Stormwater ponds: Research and management

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Lt Colonel Reynolds at the Save our Waters summit August, 2019

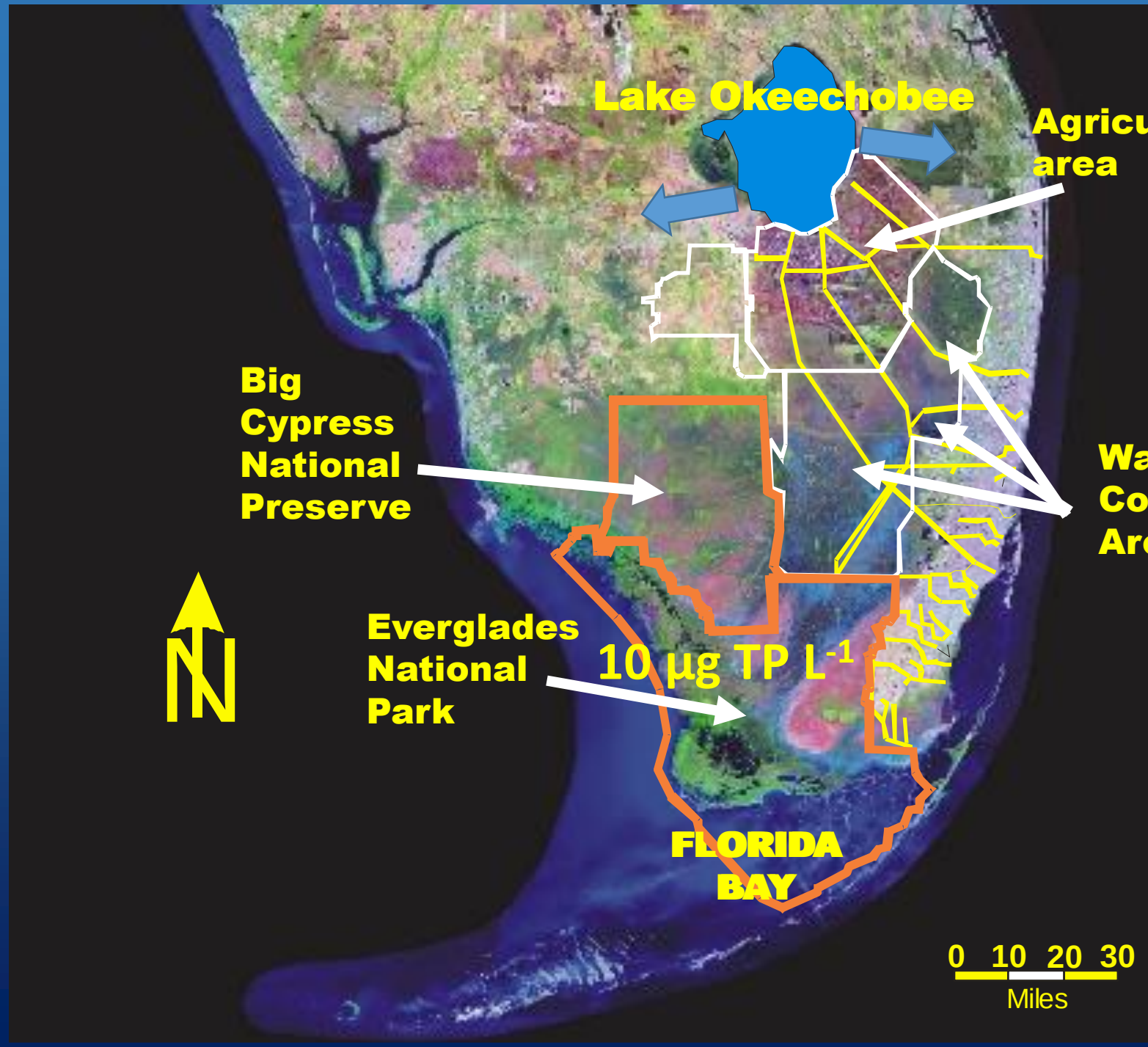
"We're all parts of the problem"

"If you moved to Florida since 1880, you're part of the problem," said Reynolds at the Army Corps. "If you've eaten food you didn't grow yourself, you're part of the problem. If you've used the bathroom in the last 24 hours, you're part of the problem. If you've driven on a road or lived anywhere there's concrete or shopped in a store, you're part of the problem," she said. "So we're all part of the problem."

We are all part of a larger system:

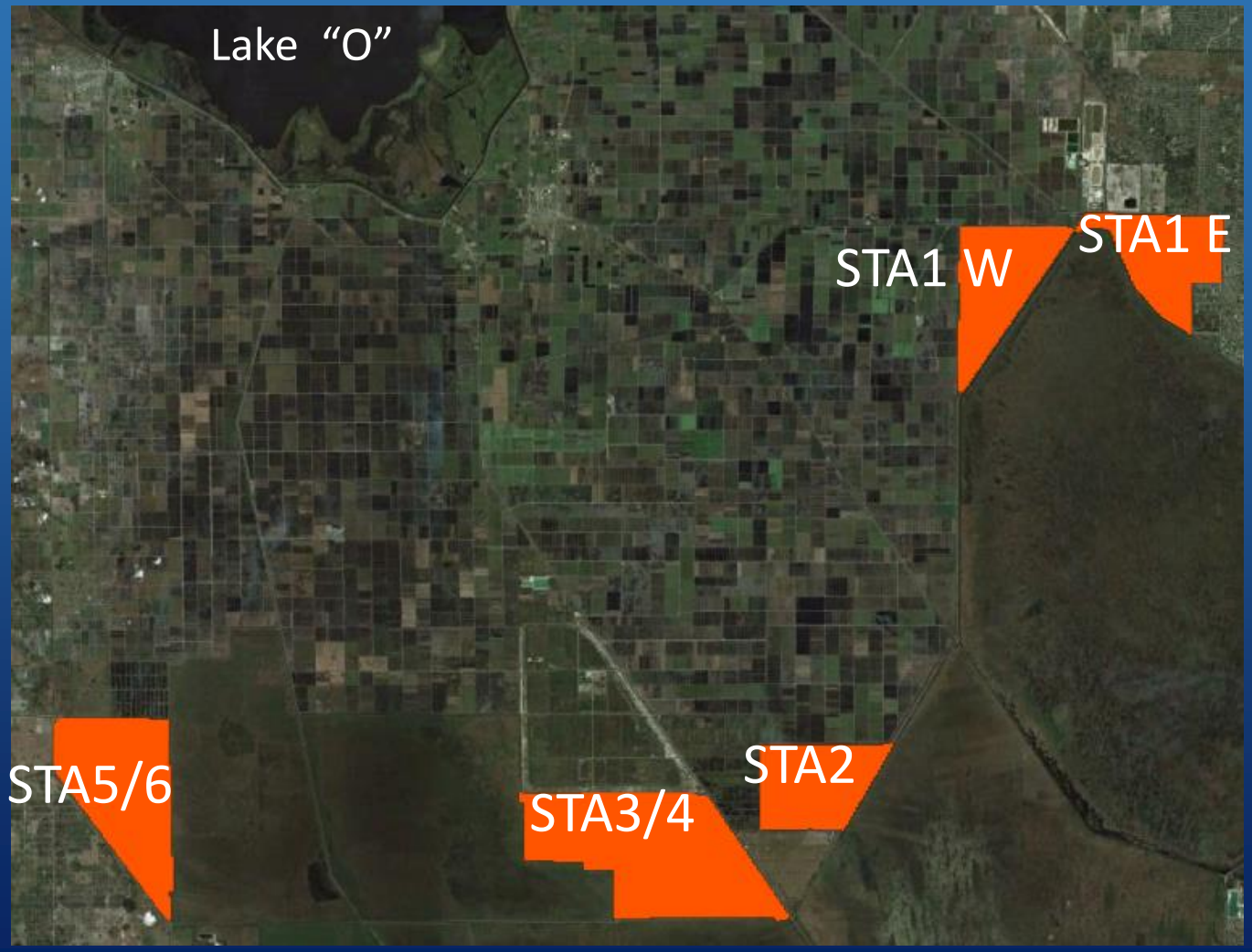
"Getting the water right"

TIMING
+
QUALITY



Stormwater Treatment Areas: a green technology to clean water

- STAs mandated by the Everglades Forever Act (EFA), section 373.4595, FL statutes
  - Reduce TP concentration in surface runoff prior to discharging in the Everglades Protection Area
  - Managed by SFWMD
  - Total area is ~ 68,000 acres (57,000 effective)
  - Treated over 4.8 trillion gallons and retained 1,874 t of P (75% load reduction)
  - Average flow-weighed mean =34µg/L (as low as 21µ/L in 2014)



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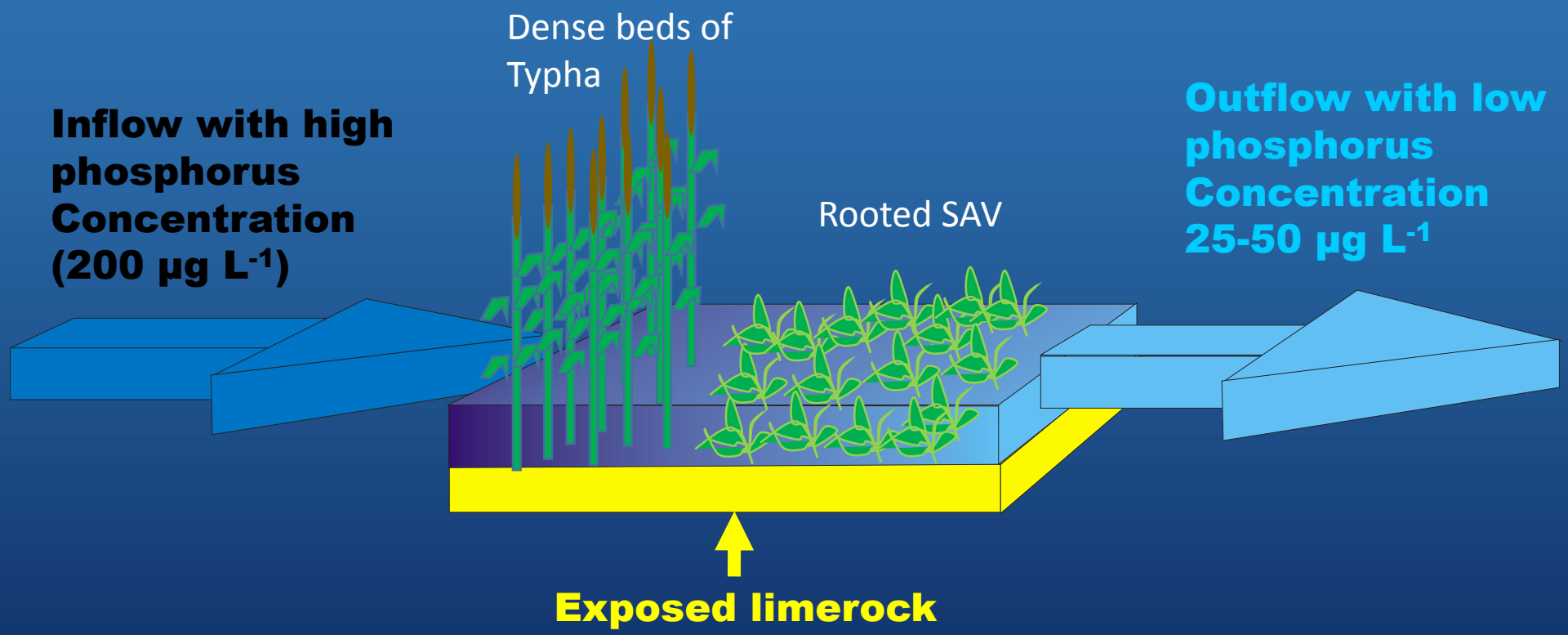

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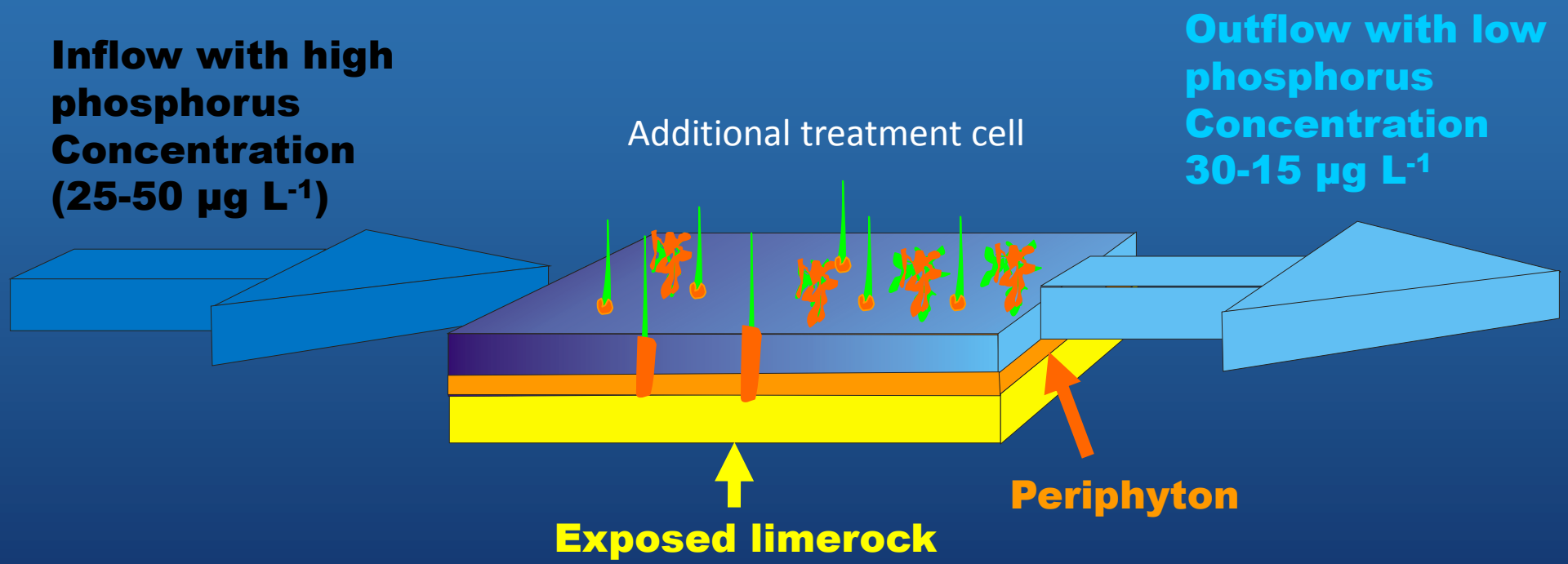
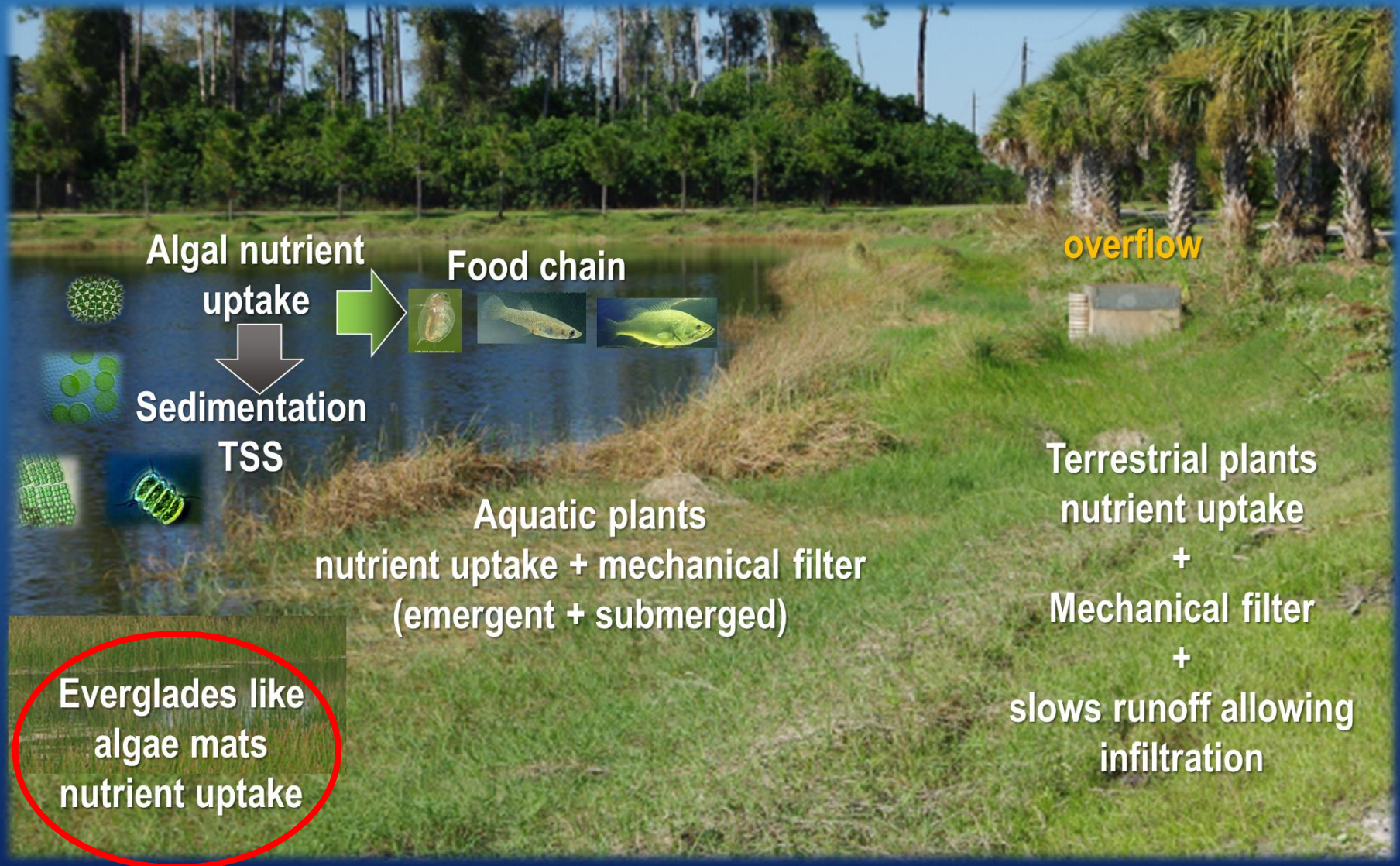


Stormwater ponds: a green technology to clean & regulate water



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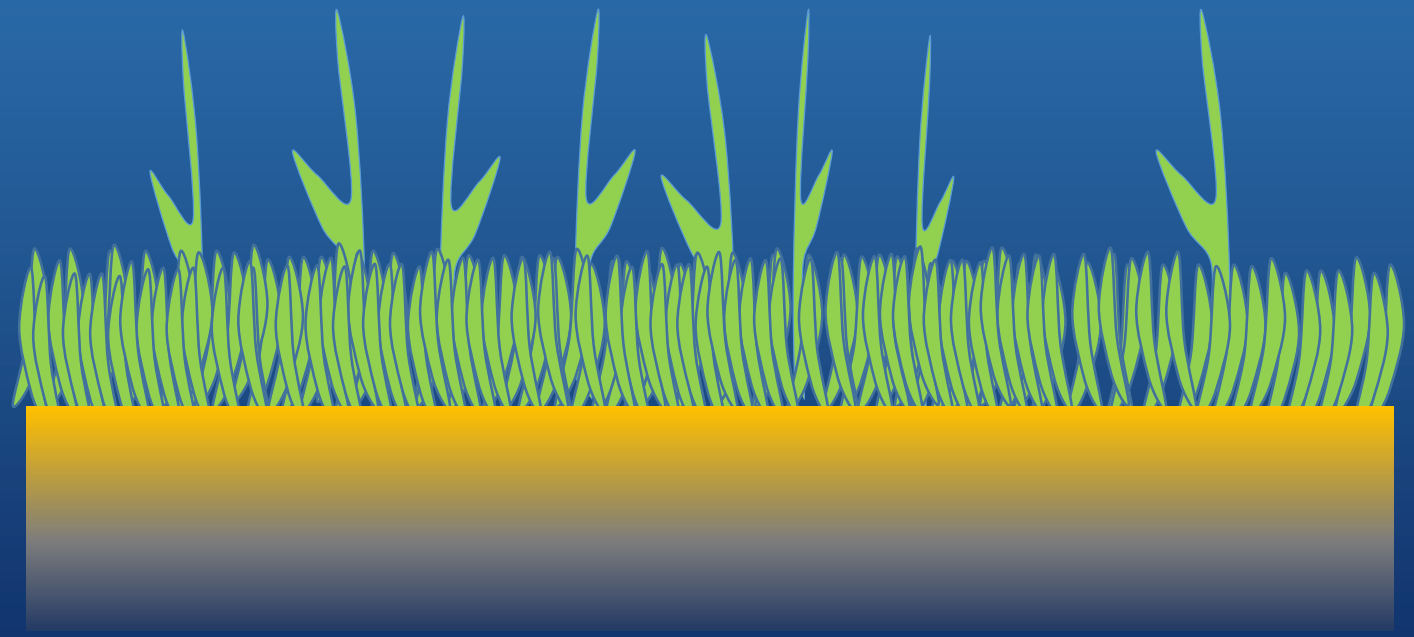

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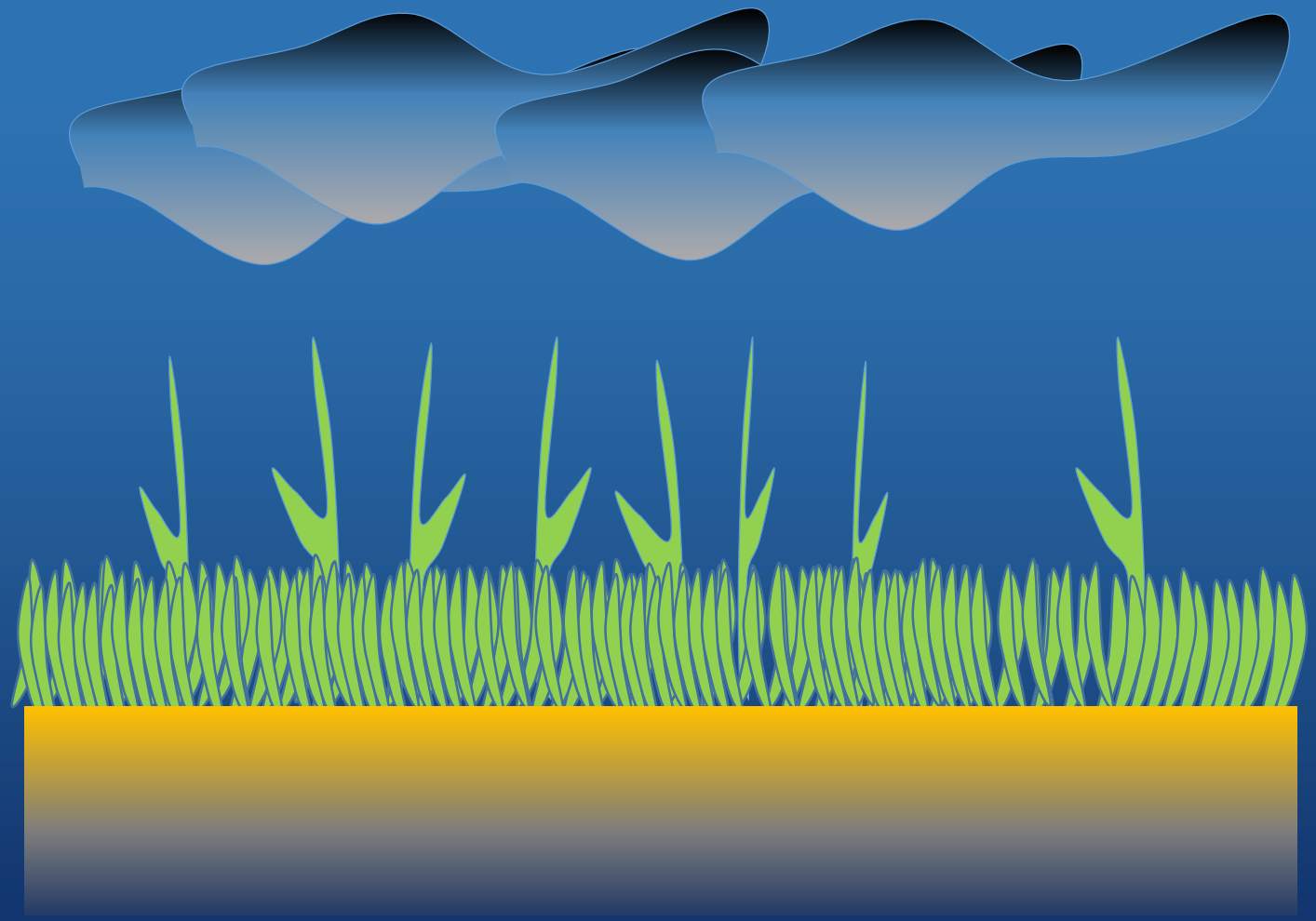

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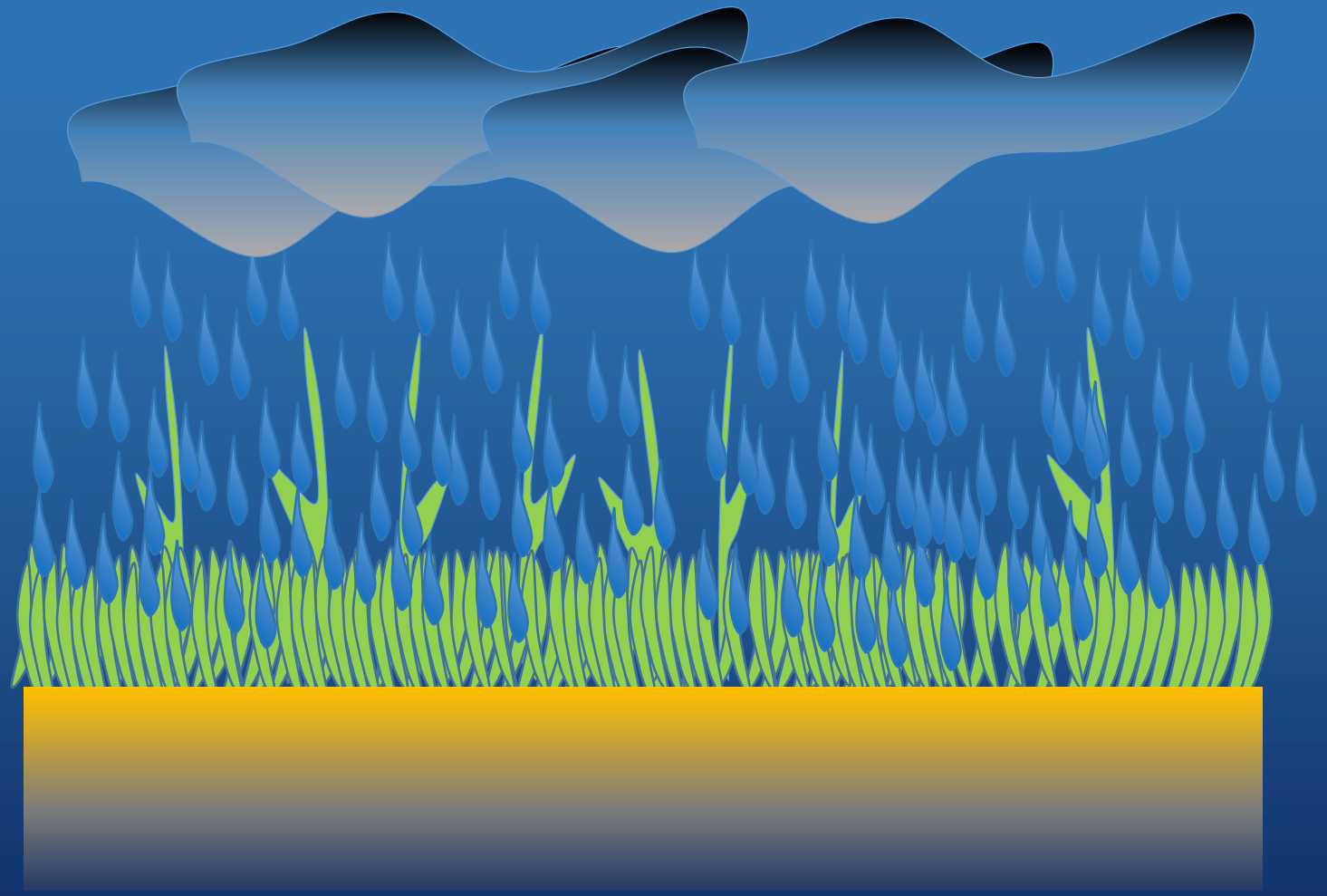

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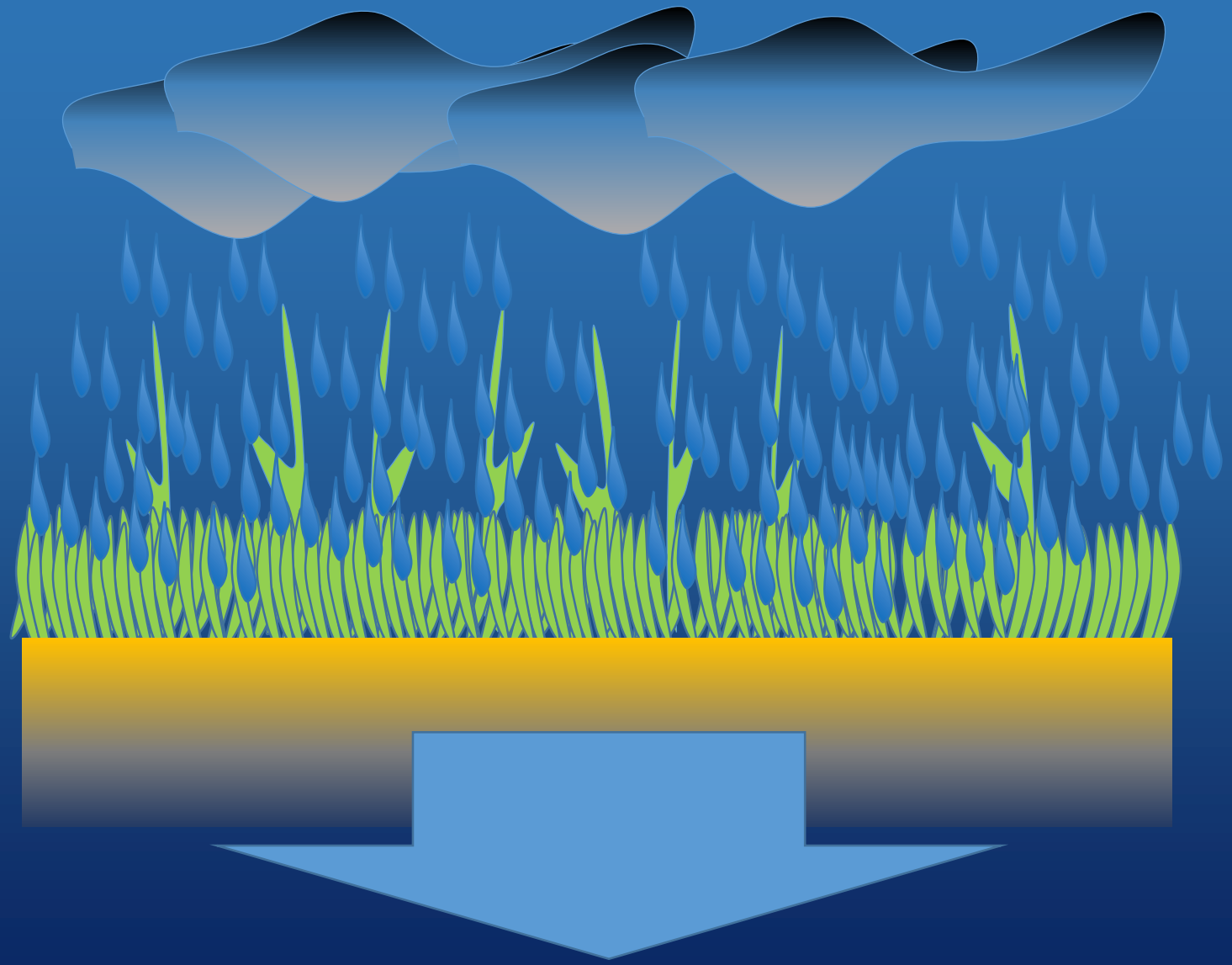
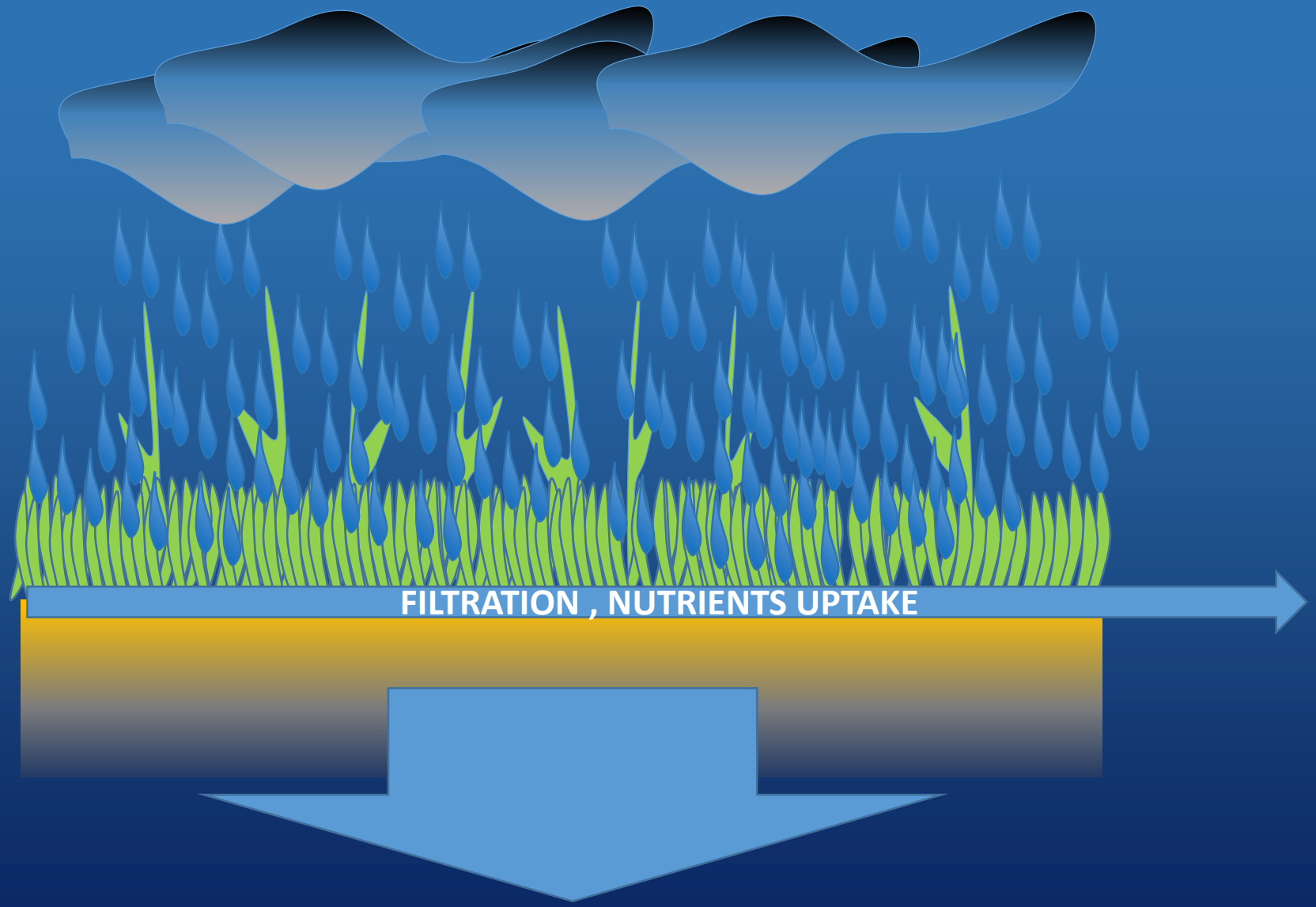
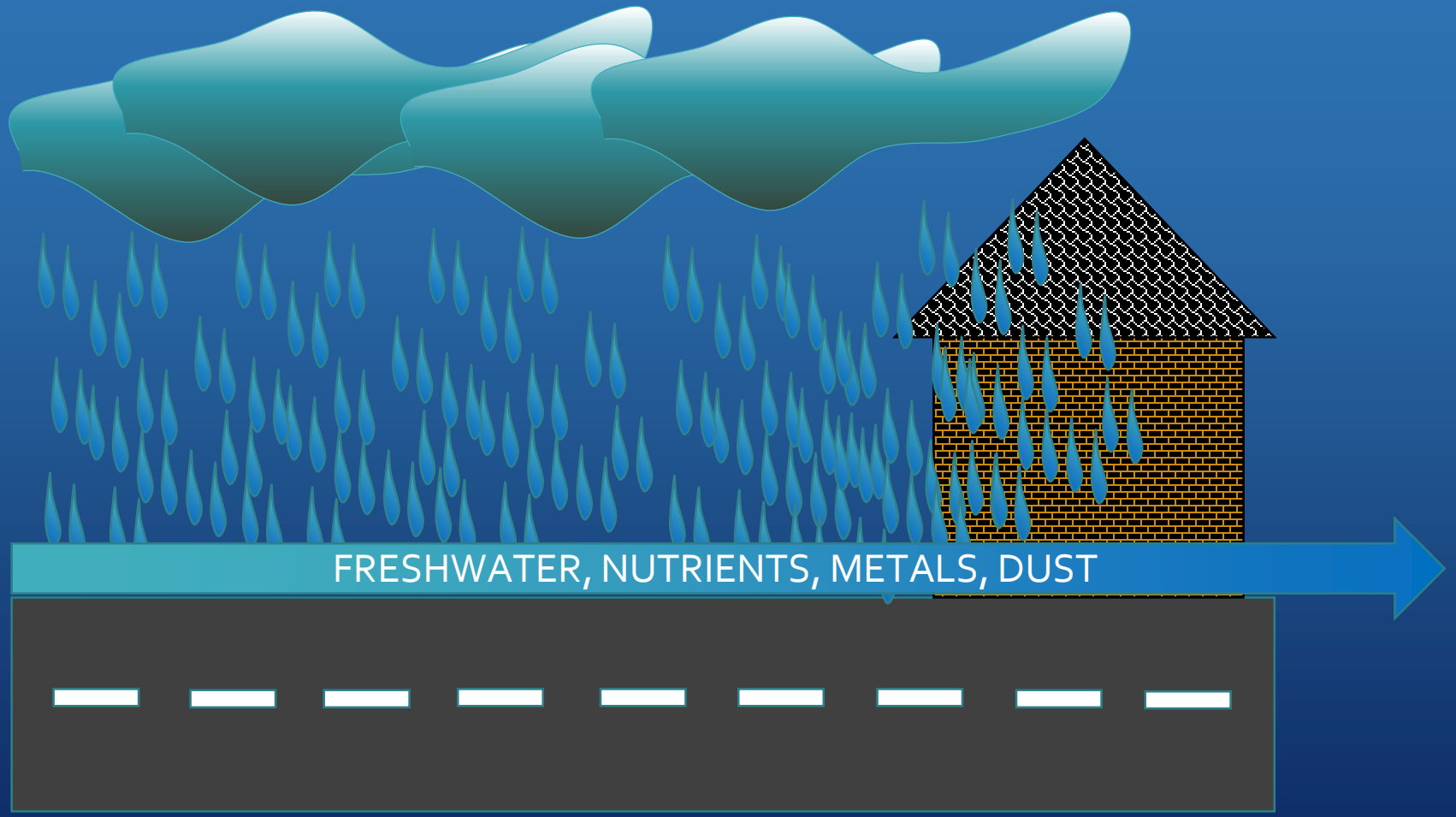


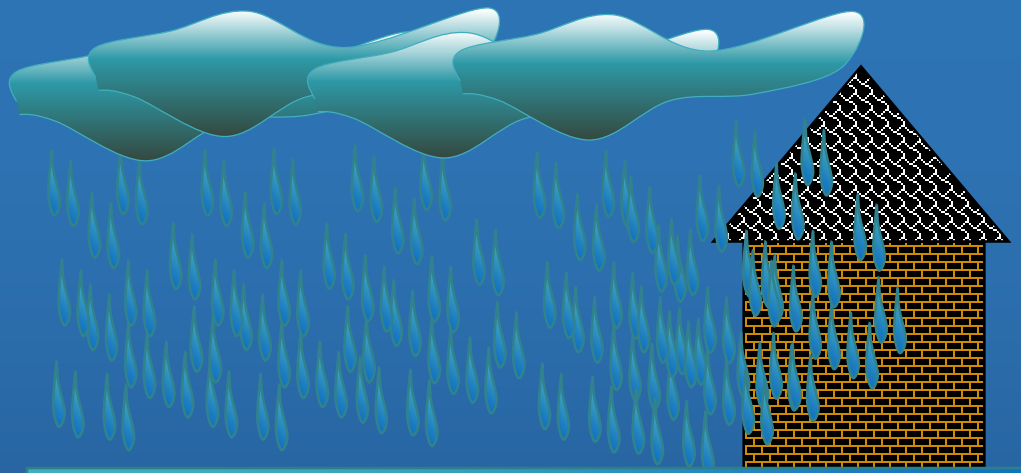
AQUIFER

PRE-URBANIZATION



POST-URBANIZATION





FRESHWATER, NUTRIENTS, METALS, DUST

STORMWATER POND

80% CLEAN FRESHWATER

FRESHWATER, NUTRIENTS, METALS, DUST

RECHARGE AQUIFER

Stormwater Treatment Areas: a green technology to clean water

Chapter 62-40 of the Florida Administrative Code

Stormwater runoff to be slowed down in order to:

- prevent erosion
- allow siltation/sedimentation prior to reaching natural hydrosystems,
- promote soil filtration over adequate soils and thus permitting
- pollutant removal
- let the aquifer recharge to ultimately protect the delicate floral and faunal balances of the downstream coasts.

➔ Through Chapter 62-40, stormwater pollutants to be reduced by 80% with respect to the State Water Quality Standards and changed to 95% reduction when such stormwater emptied into an Outstanding Florida Waterway (OFW).

Stormwater Treatment Areas: a green technology to clean water

- Removal of at least 80% of pollutant load for class III and 95% removal for class I and class II waters. (Livingston 1993). Reduction:
    - Total Suspended Solids (TSS) = 75 to 85%
    - Total Nitrogen (TN) = 37 to 60%
    - Total Phosphorus (TP) = 59 to 85%
    - Metals = 40 to 80%

- Slow down water runoffs to the sea and rivers thus mimicking the original hydro-patterns (infiltration during the dry season & deliveries during the rainy months)

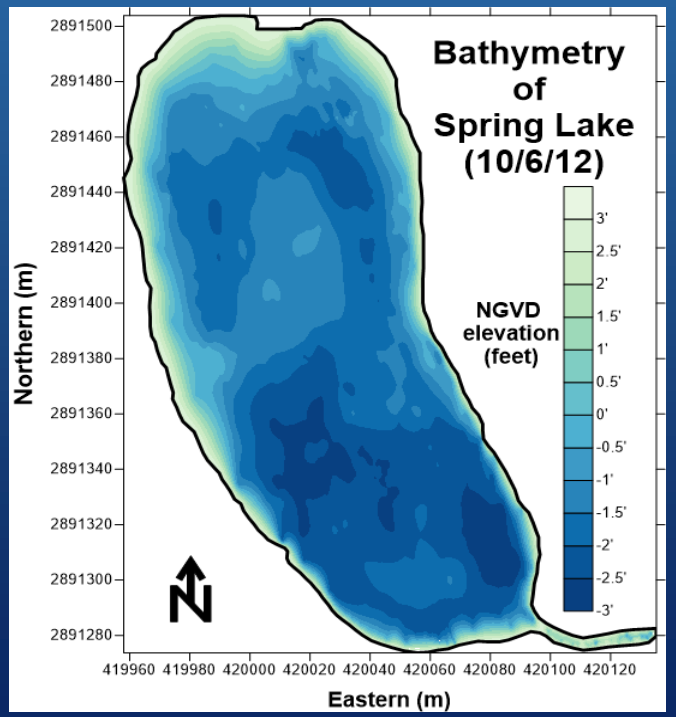
Stormwater Treatment Areas: a green technology to clean water

Wet vs. Dry ponds

Dry pond

Stormwater Treatment Areas: a green technology to clean water

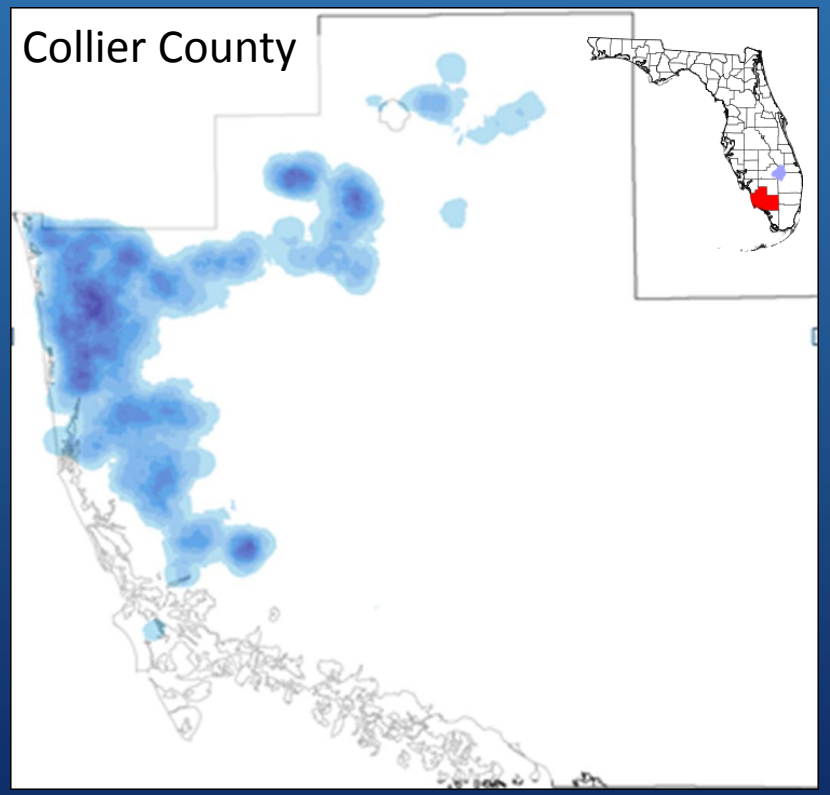
Wet vs. Dry ponds



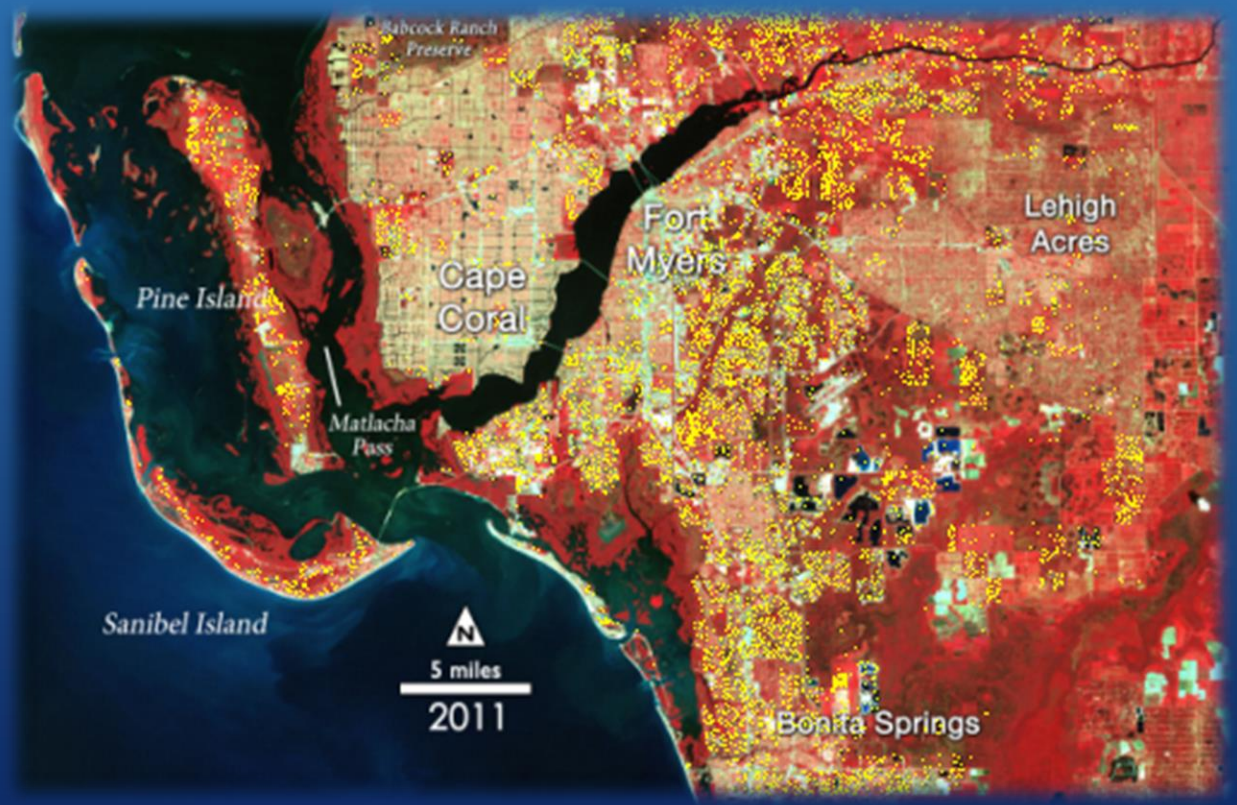
Wet pond

Stormwater Treatment Areas: a green technology to clean water

Higher density next to the coasts, and on islands: They track the people



3837 in 2013, 4220 (10% more) in 2018



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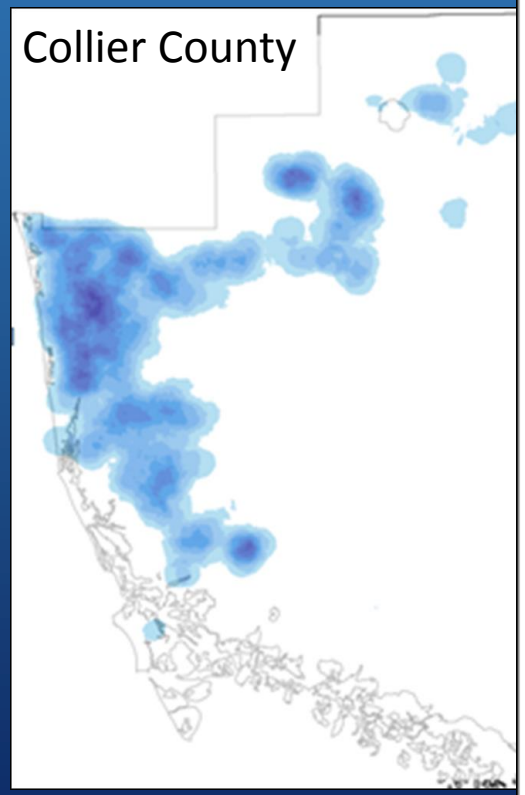

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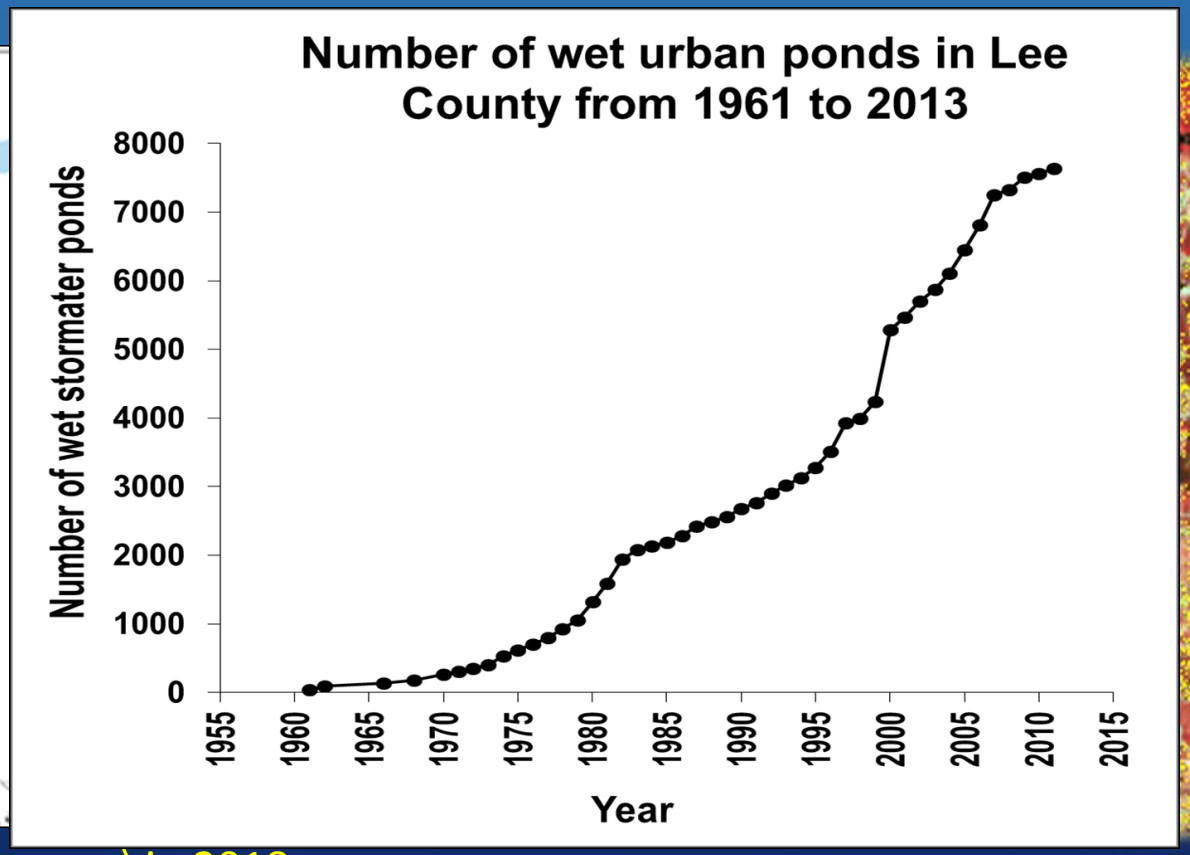

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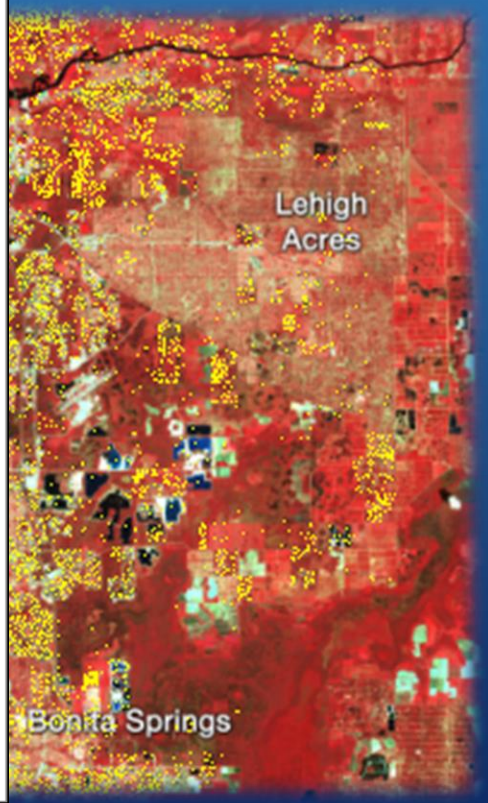

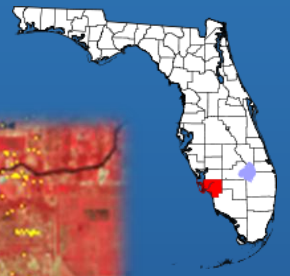

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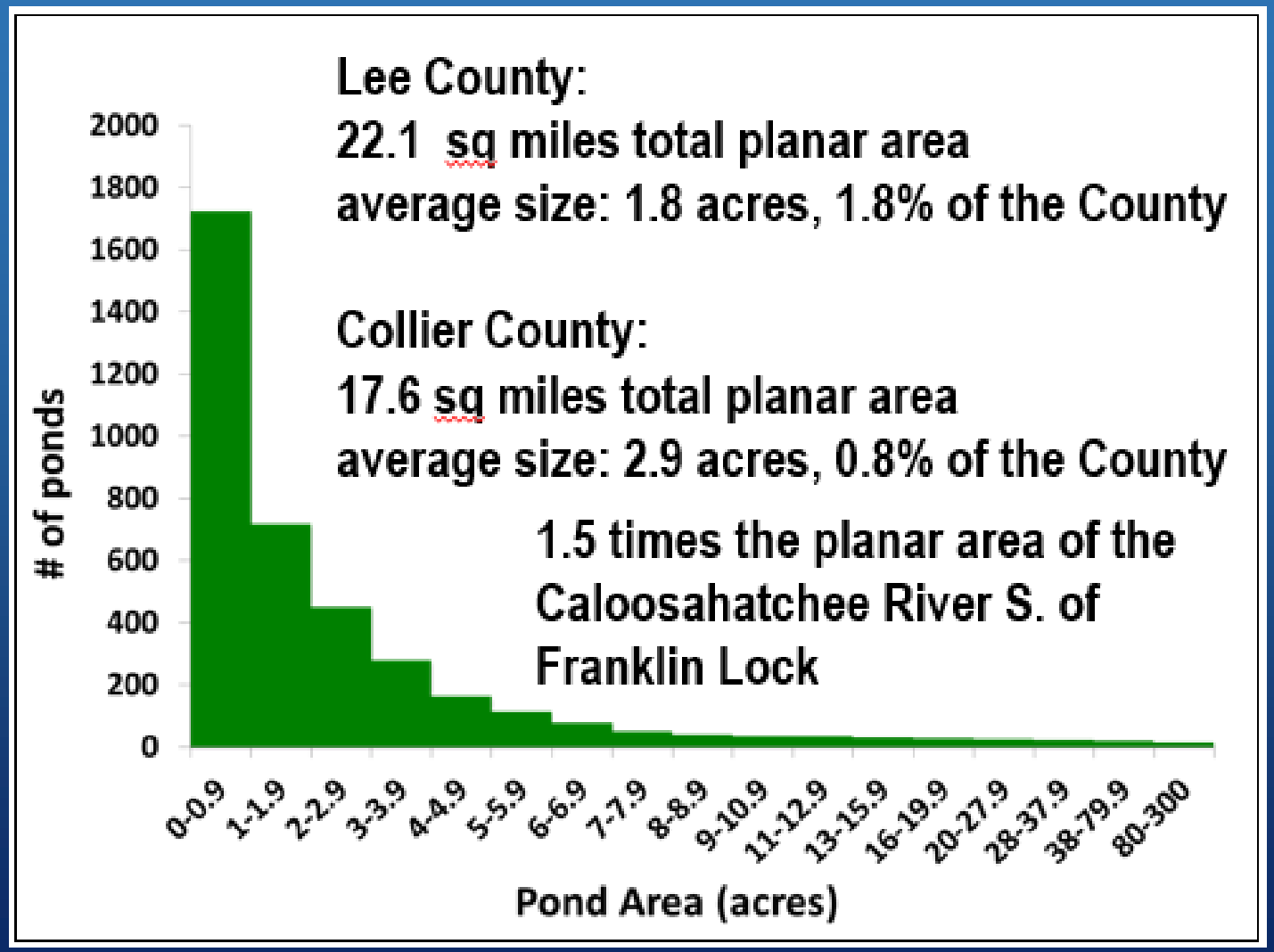

Stormwater Treatment Areas: a green technology to clean water

The good algae: Periphyton

The periphyton:

- Is the base of the food chain
- Provides with most oxygen in the water column
- Arbors beneficial bacteria and invertebrates
- Disappears when the temperature is low (but especially grows during the rainy season)
- Does not release much nutrients when it decays
- Does not create odors when it decays likely because of its high calcium carbonate (chalk) content.
- When it decomposes, it creates a "slab" of limestone which isolates the lake bed. This is mostly inorganic calcium carbonate or chalk (low sediment built up).
- Can lock phosphorus as it dries up. Limestone is a trap for phosphorus.
- Can remove nitrogen through denitrifying bacteria

The misuse of ponds:

- People want wet retention/detention ponds: “Lakes” for the view
- But, open water is NOT a good way to sequester nutrients
- All efforts to limit nutrient loading into wet ponds should be made
- Dry ponds (i.e. wetlands) should be preferred as a more efficient water treatment

Pond misused

Folks want lakes, lake front view, no view obstruction, green lawns, clear water:

Pond misused

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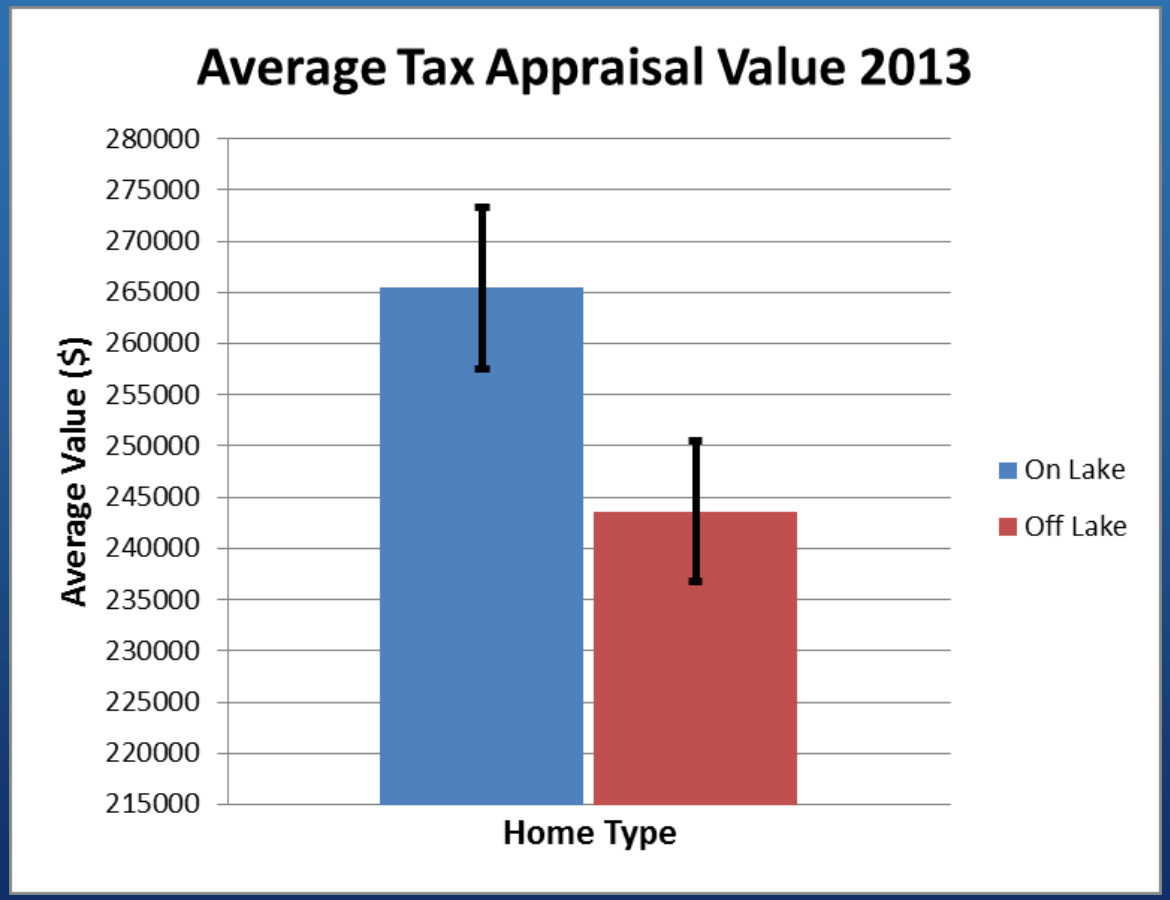
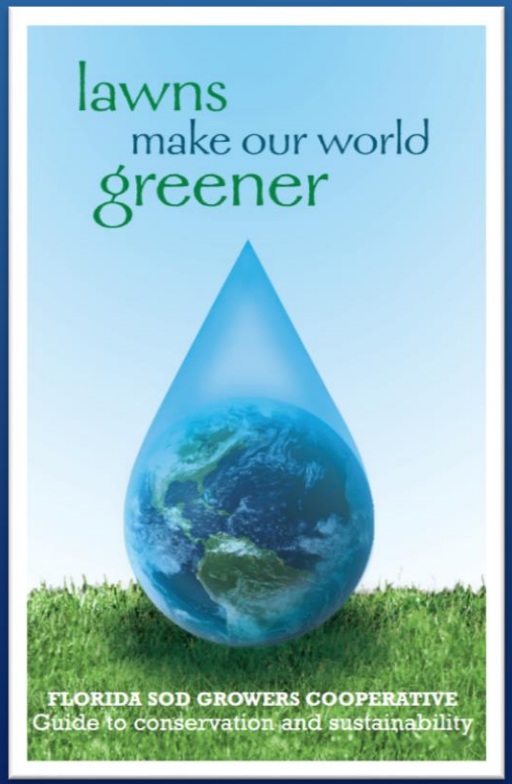


9% added value when On lake view.

Pond misused

Folks want lakes, lake front view, no view obstruction, green lawns, clear water:



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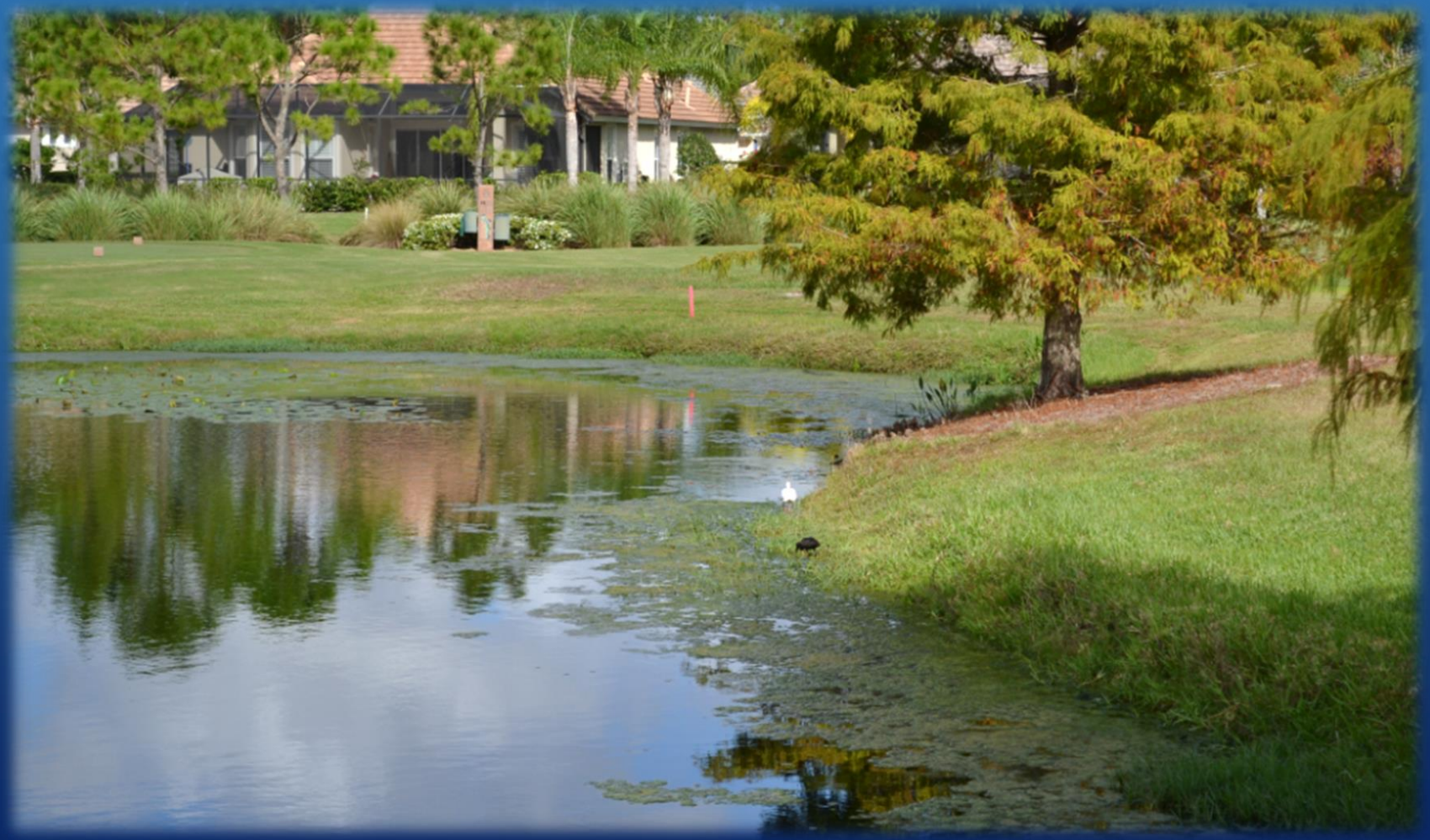


Pond misused

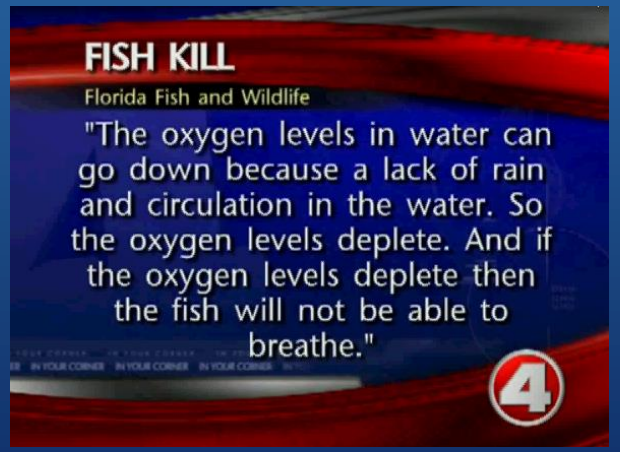
Eutrophication

Pond misused

Pond misused

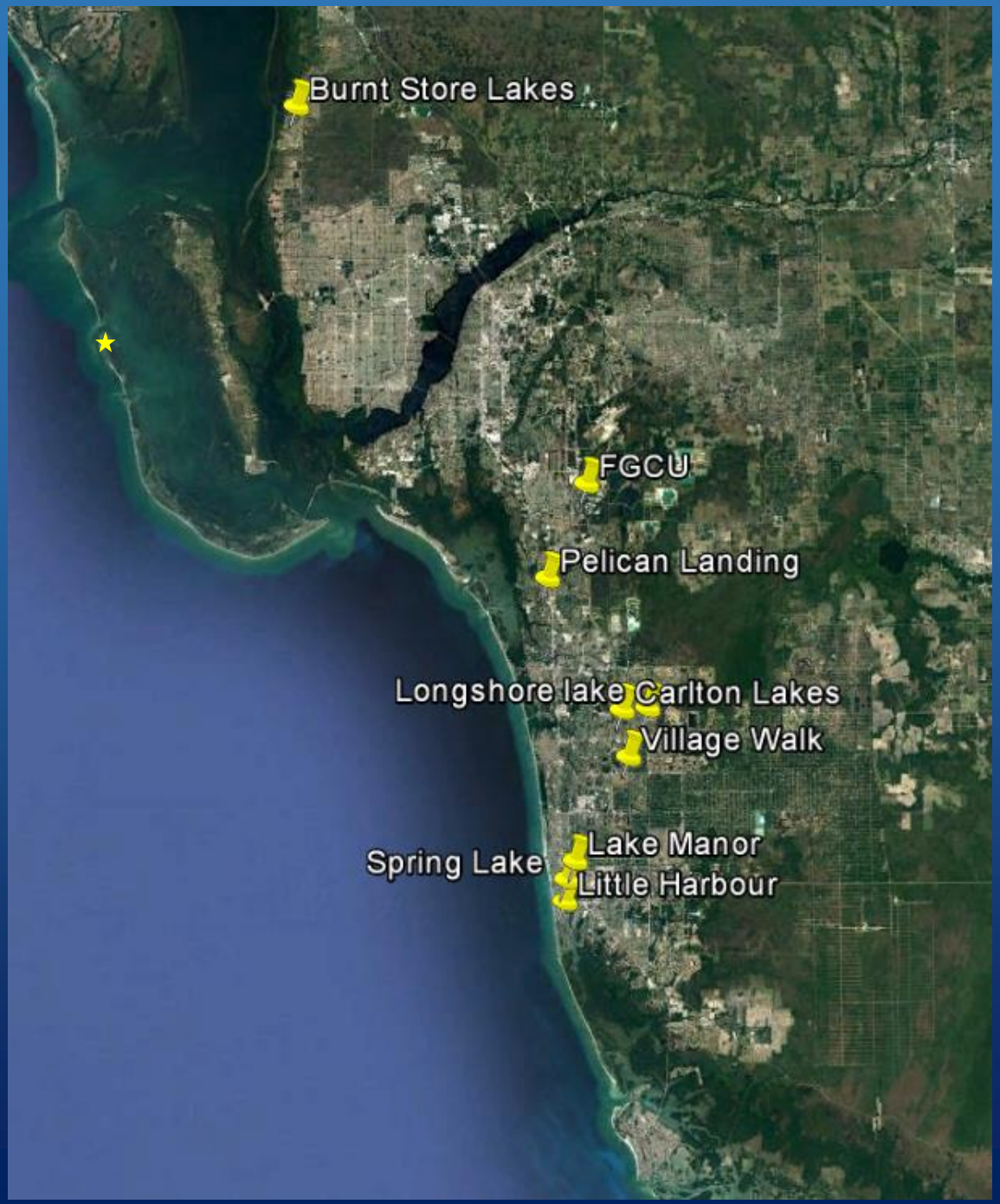
LAKE	POLLUTANTS OF CONCERN	POLLUTANT REMOVAL EFFICIENCIES
1. South Lake (#9)	TN, TP	TN = **-123%**, TP = **-192%**, TSS = 27%
2. Lois Selfon (#31)	TN, TP, Fecal Coliform	TN = **-3%**, TP = 27%
3. Alligator Lake (#10)	TN, TP, TSS	TN = **-18%**, TP = 13%, TSS = **-200%**
4. Swan Lake (#2)	Copper, Fecal Coliform	TN = 47%, TP = 69%, Copper = **-292%**
5. Half Moon Lake (#24).	TN, TP	TN = **-139%**, TP = **-363%**

Top 5 poorest ponds (AMEC, 2011)

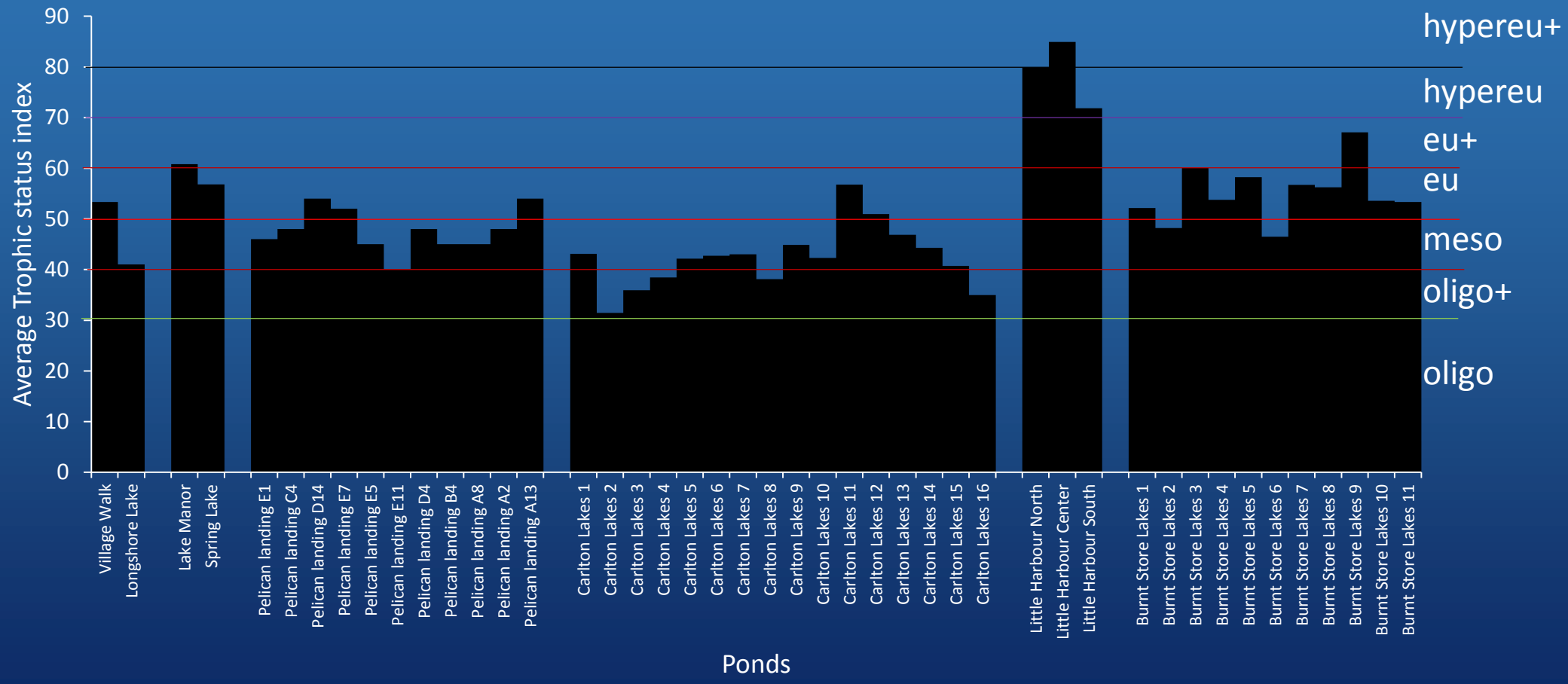


Pond misused

- South Naples (3 ponds, 1 community)
- City of Naples (2 ponds)
- North Naples (18 ponds, 3 communities)
- Estero/Bonita Springs (11 ponds)
- FGCU ponds (1 pond)
- Sanibel islands (8 ponds)
- Burnt Store Lakes (11 ponds)



Consequences of pond misused



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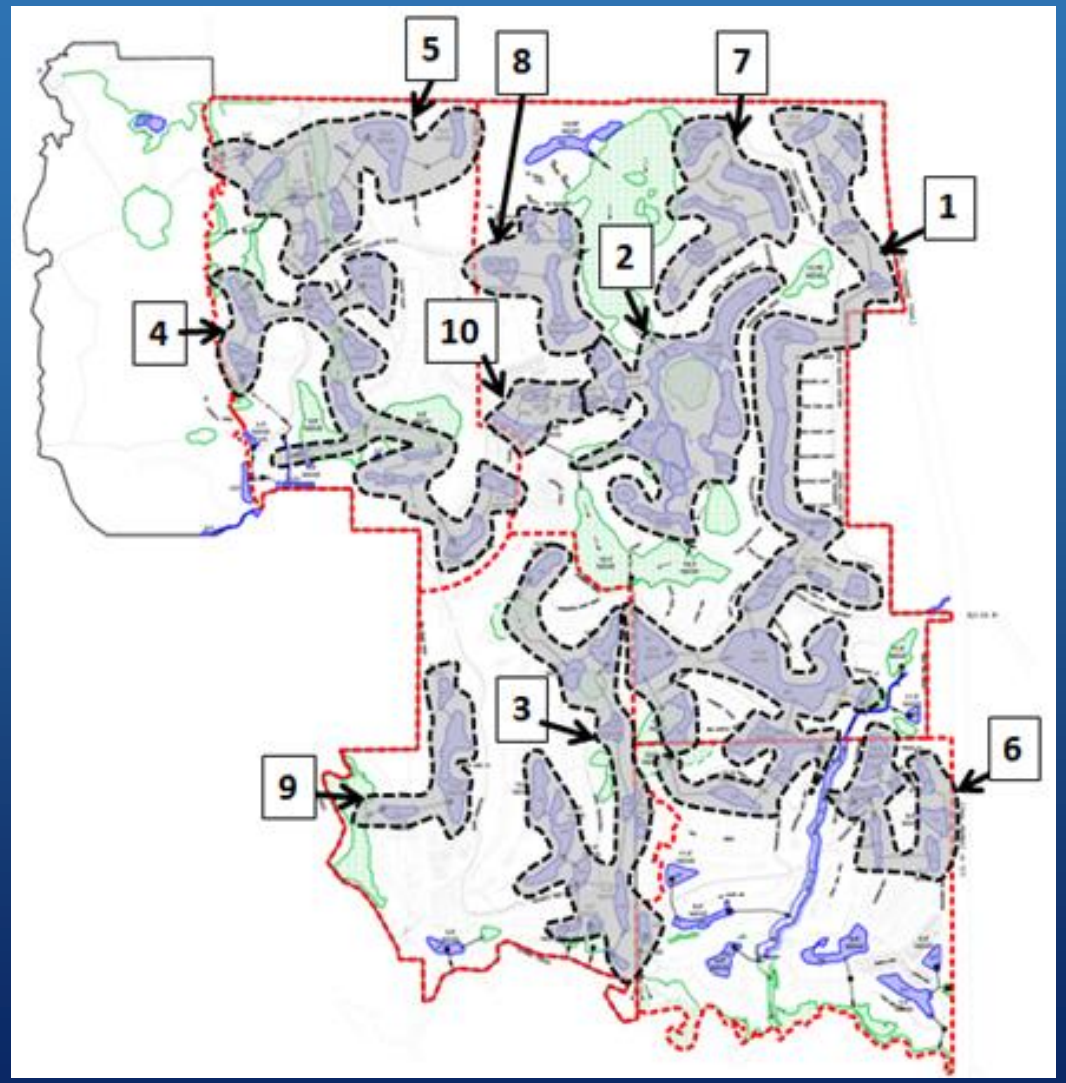
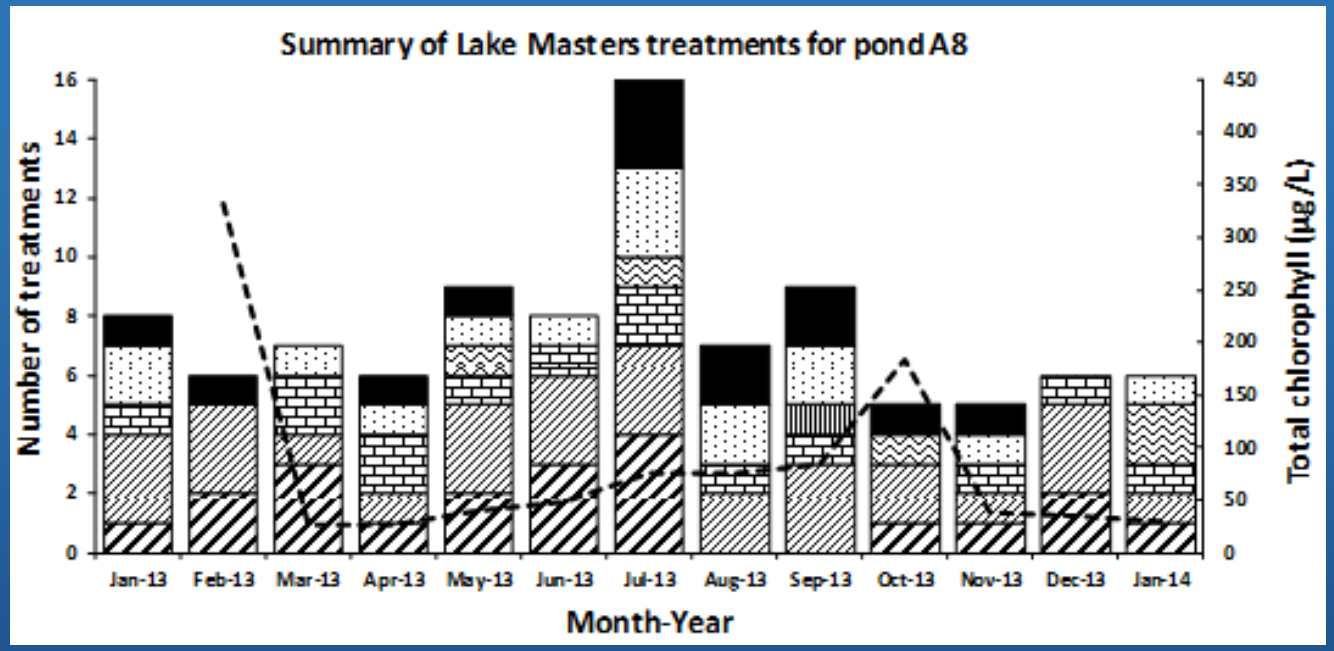
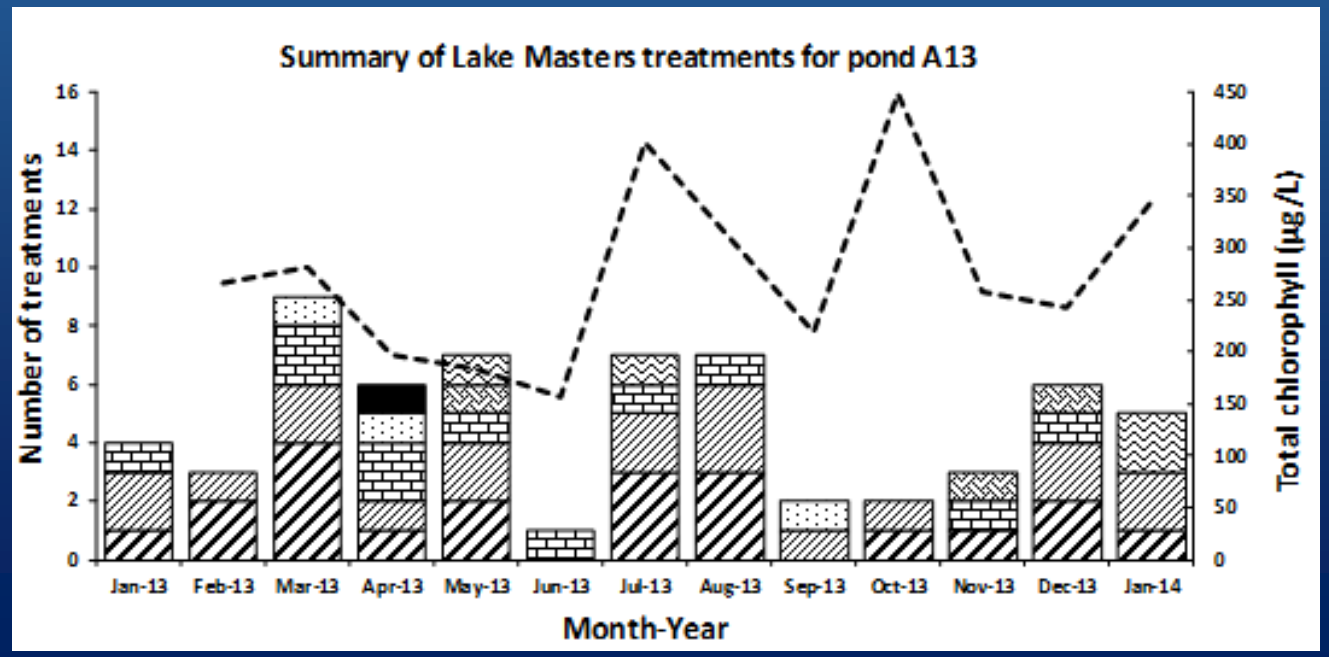


Pelican Landing
2,365 acres
91 wet ponds (216 acres)

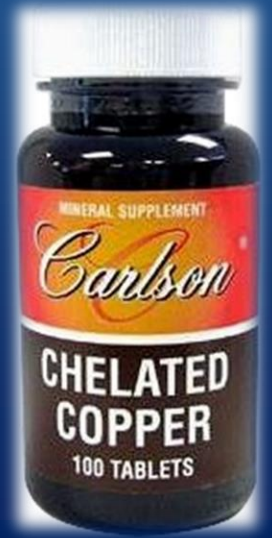
4,000 homes
~300,000 sf of retail space 475,000 sf of office space
750 hotel/motel rooms
50,000 sf conference center
65 wet boat slips
150 dry boat storage spaces, and recreational amenities (e.g. 24 tennis courts, 77 holes golf courses, canoe/kayak parks, boat ramp and a beach park).
~143 acres of upland habitat preserve
678 acres of salt and fw marshes
162 acres of public & private rights-of-way
3 acres of off site parking, 6 acres of utilities

Pond misused





Hydrothol 191
Diquat
Imazapyr
Raking
Poast
Sonar
Glyphosate
Chelated copper
Copper sulfate
Chl



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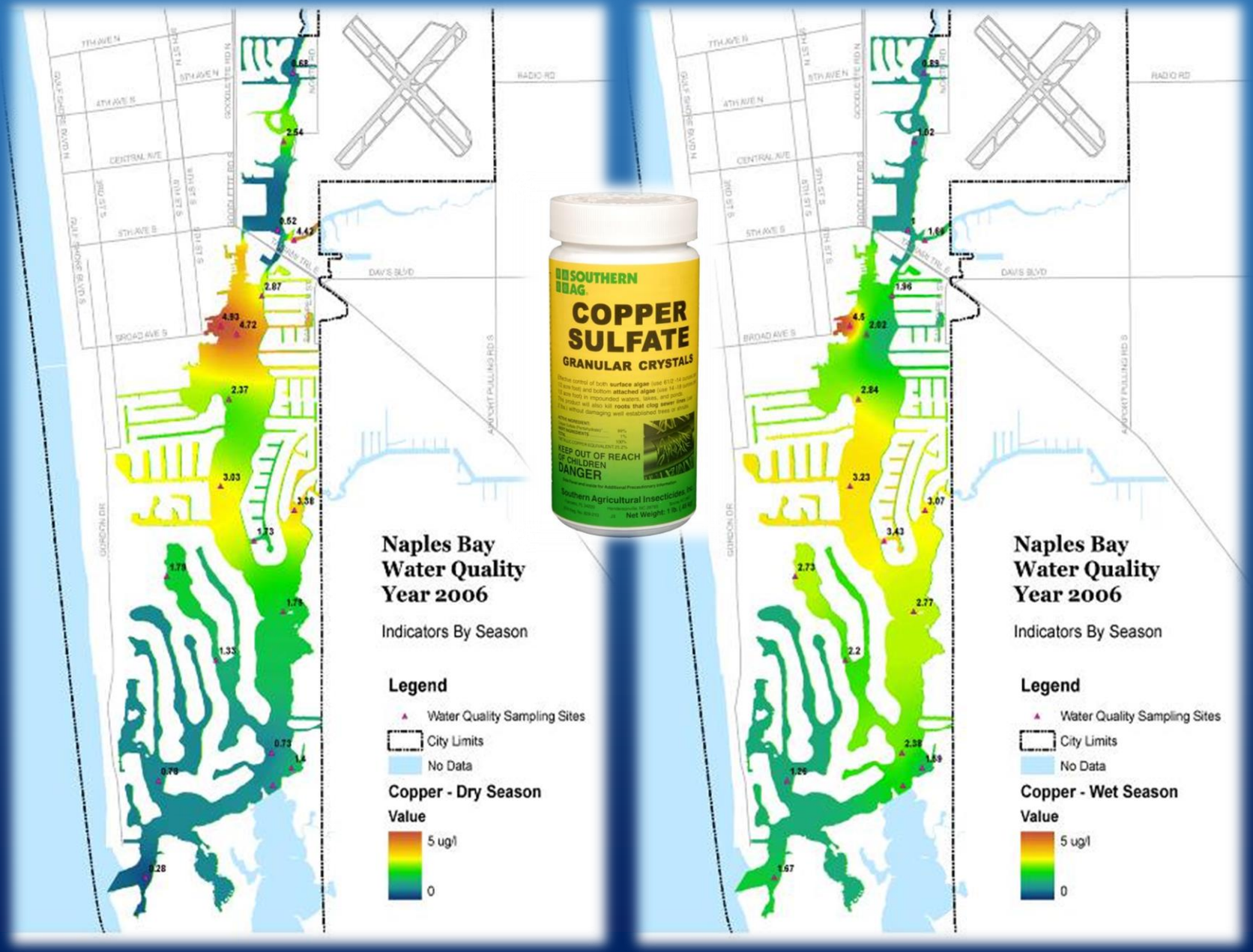
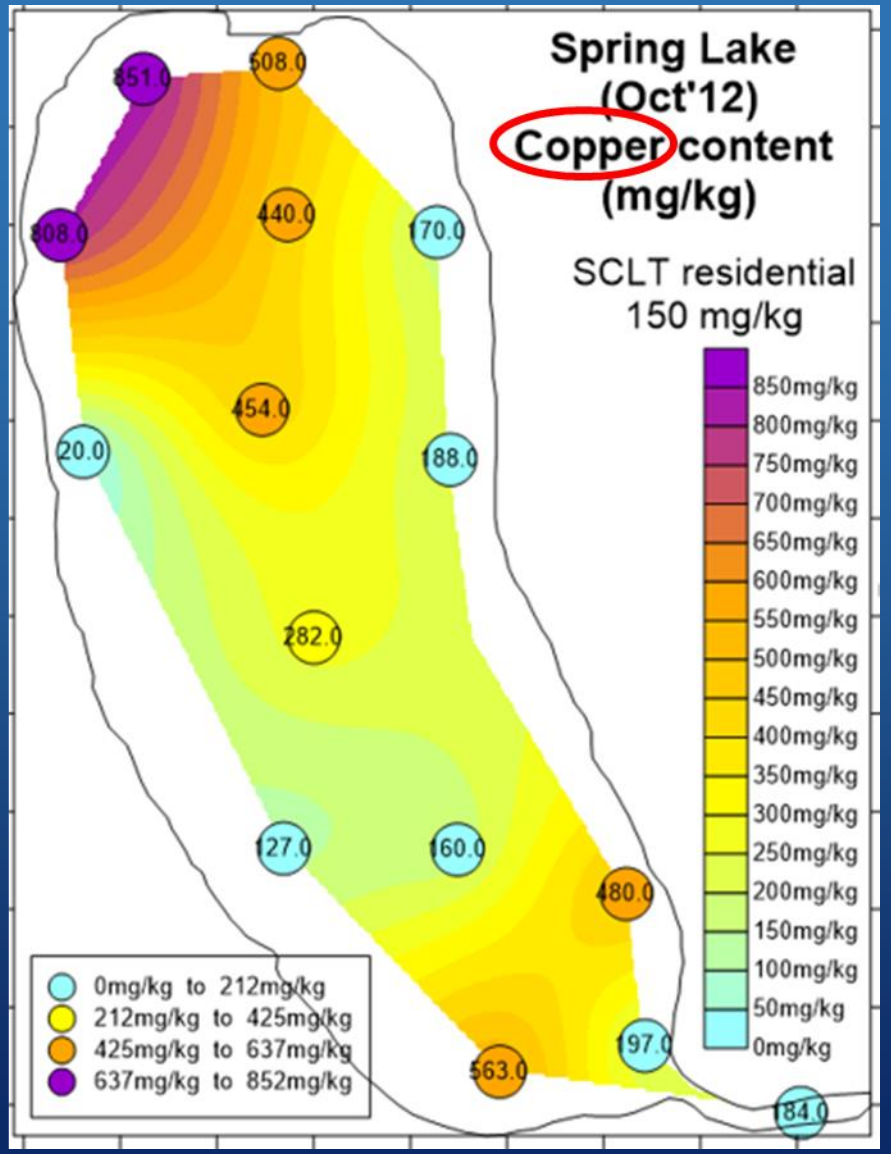


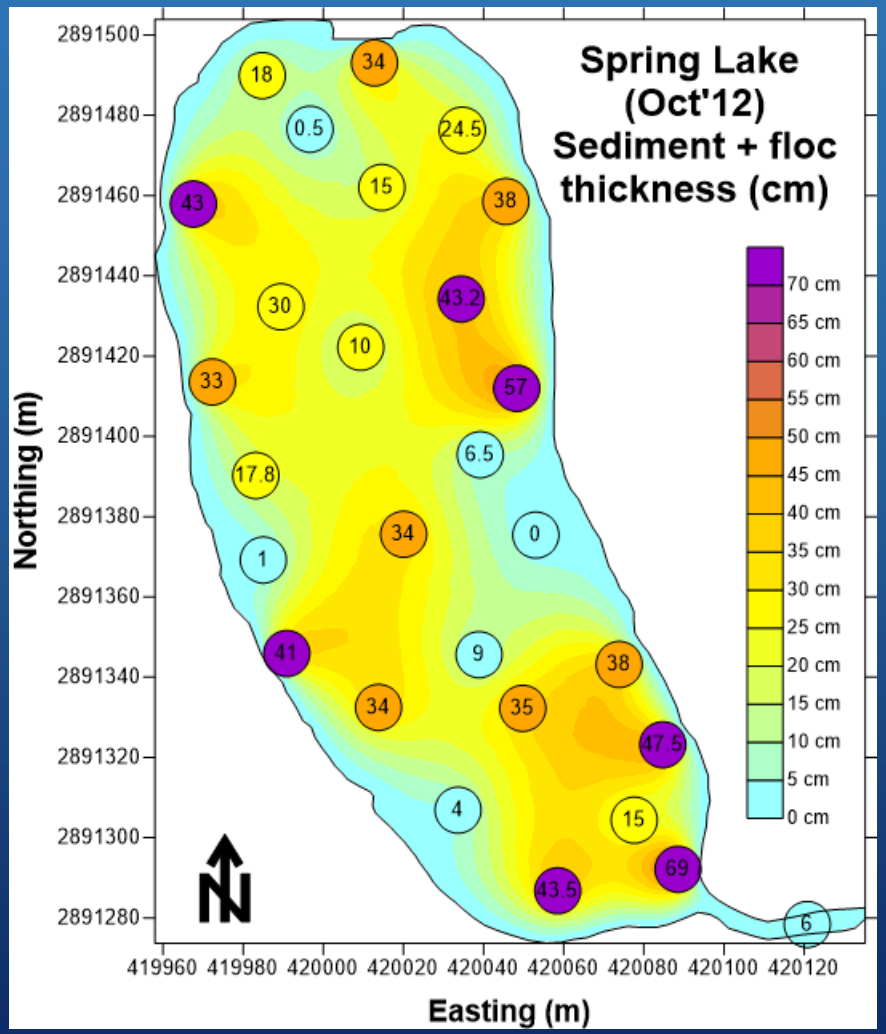
Pollution export

Consequences of pond misused



Muck accumulation

Consequences of pond misused



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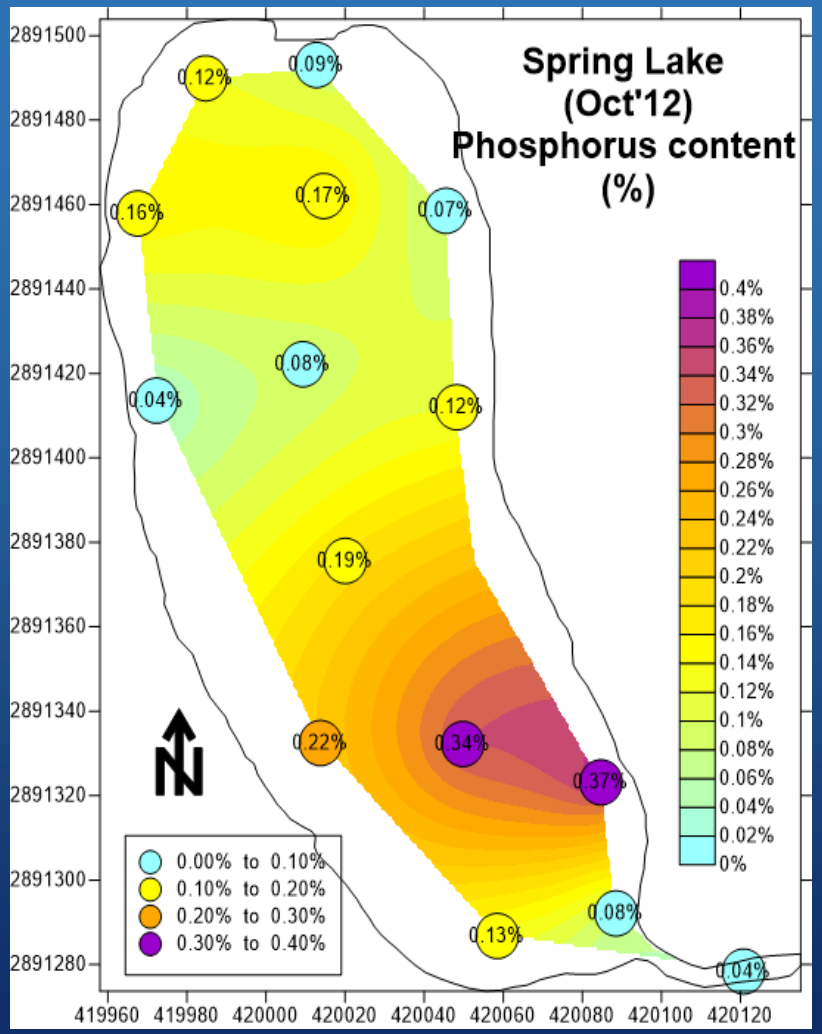
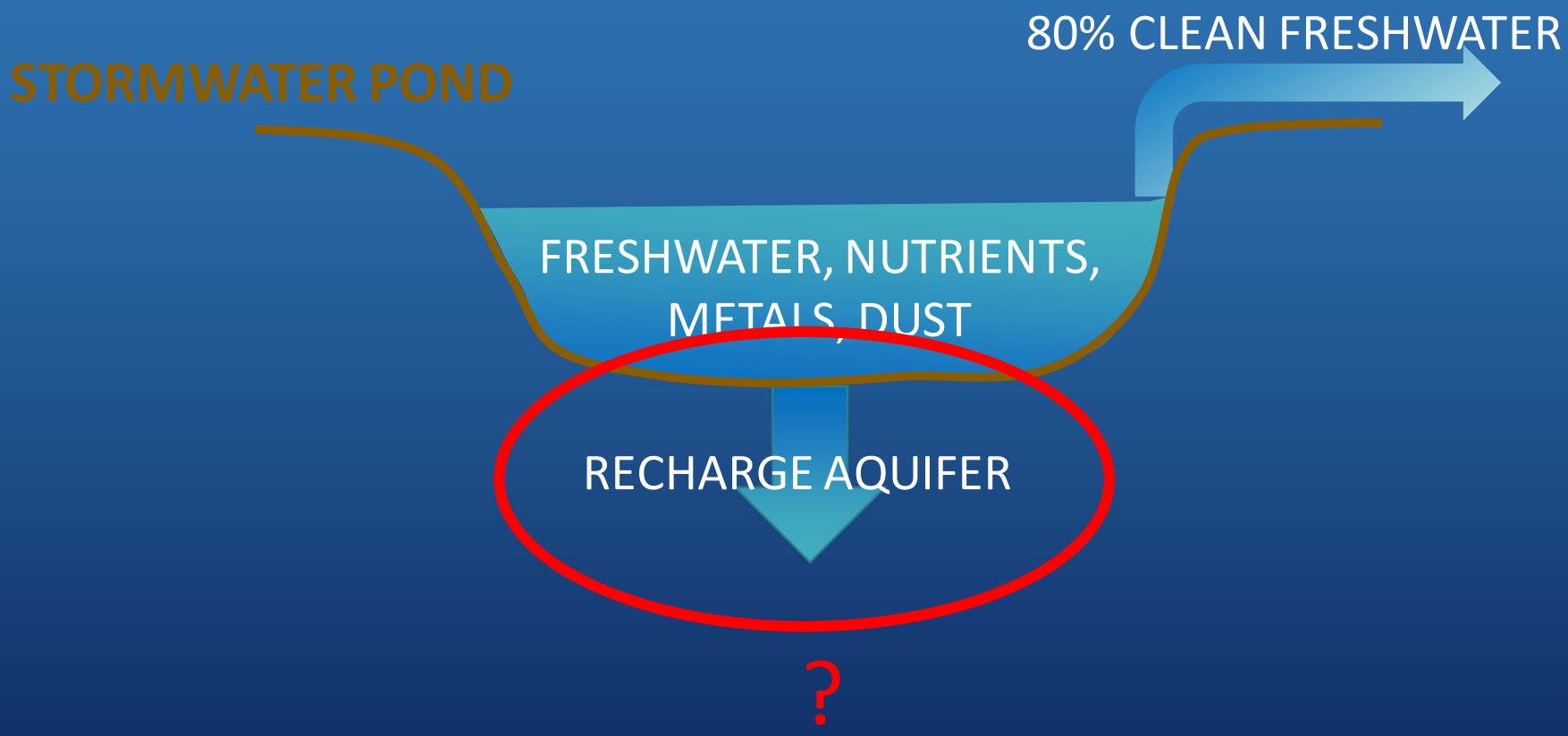


Muck accumulation

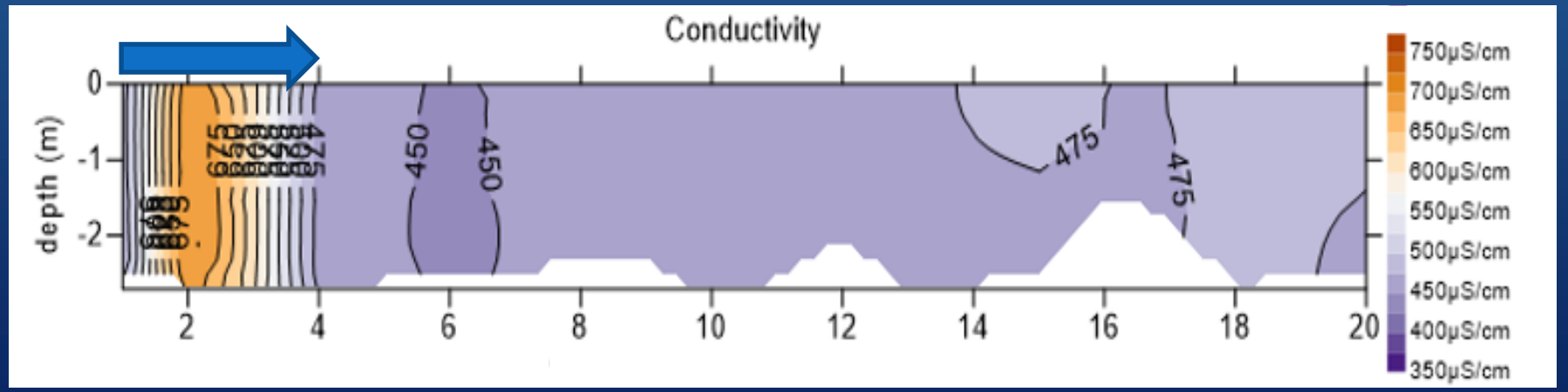
Possible unexpected effects of ponds



Groundwater discharge

Possible unexpected effects of ponds

Great hydraulic conductivity (2013)



Groundwater discharge

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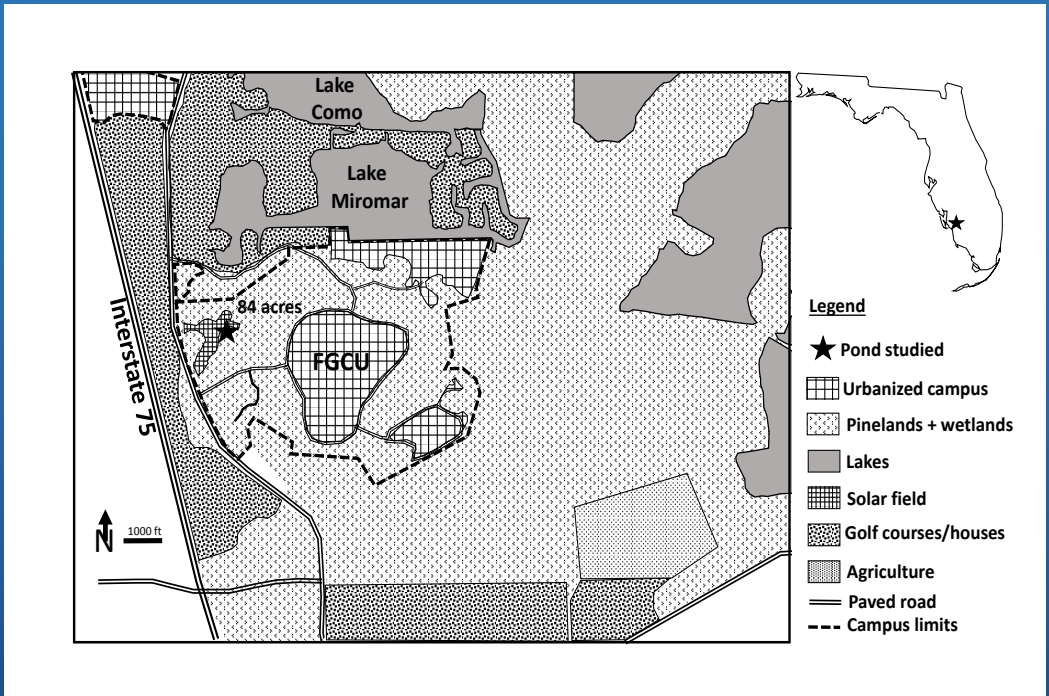

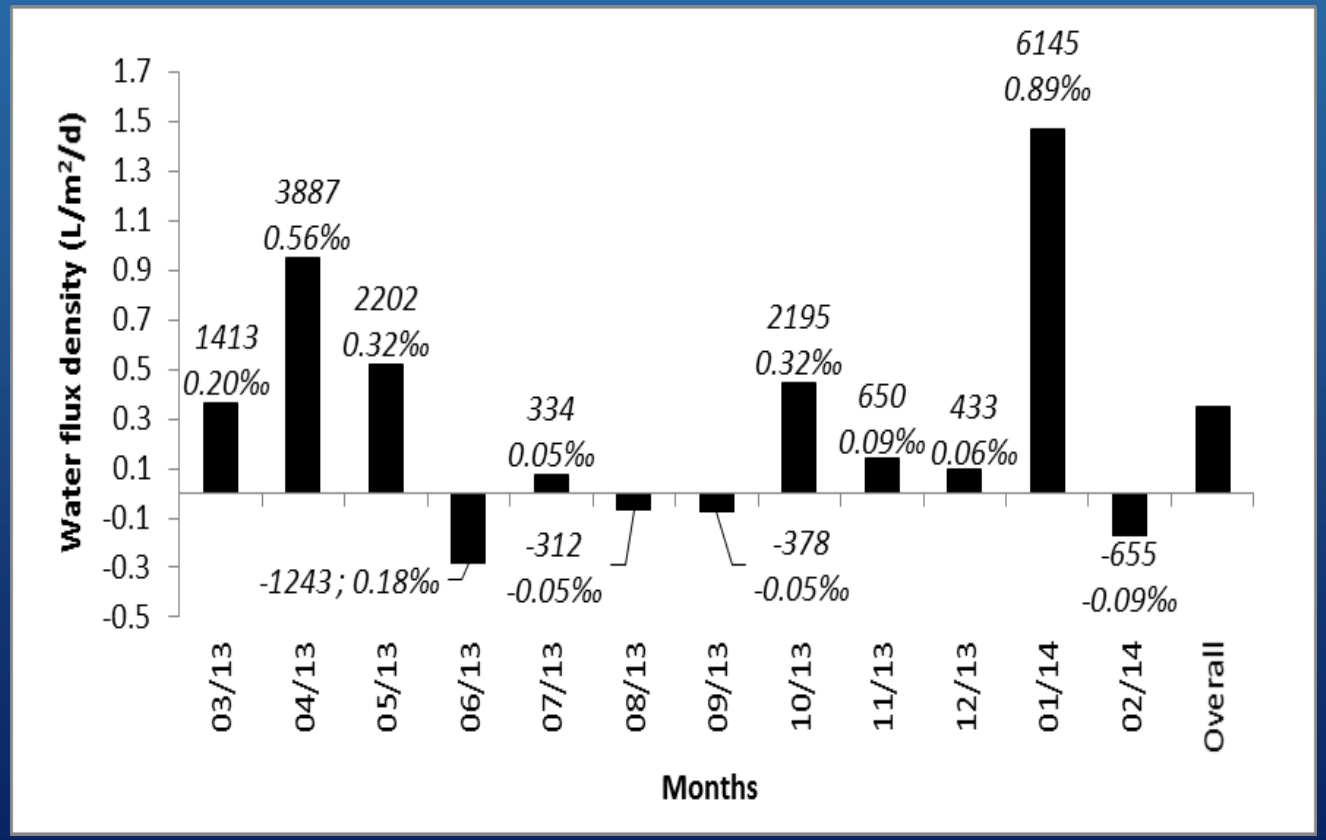

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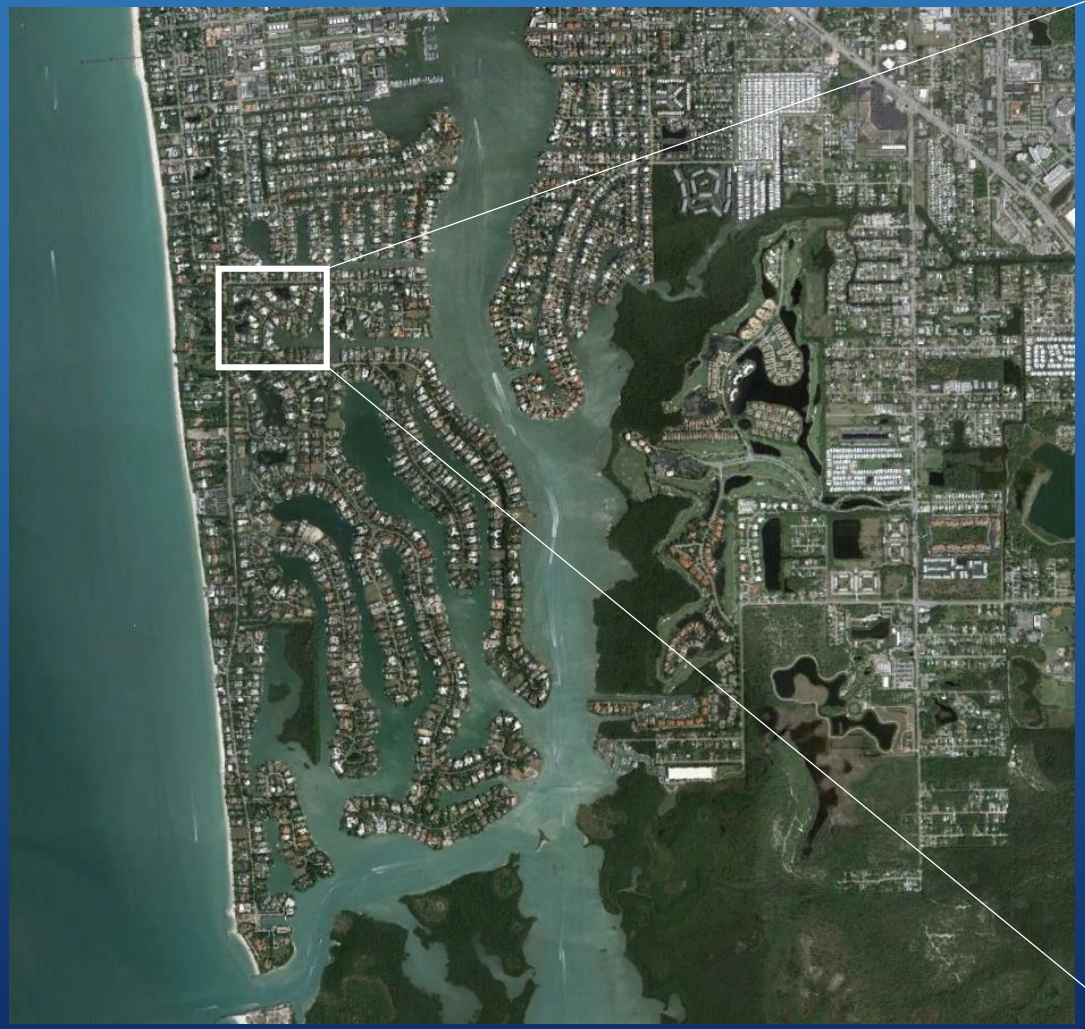

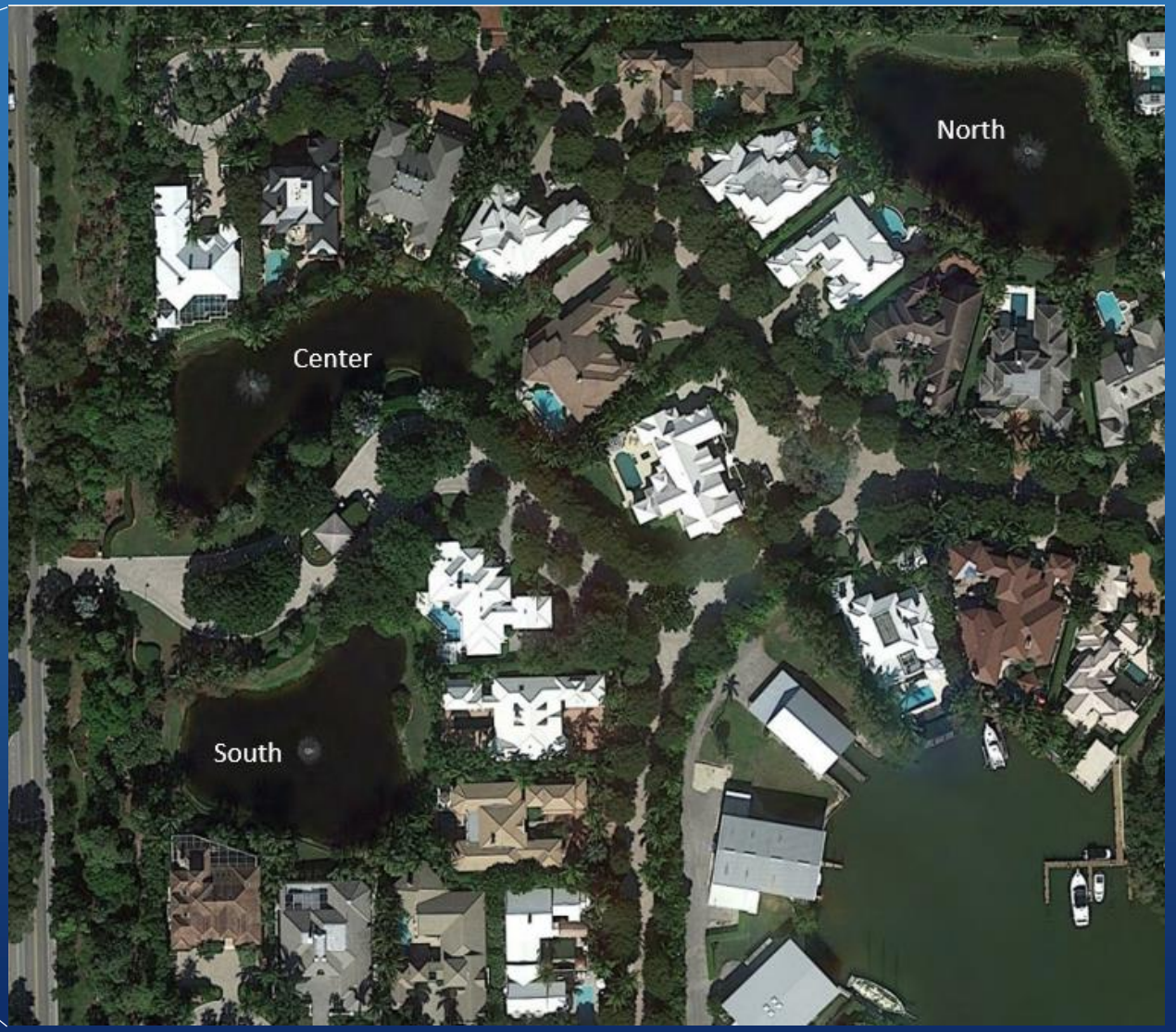

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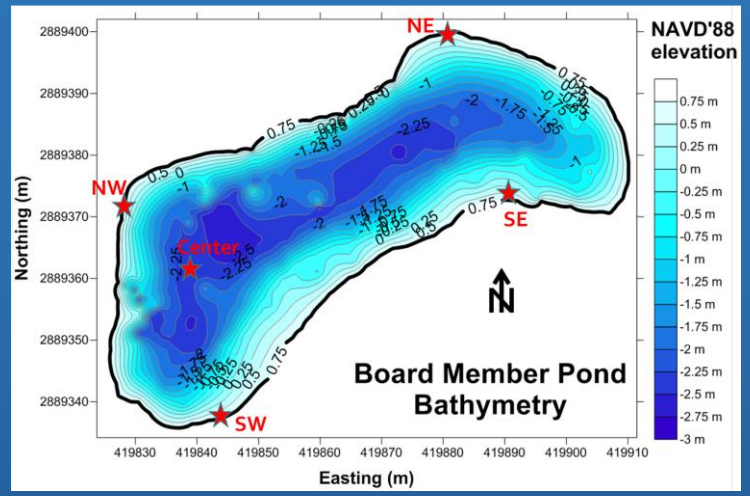

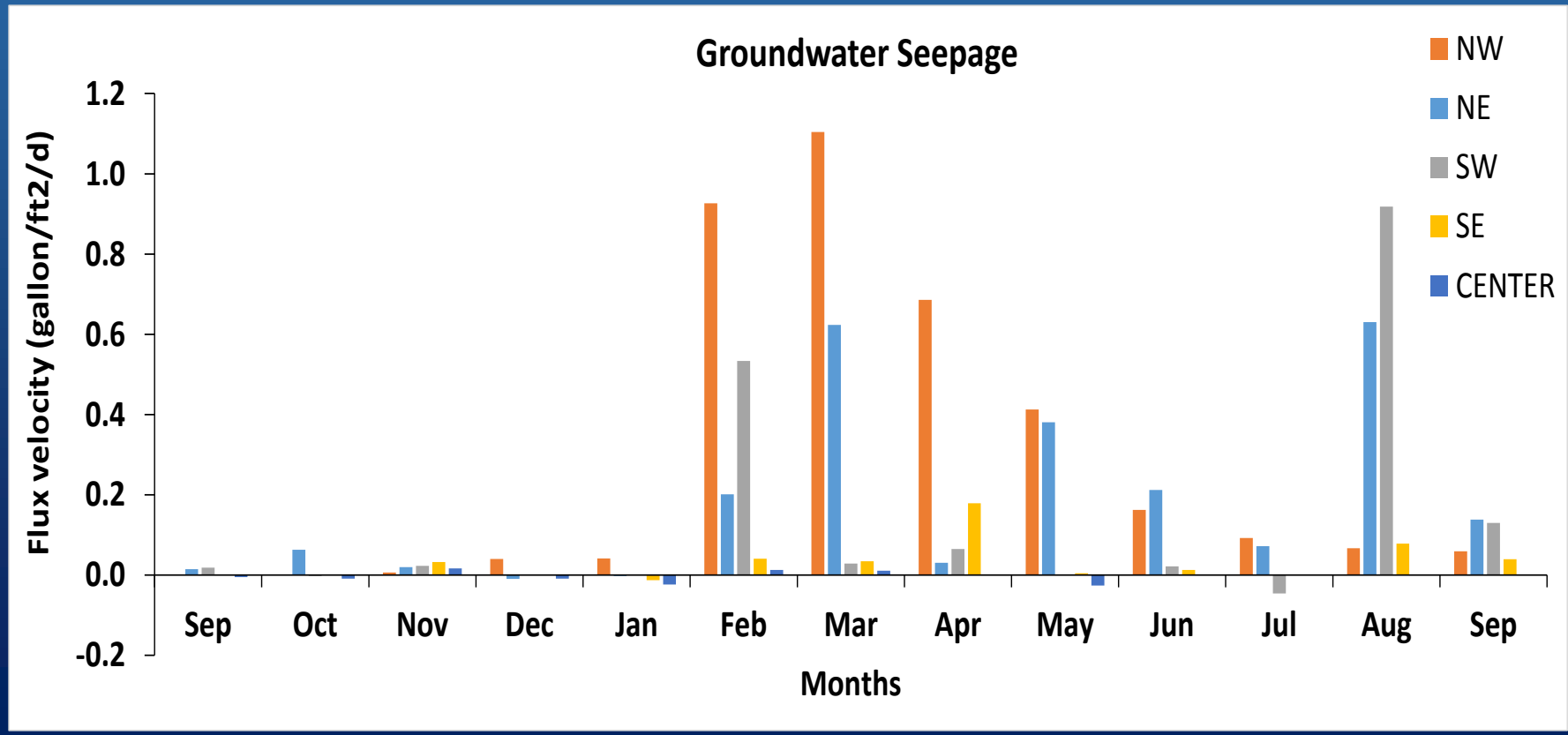

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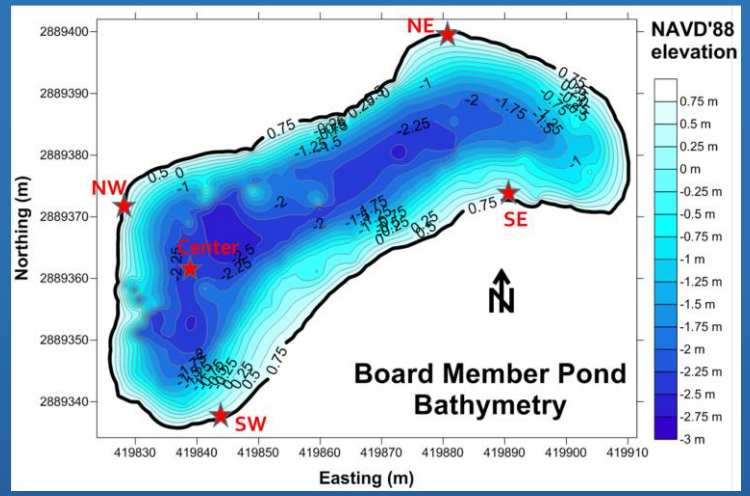

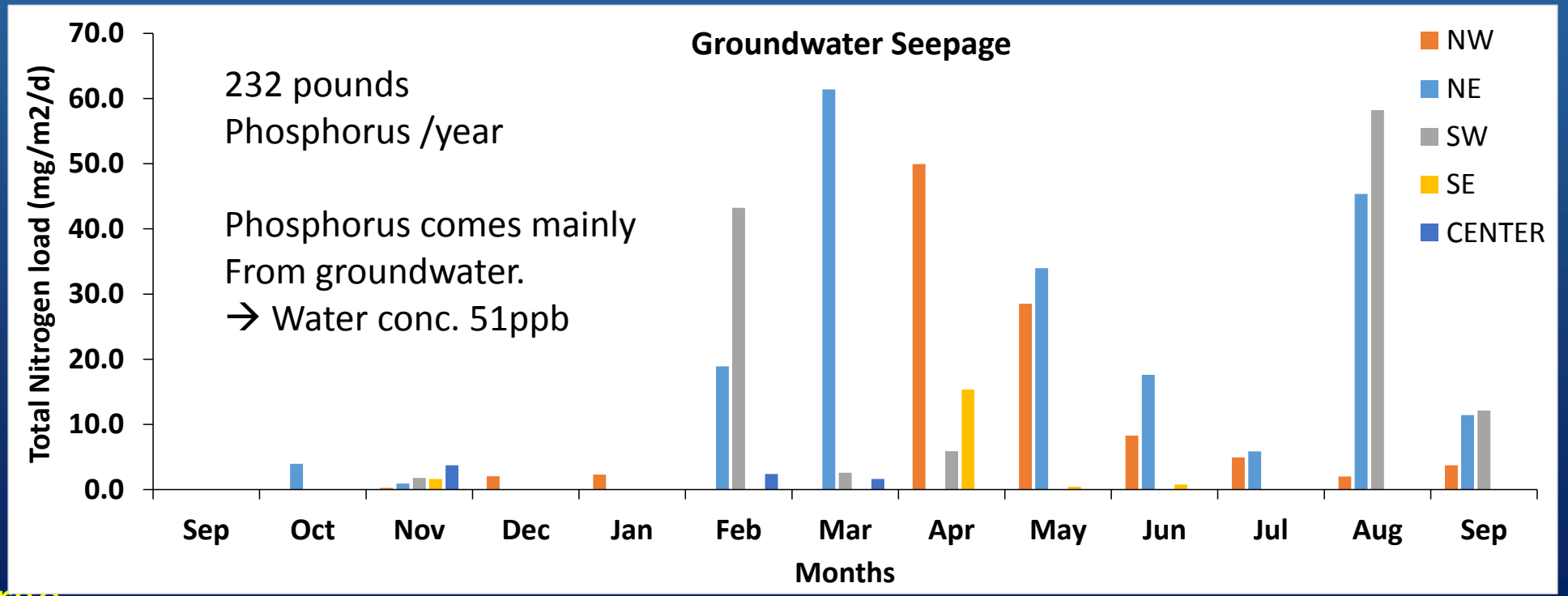

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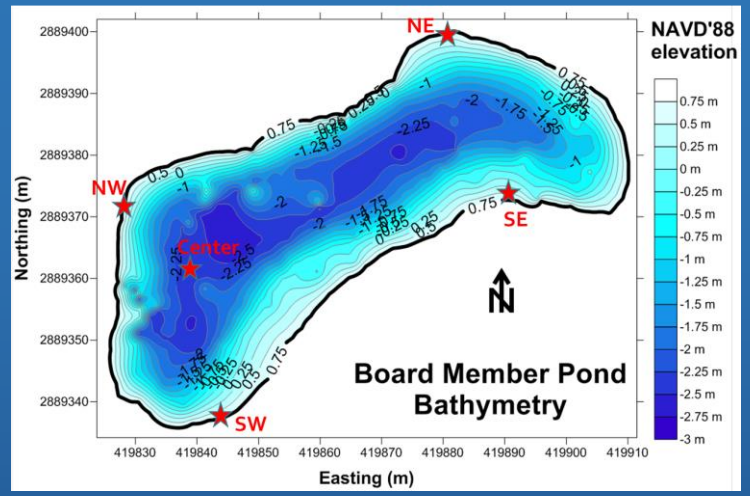

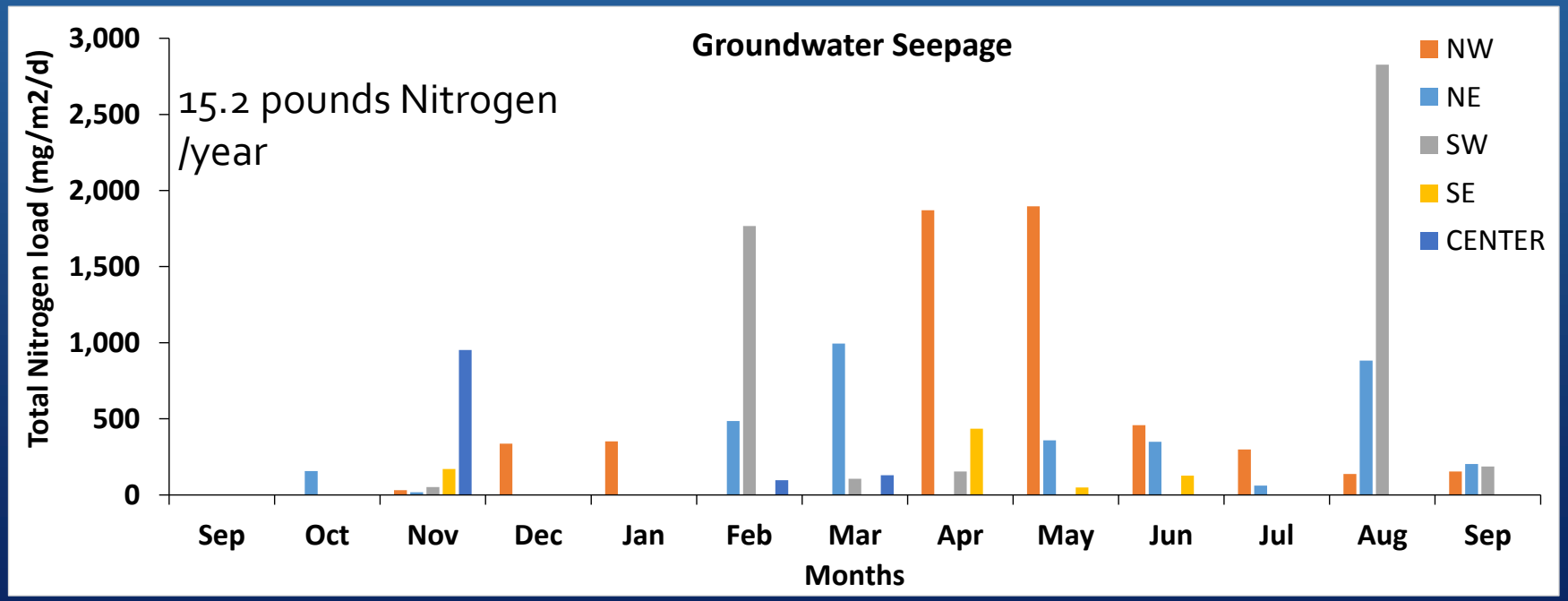

Groundwater discharge

Fixing ponds

- Chemicals
- Dyeing
- Mixing
- Dredging (e.g. Lake Manor)
- Phytoremediation (Artificial Floating Islands)
- H_2O_2
- Bacteria and enzymes

Fixing ponds

- Chemicals
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Fixing ponds

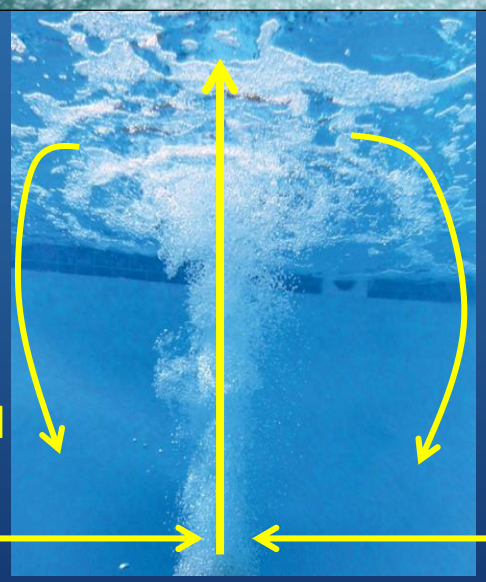
- **aeration**

Water surface

O2 dissolves into water

Temp is reduced

Convection cells are created
so that the water is not stratified



Algae circle
thru the water thus
lowering their
growth

Nutrients are released

aerator

Aerobic respiration of the muck
$C(H_2O) + O_{2aq} \rightarrow CO_2 + H_2O$

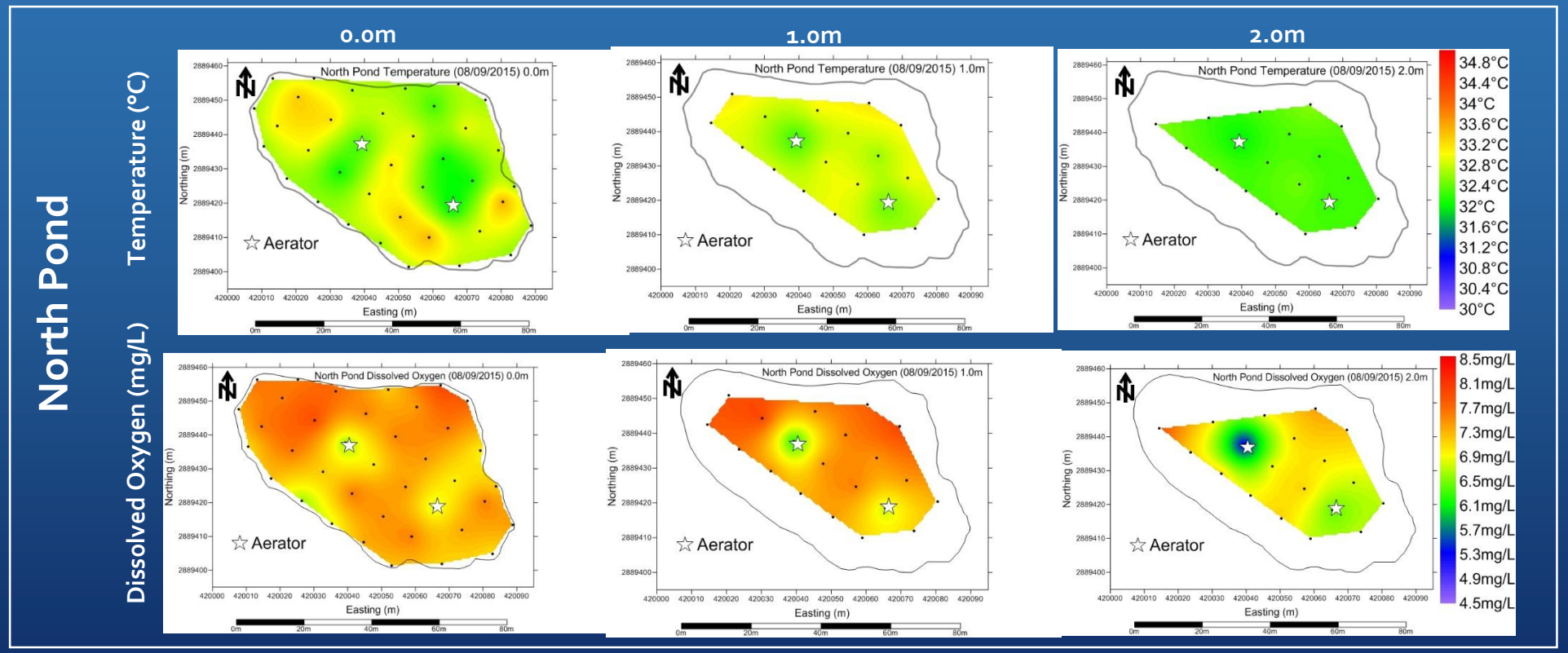
P is locked into the sediment since DO is present

$FePO_4$ **sediment**

Limitation of anaerobic bacteria mediated reactions in the sediment (redox is increased)

Fixing ponds

Aerator efficiency: seems limited



Fixing ponds

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Fixing ponds

Lake Manor (pre dredging, 2013)

Fixing ponds

Lake Manor (pre dredging, 2013)

Fixing ponds

Lake Manor (post dredging, 2014)

The 4-acre lake was just under $1,000,000.

Fixing ponds

- Chemicals
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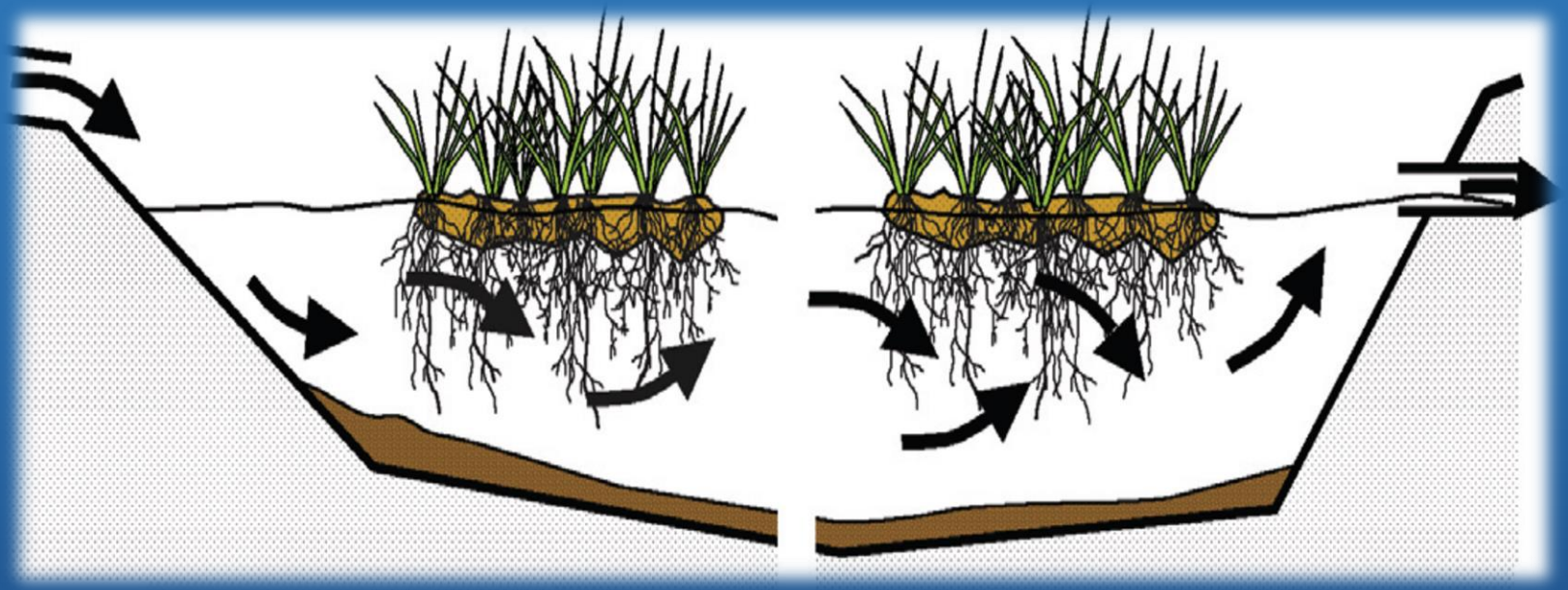
Fixing ponds



Found:

- Oxygenate the water with the plants roots
- Harbor beneficial bacteria
- Did not harbor zooplankton (but forage fishes)
- Roots had allelochemicals which controlled algae

Dettmar, 2015. MS thesis.

Fixing ponds

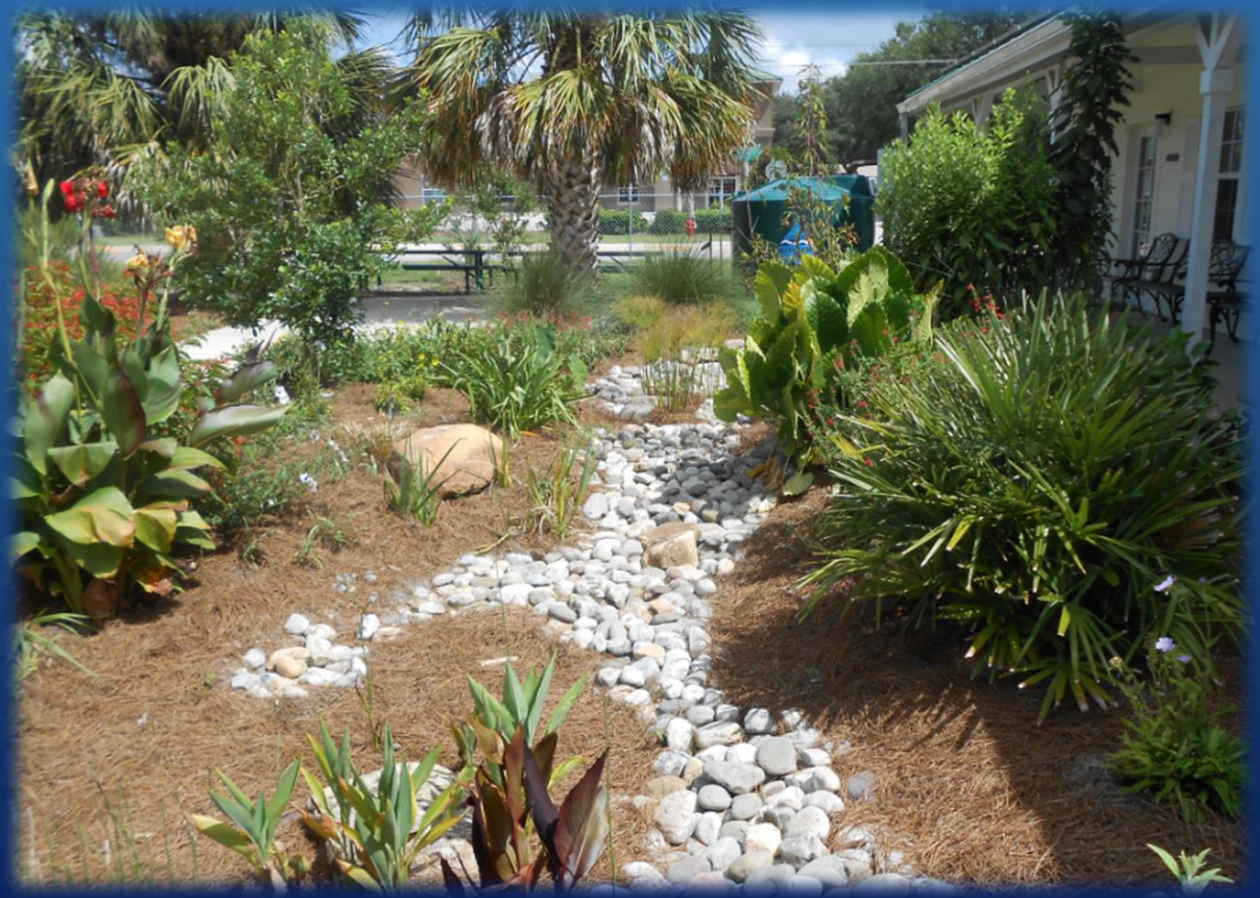
Florida-Friendly Landscaping™ PROGRAM

FRIENDLY LANDSCAPING (BILL 2080)

Fixing ponds

Florida-Friendly Landscaping™ PROGRAM

FRIENDLY LANDSCAPING (BILL 2080)



Fixing ponds

Florida-Friendly Landscaping™ PROGRAM

FRIENDLY LANDSCAPING (BILL 2080)

Fixing ponds

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Using ponds as a tool to teach about water quality: Environmental Education

Community in transition grant (FGCU) → Florida Department of Environmental Protection (Nonpoint Source Funds) NPS March 19 grant (319h grant). Sept. 2020- Sept. 2024. Pending EPA approval. Molly & Thomas, 2019.

Project FLOW: Future Leaders of Water Quality; Enhancing Local Water Quality Through Environmental Stewardship

"These are going to be the citizens that grow up in Southwest Florida and maybe will live here in Southwest Florida and will be making decisions about policies that are going to impact us in the future," said Molly Nation, a professor of environmental education at FGCU.

Using ponds as a tool to teach about water quality: Environmental Education

- All school in Lee County have a stormwater pond
- Pond as hand on material to learn about:
  - Curriculum
  - Water quality
  - Watershed
  - Nutrient limitation/ eutrophication
  - Living shoreline benefits
  - Phytoremediation
  - And more…

"These are going to be the citizens that grow up in Southwest Florida and maybe will live here in Southwest Florida and will be making decisions about policies that are going to impact us in the future," said Molly Nation, a professor of environmental education at FGCU.

Acknowledgements

Pelican Preserve

Bay Creek Community Development District
Bayside Community Development District

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Carlton Lakes

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"Everytime A Winner"

Florida Gulf Coast University

LongshoreLake

BURNT STORE LAKES