The 2014

Science Poster Session

South Florida Water Management District

B-1 Lobby

August 7 to 14, 2014

POSTER NUMBER	CATEGORY	TEXT
1	Banner	Blowing the Unpredictability of Algal Blooms Out of the Water
	Title	**Investigating the Use of Satellite Imagery to Predict Algal Blooms on Lake Okeechobee**
	Bottom Line	District staff are helping to validate satellite imagery of bloom conditions via a radiometer and correlating ambient water quality data.
	Presenter(s)	*Tricia Burke and Shawn Desantis (Water Quality Bureau)*
	Summary	SFWMD has partnered with NOAA and FDOH to help enhance the use of satellite imagery for monitoring and forecasting algal blooms on Lake Okeechobee.
2	Banner	Rolling in the Deep: How Water Levels Affect Cattail in the STAs
	Title	**Evaluation of Inundation Depth and Duration Threshold for Cattail Sustainability in STAs**
	Bottom Line	Determine optimal water depth and duration for cattail sustainability in the STAs
	Presenter(s)	*Hongjun Chen (Applied Sciences Bureau)*
	Summary	An optimal depth and duration of inundation is important for healthy cattail and phosphorus removal in STAs. Inundation depth and duration threshold for cattail sustainability will be determined.
3	Banner	Where's The Phosphorus?
	Title	**Mapping Lake Okeechobee's Sediment Quality Over Time (1988-2006)**
	Bottom Line	Mapped nutrient pools tell us where we can focus our water quality improvements
	Presenter(s)	*Yaoyang Yan and R. Thomas James (Applied Sciences Bureau)*
	Summary	Using Geographically Weighted Regressions gives most accurate total phosphorus maps of Lake Okeechobee sediments.
4	Banner	Flows Inch Up, Down by the Bay
	Title	**Northeast Florida Bay Minimum Flows and Levels Update, 2013 Using the Regional Simulation Model**
	Bottom Line	Slight net increase in flows to northeast Florida Bay with implementation of recent projects.
	Presenter(s)	*Fahmida Khatun (Hydrology & Hydraulics Bureau)*
	Summary	Flows to Taylor Slough are predicted to increase by 13.6% from diversion of flows from the C-111 canal and L-31N canal.

POSTER NUMBER	CATEGORY	TEXT
5	Banner	Mission Possible: Science to Direct Optimization of STAs
	Title	**Restoration Strategies Science Plan for the Everglades Stormwater Treatment Areas**
	Bottom Line	A Science Plan is being implemented to optimize STA performance
	Presenter(s)	*Larry Schwartz and Kim Odell (Applied Sciences Bureau)*
	Summary	The Restoration Strategies to improve Everglades water quality includes a Science Plan and construction projects (Flow Equalizations Basins and increased STA area) to optimize performance of the STAs to meet water quality requirement limits.
6	Banner	Unlocking the STA Phosphorus Removal Puzzle
	Title	**Evaluation of Phosphorus Forms and Transformations Within the Stormwater Treatment Areas (STAs)**
	Bottom Line	"Keying-in" to the biogeochemical mechanisms and factors to better understand phosphorus removal in the STAs
	Presenter(s)	*K. Pietro (Applied Sciences Bureau)*
	Summary	This multi-faceted Restoration Strategies study focuses on better understanding the biogeochemical mechanisms and factors influencing phosphorus forms, transformations and reduction in the Stormwater Treatment Areas.
7	Banner	Dr. Strangebug: Integrating Biological Control with Invasive Plant Management
	Title	**Biological Control Agents Enhance Invasive Plant Management in South Florida**
	Bottom Line	Biological control agents are reducing the invasiveness of some exotic plants in Florida. While still needed, herbicide use will decrease as biological control improves.
	Presenter(s)	*LeRoy Rodgers (Land Resources Bureau)*
	Summary	Management of Melaleuca and other invasive plants is being made easier with the help of biological controls in South Florida. The District, USDA, and other agencies are integrating natural enemies of invasive plants with other control tools such as herbicide.

POSTER NUMBER	CATEGORY	TEXT
8	Banner	The Rise and Fall of Invasive Plants in the Everglades
	Title	**Changes in Distribution and Abundance of Priority Invasive Plant Species in the Everglades: 2003—2013**
	Bottom Line	Long-term monitoring suggests progress in controlling some priority invasive plants, but not all.
	Presenter(s)	*LeRoy Rodgers (Land Resources Bureau SFWMD) and Tony Pernas (USNPS)*
	Summary	A regional integrated weed management program has resulted in a decline of invasive exotics, such as Melaleuca and Australian pine, in the Everglades. Other invaders, such as Old World climbing fern, are on the rise.
9	Banner	Dry Times are Good Times: Taking Advantage of Dry Season Water Levels to Revitalize STA Plants
	Title	**Vegetation Enhancements Ensure Water Quality Performance in the Stormwater Treatment Areas**
	Bottom Line	Maintenance of the vegetation-based treatment system is a requirement for sustained phosphorus removal
	Presenter(s)	*Lou Toth and Eric Crawford (Land Resources Bureau)*
	Summary	Sustained water quality performance in the Stormwater Treatment Areas is maintained by opportunistic vegetation enhancements when inflows are reduced during winter and spring. Over 460 acres of emergent vegetation (giant bulrush and alligator flag) were planted, and 1886 cubic yards of submerged aquatic vegetation (southern naiad) were inoculated in the STAs during the 2013-14 dry season.
10	Banner	Algae Makes a Difference: PSTA is a Key Ingredient in Improving Water Quality
	Title	**Investigation Of STA 3/4 Periphyton-Based Stormwater Treatment Area (PSTA) Performance, Design, and Operational Factors**
	Bottom Line	Evaluating the mechanisms and factors that enable the Periphyton-based Stormwater Treatment Area (PSTA) to achieve ultra-low total phosphorus concentration
	Presenter(s)	*Manuel Felipe Zamorano (Applied Sciences Bureau)*
	Summary	The 100-acre STA-3/4 Periphyton-based STA cell has consistently achieved ultra-low outflow total phosphorus concentrations.

POSTER NUMBER	CATEGORY	TEXT
11	Banner	Is “Taking a Load Off” Always Effective?
	Title	**Seasonal Dissolved Inorganic Nitrogen and Phosphorus Budgets for Two Sub-tropical Estuaries in South Florida**
	Bottom Line	Excess phosphorus loading to the St. Lucie Estuary results in algal blooms. Metabolism of Caloosahatchee Estuary can respond to nitrogen loading.
	Presenter(s)	*Christopher Buzzelli (Applied Sciences Bureau)*
	Summary	This study assessed responses of the estuaries to nutrient loads. While excess phosphorus stimulated algal blooms in the St. Lucie Estuary, the Caloosahatchee Estuary had slight response to nitrogen.
12	Banner	For “Peat’s” Sake – In the Everglades, the Organic Matter Matters
	Title	**Estimating the Peat of the Predrainage and Current Everglades**
	Bottom Line	Preserving the peat is critical to the ecological “health” of the Everglades
	Presenter(s)	*Susan Hohner, Thomas Dreschel and Martha Nungesser (Applied Sciences Bureau)*
	Summary	The Florida Everglades is a patterned peatland formed over millennia. Since the late 1800s, three-quarters of the historical Everglades peat has been lost to development and by drainage. Peat is an organically rich soil providing habitat for wildlife in the remaining ridge and slough landscape.
13	Banner	The Envelope, Please! (Seagrasses and Salinity in the St. Lucie Estuary and Indian River Lagoon)
	Title	**Evaluating Salinity Targets for Protecting Seagrass in the St. Lucie Estuary and Adjacent Indian River Lagoon**
	Bottom Line	Maintaining salinity within the envelope would prevent steep salinity declines and result in salinities favorable for protection of seagrasses.
	Presenter(s)	*Becky Robbins (Applied Sciences Bureau)*
	Summary	Long-term salinity and seagrasses monitoring confirmed the validity of the salinity envelope for protection of seagrasses in the St. Lucie Estuary and Indian River Lagoon
14	Banner	Going With the Flow: Restoring Freshwater Flows to Florida Bay
	Title	**Spatial Mapping of Florida Bay to Reduce Management Complexity**
	Bottom Line	Ongoing surveys are tracking the restoration of different areas of Florida Bay
	Presenter(s)	*Joseph Stachelek, Christopher J. Madden and Amanda McDonald (Applied Sciences Bureau)*
	Summary	Ongoing surveys are tracking the restoration of different areas of Florida Bay. Spatial mapping is used to reduce management complexity.

POSTER NUMBER	CATEGORY	TEXT
15	Banner	Lake Sediments: To Dredge or Not to Dredge?
	Title	**A Model and Water Quality Management: the Study of Lake Okeechobee**
	Bottom Line	Reduce external loads first, then manage sediments if needed
	Presenter(s)	*R. Tom James (Applied Sciences Bureau)*
	Summary	Update of water quality model is a modest improvement. Model results: Sediments can be managed, but phosphorus loads must be reduced first.
16	Banner	How a Little Restoration Goes a Long Way
	Title	**Biscayne Bay Coastal Wetlands Restoration Benefit**
	Bottom Line	The Biscayne Bay Coastal Wetland Project has shown early success in ecosystem restoration
	Presenter(s)	*Bahram Charkhian (Applied Sciences Bureau)*
	Summary	Enhanced freshwater delivery and hydrologic connectivity through implementation of the Biscayne Bay Coastal Wetland Project has resulted in significant improvement in the integrity and health of the coastal wetland ecosystem.
17	Banner	How Land Use Change and Land Management Affect Water Quality and Quantity
	Title	**Watershed Assessment Model (WAM) Applications in the Lake Okeechobee Watershed**
	Bottom Line	Reduce nutrient import to all land uses
	Presenter(s)	*Joyce Zhang and Hongying Zhao (Applied Sciences Bureau)*
	Summary	The model simulates the primary physical processes important for watershed hydrologic and pollutant transport. It is used to assess nutrient reduction strategies including Best Management Practices and other measures.
18	Banner	We Know it Will Flow, But When and Where Will it Go?
	Title	**Estimating Vegetation Resistance in Managed Wetlands to Improve Function and Sustainability**
	Bottom Line	Improving estimates of flow in STAs can lead to better operations and phosphorous removal
	Presenter(s)	*Wasantha Lal and Zaki Moustafa (Hydrology & Hydraulics Bureau)*
	Summary	Vegetation affects flow in wetlands. Understanding flow helps to operate STA systems for improved function and sustainability.
19	Banner	A Bird's Eye View for Everglades Restoration
	Title	**Applications of Very High Resolution Imagery in the Natural Sciences**
	Bottom Line	Adapting remote sensing technology to support District missions
	Presenter(s)	*Christa Zweig (Applied Sciences Bureau)*
	Summary	We are using aerial remote sensing technology to monitor and manage District resources. Photos become spatial data for Everglades scientists

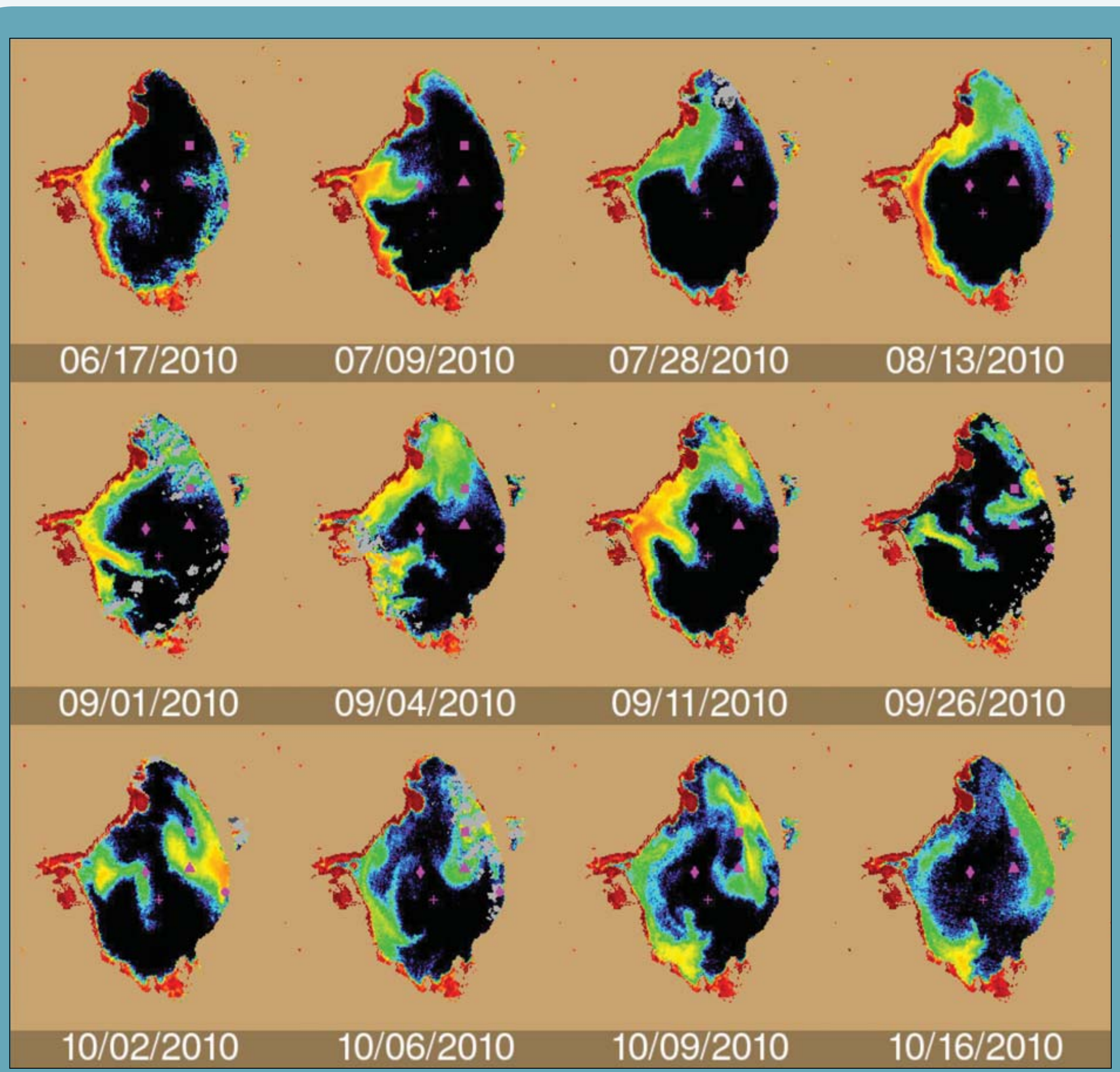
POSTER NUMBER	CATEGORY	TEXT
20	Banner	Helping Seagrasses “See the Light”
	Title	**Variations of Light Attenuation and Relative Contributions of Water Quality Constituents in the Caloosahatchee River Estuary**
	Bottom Line	While nutrient load reduction should improve water clarity, the degree or extent of improvement will be limited by the significant contributions of color and turbidity to light extinction.
	Presenter(s)	*Zhiqiang Chen (Applied Sciences Bureau)*
	Summary	Light attenuation is a primary factor controlling the growth of seagrasses. On average, both color and turbidity contributed about 40% of light attenuation, while chlorophyll *a* contributed about 10%.
21	Banner	There’s No Business Like Flow Business
	Title	**Evaluating the Benefits of Sheetflow with the Decomp Physical Model**
	Bottom Line	Results from experimental flow releases in WCA-3B indicate restoring sheetflow helps rebuild Everglades microtopography
	Presenter(s)	*Colin J. Saunders and Eric Cline (Applied Sciences Bureau)*
	Summary	The Everglades was a corrugated landscape built by natural sheetflow. Findings from the Decomp Physical Model show restored sheetflow helps rebuild microtopography.
22	Banner	Wading Birds: Are They Finicky About Where They Feed?
	Title	**Wading Bird Foraging in Lake Okeechobee**
	Bottom Line	A better understanding of how wading birds respond to changes in a managed system is necessary.
	Presenter(s)	*Michael Baranski (Applied Sciences Bureau)*
	Summary	Understanding how changes in hydrological and environmental variables affect foraging is imperative for successful management of wading bird populations. The goal of this project is to produce a model that links foraging outcomes to these variables to aid in management and restoration strategies.
23	Banner	How Modeling Saved the Dam on the Loxahatchee River
	Title	**Modeling Evaluation of Dam Removal in the Context of River Ecosystem Restoration**
	Bottom Line	The Masten Dam should be repaired rather than removed to help achieve the goal of Loxahatchee River restoration.
	Presenter(s)	*Yongshan Wan (Applied Sciences Bureau)*
	Summary	Masten Dam removal would lower water levels and aggravate saltwater intrusion of the Loxahatchee River. It should be repaired rather than removed.

Investigating the Use of Satellite Imagery to Predict Algal Blooms on Lake Okeechobee

A NOAA, SFWMD and FDOH Partnership

Shawn DeSantis[1], Patricia Burke[1], Michelle C. Tomlinson[2] Danielle Dupuy[3], Andy Reich[4]

[1]SOUTH FLORIDA WATER MANAGEMENT DISTRICT, [2]NOAA NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE, [3]CSS-DYNAMIC, [4]FLORIDA DEPARTMENT OF HEALTH



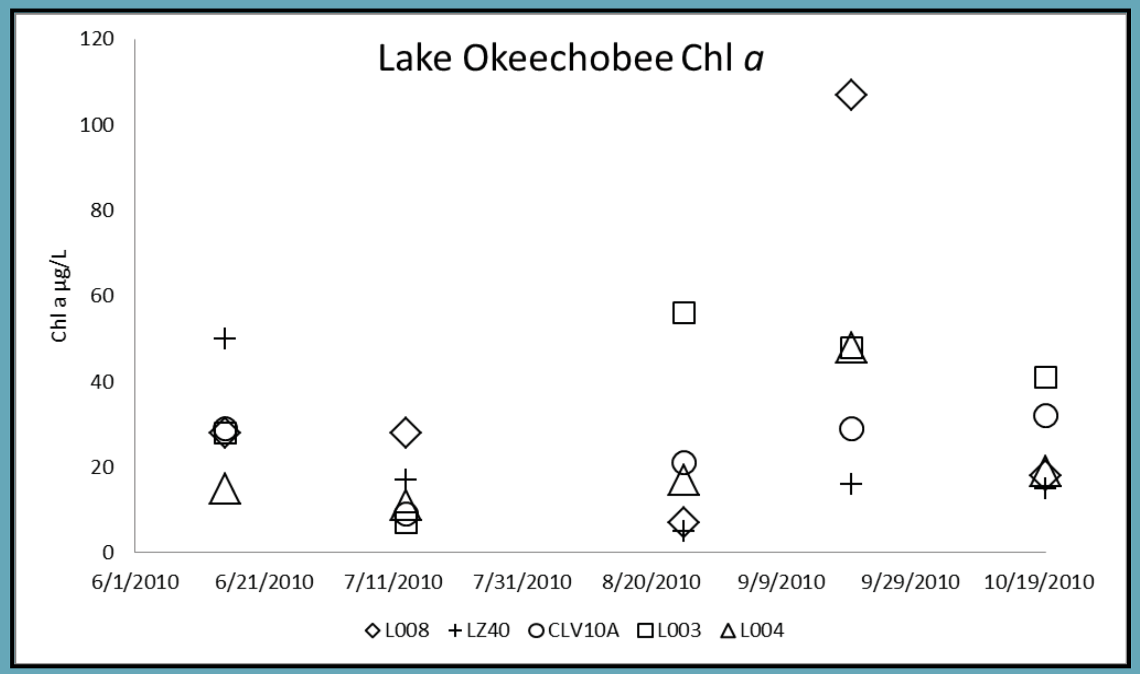
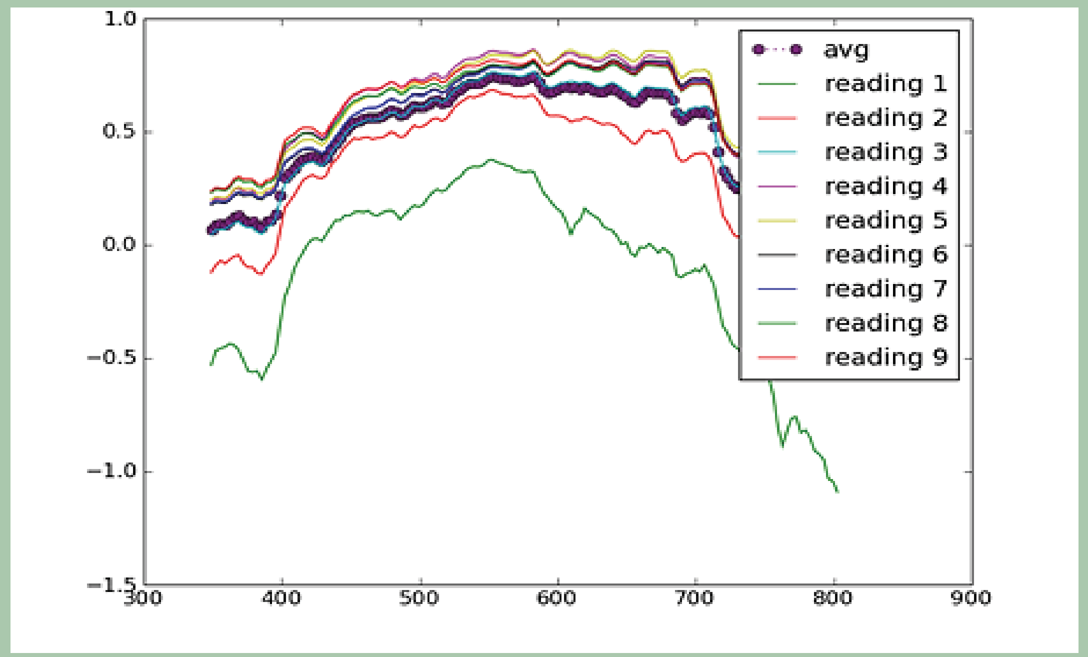


Figure 1. MERIS imagery of the 2010 Lake Okeechobee bloom. Corresponding Field chlorophyll *a* measurements collected by SFWMD.

The satellite images above are generated with a Medium Resolution Imaging Spectrometer (MERIS) Satellite. These remotely-sensed products are validated with *in situ* data. MERIS's temporal resolution has advanced the ability to monitor high biomass blooms and track the development of individual bloom events. These modeling techniques can be incorporated into an operational forecasting system.

The District is currently working with NOAA and FDOH on a partnership to collect instantaneous surface reflectance data. These readings are being taken using a Hand Held Hyperspectral Radiometer on loan to the District from NOAA. The readings are being gathered with concurrent grab collections of Chlorophyll *a* taken during the Lake Okeechobee ambient water quality monitoring trips.

The District's current Lake Okeechobee algal bloom monitoring program is useful for providing general trends on localized bloom conditions, however, the extrapolation of these data are limited spatially. A more frequent, less time consuming determination of algal bloom conditions on Lake Okeechobee would allow for timelier management decisions.



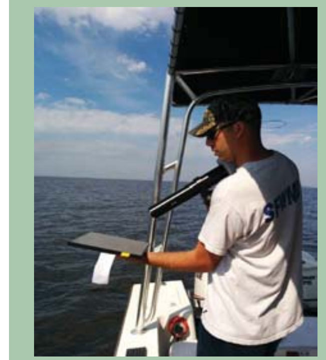


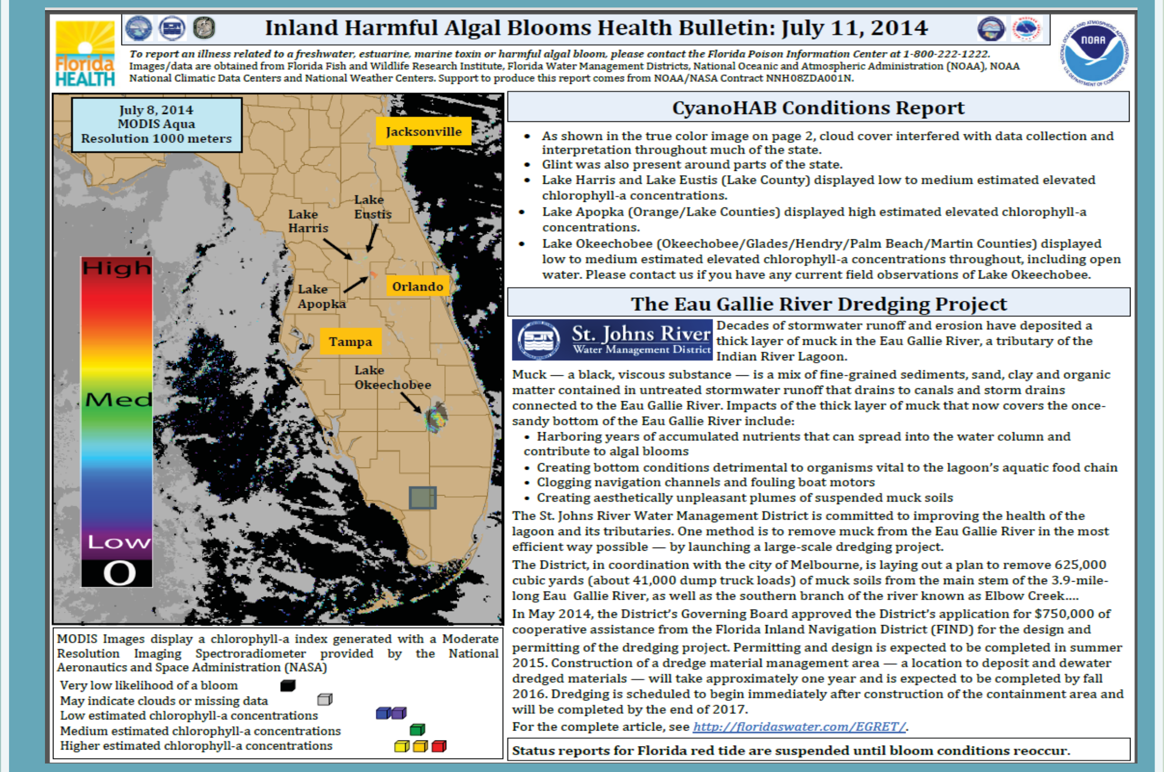
Figure 2. Wavelength data collected from the Hyperspectral Radiometer (The HyperGun) by SFWMD staff.

Field radiometry is being used to develop a correlation between satellite retrievals and in situ Chl *a*. The SFWMD is supplying NOAA staff with processed HyperGun readings and real time water quality data.

LOOKING FORWARD – POTENTIAL FUTURE USES

- Linking to current and future models (e.g. Lake Okeechobee Ecological Model) to allow predictions of bloom movements
- Providing algal bloom data for other major water bodies within the District's purview
- Providing a readily available and affordable option for monitoring and forecasting potentially harmful blooms for public health protection and response (FDOH)

There has been an increasing occurrence of Cyanobacterial blooms in Florida's lakes, rivers, and estuaries. NOAA has verified that in open water, the MERIS satellite imagery is a better indicator of cyanobacteria blooms than chlorophyll *a* concentrations alone. The use of spectral shape algorithms removes the complications associated with atmospheric corrections and sediments. NOAA is applying the same algorithms developed to detect cyanobacteria blooms from the MERIS satellite images of large water bodies and seeing if it holds true in Lake Okeechobee.


Inland Harmful Algal Blooms Health Bulletin: July 11, 2014

CyanoHAB Conditions Report

The Eau Gallie River Dredging Project

Status reports for Florida red tide are suspended until bloom conditions reoccur.

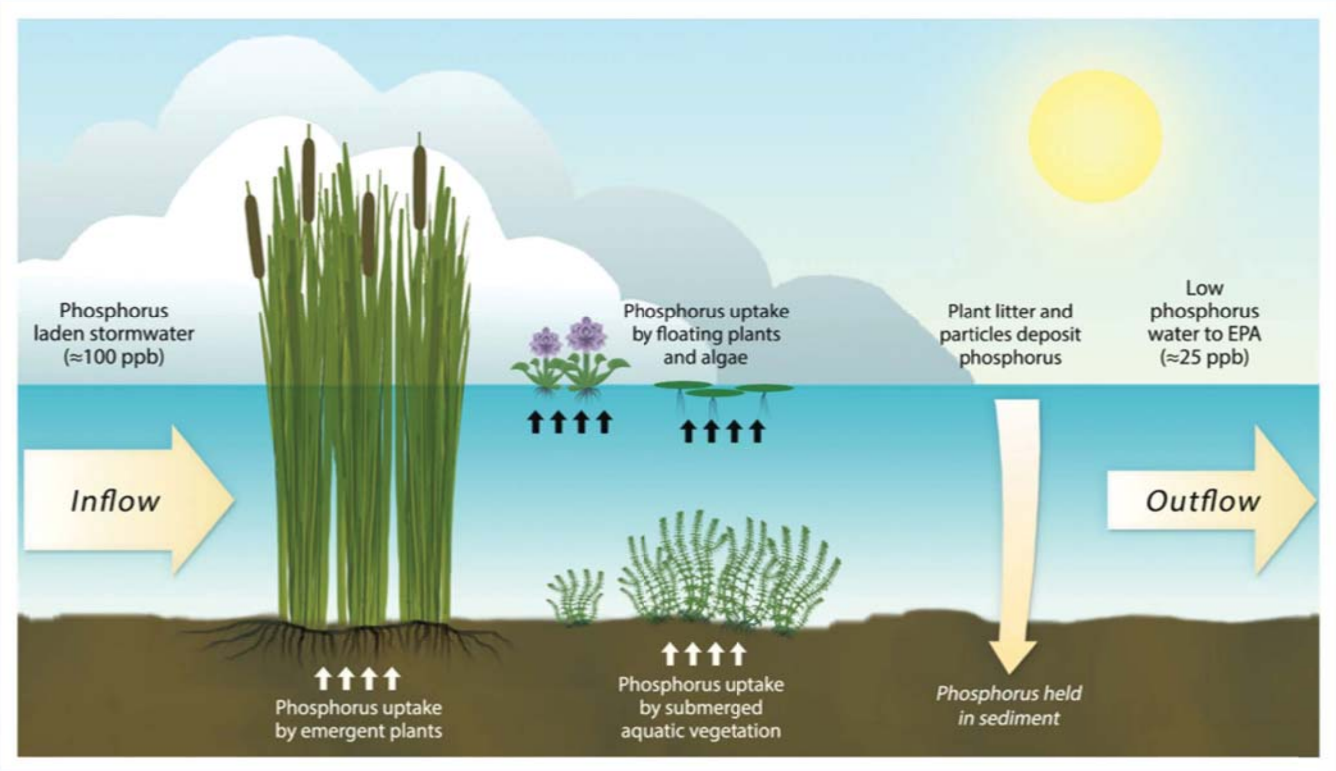
Figure 3. Most recent Algal Bloom Health Bulletin distributed by FDOH reporting bloom conditions in major water bodies in the St. John's River Water Management District and in Lake Okeechobee. Data from Lake Okeechobee has not been validated.

Evaluation of Inundation Depth and Duration Threshold for Cattail Sustainability in STAs

HONGJUN CHEN[1], Scientist 3, **KATHLEEN PIETRO**[1], Sr. Environmental Scientist, **MIKE KIRKLAND**[1], Scientist 2, **LOUIS TOTH**[2], Principal Ecologist

[1]Water Quality Treatment Technologies Section, Applied Sciences Bureau; [2]Vegetation Management Section, Vegetation & Land Management Bureau

Cattail play an important role in the removal of phosphorus in the STAs (Stormwater Treatment Areas). STAs are constructed wetlands that represent one major way to remove nutrients through plant uptake and the accumulation of peat (partially decayed plant material or organic soil).



Cattail grow well in a wide range of hydrologic regimes, but prolonged deep water inundation adversely affect cattail growth and phosphorus removal in the STAs

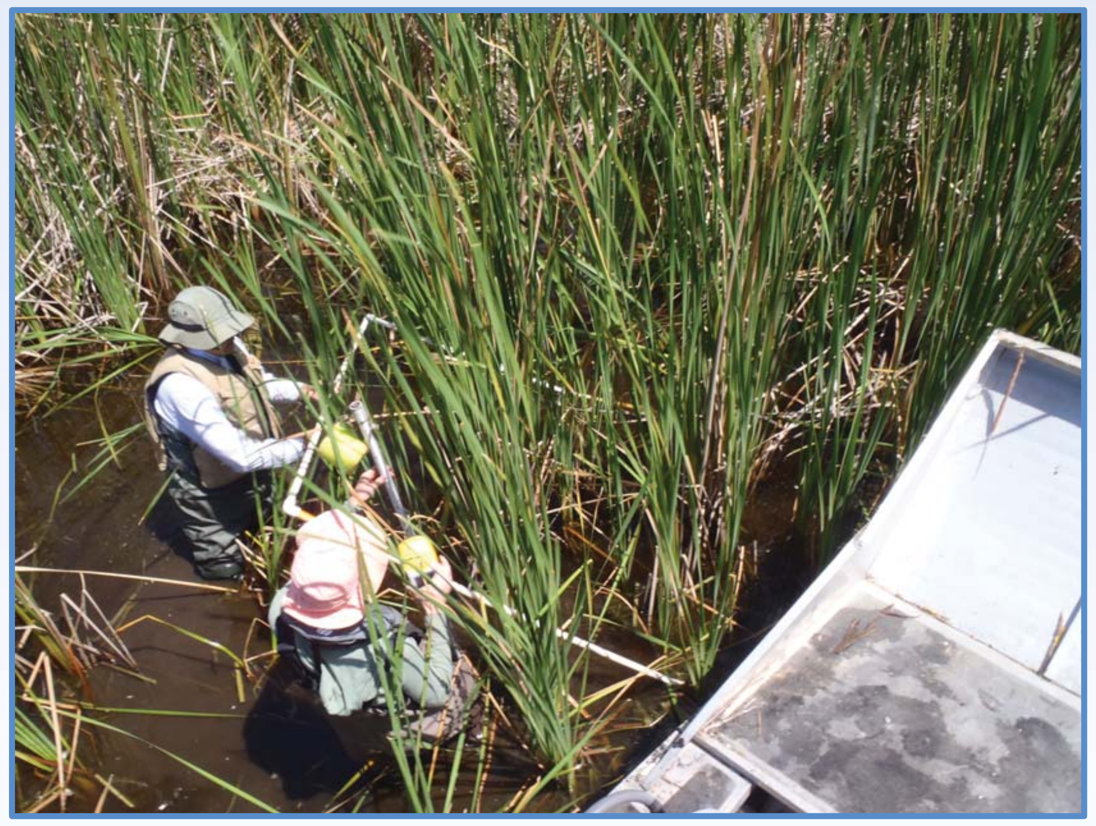


Figure 1. Healthy cattail being measured in STA-3/4

Deep inundation depths can lead to decline in cattail communities

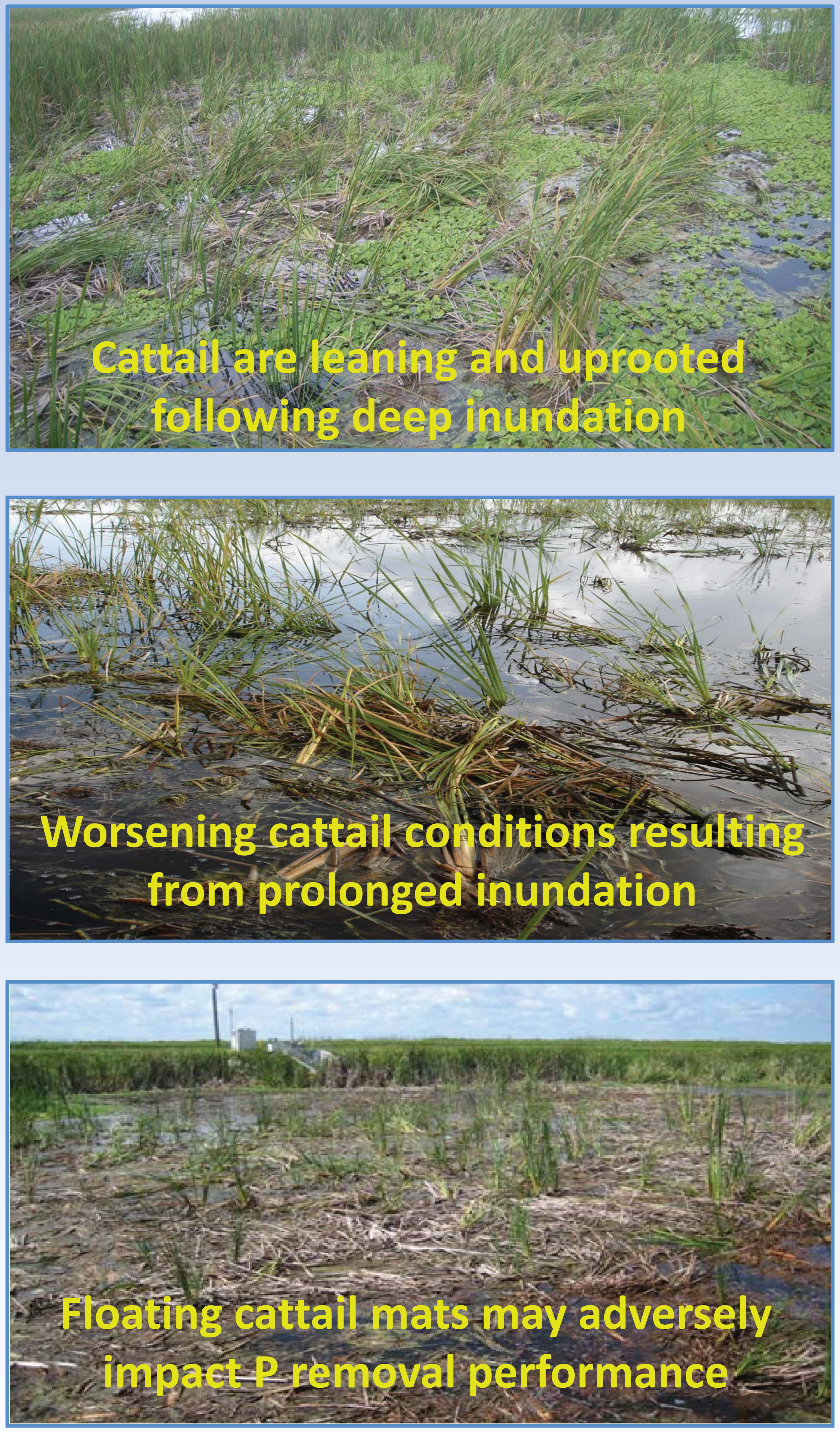


Figure 2. Impacts of deep inundation conditions on cattail communities in the STAs

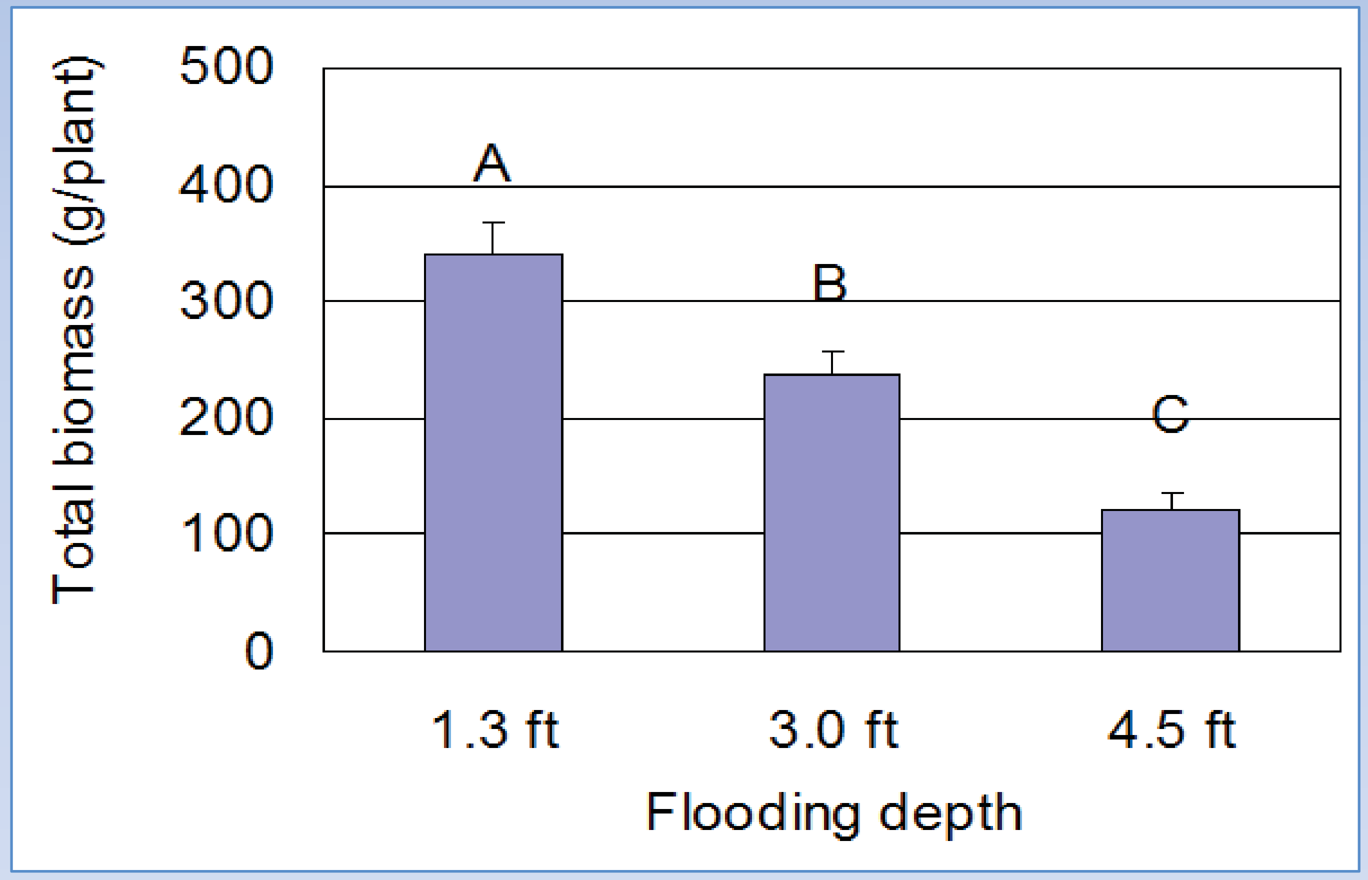


Figure 3. Impacts of inundation conditions on cattail growth showing that cattail biomass significantly decreased with increasing depth of inundation

Research Question:

What is the optimal depth and duration threshold for cattail sustainability in the STAs?

How will We Address this Question?

1) Evaluate historical hydrologic conditions in relation to cattail density and cover in the STAs
2) Observe cattail growth under different hydrologic regimes in STA-1W and STA-3/4
3) Measure cattail growth under different depths and durations of inundation in the STA-1W Test Cells

Prepared for the Water Resources Advisory Commission and SFWMD Governing Board
AUGUST, 2014

Mapping Lake Okeechobee's Sediment Quality Over Time (1988-2006)

Yaoyang Yan, Ph.D., Senior Geographer and R. Thomas James, Ph.D., Lead Scientist
APPLIED SCIENCES BUREAU, WATER RESOURCES DIVISION

OBJECTIVE

Lake Okeechobee is underlain with phosphorus (P) enriched sediments that affect the overlying water quality. The objective of this project is to develop accurate estimates of total P (TP) over space and time using Geographic Information Systems (GIS) techniques and spatial models.

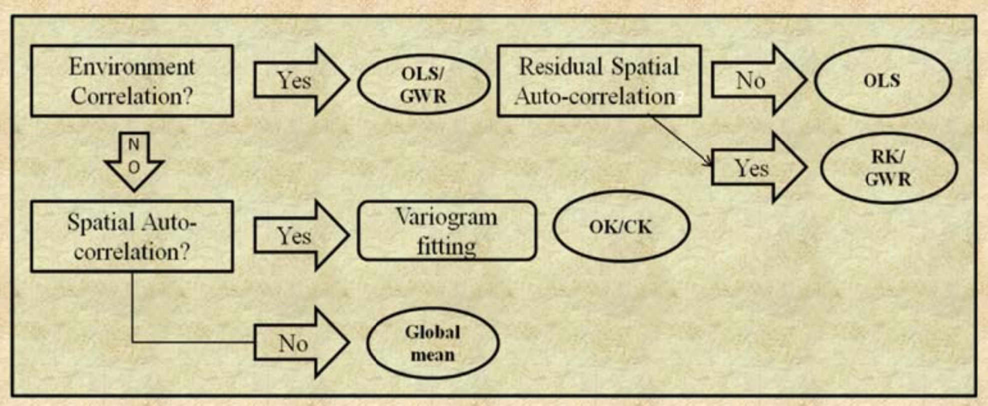
DATA SETS

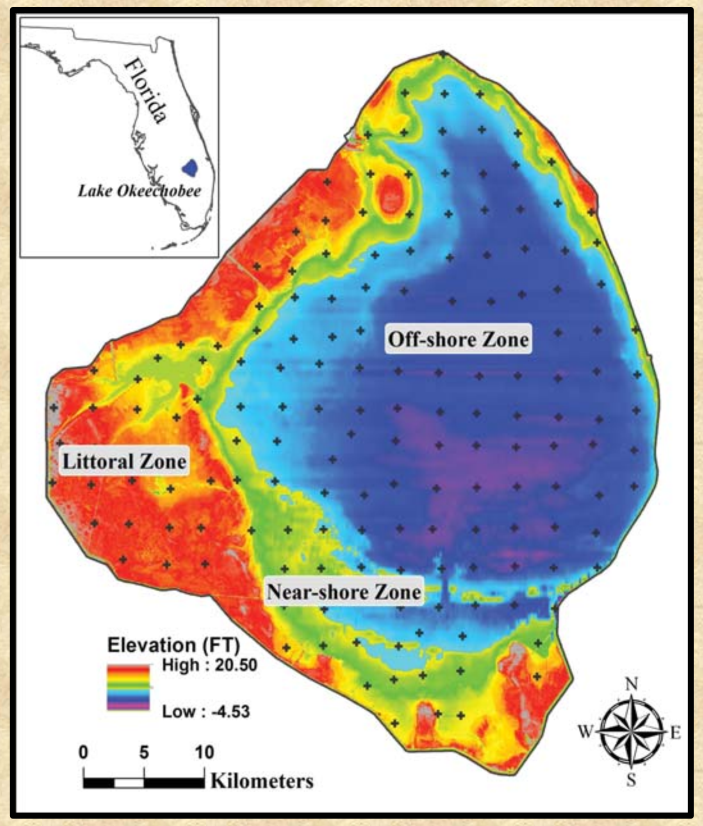
Sediment cores were obtained from Lake Okeechobee in 1988, 1998 (Fisher et al. 2001) and 2006 (Yan and James 2012) at 170 sampling points. These cores were measured for mud thickness, total nitrogen (TN), total P (TP), iron (Fe), calcium (Ca), and total carbon (TC). A digital elevation model of the lake bottom was developed from survey data collected in 2008 and LiDAR (Light Detection and Ranging) data collected from 2007-2009.

METHODS

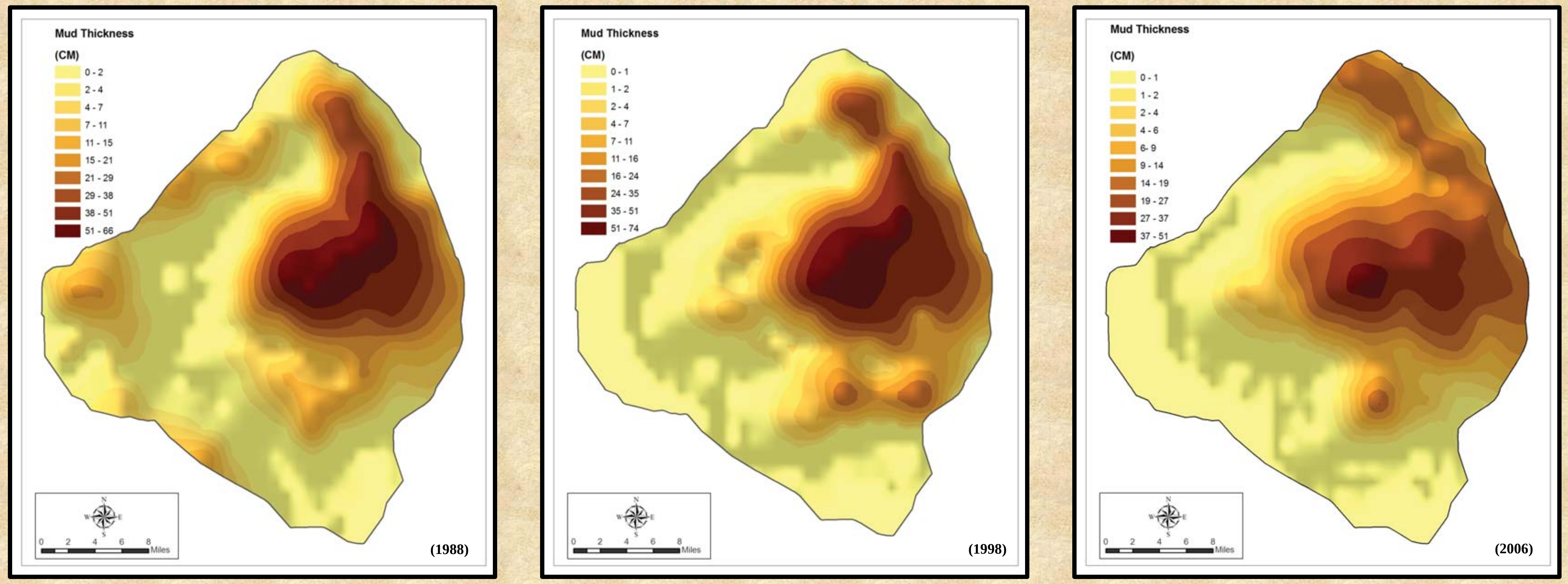
Geographically Weighted Regression (GWR) was found to provide the greatest accuracy compared with other spatial models. Optimal GWR models were applied to the TP mapping and TP weight calculations of the lake sediments and their changes over time (1988-2006).

MODEL SELECTION PROCESSES FOR SPATIAL PREDICTION
(OLS: ordinary least square, OK: ordinary kriging; RK: regression-kriging and GWR: geographically weighted regression)

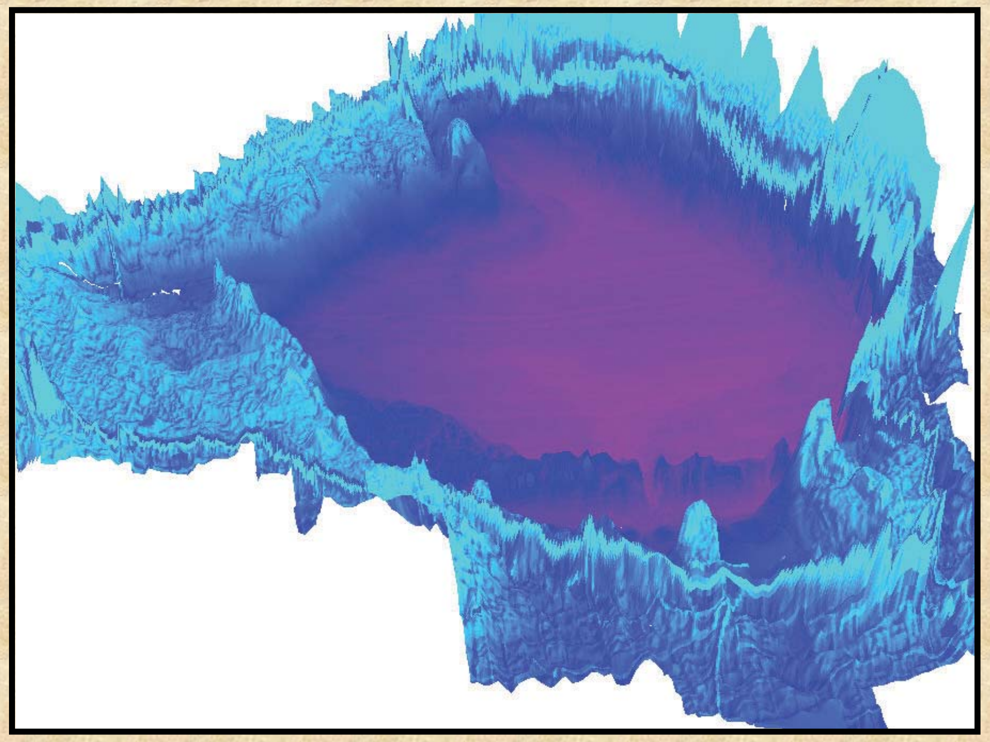




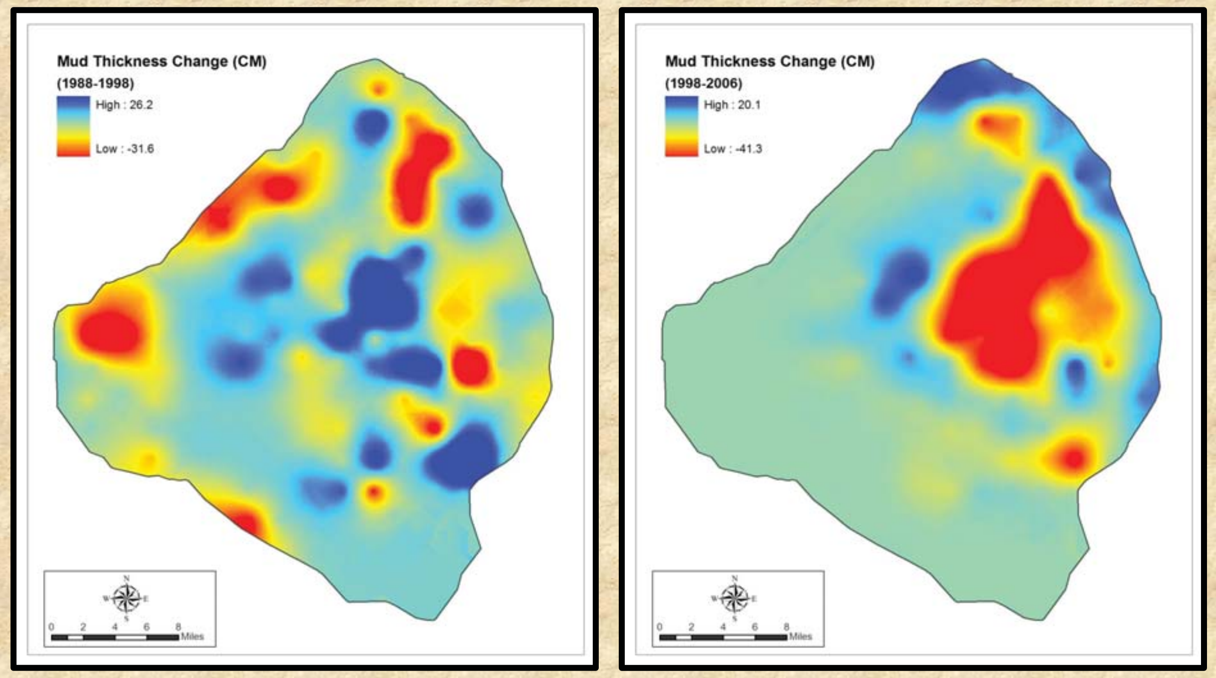
LAKE OKEECHOBEE BATHYMETRY, ZONES AND SAMPLE SITES



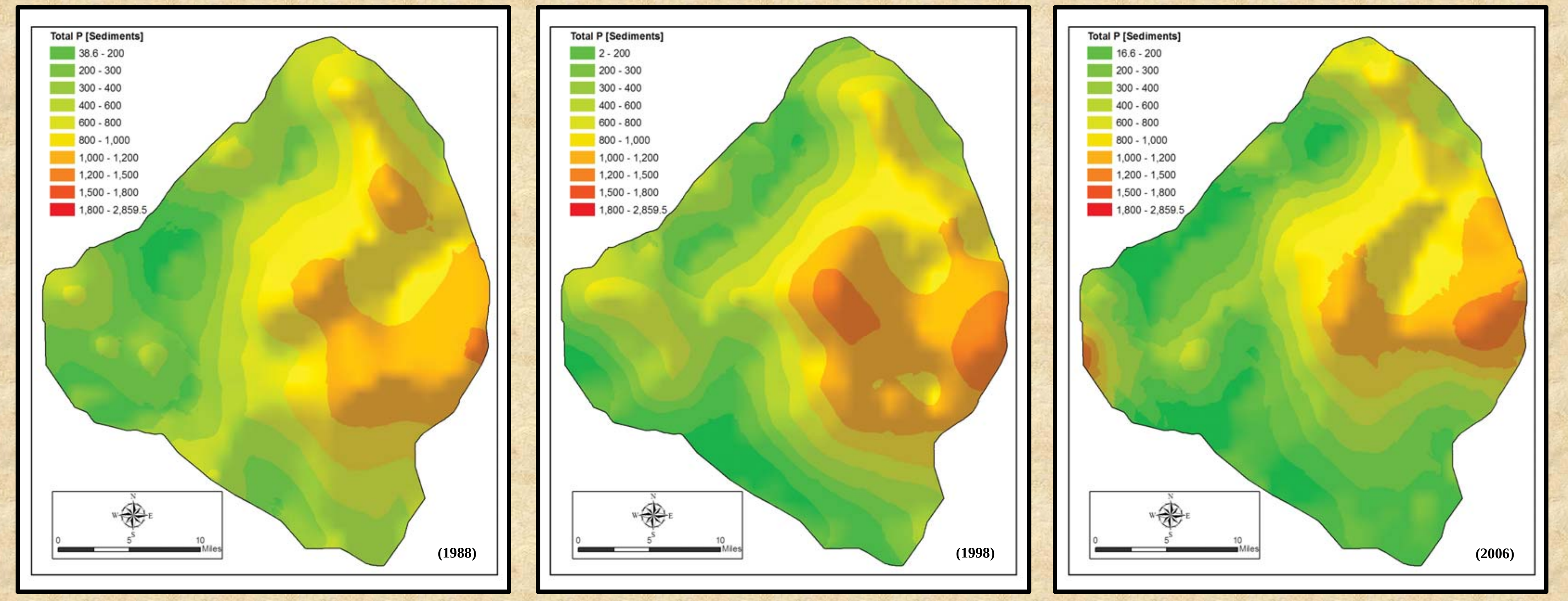
SHADED MUD THICKNESS MAPS for 1988, 1998 and 2006
The maximum mud thickness increased from 66 cm to 74 cm from 1988 to 1998, but reduced from 74 cm to 51 cm from 1998 and 2006



3-D PERSPECTIVE VIEW, LAKE OKEECHOBEE
(Vertical scale x 2000)



MUD THICKNESS CHANGES BETWEEN 1988 and 1998, 1998 and 2006
The red areas show the largest thickness decrease, and the dark blue areas show the largest thickness increase; the light color areas show minor or no changes.

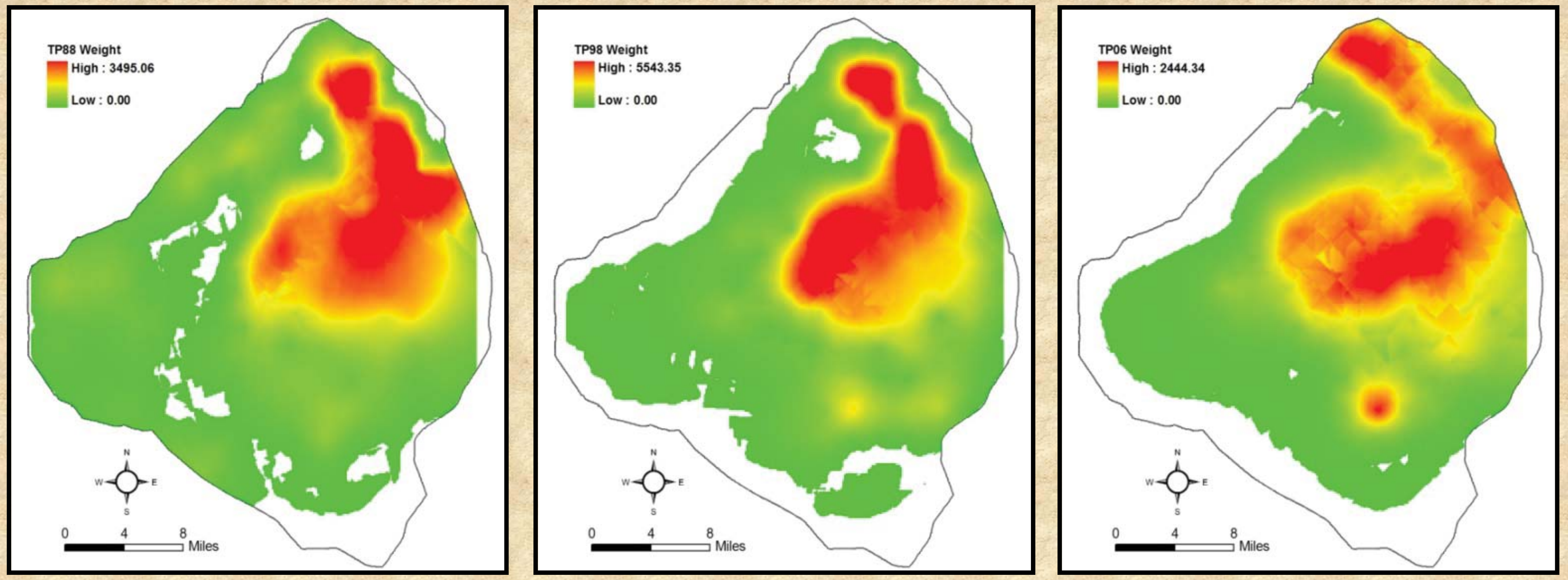


TOTAL PHOSPHORUS (TP) DISTRIBUTION FROM 1988 TO 2006, LAKE OKEECHOBEE

TP values declined from an average of 651 to 593 mg/kg from 1998 to 2006, especially in the Lake's western and southern regions. The biggest increase occurred in northern and western edges, with maximum increase up to 1000-3000 mg/kg; From 1988 to 1998, total phosphorus declined in the northern and southern areas, and increased in the central-western lake.

CONCLUSIONS

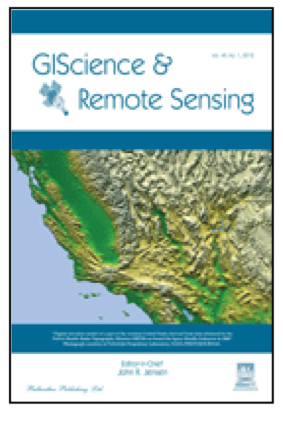
- GWR models provided the best predictions of TP in sediments;
- The dramatic change in the thickness between the 1998 and 2006 period could be caused by the three major hurricanes- Frances, Jeanne, and Wilma- that passed close to the lake on September 5, 2004, September 26, 2004 and October 24, 2005, respectively;
- The TP weights were 42,900, 60,100, and 40,800 metric tons for 1988, 1998 and 2006.



TOTAL PHOSPHORUS (TP) WEIGHTS (kg) USING GWR MODEL (TP vs. Fe) for 1988, 1998 and 2006

MODEL	ORDINARY KRIGING			GWR (TP VS. FE)			GWR (TP VS. TH & ELEV)			AVERAGE
Year	Metric Tons	Change	%	Metric Tons	Change	%	Metric Tons	Change	%	Metric Tons
1988	42,500			42,000			44,300			42,933
1998	58,900	16400	39%	60,400	18400	44%	61,100	16800	38%	60,133
2006	41,400	-17500	-30%	41,000	-19400	-32%	40,100	-21000	-34%	40,833

TP MASS (METRIC TONS) AND ITS CHANGES OVER TIME BY DIFFERENT SPATIAL MODELS



GIScience & Remote Sensing
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/tgrs20

Geographically weighted spatial modelling of sediment quality in Lake Okeechobee, Florida

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[c] Department of Civil and Environmental Engineering, Florida International University, Miami, FL 33174, USA
Published online: 30 Jun 2014.

MAJOR REFERENCES:

- Yan Y. and Tom James. Spatial Modeling of Mud Thickness and Mud Weight Calculation (1988-2006), Lake Okeechobee. *Florida Geographer*, Vol. 43, Pages 16-36, 2012 Yan et. al. 2013
- Yan Y., et. al. Geographically Weighted Spatial Modelling of Sediment Quality in Lake Okeechobee, Florida. *GIScience & Remote Sensing*. July 2014

Prepared for the
Water Resources Advisory Commission and the SFWMD Governing Board
August, 2014

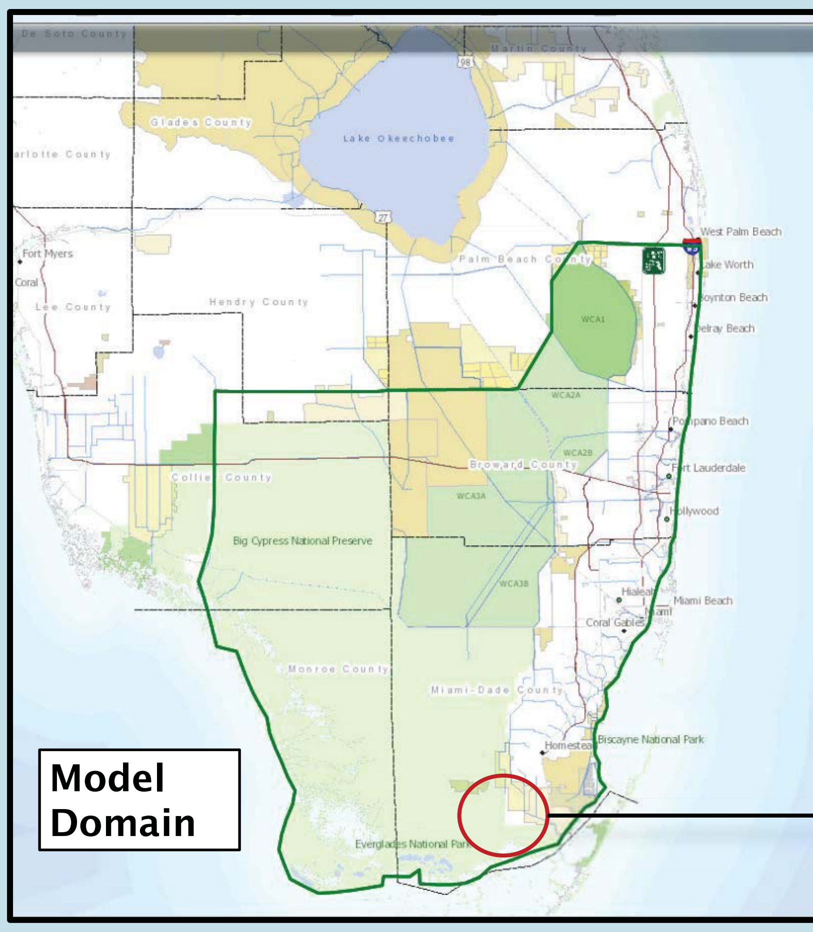
NORTHEAST FLORIDA BAY MINIMUM FLOWS AND LEVELS UPDATE, 2013 USING THE REGIONAL SIMULATION MODEL

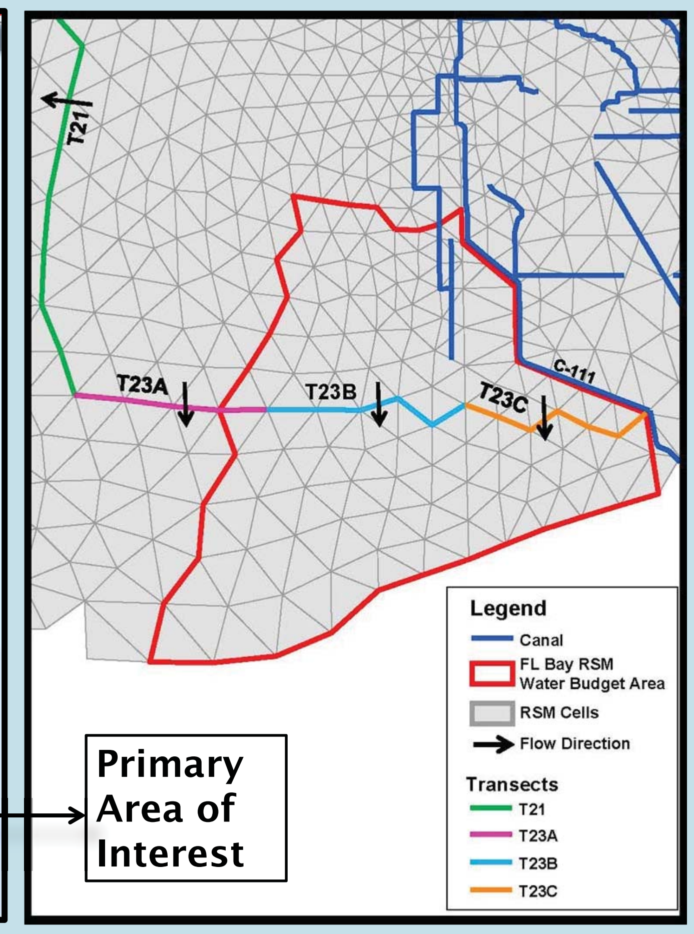
Fahmida Khatun, PE, PMP, GISP, Jose M. Otero, PE and Sashi Nair

Hydrologic & Hydraulics Bureau; Operations, Maintenance & Construction Division

OBJECTIVE: Florida Bay is an internationally recognized ecosystem that is adjacent to the Everglades, the largest subtropical wetland in the United States. Minimum Flows and Levels (MFLs) were established by rule in 2006 for northeast Florida Bay to prevent significant harm to the water resources, ecology, and ecosystem resulting from water withdrawals.

One objective of the Florida Bay MFL update 2013 is to evaluate the effects of three distinct infrastructure and operational changes upstream of northeast Florida Bay that have recently been implemented and were not in place in 2006.

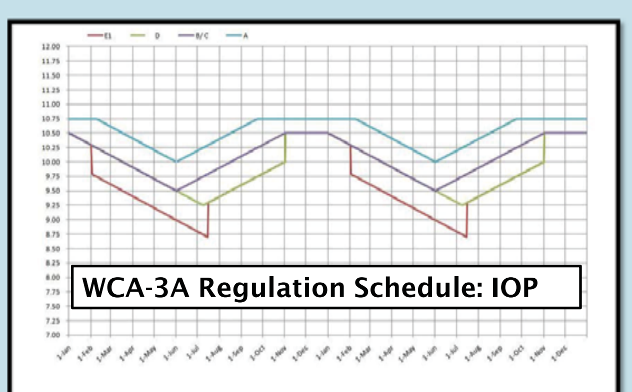


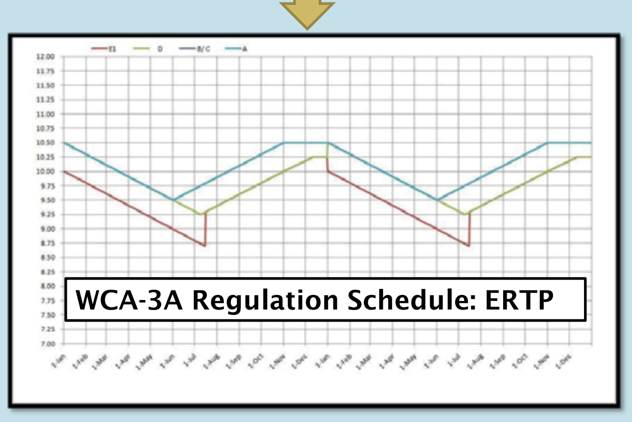


MODEL AND MODEL DOMAIN: The Regional Simulation Model (RSM), a finite volume and object-oriented hydrologic model, implemented for the Everglades and the Lower East Coast Service Areas, was used for this evaluation.

PRIMARY AREA OF INTEREST: The drainage basin of northeast Florida Bay.

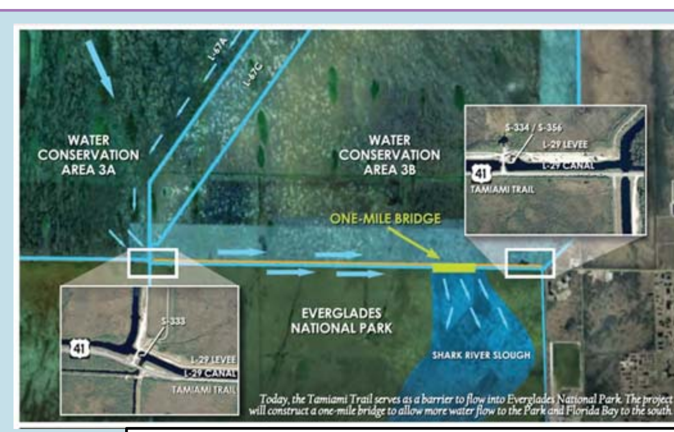
CLIMATIC PERIOD OF SIMULATION: 1965-2005 to reflect a wide range of climatic conditions.



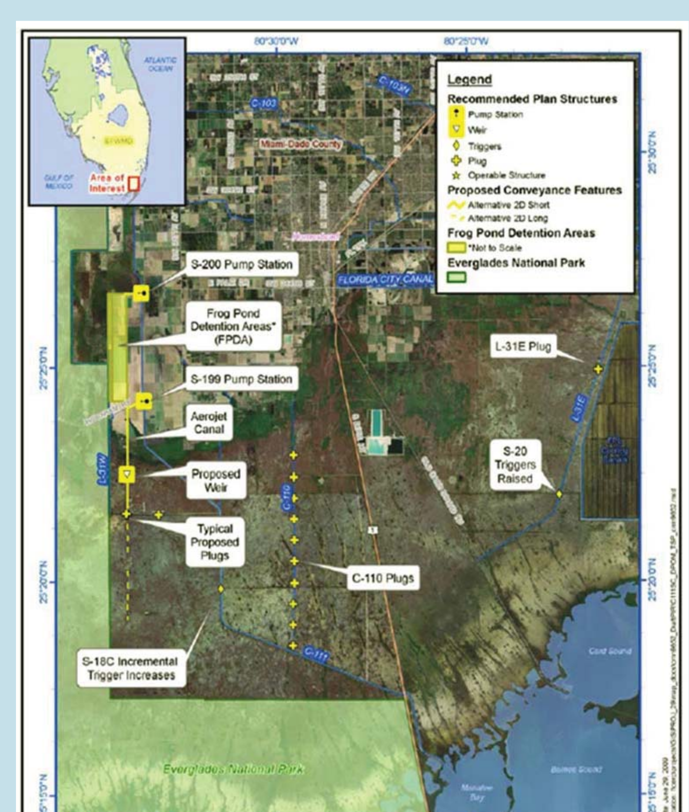


SCENARIOS: A baseline simulation (called ECB1) represents the 2006 condition when the MFL was adopted. A simulation with projects (called ECB2) is identical to the baseline simulation with the addition of three projects:

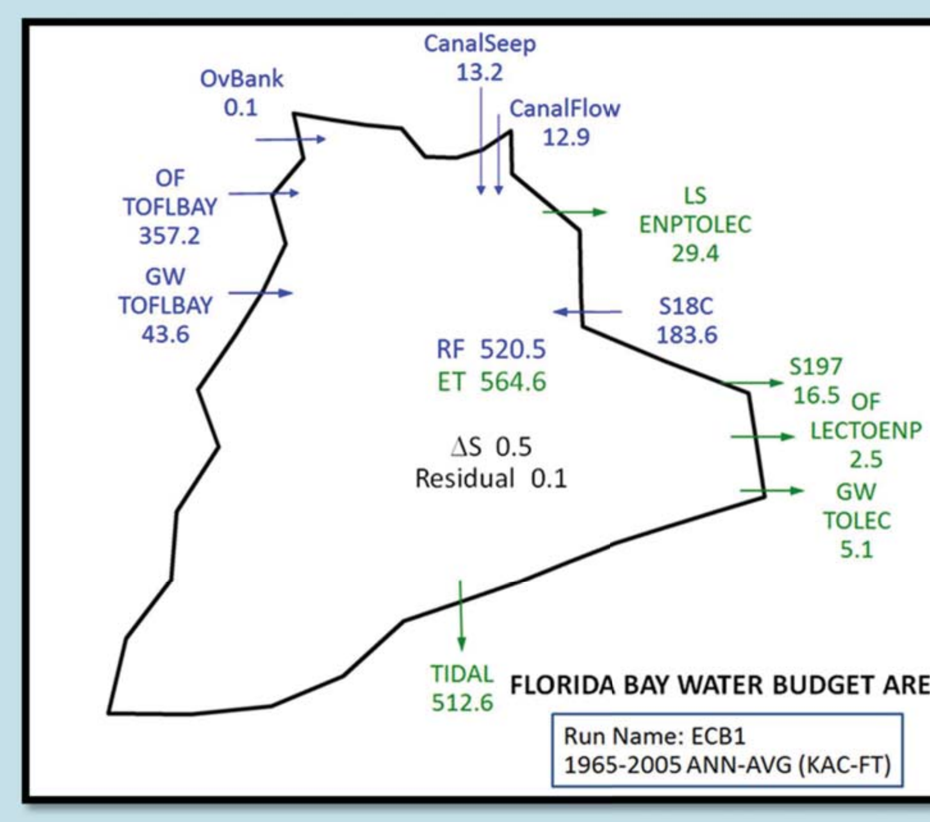
1. Everglades Restoration Transition Plan (ERTP) in place of Interim Operational Plan (IOP)
2. C-111 Spreader Canal Western Project
3. Tamiami Trail One-Mile Bridge

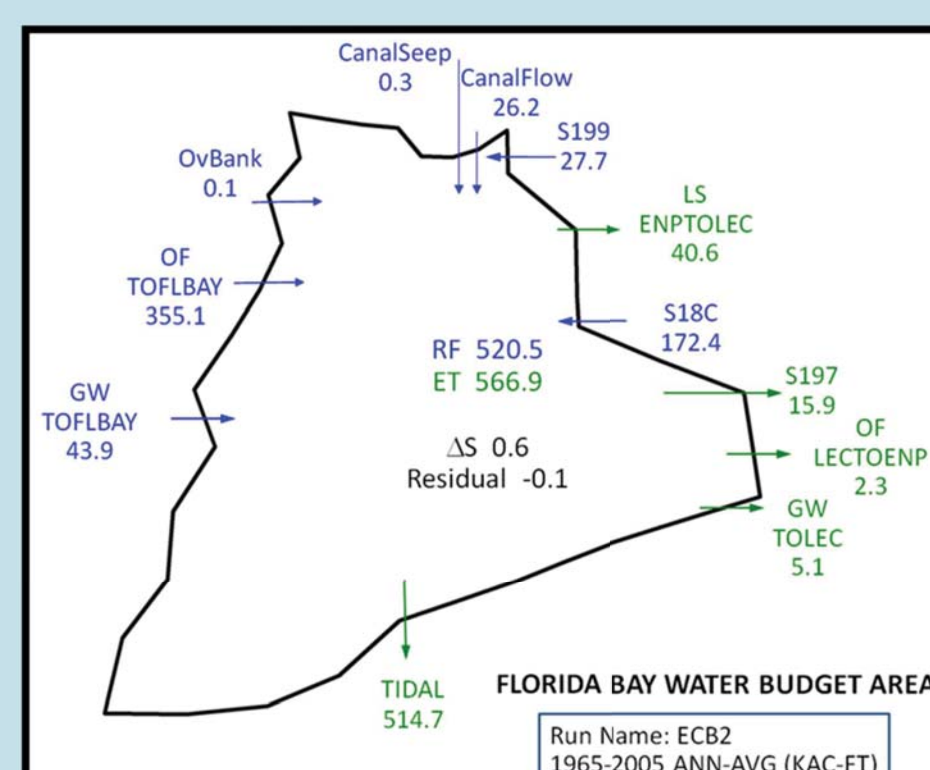


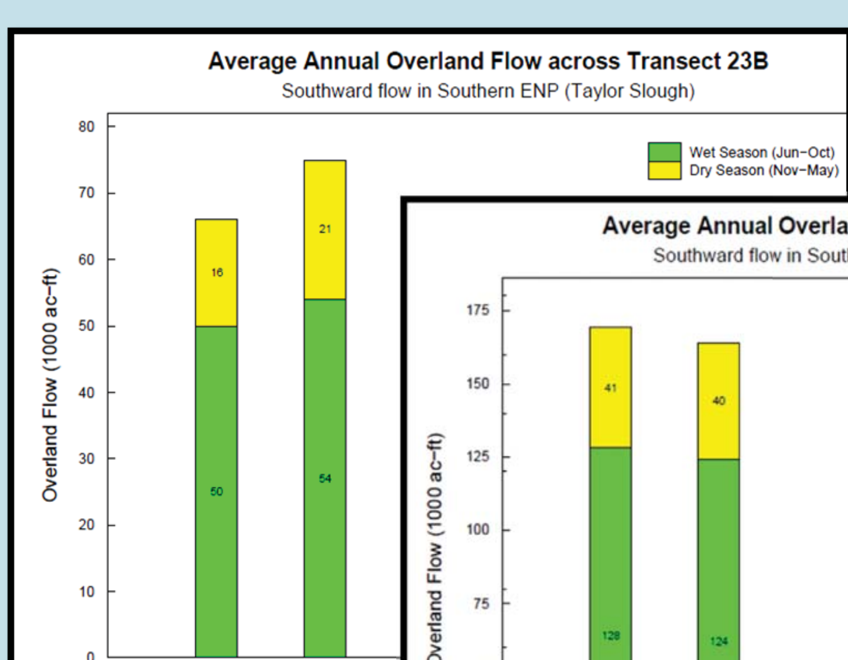
Tamiami Trail One-Mile Bridge

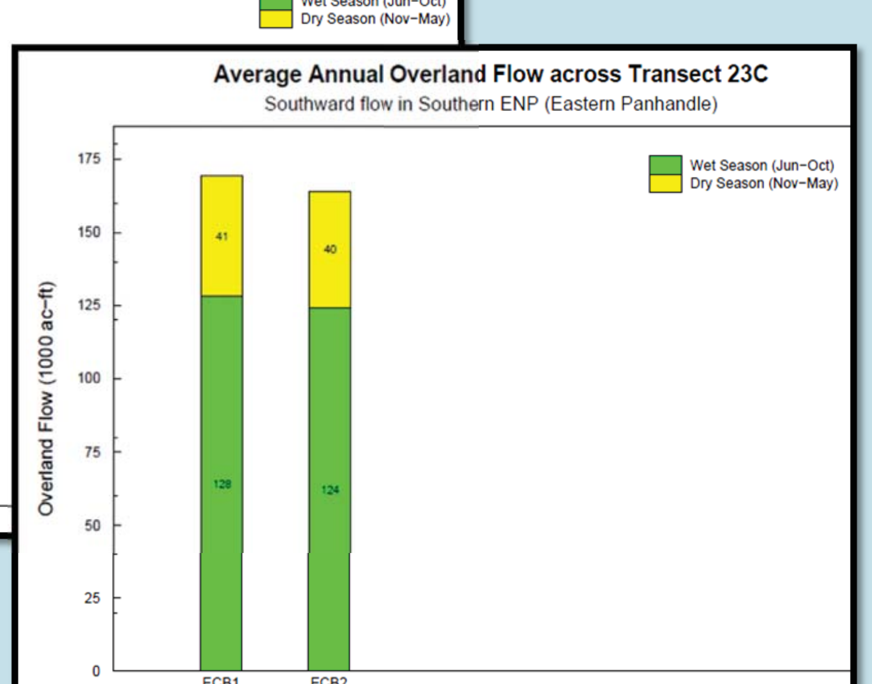


C-111 Spreader Canal Western Project









EFFECTS OF ERTP AND C-111 SPREADER CANAL WESTERN PROJECT: Due to the implementation of ERTP, the volume of flow for the S-332D pump was increased during the Cape Sable Seaside Sparrow breeding season causing additional diversion in flows from the L-31N canal to the headwaters of Taylor Slough. In addition, the C-111 Spreader Canal Western Project diverts flows from the C-111 canal to Everglades National Park (ENP) which produces a hydraulic ridge at the headwater of the Taylor Slough. Therefore, increased overland flows in Taylor Slough and reduced overland flows in the ENP eastern panhandle were noticed. Flows toward Taylor Slough increased by 13.6% and toward the eastern panhandle decreased by 3%. The combined flows toward Taylor Slough and the eastern panhandle show a net increase of 1.7%.

Transects	Average Annual Overland Flow (1000 ac-ft)						Percent Difference
	Simulation of Baseline (ECB1)			Simulation of Projects (ECB2)			Projects Relative To Baseline
	Wet Season	Dry Season	Water Year	Wet Season	Dry Season	Water Year	Water Year
T23B	50	16	66	54	21	75	13.6%
T23C	128	41	169	124	40	164	-3.0%
T23B+ T23C	178	57	235	178	61	239	1.7%

EFFECTS OF TAMIAMI TRAIL ONE-MILE BRIDGE PROJECT: Since Tamiami Trail One-Mile Bridge is located further north of the northeast Florida Bay drainage basin and L-29 maximum canal stage is not raised to allow more S-333 flows into L-29, no significant change in flow pattern was observed in the drainage basin of northeast Florida Bay due to the implementation of this project.

CONCLUSION: Evaluation of future conditions showed there will be no reduction in flows to northeast Florida Bay as a result of the implementation of three recent projects. No changes to the MFL rule criteria or prevention strategy for Florida Bay are necessary at this time.

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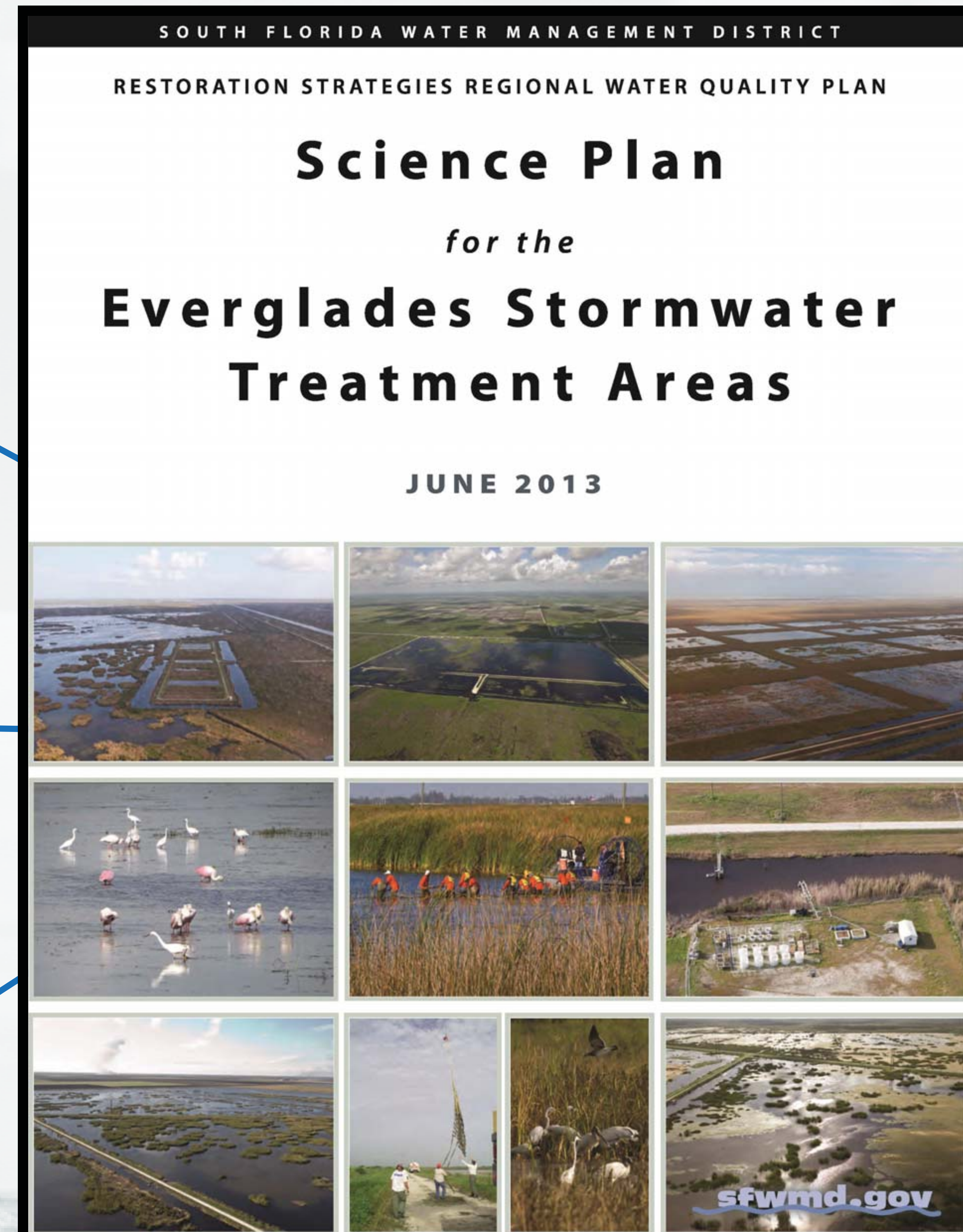
July 2014 Fahmida Khatun, PE, PMP, GISP, Senior Engineer, H & H Bureau, SFWMD , 3301 Gun Club Road, WPB, FL – 33406, email: fkhatun@sfwmd.gov

Restoration Strategies
Science Plan for the Everglades Stormwater Treatment Areas

Larry Schwartz, Ph.D. P.W.S., Principal Scientist and Kim O'Dell, PMP, Supervisor - Environmental Scientist
Water Quality Treatment Technologies, Applied Sciences Bureau


SOUTH FLORIDA WATER MANAGEMENT DISTRICT
RESTORATION STRATEGIES REGIONAL WATER QUALITY PLAN
Science Plan
for the
Everglades Stormwater Treatment Areas
JUNE 2013
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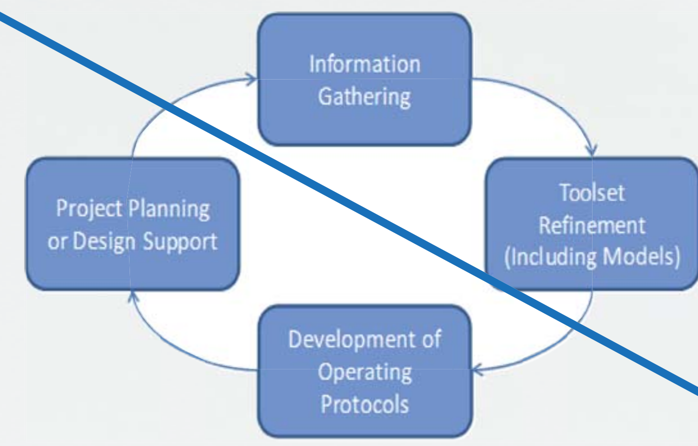
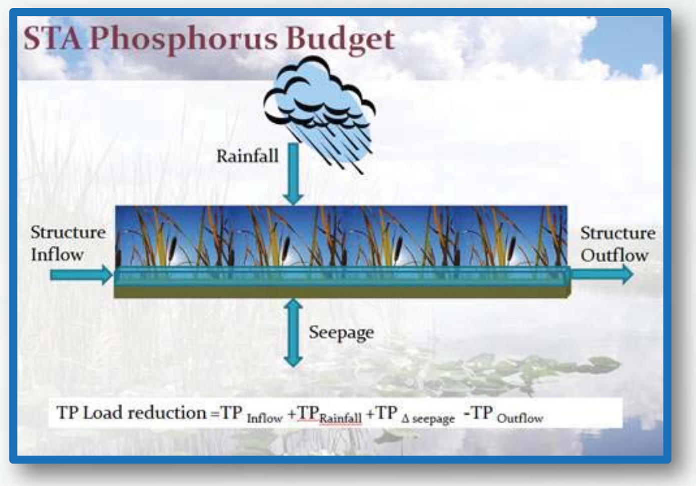
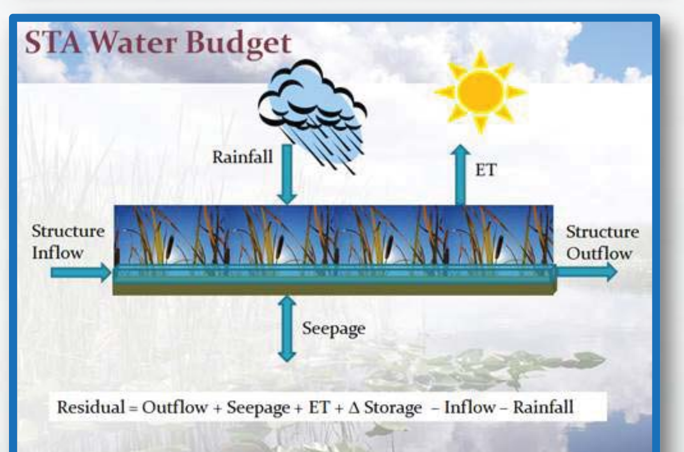
Operational Guidance for FEB and STA Regional Operational Plans

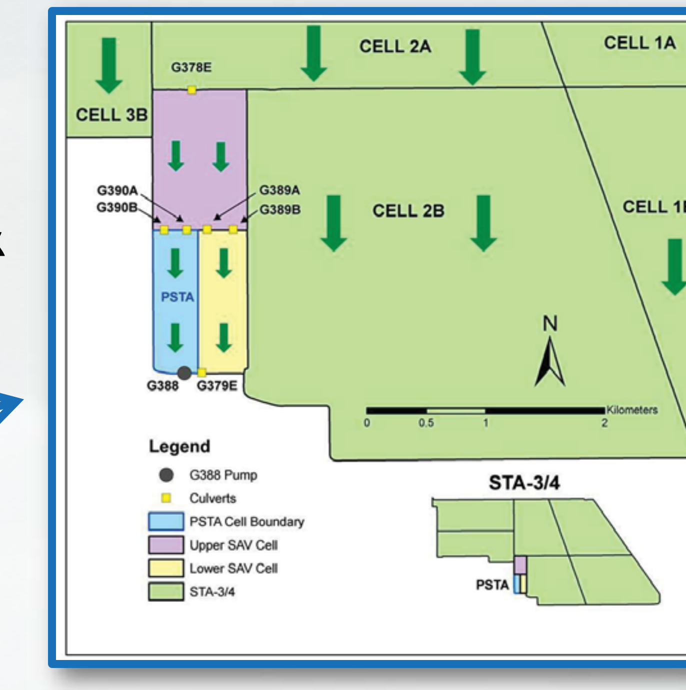


STA Water & Phosphorus Budget Improvements

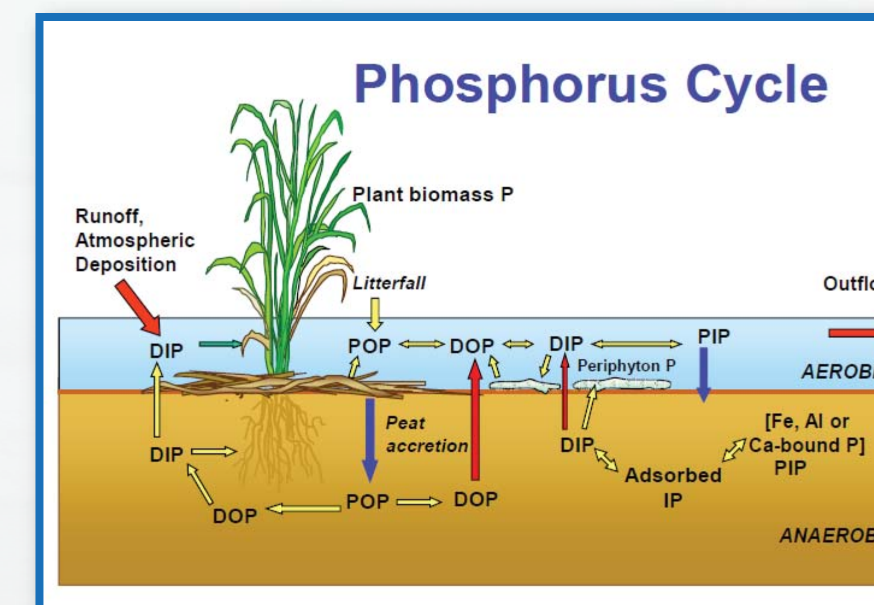


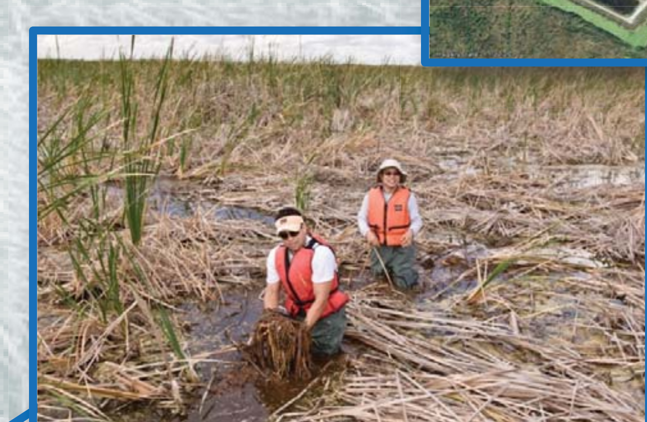


Periphyton-based Stormwater Treatment Area (PSTA): Performance, Design & Operational Factors



Phosphorus Sources, Forms, Flux, and Transformation Processes in the STAs



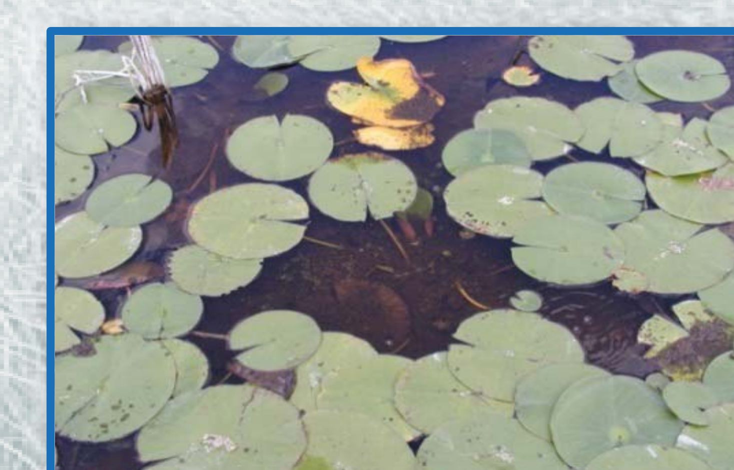


Evaluation of Inundation Depth and Duration Threshold for Cattail Sustainability

Use of Soil Amendments/Management to Control P Flux

Sampling Methods for Total P

Influence of Canal Conveyance Features on STA and FEB Inflow and Outflow TP Concentrations



Phosphorus Removal Efficacy of Alternative Vegetation in a Low Nutrient Environment in STAs

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Prepared for the Water Resources Advisory Commission and the SFWMD Governing Board, August, 2014

Evaluation of Phosphorus Forms and Transformations within the Stormwater Treatment Areas (STAs)

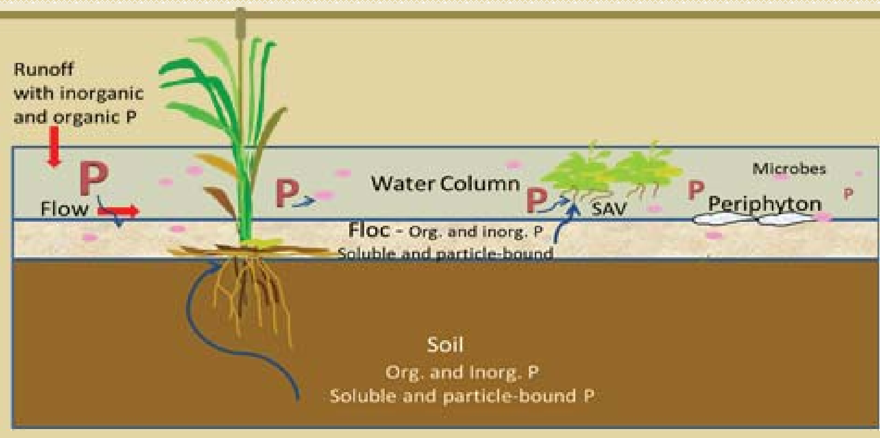
Delia Ivanoff, Sr Supv Envir Scientist; Sue Newman, Section Leader; Odi Villapando, Sr Environmental Scientist;
Colin Saunders, Lead Environmental Analyst; Kathy Pietro, Sr Environmental Scientist

APPLIED SCIENCES BUREAU – WATER RESOURCES DIVISION

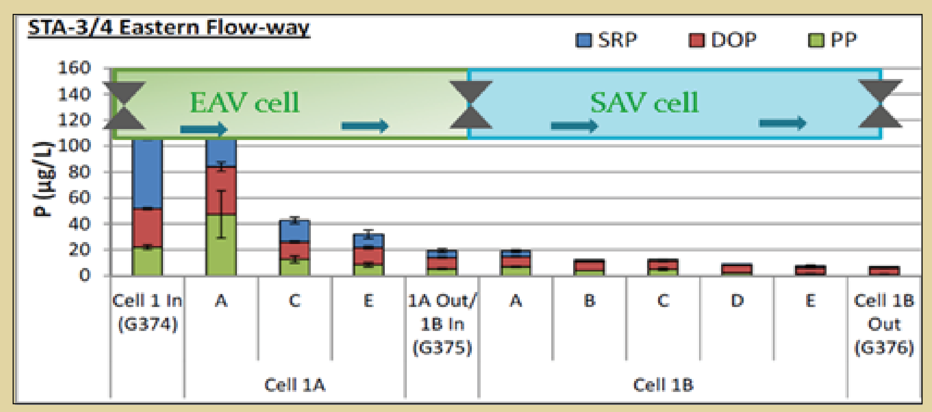
WHY study this? (Rationale and Objectives)

A better understanding of the factors influencing phosphorus (P) forms, transformations & reduction mechanisms is necessary to lead us to more scientifically-based management strategies. It will help address two key Restoration Strategies Key Questions:

- What are the sources (external, soil, plants, microbial, fauna), forms and transformation mechanisms controlling the residual P pools within the different STAs and are they the same as observed in the natural system?
- What are the key physico-chemical factors (e.g. calcium, water depth, hydraulic retention time) influencing P cycling at very low concentrations?



LEFT: SCHEMATIC SHOWING P REDUCTION WITHIN THE STA

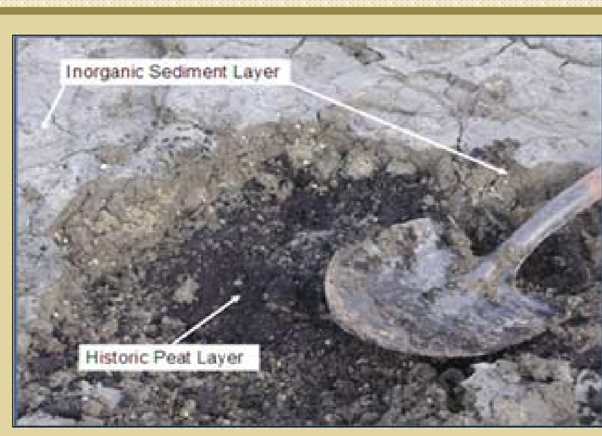


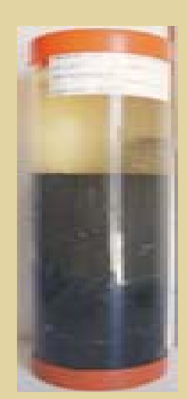
RIGHT: P CONCENTRATIONS IN THE SURFACE WATER WITHIN STA-3/4, MOVING FROM INFLOW TO OUTFLOW

EAV (Emergent Aquatic Vegetation); SAV (Submerged Aquatic Vegetation); SRP (soluble reactive P); DOP (dissolved organic P); PP (particulate P)

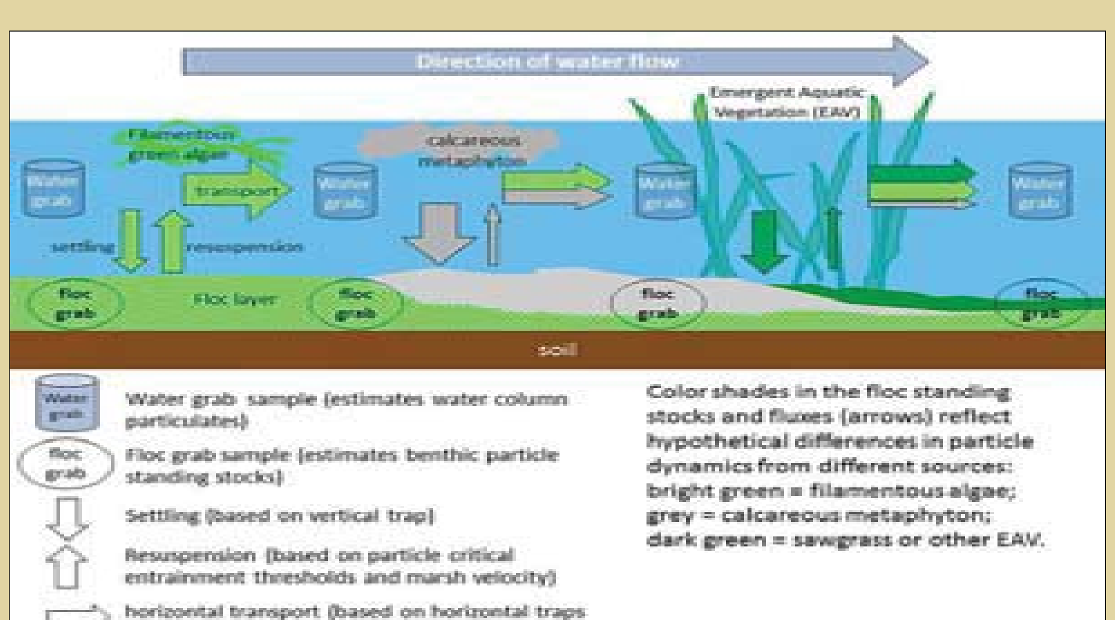
HOW can we study this? (Study Approach)

- Look at existing data – what's the data telling us?
- Field observations – short-term interval observations and measurements at different flow scenarios: stagnant, low flow, and high flow scenarios
- Sampling, measurements, and surveys – water quality, flows, vegetation, soil, microbes, fauna, waterbirds
- Controlled studies (incubations, mesocosms)





DETERMINE THE INFLUENCE OF SOIL IN P REDUCTION, TRANSFORMATIONS, AND RELEASE INTO THE WATER COLUMN (P FLUX)



SCHEMATICS OF PARTICLE DYNAMICS MEASUREMENTS

PROJECT DURATION
2014 - 2019

FREQUENT SURVEY OF VEGETATION COMMUNITIES TO DETERMINE THEIR INFLUENCE ON P TRANSFORMATION AND REDUCTION

PRELIMINARY SURVEY OF WATERBIRDS AND AQUATIC FAUNA TO DETERMINE THEIR ROLE IN P CYCLING

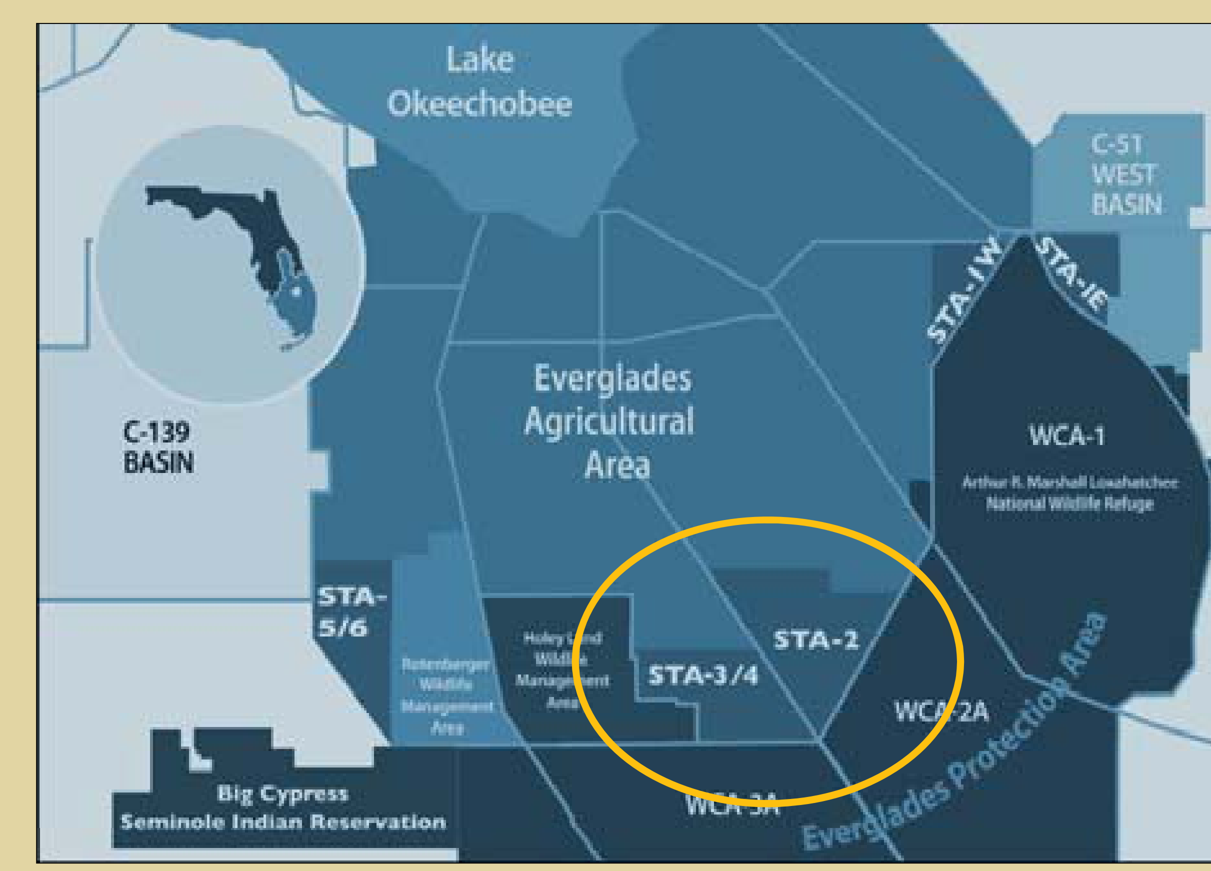
WHAT are we actually trying to find out? (Hypotheses)

Focus on P removal and transformation in the STAs

- Long-term retention of P in the STAs is a function of the type and proportion of accreted P in the system
- Microbially-mediated P transformations play a major role in very low P condition, such as toward the bottom-end of the treatment flow-way
- Release of P from the soil to the water column significantly increases water column P and impacts outflow P concentrations.
- Outflow P can be reduced by increasing settling and burial of P and minimizing resuspension of P into the water column.
- Vegetation spatial patterns can be optimized for P retention
- Aquatic fauna and water birds have significant impacts P concentrations in the water column

WHERE are we doing the study?

STA-2 & STA-3/4



OTHER CONTRIBUTORS:
Mark Cook and Christa Zweig, Marsh Ecology;
Yao Yan, WQTT; Mike Kirkland, Everglades STA;
Naiming Wang, Water Resources Modeling; and
Ceyda Polatel, Operational Hydraulics

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Biological Control Agents Enhance Invasive Plant Management in South Florida

LeRoy Rodgers, Lead Scientist
Land Resources Bureau, South Florida Water Management District

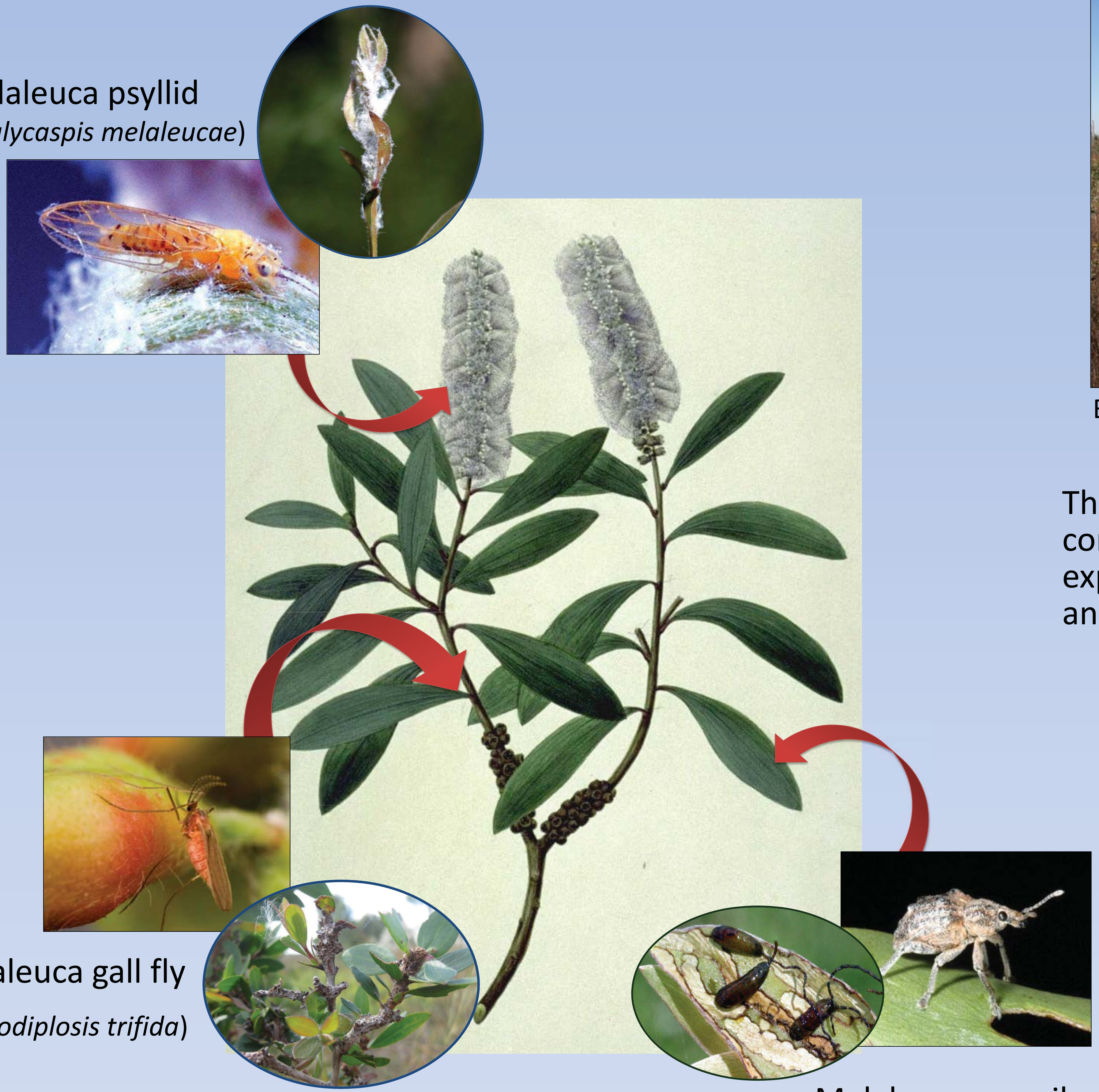
What is biological control?

Biological control is the control of invasive plants by importing specialized natural enemies of the plant from its native range. Only agents that feed exclusively on the target weed are approved for release.

The objective is to establish a sustained population of the natural enemies in order to reduce the aggressive growth of the invasive plant. Biological control will not eradicate the invader, but can be a useful component of integrated pest management strategies.

Invasive Plant Research Laboratory, Davie Florida

Melaleuca psyllid
(*Boreioglycaspis melaleucae*)



Melaleuca gall fly
(*Lophodiplosis trifida*)

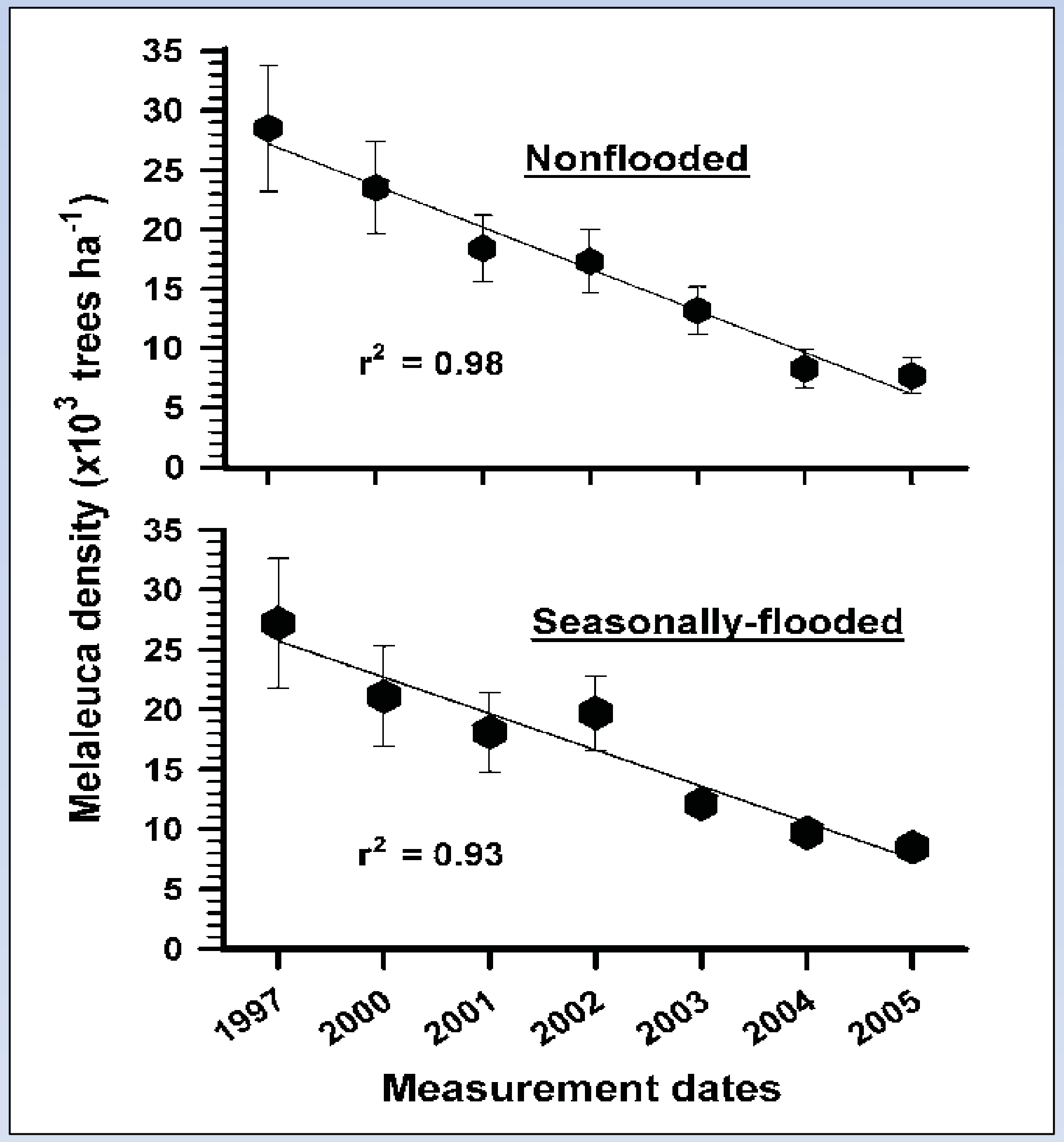
Melaleuca weevil
(*Oxyops vitiosa*)

The establishment of three biocontrol agents has reduced the invasive growth of melaleuca in Florida. As a result, less herbicide treatment is needed to maintain control of this invasive plant.

Biological Control | **No Biological Control**

Biological Controls Present | Biological Controls Removed (insecticide)

The combined effect of three melaleuca biological control agents is easily seen when comparing experimental plots with biocontrol agents present and absent (removed with insecticides).



Density Changes in Two Melaleuca Populations in South Florida between 1997 and 2005
Source: Rayamajhi et al., 2009

Integrating Biological Control with Herbicides

The SFWMD, USDA Agricultural Research Service, US Army Corps of Engineers, and other partner agencies are working together to develop a biological control program for invasive plants in South Florida. The state of the art quarantine facility in Davie, Florida serves as a base of operations for testing potential agents and the CERP Biological Control Program. After rigorous testing to confirm host specificity, approved agents are reared at the facility, then strategically released in the field. In addition to melaleuca , biocontrol agents have been approved and released for Old World climbing fern, air potato, water hyacinth, and other invasive plant species in Florida.

Rayamajhi, M.B., P.D. Pratt, T.D. Center, P.W. Tipping and T.K. Van. 2009. Decline in exotic tree density facilitates increased plant diversity: The experience from Melaleuca quinquenervia invaded wetlands. Wetlands Ecology and Management, 17:455–467.

Poster created by: LeRoy Rodgers July 2014
SCIENCE POSTER FOR WATER RESOURCES ADVISORY COMMISSION AND SFWMD GOVERNING BOARD – AUGUST, 2014

Changes in Distribution and Abundance of Priority Invasive Plant Species in the Everglades: 2003—2013

Leroy Rodgers, Lead Scientist

LAND RESOURCES BUREAU, SOUTH FLORIDA WATER MANAGEMENT DISTRICT

BACKGROUND

Four invasive plant species—Australian pine (*Casuarina* spp.), Brazilian pepper (*Schinus terebinthifolius*), melaleuca (*Melaleuca quinquefolia*), and Old World climbing fern (*Lygodium microphyllum*)—are well established in the Greater Everglades and are a high priority for control due to documented ecological impacts.

The South Florida Water Management District and National Park Service collaborate on a region-wide aerial surveillance and mapping program. The aerial survey program has two main objectives: 1) determine the distribution and abundance of invasive plants and 2) provide rapid and cost-efficient spatial data to land managers to direct control efforts.

METHODS

Surveys were conducted in 2003 and 2012/13. Biologists made visual estimates of invasive plant locations and abundance from aircraft along fixed east-west transects. Data were collected using digital aerial sketch mapping (DASM), which involves digitizing infestation areas on touch screen computers and assigning species and percent cover estimates to each polygon (Fig. 1). Zonal analysis using a 4-km grid was used to assess landscape level distribution and abundance of the four species in 2003 and 2013.

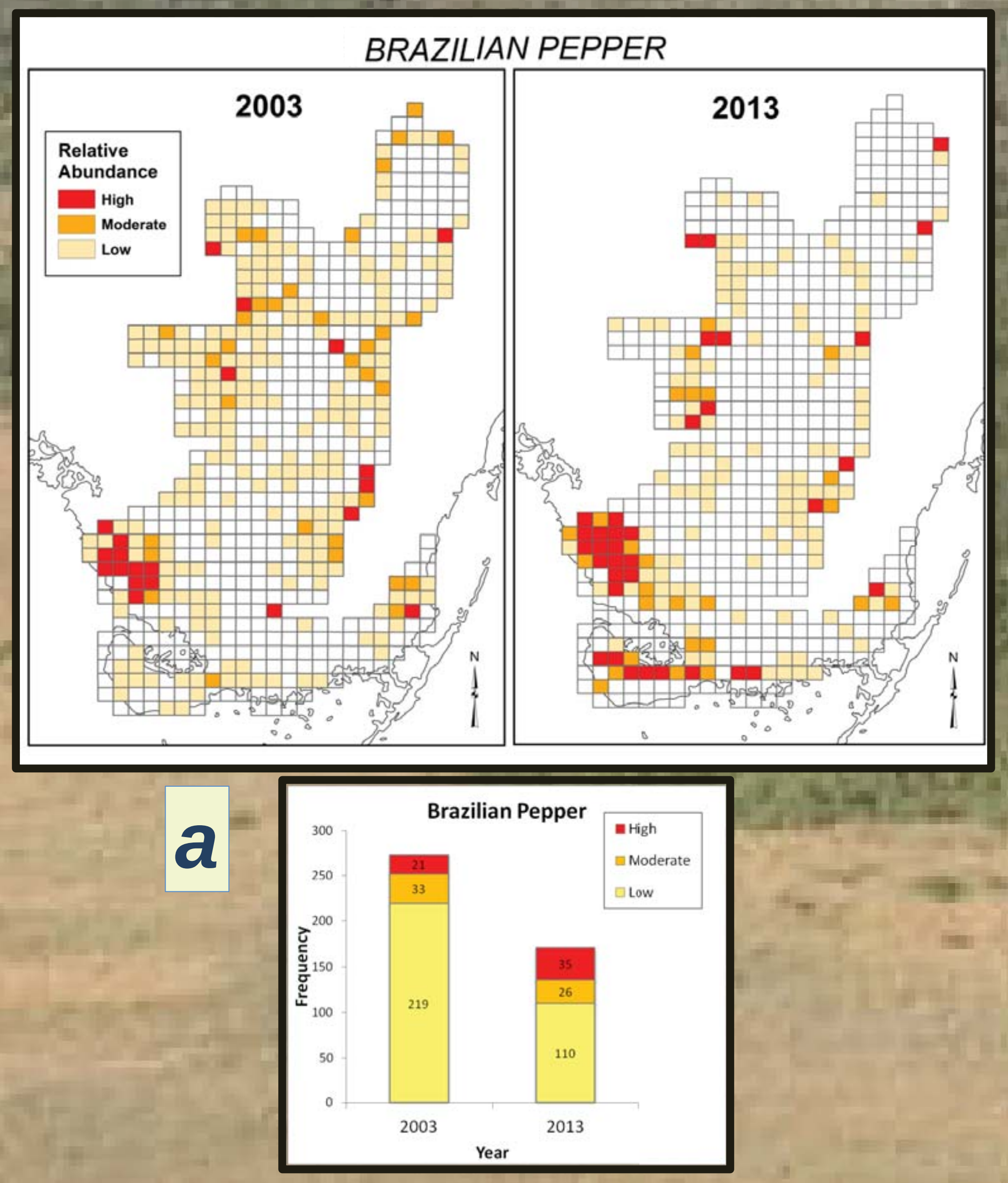
Species	Infested Area (ha)	Canopy Area (ha)
Brazilian Pepper	14,442	3,499
Melaleuca	9,046	2,111
Old World Climbing Fern	7,326	935
Australian Pine	2,765	423

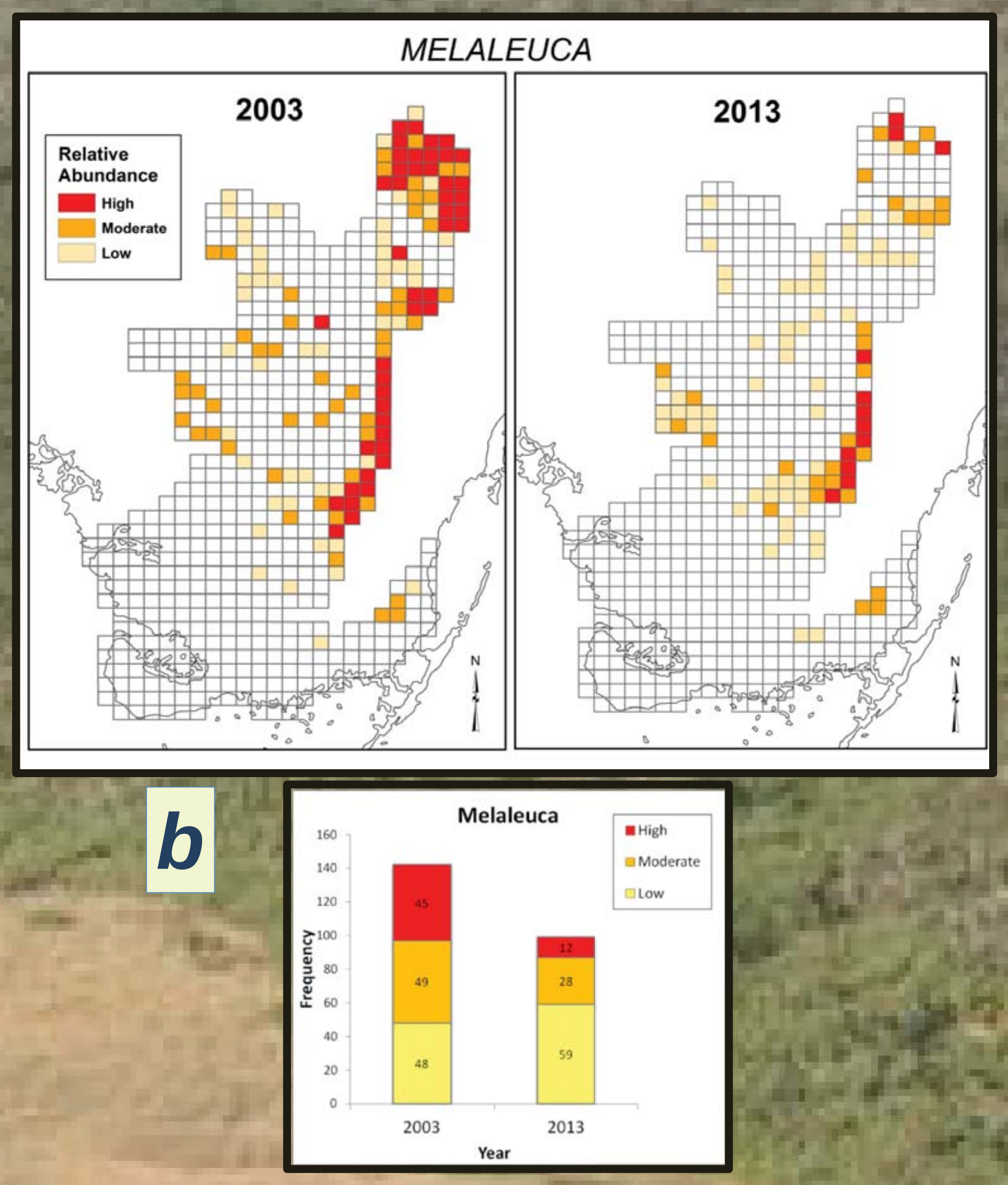
Table 1. 2013 infested area and canopy area of four priority invasive plant species in the RECOVER Greater Everglades Module. Canopy area is calculated as the product of infestation polygon area and percent cover of target species in the polygon.

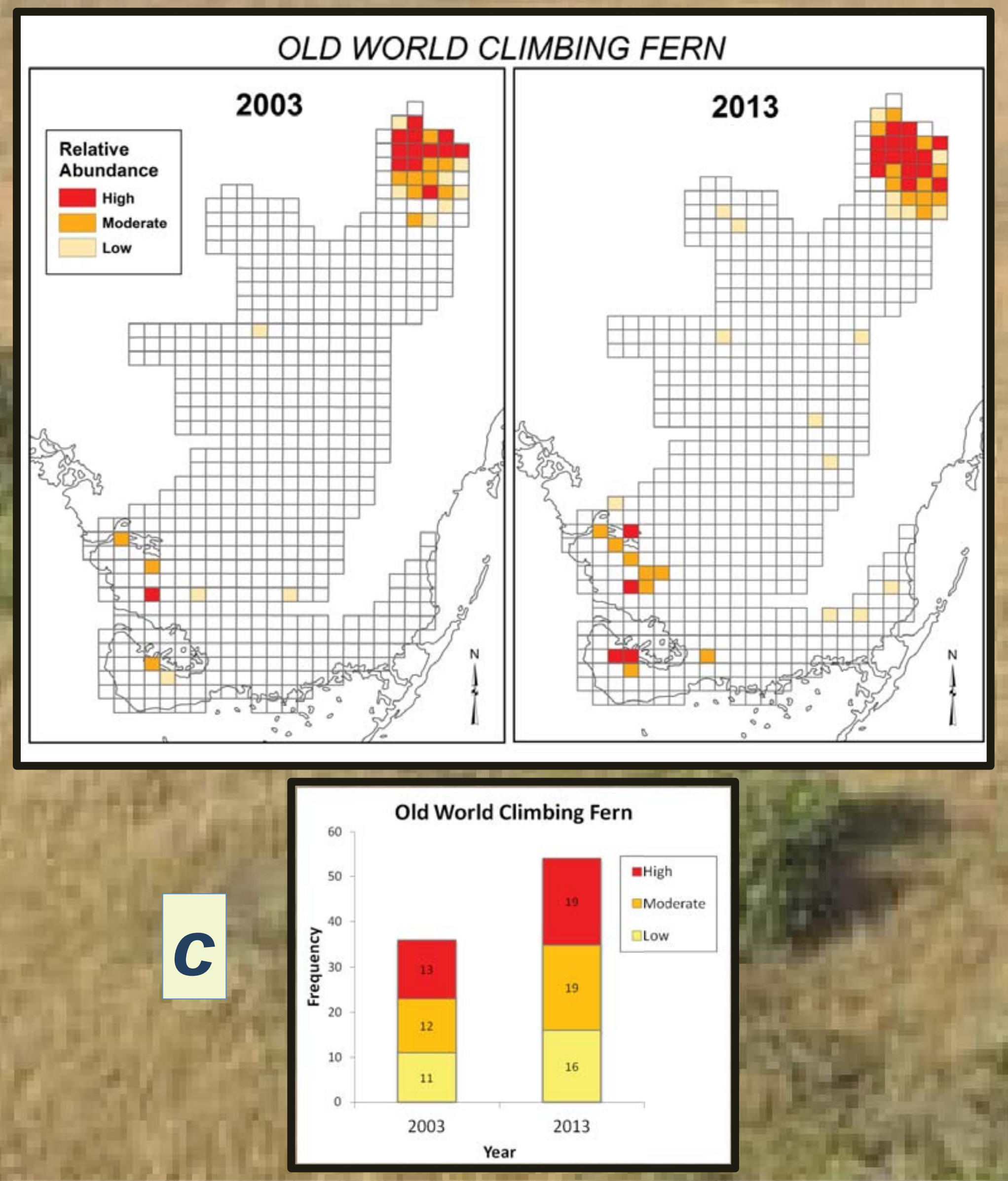
KEY FINDINGS

- Brazilian Pepper is the most abundant and widely distributed of the four species (Table 1). Overall abundance decreased between 2003 and 2013 but Brazilian Pepper increased in the south western Everglades (Fig. 2a).
- The relative abundance of Melaleuca decreased substantially between 2003 and 2013. The number of grid cells classified as high density Melaleuca fell 73% (Fig. 2b).
- Australian Pine is the least abundant of the surveyed species (Table 1) and showed the greatest decrease in abundance and distribution (Fig 2d).
- In contrast, Old World Climbing Fern increased in abundance and spatial distribution during the monitoring period (Fig 2c). Most expansion of this invasive plant occurred in the Loxahatchee NWR and southwestern Everglades NP.
- Reductions in Melaleuca, Brazilian pepper, and Australian pine abundance are attributed to ongoing interagency control programs.
- Expansion of Old World Climbing Fern reflects limited management resources and control challenges of this highly invasive plant.

Figure 1. Observers digitally record polygons and attribute data for targeted invasive species.







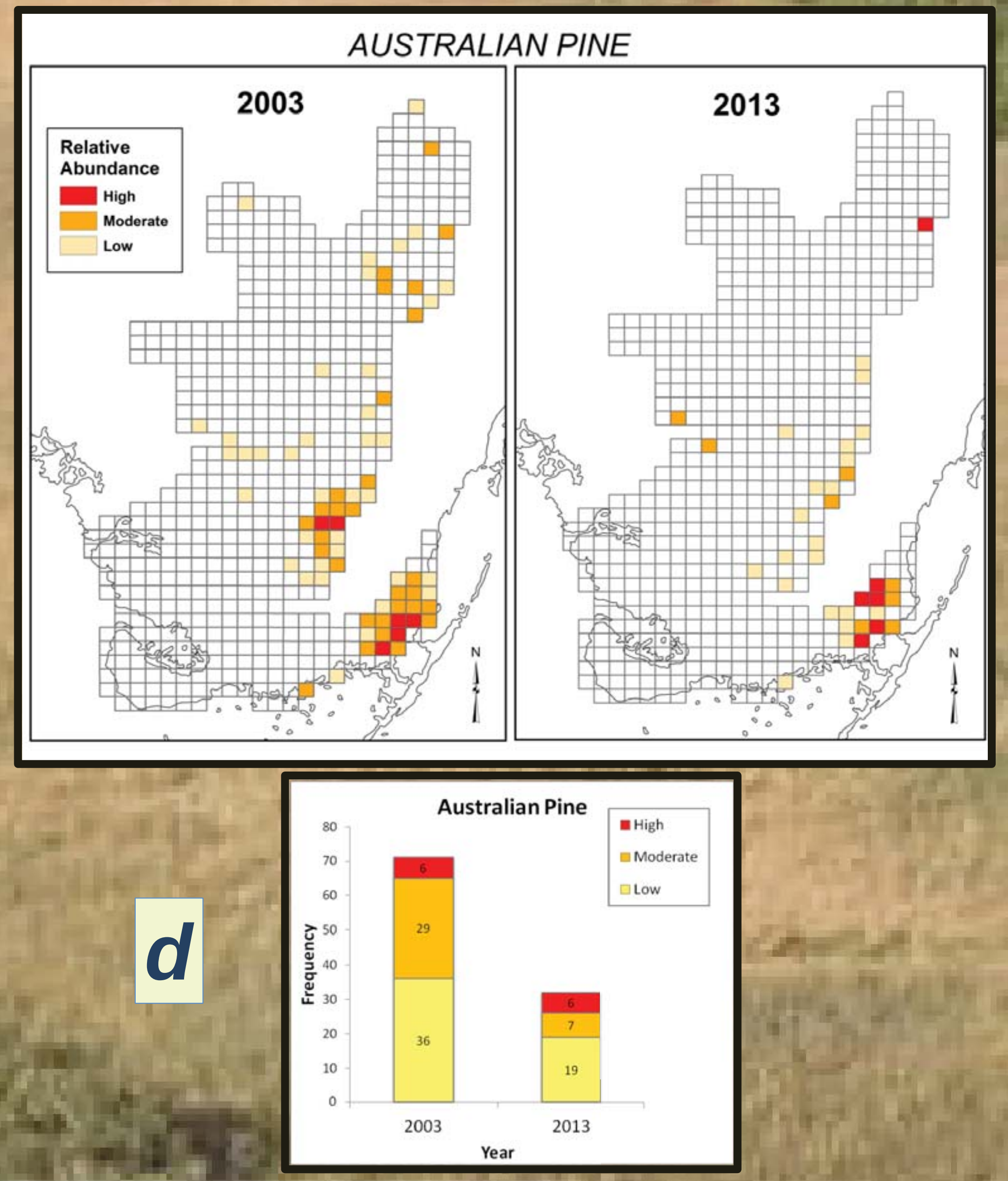


Figure 2a-d: Distribution and Relative Abundance of Brazilian Pepper (a), Melaleuca (b), Old World Climbing Fern (c), Australian Pine (d) in the Greater Everglades Module 2003–2013.

The stacked bar charts show the frequencies of 4 km grid cells with high, moderate, and low infestation levels of each species in 2003 and 2013.

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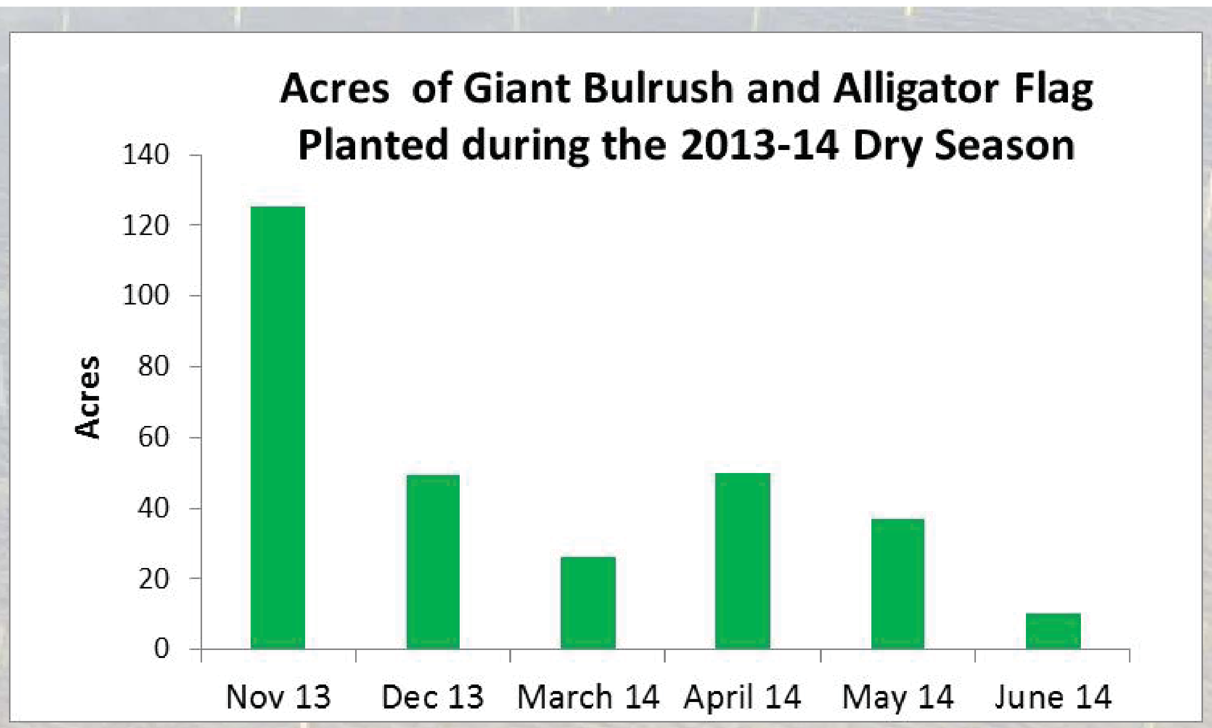
Vegetation Enhancements Ensure Water Quality Performance in The Stormwater Treatment Areas

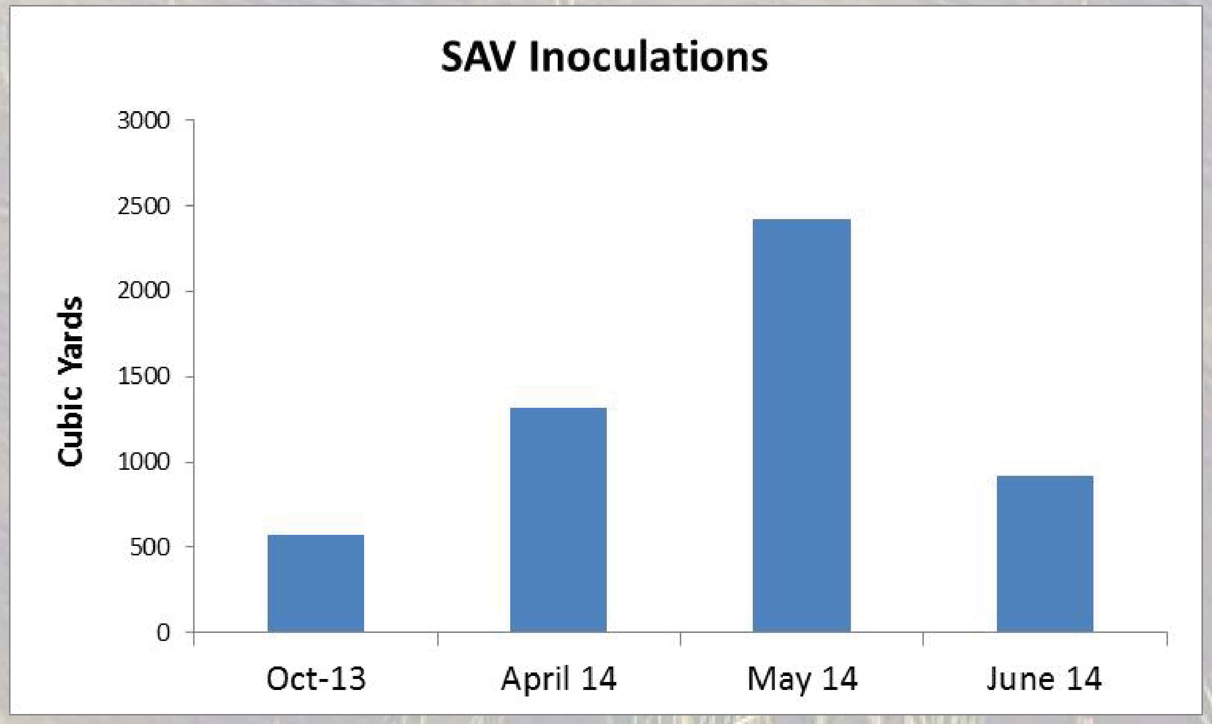
Phosphorus Uptake and Removal in The Stormwater Treatment Areas is Maximized When Treatment Cells are Covered With a Uniform Distribution of Dense Vegetation

Lou Toth, Principal Ecologist and Eric Crawford, Scientist 3
VEGETATION MANAGEMENT

A number of factors, including excessive water depths, topographic irregularities, soil characteristics, wind and flow, herbivory, and seasonality can lead to localized, as well as widespread, declines in vegetation cover with associated impacts on water quality performance. In treatment cells dominated by emergent vegetation (EAV cells) density of cattail is often reduced by chronic exposure to high stormwater inflows, which result in water depths > 3 feet at the upstream ends of these cells. Expanses of submerged aquatic vegetation (SAV cells) are highly susceptible to uprooting by high velocity flows, can be decimated by herbivory (grazing), and typically undergo a winter dieback of varying proportions.



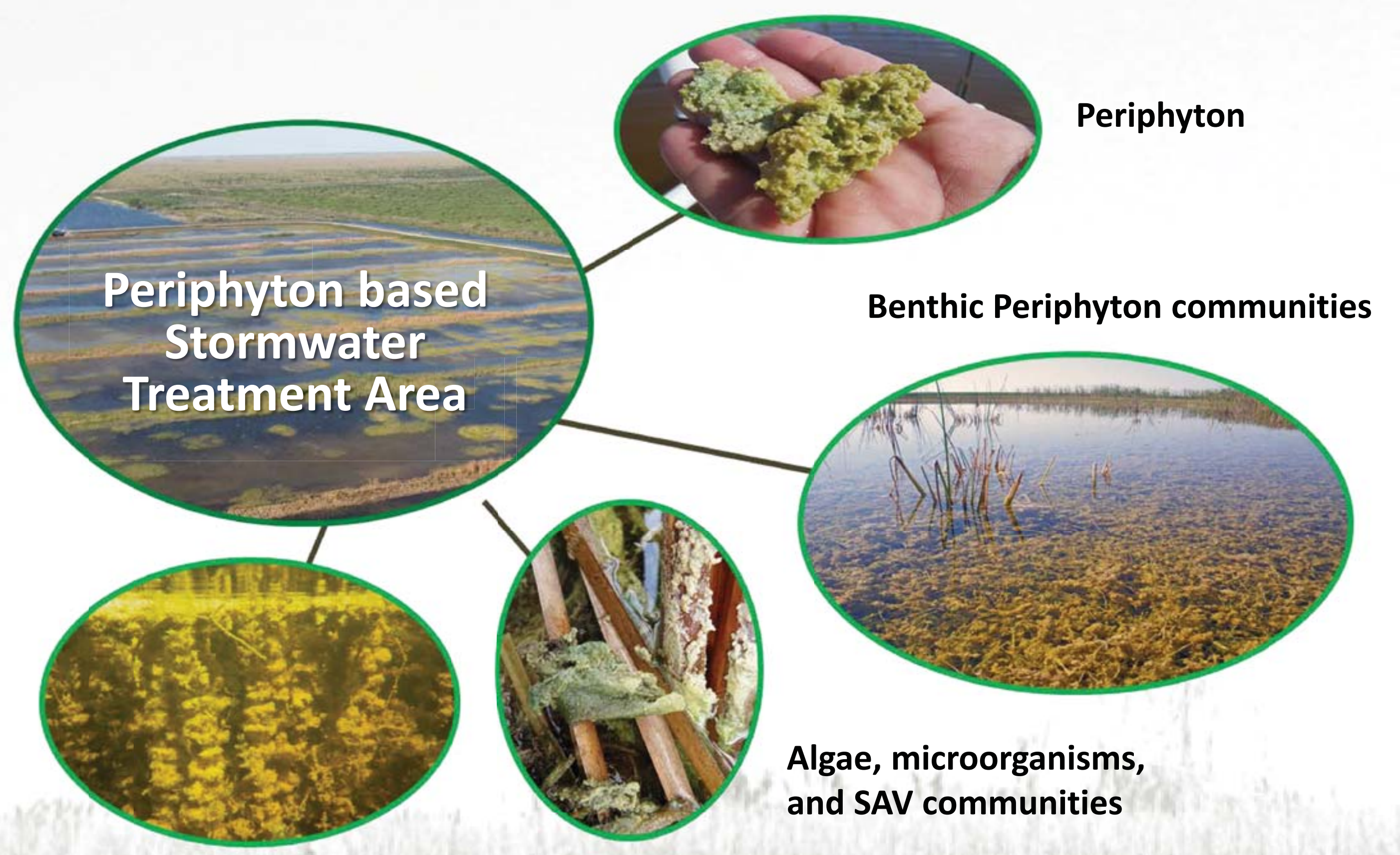
EAV cells are periodically revitalized with plantings of giant bulrush and alligator flag, which are more tolerant of deep water conditions than cattail. Giant bulrush and alligator flag also are planted to compartmentalize SAV cells, which provides a buffer from wind and flow and prevents beds of submerged plants from uprooting. Inoculations of southern naiad provide "founder sites" for revitalization of SAV cells.



INVESTIGATION OF STA 3/4 PERIPHYTON-BASED STORMWATER TREATMENT AREA (PSTA) PERFORMANCE, DESIGN, AND OPERATIONAL FACTORS

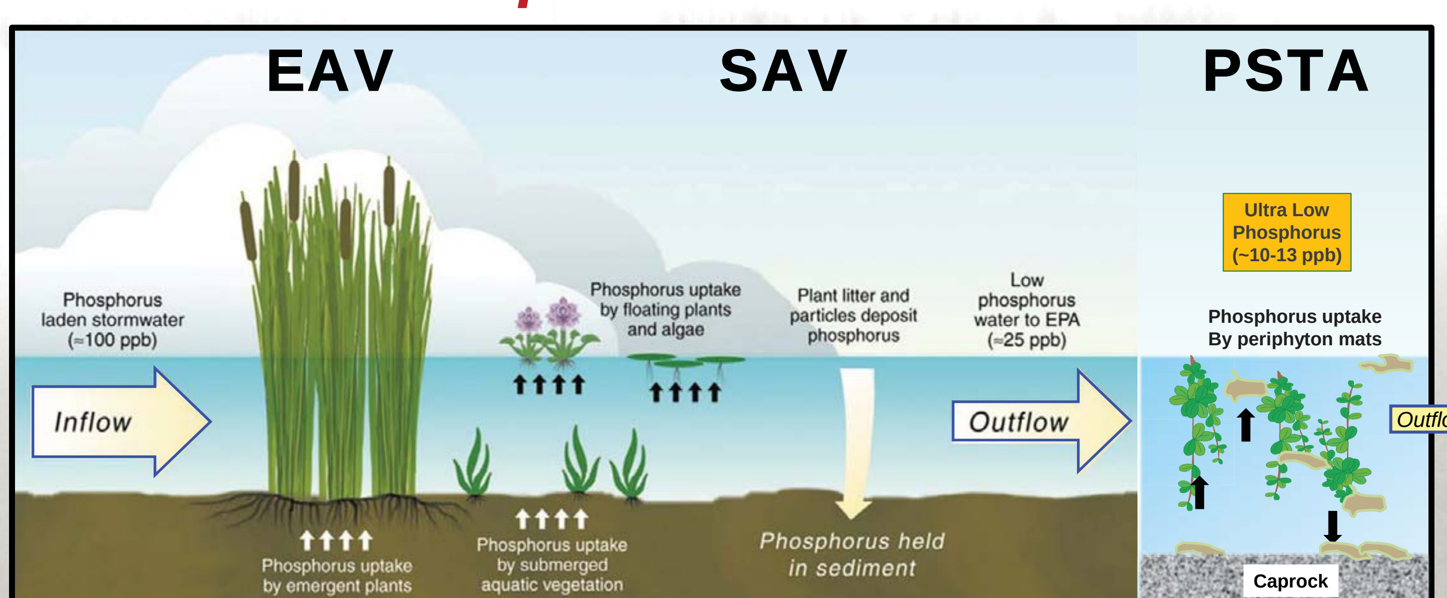
MANUEL F. ZAMORANO, DELIA IVANOFF, TRACEY PICCONE, HONGYING ZHAO, ORLANDO DIAZ, RICHARD JAMES, ERIC FLAIG

What is PSTA?

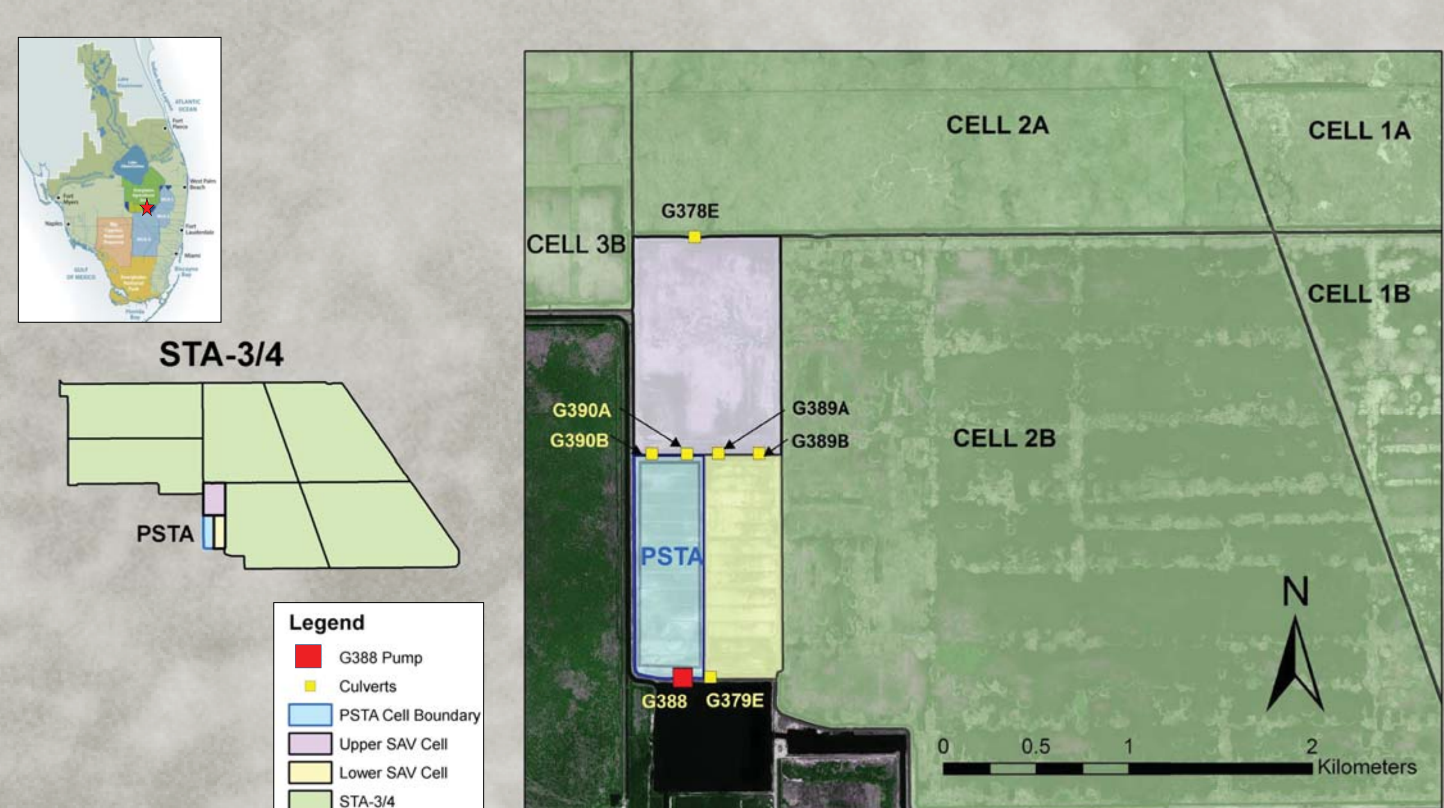


Concept

Phosphorus reduction

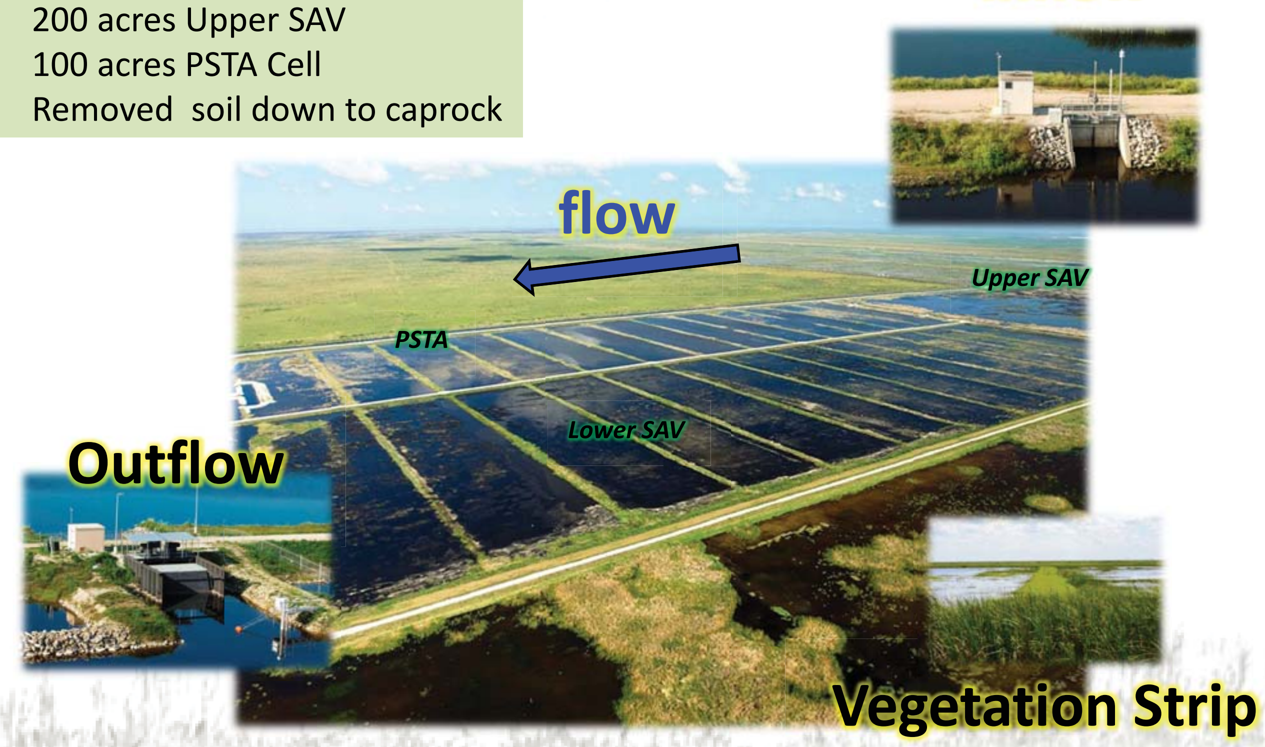


Where is PSTA?



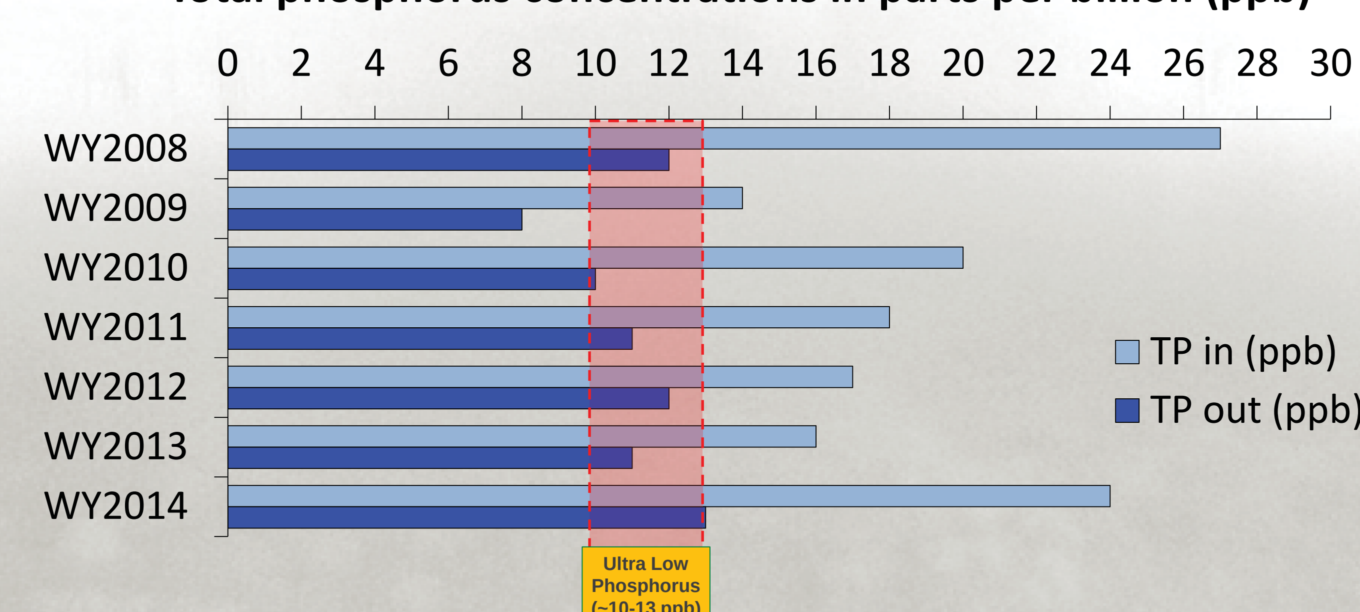
STA-3/4 PSTA

- 400 acres Total
- 200 acres Upper SAV
- 100 acres PSTA Cell
- Removed soil down to caprock

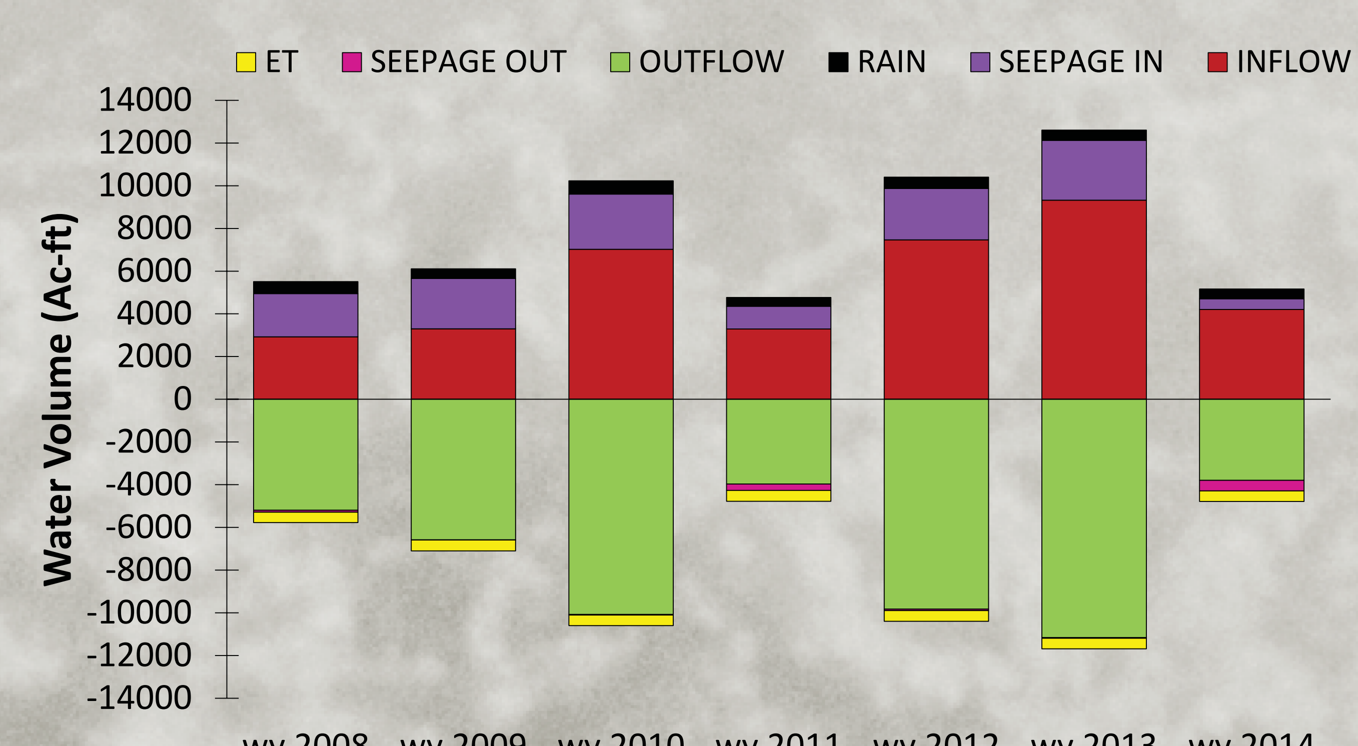


Why PSTA?

Performance



Water Budget



Objective → Determine

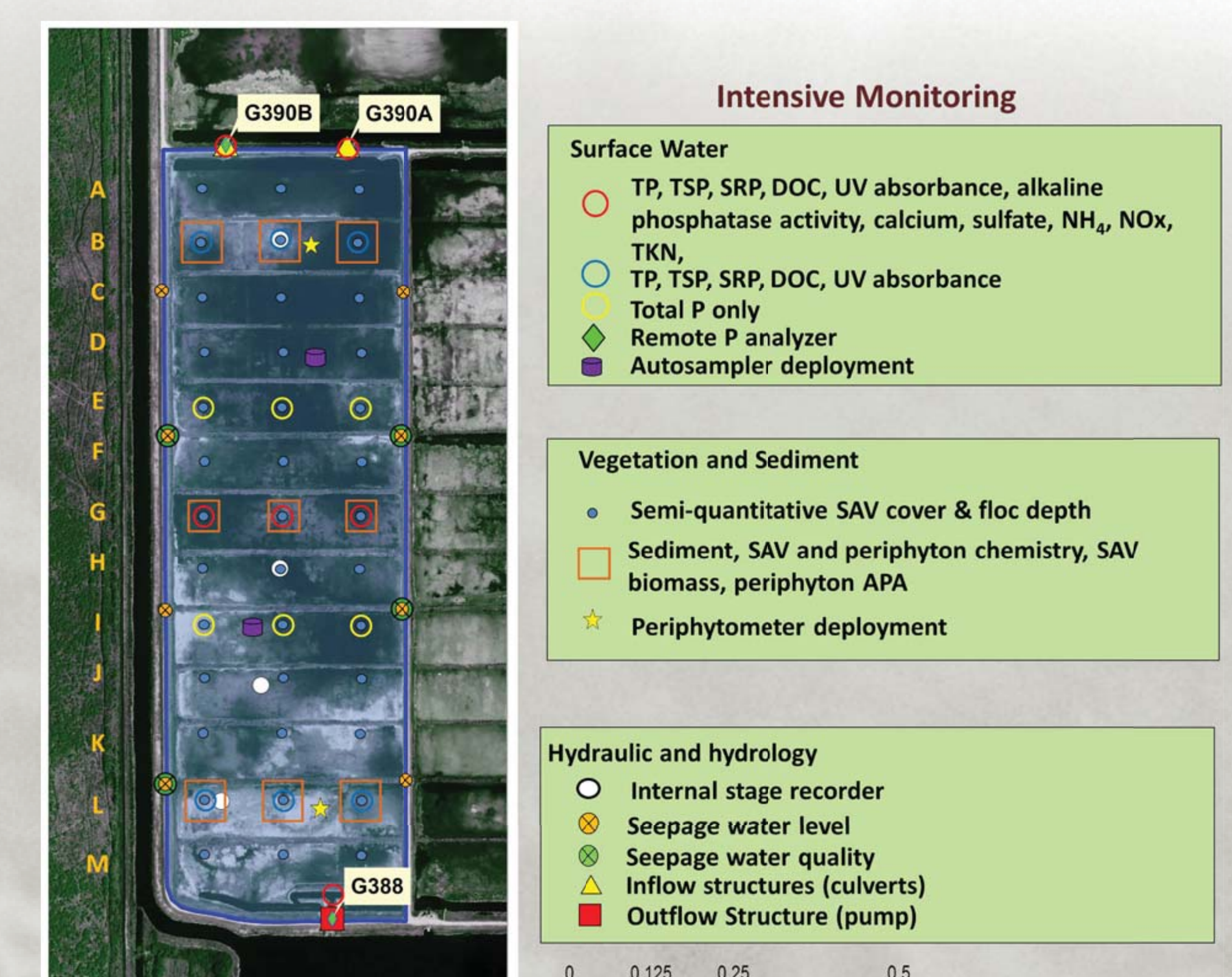
- What are the important design elements that enable the PSTA Cell to achieve ultra-low outflow TP levels?
- What are the key operational ranges that enable the PSTA Cell to achieve ultra-low outflow TP levels?
- What management practices are required to sustain the PSTA Cell's good performance?

Guidelines

Full-scale implementation of the PSTA technology

How?

Evaluate the processes that create ultra-low TP concentrations in PSTA



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AUGUST, 2014

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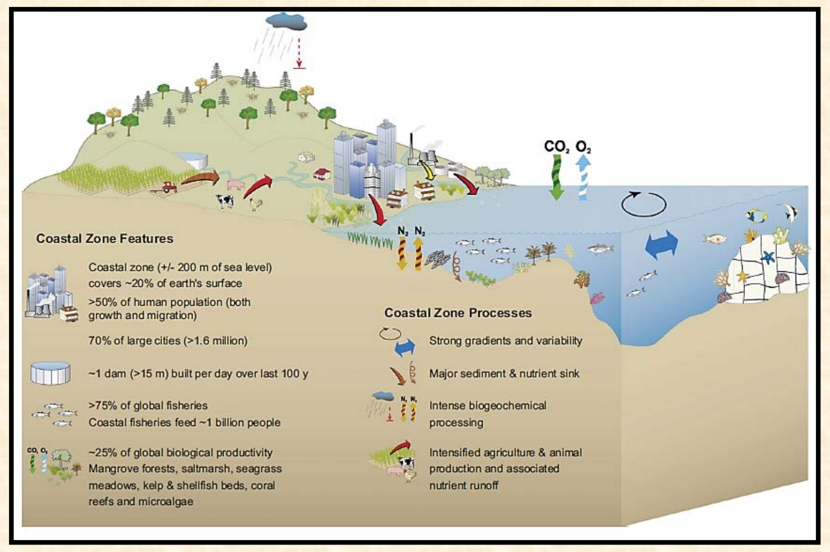
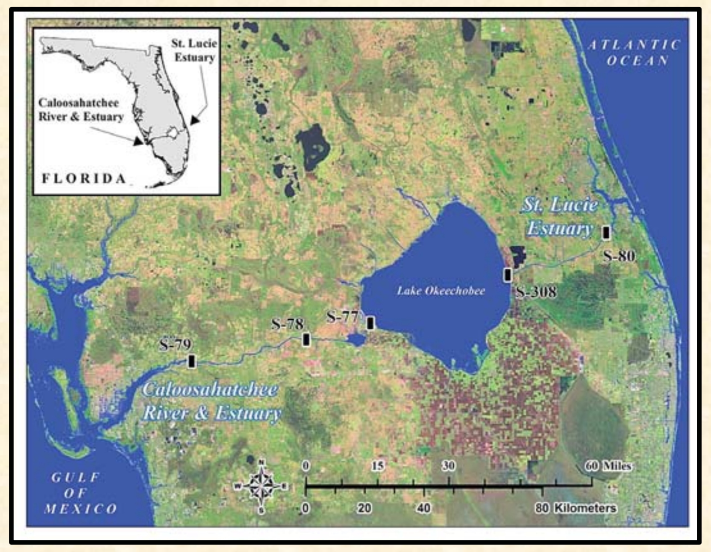
Seasonal Dissolved Inorganic Nitrogen and Phosphorus Budgets for Two Sub-tropical Estuaries in South Florida

Christopher Buzzelli, Ph.D, Sr. Scientist, Peter Doering, Ph.D, Section Administrator, and
Yongshan Wan, PhD, Section Leader, Coastal Ecosystems Section, Applied Sciences Bureau, South Florida Water Management District
Joseph N. Boyer, Ph.D, Director, Center for the Environment and Department of Environmental Science and Policy, Plymouth State University





Introduction

- Landscape-scale factors include climate, agriculture, development, Lake Okeechobee outflow, managed inflow, and tropical storms
- Geomorphology, inflow, circulation, and internal biogeochemistry determine estuary responses to external nutrient loading
- The goal of this study was to develop seasonal dissolved inorganic nitrogen (DIN) and phosphorus (DIP) budgets for the two estuaries in south Florida, the Caloosahatchee River Estuary (CRE) and the St. Lucie Estuary (SLE), from 2002-2008

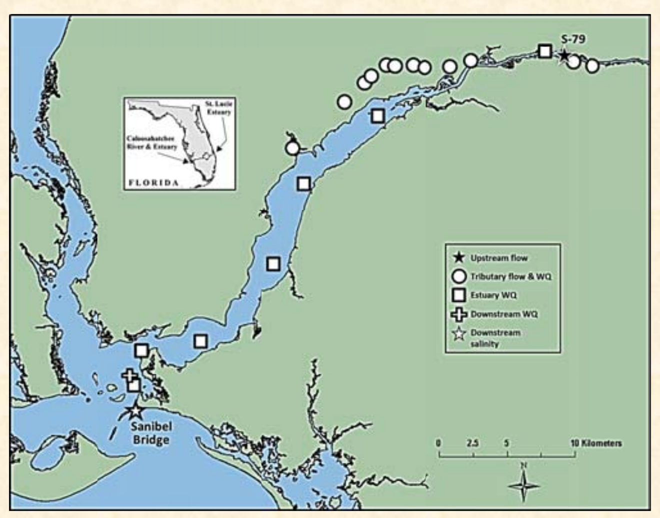
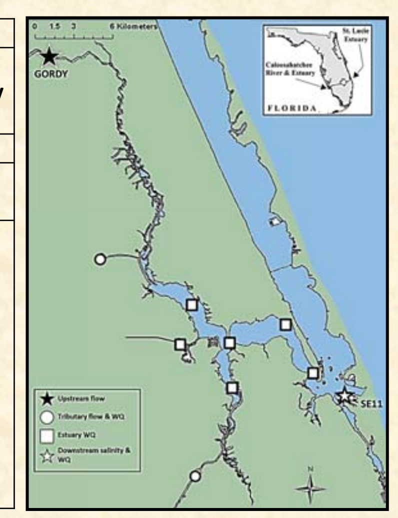


Table 1. Summary of data sources for water, salt, and nutrient budgets.

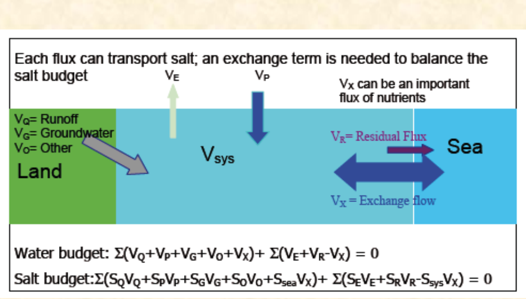
Abbreviation	Unit	CRE	SLE
V_{rain}	10^6 m^3 d^{-1}	Nexrad	Nexrad
V_Q	10^6 m^3 d^{-1}	DBHydro S-79	DBHydro S484980 +Gordy
V_{TGW}	10^6 m^3 d^{-1}	Tidal basin model	30% of total Q
V_E	10^6 m^3	Interpolated bathymetry	Interpolated bathymetry
S_E		DBHydro CES stations	DBHydro SE stations
S_O		Shell Point daily model	DBHydro station SE-11
DIP_{rain}	g m^{-3}	DBHydro averages	DBHydro averages
DIP_{Qc}	g m^{-3}	Lee County Stations	DBHydro S-484980
DIP_{TGW}	g m^{-3}	Lee County Stations	DBHydro S-484980
DIP_E	g m^{-3}	DBHydro CES stations	DBHydro SE stations
DIP_O	g m^{-3}	Lee County Stn. PI-01	DBHydro station SE-11
DIN_{rain}	g m^{-3}	NADP St. Petersburg, FL	NADP St. Petersburg, FL
DIN_{Qc}	g m^{-3}	DBHydro station S-79	DBHydro S-484980
DIN_{TGW}	g m^{-3}	Lee County Stations	DBHydro S-484980
DIN_E	g m^{-3}	DBHydro CES stations	DBHydro SE stations
DIN_O	g m^{-3}	Lee County Stn. PI-01	DBHydro station SE-11



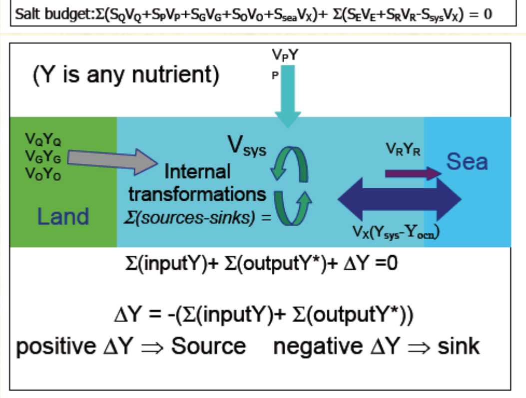
Methods

- Applied the Land Ocean Interactions in the Coastal Zone (LOICZ; http://www.loicz.org/) approach
- Seasonal DIN and DIP budgets 2002-2008 for CRE and SLE (2 estuaries x 2 seasons x 7 years x 2 nutrients = 56 budgets)
- Spatial and vertical boundaries for both estuaries
  CRE = S-79 to Sanibel Bridge = 56.9 km^2; 2.4 m depth; V_{CRE} = 140 x 10^6 m^3
  SLE = (S-49 + S-48 + S-80 + Gordy Rd.) to St. Lucie Inlet = 22.0 km^2; 2.7 m depth; V_{CRE} = 53 x 10^6 m^3
- Required data
  Rainfall (Q_{rain}), upstream inflow (Q_0), inflow from tributaries and ground water (Q_{TGW})
  Salinity, DIN and DIP in rainfall, inflow, and oceanic boundaries (DIN_{rain}, DIP_{rain}, DIN_{Qc}, DIP_{Qc}, DIN_{TGWc}, DIP_{TGWc}, DIN_O, DIP_O, S_O)
  Salinity, DIN and DIP in the CRE and SLE (S_E, DIN_E, DIP_E)
- Assumptions & Calculations
  Steady-state condition at seasonal scale
  Water budget and salt budget used to estimate net exchange between estuary and ocean boundary
  Difference between inputs and exchange = Net production or consumption of DIN and DIP (ΔDIN or ΔDIP)
  Redfield stoichiometry (C:N:P = 106:16:1) used to calculate Net Ecosystem Metabolism (NEM)
  Difference between actual and expected ΔDIN used to calculate relative denitrification ($N_{fix}D$)
- Output
  DIN and DIP loadings (DIN_Q and DIP_Q; g m^{-2} d^{-1}); Flushing time (T_f; days)
  ΔDIN or ΔDIP (g m^{-2} d^{-1}); NEM (g C m^{-2} d^{-1}); $N_{fix}D$ (g N m^{-2} d^{-1})

Water & Salt Budgets



Nutrient Budgets



Photosynthesis-respiration

$$106CO_2 + 16H^+ + 16NO_3^- + H_3PO_4 + 122H_2O$$
$$\rightarrow (CH_2O)_{106}(NH3)_{16}H_3PO_4 + 138O_2$$

Net Ecosystem Metabolism

$$NEM = [p - r] = -\Delta DIPx(\frac{C}{P})_{part}$$

Expected Net Nitrogen Change

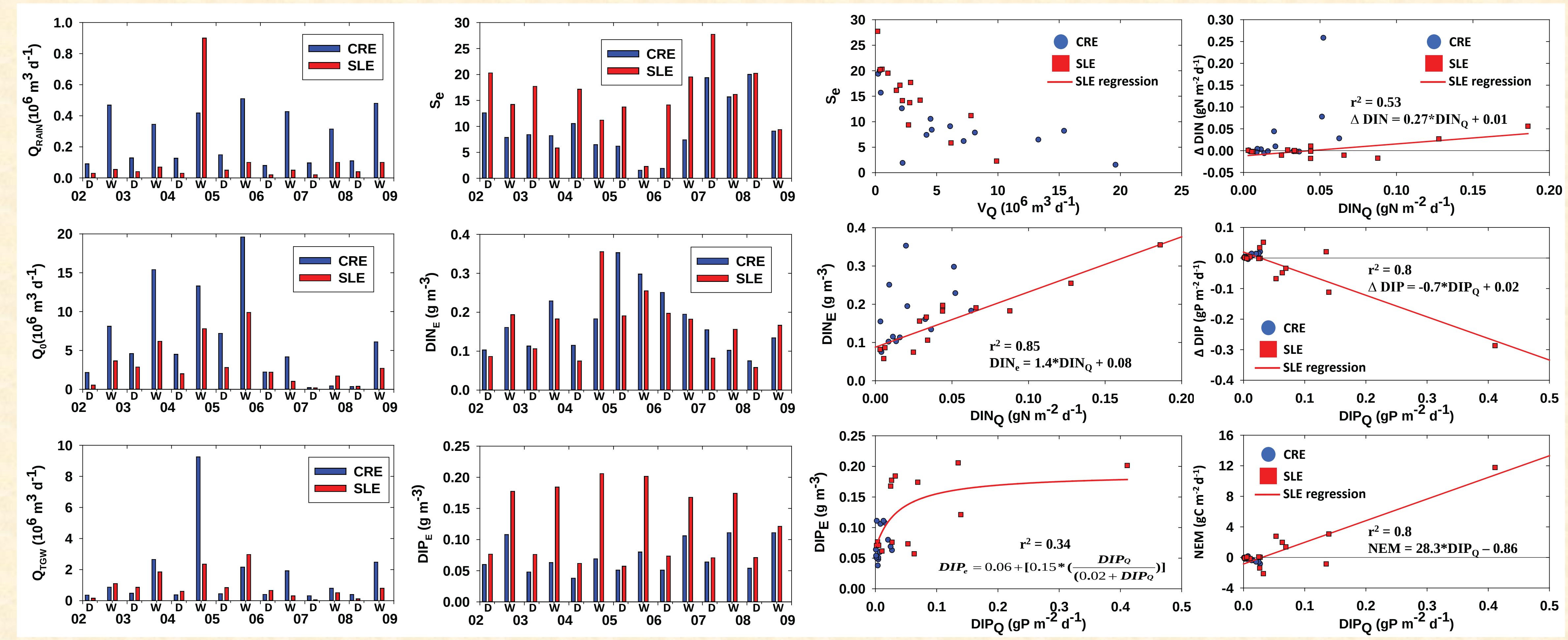
$$\Delta N_x = (\Delta DIN + \Delta DON)_x = (\Delta DIP + \Delta DOP)x(\frac{N}{P})_{part}$$

Actual Net Nitrogen Change

$$N_{fix}D = nfix - denit = \Delta N - \Delta P*(N:P)_{part}$$

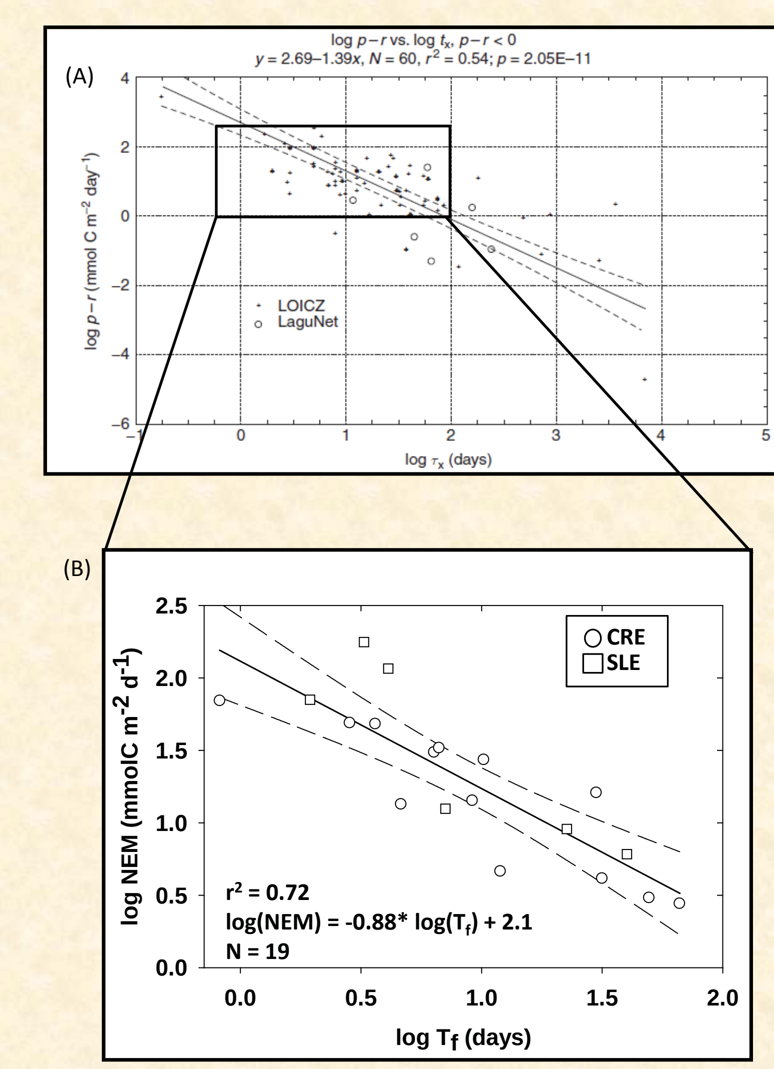
Results

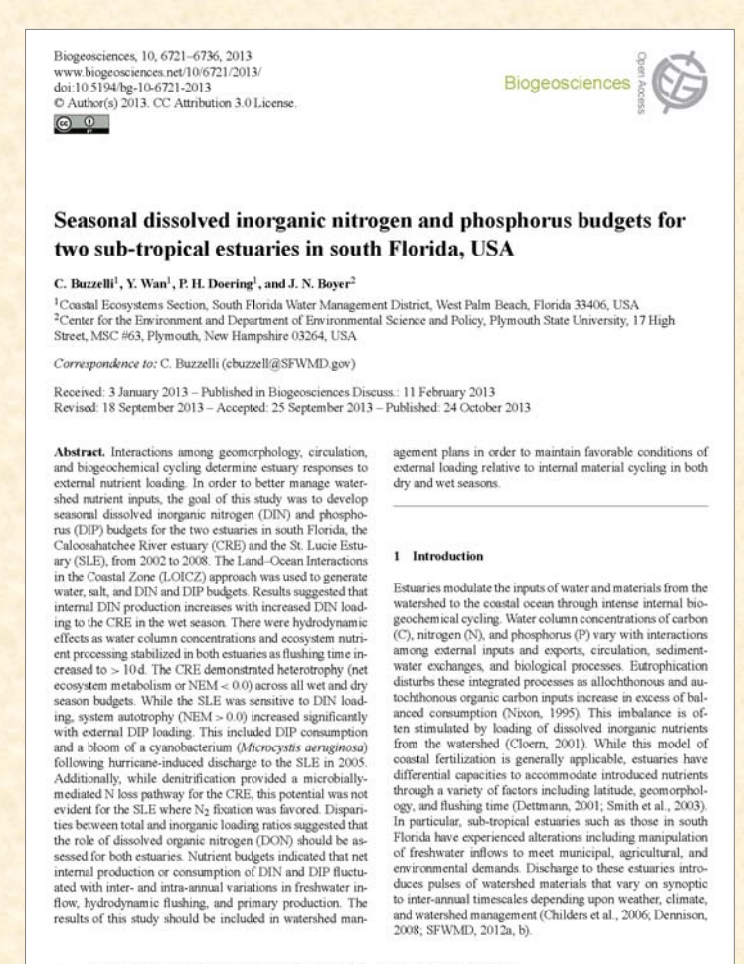
- Q_{RAIN} to CRE varied more seasonally; rainfall to SLE varied more inter-annually including extreme in 2004
- Q_0 and Q_{TGW} to both estuaries varied seasonally and inter-annually. Freshwater inflow inverse to salinity in both estuaries
- DIN concentrations greater in wet season and similar between CRE and SLE except in 2004-05; DIN_E followed inter-annual variations in freshwater inflow
- DIP concentrations similar between dry and wet seasons in CRE and inverse to inflow; DIP_E much greater and more seasonal in SLE over all inflows
- DIN_E increased linearly with DIN_Q to SLE; DIP_E increased hyperbolically with DIP_Q to SLE; No discernable relationships between loading and concentrations in CRE
- Slight net production of DIN (ΔDIN > 0.0) with increased DIN_Q to both estuaries. Net consumption of DIP (ΔDIP < 0.0) with DIP_Q in SLE. No response of CRE to DIP_Q
- NEM > 0.0 (autotrophic) with increased DIP_Q to the SLE . NEM ≤ 0.0 (heterotrophic) in CRE
- Net denitrification in CRE, net N_2-fixation in the SLE



Significance

- DIN_E in the CRE influenced by internal cycling including increased rates of primary production, remineralization and denitrification in the wet season. Sediment –water interface probably important as DIN sink in the CRE.
- DIN_E in the SLE less predictable and more affected by net N_2 fixation. Denitrification not a DIN sink in the SLE. Water column and sediment environments less connected in the SLE
- SLE responds to DIP_Q with large increased in primary production. Potential for export of surplus DIN with increased DIP_Q
- CRE 2.5 times larger and receives twice the Q_0 as the SLE, but DIN_Q and DIP_Q are 60-70% those to the SLE
- C, N, P cycling in both estuaries enhanced when T_f ≤ 10 d; decrease and stabilize in both estuaries when T_f > 10 d
- Negative relationship between log(T_f) and log(NEM) similar to other estuaries when p – r < 0.0

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doi:10.5194/bg-10-6721-2013

Biogeosciences Open Access

Seasonal dissolved inorganic nitrogen and phosphorus budgets for two sub-tropical estuaries in south Florida, USA

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Abstract. Interactions among geomorphology, circulation, and biogeochemical cycling determine estuary responses to external nutrient loading. In order to better manage watershed nutrient inputs, the goal of this study was to develop seasonal dissolved inorganic nitrogen (DIN) and phosphorus (DIP) budgets for the two estuaries in south Florida, the Caloosahatchee River estuary (CRE) and the St. Lucie Estuary (SLE), from 2002 to 2008. The Land–Ocean Interactions [...] agement plans in order to maintain favorable conditions of external loading relative to internal material cycling in both dry and wet seasons.

1 Introduction

Published by Copernicus Publications on behalf of the European Geosciences Union.

Table 2. Comparison of estuarine attributes.

Attribute	Unit	CRE	SLE	CRE:SLE
Surface Area	km^2	56	22	2.5
T_f	d	18.4	11.4	1.6
Q	10^6 m^3 d^{-1}	6.3	3.1	2.0
DIP_Q	g P m^{-2} d^{-1}	0.003	0.005	0.6
DIN_Q	g N m^{-2} d^{-1}	0.005	0.007	0.7
ΔDIP	g P m^{-2} d^{-1}	0.014	-0.031	
ΔDIN	g N m^{-2} d^{-1}	0.055	0.002	
NEM	g C m^{-2} d^{-1}	-0.544	1.171	
$N_{fix}D$	g N m^{-2} d^{-1}	-0.043	0.228	
Trophic Status	p vs. r	heterotrophic	autotrophic	

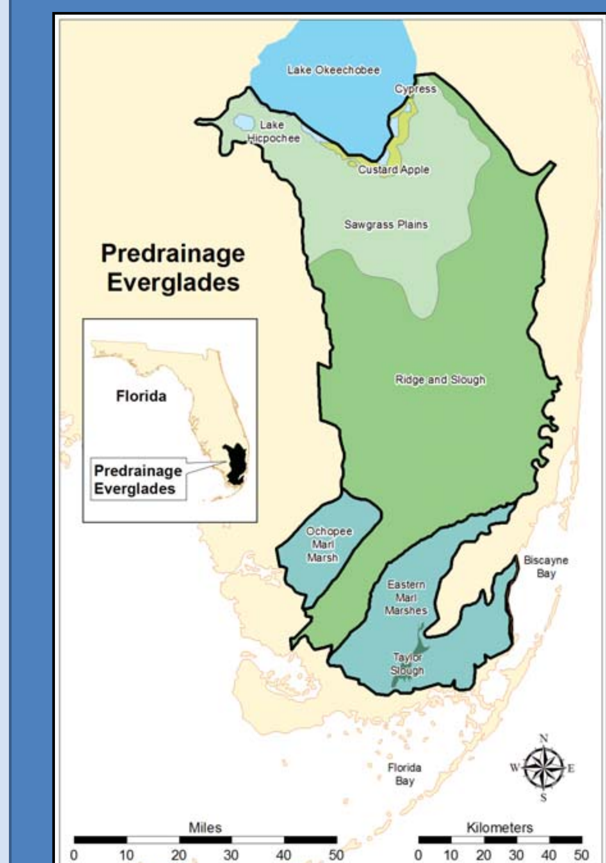
Prepared for the Indian River Lagoon Symposium, 2014- *The Lagoon Makes us All Neighbors*, February, 2014, Christopher Buzzelli (cbuzzell@sfwmd.gov)

ESTIMATING THE PEAT OF THE PREDRAINAGE AND CURRENT EVERGLADES

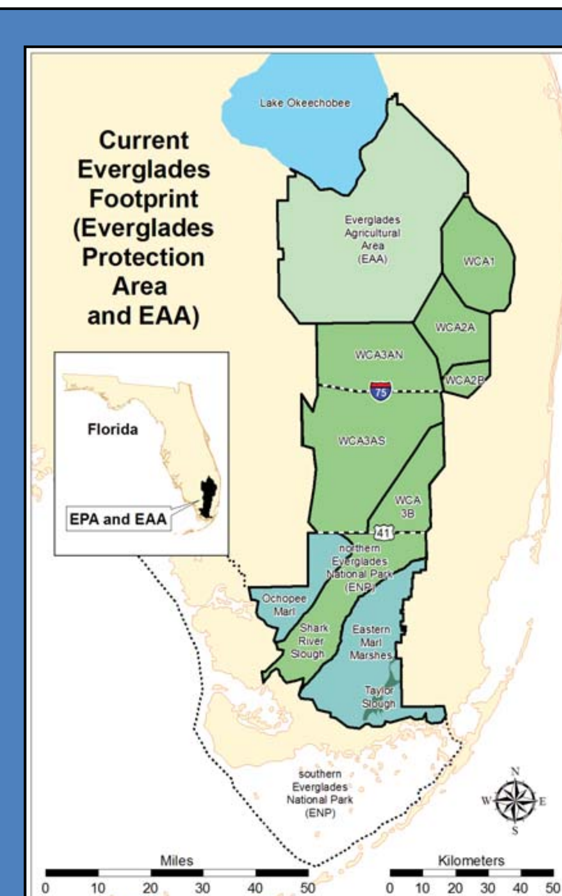
Susan M. Hohner, Sr. Geographer and Thomas W. Dreschel, Section Leader

EVERGLADES SYSTEMS ASSESSMENT, APPLIED SCIENCES BUREAU

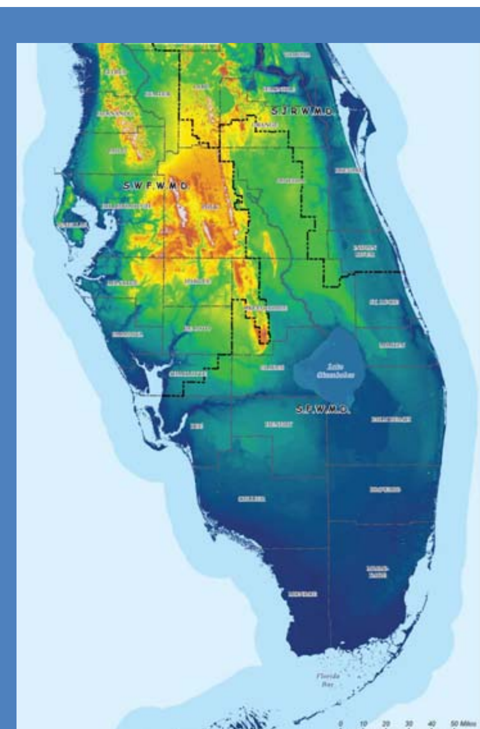
- **Peat is a primary component of the CERP Performance Measure for Ridge and Slough Landscape**
- **Peat is critical for the creation of Habitat for Wildlife under the Everglades Forever Act**

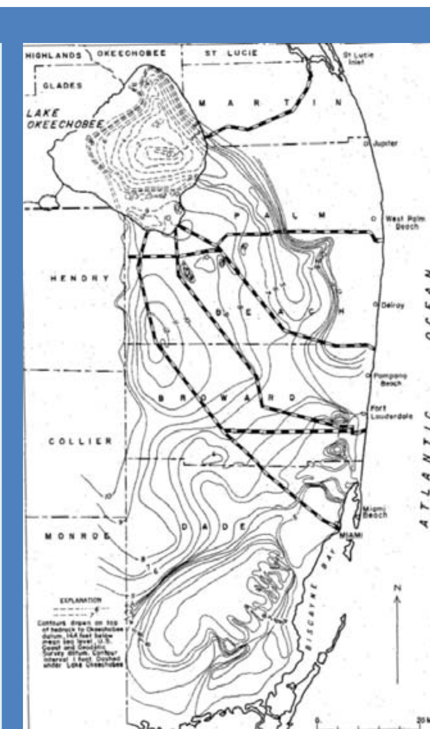


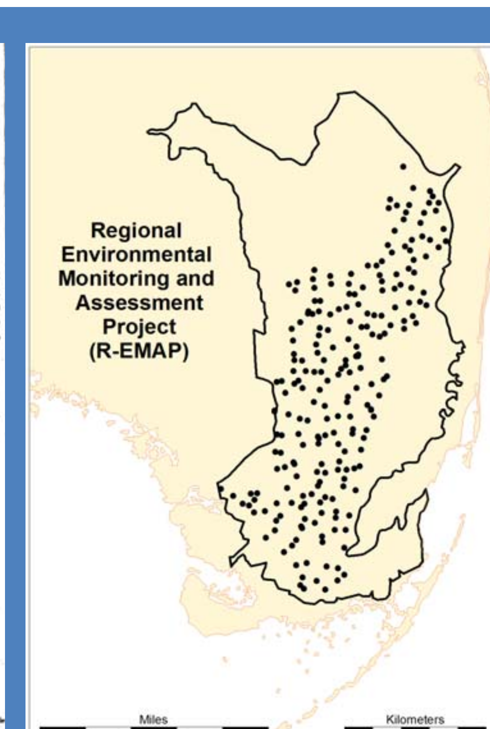
The current Everglades is about one-half of the AREA, but less than one-fourth of the PEAT volume, mass and carbon of the predrainage Everglades



The Data Sets used for GIS Analysis





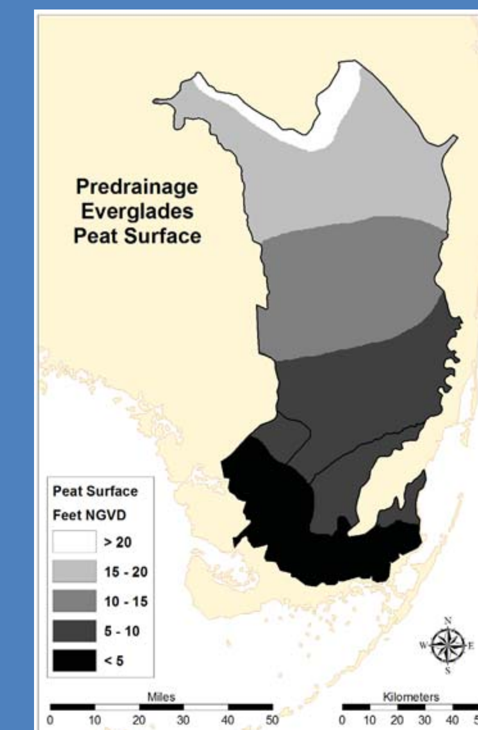


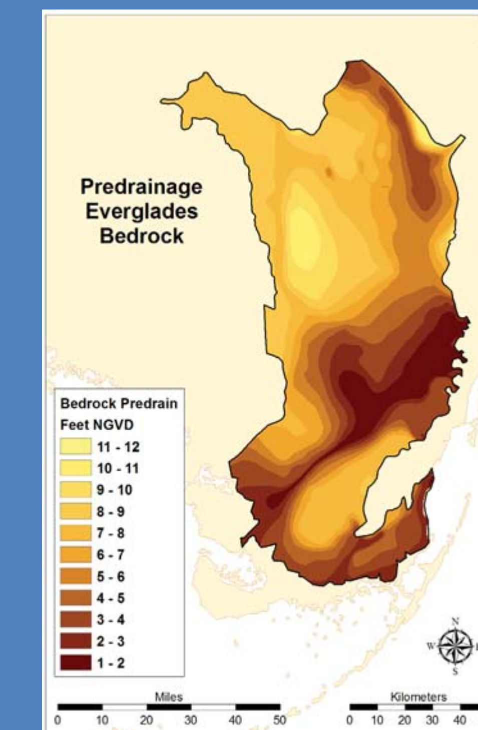
Predrainage Surface Elevation
Natural System Regional Simulation Model

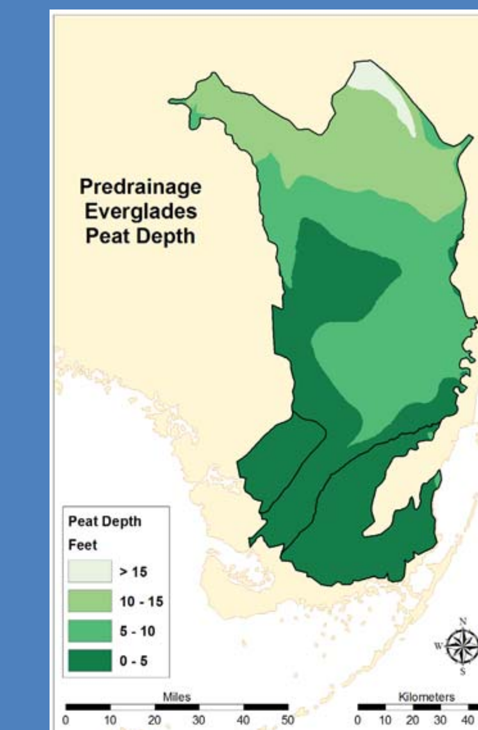
Current Surface Elevation
South Florida Topography Project

Bedrock Elevation
Parker, et al., 1955

R-EMAP Soil Samples
USEPA, 1998
Regional Environmental Monitoring and Assessment Program

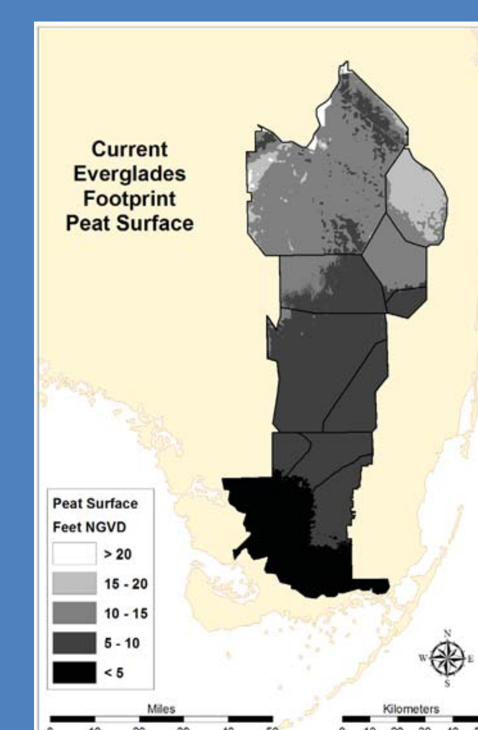


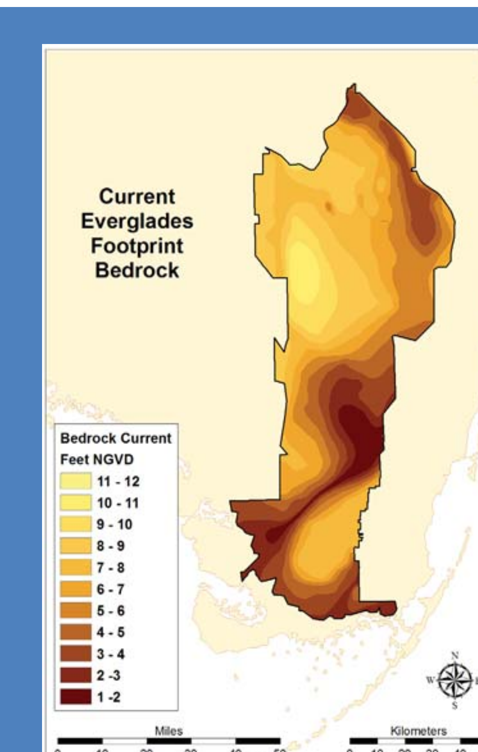


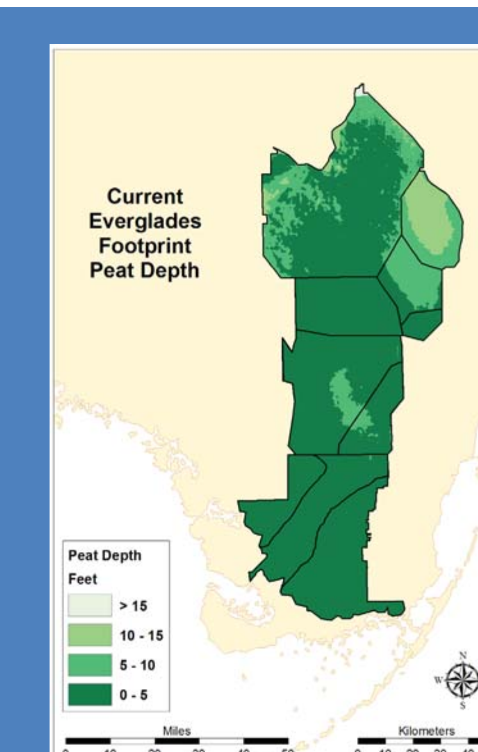


Surface Elevation minus Bedrock = Peat Depth

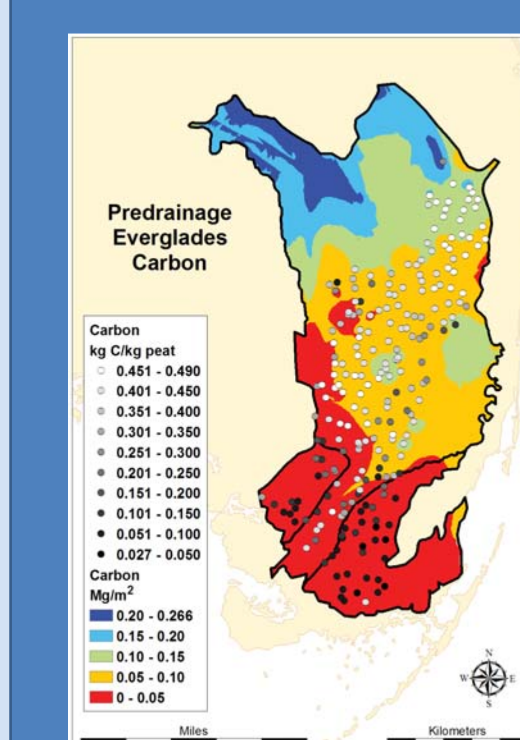
- **Predrainage Everglades had a peat volume of about 20 billion m^3**
- **Current Everglades has a peat volume of about 5 billion m^3**



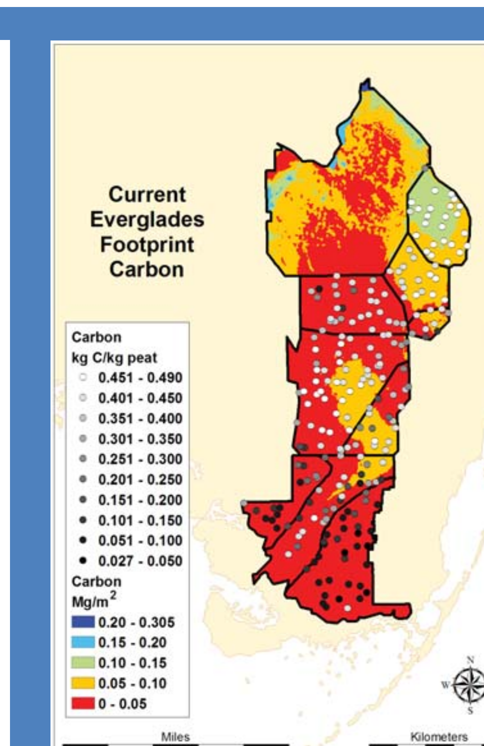




Carbon content derived from R-EMAP Soil samples



- **The predrainage Everglades contained about 900 million metric tons of carbon with an average peat depth of about 2 meters**
- **The current Everglades Protection Area contains about 200 million metric tons of carbon with an average peat depth of about ¾ meter**
- **The US produced 1,800 million metric tons of carbon (CO_2 emissions) in 2012 (USEPA)**



Susan M. Hohner and Thomas W. Dreschel
Everglades Systems Assessment Section, Applied Sciences Bureau
Prepared for the Water Resources Advisory Commission and SFWMD Governing Board, August, 2014

Evaluating Salinity Targets for Protecting Seagrass in the St. Lucie Estuary and Adjacent Indian River Lagoon

Becky Robbins, Mayra Ashton, Barbara Welch, and Beth Orlando - South Florida Water Management District, West Palm Beach, FL

ABSTRACT

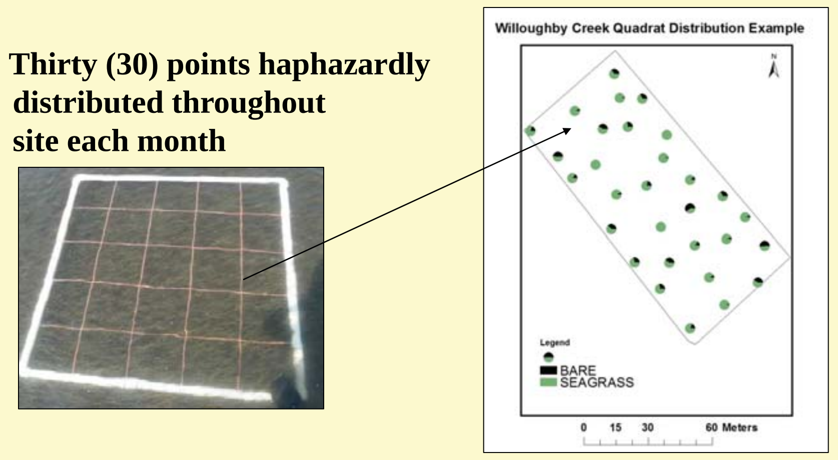
The St. Lucie Estuary (SLE) "salinity envelope" was established under the Indian River Lagoon Surface Water Improvement and Management Program to protect oysters and seagrass. The envelope is achieved when salinity is between 12 and 20 psu at the US1 Bridge, which results in salinities typically being greater than 20 psu in downstream seagrass beds. Salinity and seagrass data (2008 – 2013) were used to evaluate the appropriateness of the envelope for protecting seagrass. Seagrass percent occurrence typically declined when salinity fell below the envelope with recovery occurring when salinities were within or above the envelope. In 2010/2011, salinity exceeded the envelope's upper limit for over 8 months and then rapidly declined. Even though salinity remained within seagrass tolerance ranges during this decline, seagrass percent occurrence decreased. Maintaining salinity within the envelope would prevent steep salinity declines and result in favorable salinities suggesting the envelope is appropriate for protecting seagrass.

STUDY AREA

Figure 1. Automatic salinity recorders are located on the A1A and US1 bridges, seagrass is monitored near the mouth of the St. Lucie Estuary (WILL_CR). Salinity targets set/measured at US1.

METHODS

- Thirty (30) points haphazardly distributed throughout site each month



- Each point monitored using a 1m^2 quadrat subdivided into 25 equal quadrants
- Number of quadrants containing seagrass counted
- Seagrass percent occurrence per quadrat calculated by dividing the number of quadrants occupied by seagrass by total possible (25) then multiplying by 100
- Percent occurrence for entire site calculated as the quadrat percent occurrence (N=30) averaged for each month

SALINITY

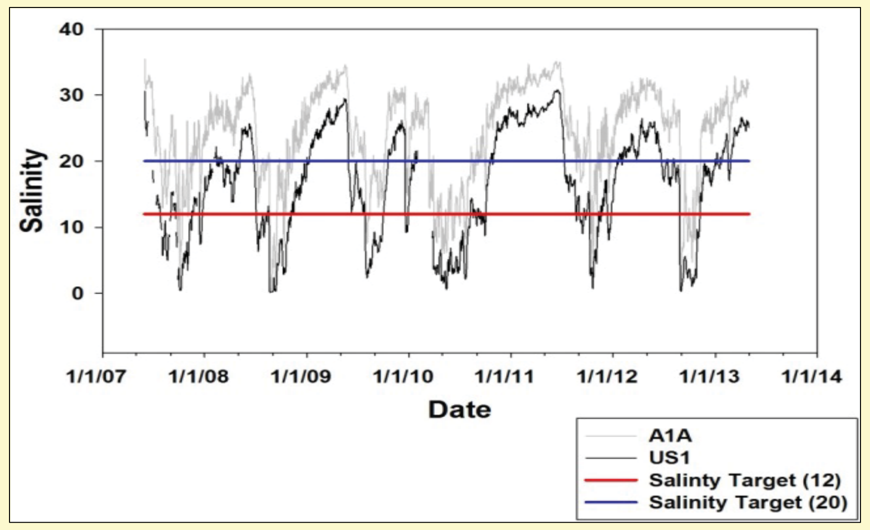


Figure 2. Daily average salinity.

- Salinity patterns similar at both bridges with A1A values higher
- Targets ("salinity envelope": 12 – 20 psu at US1) rarely met during study period
- Consecutive days within the salinity envelope rarely exceeded 30 days (seagrass monitoring typically conducted monthly)

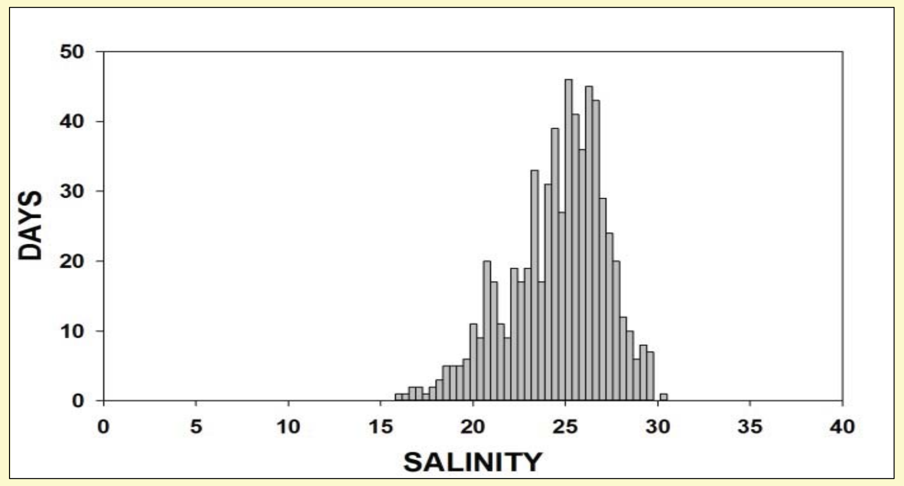


Figure 3. Frequency distribution of daily average salinity at A1A when salinity envelope met at US1.

When salinity envelope was met:

- Salinity at A1A was above 20 psu, 96 percent of the time
- Salinity never fell below 16 psu

SEAGRASS

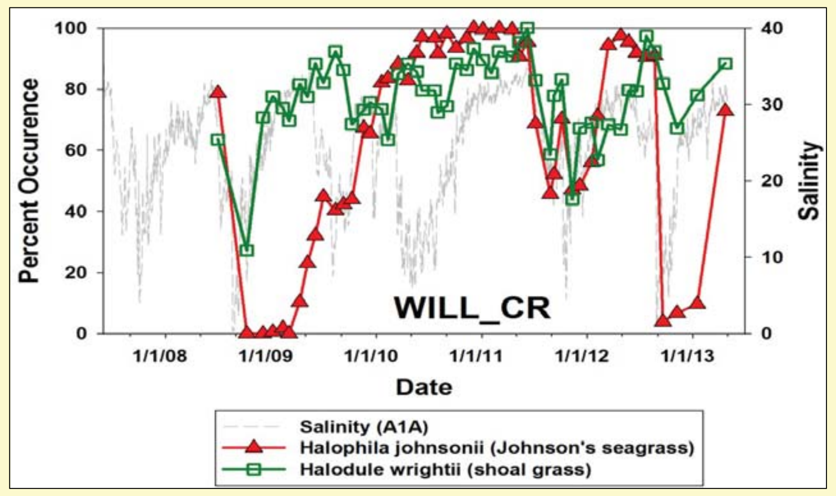


Figure 4. Seagrass percent occurrence over time.

- The most upstream, persistent seagrass bed in the St. Lucie Estuary is located near Willoughby Creek; the South Florida Water Management District monitors seagrass at this location (WILL_CR: Figure 1)
- Two seagrass species present at the WILL_CR site:
  - *Halophila johnsonii* (Johnson's seagrass)
  - *Halodule wrightii* (Shoal grass)

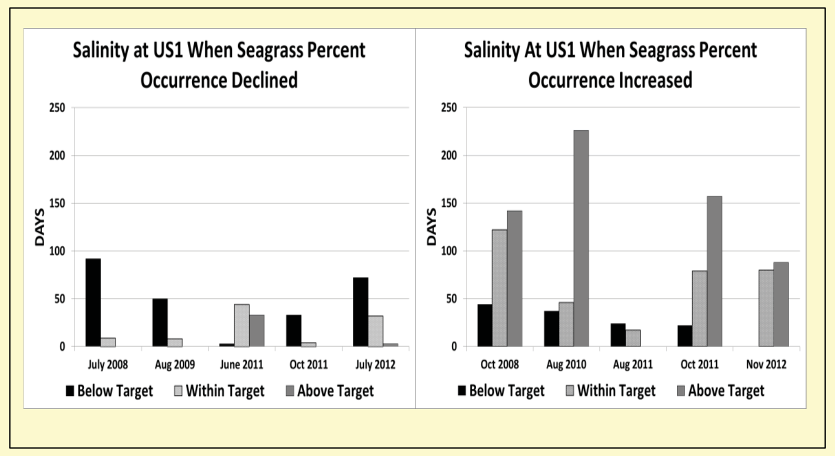


Figure 5. Salinity at US1 associated with changes in percent occurrence at WILL_CR (Below target = salinity < 12; Within target = salinity ≥ 12 and ≤ 20; Above target = salinity > 20.)

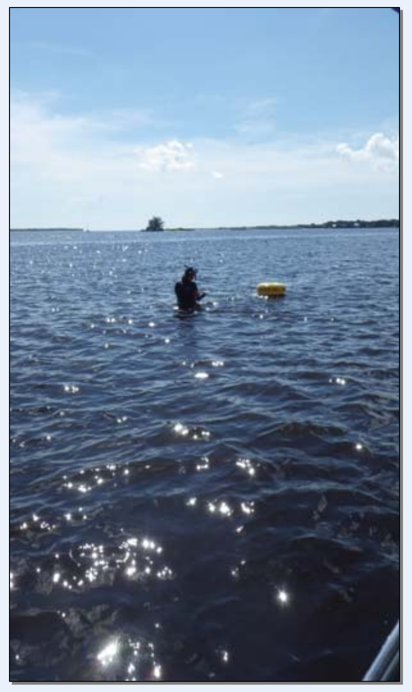
- Seagrass percent occurrence increases were typically associated with salinity above 12 psu at US1
- Seagrass percent occurrence declines were most often associated with US1 salinities below 12 psu
- Exception: percent occurrence declined during the growing season in 2011 following a prolonged (8.5 month) period where salinity was above the 20 psu target then fell sharply but stayed above 12 psu target. Salinity fell from 35 to 18 psu at A1A and seagrass percent occurrence declined

CONCLUSIONS

- The lower salinity target of 12 psu at US1 appears to be appropriate for maintaining seagrass beds near the mouth of the SLE and in the adjacent Southern Indian River Lagoon
- Achieving the upper target of 20 psu at US1 would result in less salinity variability than currently occurs and is expected to provide appropriate conditions for seagrass growth
- The percent occurrence patterns observed suggest that even when salinity is within generally accepted seagrass salinity ranges (Irlandi 2006), rapid/steep drops in salinity may lead to declines in seagrass percent occurrence (mesocosm studies would help evaluate this hypothesis)
- Seagrass recovery took from 8 to 17 months for Johnson's seagrass and 8 to 10 months for shoal grass

BOTTOM LINE

Maintaining salinity within the salinity envelope would prevent steep salinity declines and result in favorable salinities for protection of seagrasses.



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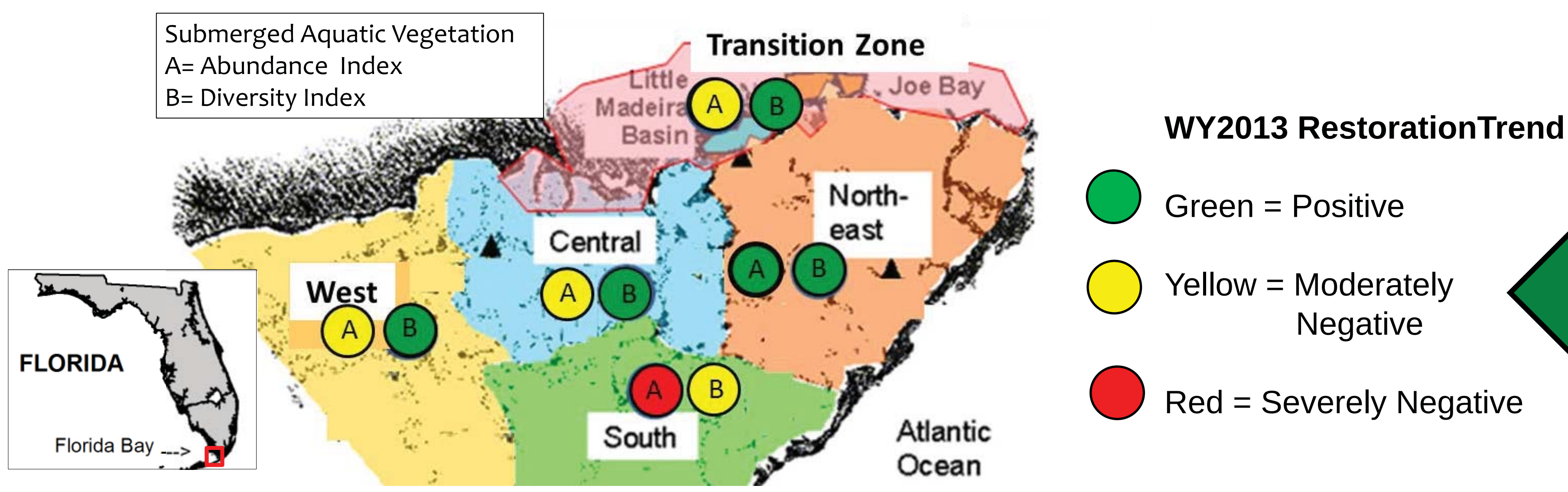
Becky Robbins (brobbins@sfwmd.gov), Indian River Lagoon Symposium – Lagoon Biodiversity -February 2014.

Spatial Mapping of Florida Bay to Reduce Management Complexity

Joseph Stachelek, Scientist 3; Christopher Madden, Environmental Scientist Lead; Amanda Mcdonald, Staff Environmental Scientist
EVERGLADES SYSTEMS ASSESSMENT – APPLIED SCIENCES BUREAU – WATER RESOURCES DIVISION

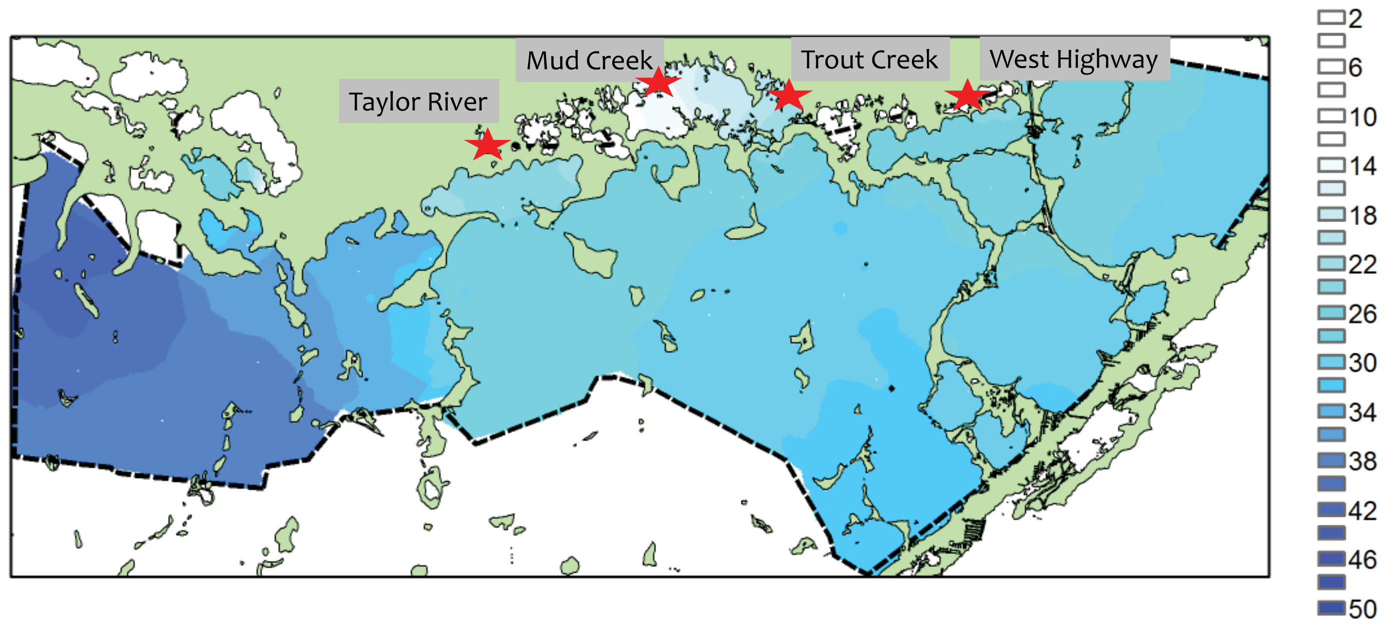
Stoplight indicators are used to track restoration progress from an ecological perspective



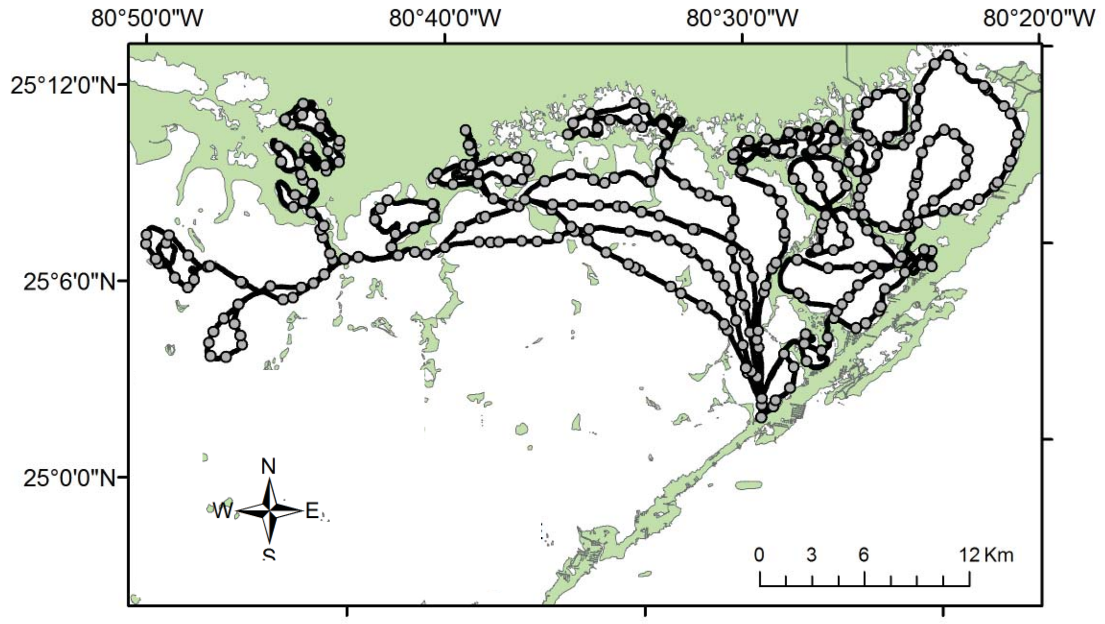
Spatial differences show that restoration trends differ across each Florida Bay basin

Current restoration efforts such as the C-111 Spreader Canal Western Features Project are aimed at shifting water to western areas of the bay

Discharges from the major freshwater input points are concentrated in the eastern Transition Zone

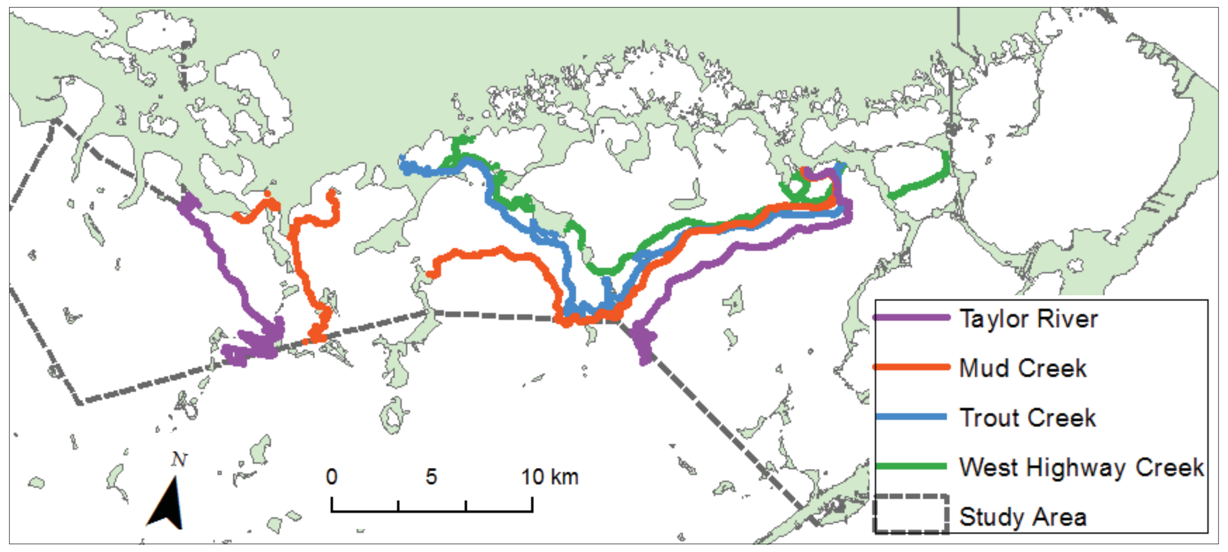


- Ongoing synoptic surveys are tracking the response of different areas of the bay to restoration
- A boat mounted flow-through collection system is used to make thousands of closely spaced surface water measurements across the bay in a single survey



- Distributed monitoring approaches involving District synoptic surveys and stoplight indicators are well positioned to detect restoration progress

However, surface water conditions are more widely related to discharge from the western freshwater input points



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A Model and Water Quality Management: The Study of Lake Okeechobee

R. Thomas James, Lead Scientist, Lake and River Ecosystems

"Models tell you what you know, what you don't know, and what you should know"

– Dick Wiegert, Ecologist, University of Georgia

"Essentially, all models are wrong, but some are useful"

– George E. P. Box, Statistician, University of Wisconsin

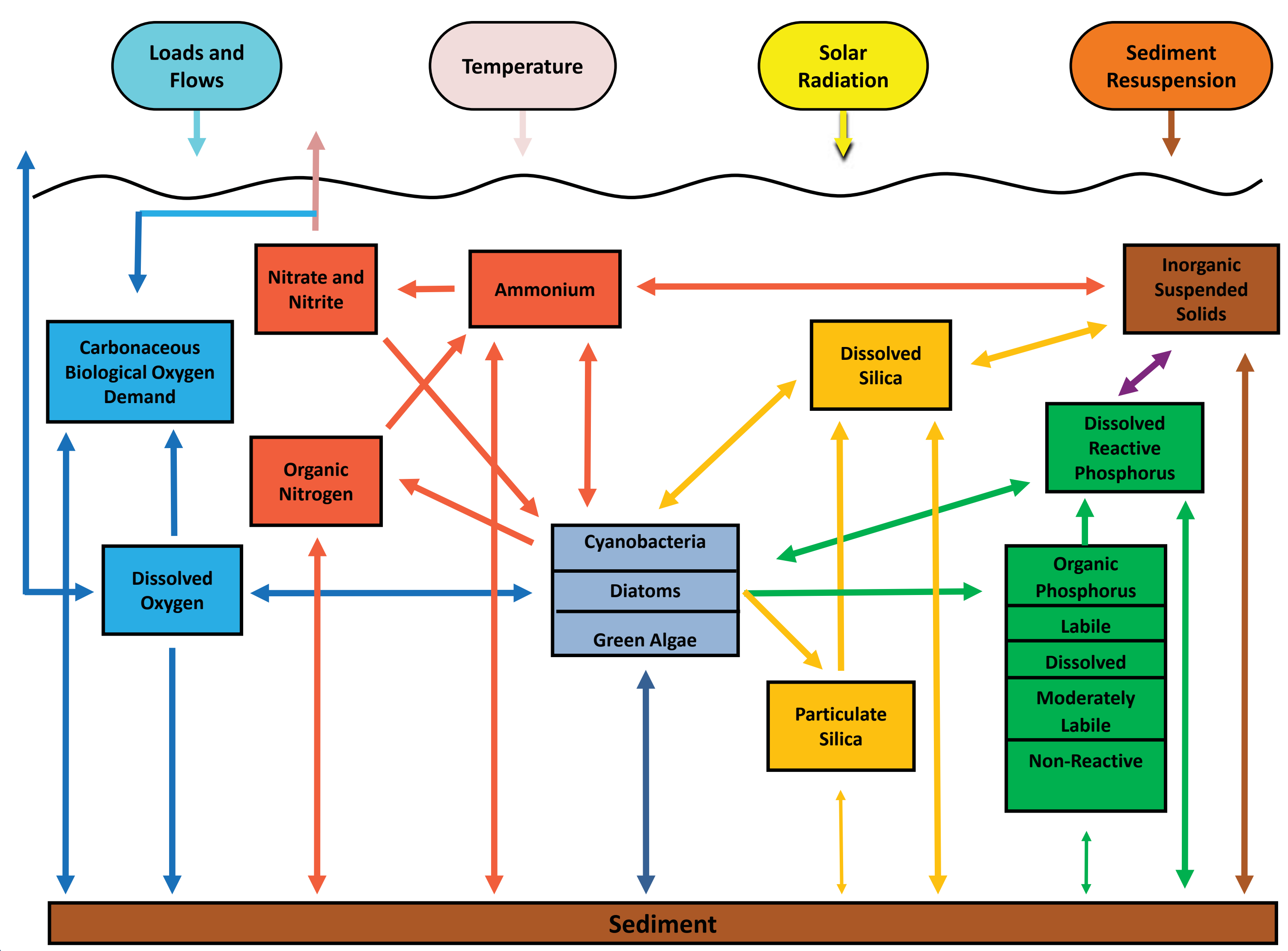
SUMMARY

The Lake Okeechobee Water Quality Model (LOWQM) improves our understanding of internal nutrient cycling within the lake and assesses lake-wide responses to management alternatives such as load reduction, sediment management and water augmentation. An updated model calibration is presented that includes weather events of hurricanes in 2004 and 2005 and droughts in 2007 to 2008 and in 2011. The new calibration was slightly better at predicting water quality of the lake despite significant changes in predicted nitrogen and phosphorus cycling.

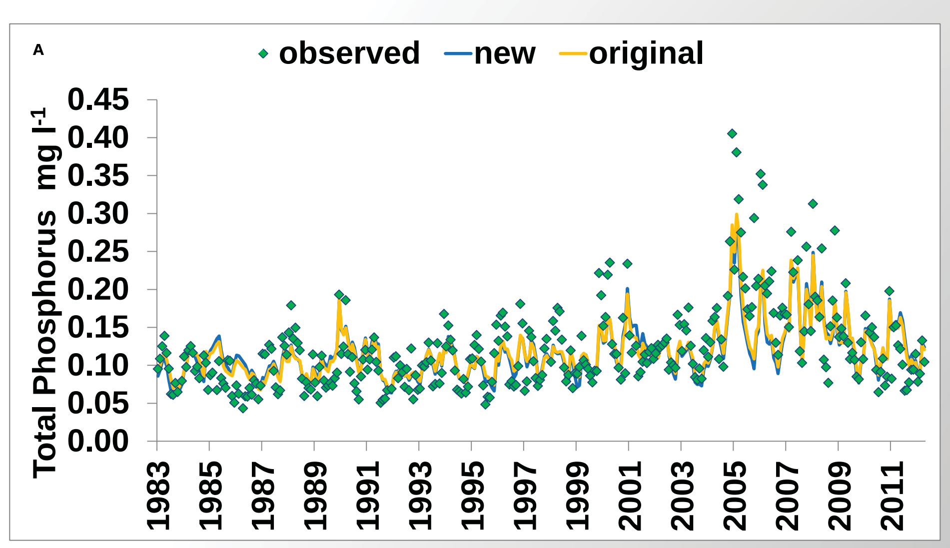
MODEL INPUTS

- **Water quality**
- **Flows**
- **Loads**
- **Weather**
- **Sediment quality**
- **Nutrient and algal dynamics**

THE LAKE OKEECHOBEE WATER QUALITY MODEL (LOWQM)



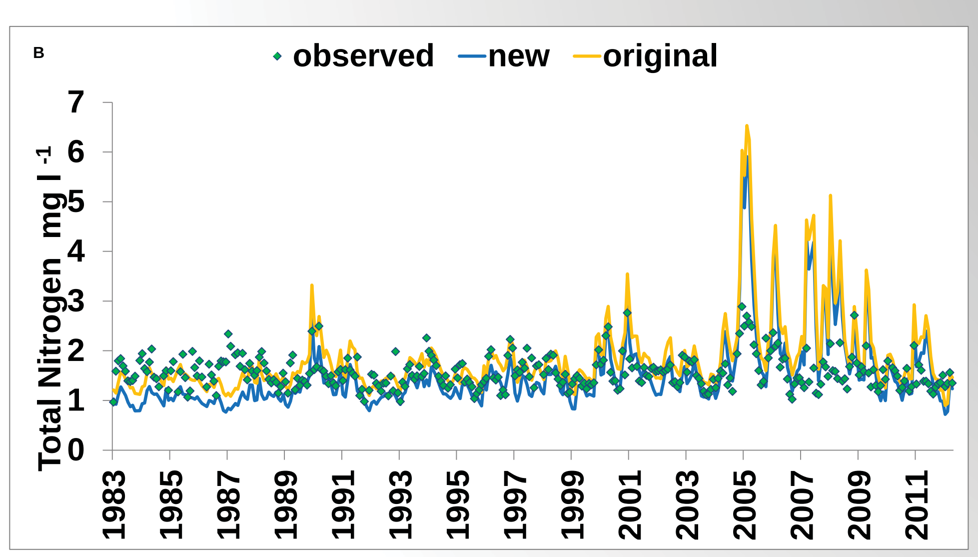
MODEL OUTPUTS

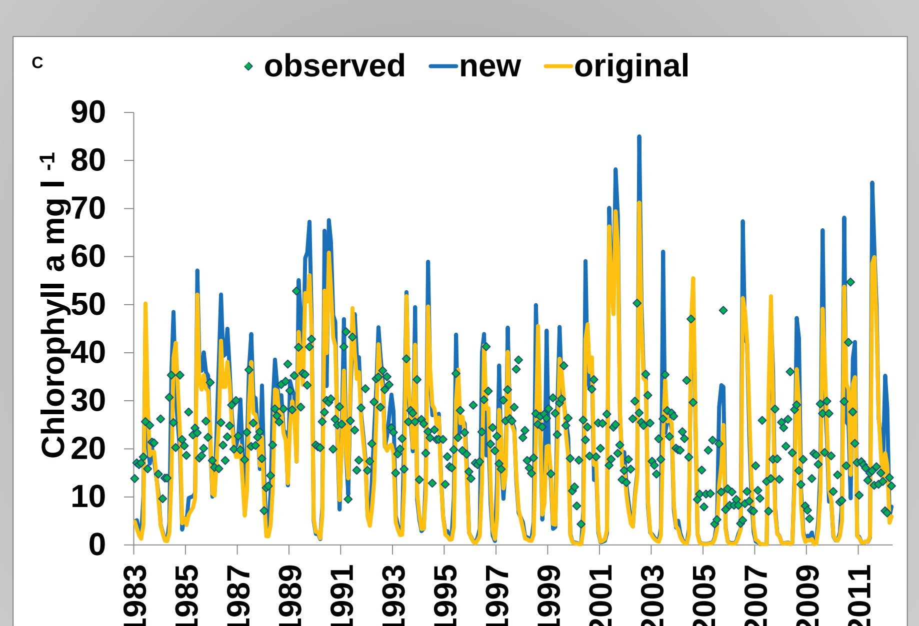


Model results for phosphorus are good.
Results for nitrogen are only fair because nitrogen dynamics are more complex with more biological interactions.

Suggested improvements:

- Enhance model equations
- Measure nitrogen dynamics in the lake

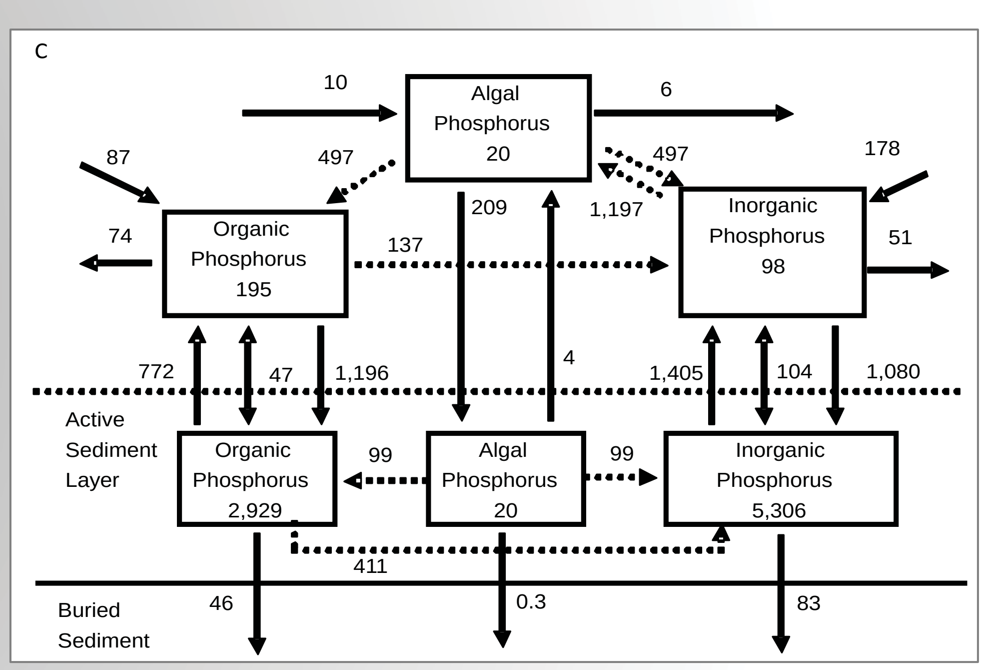




LOWQM simulation results for algae are fair.

Suggested improvements:

- Enhance model equations
- Measure algal growth on the lake

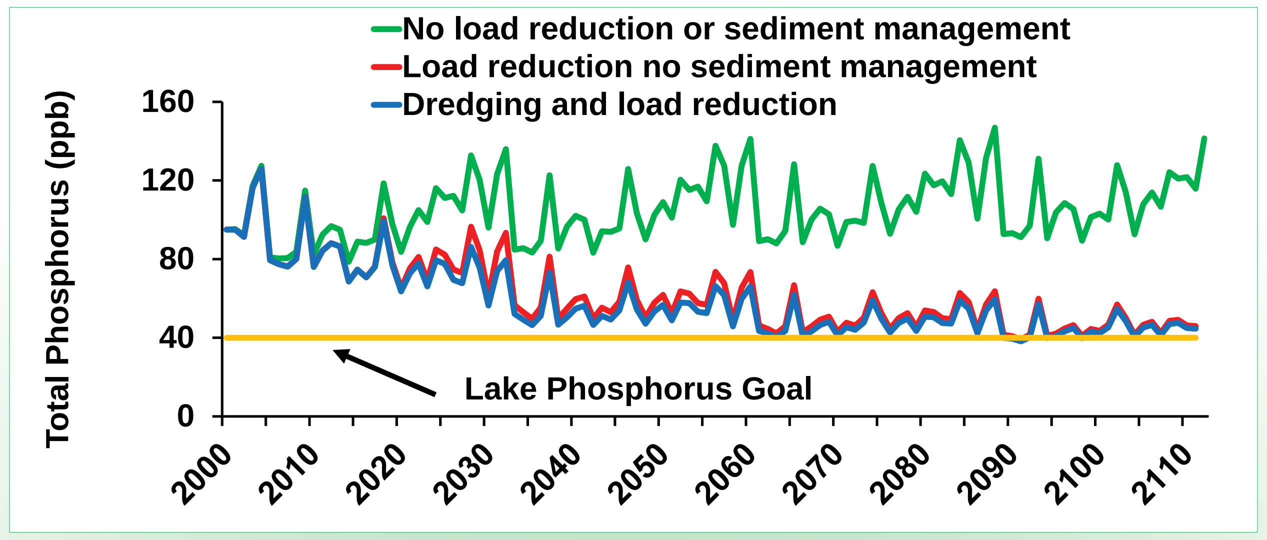


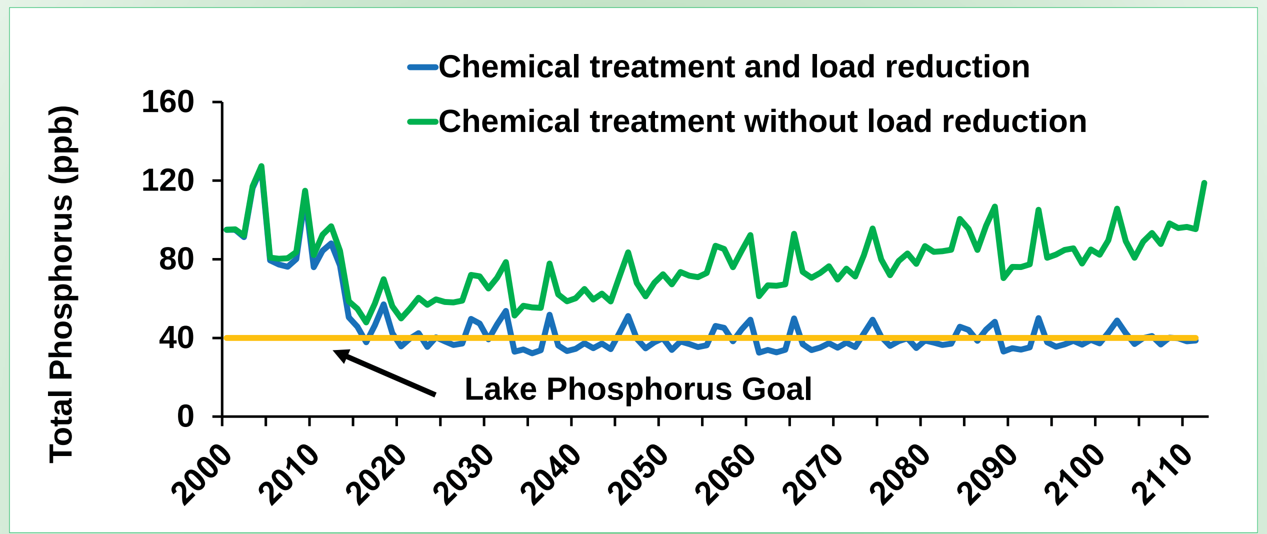
Phosphorus cycling (in mg/m²/yr) shows:

1. Significant sediment water interactions
2. Sediments are a net sink of phosphorus
3. Significant flow of inorganic phosphorus from sediments to water column

QUESTIONS AND ANSWERS

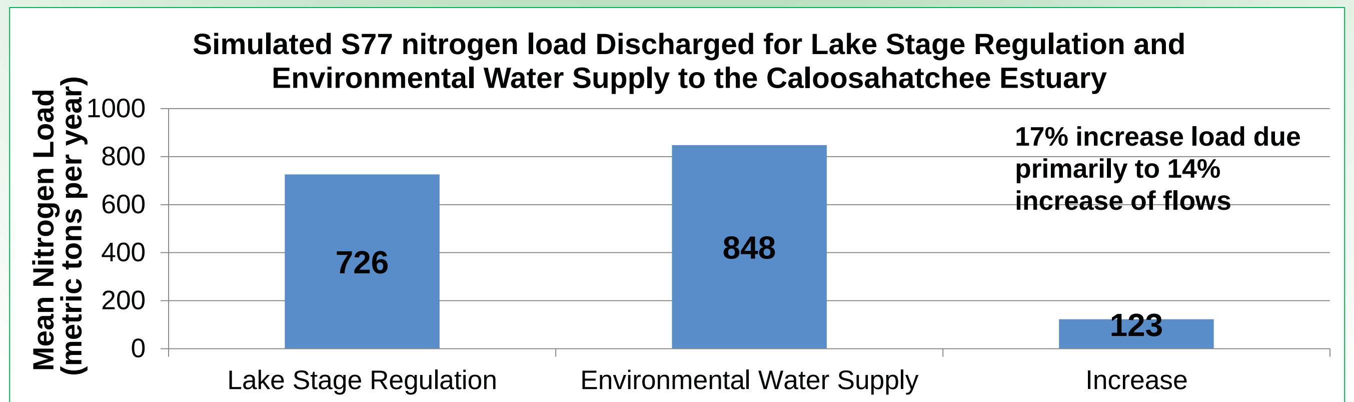
- How does phosphorus load reduction affect Lake Okeechobee water quality?
- Can phosphorus in lake sediments be managed?
- Does water supply augmentation affect water quality in the estuaries?

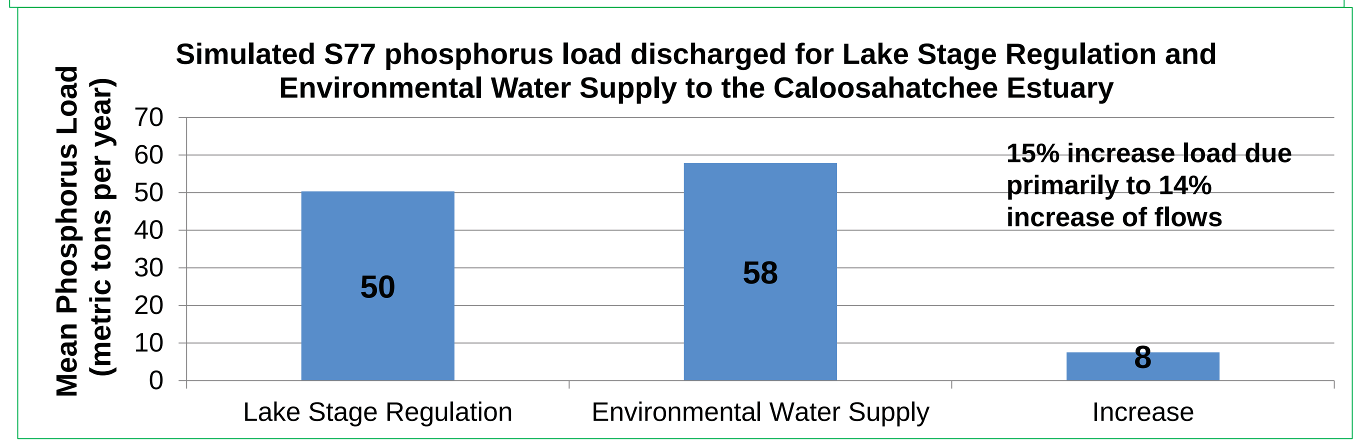




✓ Reducing phosphorus load to 140 metric tons per year will (over time) reduce the in-lake concentration to 40 ppb

✓ Sediments can be managed with dredging or chemical treatment, but results will not be effective in the long term without external load reductions





✓ Water augmentation will result in small nutrient load increases to the estuaries

BISCAYNE BAY COASTAL WETLANDS RESTORATION BENEFIT

Bahram Charkhian, Lead Environmental Scientist - Applied Sciences Bureau, Water Resources Division

INTRODUCTION

The purpose of the Biscayne Bay Coastal Wetlands (BBCW) project is to contribute to the restoration of Biscayne Bay and adjacent wetlands as part of a comprehensive plan for restoring the south Florida ecosystem. The project intends to redistribute freshwater runoff from the watershed away from the existing canal discharges and into the coastal wetlands adjoining Biscayne Bay to provide a more natural and historic overland flow through existing coastal wetlands. This project will also help restore saltwater wetlands and the nearshore bay through the re-establishment of optimal salinity concentrations for fish and shellfish nursery habitat.

BBCW Phase 1 is composed of three components: Deering Estate, Cutler Wetlands and L-31E Flow Way (Figures 1,2 and 3). In advance of congressional authorization, the SFWMD constructed the Deering Estate Flow Way and installed culverts for the L-31E Flow Way. Short-term hydrologic improvements are being realized.

Monitoring is currently underway at completed components to track project performance and for adaptive management purposes. Baseline monitoring is complete and routine compliance monitoring consists of water quality and ecological parameters.

Figure 1. BBCW Project Phase 1 Flow-way Components

Figure 2. Deering Estate Flow-way showing project Features, Monitoring Stations, Including Pump Station (S-700) and Weir

Figure 3. Deering Estate Pump Station (S-700)

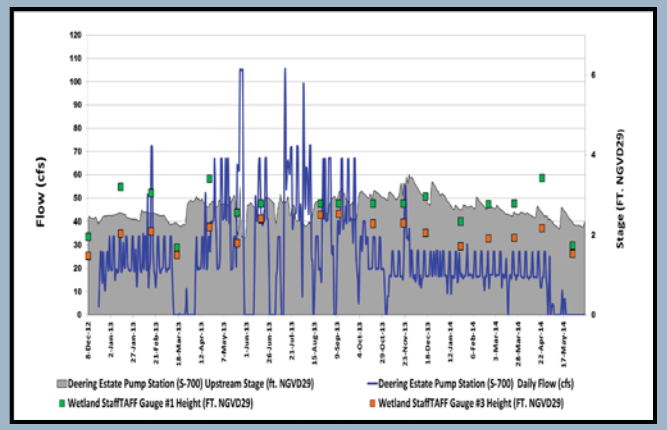
OBJECTIVES and RESULTS

FRESH WATER DELIVERED TO PROJECT

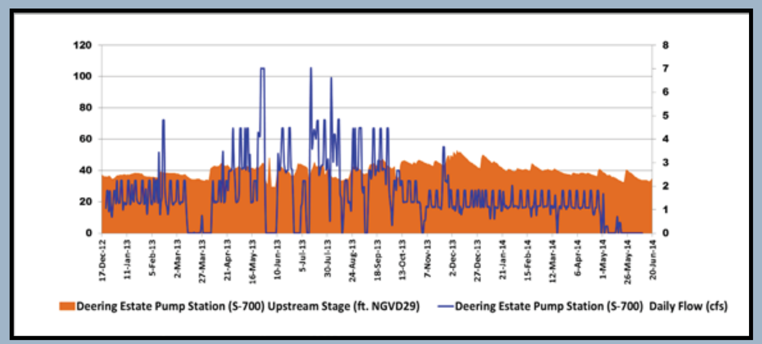
- IMPROVE QUANTITY, QUALITY, TIMING AND DISTRIBUTION OF FRESHWATER TO BISCAYNE BAY AND MINIMIZE POINT SOURCE DISCHARGES
  - Freshwater flow to freshwater and saltwater wetlands at the Deering Estate and saltwater wetlands east of the L-31E Culverts has been enhanced (26,000 ac-ft. of water diverted from C-100 via Deering Estate Flow-way since December 2012)
  - Timing of flows to the wetlands at Deering Estate has been improved by increasing needed freshwater to these wetlands during the dry season
  - Distribution has been improved by the project as all water redirected to coastal wetlands from C-100 by the project helps restore more natural sheet flow
  - Point source discharges from the C-100 has been significantly reduced or eliminated
  - The water quality of all water redirected from canals to wetlands via the Deering Flow-way or L-31E Culverts will improve prior to that water entering Biscayne Bay
- RE-ESTABLISH CONNECTIVITY BETWEEN THE COASTAL AND ADJACENT WETLANDS
  - The Deering Estate Flow-way and L-31E Culverts help restore the hydrologic connection between upstream surface water and coastal wetlands

S-700 On/Off Headwater Triggers

S-700 Operations	Pump Rate (cfs)	Headwater On Stage (feet NGVD)	Headwater Off Stage (feet NGVD)
Dry Season Normal Operations (10/15 through 4/15)	25	2.6	2.2
Wet Season Normal Operations (4/16 through 10/14)	50	2.6	2.2
Excess Water Available (Any	75	2.7	2.2
(Any time of Year)	100	2.8	2.2



Comparison of Water Levels at Deering Estate Wetland Staff Gauges 1 and 3 Versus S-700 Daily Flow and Stage



S-700 has Diverted Approximately 26,347 Acre-feet of Fresh Water from the C-100 Canal to the Historic Remnant Wetlands Near Cutler Creek East of Old Cutler Road

Rehydration (Sheet Flow) of Historical Remnant Slough within Vicinity of Cutler Creek of Deering Estate Flow-way

Prepared for the Water Resources Advisory Commission and the SFWMD Governing Board – AUGUST, 2014

RESTORATION COASTAL HABITAT

- PRESERVE AND RESTORE NATURAL COASTAL GLADES HABITAT
  - Wetland stage and inundation have been increased in Cutler Creek/Slough as a results of redirection of flow from the C-100 via the S700 and Deering Estate Flow-way
  - Vegetation within vicinity of Deering Estate Component responding to changed hydrology with die-off of upland vegetation & emergence of wetland species
  - Reduced Non-Native Vegetation -Percentage cover of category I and II invasive exotic plants within vicinity of the L-31E culverts to less than five percent

Estimated Acreage of Impounded Surface Water Under Different Pumping/Flow Rates within Deering Estate

Pumping Rate(cfs)	Duration of Testing (hours)	Estimated Acres of Impounded Surface Water	Percentage of Inundate Historic Remnant Wetlands within Cutler Creek
0	5	0	0%
25	5	19	58%
50	5	25	76%
75	5	27	82%
100	5	31	94%

- Inundation within the slough under various pumping rates was determined
- 19 acres of wetland are inundated under a pumping rate of 25 cubic feet per second (cfs), about 58% of the historic slough area
- Under a 100-cfs rate, 31 acres of wetland was inundated—94% of the historic slough area

Delineation of the Historical Freshwater Wetland Slough in Deering Estate and Areas of Inundation at Different Pump Rates

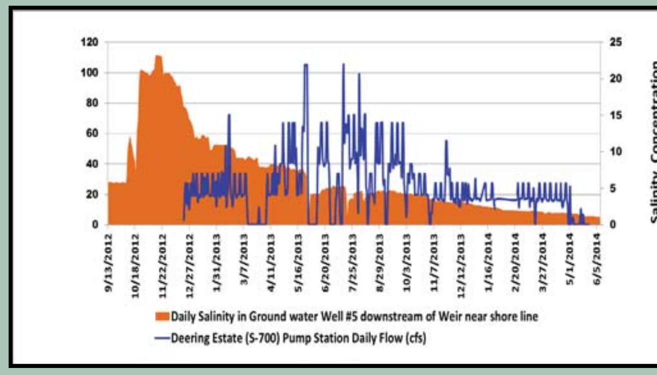
Completed Treatment of Category I and II invasive Exotic Plant within vicinity of L-31E Culverts in May 2014

Emergence of Wetlands Species C. Jamaicense (Sawgrass)Spatial Coverage within the Influence of Flow from Culverts S-23A and S-23B of L-31E Culverts (April 2013)

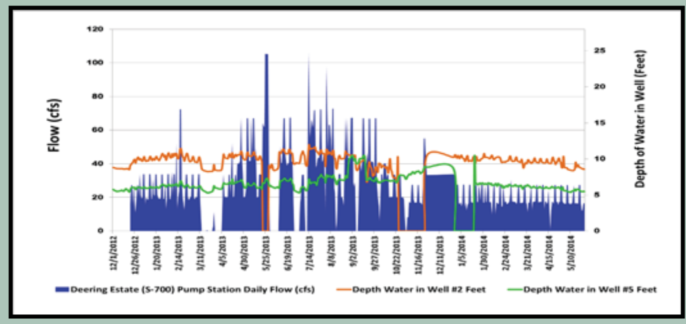
Changes in the Vegetation Communities and the Beginnings of the Die-Back of Upland Trees that have Grown into the Historic Wetlands Within the Vicinity of Cutler Creek in Deering Estates (June 2014)

IMPROVEMENT OF SALINITY REGIMES

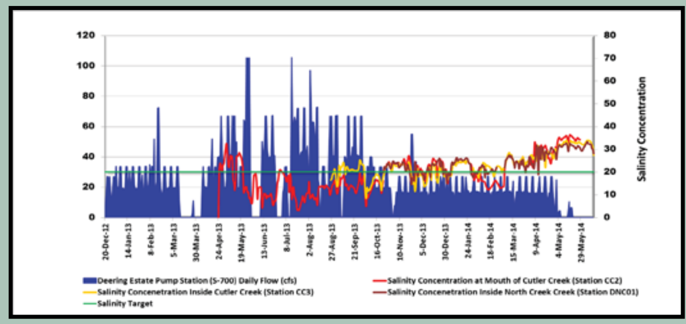
- IMPROVE NEAR-SHORE AND SALTWATER WETLANDS SALINITY REGIMES
  - ✓ Reduced salinity in surface water in Cutler Creek and North Creeks and nearshare at mouth of Cutler Creek as a result of water diverted from C-100 by S700 and Deering Estate Flow-way
  - ✓ Although not monitored, the reduction in point source discharges from C-100 should have improved salinity conditions in the nearshore area of Biscayne Bay in the vicinity of the mouth of C-100
- RE-ESTABLISH PRODUCTIVE NURSERY HABITAT
  - ✓ Reduced salinity in groundwater and surface water within vicinity of Deering Estate Flow way
  - ✓ Reduced Direct Canal Discharge- Enhancing Sheet Flow and rehydration of Deering Estate Flow way component fresh and saltwater wetlands



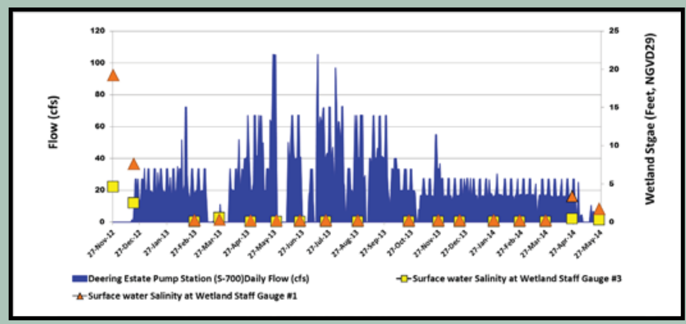
Comparison of salinity concentration in Groundwater within the vicinity of historic remnant wetlands of Deering Estate versus S-700 daily flow



Comparison of Groundwater Levels Within the Vicinity of Historic Remnant Wetlands of Deering Estate



Comparison of Surface Water Salinity at Deering Estate Nearshore Salinity Monitoring Stations



Comparison of Surface Water Salinity at Deering Estate Wetland Staff Gauges Versus S-700 Daily Flow

Watershed Assessment Model (WAM) Applications in the Lake Okeechobee Watershed

Joyce Zhang, Principal Engineer and Hongying Zhao, Lead Engineer - Applied Sciences Bureau, Water Resources Division

INTRODUCTION

The Watershed Assessment Model (WAM) is a process based model that can be used to perform watershed-related hydrological and water quality analysis (Figure 1). It simulates surface and ground water flow and water quality based on land use, soil, weather and land management practices (Figure 2). The model was applied to the Lake Okeechobee watershed and calibrated using data collected from 1998 to 2007 (HDR and SWET, 2009). In this study, the calibrated model was used to evaluate phosphorus load reductions associated with the implementation of Best Management Practices (BMPs) in the Lake Okeechobee watershed (Figure 3).

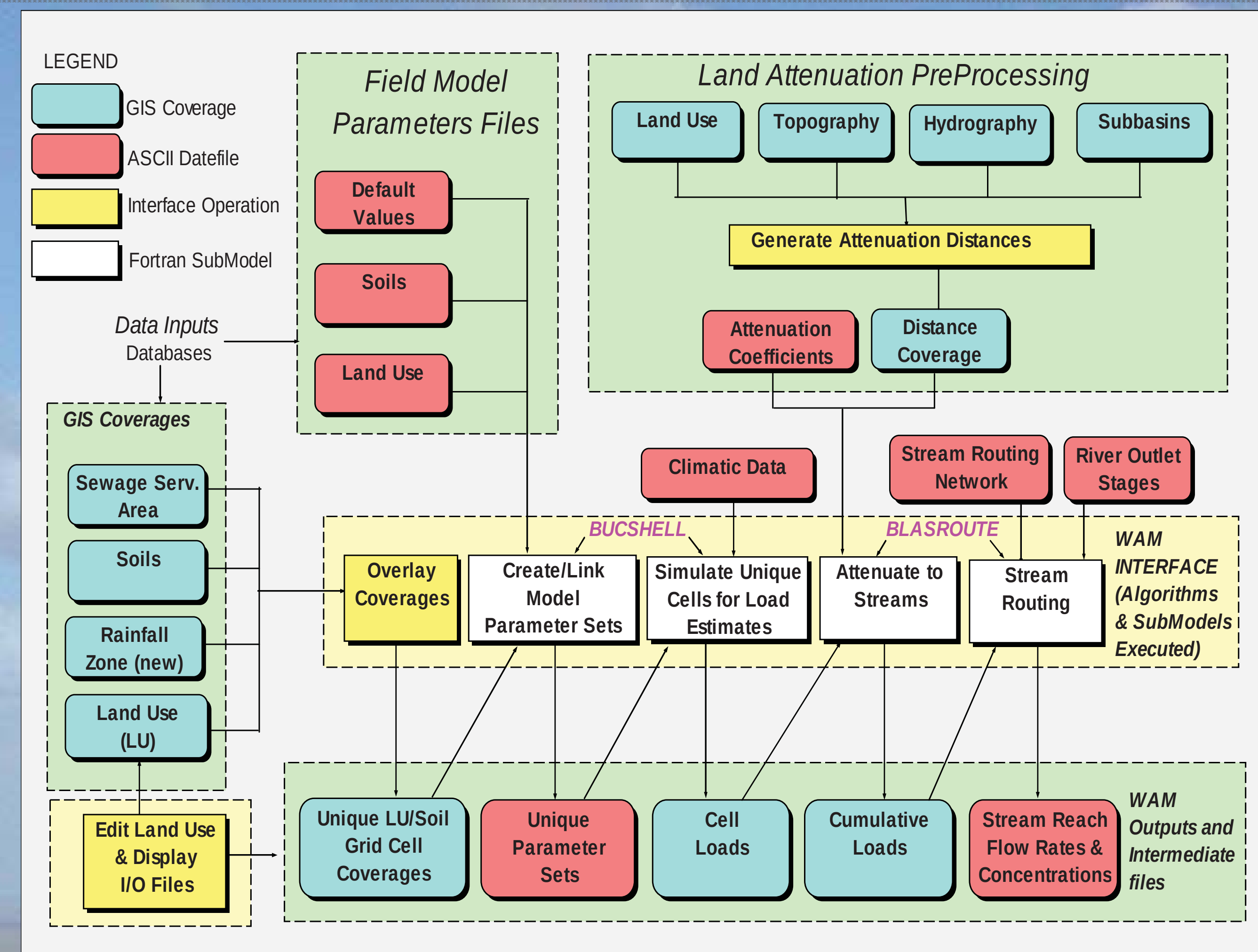


FIGURE 1. WAM MODELING PROCESS (FROM WAM TECHNICAL MANUAL)

METHODS

- BMP parameters adjusted for simulating owner-implemented BMPs:
  - ➢ Revise the fertilizer application rate for both TN and TP (kg/ha)
  - ➢ Revise the BMP effectiveness factors
- Parameters adjusted for the typical cost-share BMPs:
  - ➢ Increase the retention depth and storage ratio,
  - ➢ Revise the BMP effectiveness factors
- Re-run the model with a simulation period from 1991 to 2007 to better represent the long-term annual average conditions.

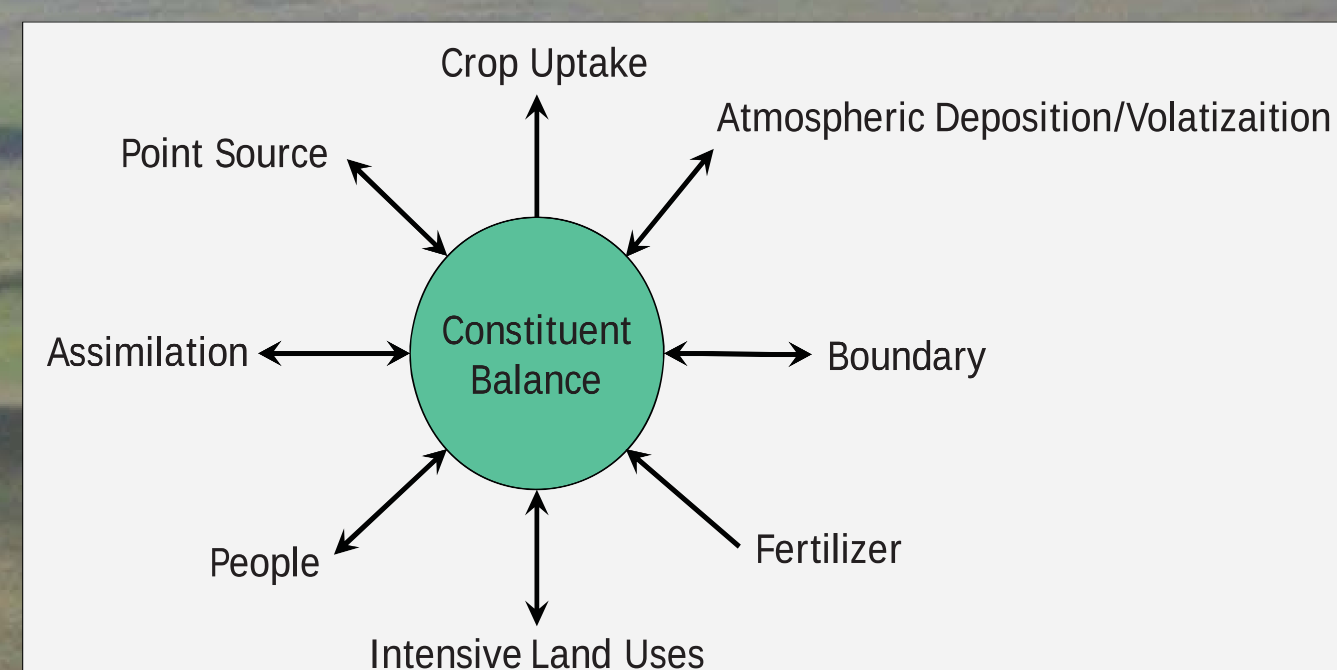


FIGURE 2. COMPONENTS OF THE NUTRIENT BALANCE SIMULATED BY WAM (FROM WAM TRAINING PRESENTATION)

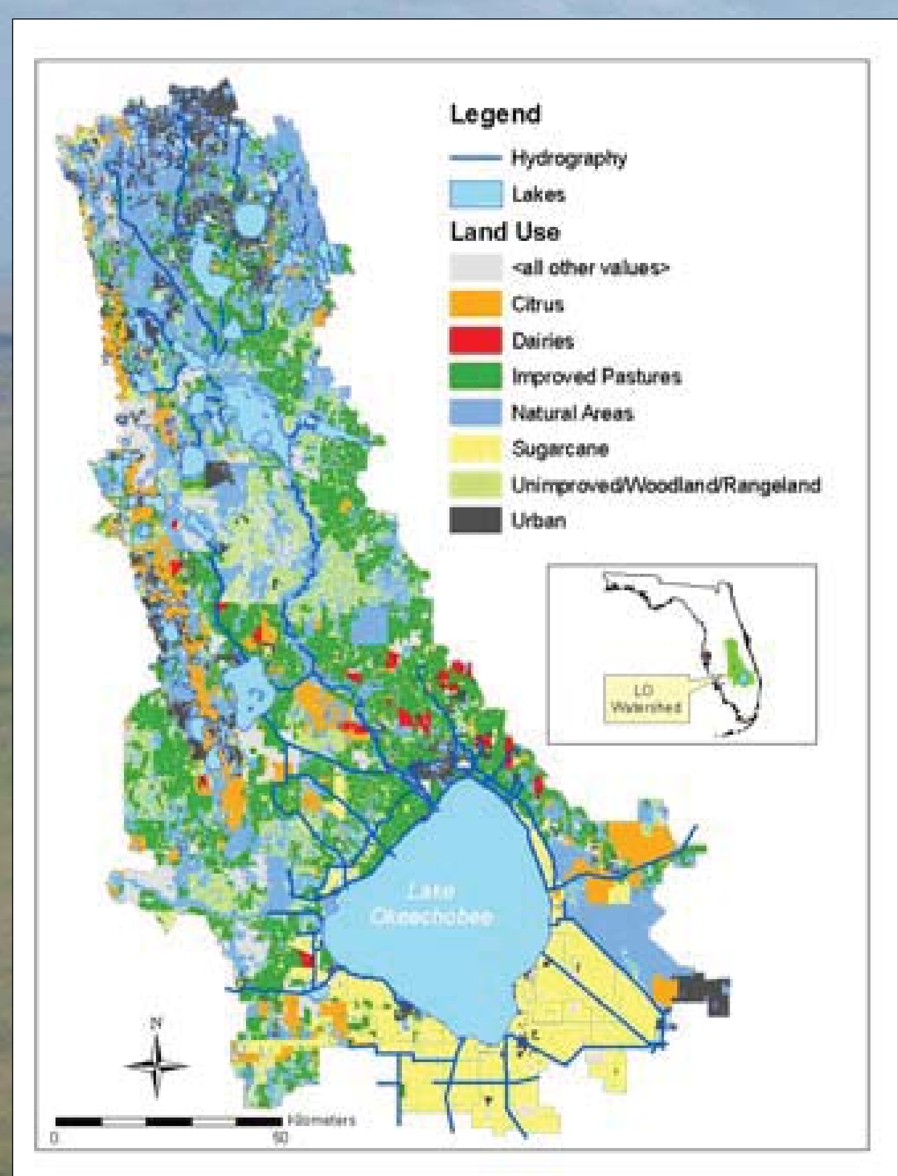


FIGURE 3. LAKE OKEECHOBEE WATERSHED AND ITS LAND USES (2006 DATA)

SUMMARY AND CONCLUSIONS

- The phosphorus load to the lake is over 500 metric tons on a long-term average annual basis and the lake's target load is 140 metric tons per year.
- The phosphorus load reductions associated with the implementation of BMPs were simulated using WAM.
- It was estimated that approximately 28 and 56 metric tons of phosphorus reductions could be achieved through the implementation of owner-implemented and cost-share BMP programs, respectively.
- Additional reduction strategies and technologies will need to be identified and implemented to meet the lake's target load.

REFERENCES

HDR and SWET. 2009. WAM Enhancement and Application in the Lake Okeechobee Watershed. Final report submitted to South Florida Water Management District, West Palm Beach, FL 33406

OBJECTIVES

The overall objective of this study was to quantify phosphorus load reductions under the BMP programs. Specific objectives are:

1. Identify parameters representing different BMP conditions,
2. Set up WAM using the new parameter values,
3. Extend the modeling period for a 17 year simulation to represent the long-term average conditions, and
4. Evaluate the changes of phosphorus loads under different BMPs.

MODEL SIMULATION RESULTS

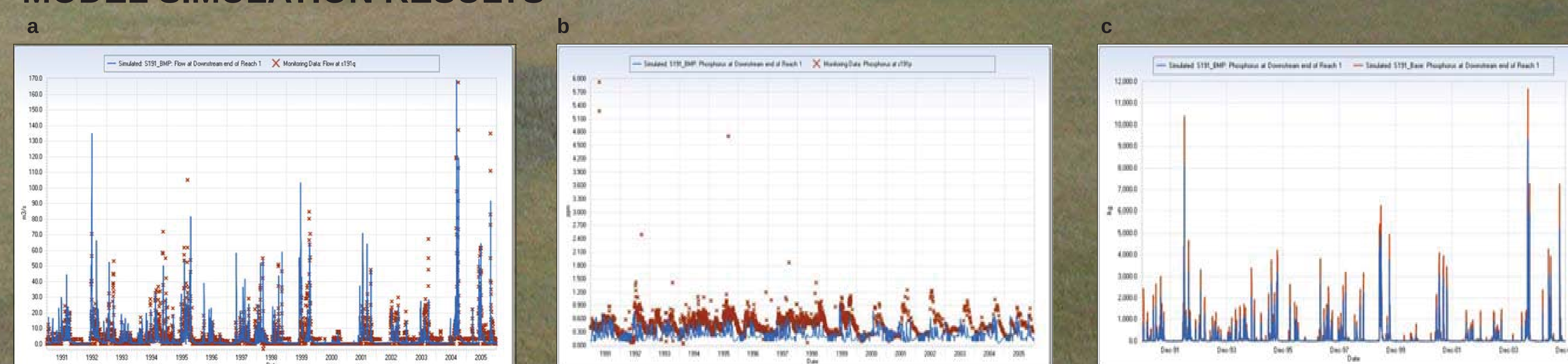


Figure 4. (a) Flow calibration results at structure S-191, (b) Phosphorus concentration comparison at the downstream reach, and (c) Load reductions under BMPs vs. base.

Prepared for the Water Resources Advisory Commission and SFWMD Governing Board – AUGUST, 2014

Estimating Vegetation Resistance in Managed Wetlands to Improve Function and Sustainability

A.M. Wasantha Lal P. E., D.WRE, Ph.D., Z. M. Moustafa, Ph.D., W. M. Wilcox, P.E.

ABSTRACT

Vegetation roughness to flow affects managed wetlands (Stormwater Treatment Areas or STAs) that are used to remove phosphorous from agricultural runoff prior to releasing into the Everglades. Field level vegetation roughness is characterized in this study mathematically as a function relating discharge to water depth and energy gradient. Through improved understanding of flow dynamics, operational strategies for maintaining STA function and sustainability can be explored.

The objective: The objective of the current field experiment is to obtain a function for vegetation resistance, and fit a power-law type equations to it. In this study, the function describing vegetation resistance is obtained using wave speeds and attenuations in generated waves in the wetland.

The method: The field experiment was carried out by generating sinusoidal water waves inside the 5 km by 2 km storm water treatment area STA34 (cell 3A) using two 1000 cfs pumps while monitoring water levels at 12 stations within the cell. The wave propagation characteristics were used to develop graphical and algebraic functions describing bulk vegetation roughness in terms of depth and discharge.

Dependencies:

Resistance to flow in vegetated wetlands depends on:

hydraulic properties such as the water depth and the energy slope, along with the flow regime (Reynolds number),

vegetation properties such as the type (species), size, density, stem flexibility, canopy height, vegetation architecture,

micro topographic properties due to peat accumulation, landscape features, etc.

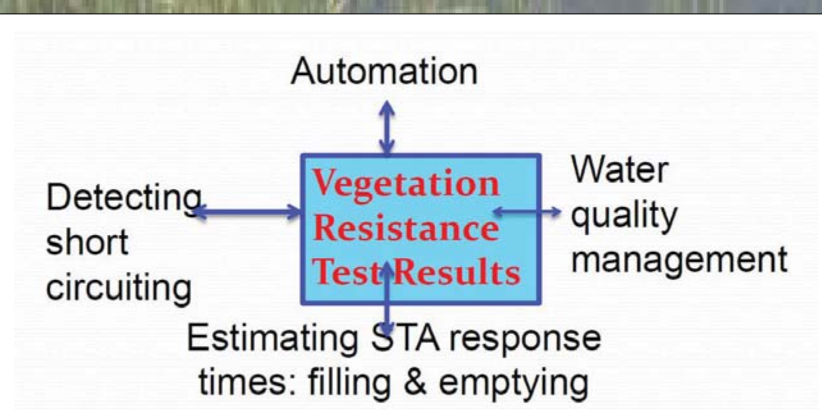


Figure 1

WHY SINUSOIDAL DISTURBANCES?

Reasons for using sinusoidal disturbances

Ability to isolate noise by selecting certain frequencies

Ability to control depth of penetration

Availability of analytical methods for solution

DIAGRAMS

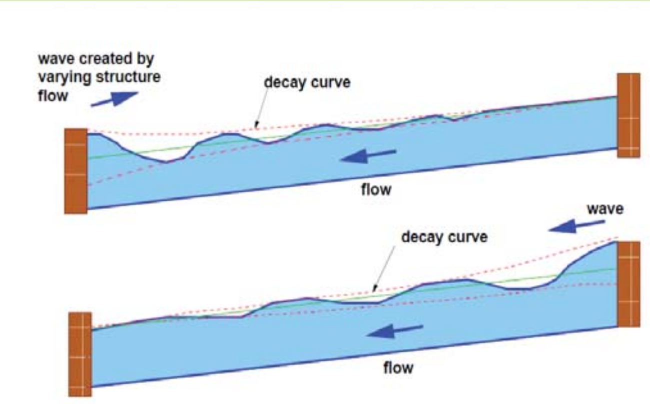


Figure 2: Field test configurations: waves can be generated at downstream or upstream ends

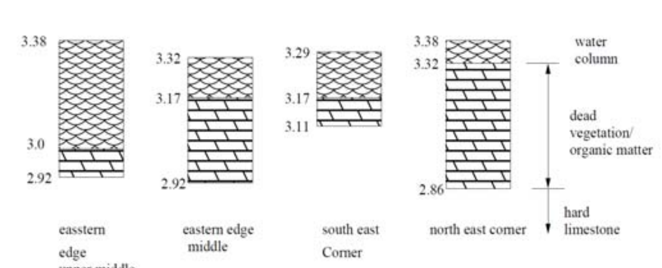


Figure 4: Soil profiles; the levels are in meters NGVD

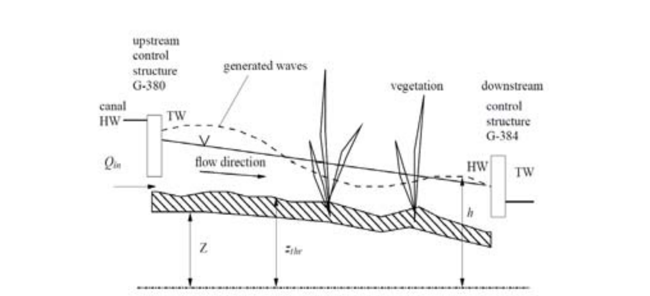


Figure 3: Cross section

FIELD TEST IMPLEMENTATION

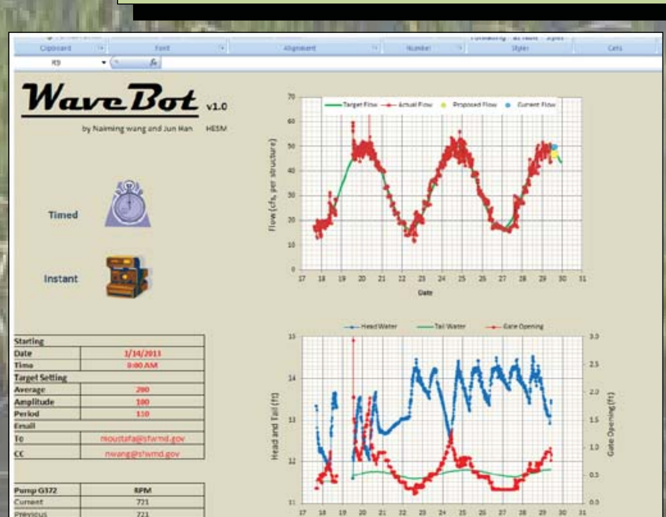


Figure 9: Software used to automate the gate opening and send a sinusoidal discharge Wave to the wetland

Figure 10: Amphibious vehicle Marshmaster used to Deploy data loggers in STA3/4 wetland

STA34 MAPS

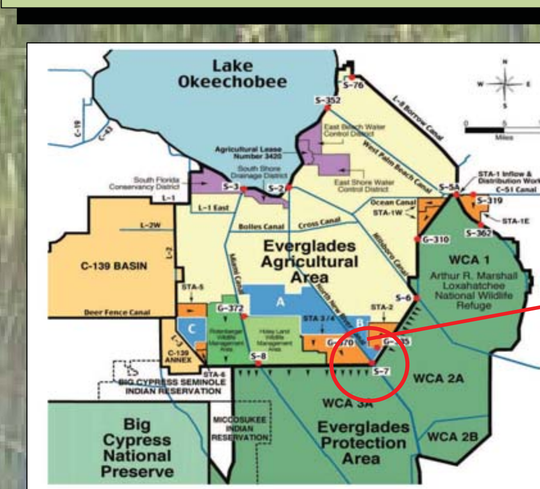


Figure 5: A regional map

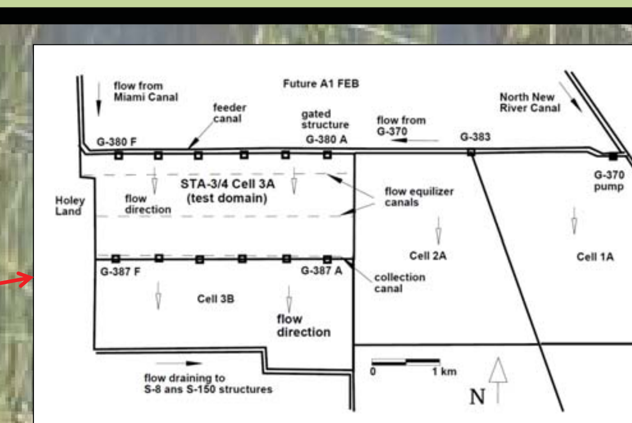


Figure 7: Flow ways into STA34

Figure 6: A satellite map of STA34 Times of arrival of 50 Hr waves are shown

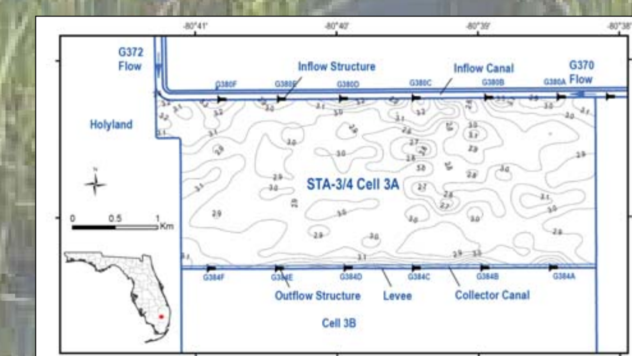


Figure 8: Elevation contours

ANALYTICAL SOLUTION OF INVERSE PROBLEM

If a power-law type function is used for vegetation resistance,

$$q(h,s_f) = \frac{1}{n_b} h^{1+\gamma} |s_f|^{\alpha} \mathrm{sgn}(s_f)$$

where h = water depth; q = discharge per unit width; s_f = energy slope; n_b, γ and α parameters that determine static and dynamic flow characteristics within the flow domain.

The linearized form of the diffusion wave model gives

$$\frac{\partial h}{\partial t} + a(h,s_f)\frac{\partial h}{\partial x} = K(h,s_f)\frac{\partial^2 h}{\partial x^2} \quad (3)$$

$$a = \frac{\partial q}{\partial h} = (1+\gamma)\frac{1}{n_b} h_n^{\gamma} |s_{fn}|^{\alpha} \mathrm{sgn}(s_{fn}) = (1+\gamma)\frac{q_n}{h_n} \quad (4)$$

$$K = \frac{\partial q}{\partial s_f} = \alpha \frac{1}{n_b} h_n^{1+\gamma} |s_f|^{\alpha-1} = \alpha \frac{q_n}{s_{fn}} \quad (5)$$

where a and K are defined as: a = kinematic celerity of a hyperbolic system without dispersion; K = hydraulic diffusivity.

For a sinusoidal disturbance of amplitude h' expressed in complex form as $\mathbf{h}_* = h' e^{\mathbf{f}t - \mathbf{k}x}$ where $\mathbf{k} = k_1 + k_2\mathbf{I}$ and $\mathbf{f} = f_1 + f_2\mathbf{I}$, $\mathbf{I} = \sqrt{-1}$; f_1 = time decay constant assumed 0 for continuous waves; f_2 = frequency of the discharge wave; $= 2\pi/P$; P = wave period; k_1 = spatial decay constant; k_2 = wave number $= 2\pi/L$; L = wave length.

The values of K and a are calculated using the wave number k_2 and decay constant k_1 measured at various locations in the wetland.

$$K = \frac{\partial q(h,S)}{\partial S} = \frac{f_2}{k_2}\frac{k1}{(k_1^2 + k_2^2)} \quad (6)$$

$$a = \frac{\partial q(h,S)}{\partial h} = \frac{f_2}{k_2}\frac{(k_2^2 - k_1^2)}{(k_2^2 + k_1^2)} \quad (7)$$

Best-fit methods or filtering methods are used to obtain k_1 and k_2 from field data

$$c = \frac{\Delta l}{\Delta t} \quad (8)$$

where Δt = phase lag or the time taken for the peak of the water level wave to travel the distance between two gauge locations at a distance Δl. The wave number k_2 is calculated using

$$k_2 = \frac{f_2 \Delta t}{\Delta l} = \frac{f_2}{c} \quad (9)$$

where P = wave period $= 2\pi/f_2$. The decay coefficient k_1 is calculated using

$$k_1 = -\frac{1}{\Delta l}\ln\left(\frac{y_{dn}}{y_{up}}\right) \quad (10)$$

Equations 4 and 5 give the values of α and γ.

When using this method, three physical parameters γ, α and n_b are calibrated to match three physical characterizations of hydraulics

- γ gives the correct wave speed
- α gives the correct attenuation
- n_b gives the correct discharge

CONCLUSIONS

- The inverse problem of wave propagation solved using analytical methods allowed for the development of power-law equations for vegetation resistance.
- The three power-law equations obtained using three wave tests at three different water depths were able to describe vegetation resistance behavior in STA34.
- A single graphical function could also represent the same information
- The power-law type equations were able to describe the wave attenuation, wave speed and discharge more accurately than the Manning's equation.
- Flow through emergent vegetation in STA34 behaves like porous media flow at low depths.
- The flow becomes more turbulent at higher depths according to the resistance equations.
- The equations developed can give the wave speed, attenuation rate and the discharge of water level disturbances in a wetland
- The Manning's equation is not suitable to describe vegetation
- Improved understanding of vegetation resistance and flow can inform operation of the STAs to maintain function and sustainability.

SAMPLE RESULTS

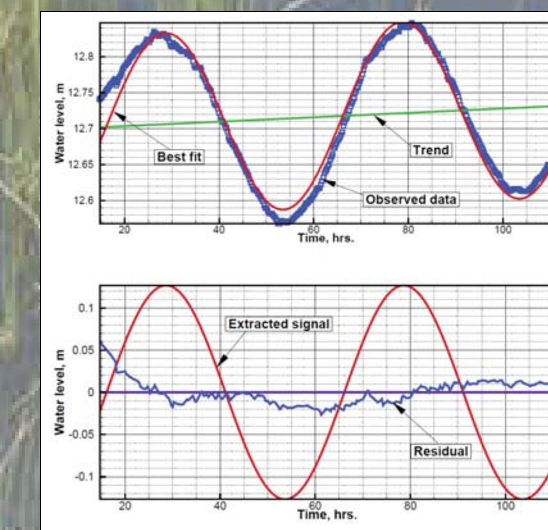


Figure 11: Water levels at G380TW due to 50 Hr period discharge wave at Q=25.5 cms

Figure 12: Wave amplitude due to 50 Hr discharge wave moving south

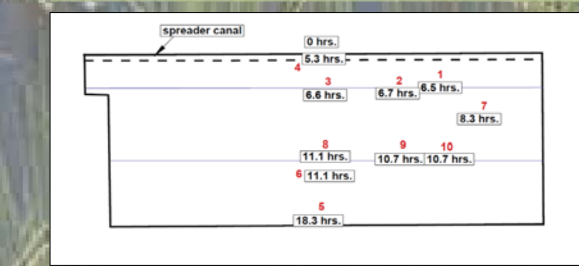


Figure 13: Time lags due to 50 Hr discharge wave moving south

VEGETATION RESISTANCE FUNCTIONS

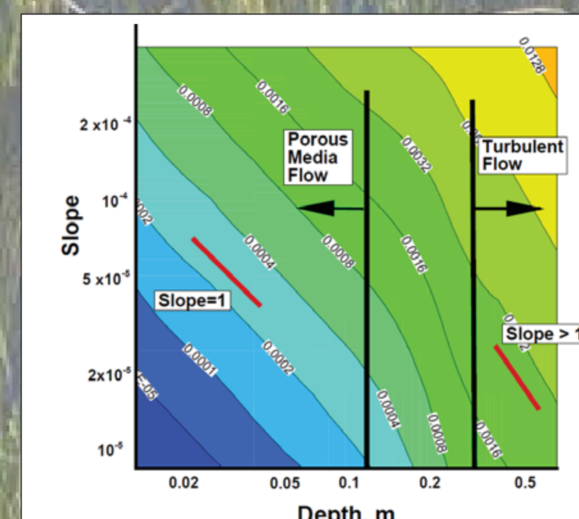


Figure 14: Graphical function: discharge against depth and energy slope

$$Q = B\frac{1}{0.388}h^{0.951}s_f^{0.583}$$

Single power law equation for all depths

Resistance Equation	Depth / Period	≈ 0.41 m 50 hour wave	≈ 0.26 m 65 hour wave	≈ 0.10 m 110 hour wave
$Q = B\frac{1}{0.388}h^{0.951}s_f^{0.583}$	Discharge	2.3%	5.3%	7.6%
	Wave speed	10.2%	9.0%	11.4%
	Amplitude ratio	13.4%	25.9%	3.7%
$Q = B\frac{1}{0.00933}hs_f$	Discharge	8.1%	15.8%	18.2%
	Wave speed	35.6%	10.2%	5.2%
	Amplitude ratio	31.2%	19.2%	9.8%
$Q = B\frac{1}{0.768}hs_f^{0.5}$	Discharge	6.4%	8.9%	6.6%
	Wave speed	4.7%	14.0%	15.6%
	Amplitude ratio	12.8%	25.4%	8.2%
$Q = B\frac{1}{0.386}h^{1.666}s_f^{0.5}$	Discharge	15.8%	22.8%	53.8%
	Wave speed	15.3%	17.4%	42.7%
	Amplitude ratio	57.1%	9.1%	16.7%

Table: Various power-law approximations and their errors

$$Q_0 = 900 \text{ cfs}, d \approx 0.41 \text{ m}: \quad Q = B\frac{1}{0.995}d^{0.856}s_f^{0.49}$$

$$Q_0 = 650 \text{ cfs}, d \approx 0.26 \text{ m}: \quad Q = B\frac{1}{0.192}d^{1.426}s_f^{0.58}$$

$$Q_0 = 200 \text{ cfs}, d \approx 0.10 \text{ m}: \quad Q = B\frac{1}{0.026}d^{0.951}s_f^{0.88}$$

Three power law equations for three depths

PREVIOUS WORK

Previous work on field tests:

Lal, Wasantha, A. M. (2005). Van Zee, Randy and Belnap, M. (2005), Case study: A model to simulate regional flow in south Florida, *J. Hydraul. Engrg., ASCE*, 131(4), 247-258.

Lal, Wasantha, A. M. (2006). Determination of multiple aquifer parameters using generated water level disturbances, *Water Resources Research*, (42), 1-13.

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Previous work on vegetation resistance

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A.M. Wasantha Lal P. E., D.WRE, Ph.D., Z. M. Moustafa, Ph.D., W. M. Wilcox, P.E. – Prepared for the Water Resources Advisory Commission and SFWMD Governing Board – AUGUST, 2014

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Applications of Very High Resolution Imagery in The Natural Sciences

Christa L. Zweig[1], Sue Newman[1], Delia Ivanoff[1], Matt Burgess[2], and H. Franklin Percival[2]
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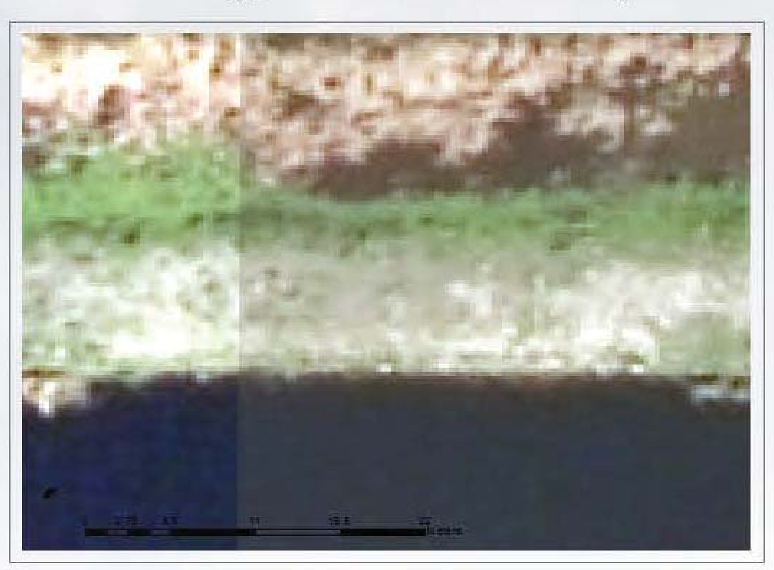
- Working with the University of Florida Aerial Systems Research Group, we attached a camera system to a District helicopter.
- Helicopters are flexible in their altitude requirements and flight paths.
- These photos, with their associated GPS information, can be used as critical data for scientific research.

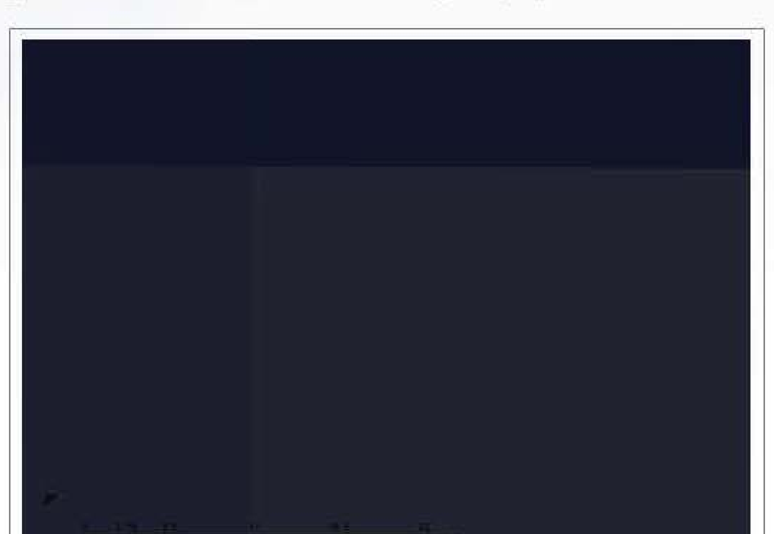
Can be used to assess many features important to District operational, land management, and restoration decisions (structure & levee inspections, exotic vegetation assessment, STA vegetation health, etc.) and can quickly and safely assess damage due to hurricanes, fires, and water management.

COMPARISON OF DIFFERENT IMAGERY

Alligators And Wading Birds In Sta 1 East (1.7 Cm Resolution)



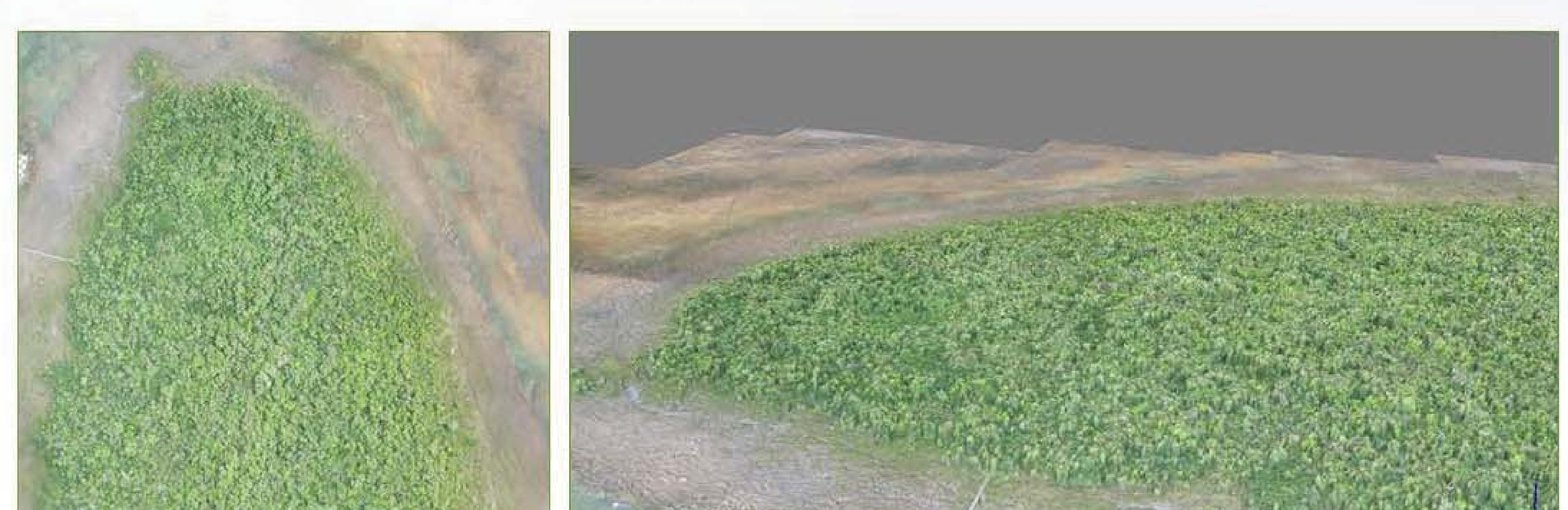
High-altitude Aerial Imagery (1 Ft Resolution)



Landsat (30 M Resolution) Satellite

EXAMPLES

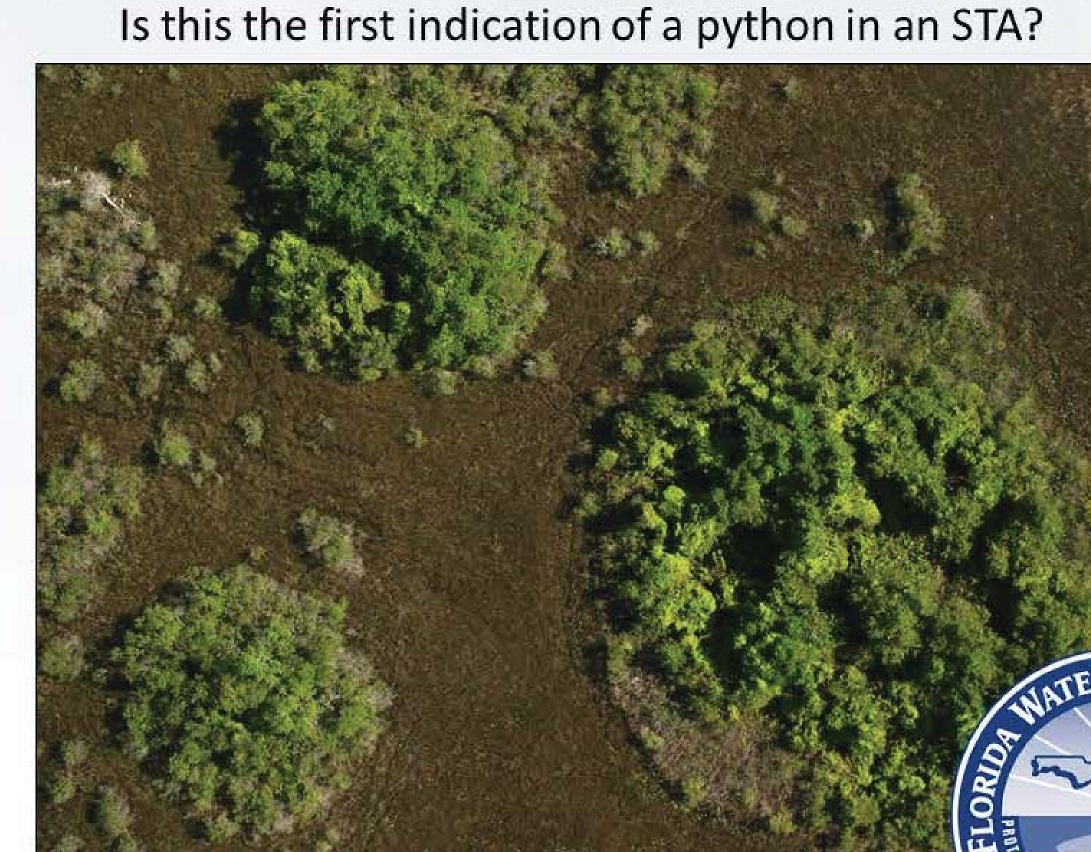
DIFFERENT SPECIES OF SUBMERGED AQUATIC VEGETATION IN STA 1 EAST



HIGH RESOLUTION AND 3D RENDERING OF A TREE ISLAND

EXOTIC SPECIES INFESTATIONS

A 7-foot snake is seen stalking two birds in STA 1 West. Is this the first indication of a python in an STA?



Old World Climbing Fern

Science Posters Prepared for the Water Resources Advisory Commission and the SFWMD Governing Board - August 2014

Variations of Light Attenuation and Relative Contributions of Water Quality Constituents in the Caloosahatchee River Estuary

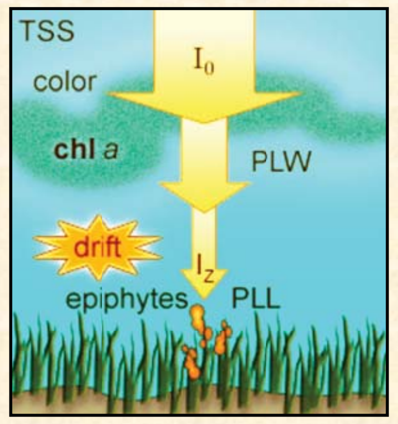
Zhiqiang Chen, Ph.D., Sr. Scientist, Peter Doering, Ph.D., Section Administrator
Coastal Ecosystems Section, Applied Sciences Bureau, South Florida Water Management District

ABSTRACT

Submersed aquatic vegetation (SAV) is an important valued ecosystem resource in the Caloosahatchee River Estuary (CRE).
Light attenuation is a primary factor that controls SAV distribution and abundance. Multiple data sets collected over decades at locations throughout the estuary were compiled to examine the relationship between light attenuation (Kpar) and water quality constituents: Color, turbidity, phytoplankton [Chlorophyll a, Chl *a*] in the CRE. A statistical model was first developed to determine the relative contribution of each constituent to total light attenuation. The model was then used to assess the relative contribution of each constituent as a function of location in the estuary and magnitude of freshwater discharge at the S-79 to the estuary. On average, both color and turbidity contributed about 40% of light attenuation, while Chl *a* contributed about 10%. However, the relative contributions vary with freshwater inflows and regions of the estuary. Color was a main factor impacting light attenuation in the upper estuary and/or during the higher flow conditions. In contrast, turbidity became a major factor in the lower estuary and during lower flow conditions. The observed relative contributions of color, Chl *a* and turbidity and their variations with flow and location would be helpful with developing and assessing a restoration strategy in the system.

INTRODUCTION

- Submersed aquatic vegetation (SAV) is an important valued ecosystem resource in the Caloosahatchee River Estuary (CRE). Light attenuation is a primary factor that controls SAV distribution and abundance.
- Light is attenuated by three water quality constituents: Color, turbidity or total suspended solids [TSS], phytoplankton [Chlorophyll a, Chl *a*]. The concentrations of water quality constituents vary as a function of freshwater inflow and locations in the estuary.
- The goal of this study was to develop a light attenuation model and examine variations of light attenuation and relative contributions of water quality constituents and how they vary with freshwater inflows and locations in the estuary.



METHODS

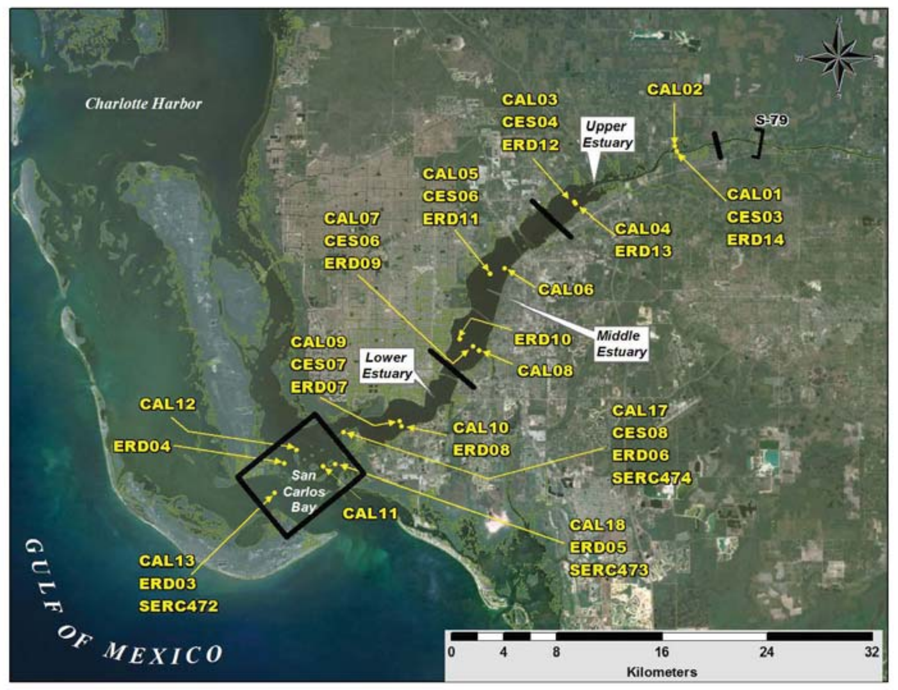


Fig. 1 Map of the Caloosahatchee River Estuary, showing segments, and water quality monitoring stations.

Table 1. Sampling stations in the four regions of the Caloosahatchee Estuarine System

Region of Estuary	Program			Km from S-79
	ERD	CAL	CES	
Upper	12,13	01,02,03,04	03,04	6-14
Middle	09,10,11	05,06,07,08	05,06	14-28
Lower	06,07,08	09,10,17	07,08	28-41
San Carlos Bay	03,04,05	18,11,12,13	na	41-49

- Water quality and light attenuation were taken at stations along the CRE (Fig. 1) collected from three programs spanning from 1995 to 2009. The Caloosahatchee Estuary (CAL) program sampled monthly water quality at 18 stations from 1994-1996. The Environment Research and Design (ERD) Program sampled 15 sites in the CRE on wet and dry seasons of each year (2000-2003). The Center for environmental studies (CES) program sampled 7 stations in the estuary and one station upstream of S-79 on monthly basis from 1999-2009. All data collected by the SFWMD or contactors working on behalf of the SFWMD. Data for CAL and CES programs are available on DBHYDRO. Data for ERD are available upon request. The CRE was divided into four regions: Upper, Middle, Lower estuary and San Carlos Bay (Table 1). Table 1 also shows associations of sampling stations with regions.
- Water quality constituents include salinity, turbidity, color, chlorophyll *a* (Chl *a*) that were sampled either at mid-depth or 0.5 m from the surface. If there were two or more samples at a station, then values were averaged. Vertical profiles of photosynthetically active radiation (PAR) were obtained at depth intervals of 0.25 m, and only PAR within 2 meters of the surface were used to calculate the light attenuation coefficient (Kd). The relationships between Kd and color, turbidity, Chl *a* were examined using multiple linear regression analysis (SAS 9.3). In the regression model, a forced intercept of 0.15 was specified. The value of 0.15 is the contribution of pure water to the total light attenuation coefficient at a depth of around 2 meters (Kelly Dixon, Mote Marine Laboratory, personal communication). The relative contributions of water constituents were calculated by dividing products of water quality concentrations and their respective linear regression coefficients by the estimated Kd.
- Average freshwater inflow (CFS) at S-79 for the 30 days prior to sampling was calculated from daily flow rate, and four flow categories (<450, 450-2800, 2800-4500 and >4500) were used to examine variations of Kd and contributions of water constituents.

RESULTS

$$Kd = 0.15 + 0.014 \times Color + 0.049 \times Chl\ a + 0.14 \times Turbidity \quad \text{(CRE model)}$$
$$Kd = 0.3 + 0.014 \times Color + 0.024 \times Chl\ a + 0.062 \times Turbidity \quad \text{(M\&M model)}$$

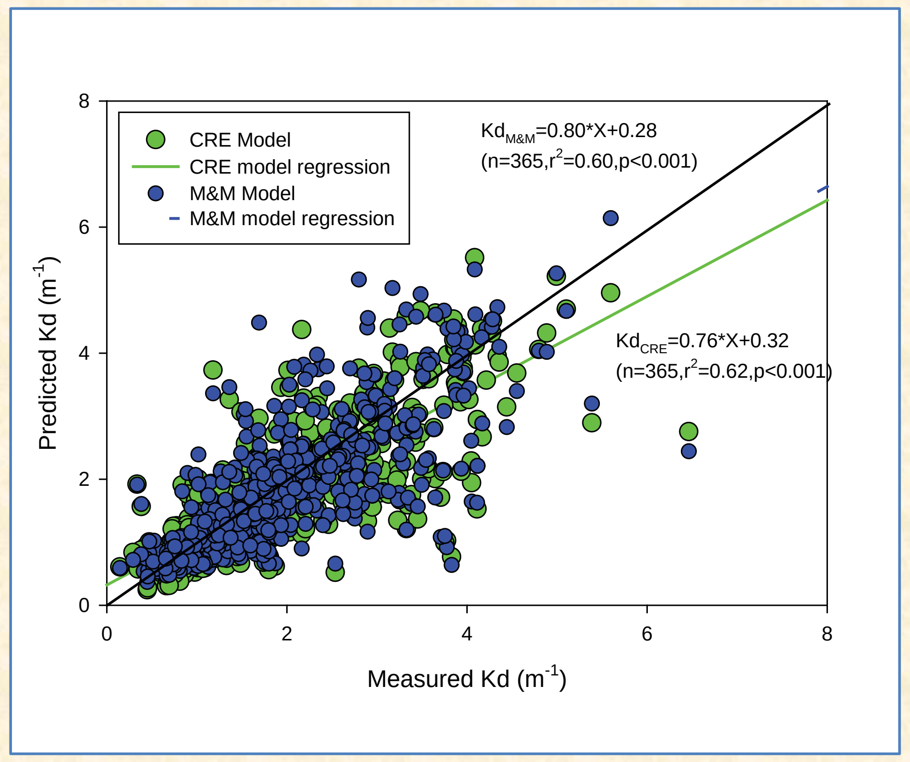


Fig. 2 Relationships between measured Kd and predicted Kd from linear regression model in this study (CRE model, green dots) and McPherson and Miller model (1994, M&M model, blue dots).

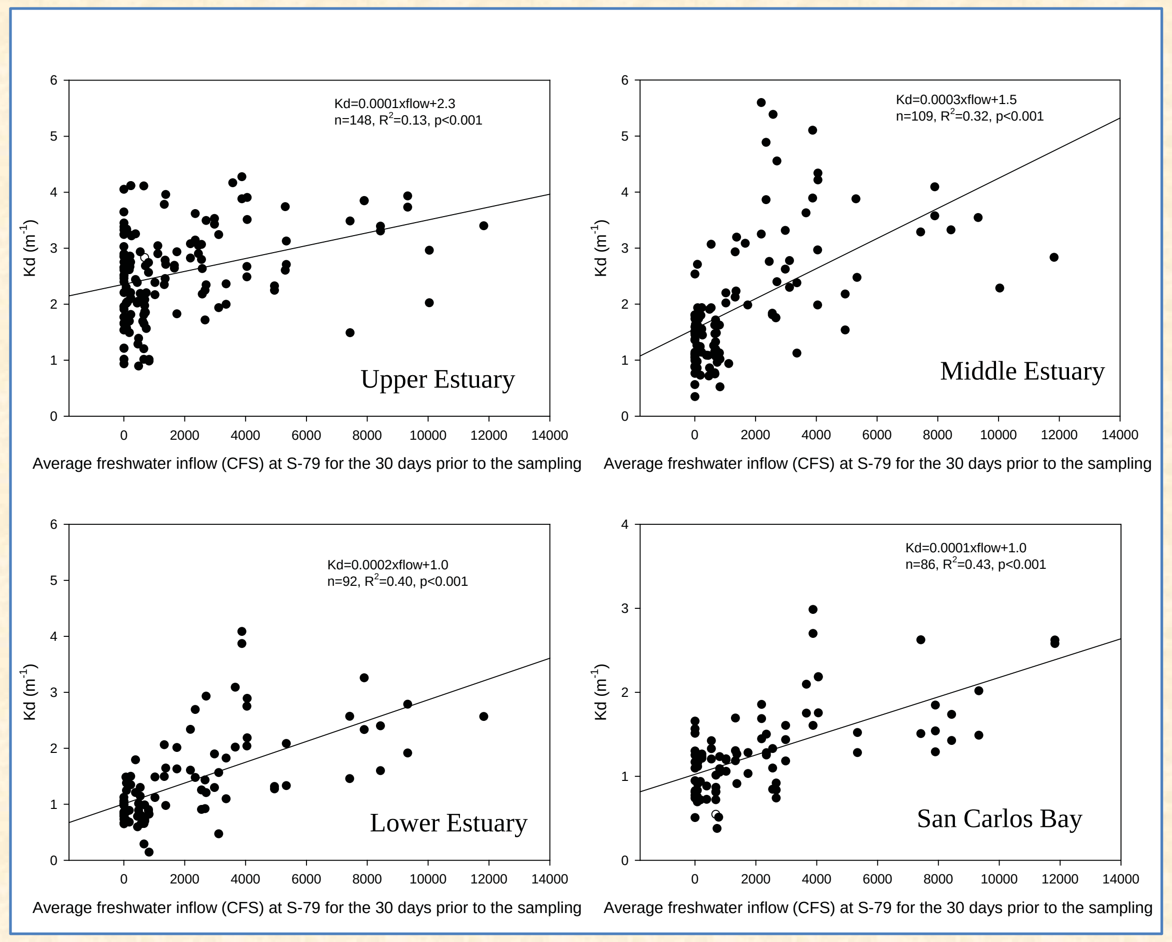


Fig. 3 Relationships between Kd and freshwater inflows in four regions. All regions show significant positive correlations. The strength of the correlations increase with distance downstream toward San Carlos Bay.

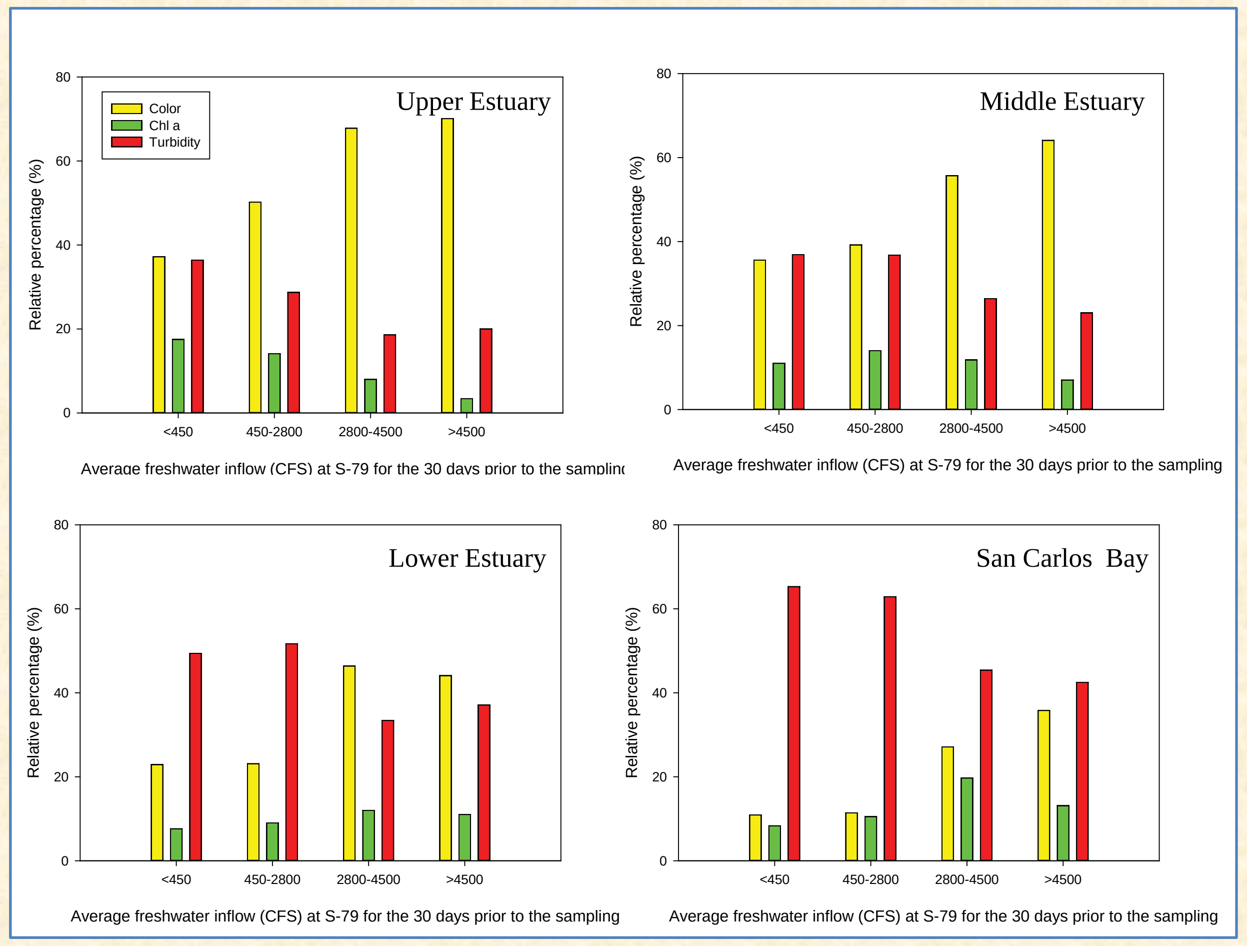


Fig. 4 Variations of contributions of color, Chl *a* and turbidity to light attenuation with flows and regions.

Table 2. Variations of contributions (%) of color, Chl *a* and turbidity to light attenuation with regions and flows

Water quality constitents	Flow < 450				Averages over regions
	Upper Estuary	Middle Estuary	Lower Estuary	San Carlos Bay	
Color	37.2	35.6	22.9	10.9	26.7
Chl *a*	17.5	11.0	7.6	8.3	11.1
Turbidity	36.4	36.9	49.4	65.3	47.0
450 <= Flows < 2800					
Color	50.2	39.2	23.1	11.4	31.0
Chl *a*	14.1	14.0	9.0	10.5	11.9
Turbidity	28.7	36.8	51.7	62.9	45.0
2800 <= flows < 4500					
Color	67.8	55.7	46.4	27.1	49.3
Chl *a*	8.0	11.8	12.0	19.7	12.9
Turbidity	18.6	26.4	33.4	45.4	31.0
Flows >= 4500					
Color	70.1	64.1	44.1	35.8	53.5
Chl *a*	3.4	7.0	11.0	13.1	8.6
Turbidity	20.0	23.0	37.1	42.5	30.7
Average over all regions and all flows					
Color	40.1				
Chl *a*	11.1				
Turbidity	38.4				

HIGHLIGHTS

- A new model linking light attenuation to water quality (color, Chl *a* and turbidity) was developed using 15 years' data. The model predicts Kd values comparable to those calculated using a previous model (McPherson and Miller, 1994).
- Light attenuation increased with increasing freshwater inflow in all regions. The significance of the correlations between Kd and flows increased from the upper to lower estuary.
- On average, both color and turbidity contributed about 40% of light attenuation, while Chl *a* contributed about 10%. However, the relative contributions vary with freshwater inflows and regions of the estuary. Color was a main factor impacting light attenuation in the upper estuary and/or during the higher flow conditions. In contrast, turbidity became a major factor in the lower estuary and during lower flow conditions. Chl *a* contributed the least with maximum percentage less than 20%.
- **While nutrient load reduction should improve water clarity, the degree or extent of improvement will be limited by the significant contributions of color and turbidity to light extinction.**

Prepared for the
Charlotte Harbor Watershed Summit
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Water Resources Advisory Commission and
SFWMD Governing Board – AUGUST, 2014

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

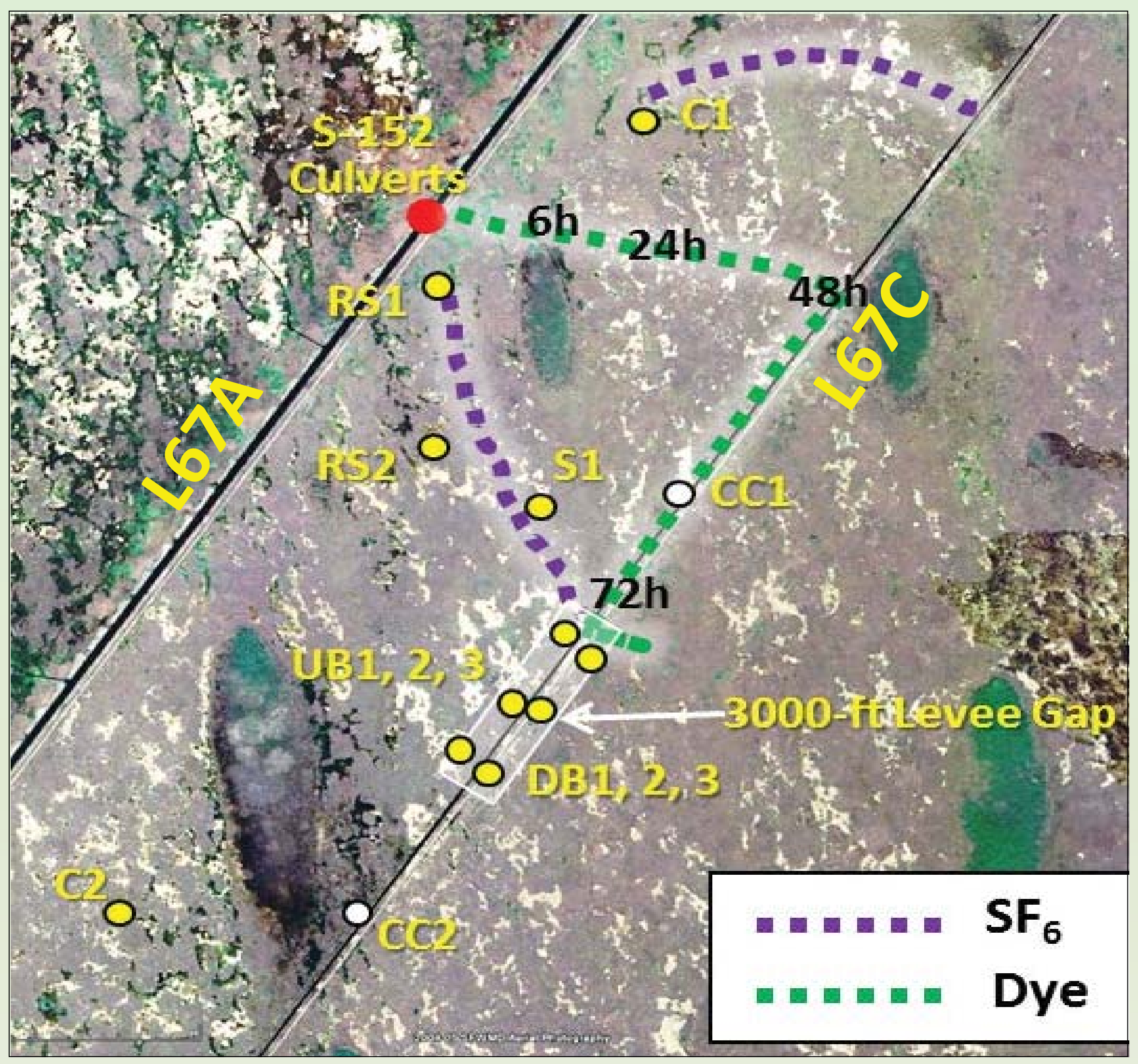
EVALUATING THE BENEFITS OF SHEETFLOW WITH THE DECOMP PHYSICAL MODEL

ERIK TATE-BOLDT, Scientist 1; **CHRIS HANSEN**, CW DPM Scientific Technician; **ERIC CLINE**, Scientist 3; **SUE NEWMAN**, Section Leader;
FRED SKLAR, Section Administrator; **COLIN SAUNDERS**, Lead Environmental Analyst

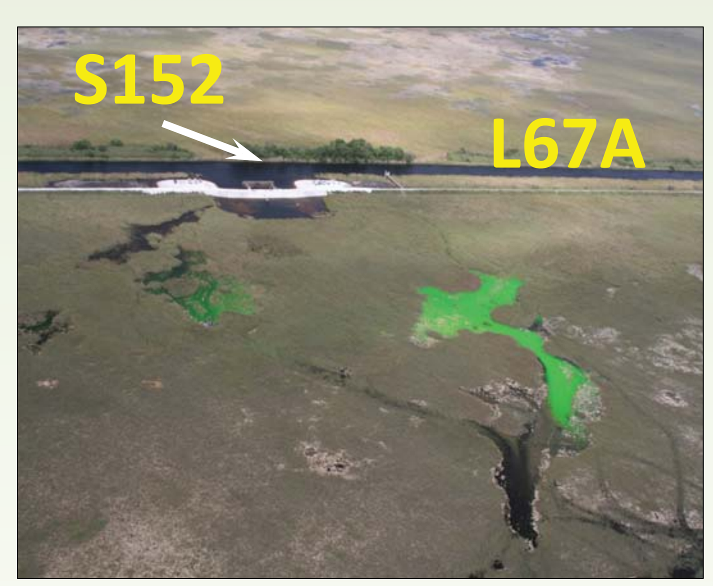
EVERGLADES SYSTEMS ASSESSMENT – APPLIED SCIENCES BUREAU – WATER RESOURCES DIVISION

WHAT IS THE DECOMP PHYSICAL MODEL OR "DPM"?

DPM is a landscape-scale field test to evaluate benefits of sheetflow and canal backfilling in restoring the Ridge-and-Slough landscape.



- Ten gated culverts (S152) deliver water from L67A into the "Pocket"
- 3000-ft levee gap on L67C, and three 1000-ft backfill treatments
- Hydrologic and ecological responses measured at 13 sites
- The first pulse flow event was conducted Nov5-Dec30, 2013



WHY SHEETFLOW?

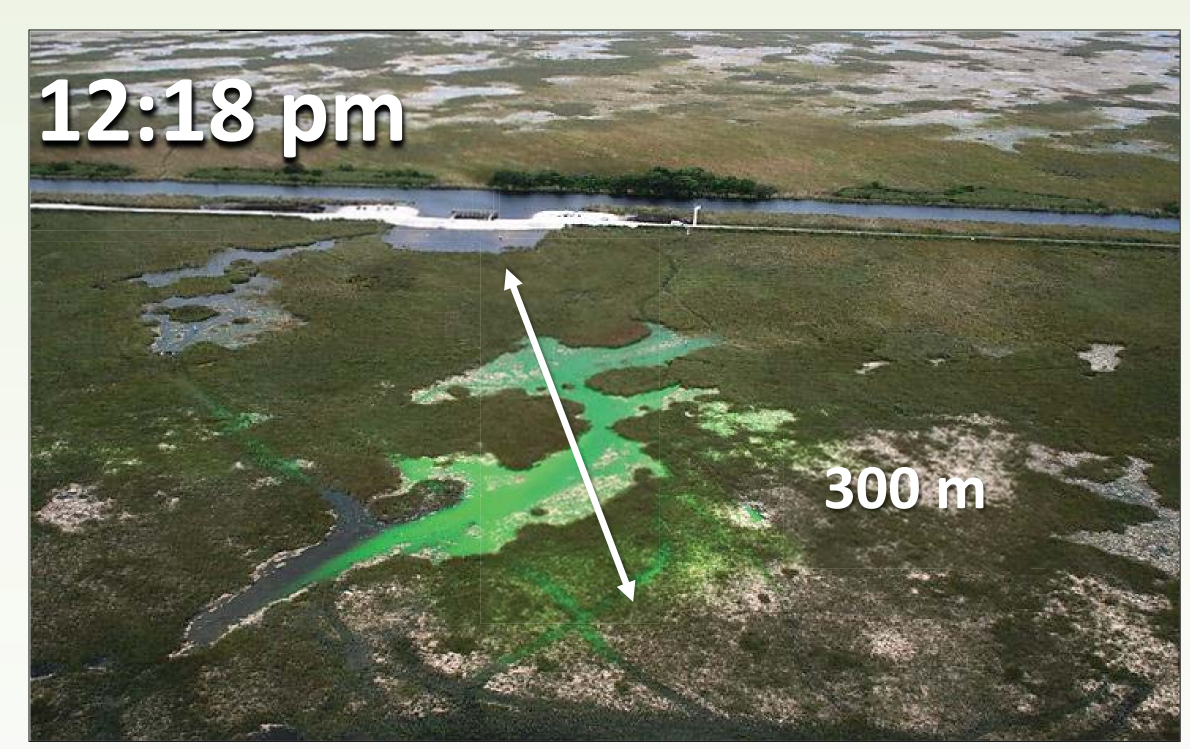
- Historically, the Everglades developed linear sawgrass ridges and deep sloughs oriented parallel to flow
- Unimpeded by barriers, high water velocities (2-3 cm s^{-1}) entrained and moved sediment from sloughs to ridges, building and maintaining the corrugated microtopography

DO WE NEED TO BACKFILL CANALS?

- Canals can potentially stop the flow of natural sediments, or worse, leak high nutrients to marshes downstream

METHODOLOGIES TO TRACK SHEETFLOW

• Fluorescein Dye • SF6 Tracer • Acoustic Doppler Velocimeters (ADVs)



- Water velocities of 2-5 cm s^{-1} were maintained throughout flow event (Nov-Dec)
- Velocities were highest wihtin 1-km of S-152
- Velocities were above theoretical thresholds required to entrain Everglades sediments
- Sediment tracers showed sediment moved at velocities ranging from 0.5 - 2 cm s^{-1}
- Sediment traps also showed that transport increased 5-20-fold throughout the high flow event
- Sediment transport increased in sloughs, and less so in ridges, suggesting sheetflow will redistribute sediments from slough-to-ridge *and rebuild microtopography*

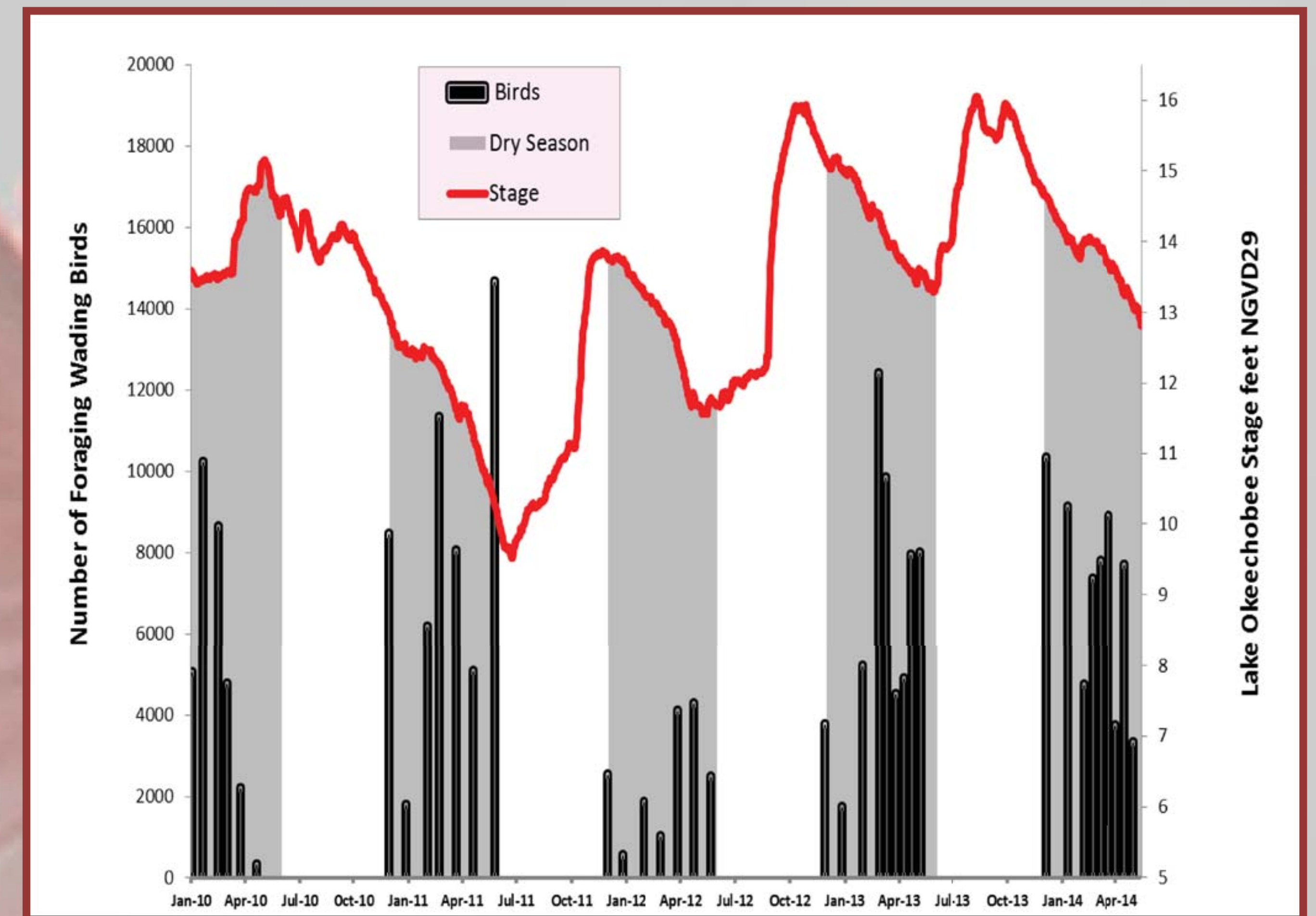
Wading Bird Foraging in Lake Okeechobee

Michael Baranski, Environmental Scientist - Lake and River Ecosystems Section, South Florida Water Management District, West Palm Beach, FL

Wading bird foraging has been monitored by the SFWMD in Lake Okeechobee since 2010. These data can be used as indicators of habitat quality and provide an important tool for examining the effects of hydrology, restoration efforts, and changes in the trophic levels that constitute the prey base.

Foraging success is directly linked to nesting productivity. Understanding how changes in hydrological and environmental variables affect foraging is imperative for successful management of wading bird populations. Lake stage, recession rate, vegetation and days since drydown are four important factors that help determine where birds may forage and how successful they will be.

Comparison of wading bird abundance 2010-14 with lake stage



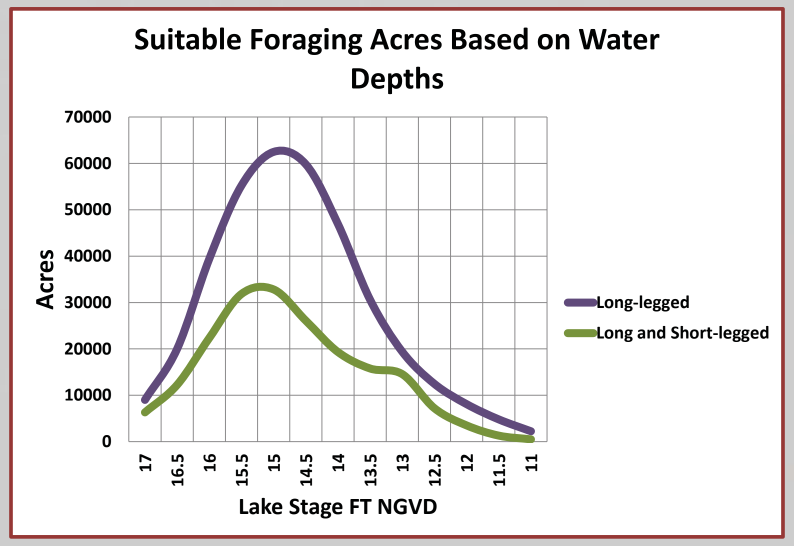
Preferred Foraging Water Depths

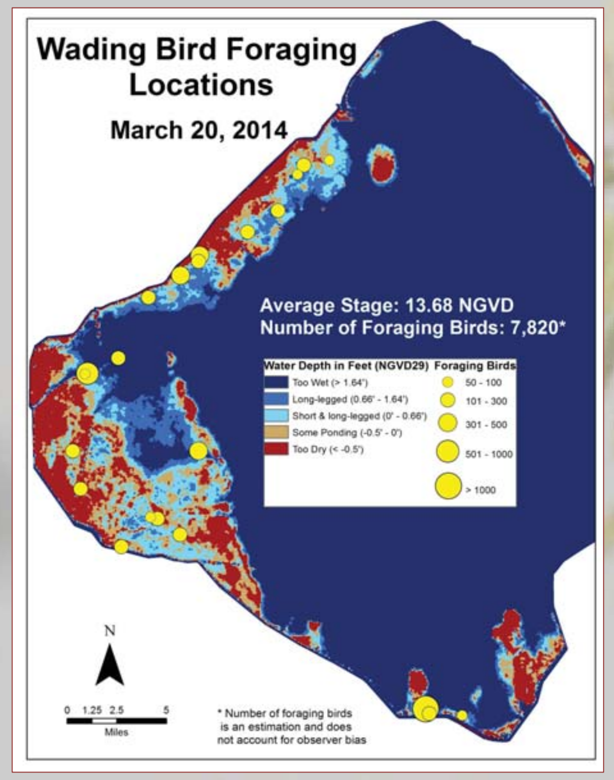
Short-legged 0-20cm

Long-legged 0-50cm

Lake Stage

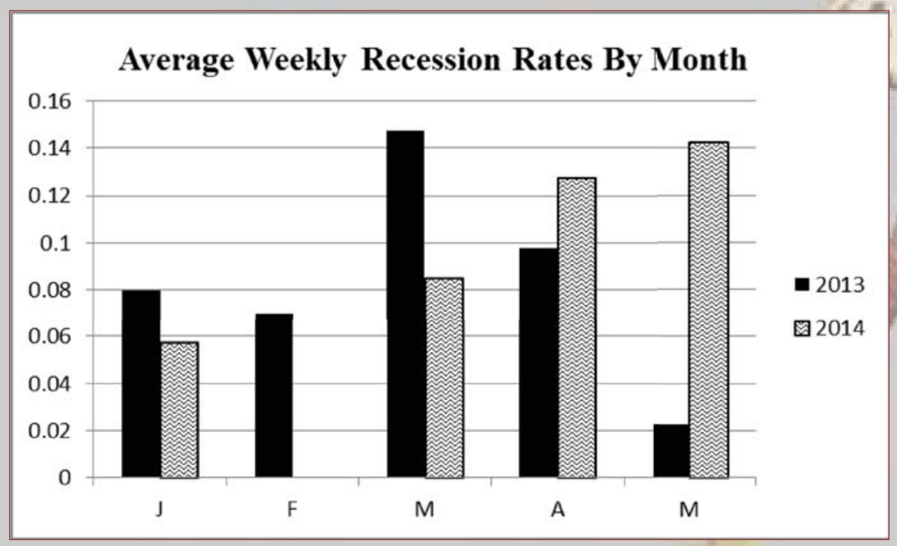
How many acres are available for foraging based on preferred depths at different lake levels?





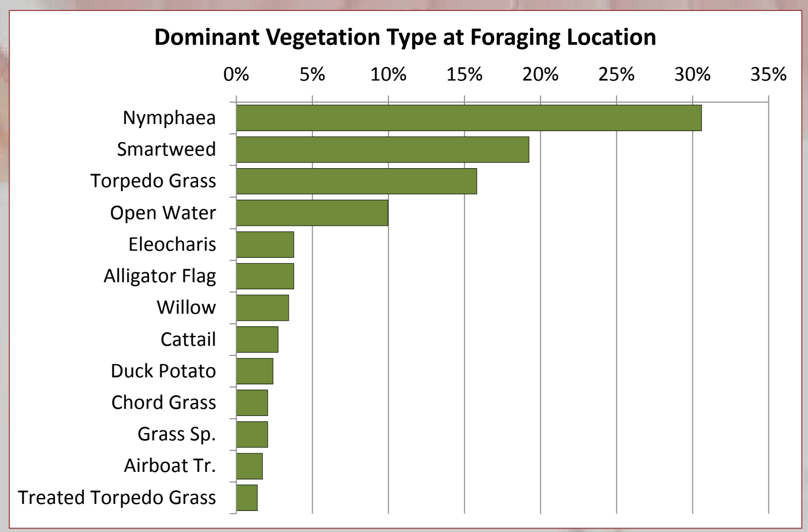
Recession Rate

How fast should water recede?



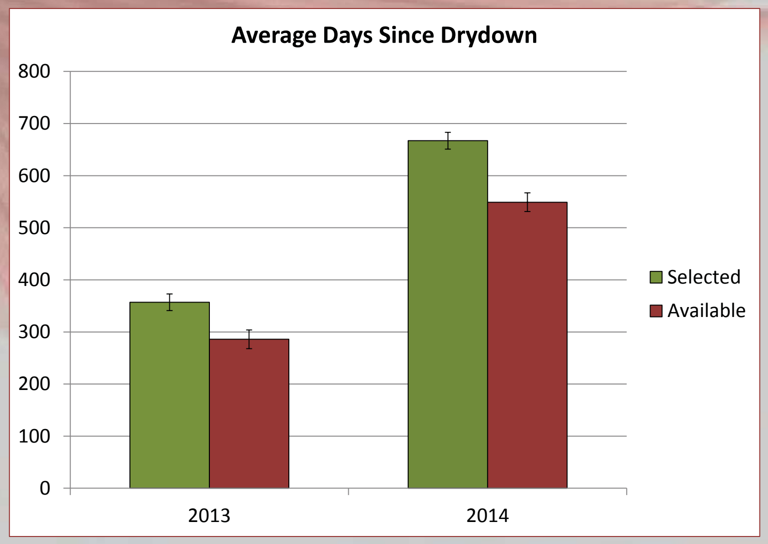
Vegetation

What type of emergent vegetation do birds prefer to forage in?



Days Since Drydown

Do birds prefer areas that have stayed wet longer?



Build A Model!

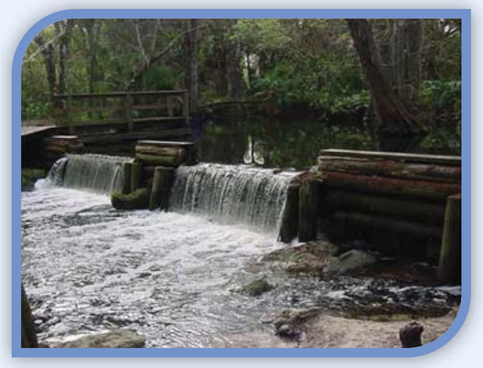
Environmental variables to be considered for this model include the four above as well as dry-to-wet reversals, disruptions (reversals), and submergent vegetation community. These variables are known to play a role in prey density and availability which directly affect foraging success. The goal is to produce a model that links foraging outcomes to these variables to aid in management and restoration strategies.

Special thanks to Chuck Hanlon, Therese East, Bruce Sharfstein, Amy Peters and Andy Rodusky

Poster completed by Michael Baranski August, 2014

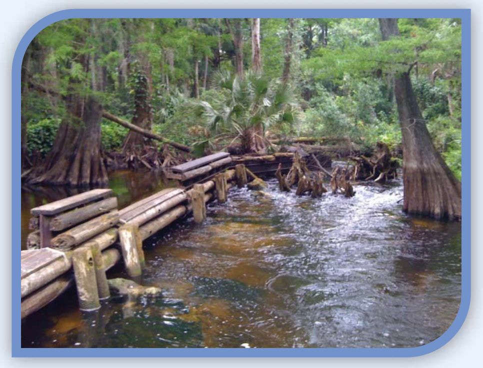
Modeling Evaluation of Dam Removal in the Context of River Ecosystem Restoration

Yongshan Wan, PhD, Section Leader, Detong Sun, PhD, Senior Scientist, Coastal Ecosystems Section, Applied Sciences Bureau, South Florida Water Management District
John Labadie, PhD, Professor, Department of Civil and Environmental Engineering, Colorado State University



ABSTRACT

Applications of environmental models may provide imperative information to enable informed decision-making of river management actions, which are often made in the face of high system complexity and uncertainty. We applied Hydrologic Engineering Centers River Analysis System (HEC-RAS) and Curvilinear Hydrodynamics Three-Dimensional (CH3D) models to aid in the decision-making of the proposed removal of the Masten Dam, a small, 'run-of-the-river' dam on the Loxahatchee River, a federally designated 'Wild and Scenic River' in south-east coast of Florida (USA). Anthropogenic alteration of the system has led to changing hydroperiods and salinity regimes in the floodplain. Both models are calibrated against measured data taken at varying temporal and spatial scales. The HEC-RAS modelling results show that removal of the Masten Dam would lower water levels in the upstream riverine reach, leading to reduced soil moisture or inundation in the floodplain. The CH3D modelling results indicate that dam removal would increase river salinity during the dry season in the tidal reach where salinity compliance for environmental flow regulation is measured. These environmental changes would exert additional stress on freshwater vegetation communities in the floodplain. Given the scarcity of water resources in the region, removal of the Masten Dam would not offer an effective restoration strategy. This study demonstrates not only the need for evaluation of dam removal on a case-by-case basis but also the usefulness of environmental models in providing the technical basis for such management decisions.



STUDY AREA

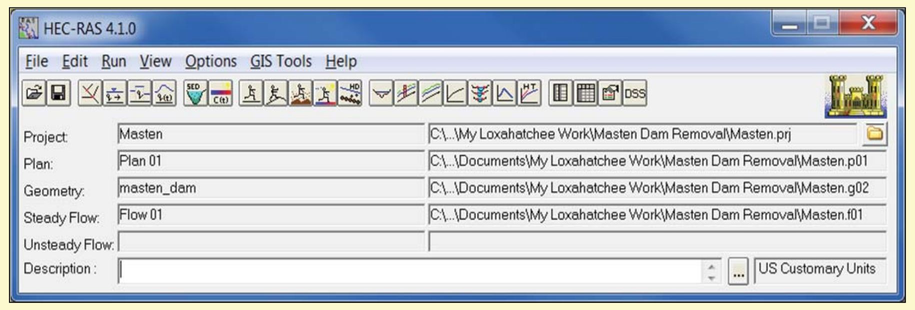
Masten Dam is a small, 'run-of-the-river' dam located in the upper reach of the Loxahatchee River. The need for frequent repairs has raised major concerns, and removal of the dam was proposed by a group of stakeholders.

DATA

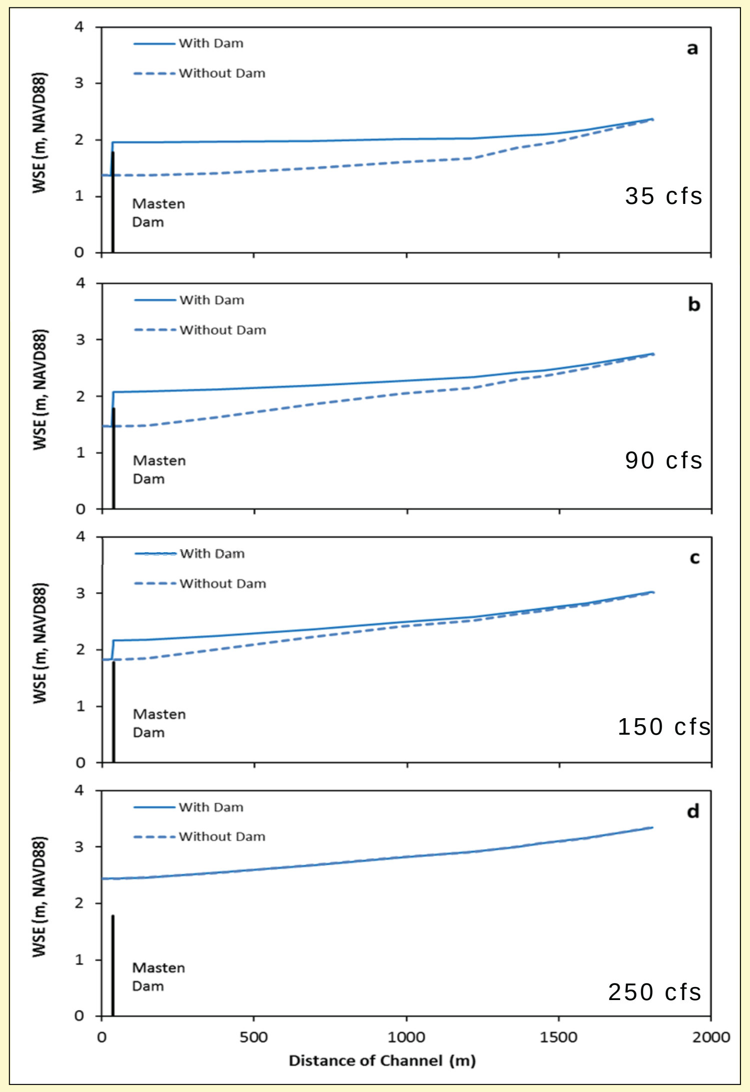
- Salinity
- Stage
- Flow
- LiDAR
- Bathymetry
- Weather
- Vegetation

MODELING WATER LEVEL

- **Hydrologic Engineering Centers River Analysis System(HEC-RAS) Model**



- **Water surface elevation profile simulated with HEC-RAS**



- **The floodplain between Lainhart Dam and Masten Dam at the flood rate of 150 cfs**

Condition	Area of floodplain inundation (ha)	Volume of water storage in floodplain (m^3)
With Masten Dam	7.0	22 760
Masten Dam removal	5.4	16 800
Percent reduction	22	26

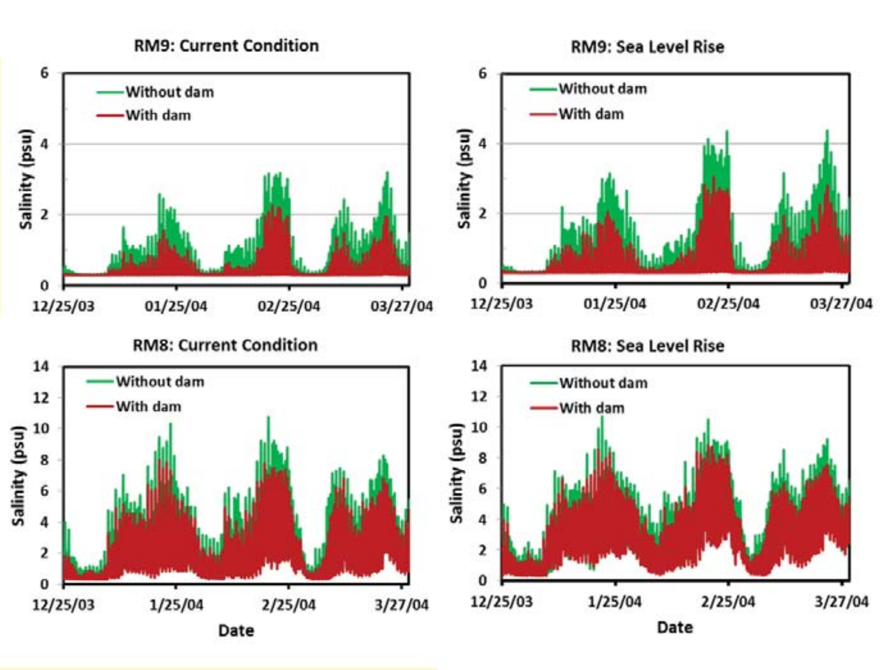
MODELING SALINITY

- **Curvilinear Hydrodynamics Three-Dimensional (CH3D) Model**

- **Model calibration and validation**

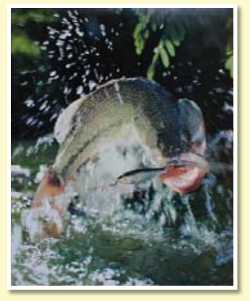
Location		Salinity			Water surface elevation		
		r^2	RMSE (psu)	RRE (%)	r^2	RMSE (m)	RRE (%)
RM 9	Calibration	0.72	1.1	15.2	0.88	0.13	12.1
	Validation	0.71	1.2	15.8	0.86	0.14	12.9
RM 8	Calibration	0.80	1.49	12.5	0.91	0.11	9.1
	Validation	0.80	1.56	12.7	0.90	0.12	9.7
RM 6	Calibration	0.86	3.86	13.2	0.92	0.10	8.1
	Validation	0.86	3.92	14.8	0.92	0.10	8.5

- **Simulated salinities at RM9 and RM8 of the Loxahatchee River at the current and sea level rise conditions. Salinities are simulated (2.5 min output) with and without Masten Dam.**



IMPLICATIONS

- **Reduced water level and floodplain inundation would result in encroachment of dry species into the floodplain and loss of fish habitat**
- **Increasing salinity suggests that the 2 psu MFL criterion would be exceeded more often with Masten Dam removed**
- **Masten Dam removal implies that much more water would be required to reach the restoration goals**



BOTTOM LINE

Masten Dam should be repaired rather than removed to help achieve the goal of Loxahatchee River restoration.

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