The role of conservation paleobiology in Everglades restoration and urban planning for South Florida

G. Lynn Wingard[1], Bethany Stackhouse[1], Andre Daniels[2]

[1] Florence Bascom Geoscience Center, Reston VA

[2] Wetland and Aquatic Research Center, Davie FL

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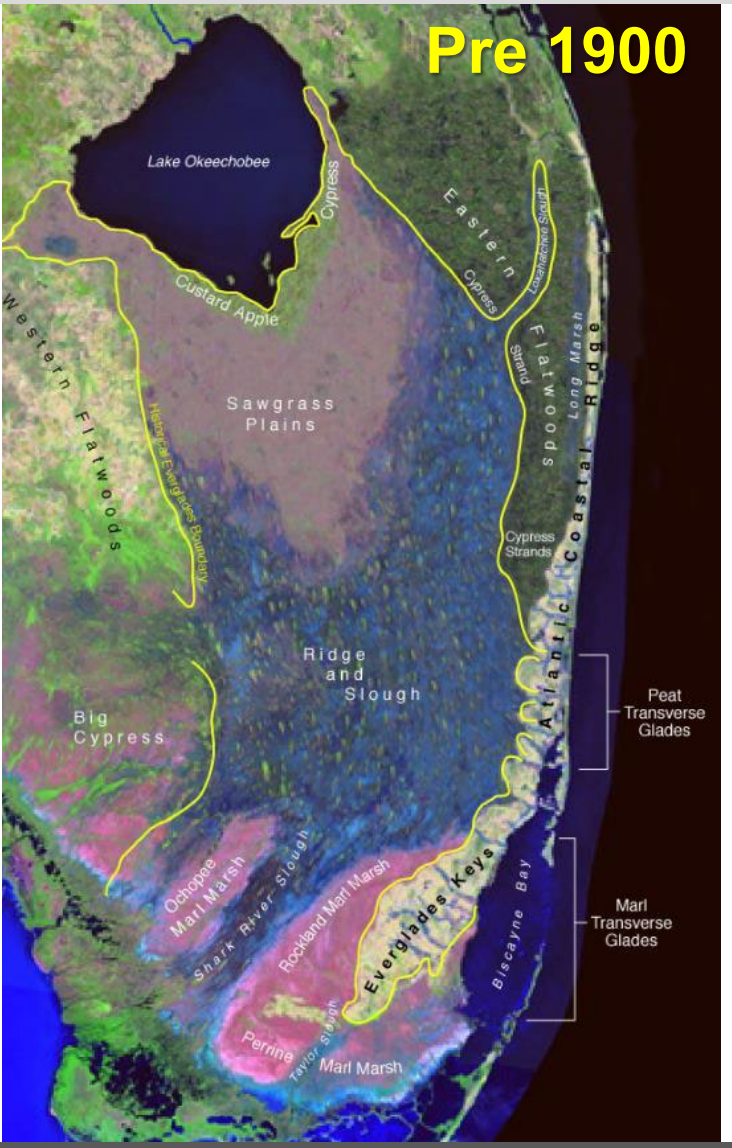
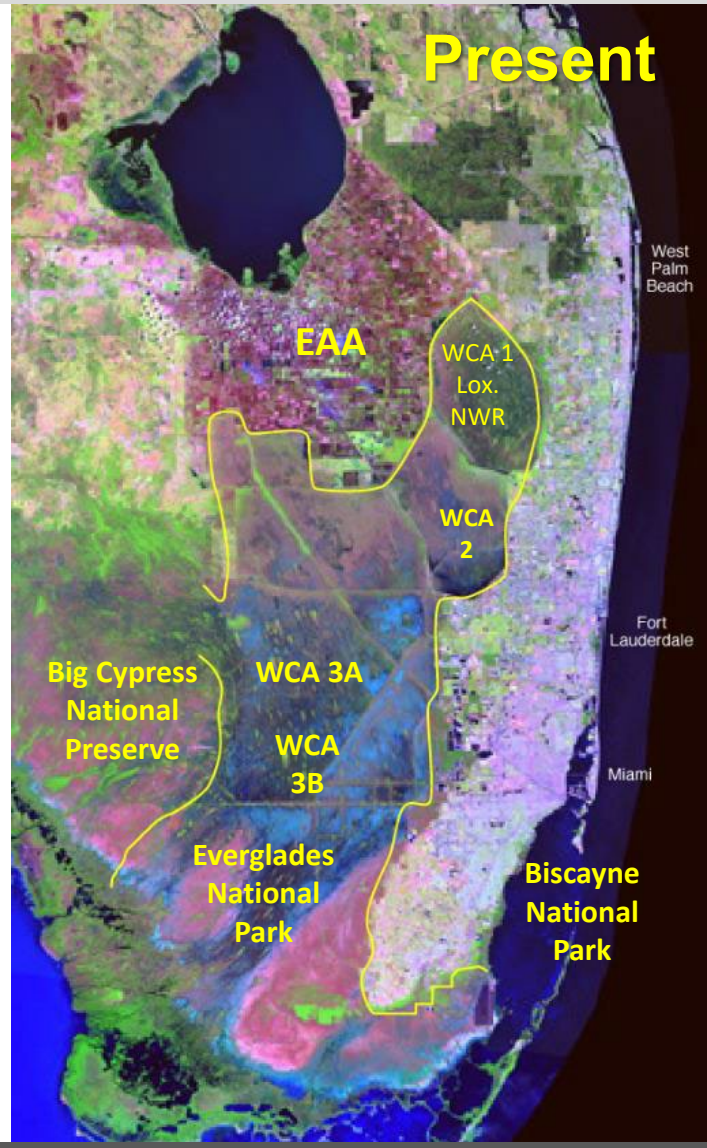
Anthropogenic Alteration of South Florida



Common goal of restoration of any ecosystem is to return the ecosystem to a pre-existing unaltered state, but . . .

- Is this the right approach?
- If yes, how are these conditions identified and restoration targets established?
- What is an appropriate baseline?

These are a few of the many questions that conservation paleobiology can answer



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Images: C. McVoy 2011

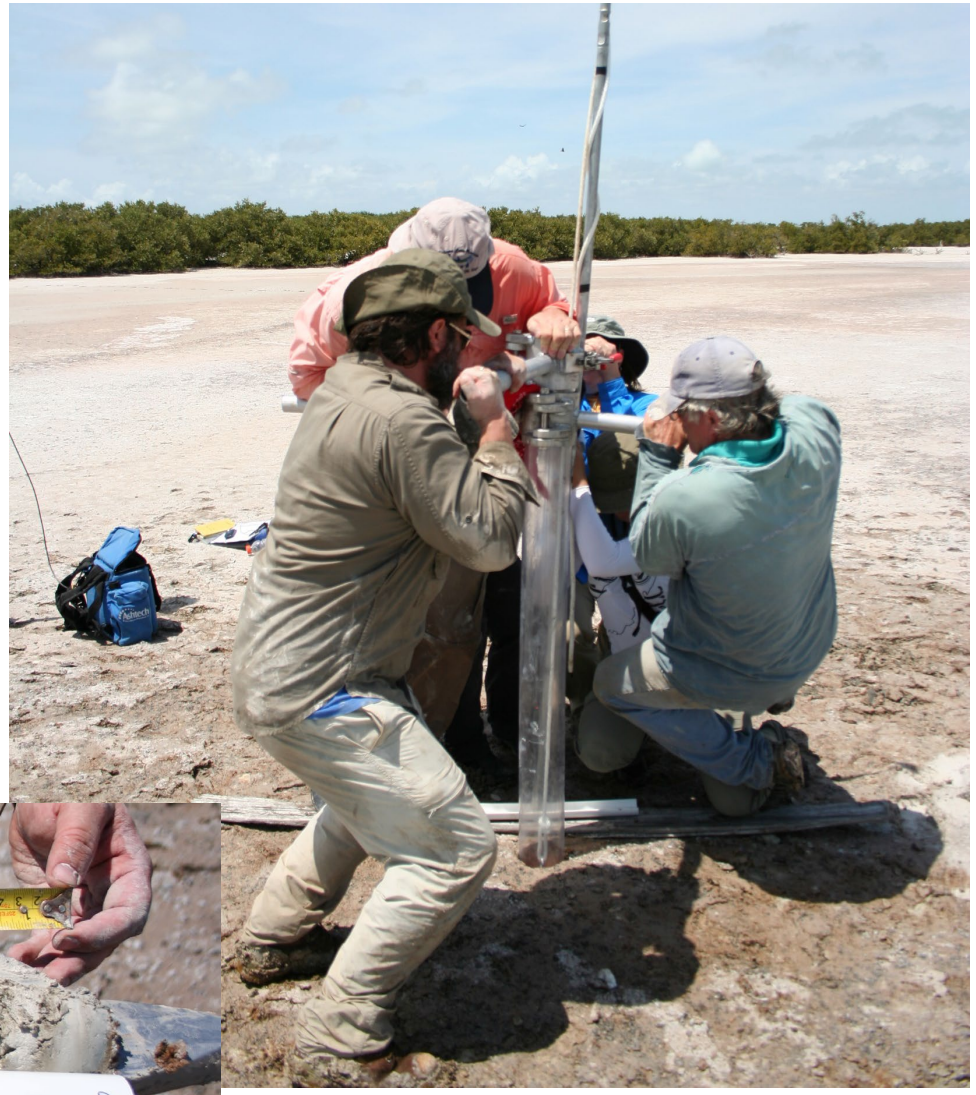
Reconstructing Pre-Alteration Flow and Salinity

Management Issue:

Everglades restoration is focused on restoring more natural hydrologic patterns – flow through the wetlands and salinity in the estuaries.

The Problem:

- System was already altered prior to instrumental measurements so how do you set hydrologic targets
- The large-scale hydrologic models do not always produce documented historical conditions

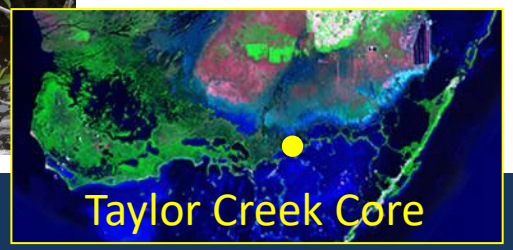


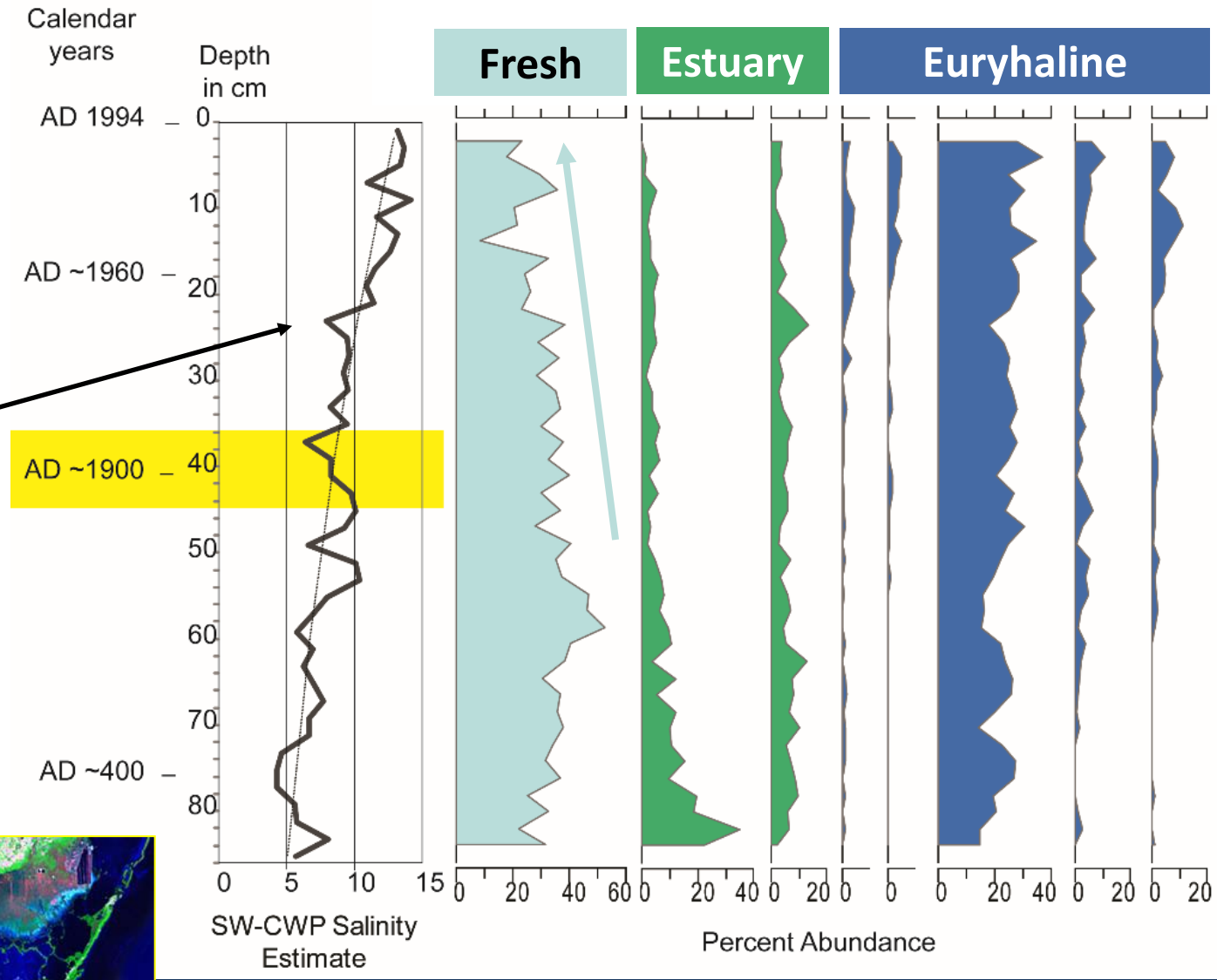
Marshall, Wingard, Pitts 2014
Estuaries & Coasts v. 37

Reconstructing Pre-Alteration Flow and Salinity

Conservation Paleobiology tools:

- Analysis of species present in core
- Apply modern analog data
- Calculate average salinity for each core segment based on % abundance of species and their mean and median modern salinity

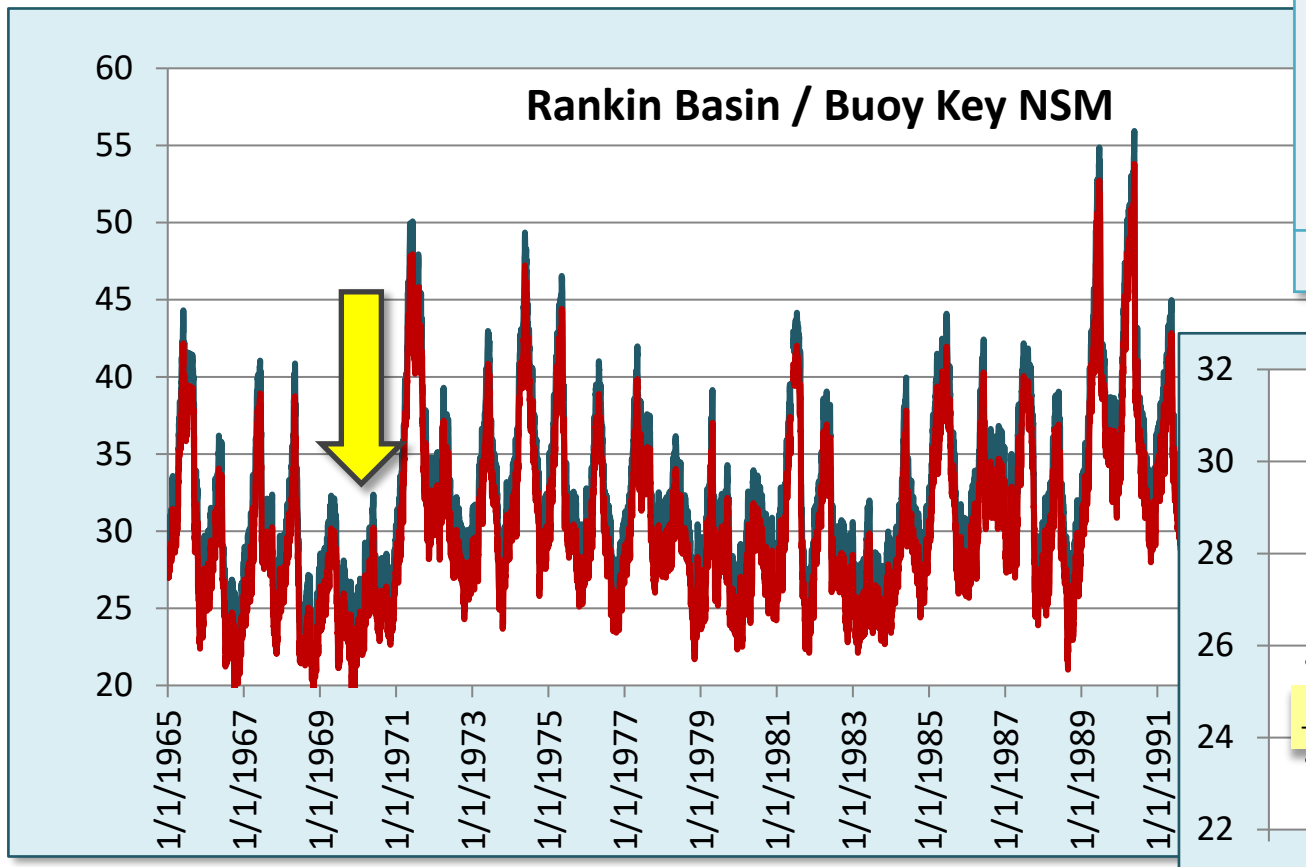




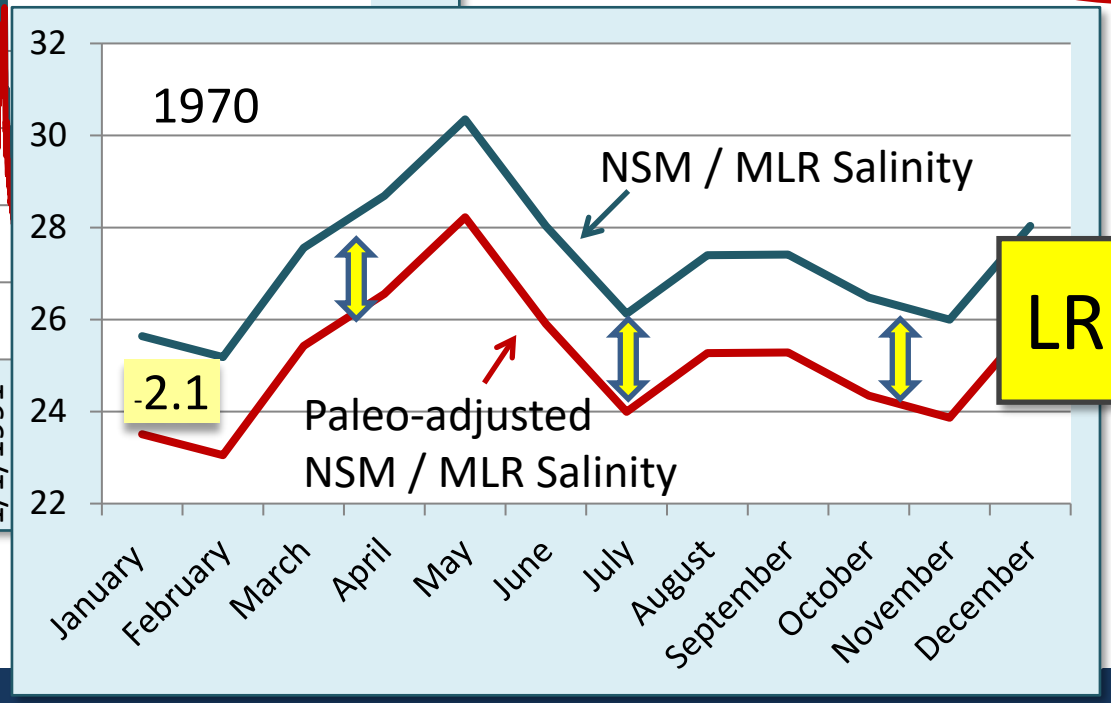
Wingard & Hudley 2012 Est. & Coasts, v. 35

Reconstructing Pre-Alteration Flow and Salinity

Use the paleosalinity estimates to adjust the models (Natural Systems Model = NSM)



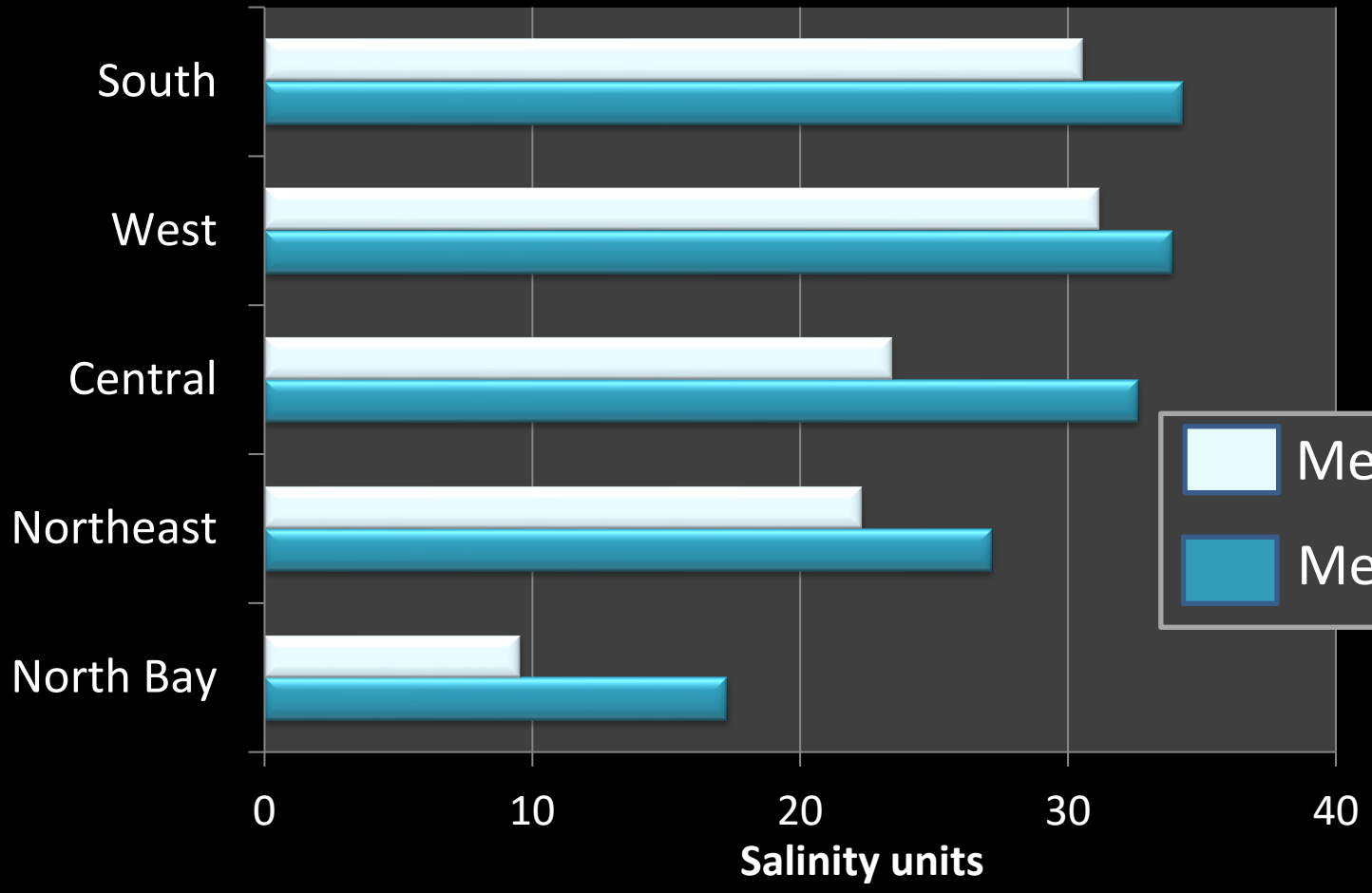
Core Name	NSM Mean Salinity (1965-2000)	Paleosalinity Estimate	NSM Salinity Adjustment for Paleosalinity Time Series
Rankin Lake	30.4	28.3	-2.1

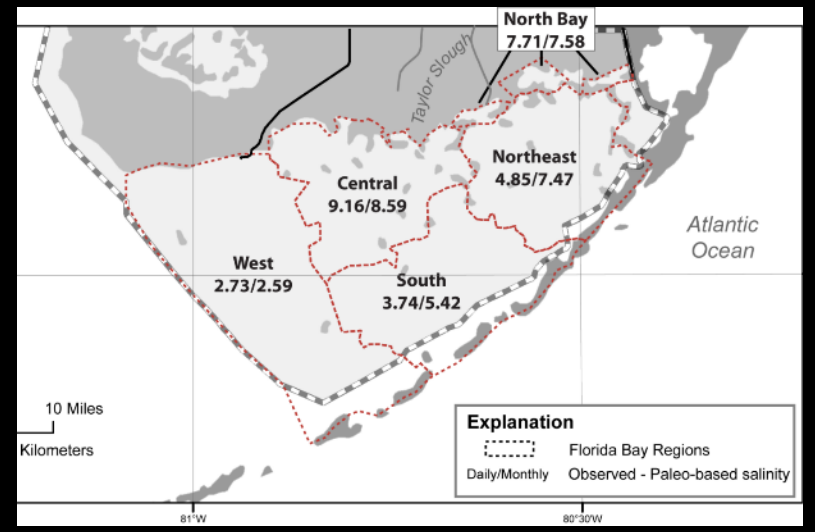


LRMS

Results: Observed vs. Paleo-based Estimates

Results aggregated by Florida Bay region





Paleo-estimated salinity values are the targets for restoration of Florida Bay

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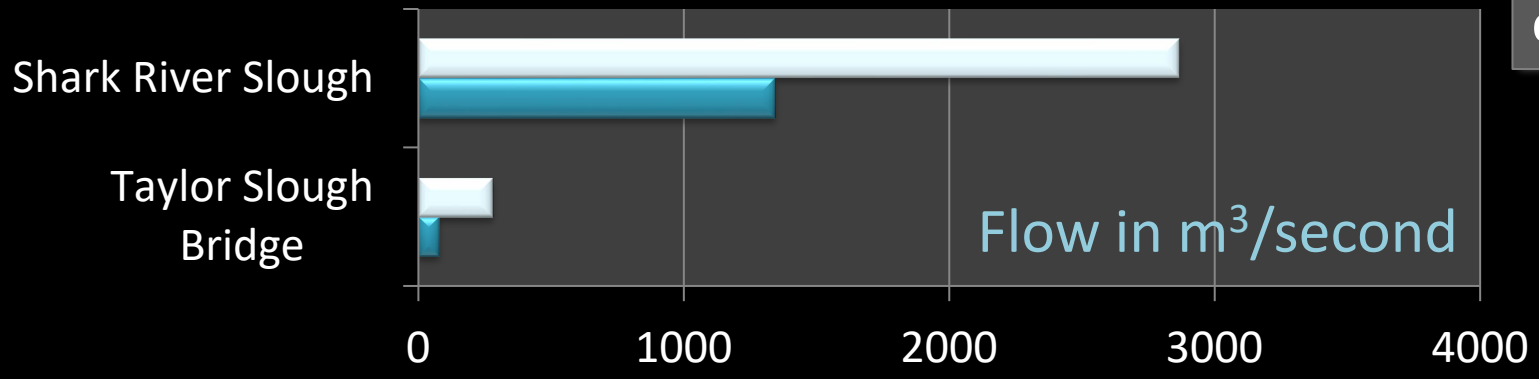
Marshall, Wingard, Pitts 2014 Estuaries & Coasts v 37

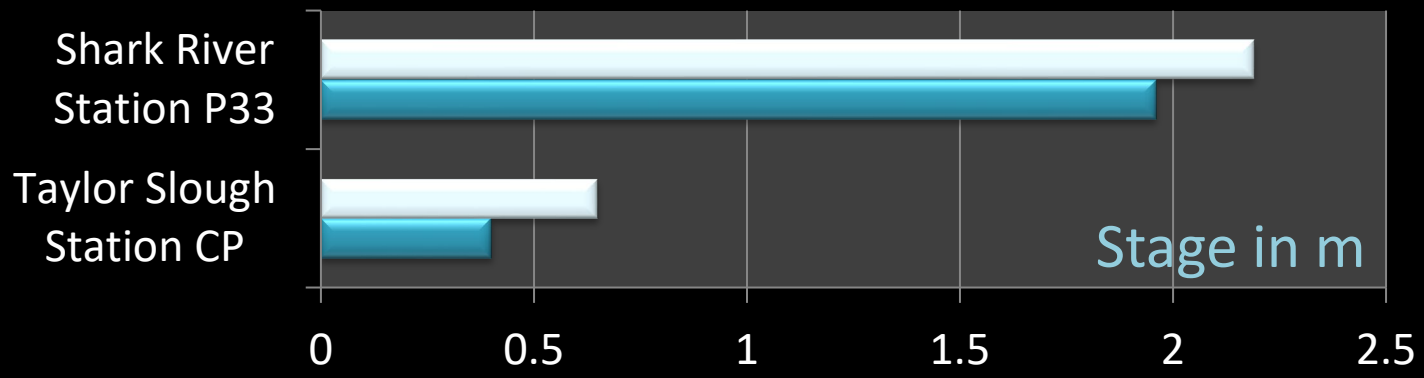
Results: Observed vs. Paleo-based Estimates

Present day observed stage & flow compared to paleo-based



Flow through the Everglades needs to be 1.5 to 2 times greater than present condition

Paleoestimate
Observed



Stage needs to be ~.25 m higher than present condition

Paleoestimate
Observed

Identifying Indicator Species

Management Issue:

Everglades restoration planning requires identification of ecosystem components to be used as indicators of restoration success

Information gap for the 0 – 10 psu salinities – the goal of restoration in the nearshore areas

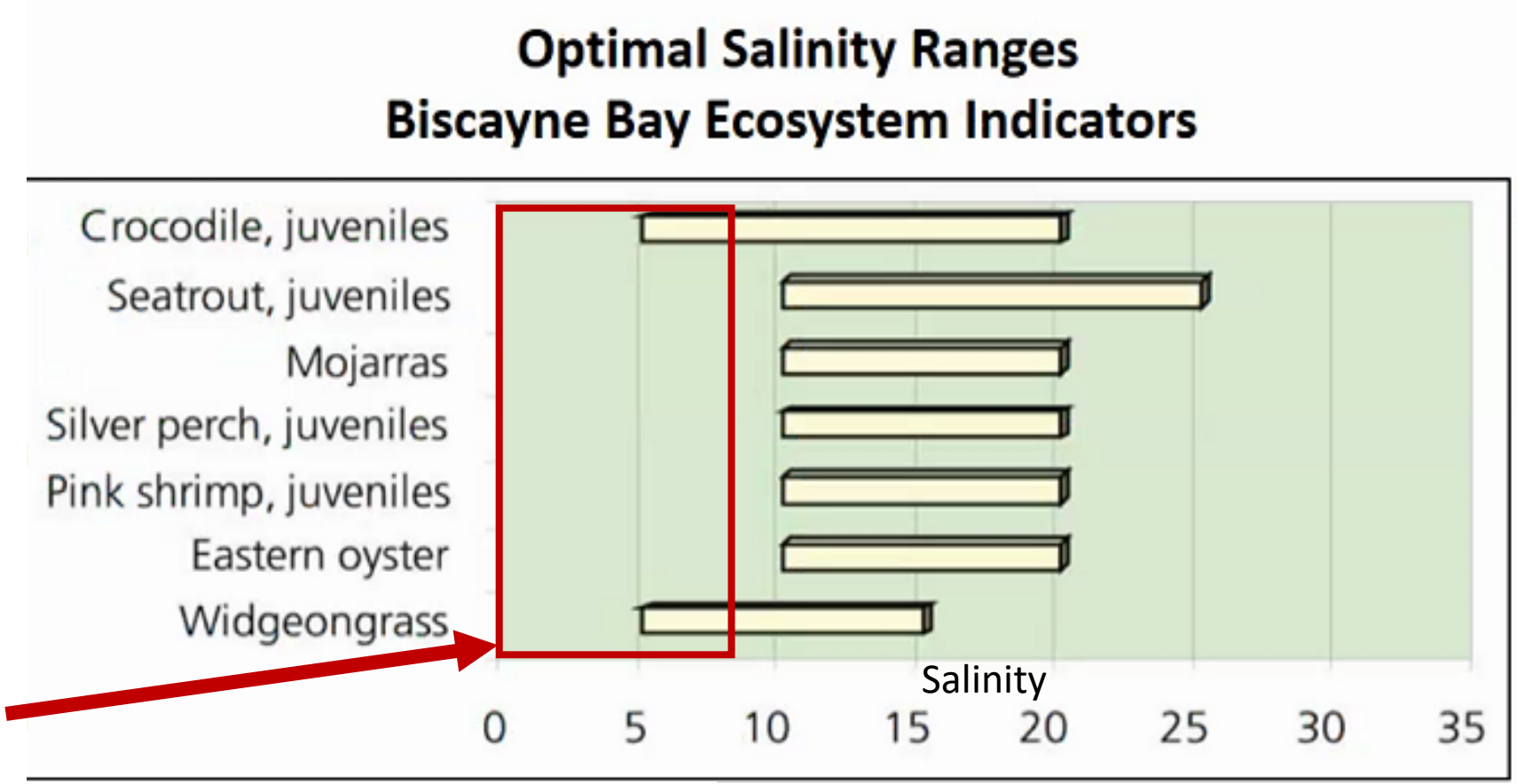


Figure 2 NPS SFNRC Tech Series 2008:2

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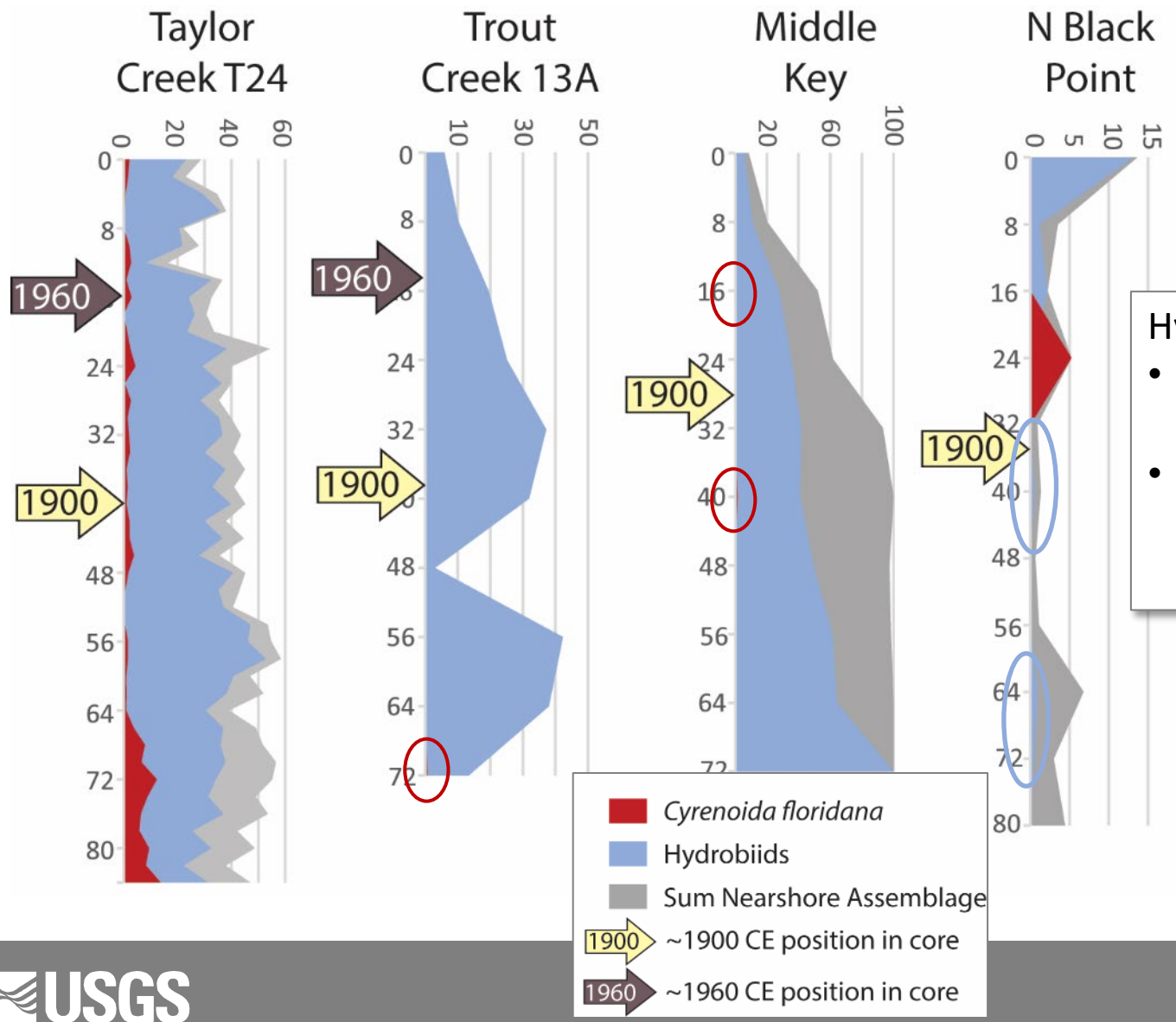
Chart from NPS SFNRC Tech Series 2008:2 Report Estimates of Flows to Meet Salinity Targets…

What taxa were present prior to hydrologic alteration?



Hydrobiidae present in all cores

- In general declining in all cores in 20th century
- But still present at Taylor, primary source of outflow in Florida Bay

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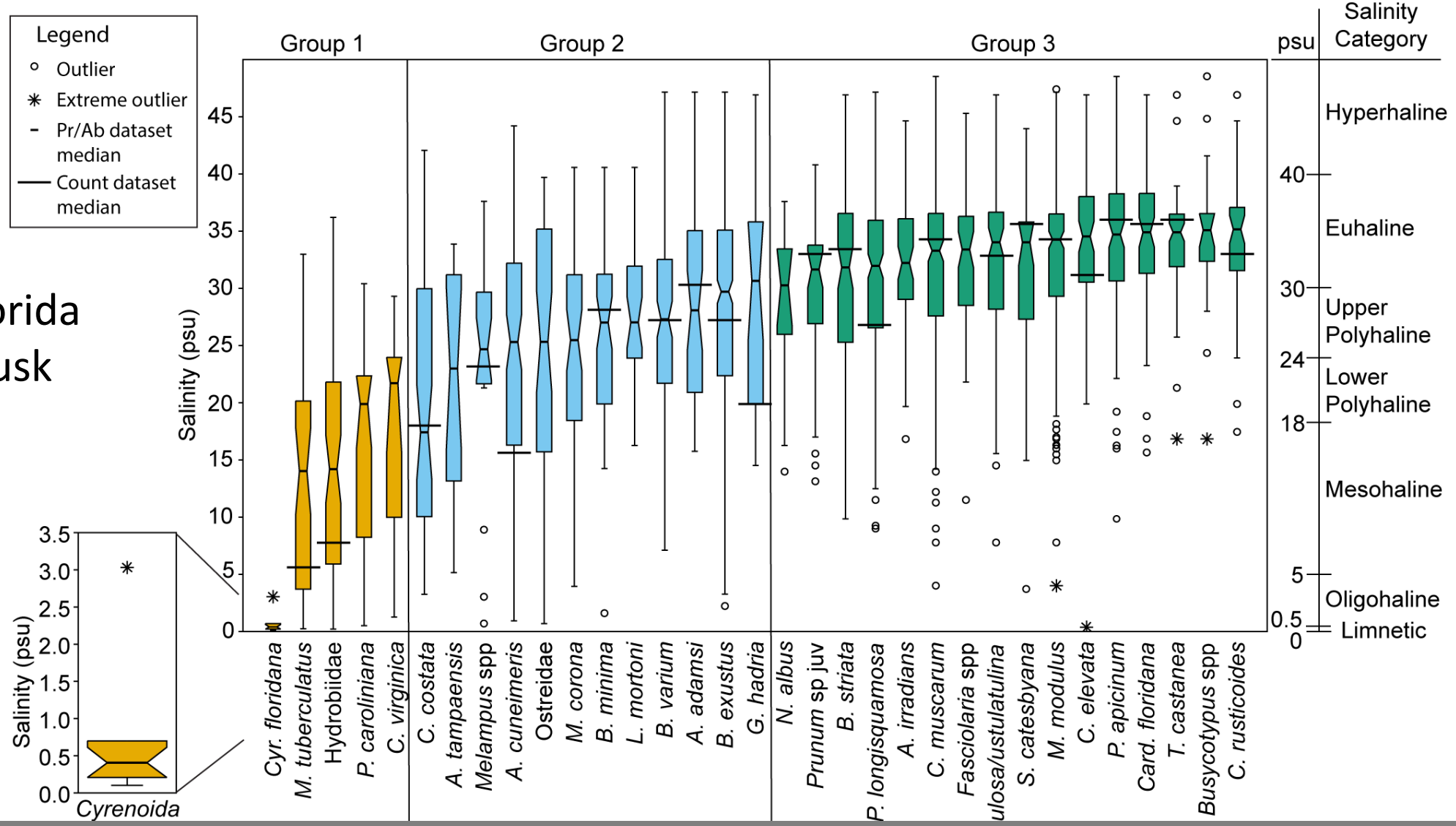
What do the modern analog data tell us?

South Florida live mollusk data



Wingard et al. 2022
Bull Mar Sci v. 98

Identifying Potential Indicator Species

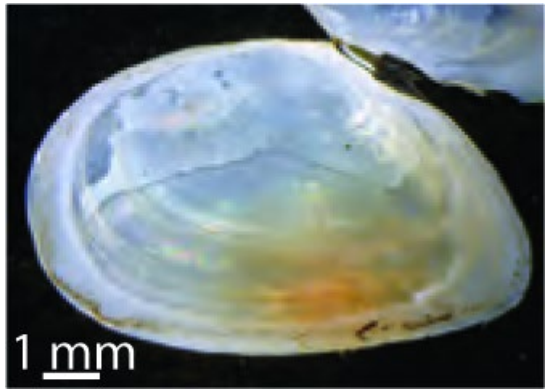
Ranked value as an indicator:

1	Hydrobiidae
1	Larger Freshwater gastropods (*Pomacea*, *Planorbella*, Physidae)
1	*Cyrenoida floridana*
2	*Polymesoda caroliniana*
2	*Crassostrea virginica*
3	*Pyrgophorus platyrachis*
3	*Ellobium dominicense*
3	*Macoma mitchelli*
3	*Neritina virginea*
3	*Tagelus plebeius*

Partial list of proposed nearshore / low salinity indictor taxa

Tagelus plebeius

Macoma mitchelli

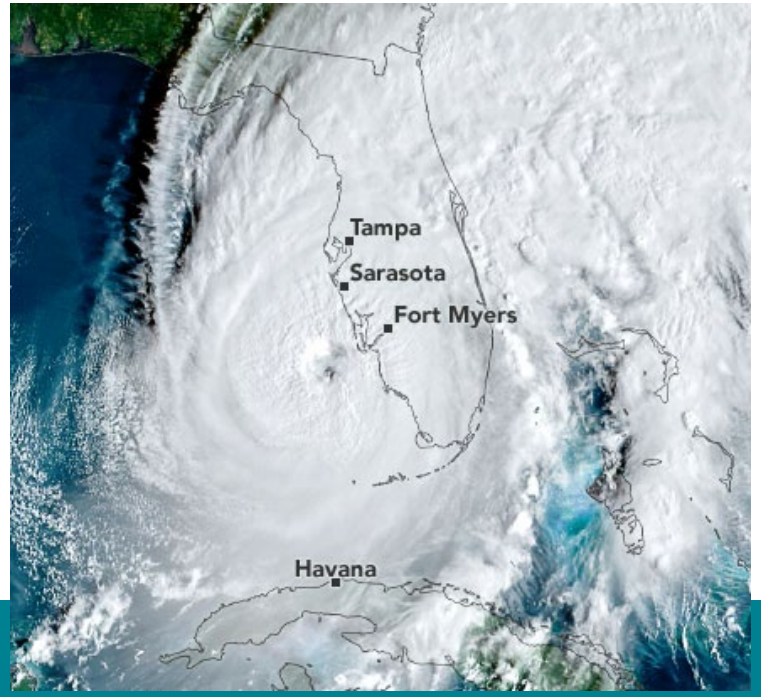


Physa sp.

Coastal Resiliency

Management Issues:

- Constant “sunny” day flooding in urban areas
- Uncertainty of impacts of combined drivers – sea level, climate, storms and anthropogenic alterations



NASA GOES Satellite image – Hurricane Ian 9/28/22

Sea level rise is combining with other factors to regularly flood Miami

August 8, 2019
Washington Post

Late July – early August 2019, new record for “sunny day” flooding

“Today’s flood will become tomorrow’s high tide”
Margaret Davidson, NOAA Coastal Services Center (Miami Herald, 3/30/18)

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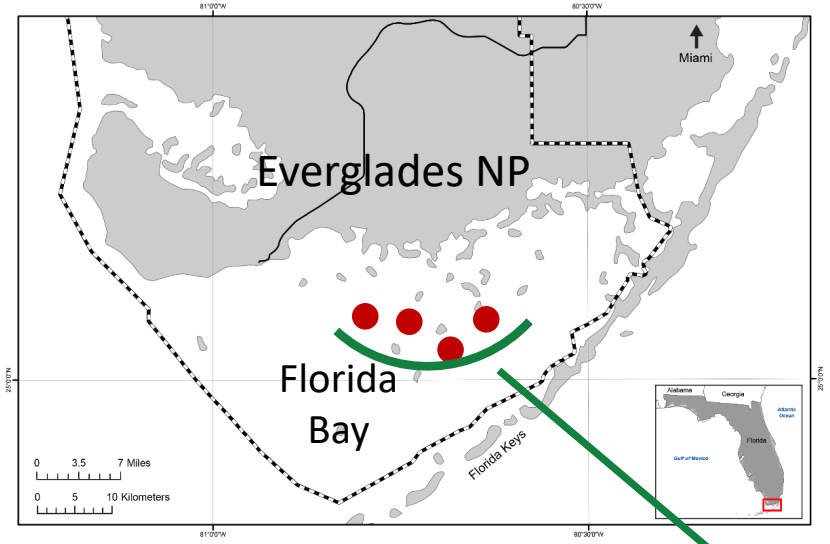
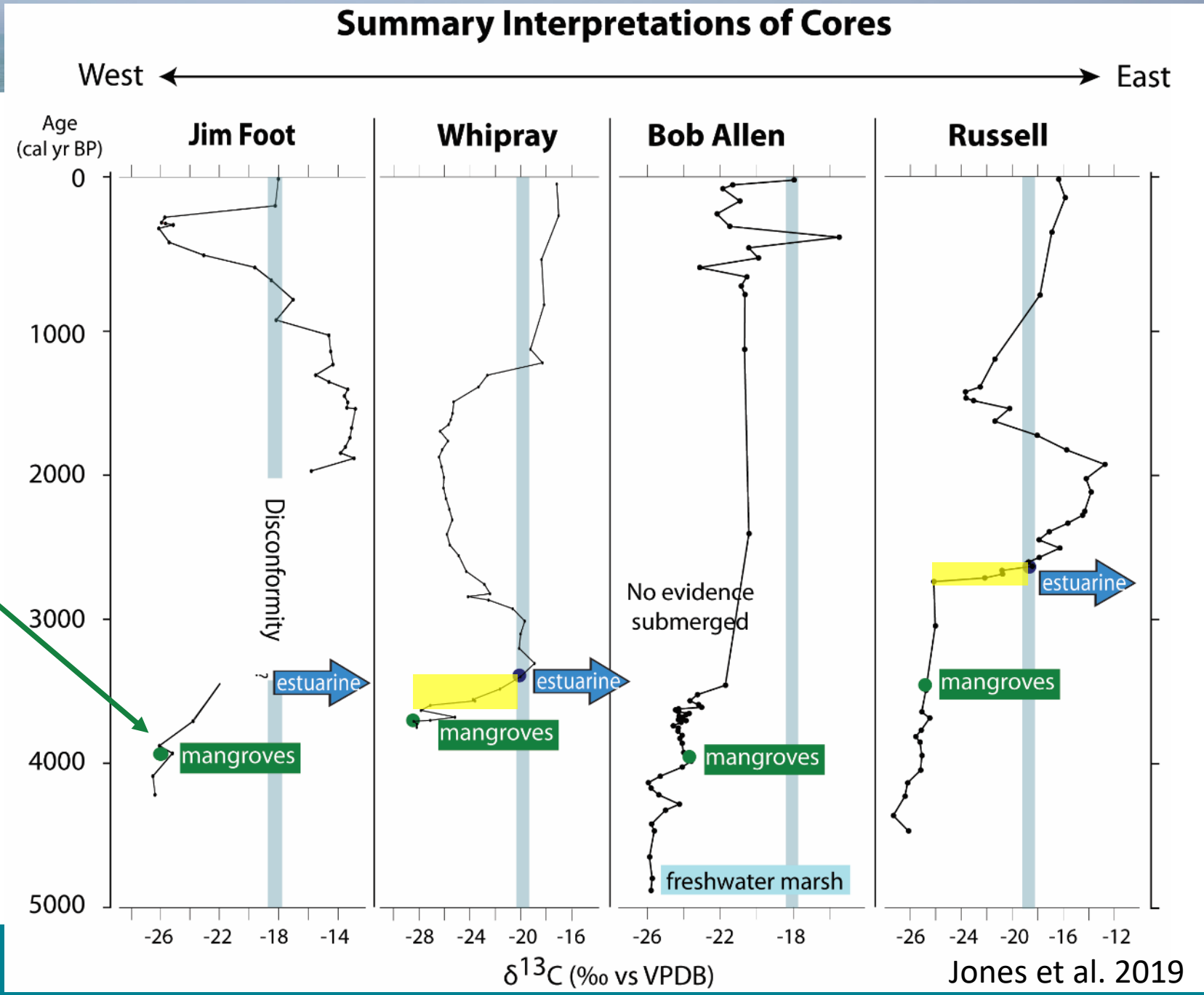
Results:



Position of mangrove coast
~4000 - 3200 years ago (Cores = ●)

Transition from coastal mangrove to estuary happened approximately ~3400 – 2800 ybp and in < 200 years!

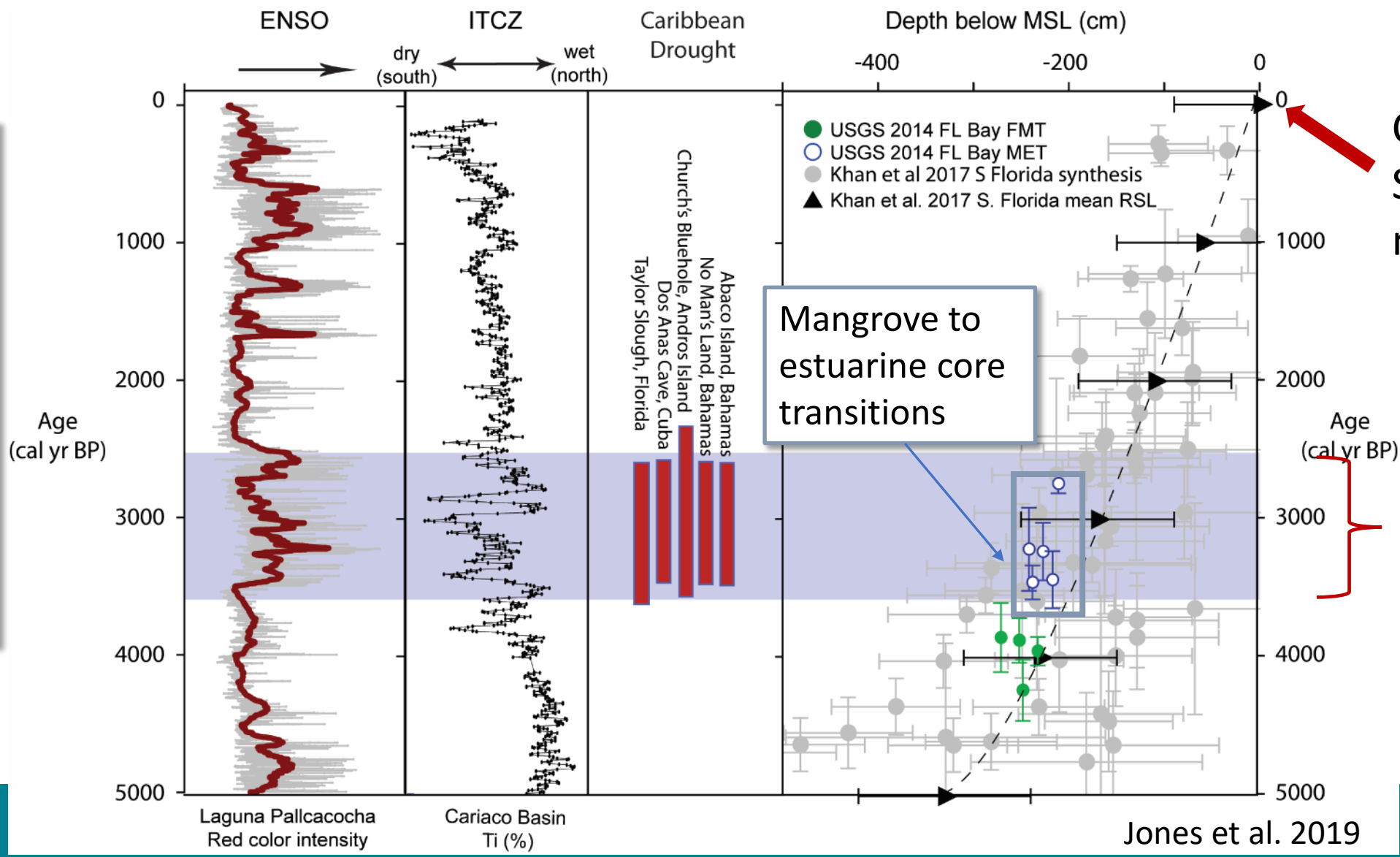


Jones et al. 2019

USGS

Proposed Cause – Increased Climate Variability?

Mangrove to Estuarine transitions in cores correspond to shifts in climate indicators in the region.



Current SLR 3.70 mm/yr

~0.67 mm/yr

Jones et al. 2019

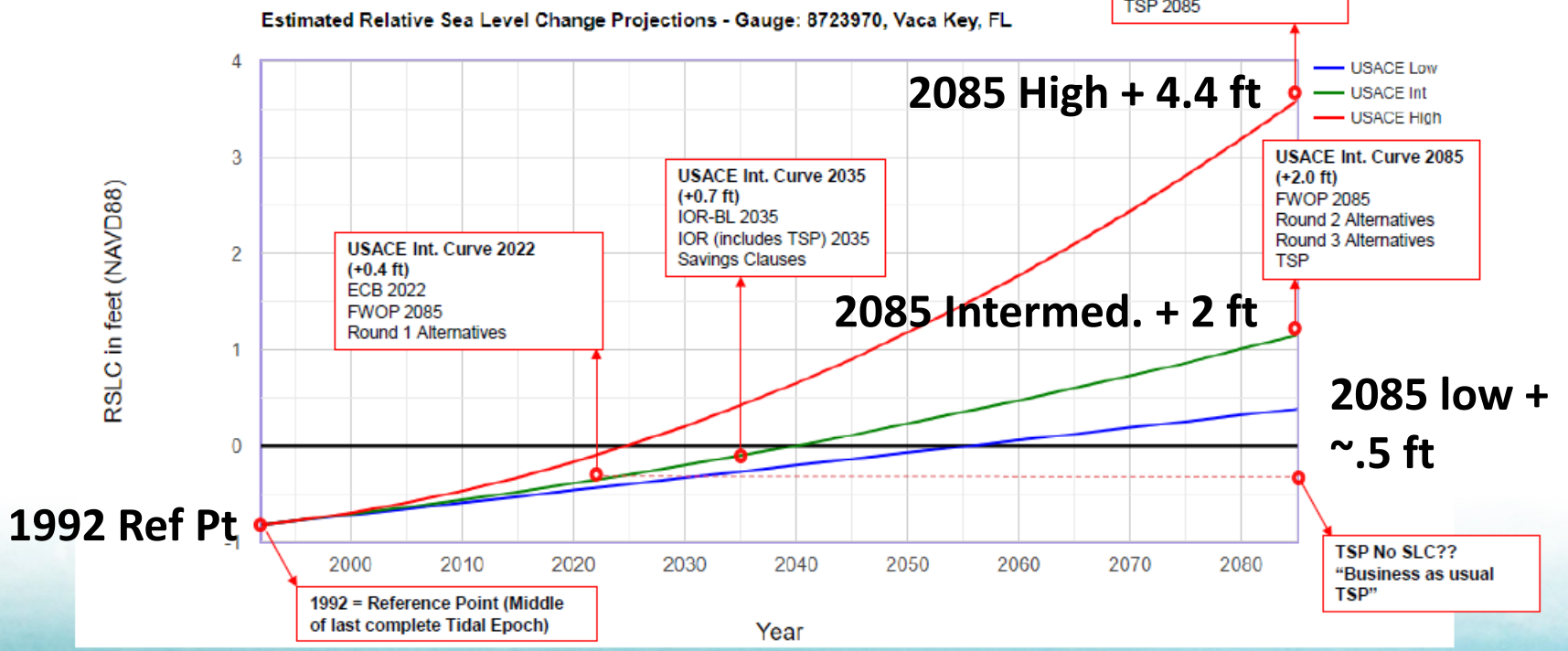
USGS

Coastal Resiliency

Application: Provide resource managers & modelers …

1) Time frame of coastal change in recent past (<200 years) under substantially lower rates of sea level rise
2) Climate alone is a significant driver of coastal change in south FL

Modeling and Sea Level Curves



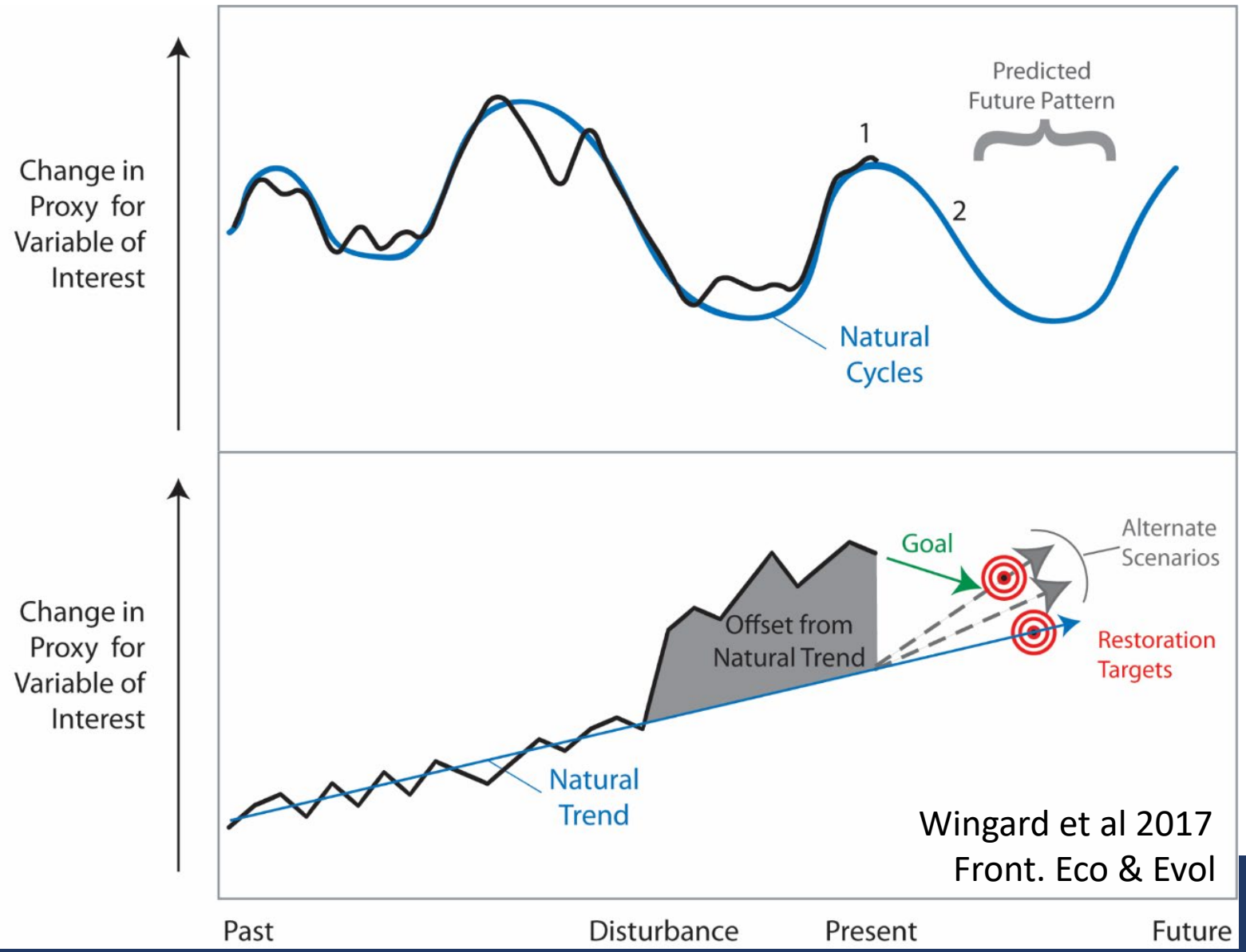
SL curve courtesy of USACE Modeling Center / Andrew Coman

Application of Conservation Paleobiology Data to Restoration

Anticipatory target setting

- Understanding centennial to millennial scale trends allows prediction of future trajectories of change
- Use information to set targets that aim toward returning system to the **natural trajectory of change**

The past is the key to the future!



Wingard et al 2017
Front. Eco & Evol

USGS

Acknowledgements

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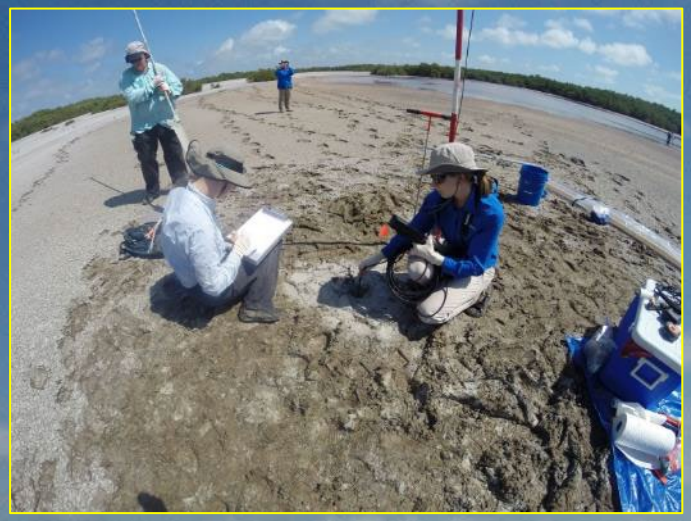

The people who have contributed to this research:

- Dr. Frank Marshall, Cetacean Logic Foundation
- Dr. Miriam Jones, USGS
- And many more!

For more information:
usgs.gov/centers/fbgc/science/paleoclimate-and-paleoecology

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