



Planning for Sea Level Rise in Florida's Coastal Communities



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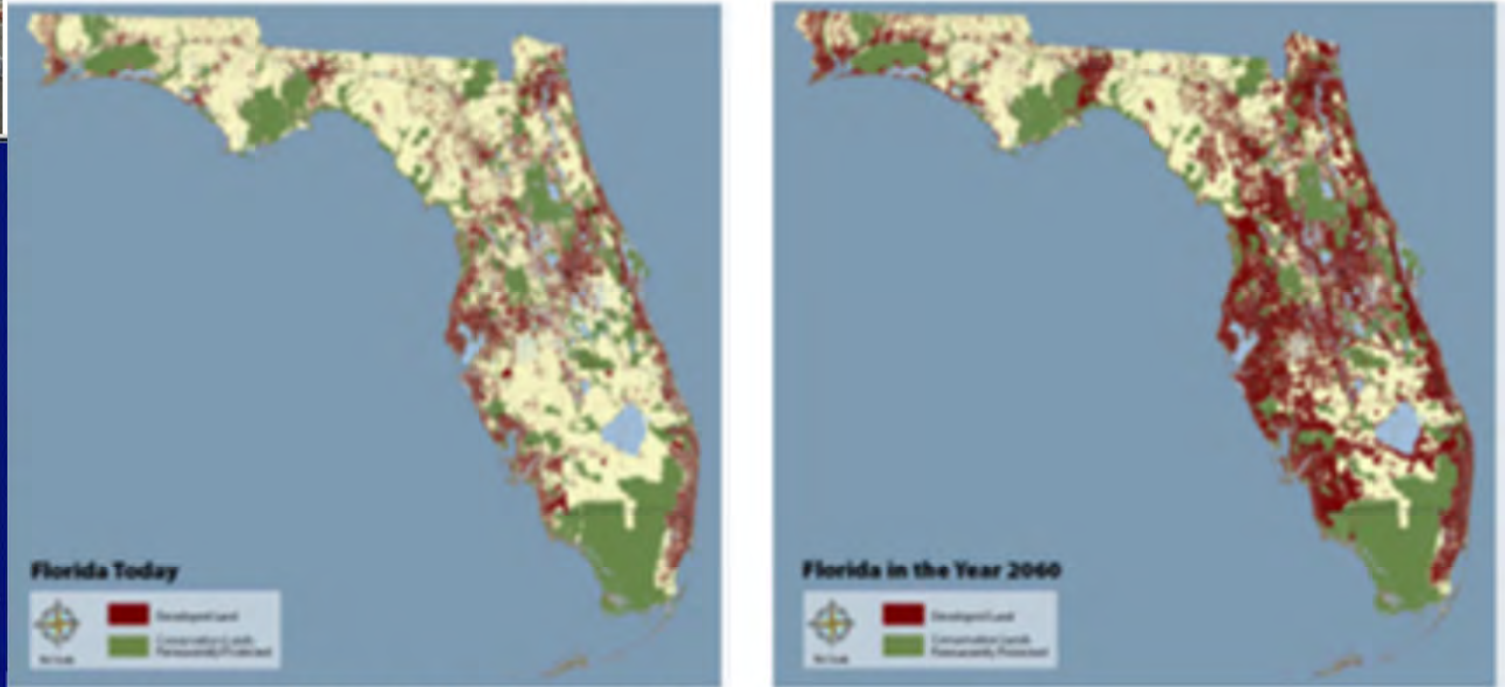


Why are seas rising?

- Warmer water, more volume...
- Melting glacial ice, more water...
- Global warming accelerates both of these dynamics...



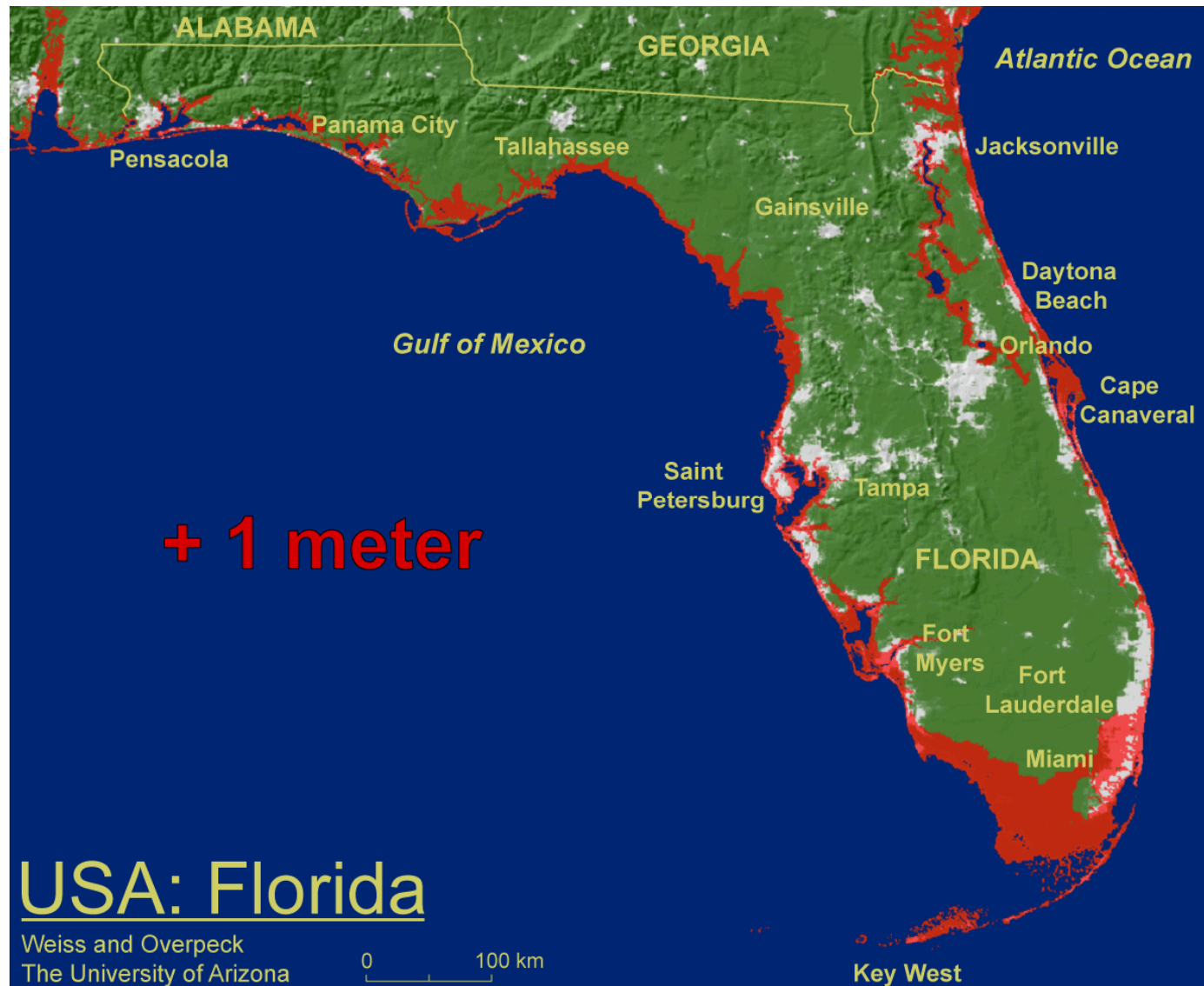
The Urban Sprawl Epidemic in Florida



Images source: 1000 Friends of Florida, Florida 2060 Report

If Florida continues to grow by 2.5-3.0 million residents each decade and low density development patterns persist, then much of the state will be developed by 2060.

Florida Sea Level Rise Exposure



Hollywood, Florida at 1 Meter Sea Level Rise



Miami at 1.25 Meters Sea Level Rise



Ocean Drive Miami



Ocean Drive Miami



If all the ice melts...





How to Plan for SLR?

- Information intensive
- Cross jurisdictional
- Incremental to transformative





Existential Crisis

For coastal communities

- Non-stationarity
- Long slow persistent change
- Long-term managed relocation a reality
- Lots of engineering options in the interim



FL planning at multiple levels

- State level guidance and legal changes:
 - Adaptation Action Areas (optional)
 - Technical support through DEO and DEP
 - DOT infrastructure planning
- Regional Planning
 - RPC's, Climate Compacts
 - Capacity, technical support, and collaborative networks



The Southeast Florida Regional Climate Change Compact represents a joint commitment of Broward, Miami-Dade, Monroe and Palm Beach Counties to partner in mitigating the causes and adapting to the consequences of climate change.





Barriers to Climate Adaptation Planning

- **Information** (Ekstrom et al., 2010; Bierbaum et al., 2012; Amundsen et al., 2010; Shi et al., 2015; Uittenbroek et al., 2013)
- **Leadership** (Ekstrom et al., 2010; Bierbaum et al., 2012; Shi et al., 2015)
- **Resources** (Ekstrom et al., 2010; Bierbaum et al., 2012; Carmin, 2012; Shi et al., 2015; Uittenbroek, 2016; Lonsdale et al., 2017)
- **Jurisdictional borders** (Bierbaum et al., 2012; Anguelovski et al., 2011)
- **Political** (Bierbaum et al., 2012; Anguelovski et al., 2011; Carlson & McCormick 2015)
- **Values and Beliefs** (Anguelovski et al., 2011; Hamin et al., 2014; Shi et al., 2015; Uittenbroek et al., 2013)
- **Uncertainty** (Adger et al., 2009; Anguelovski et al., 2011; Hamin et al., 2014; Uittenbroek et al., 2013; Carlson & McCormick 2015)
- **Capacity** (Amundsen et al., 2010; Hamin et al., 2014; Shi et al., 2015; Lonsdale et al., 2017)
- **Lack of Mandate for Climate Adaptation** (Hamin et al., 2014; Stevens and Senbel, 2017)

STATE MANDATE

PLAN!

GET READY FOR IT!



- (Hamin et al., 2014; Stevens and Senbel, 2017)
- Peril of Flood Act (2015)
 - Requires consideration of SLR as a source of flooding in Coastal Management Element of the Comprehensive Plan



“Each coastal management element required by s. 163.3177(6)(g) shall be **based on studies, surveys, and data**; be consistent with coastal resource plans prepared and adopted pursuant to general or special law; and contain: (f) A redevelopment component that outlines the principles that must which shall be used to **eliminate inappropriate and unsafe development** in the coastal areas **when opportunities arise**. The component must: 1. Include development and redevelopment principles, strategies, and engineering solutions that **reduce the flood risk** in coastal areas which results from high-tide events, storm surge, flash floods, stormwater runoff, and the **related impacts of sea-level rise**.” (SB 1094, 2015; Chapter 2015-69, emphasis added)



SLR Planning at local level

- Butler et al. 2016 identified 21 coastal counties and municipalities taking one or more SLR planning actions (before the Peril of Flood act of 2015)
- What made a difference?
 - Regional vulnerability assessments
 - Hazard exposure and experience



Comp Plans and Survey

- 86 comp plans
 - DEO list of compliant communities
 - List from prior research on SLR
- Assessing
 - Planning intelligence/information
 - Responses to impacts (protect, accommodate, avoid, relocate)
 - Collaboration (who and why)



DEP sponsored survey

- ❖ Designed online survey in Qualtrics
 - ❖ Consultation with Department of Environmental Protection
 - ❖ Pilot tested with state and regional agency officials
 - ❖ Refined and finalized
- ❖ Target population - Planning director / planners / consultants
- ❖ Time period: June – August 2019
 - ❖ Follow-up emails with non respondents
- ❖ Multiple choice, rank order, open ended questions



Survey questions

- SLR Impacts
- Challenges/Barriers
- Vulnerability Assessments
- Plans and policies
- Affordable housing/gentrification
- Nature based mitigation responses
- Needs and Capacity Building

Respondents



- 186 completed individual surveys
- 96 municipalities represented
- Small—5000 population, \$400K exp
- Large—2.8 million pop, ~\$10 billion
- Wide regional representation, both Atlantic and Gulf Coasts

SLR Impacts

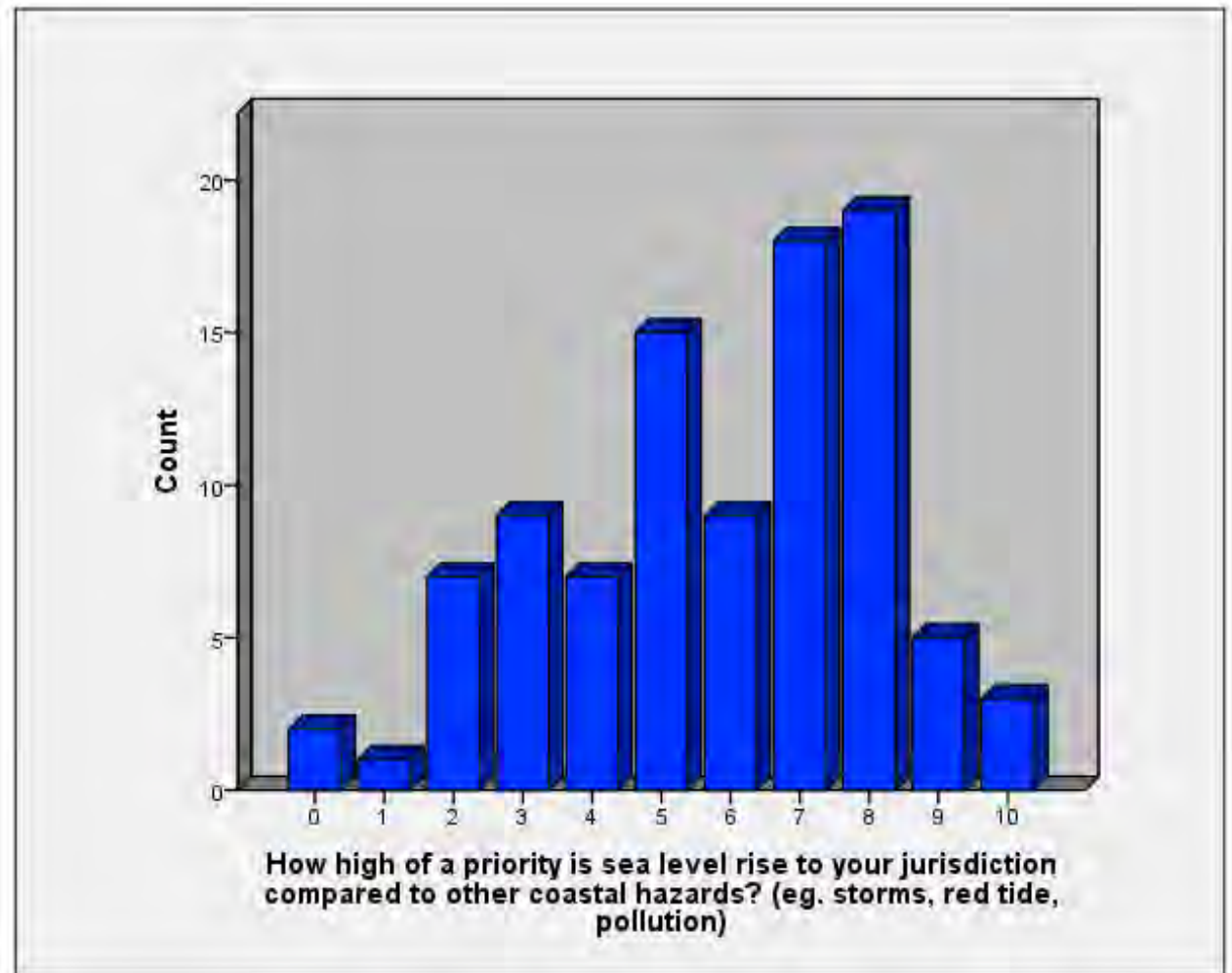
58% respondent communities said have to deal with SLR impacts



Hazard ID	# of Municipalities who answered	Never	A Few Times a Year	Monthly	Weekly
Flooding Related Road Closures	42	9.4%	41.7%	4.2%	1%
Coastal Erosion	41	8.3%	32.3%	10.4%	6.3%
Sunny Day Flooding	41	12.5%	38.5%	5.2%	1%
Groundwater salinization	41	30.2%	17.7%	3.1%	6.3%



SLR as relative Priority



Barriers to Adaptation



Barrier to SLR Adaptation	Severe Limit	Limit Some	Total
Funds to Implement	33.3%	35.4%	68.7%
Funds to Plan	26%	33.3%	59.3%
Internal Capacity	21.9%	28.1%	50%
How Far Ahead to Plan	6.3%	31.3%	37.6%
Coordinate Within Jurisdiction	8.3%	27.1%	35.4%
Difficulty Choosing Projection Curves	8.3%	24.0%	32.3%
Elected Officials Priorities	9.4%	18.8%	28.2%
Constituency Priorities	2.1%	24.0%	26.1%
Coordinate With Neighboring Jurisdictions	6.3%	13.5%	19.8%



New Comp Plan language due to PoFA

- ❖ New language – 37.5%
- ❖ In process – 18.8%
- ❖ No new language – 13.5%
- ❖ Do not know – 21.9%

So, nearly 60% of communities are developing new SLR language in response to PoFA.



Planning Goals/Objectives

- Risk reduction to flood
 - Public and private
 - Protect or restore natural functions and features
 - Eliminate unsafe development
 - Increase resilience to flooding

Objective 2.5: Development and redevelopment within the town shall proceed in a manner that lessens risk to public investments and private property by utilizing policies, techniques and practices that reduce negative impacts of flooding and sea level rise.

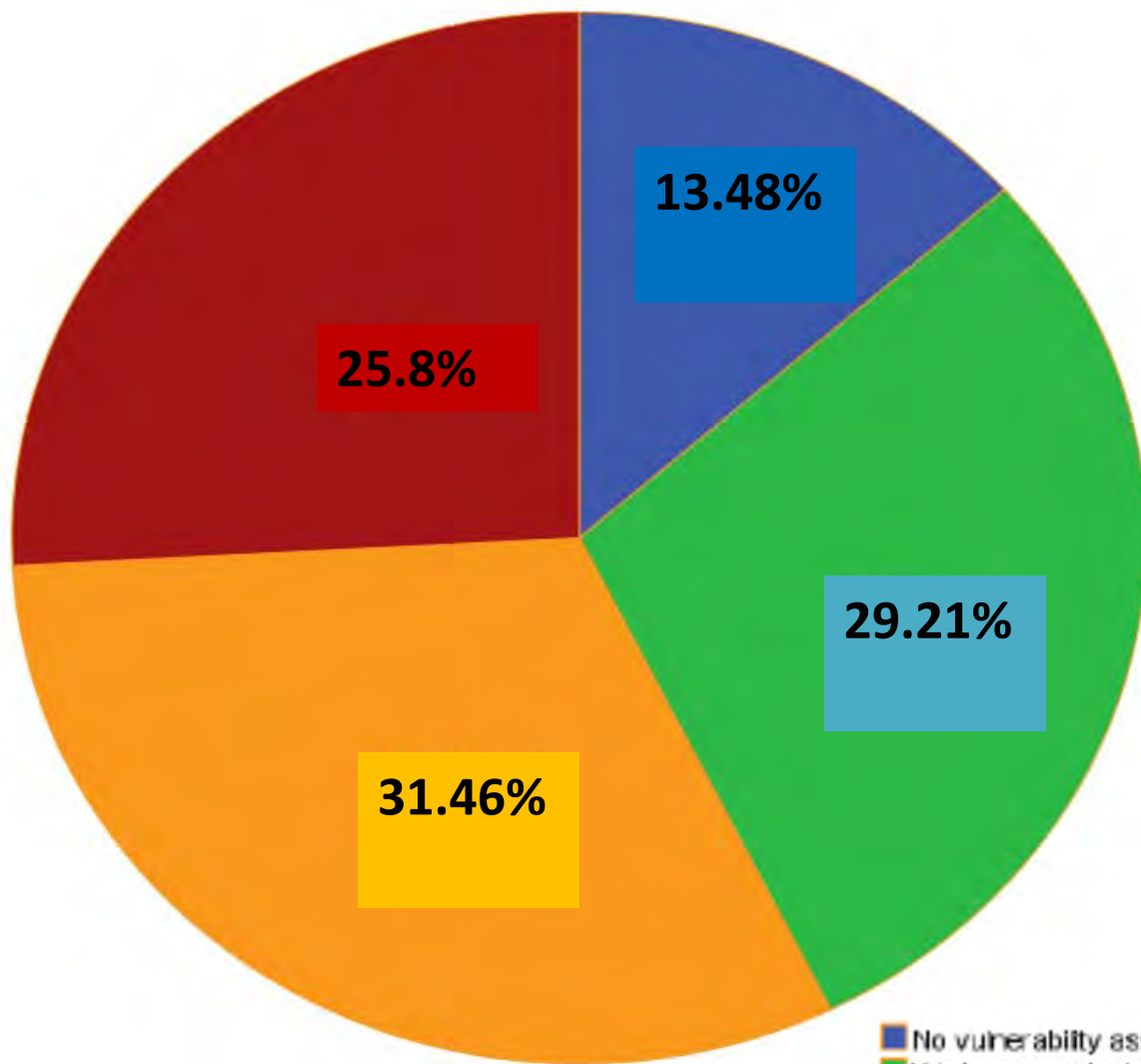


Planning intelligence

- Vulnerability Assessment
- Current and Credible Information
- Ongoing Monitoring



By 2020, identify public facilities and infrastructure at risk from sea level rise and plan for updates to the assessment every five years. The City shall analyze vulnerability to public facilities and infrastructure, including but not limited to: public buildings and facilities, including police and fire stations; water and water reclamation facilities, transmission lines and pumping stations; stormwater systems; roads and bridges; and other transportation and transit infrastructure.

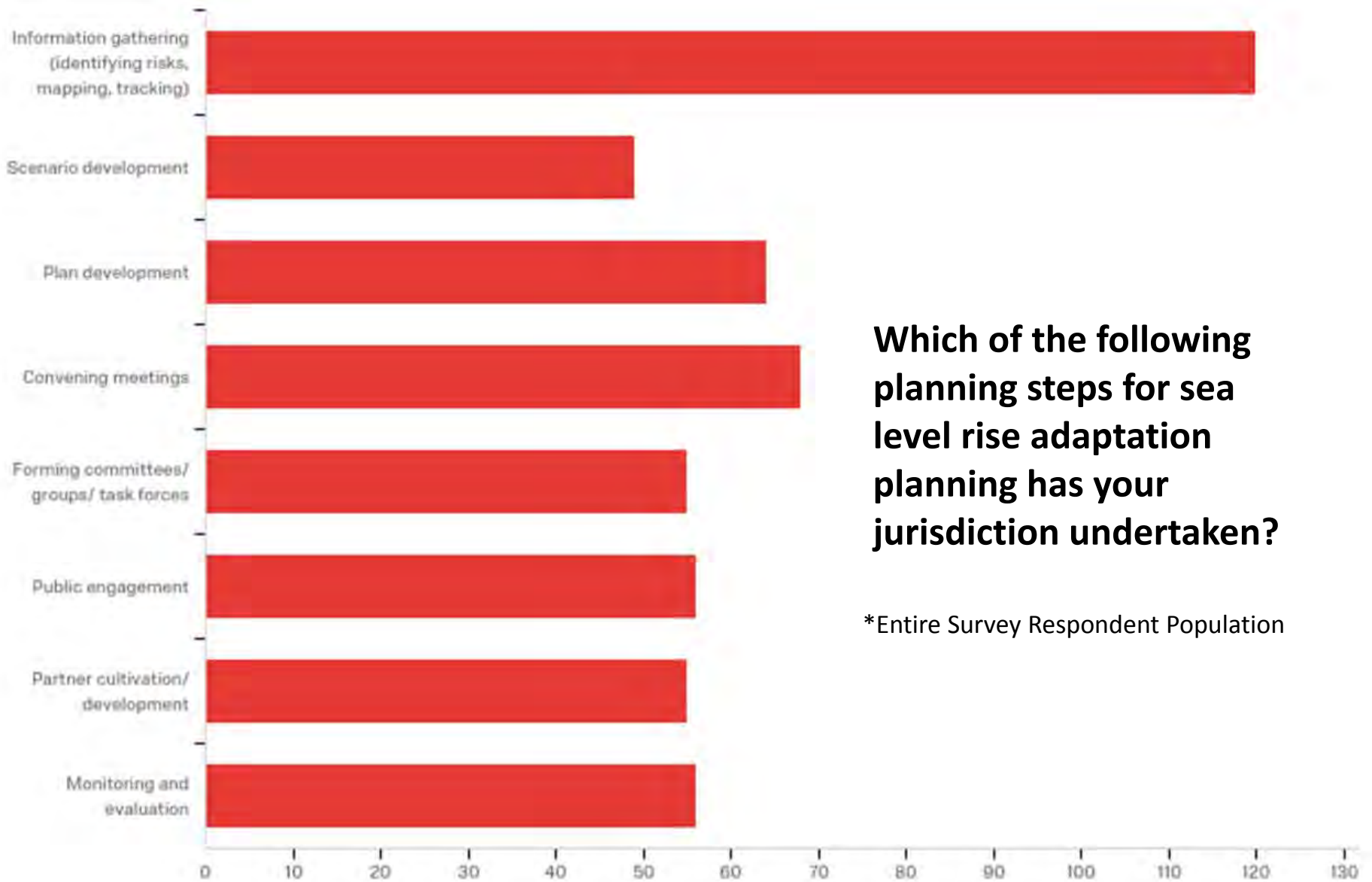


Has your community conducted or have access to a sea level rise vulnerability assessment?

- No vulnerability assessment
- We have conducted our own
- We use an assessment provided by a regional authority
- We use visualization tools (e.g., NOAA Sea Level Rise Viewer, Climate Central Surging Seas, Geoplan Sea Level Rise Sketch Planning Tool)

Which of the following planning steps for sea level rise adaptation planning has your jurisdiction undertaken?

*Entire Survey Respondent Population





Responses in Plans

- Policy and other plan changes
 - Land dev code, LMS, CIP, etc.
- Further evaluation then action
 - Tiering responses to changes
- Protect—43% of plans
- Accommodate—43% of plans
- Avoid—17% of plans
- Retreat—22% of plans
 - Was 1/21 pre-PoFA analysis!!



Nature Based Responses

❖ 76% respondents using nature based strategies

Beach nourishment and dune stabilization or restoration dominates (~25% each)

Living shorelines, greenway/passive rec (~15% each)



Climate Justice



- Climate vulnerabilities
 - Communities of color and low-income communities impacted
- Peculiarities of SLR
 - Gentrification to higher ground
 - In Florida, higher ground often lower cost (further from beach)
 - Vulnerabilities push wealthier populations inland

In the plans?

- Largo

“Seek out community input from vulnerable and historically disadvantaged groups in order to ensure equitable access to resources, reduce health disparities, and increase community resiliency.”



In the survey



- Flood displacement
 - 24% respondents predict such displacement
- 3 respondents see residents moving to higher ground
- People tend not to move until experience flooding
- 60% don't know where people moving
- ~30% see people moving from higher to lower income neighborhoods



Collaboration in survey

- Regional networks/partners
 - RPCs--95
 - Regional cooperative--46
 - National estuarine orgs--28
- Top 3 benefits
 - Networking with other coastal planners/professionals
 - Learning from experiences of other planners/managers
 - Workshops and training for sea level rise strategies or tools



Comprehensive Plan Analysis

- Pre-PoFA
 - 21 comp plans in state dealt with SLR
 - Hedging, limited commitments
- Post-PoFA
 - 80+ comp plans and counting
- More comprehensive approach
 - Information—VAs, models, monitor
 - Responses—protect, accommodate, relocate
 - Collaboration—interlocal, state, fed, regional

Conclusions

- SLR Planning in FL ramping up
- Information intensive, main focus now
- Many responses tiered to changing conditions
- Working together and state support needed to overcome barriers
- Nature based responses happening
- Climate justice largely ignored



An aerial photograph of a university campus. In the foreground, a large pond with a central fountain is visible. The campus includes several buildings, a large green field, and a parking lot. A dense forest surrounds the campus. The sky is blue with some clouds. The text "URBAN WATER RESILIENCE" is overlaid in yellow, and "CHALLENGES & OPPORTUNITIES" is overlaid in white below it.

URBAN WATER RESILIENCE

CHALLENGES & OPPORTUNITIES



Urban Flooding in Anam, Nigeria



Urban Flooding in Anam, Nigeria



Anam New City Urban Design

Ecological Transect



SEASONALLY FLOODED

EBENEBE TREES

GRASSLANDS

DOMESTIC GARDENS

SAVANNAH

WOODLANDS

BAMBOO THICKET

ECOTONE MOSAIC

AGRICULTURE

RIPIARIAN

AQUATIC

LAND

INFRASTRUCTURE

URBAN

LAND

WATER

ENERGY

ECONOMY

MOBILITY

METRICS



Urban Flooding in New York, NY



Urban Flooding in New York, NY



Roosevelt Island Redevelopment - New York, NY



Green Infrastructure - New York, NY




Floodproof Home Renovations



Green infrastructure in TLH



Capital Cascade Trail Segment 3 and FAMU Way Corridor  GENESIS GROUP

Building better for the future.





Harmful Algal Blooms & What's Next for Florida

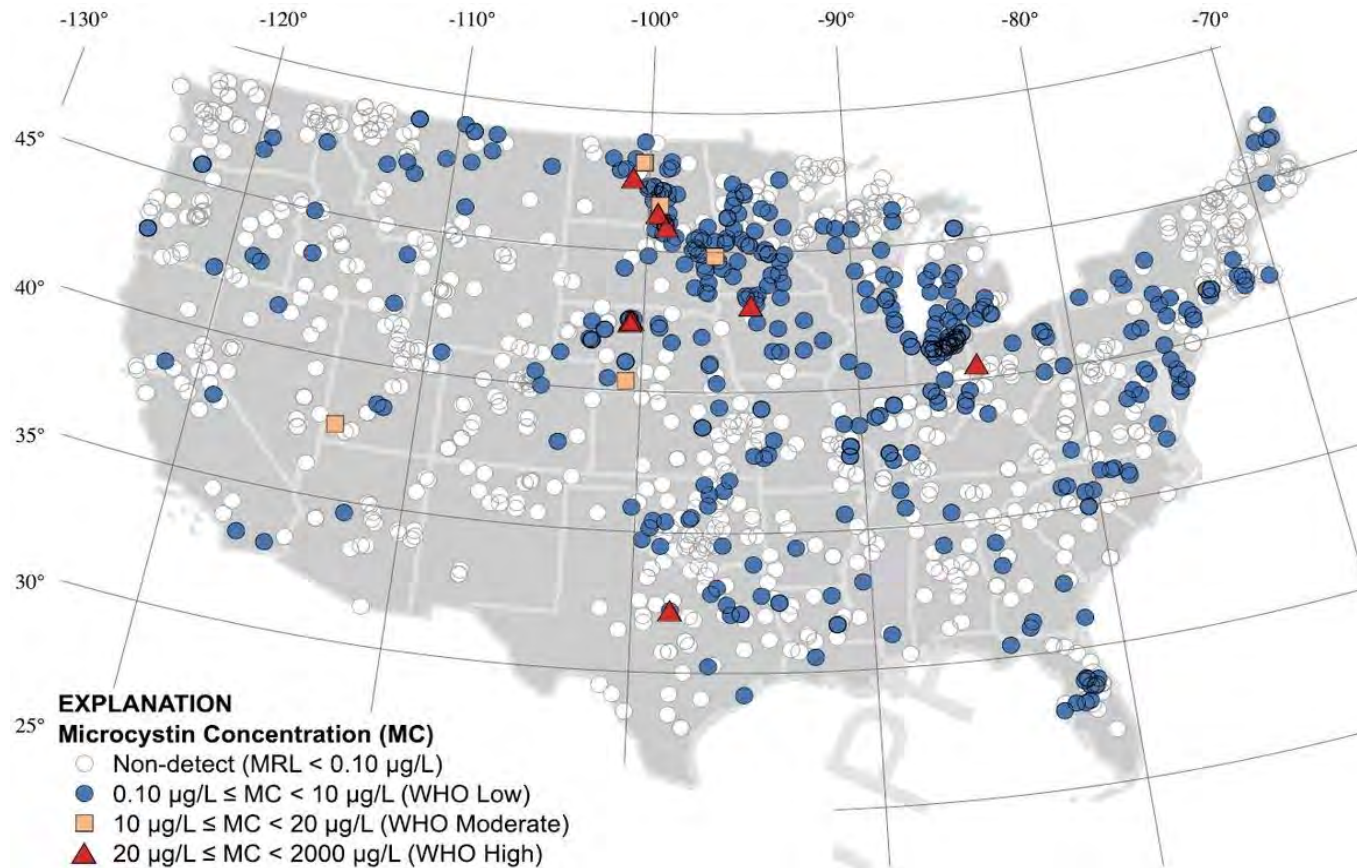
October 29, 2019

AECOM Imagine it.
Delivered.



*Lake Erie
September 18, 2019*

2019 US Algae Issue - States with Blooms, Advisories and/or Beach Closures



Source: USGS 2019

2019 Recent Events

July 2019



All 21 Mississippi public beaches closed due to toxic algae July 7, 2019

August 2019



3 dogs died within hours of coming in contact with Toxic algae in NC. USA Today August 13, 2019



Scientists think toxic algae may be to blame for Florida's stumbling Panthers. USA Today August 23, 2019

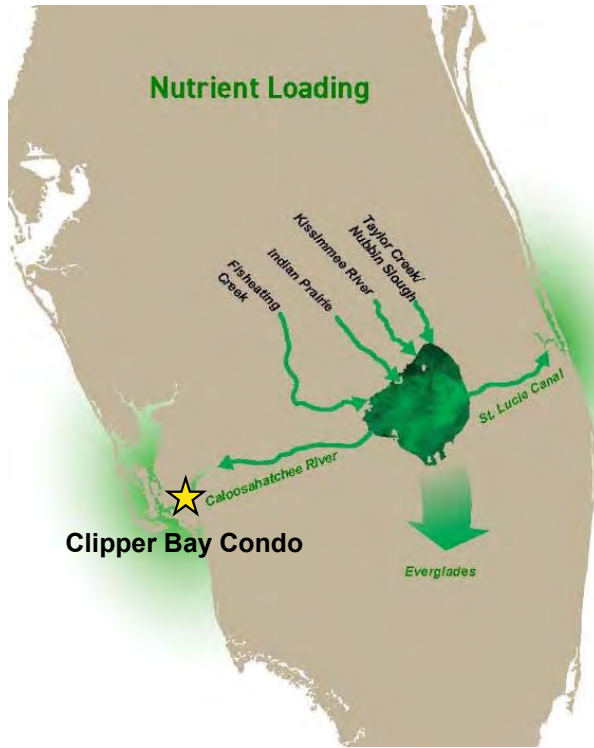


Toxic Algae that's killed 9 dogs found in Central park. New York Post August 24, 2019



September 2019?

2018 - Emergency Response Action



Lee County, FL HAB Cleanup Sites



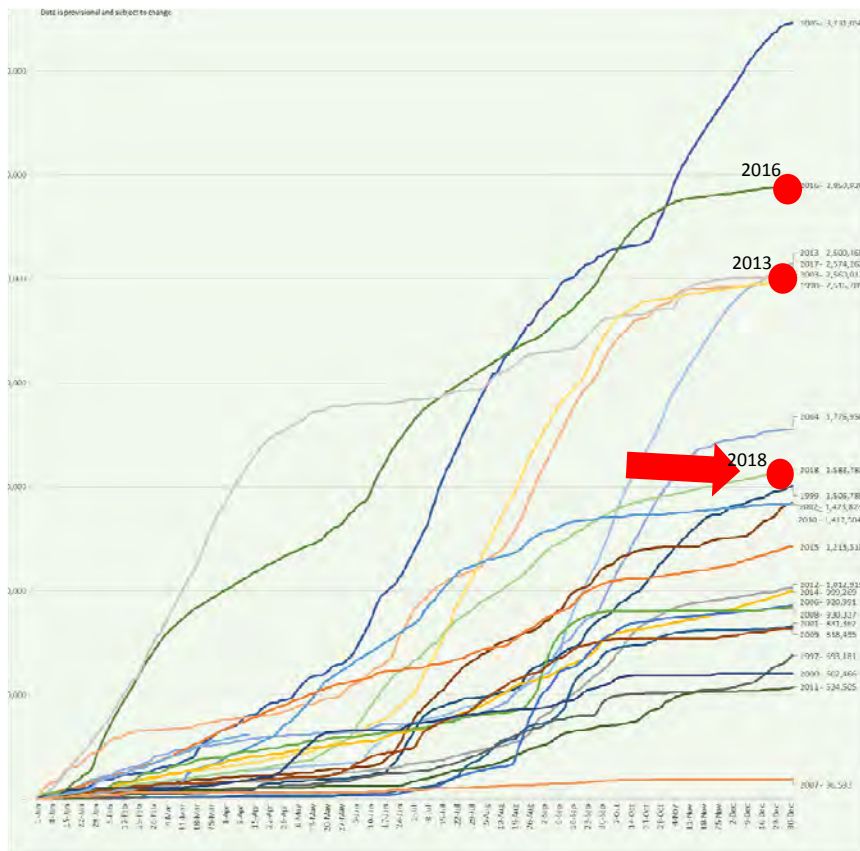
August 9, 2018
Clipper Bay Condo, Cape Coral, FL



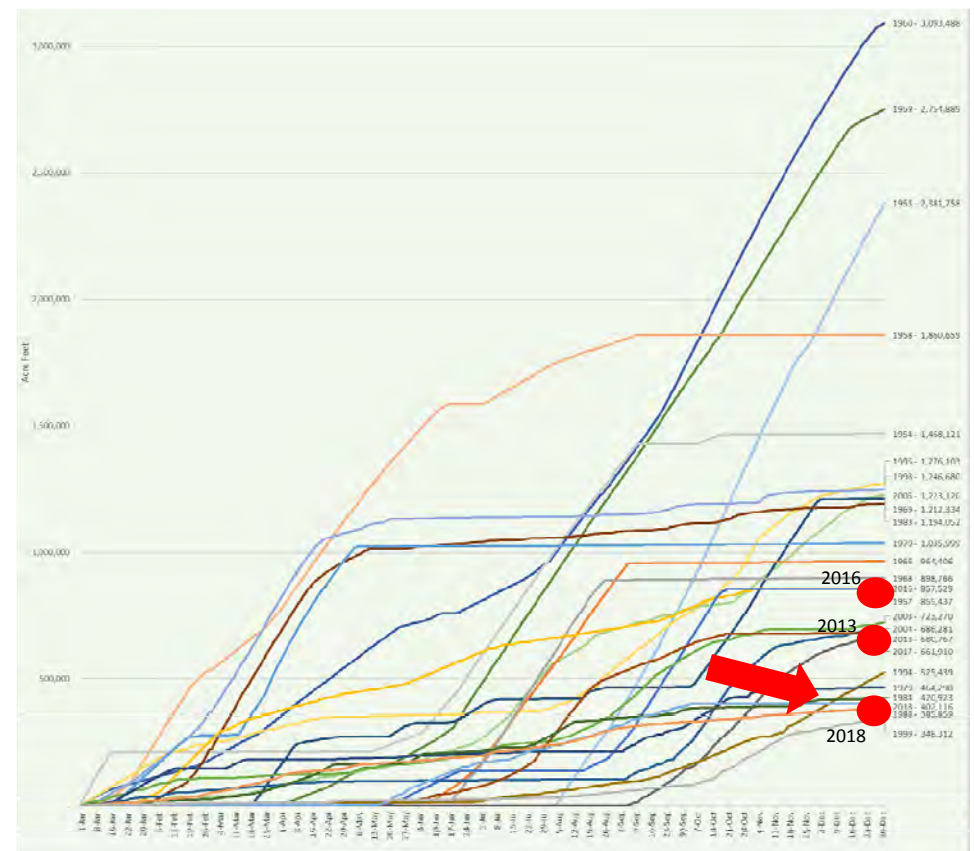
August 10, 2018
Clipper Bay Condo, Cape Coral, FL

Lake Okeechobee Top 25 Discharges (1967-2019)

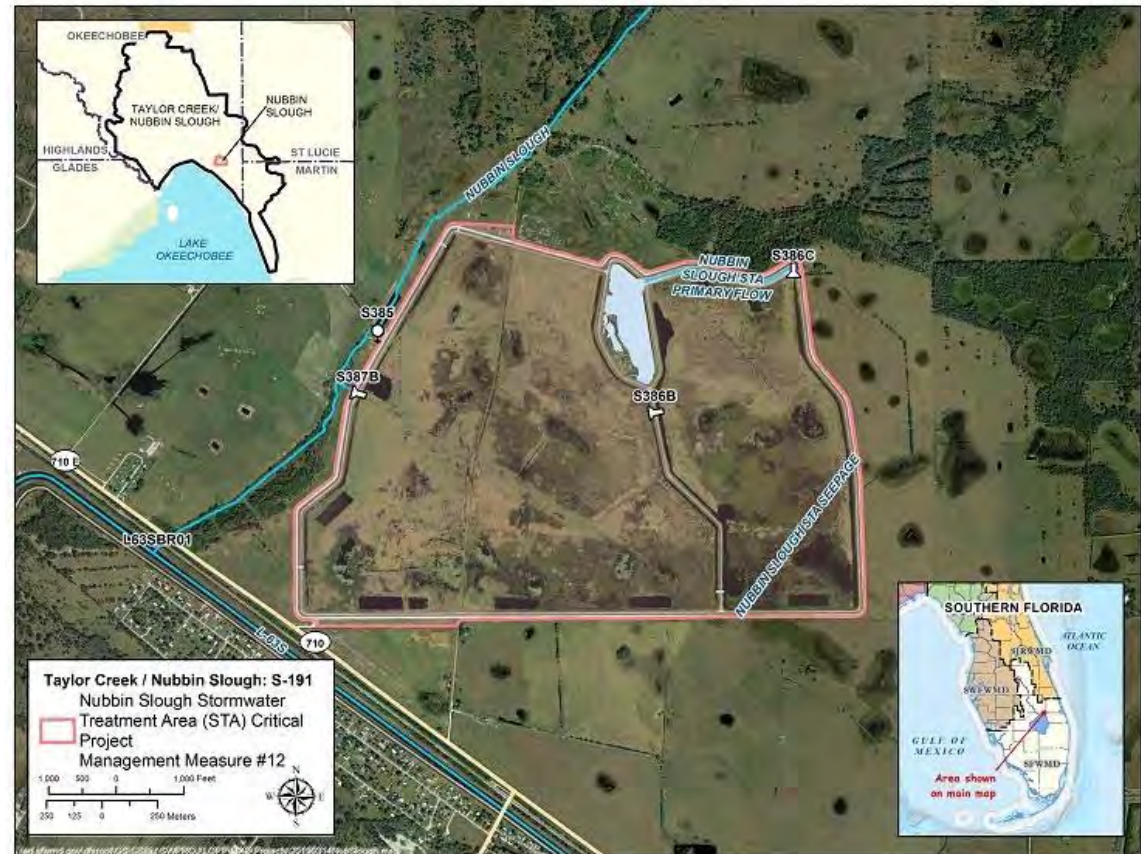
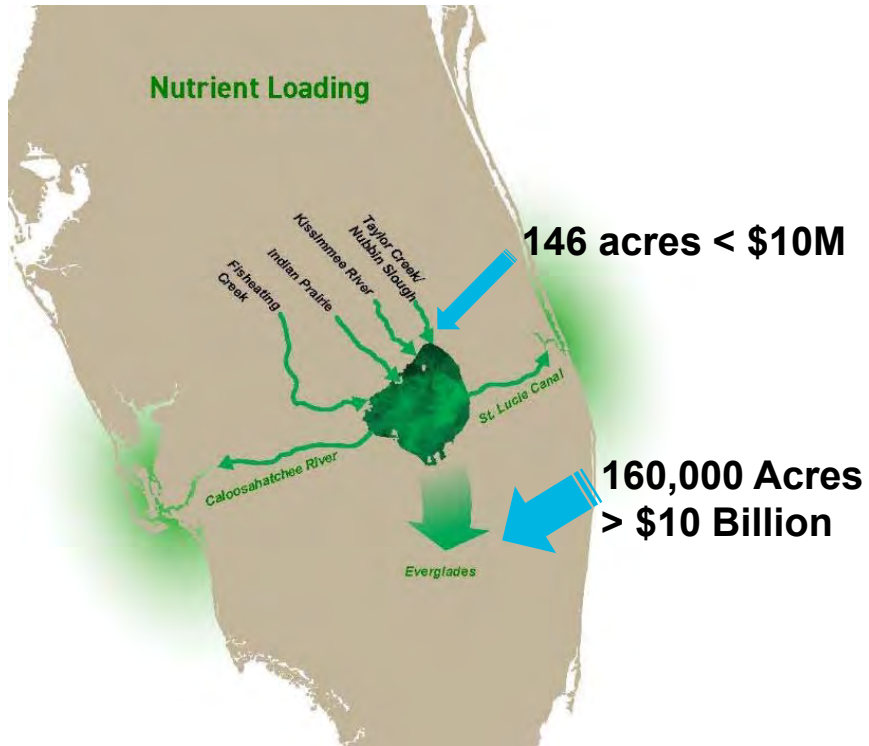
S-79 Spillway Caloosahatchee River



S-80 Spillway St. Lucie Canal

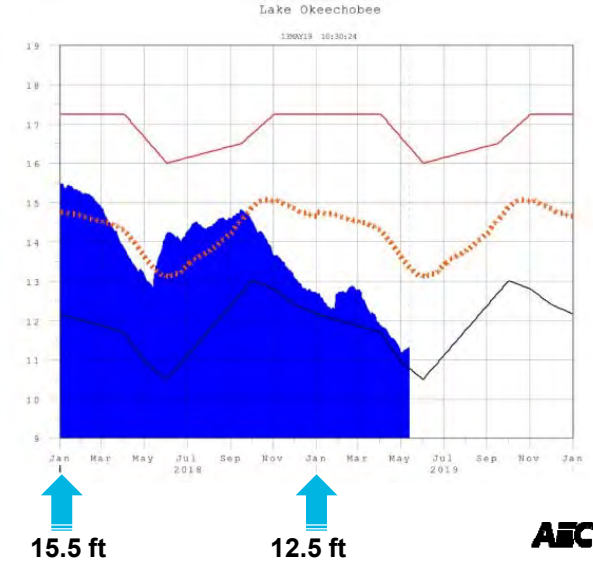
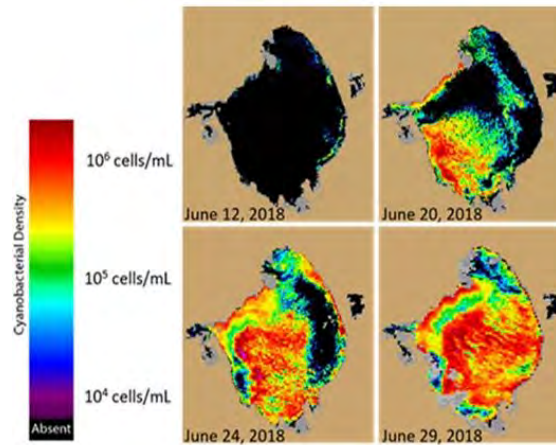
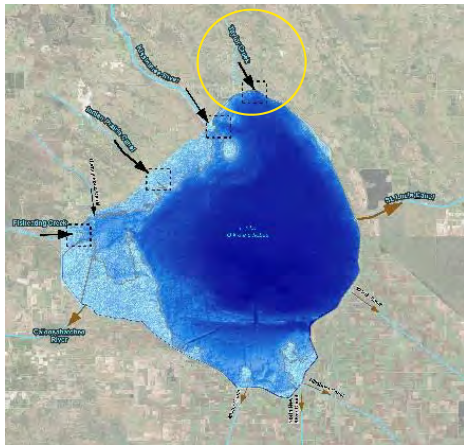


Lake Okeechobee HABs



The Problem –TP and TN Loading into Lake Okeechobee

Water Body	Annual Loading in Tons		Removal based on 8 hrs/ day		VS	Total Annual TP Removal
	TP	TN	TP-97%	TN-90%		
Taylor Creek/ Nubbin Slough	98	270	32	81		2
Kissimmee River	35	180	11	54		0
Indian Prairie	45	379	15	114		0
Fisheating Creek	47	230	15	69		0
Total	224	1060	72	318		2



Harmful Algal Bloom Interceptor Treatment and Transformation System (HABITATS)

Interception



2018 Water Resources Development Act (WRDA) requires ERDC to demonstrate scalable technologies for the mitigation of Harmful Algal Blooms (HABs) SEC. 140. Harmful Algal Bloom Technology Demonstration

Public Private Partnership (P3)



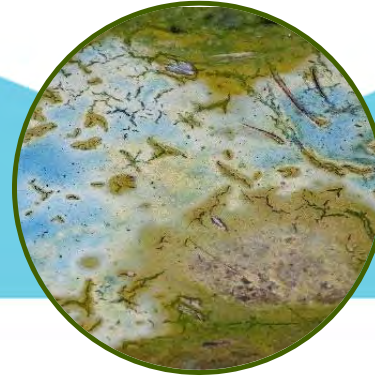
Treatment Water Phase (effective in all stages)



Nutrient Rich Water



Greenish Water



Decaying Algae Mats

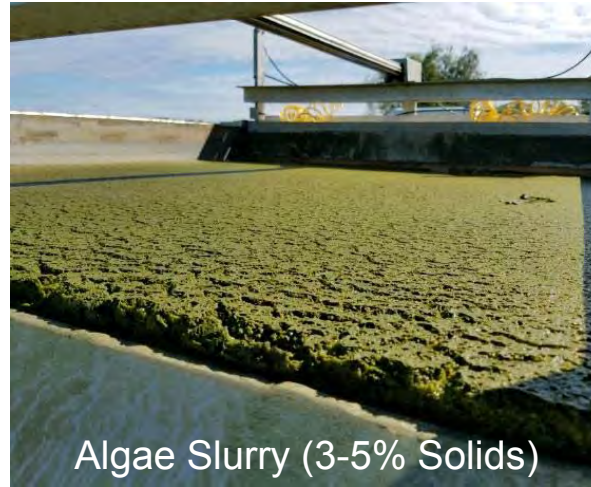


CLEAN WATER



AECOM

Treatment Solid Phase (Dewatering of Recovered Biomass)



Algae Slurry (3-5% Solids)



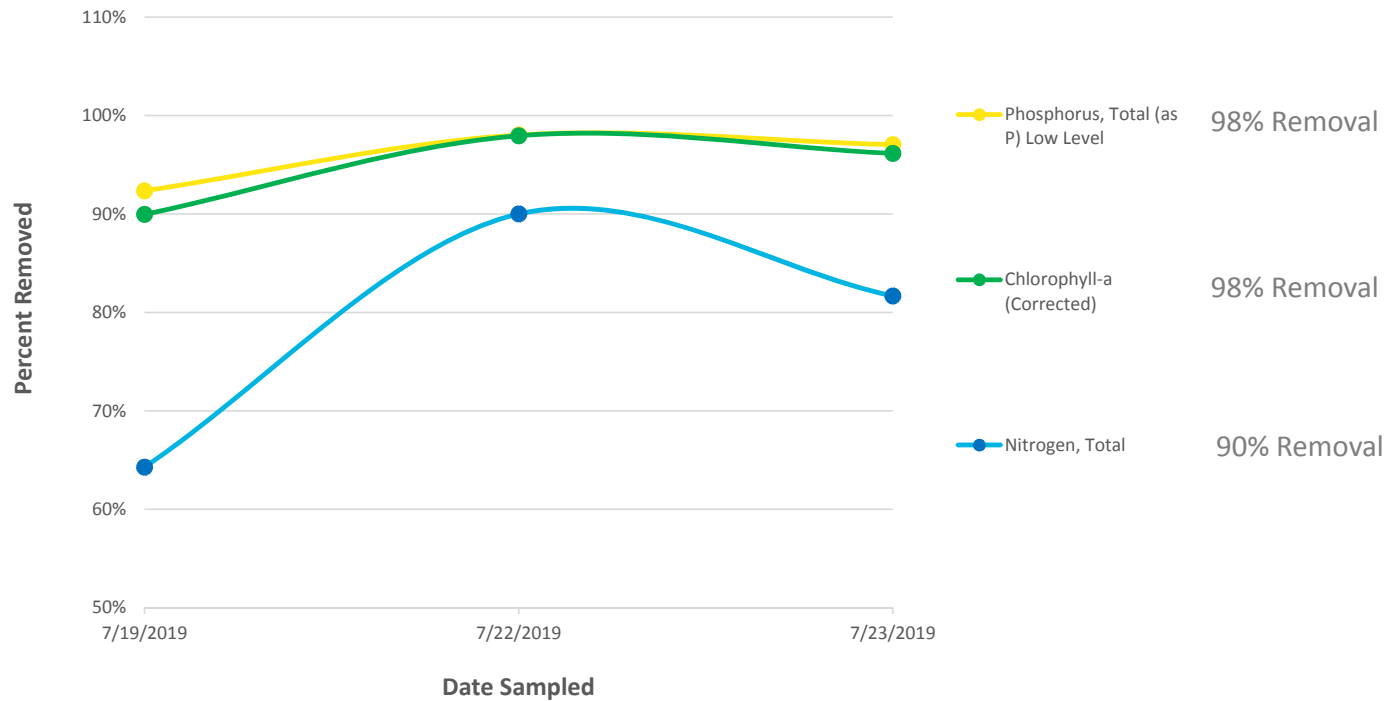
Algae Cake (15-18% Solids)



HABITATS Results

Percent Removal of Nutrients and Chlorophyll-*a*

USACE HABITATS
Lake Okeechobee, Florida



Lake Agawam – Southampton, NY – October 2019



New York Gov. Andrew Cuomo – Governors HAB Mitigation Initiative



Transformation

1 Green Products: Bio Foam



2 Green Fuel: Hydrothermal Liquifaction (HTL) – Biocrude



3 Green Energy: Algae bioreactor



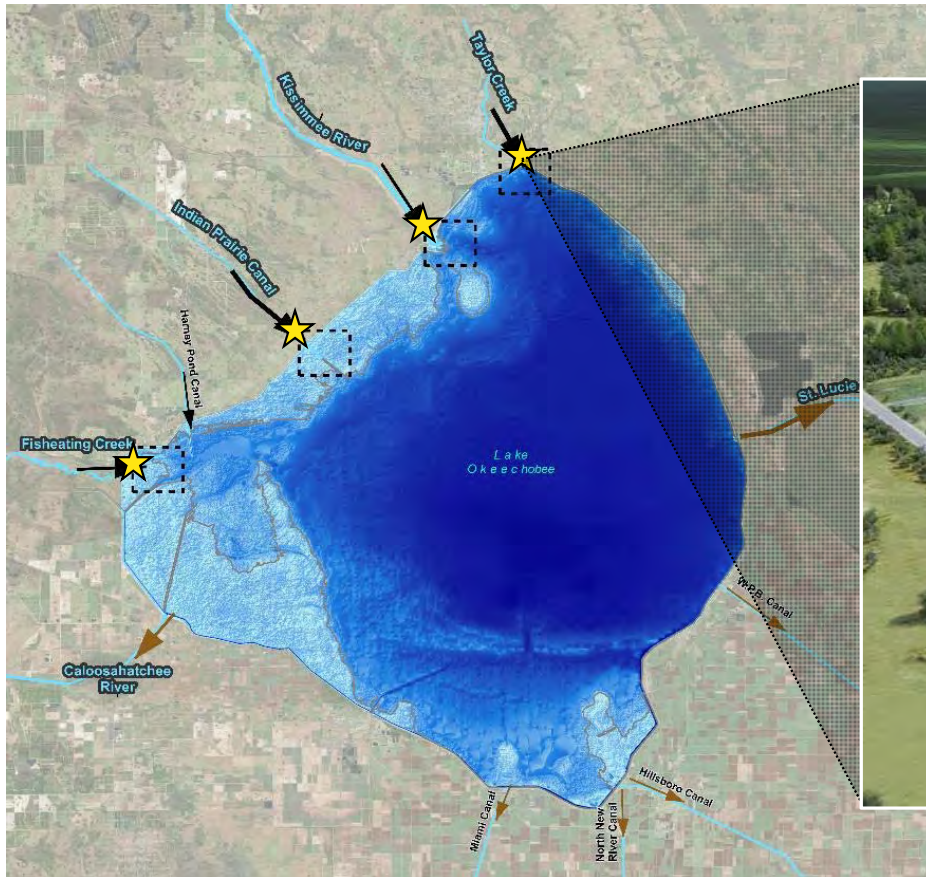
What's Next for Florida

Land Based Interception



Next Steps

★ Pilot Treatment Plants



Mobile Fleet Rendering



Springs Protection



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