

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)



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

BASIN MANAGEMENT ACTION PLAN

for the Implementation of Total Maximum Daily Loads for Nutrients
Adopted by the Florida Department of Environmental Protection

in the

**Indian River Lagoon Basin
Banana River Lagoon**

developed by the
Banana River Lagoon Stakeholders

in cooperation with the
Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
Bureau of Watershed Restoration
Tallahassee, Florida 32399

January 2013

BASIN MANAGEMENT ACTION PLAN

for the Implementation of Total Maximum Daily Loads for Nutrients
Adopted by the Florida Department of Environmental Protection

in the

**Indian River Lagoon Basin
North Indian River Lagoon**

developed by the
North Indian River Lagoon Stakeholders

in cooperation with the
Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
Bureau of Watershed Restoration
Tallahassee, Florida 32399

January 2013

BASIN MANAGEMENT ACTION PLAN

for the Implementation of Total Maximum Daily Loads for Nutrients
Adopted by the Florida Department of Environmental Protection

in the

**Indian River Lagoon Basin
Central Indian River
Lagoon**

developed by the
Central Indian River Lagoon Stakeholders

in cooperation with the
Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
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Tallahassee, Florida 32399

January 2013

FINAL

BASIN MANAGEMENT ACTION PLAN

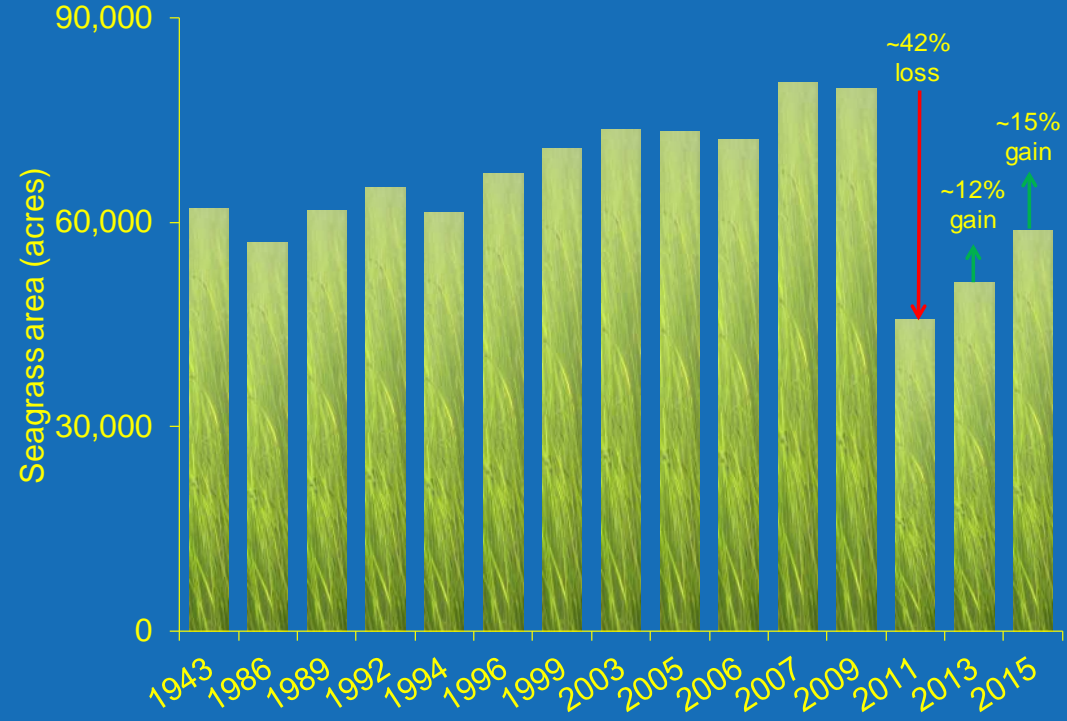
for the Implementation of
Total Maximum Daily Loads for Nutrients
and Dissolved Oxygen by
the Florida Department of Environmental Protection
in the
St. Lucie River and Estuary Basin

developed by the
St. Lucie River and Estuary Basin Technical Stakeholders

in cooperation with the
Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
Bureau of Watershed Restoration
Florida Department of Environmental Protection
Tallahassee, FL 32399

May 2013

How are we doing?



(Historic coverage)

Mapping years

Good management

Good luck

↑
Vero WWTP discharge ↓

Drought

↑
↑

Mini-drought

'04 hurricanes surge and flushing

↑
↑

Drought

TS Fay flushing

~42% loss

~12% gain

~15% gain



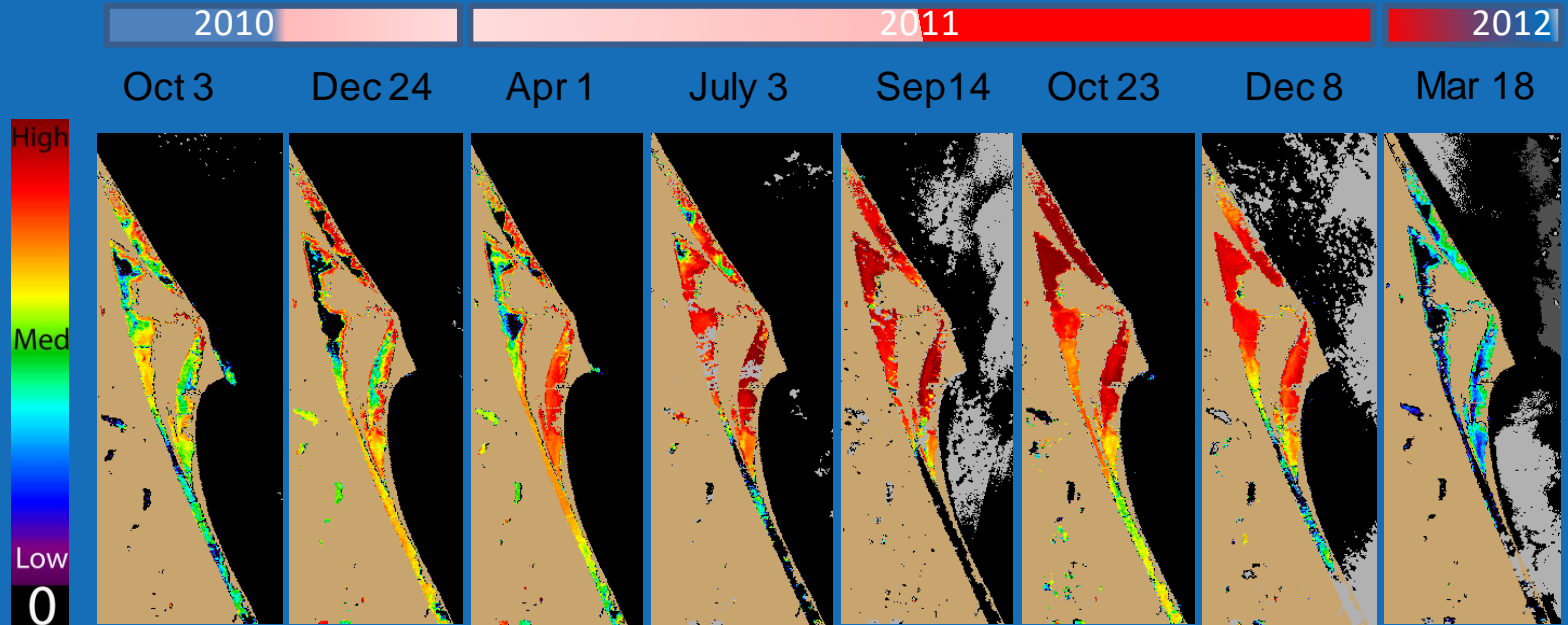
How are we doing?

- **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 > > 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*)



D. Scheidt, IHA



K. Young, Volusia County

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

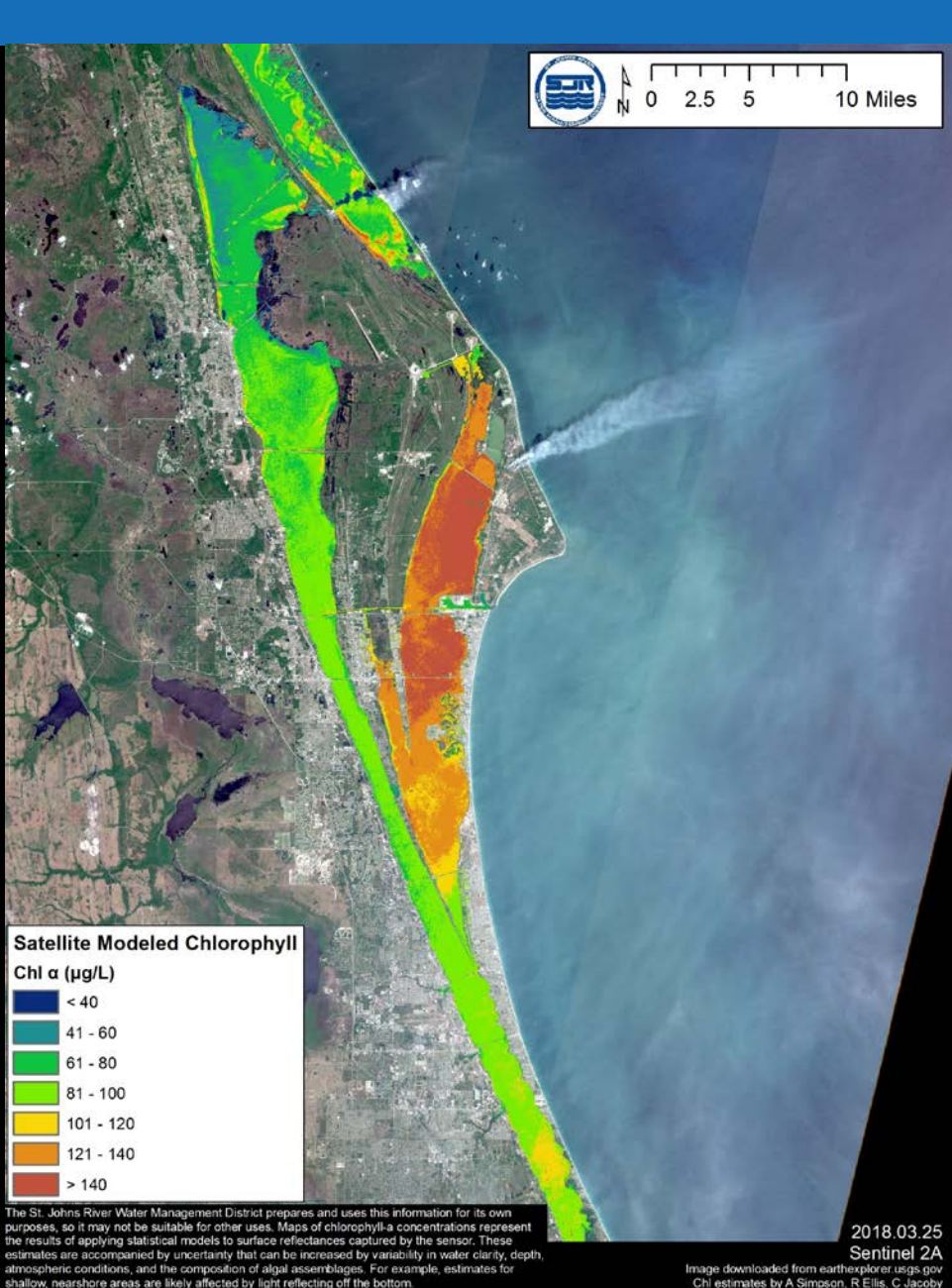
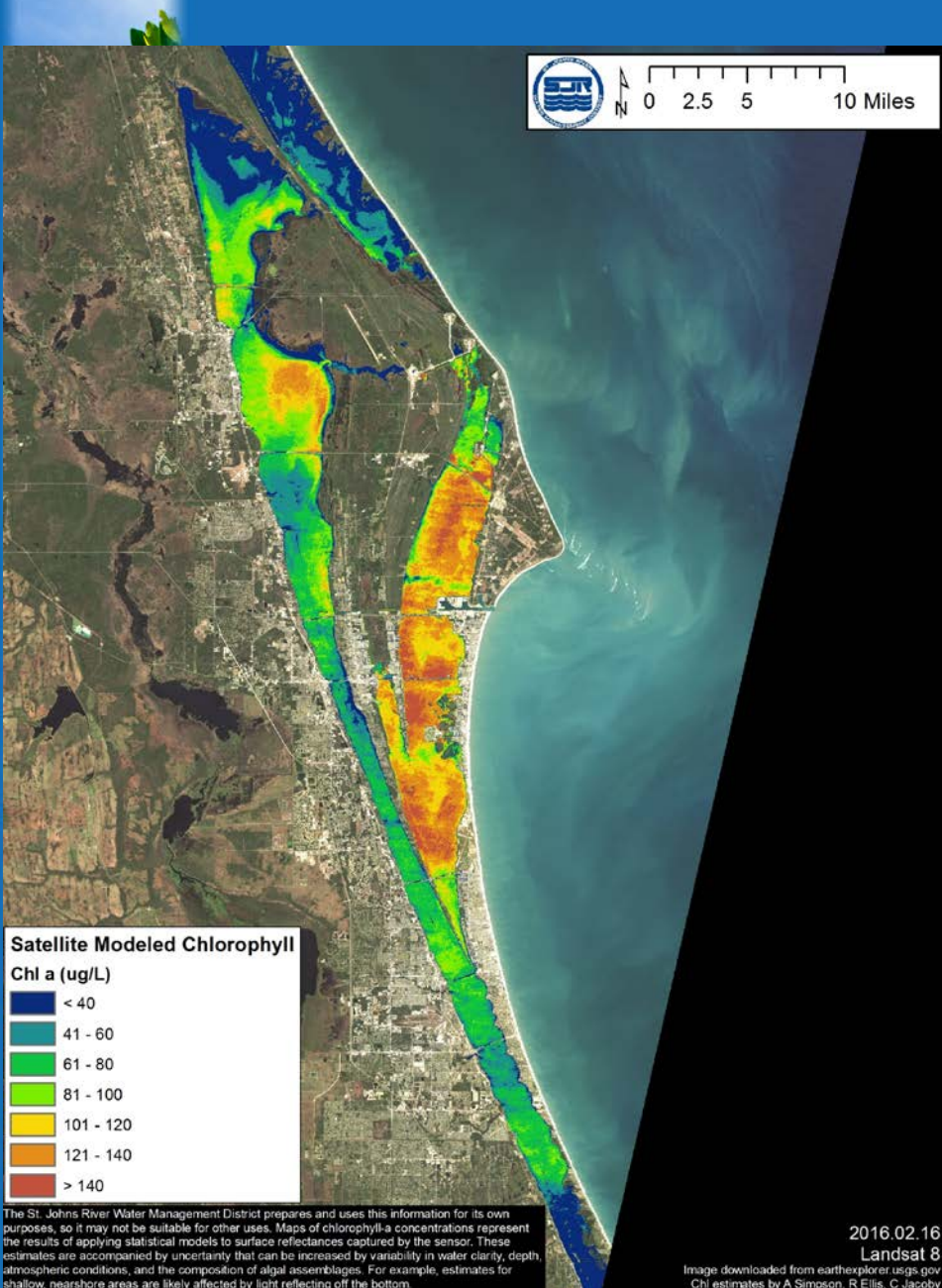
Banana River; 8/28/13; photo by D. Scheidt



Other?

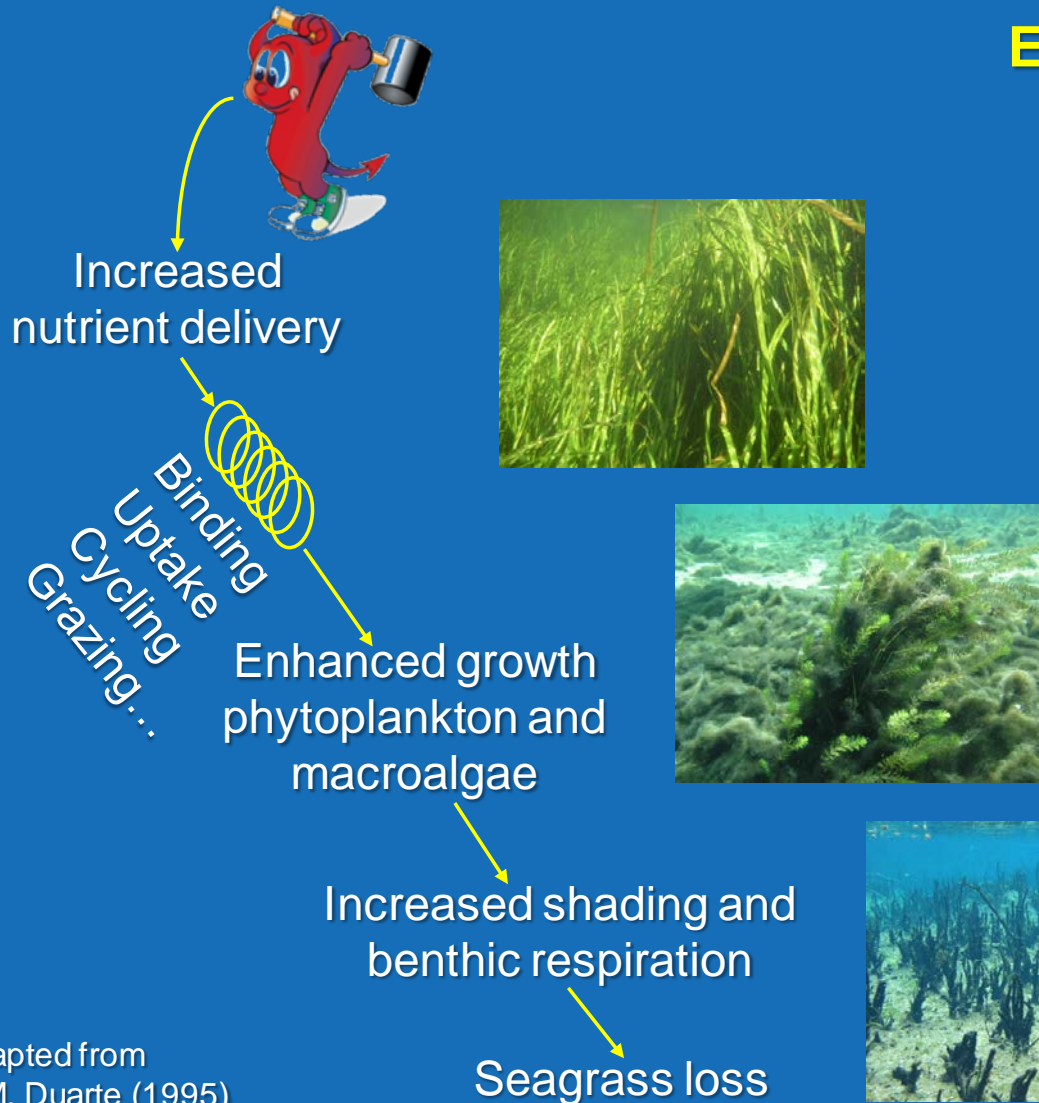
IRL east shore by 528 Cswy; 9/6/13; photo by T. Miller

St. Johns River Water Management District



What happened?

Eutrophication progression scheme



Adapted from
C.M. Duarte (1995)

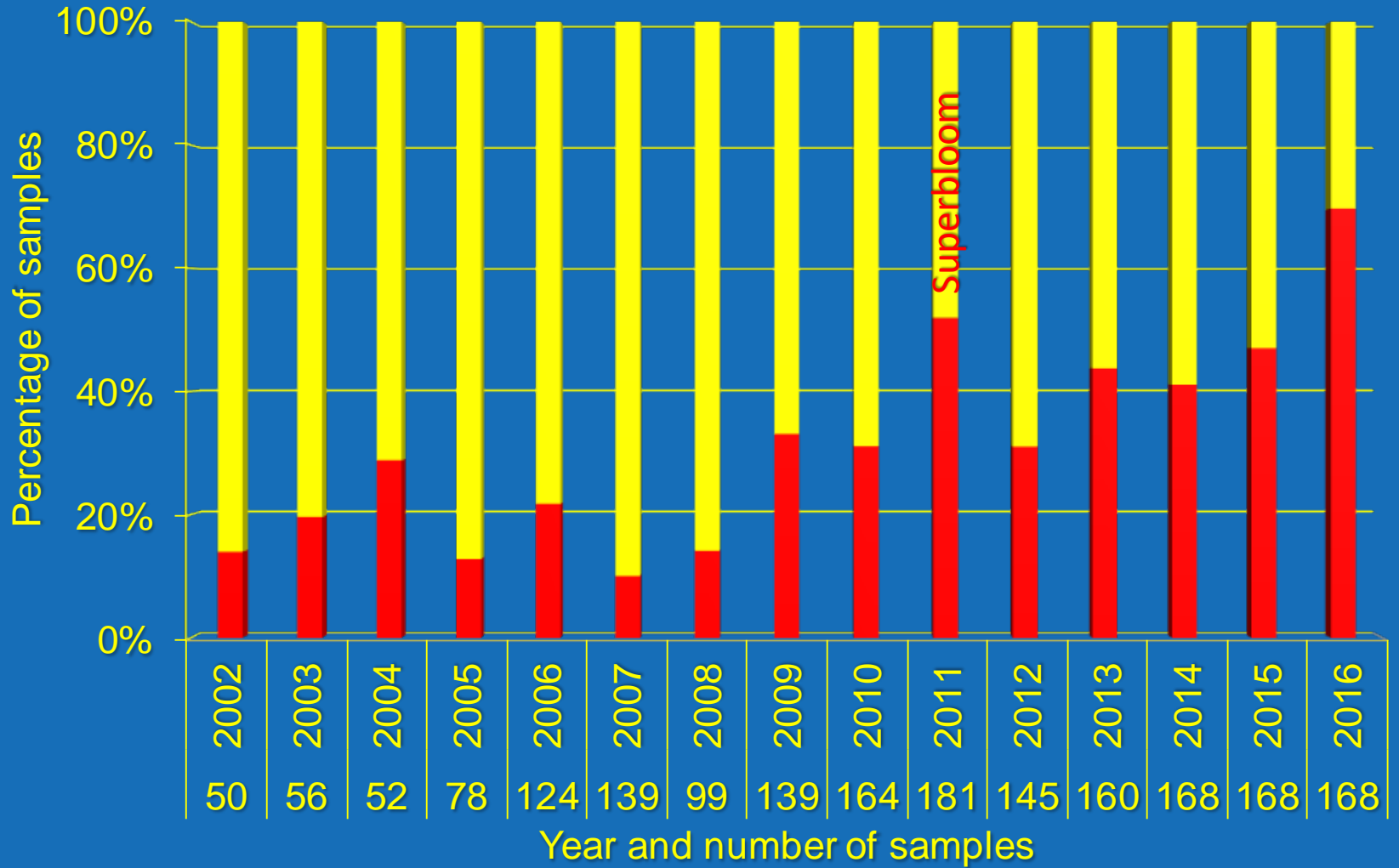


What have we learned?



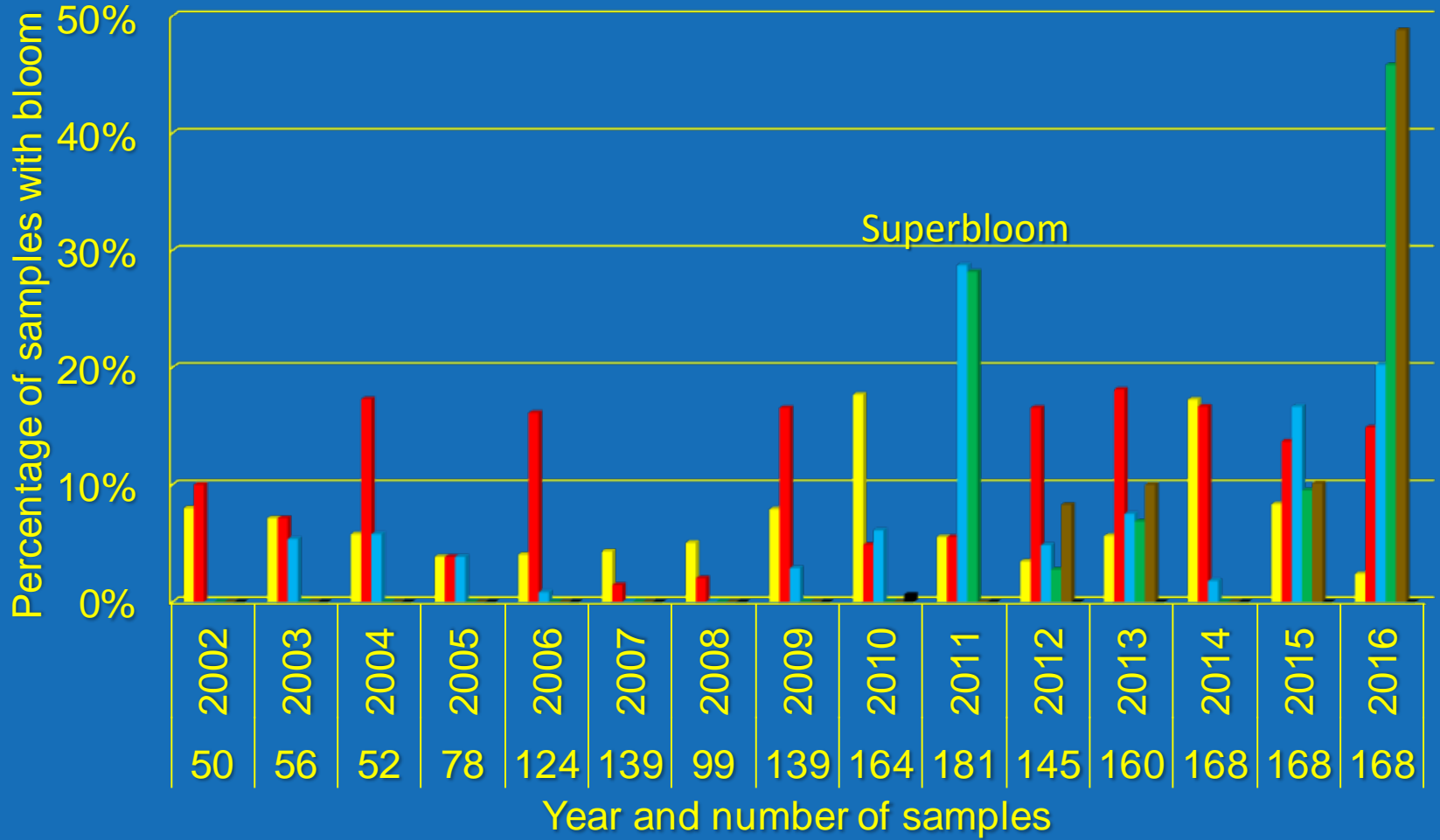
13 stations

■ Unique bloom ■ No bloom



13 stations

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





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

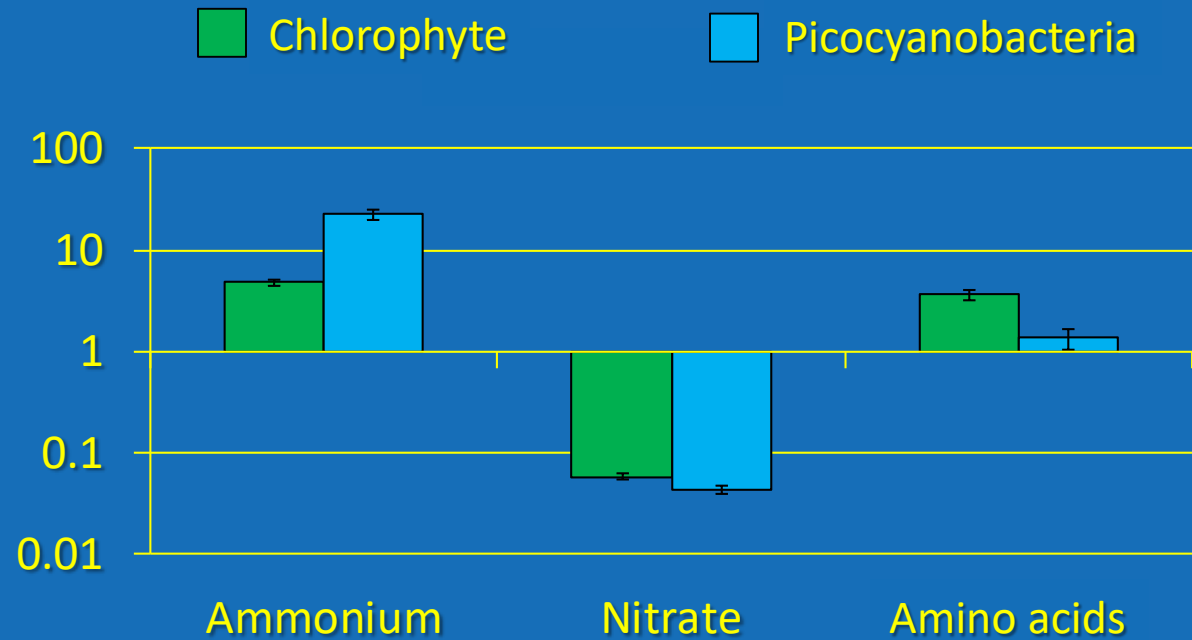
Newer dominants

	Diatoms
	<i>Pyrodinium bahamense</i>
	Dino-flagellates
	Filamentous cyanobacteria
	Pico-cyanobacteria
	Chlorophyte
	Mixed nano-flagellates
	<i>Aureoumbra lagunensis</i>



Relative preference index

> 1 \Rightarrow preferred



Use different types of N
(also P)

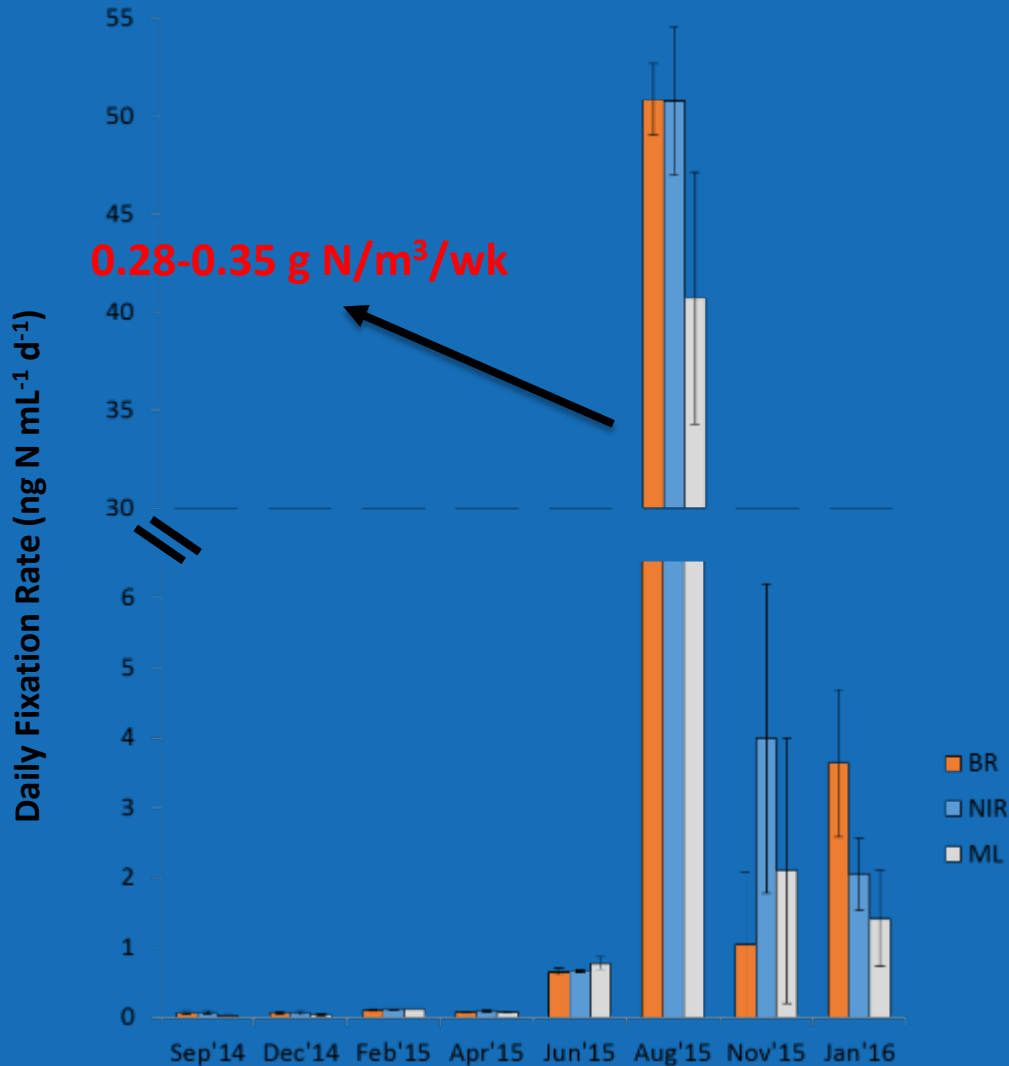
Bypass microbial loop

Less loss

Use organic forms

Faster cycling

Compete well



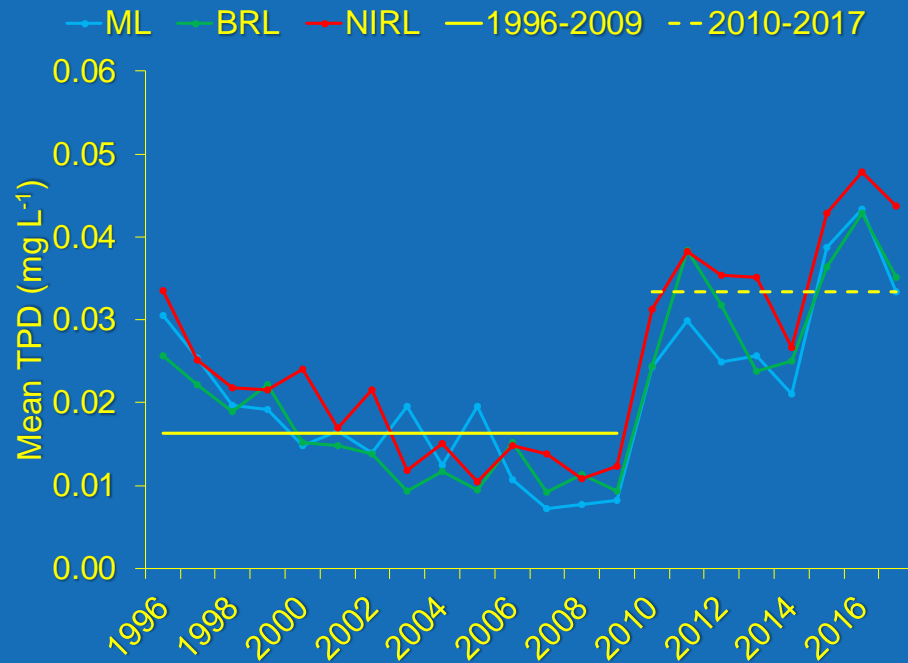
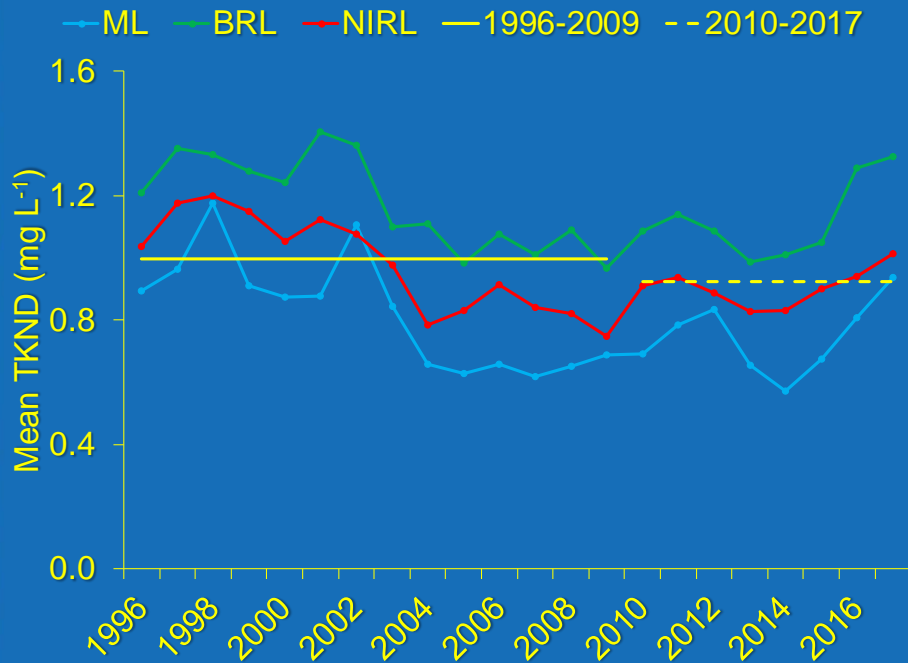
“Fix” N
(pull it out of thin air)

+ correlations w/
of picocyanobacteria
°C

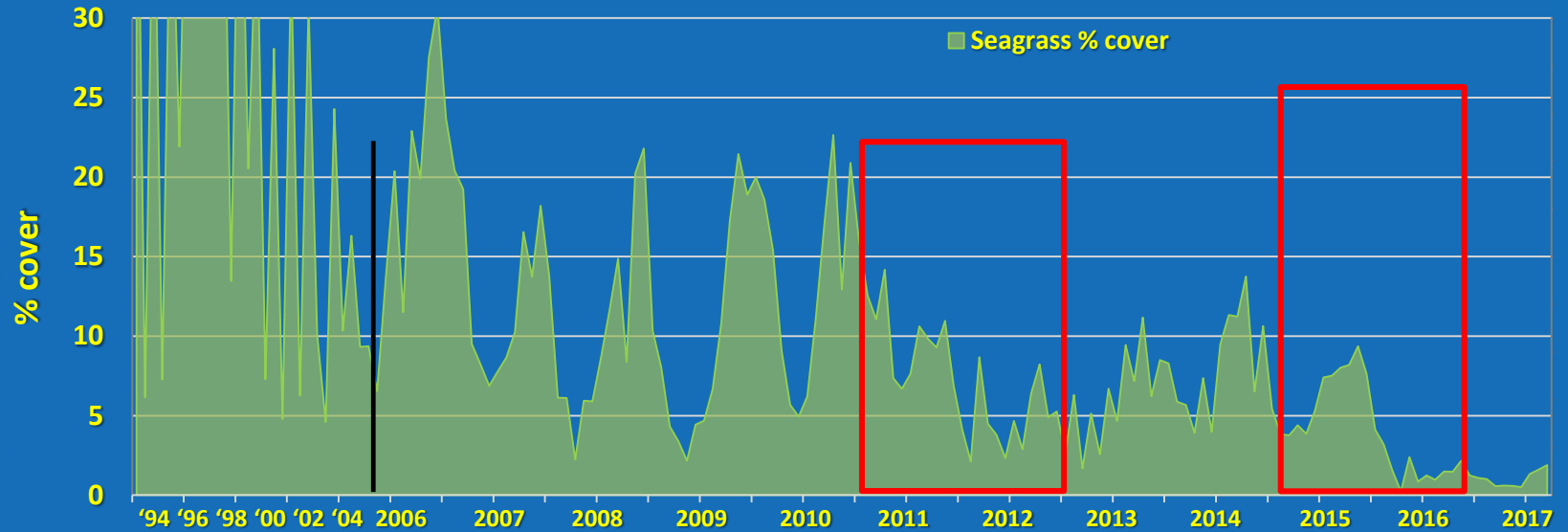
– correlations w/
[N]
[N]:[P]

[N] ↓ or [P] ↑ ⇒
N fixation ↑

St. Johns River Water Management District

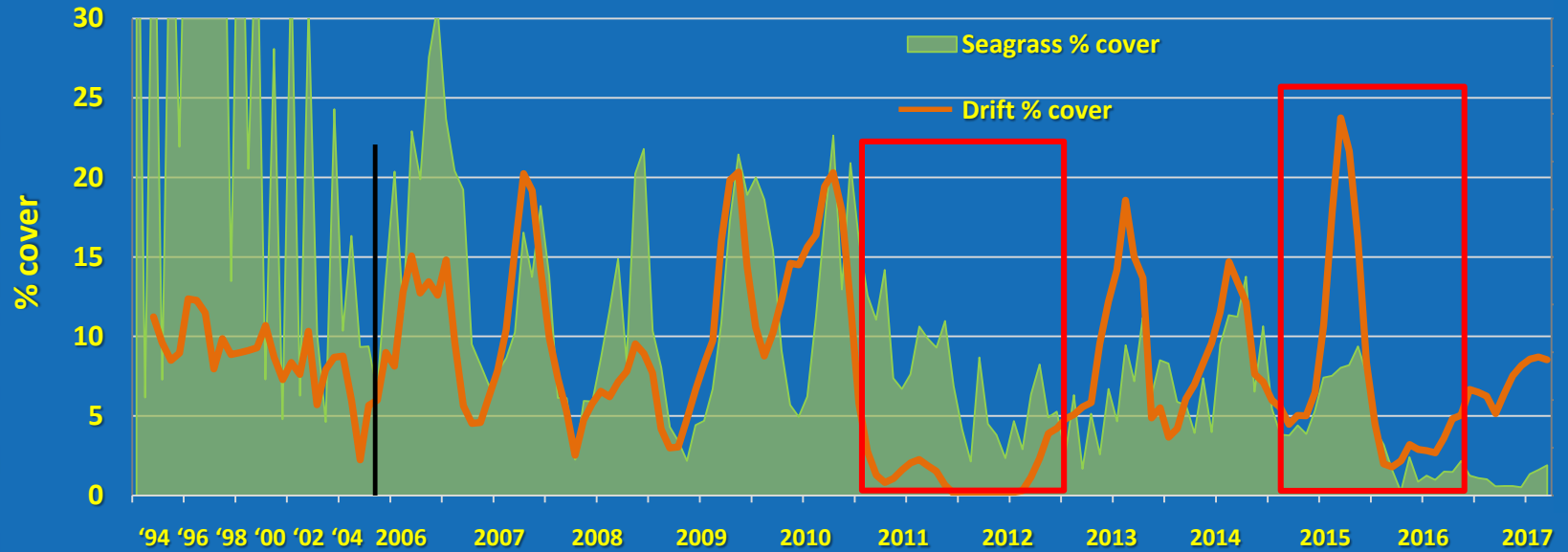


Mean % cover of seagrass (1994 – 2017)



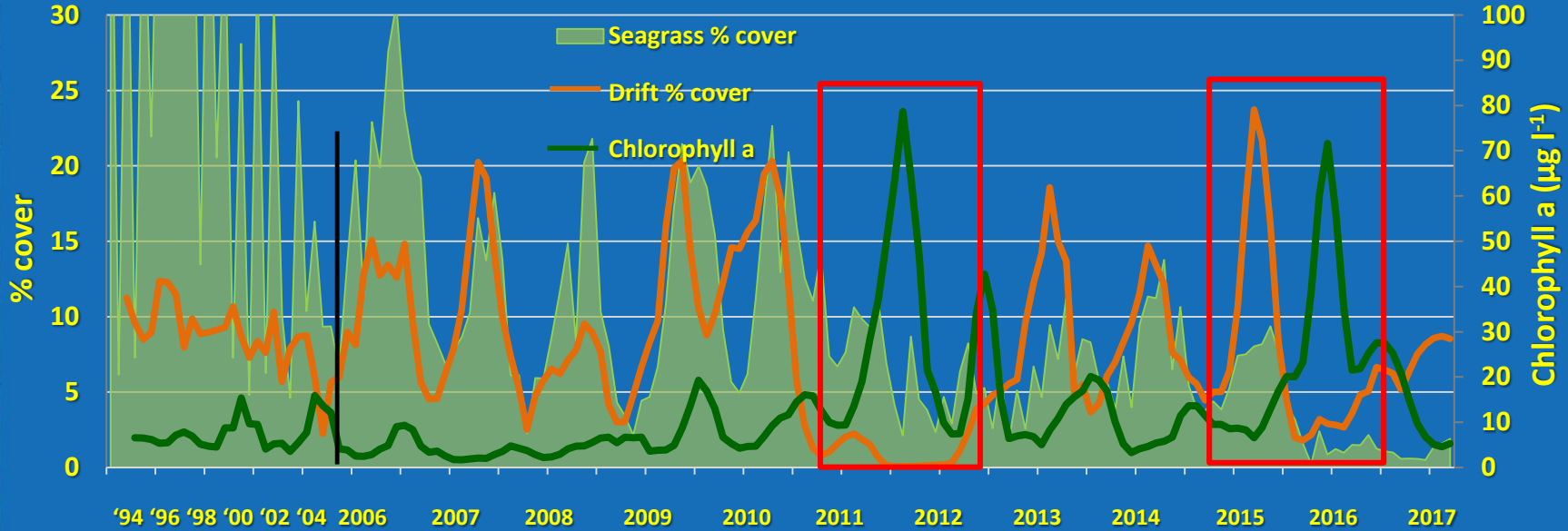
Compressed scale | Monthly →
(bi-annual sampling)

Mean % cover of seagrass and drift macroalgae (1994 – 2017)

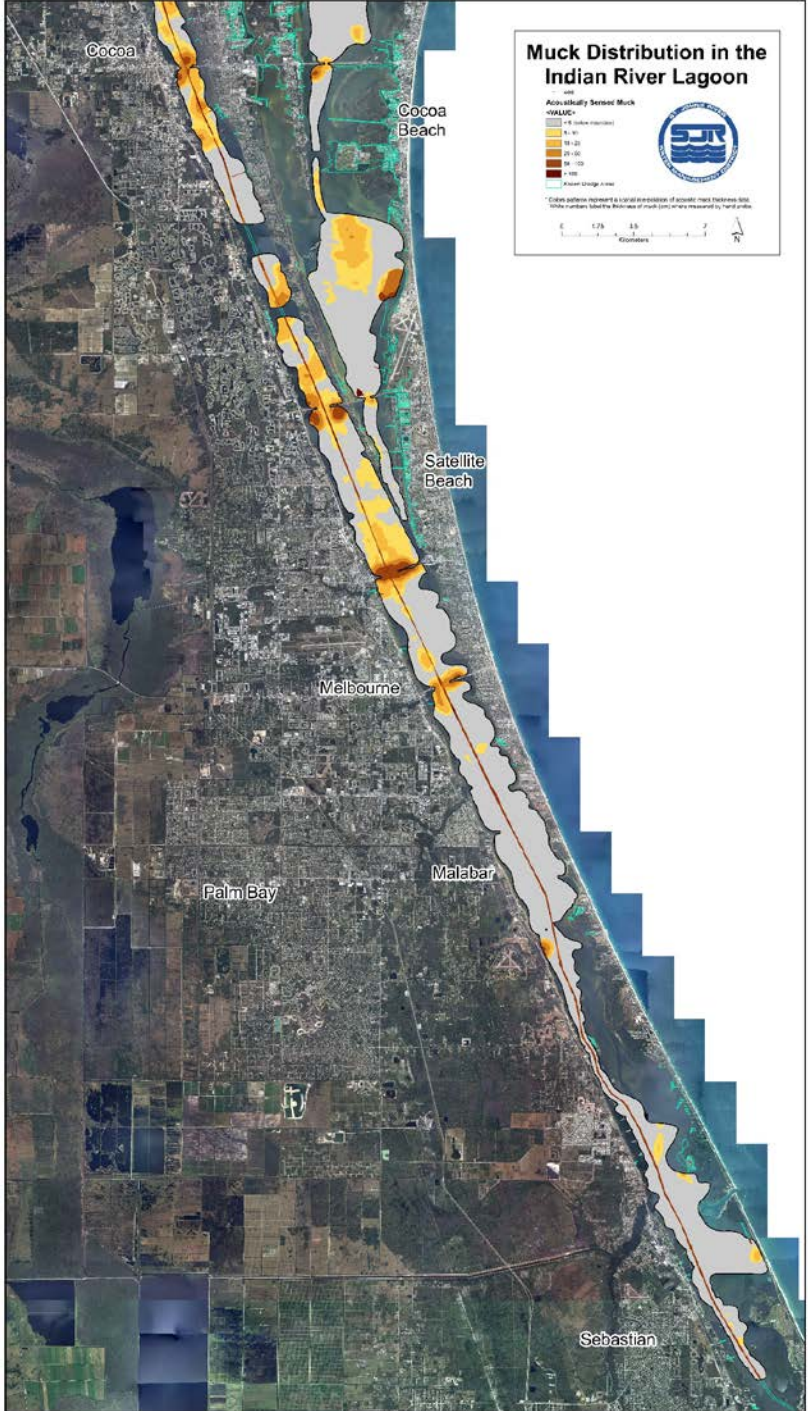
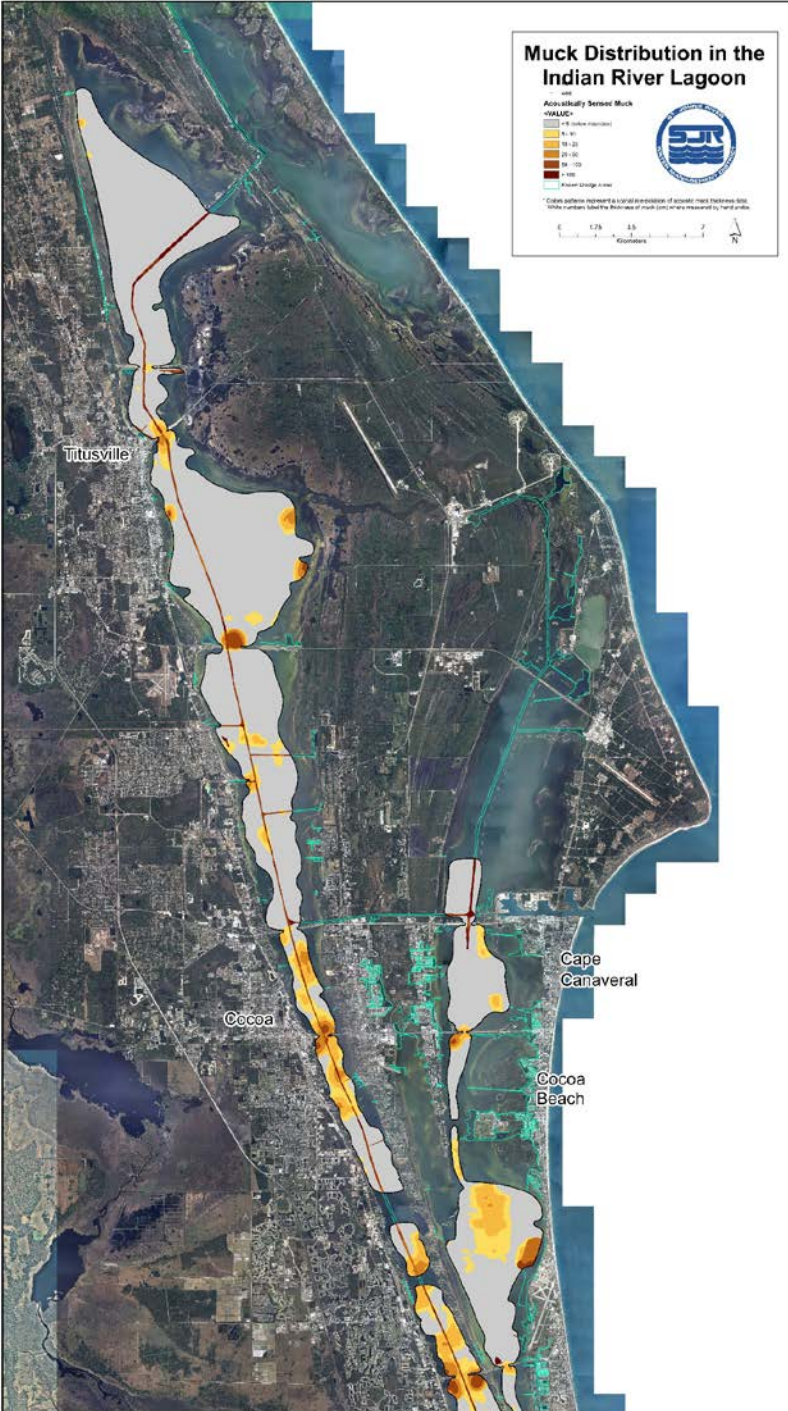


Compressed scale | Monthly →
(bi-annual sampling)

Mean % cover of seagrass and drift macroalgae and mean chlorophyll concentrations (1994 – 2017)



Compressed scale | Monthly →
(bi-annual sampling)



What have we learned?

- **Legacy loads \Rightarrow internal load**
(especially ammonium used by brown tide)
- **Drift algae \Rightarrow key role in cycling**
(loss/lack of growth made nutrients available)
- **Small phytoplankton \Rightarrow make their own N**
(fix nitrogen under certain conditions)
- **Small phytoplankton \Rightarrow use organic N and P**
(e.g., amino acids)
- **Small phytoplankton \Rightarrow more efficient blooms**
(growth rates and nutrient uptake)



Take-home messages

- **Nutrients \Rightarrow 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

