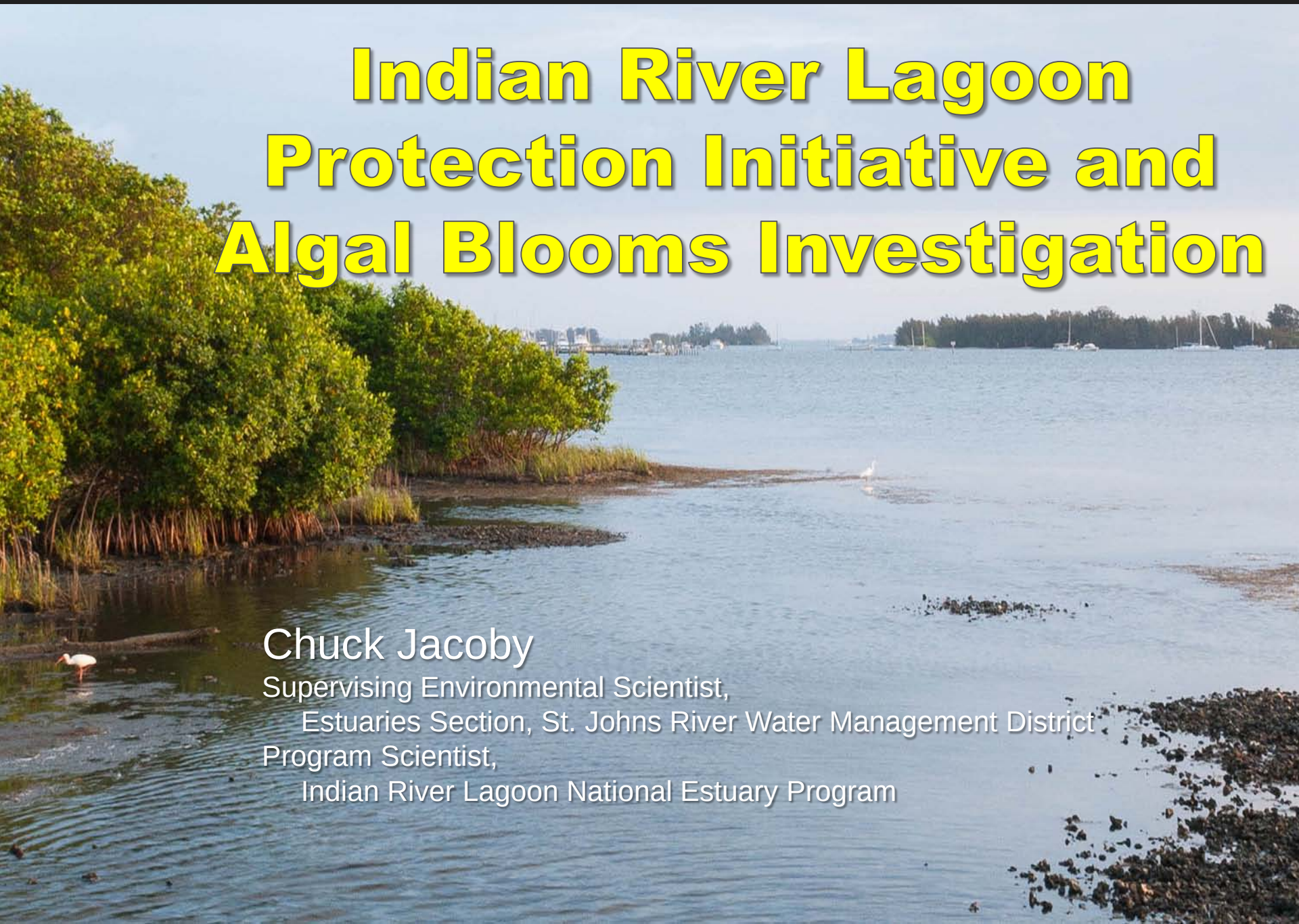
Indian River Lagoon Protection Initiative and Algal Blooms Investigation



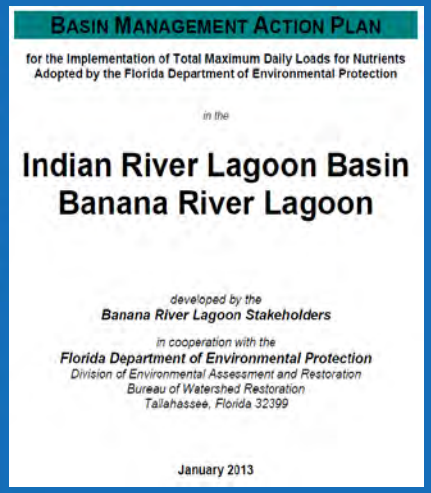
Chuck Jacoby
Supervising Environmental Scientist,
Estuaries Section, St. Johns River Water Management District
Program Scientist,
Indian River Lagoon National Estuary Program

Lagoon is:

- Sensitive
- Long (156 miles)
- Shallow
- Wind & tide driven
- Not a river (no flow)
- Segmented (flushing 2 wks–3 mos)
- Diverse
  - ecology
  - challenges

Nutrient impairment

- **Total Maximum Daily Load (TMDL) = safe load**
- **Loads + Margin of Safety > TMDL ⇒ reductions**
- **Adaptive approach to uncertainty**
  - **monitor (seagrass = a key indicator)**
  - **evaluate progress**
  - **adapt as needed**
- **Summarize in Basin Management Action Plans**


BASIN MANAGEMENT ACTION PLAN

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

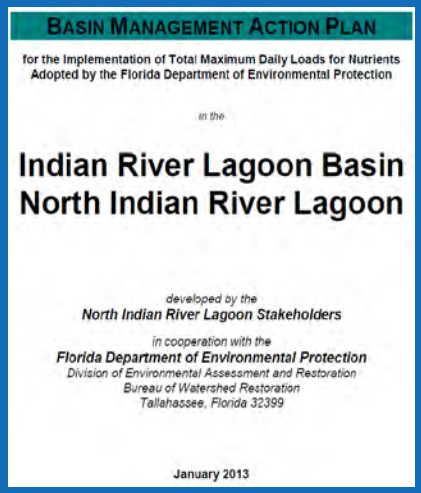
in the

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

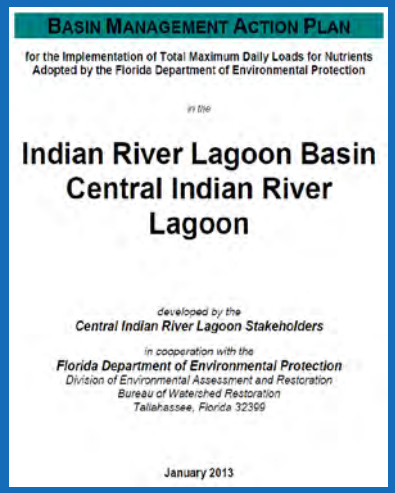
in the

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

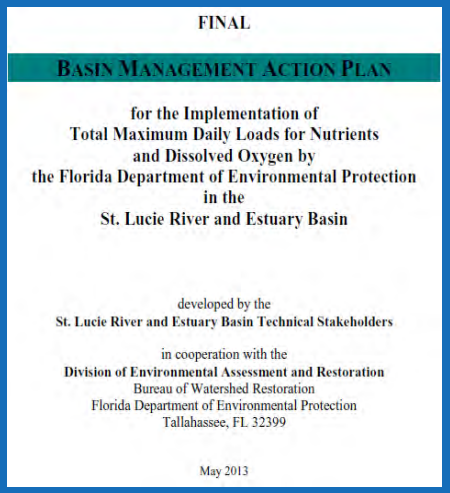
in the

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
Bureau of Watershed Restoration
Tallahassee, Florida 32399

January 2013


FINAL

BASIN MANAGEMENT ACTION PLAN

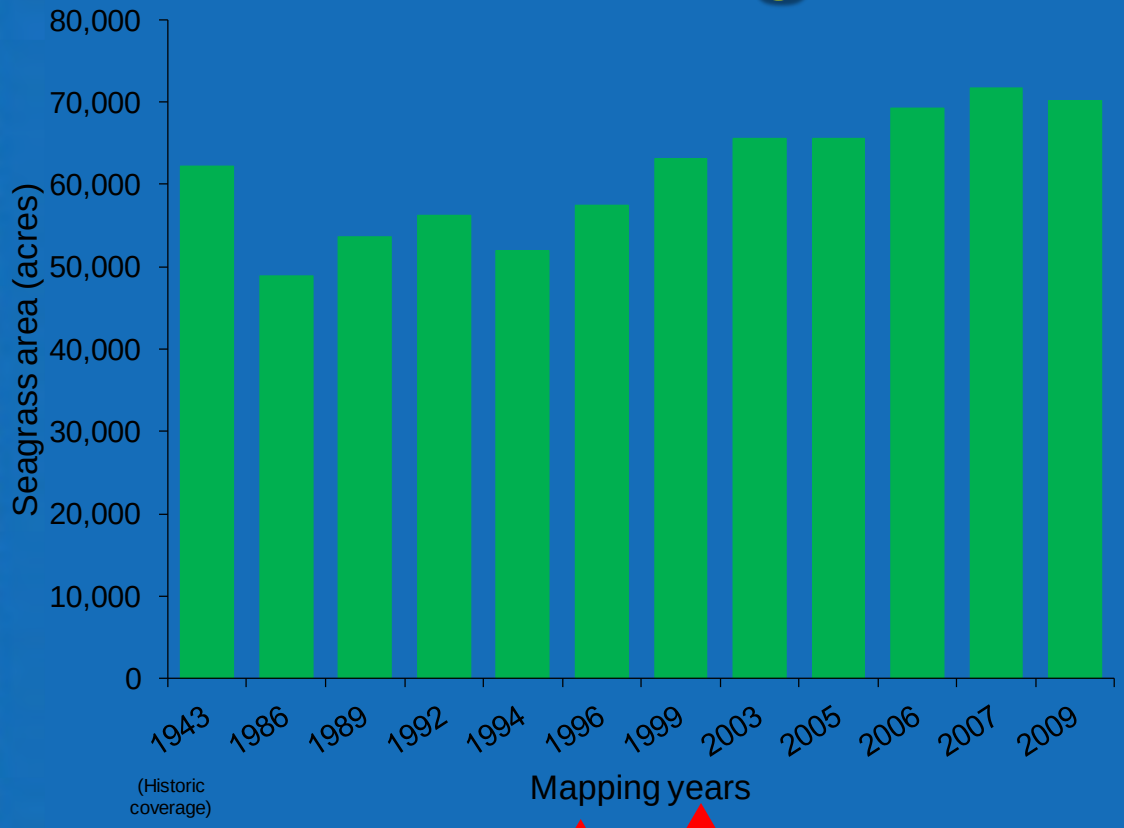
for the Implementation of
Total Maximum Daily Loads for Nutrients
and Dissolved Oxygen by
the Florida Department of Environmental Protection
in the
St. Lucie River and Estuary Basin

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

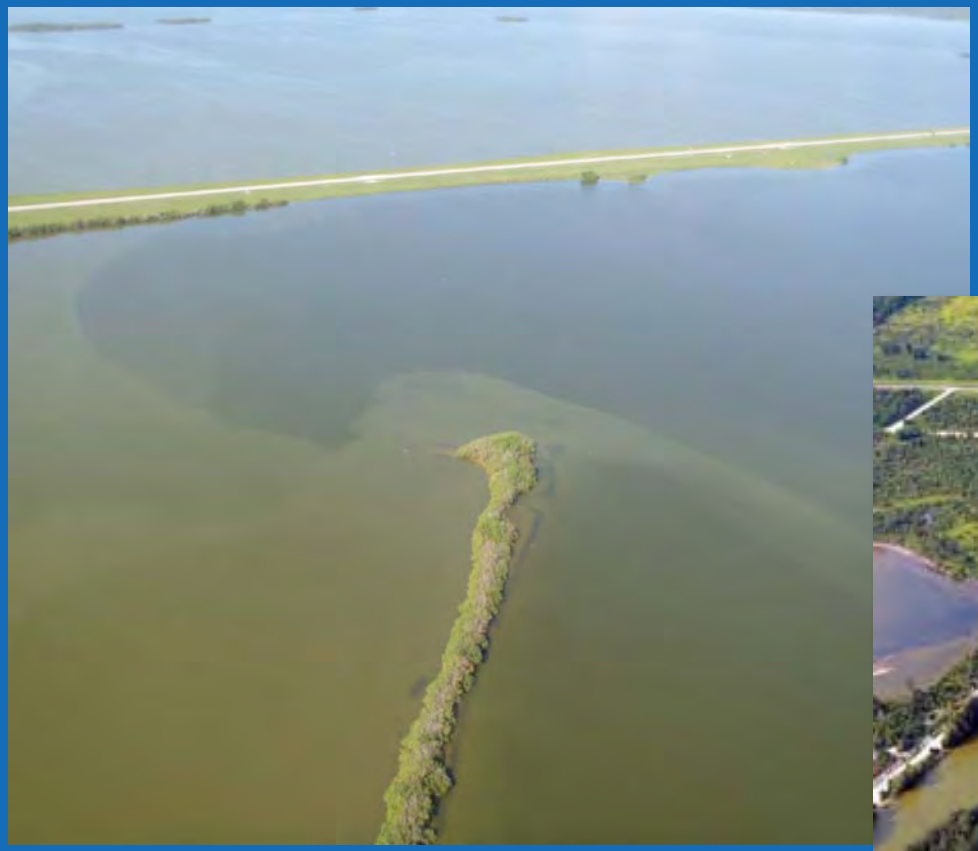
in cooperation with the
Division of Environmental Assessment and Restoration
Bureau of Watershed Restoration
Florida Department of Environmental Protection
Tallahassee, FL 32399

May 2013

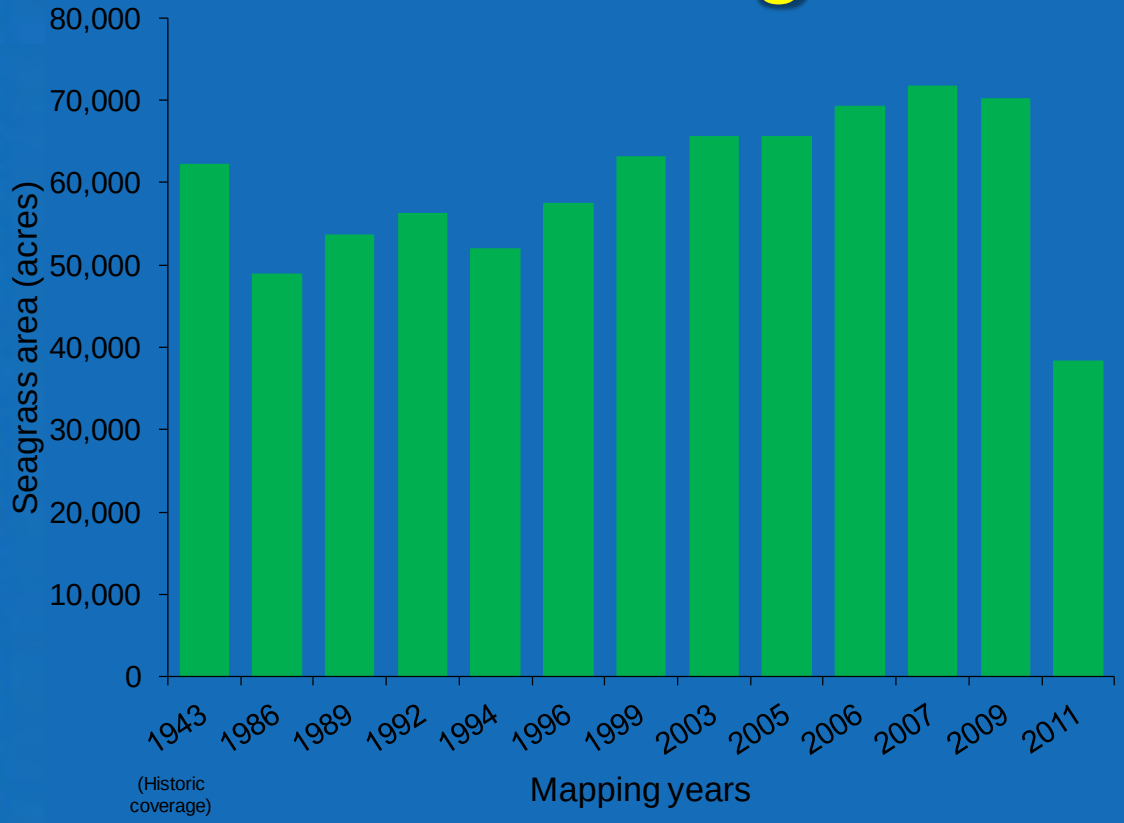
Seagrasses


80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
Seagrass area (acres)
1943
1986
1989
1992
1994
1996
1999
2003
2005
2006
2007
2009
(Historic coverage)
Mapping years
Drought & Vero WWTP discharge ⇓
Mini-drought
'04 hurricanes surge & flushing
Drought & IRFWCD discharge ⇓
TS Fay flushing

Algal blooms

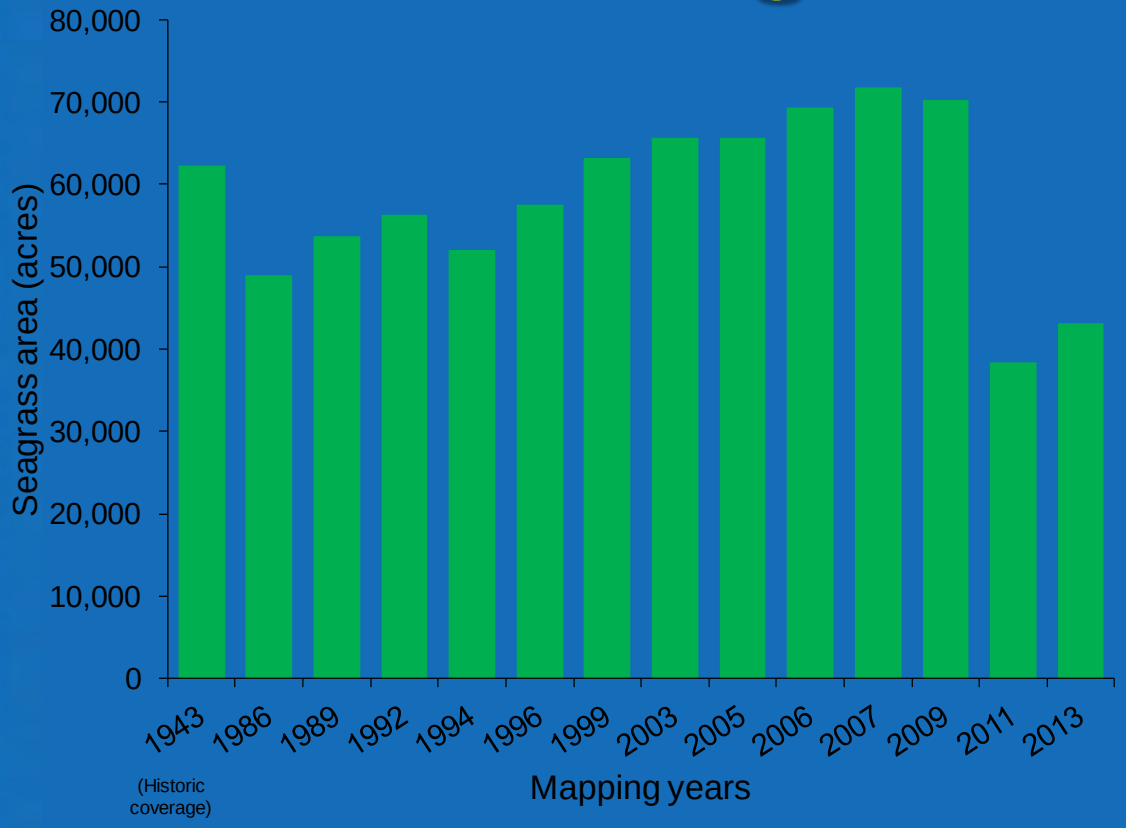


Seagrasses



Loss of ~30,000 acres
~45% of the acres mapped in 2009

Seagrasses



Some recovery in 2013

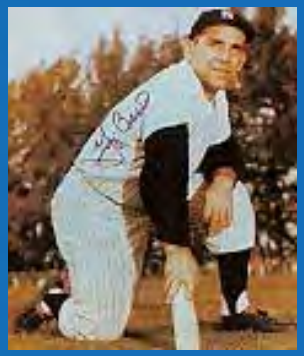
~12% gain from 2011 – not uniform

What happened?

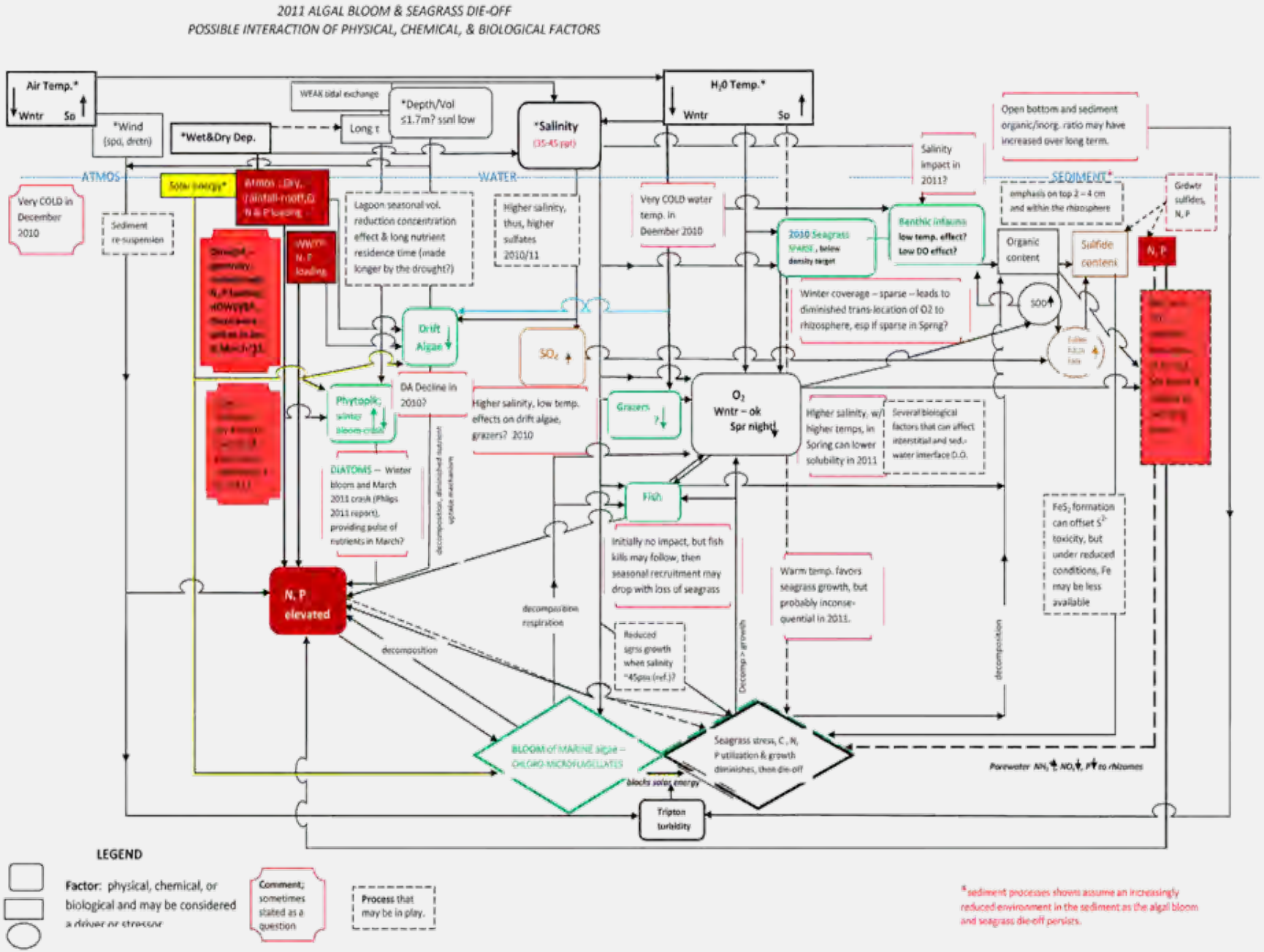
Caveats

"All models are wrong;
some models are useful."
(attributed to George Box)

"Ecosystems are not only more complex than we think,
they are more complex than we can think."
(Egler, Frank. 1977. *The nature of vegetation: its management and mismanagement*.
Aton Forest Publishers, Norfolk, Connecticut)



"It's tough to make predictions,
especially about the future."
(Yogi Berra)


2011 ALGAL BLOOM & SEAGRASS DIE-OFF
POSSIBLE INTERACTION OF PHYSICAL, CHEMICAL, & BIOLOGICAL FACTORS
Air Temp.*
Wntr Sp
*Wind (spd, drctn)
*Wet&Dry Dep.
WEAK tidal exchange
Long t
*Depth/Vol ≤1.7m? ssnl low
*Salinity (35-45 ppt)
H2O Temp.*
Wntr Sp
Open bottom and sediment organic/inorg. ratio may have increased over long term.
Salinity impact in 2011?
ATMOS
WATER
SEDIMENT*
Very COLD in December 2010
Sediment re-suspension
Solar energy*
Lagoon seasonal vol. reduction concentration effect & long nutrient residence time (made longer by the drought?)
Higher salinity, thus, higher sulfates 2010/11
Very COLD water temp. in Deember 2010
2010 Seagrass SPARSE, below density target
Benthic infauna low temp. effect? Low DO effect?
emphasis on top 2 – 4 cm and within the rhizosphere
Organic content
Sulfide content
Grdwtr sulfides, N, P
N, P
Winter coverage – sparse – leads to diminished trans-location of O2 to rhizosphere, esp if sparse in Spring?
SOD
Drift Algae
SO2
DA Decline in 2010?
Higher salinity, low temp. effects on drift algae, grazers? 2010
Phytoplk winter bloom-crash
Grazers ?
O2 Wntr – ok Spr night
Higher salinity, w/l higher temps, in Spring can lower solubility in 2011
Several biological factors that can affect interstitial and sed.-water interface D.O.
DIATOMS – Winter bloom and March 2011 crash (Philips 2011 report), providing pulse of nutrients in March?
decomposition, diminished nutrient uptake mechanism
Fish
Initially no impact, but fish kills may follow, then seasonal recruitment may drop with loss of seagrass
FeS2 formation can offset S2- toxicity, but under reduced conditions, Fe may be less available
Warm temp. favors seagrass growth, but probably inconse-quential in 2011.
N, P elevated
decomposition
decomposition
decomposition
Decomp > growth
Reduced sgrss growth when salinity ~45ppt (ref.)?
BLOOM of MARINE algae – CHLORO-MICROFLAGELLATES
blocks solar energy
Seagrass stress, C, N, P utilization & growth diminishes, then die-off
Porewater NH4 ↑, NO3 ↓, P ↑ to rhizomes
Tripton turbidity
LEGEND
Factor: physical, chemical, or biological and may be considered a driver or stressor
Comment; sometimes stated as a question
Process that may be in play.
* sediment processes shown assume an increasingly reduced environment in the sediment as the algal bloom and seagrass die-off persists.

Eutrophication progression scheme

Increased nutrient delivery

Binding
Uptake
Cycling
Grazing…

Enhanced growth phytoplankton & macroalgae

Increased shading & benthic respiration

Seagrass loss

Adapted from
C.M. Duarte (1995)

What will we do?

Indian River Lagoon Protection Initiative

St. Johns River Water Management District

Strategic Plan

April 2013 to October 2018

April 9, 2013

Appendix

Strategic Initiatives

Initiative

Indian River Lagoon Protection

Objective

To restore the water quality and ecological habitat value of the Indian River Lagoon.

Background

The salient goal for restoration of the Indian River Lagoon is increased abundance of seagrasses. The lagoon has a thriving sport fishery, which is largely dependent on the health and abundance of seagrasses.

Current and ongoing focus

In 2011, an extensive and persistent phytoplankton bloom developed that decreased water clarity to historically low levels. During the bloom, seagrasses declined over large areas to levels lower than previously measured. The loss of seagrasses amounted to about 35,000 acres. Based on the minimum estimated annual value of seagrass beds, this equates to approximately a $175 million loss to commercial and recreational fisheries. A second phytoplankton bloom developed in 2012.

The ecological causes of these blooms are unknown. The blooms were not expected given the extensive reconnection and restoration of wetlands, an antecedent trend toward improved seagrass cover, and no concomitant and proportionate increase in pollutant and freshwater loadings. Lacking a better understanding of causation, it is unlikely that a cost-effective strategy for bloom prevention can be developed. This initiative would support the additional data collection, analysis, and modeling needed to deduce the fundamental causes of the blooms as a basis for development of an improved management plan.

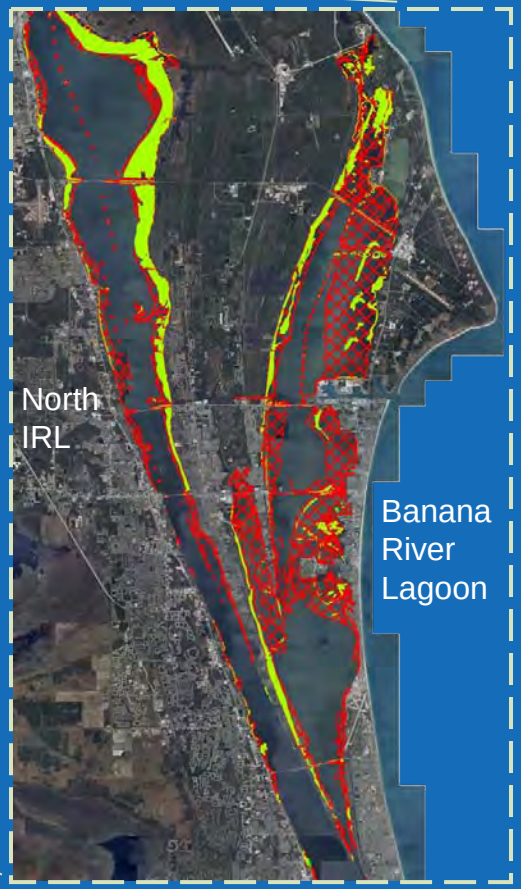
Sample Projects

1. Comprehensive Conservation and Management Plan implementation
2. Investigation of recent phytoplankton bloom
3. Coastal wetland rehabilitation projects (federal/SJRWMD cooperative funding)
4. Small projects funded by Indian River Lagoon license plate funds (Volusia, Brevard, and Indian River counties

Indian River Lagoon Algal Blooms Investigation

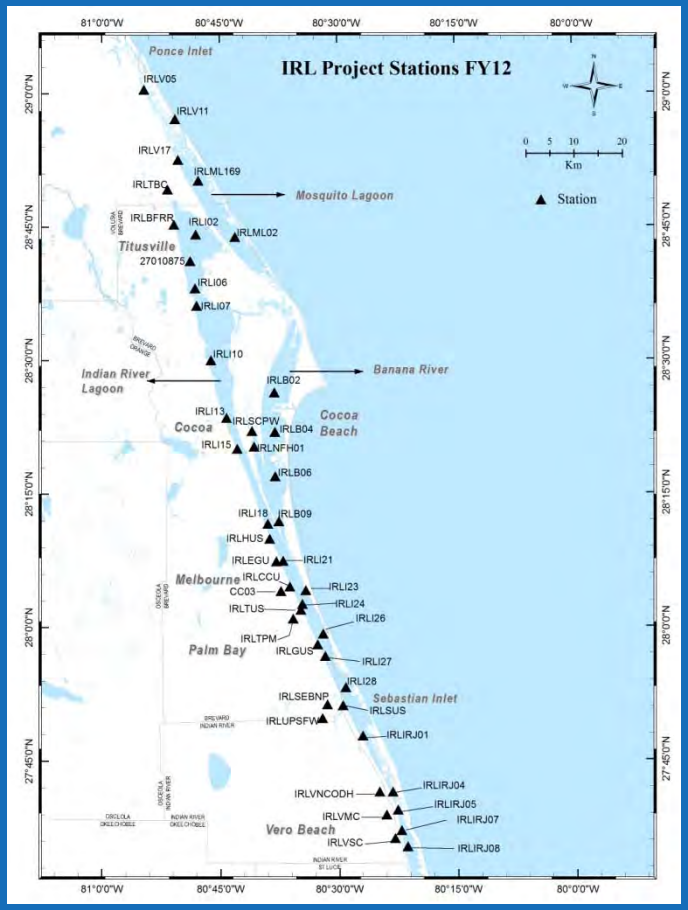
Project location =
2011 superbloom area
Timeframe =
4 years

Red hatching → *seagrass loss 2009–2011*



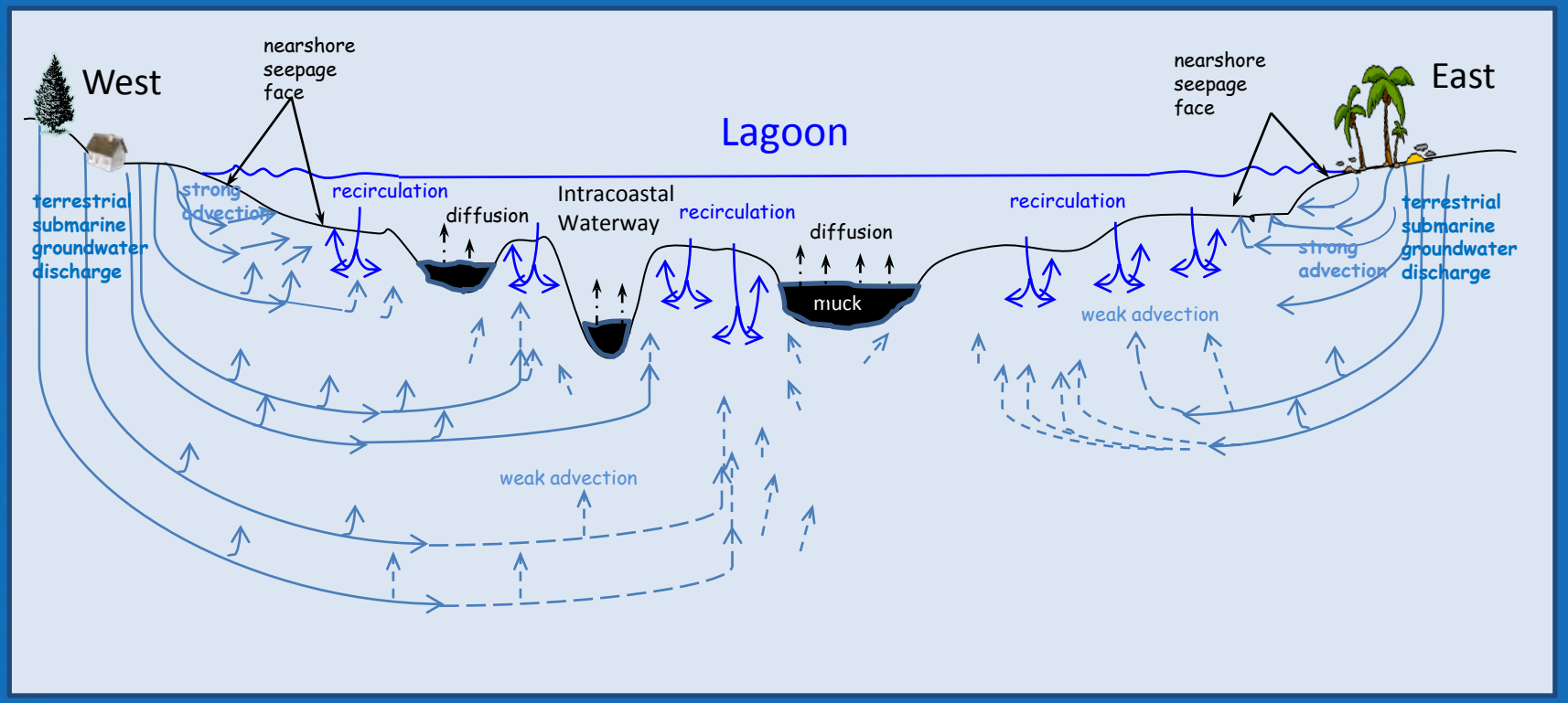
Blue Team

- **Enhanced sampling**
  - event sampling of inputs
  - atmospheric deposition
  - sensors for continuous data
  - bacterioplankton
  - phytoplankton
  - microzooplankton
- **Updated & enhanced models**
- **Nutrition for bloom species**
- **Grazing by microzooplankton**



Sand Team

- Sediment survey
- Groundwater model
- Internal nutrient budget (flux)



Green Team

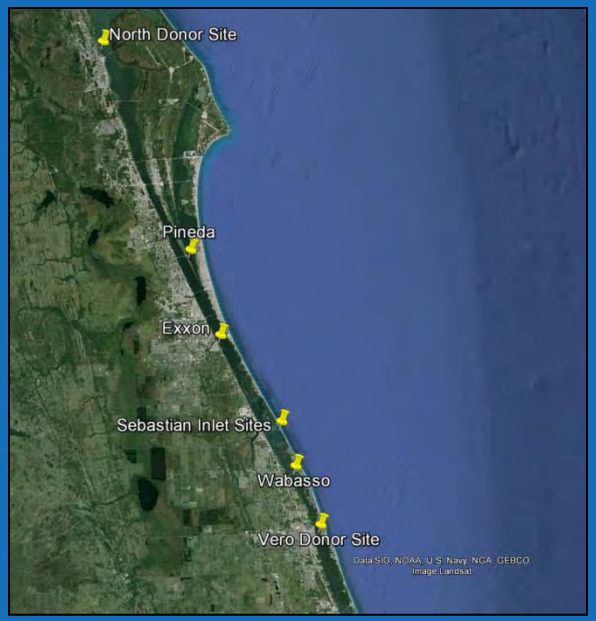
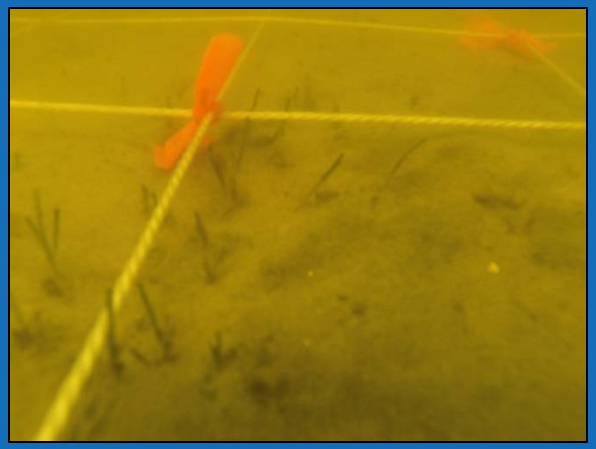


Figure 1. Map of donor and recipient sites in this study.



- **Seagrass transplanting**
- **Drift algae mapping**
- **Drift algae tolerance**
  - **temperature**
  - **salinity**
  - **light**
- **Nutrient content & release**
  - **drift algae**
  - **seagrasses**

Orange Team

- **Enhanced sampling**
  - **fisheries independent monitoring**
  - **macrozooplankton**
  - **infauna**
  - **epifauna**
- **Grazing**
  - **macrozooplankton**
  - **infauna**
  - **epifauna**

Goals

- **Understand**
  - **the lagoon's nutrient inventory & cycling**
  - **processes that regulate blooms**
- **Evaluate & recommend strategies**
  - **ameliorate blooms**
    - **magnitude**
    - **duration**
    - **frequency**
  - **facilitate seagrass growth & expansion**
  - **enhance diverse trophic structure**

Thank you for your time