P
- $\Rightarrow$  16 tons N and 1.6 tons P
- Triple for total area?

- Internal source = muck?
- °C effect?
  - flux ↑↑ as °C ↑↑
  - [P] and [N] ↑↑ as °C ↑↑
- pH effect?
  - flux ↑↑ as pH ↑↑
  - pH ↑↑ as algae draw [CO<sub>2</sub>] ↓↓
  - [TPD] ↑↑ as algal biomass ↑↑
- Spatiotemporal resolution?



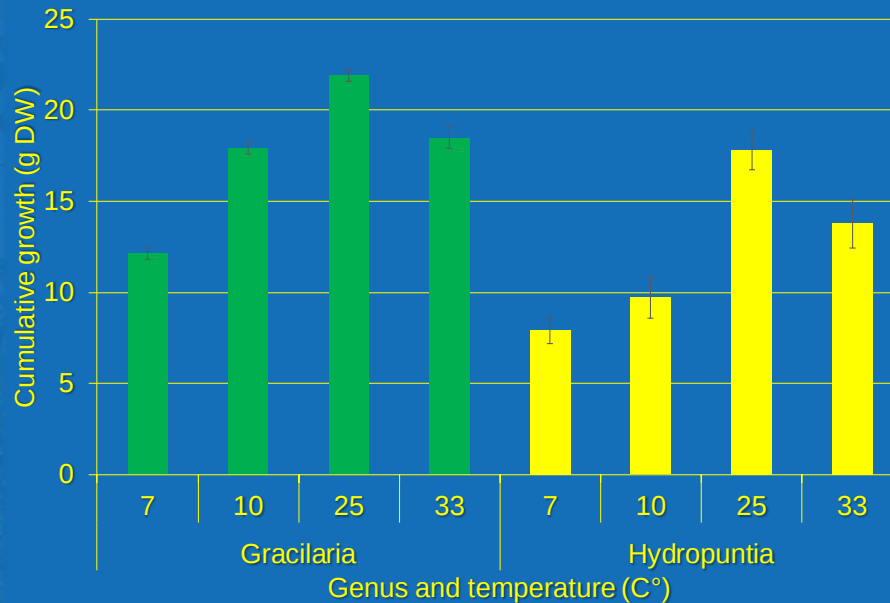
- Internal source = drift
- “Bycatch” ↓
- Mortality ⇒ N and P?
- Cycling change?

BRL



# St. Johns River Water Management District

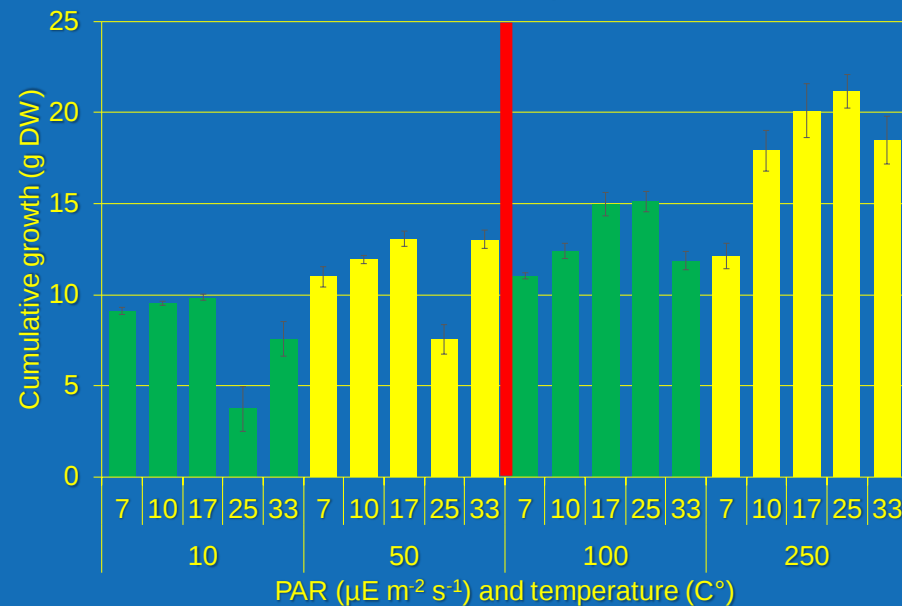
25 psu, 12 h at 250  $\mu\text{E m}^{-2} \text{s}^{-1}$



- °C  $\Rightarrow$  stress
- Not mortality

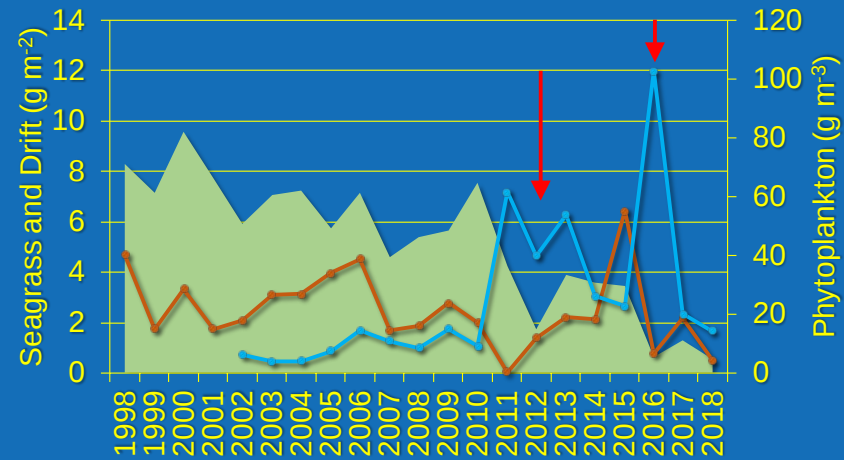
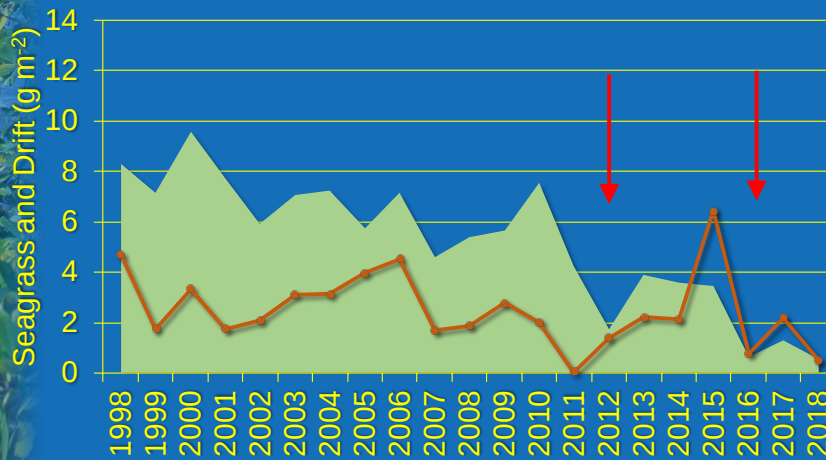
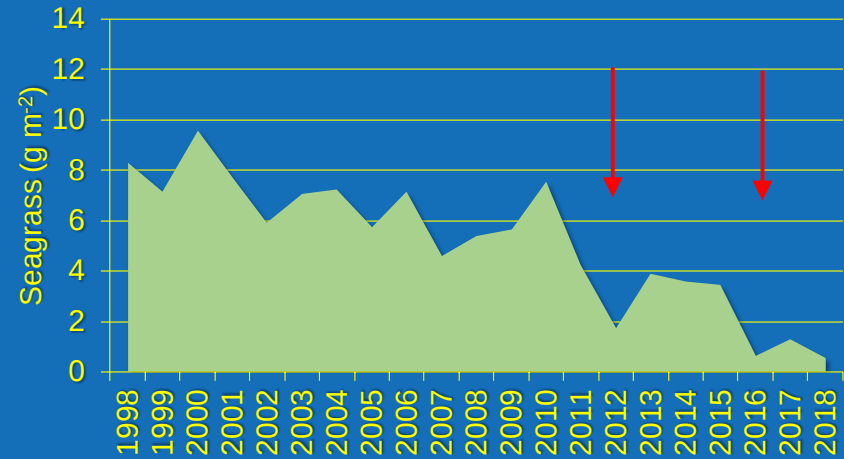
- °C + PAR  $\Rightarrow$  stress
- Not mortality
- Cycling change

Gracilaria at 25 psu

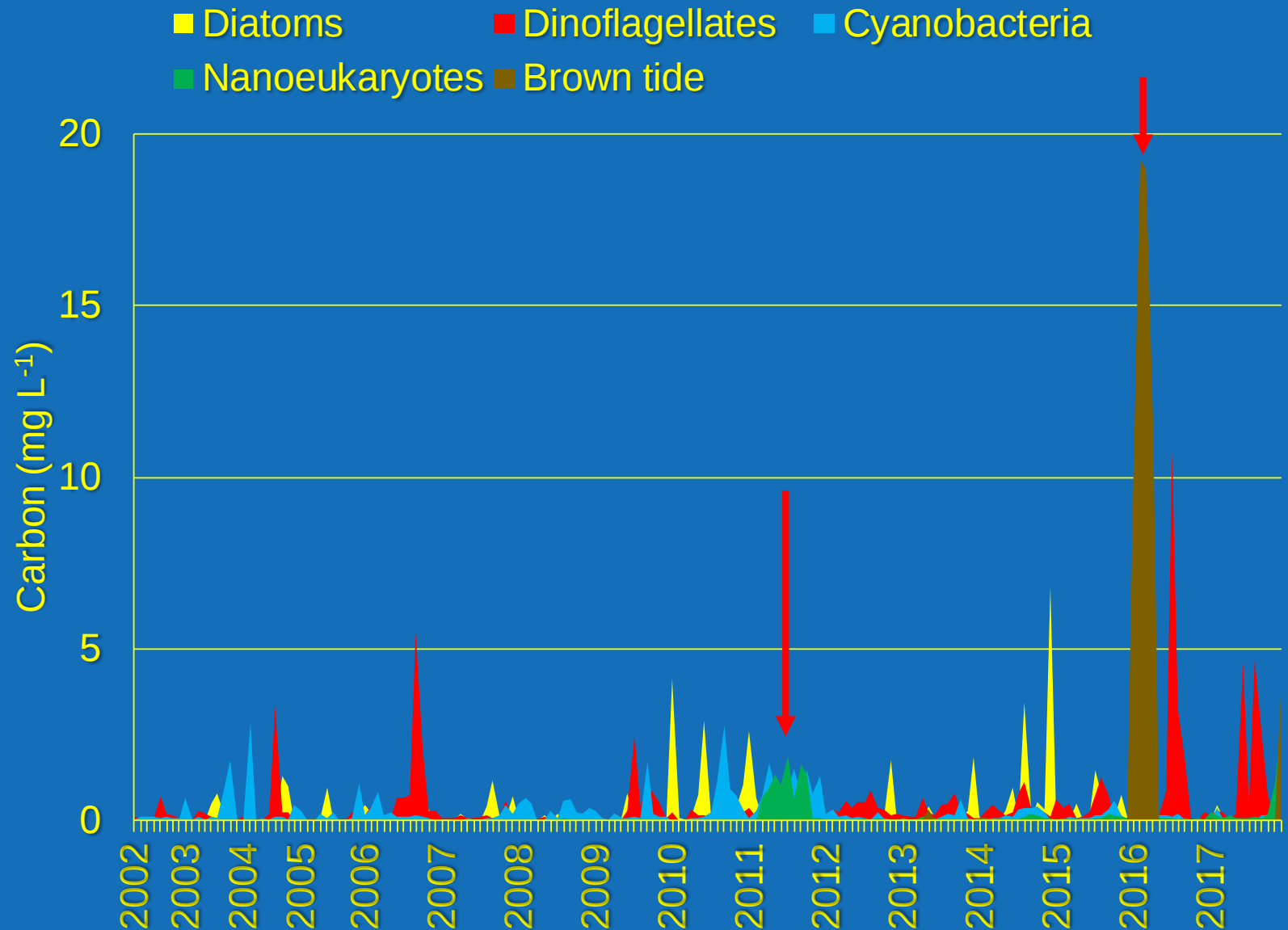


## NIRL

- “Cycling” visible
- Drift ~parallels seagrass
- Phytoplankton drives
- System “flashier”

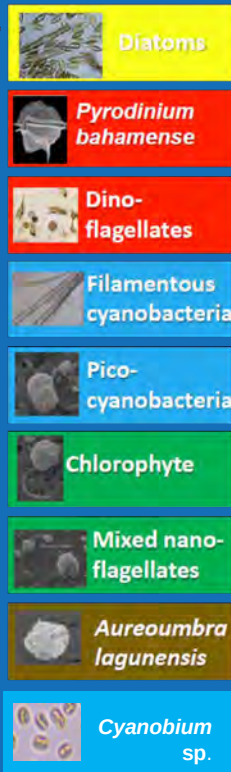


# Banana River Lagoon





Newer  
dominants



- Smaller
- Turn over faster
- Brown tide has resting stage
- Use “organic” N and P
- Fix N (picocyanobacteria)?
- Top-down control?
  - microzooplankton OK
  - mesozooplankton not at high densities
  - infauna (clams) OK except brown tide
  - epifauna OK except brown tide



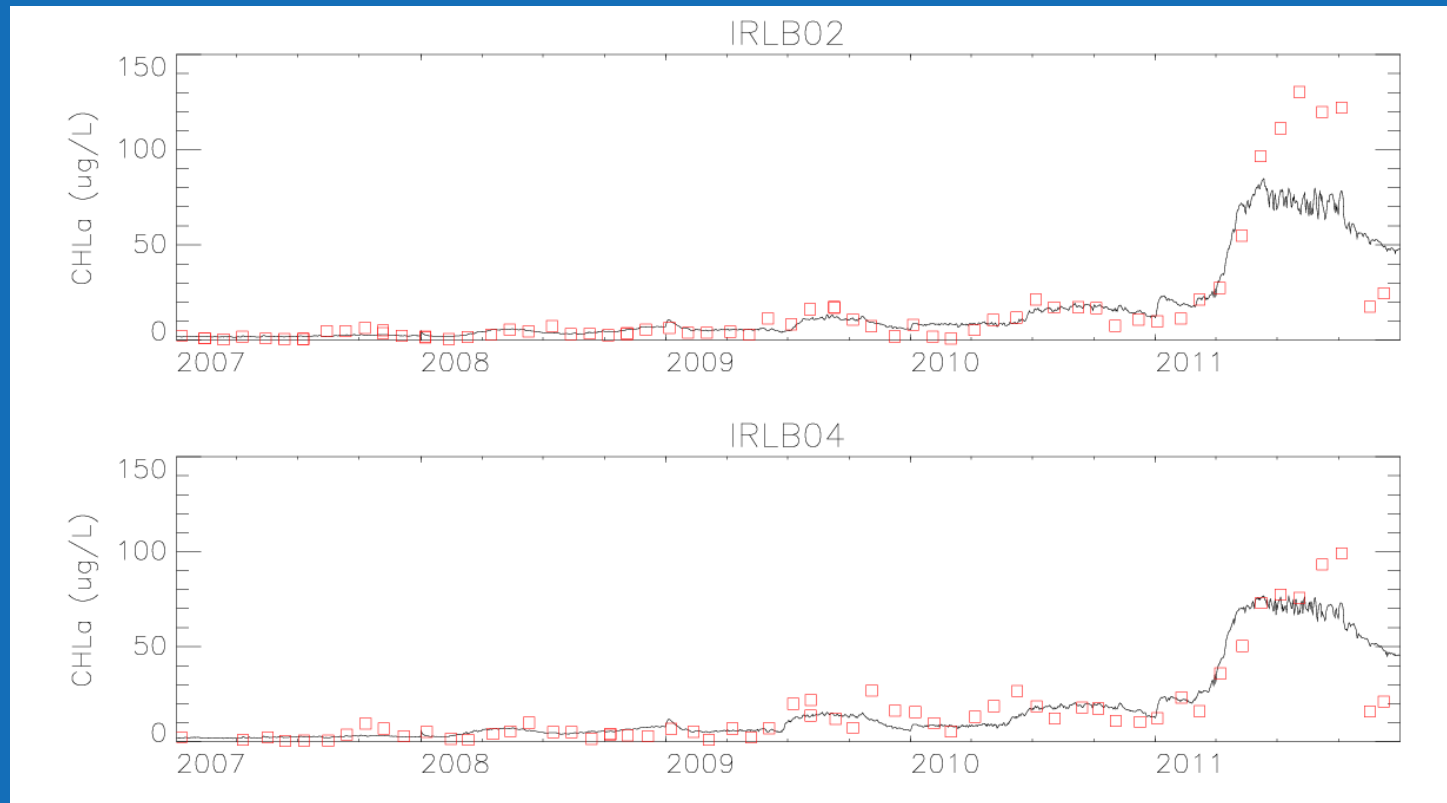
**How does this egghead stuff help?**

# Take-homes for managers

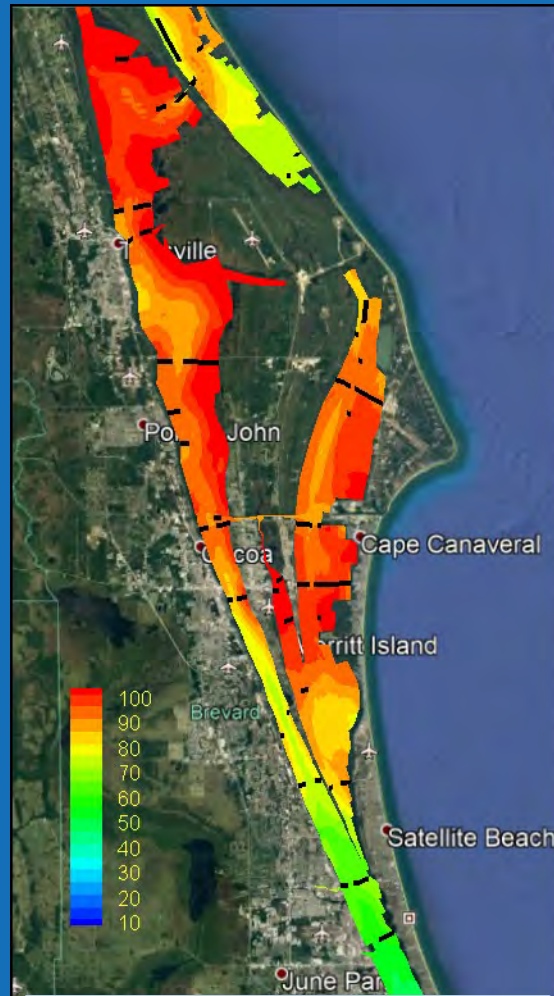
- Nutrients  $\Rightarrow$  chlorophyll = the issue



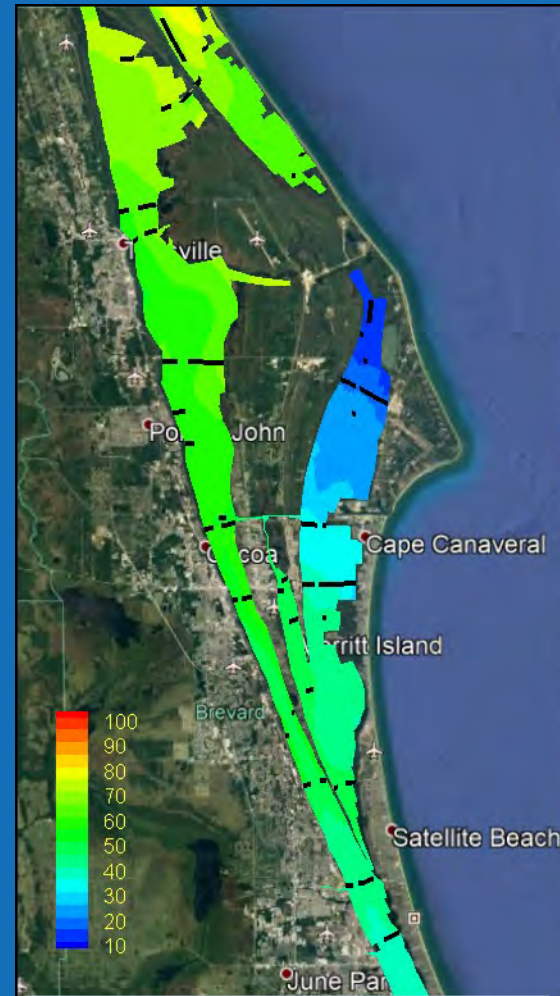
## Modeled versus measured chlorophyll for June 2011



## Monthly average chlorophyll for June 2011



Current Condition



TMDL Condition

# Take-homes for managers

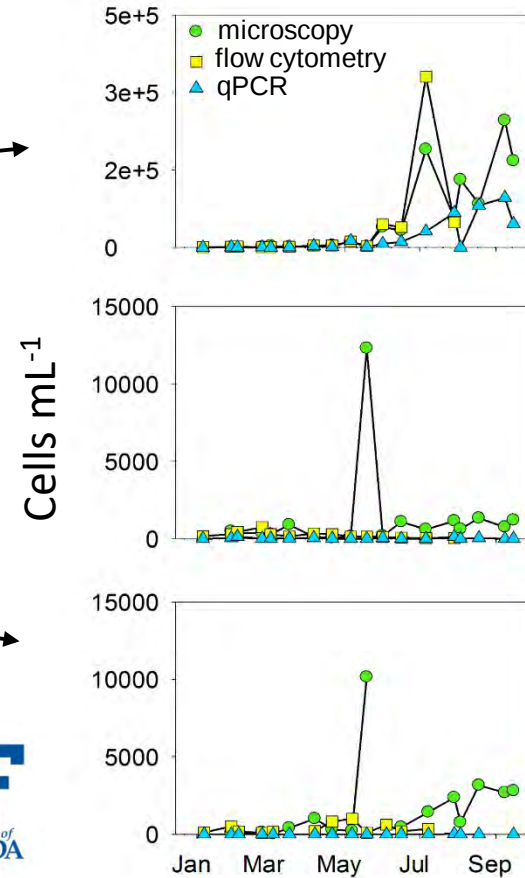
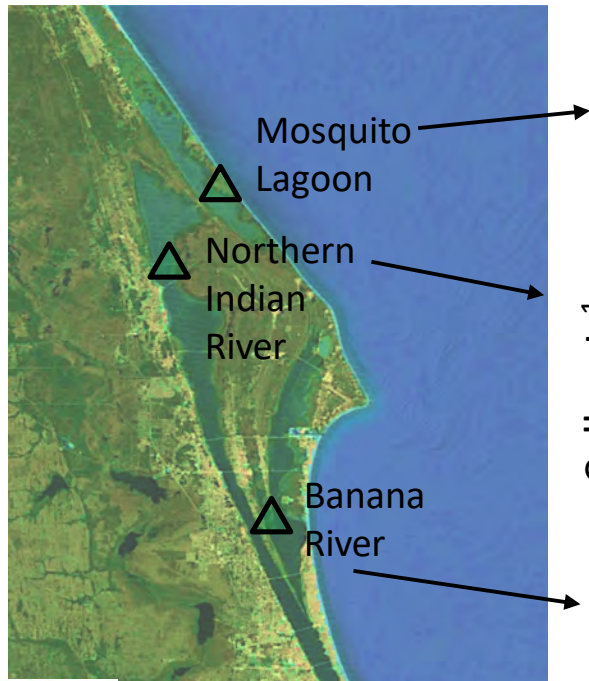
- Nutrients  $\Rightarrow$  chlorophyll = the issue
- Nutrient cycling complex  $\Rightarrow$  look beyond loads
- New sources of chlorophyll = bad actors
- Data “below” chlorophyll-a  $\Rightarrow$  value
- Superbloom = perfect storm + new norm
- Events matter  $\Rightarrow$  “elbow room” in TMDL
- Ecosystem shift  $\Rightarrow$  challenge to restoration



# Investments in improvements

- 
- **Internal loads**
    - muck
    - groundwater  
(150 m x 10 km  
≈ 7% of daily St Lucie flow: max)
    - adjust TMDL
  - **Drift algae**
    - role in cycling
    - harvest for N and P
  - **Phytoplankton**
    - life cycles
    - competition
    - N fixation and N:P
    - organic v inorganic N and P
  - **Filter feeder enhancement**
    - type
    - source
    - site selection
    - protection
  - **Seagrass rehabilitation**
    - source
    - site selection
    - planting
    - protection

# IRL NEP project in 2015: develop and validate tools for brown tide monitoring and event response (pre-bloom)

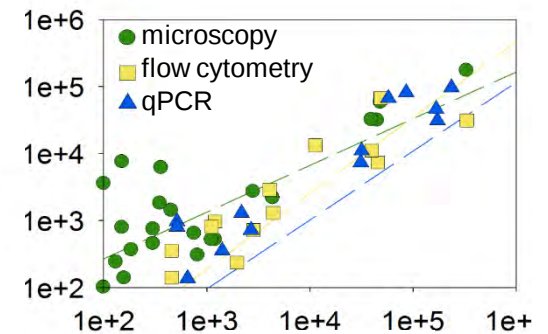


- microscopy
- flow cytometry\*
- ▲ qPCR\*\*

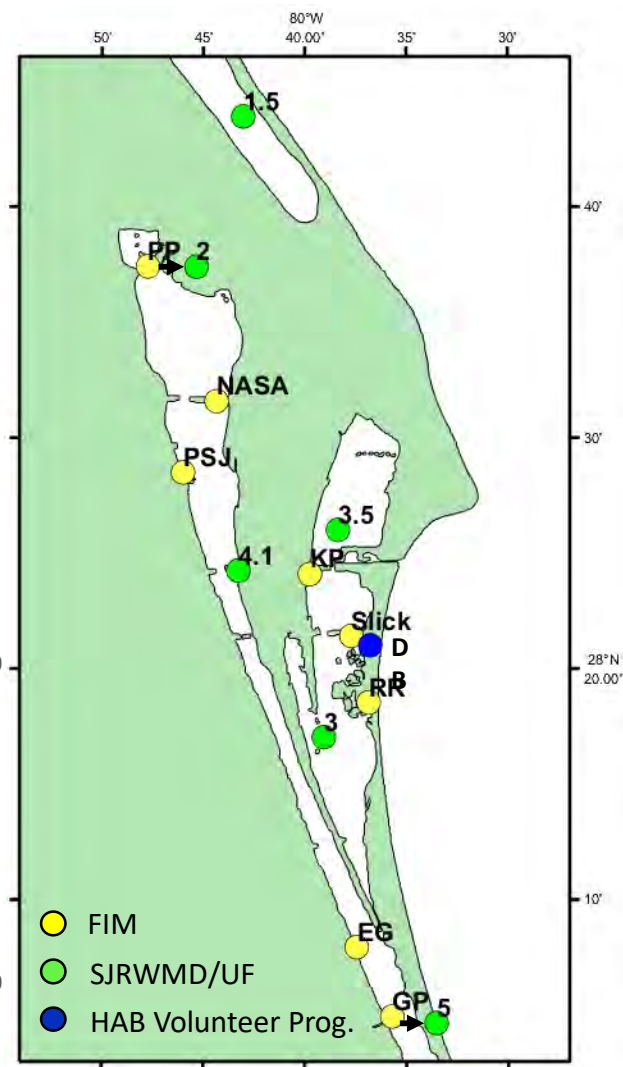
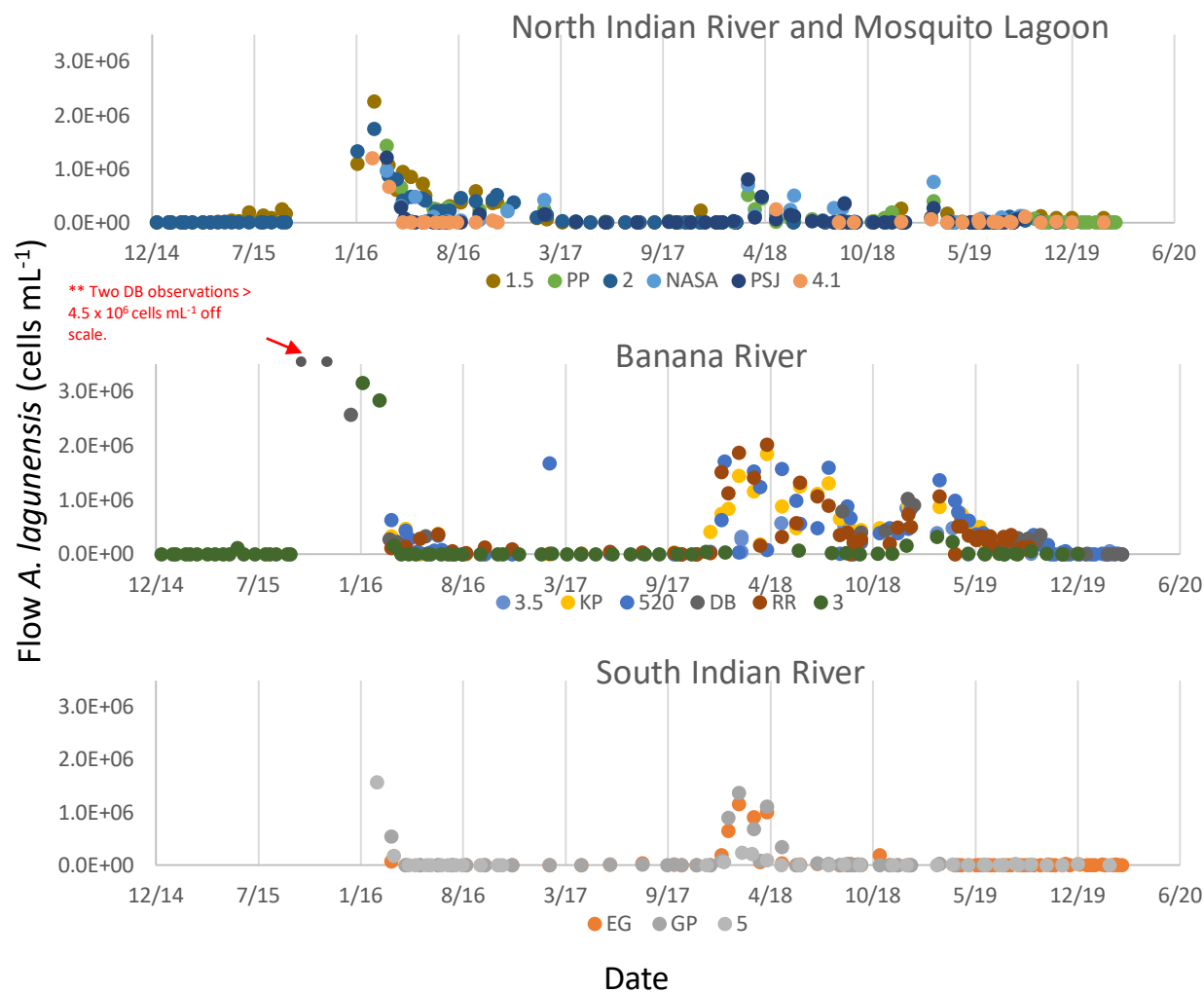
\*Antibody-based detection, Buskey et al., 1999, Gobler et al. 2013, Koch et al. 2014

\*\*Tilney, unpublished

## Method validation

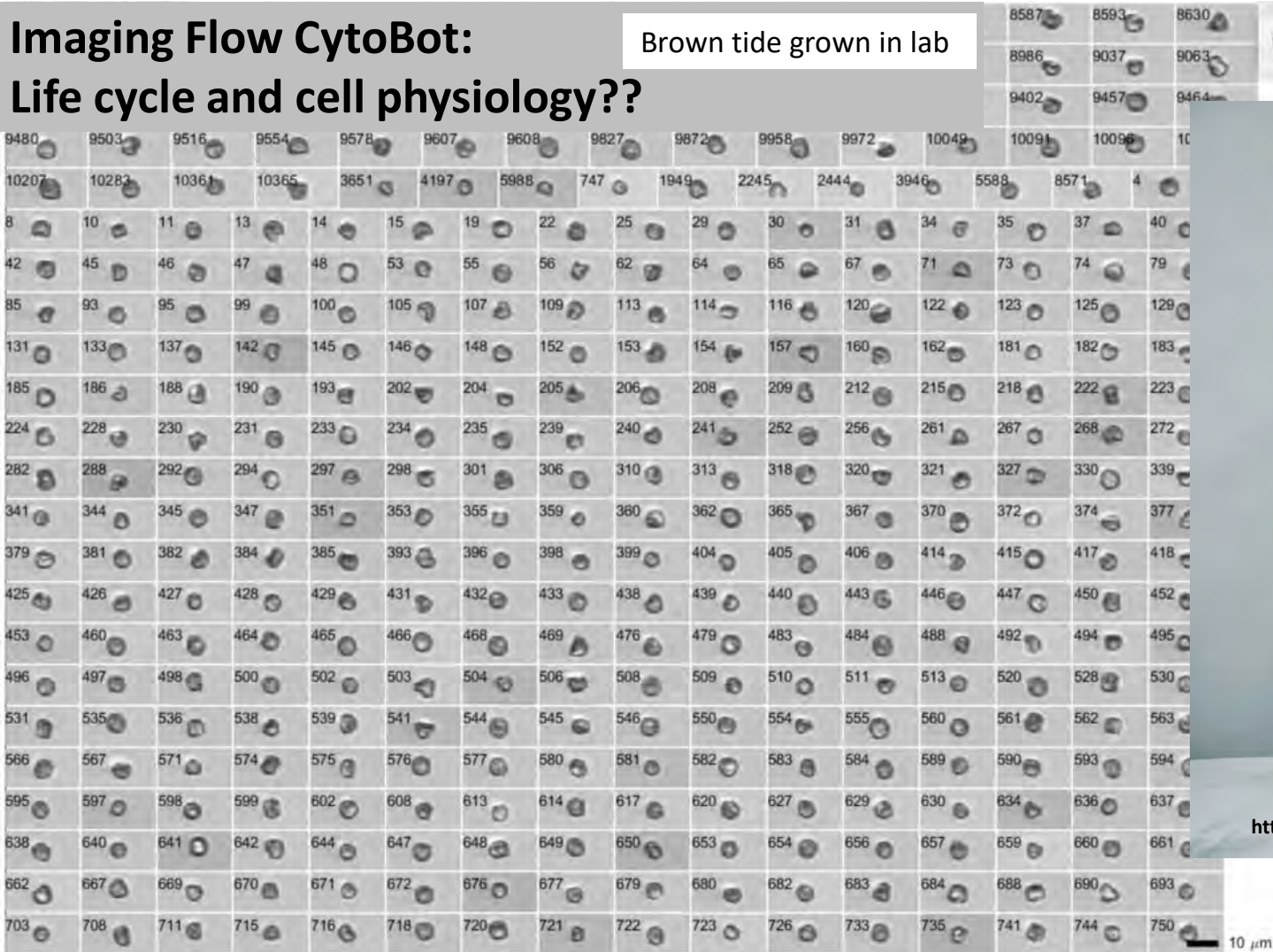


# Flow *A. lagunensis* antibody counts



# Imaging Flow CytoBot: Life cycle and cell physiology??

Brown tide grown in lab



<https://mclanelabs.com/imaging-flowcytobot/>

# Imaging Flow CytoBot: Life cycle and cell physiology

Field samples → lots of diversity  
in small size classes



- WIZ probe (Systea S.p.A.)
  - ammonia
  - orthophosphate
  - nitrate + nitrite
  - nitrite





**Thank you**