Southern Estuaries: Florida Bay History, Conditions, Needs

CEPP Workshop
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Outline

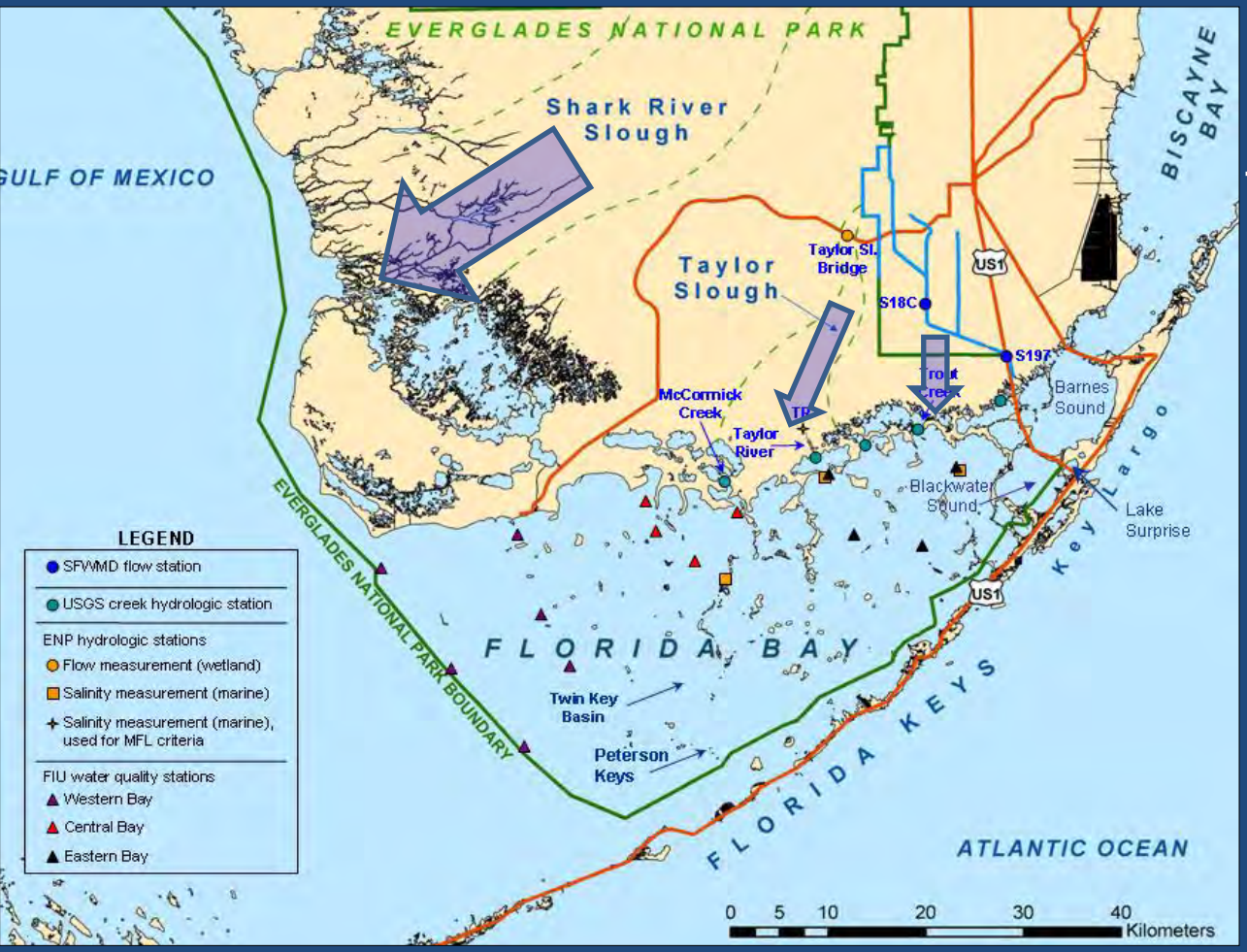
- Background on Florida Bay
- Salinity Conditions and long-term decreases in freshwater flow
- Ecological change and importance of salinity
- Ecosystem consequences and needs

……the bottom line: need more fresh water

Florida Bay: background

- Terminal recipient of freshwater flow from the Everglades watershed
- Potentially affected by all upstream activities

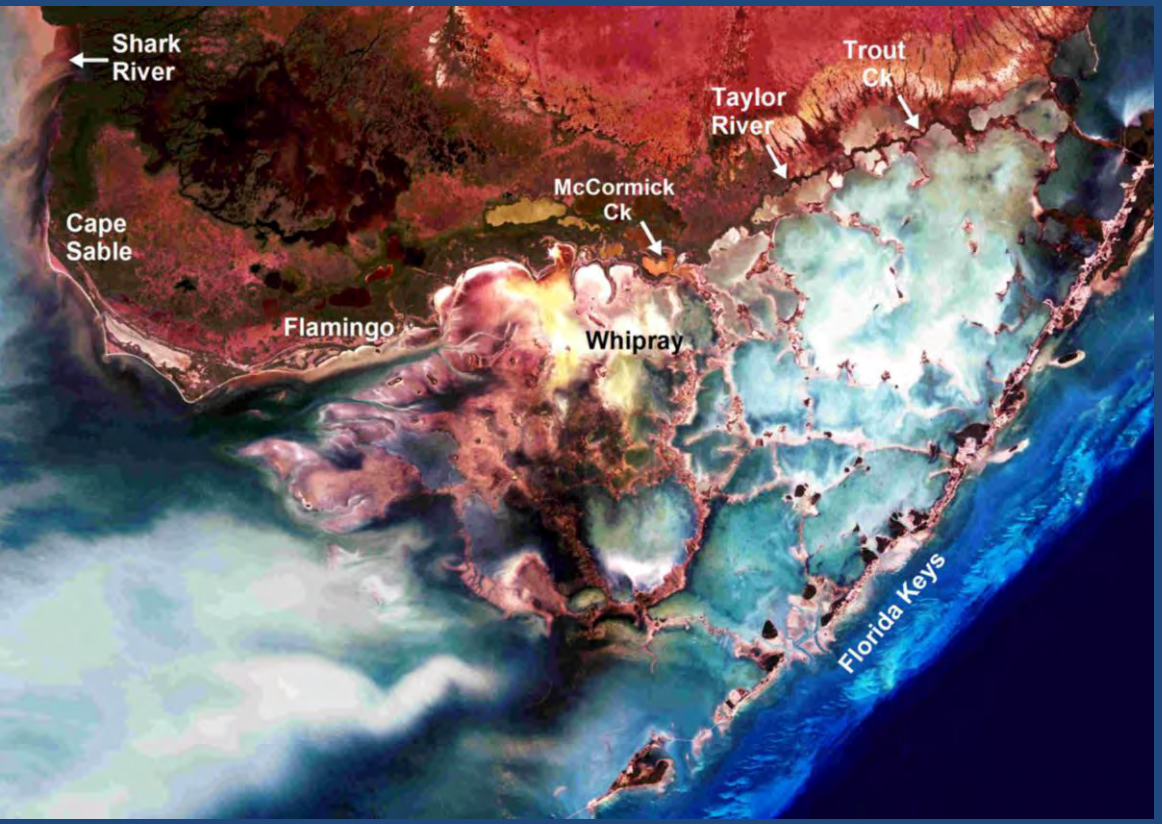
Florida Bay: background



Managed freshwater inflow currently via three main routes:

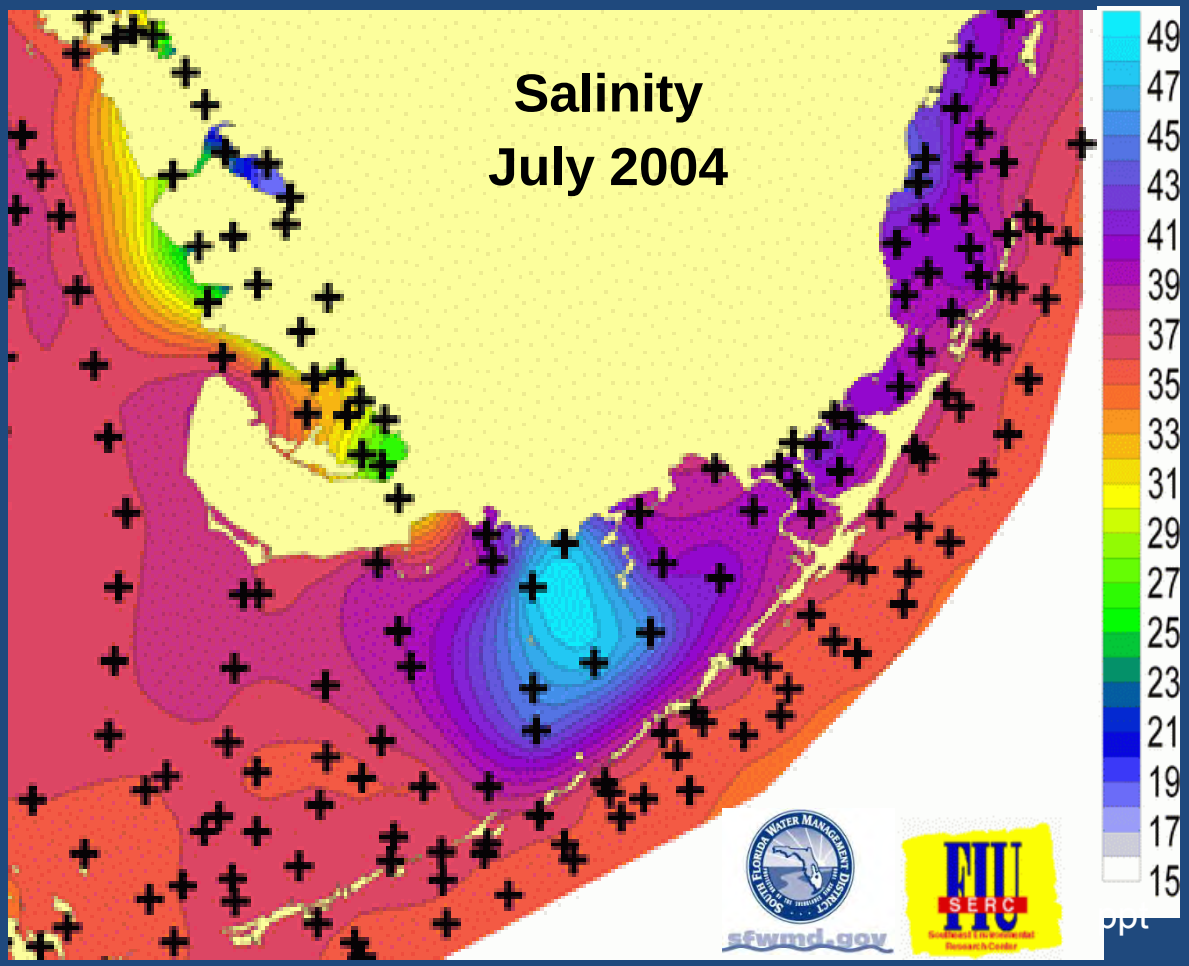
- Shark River Slough
- Taylor slough
- C-111 canal

Florida Bay: background



- Shallow depth (about 1 m)
- Mud banks & low tidal energy restrict mixing & ocean exchange (creates “lakes”)
- Depth + limited exchange + high evaporation: salinity has risen to 70 ppt (double seawater salinity)

Florida Bay: Hydrologic Change & Effects

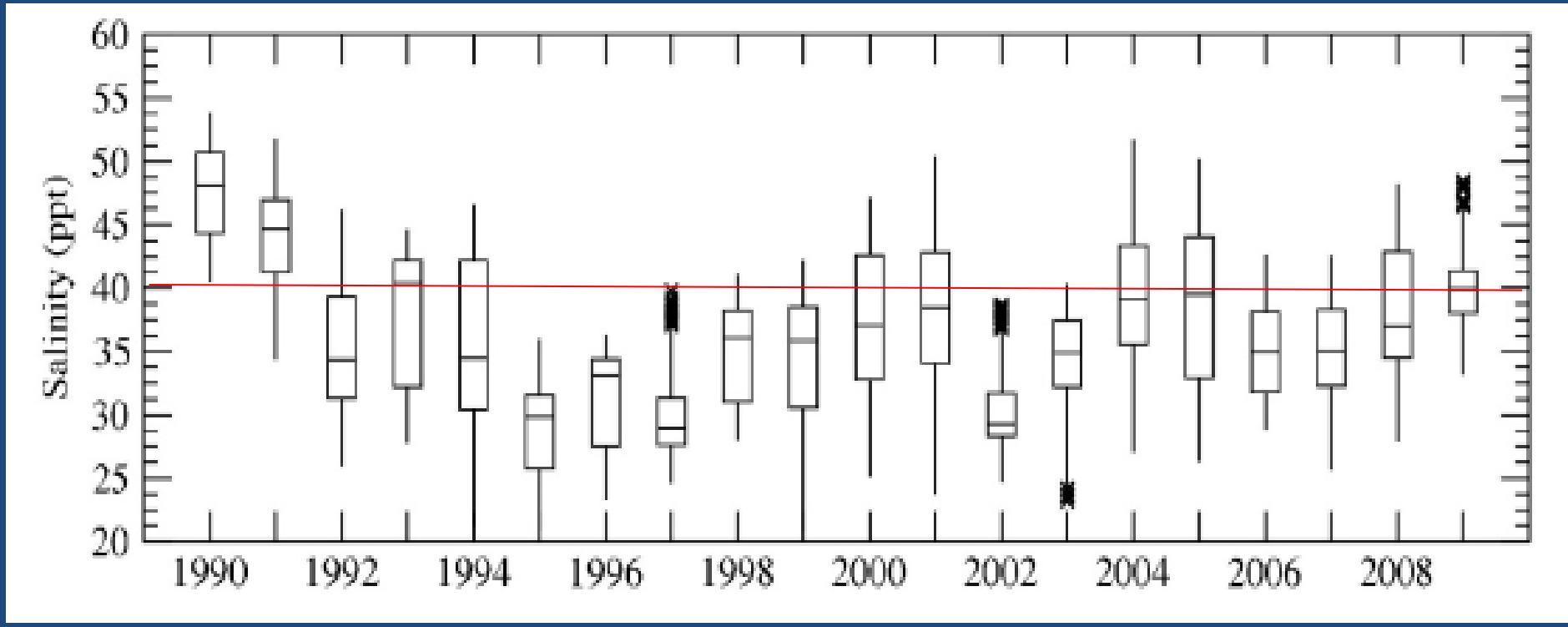


From J. Boyer

Hypersalinity (> 40 ppt) has been common, especially in the central bay

Central Florida Bay Salinity:

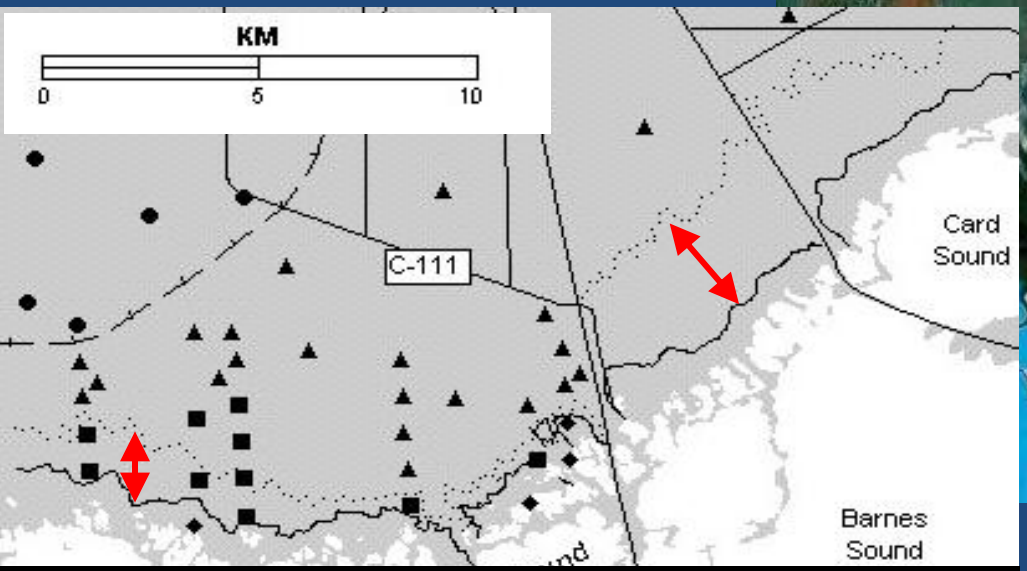
Hypersalinity (> 40 ppt) is common



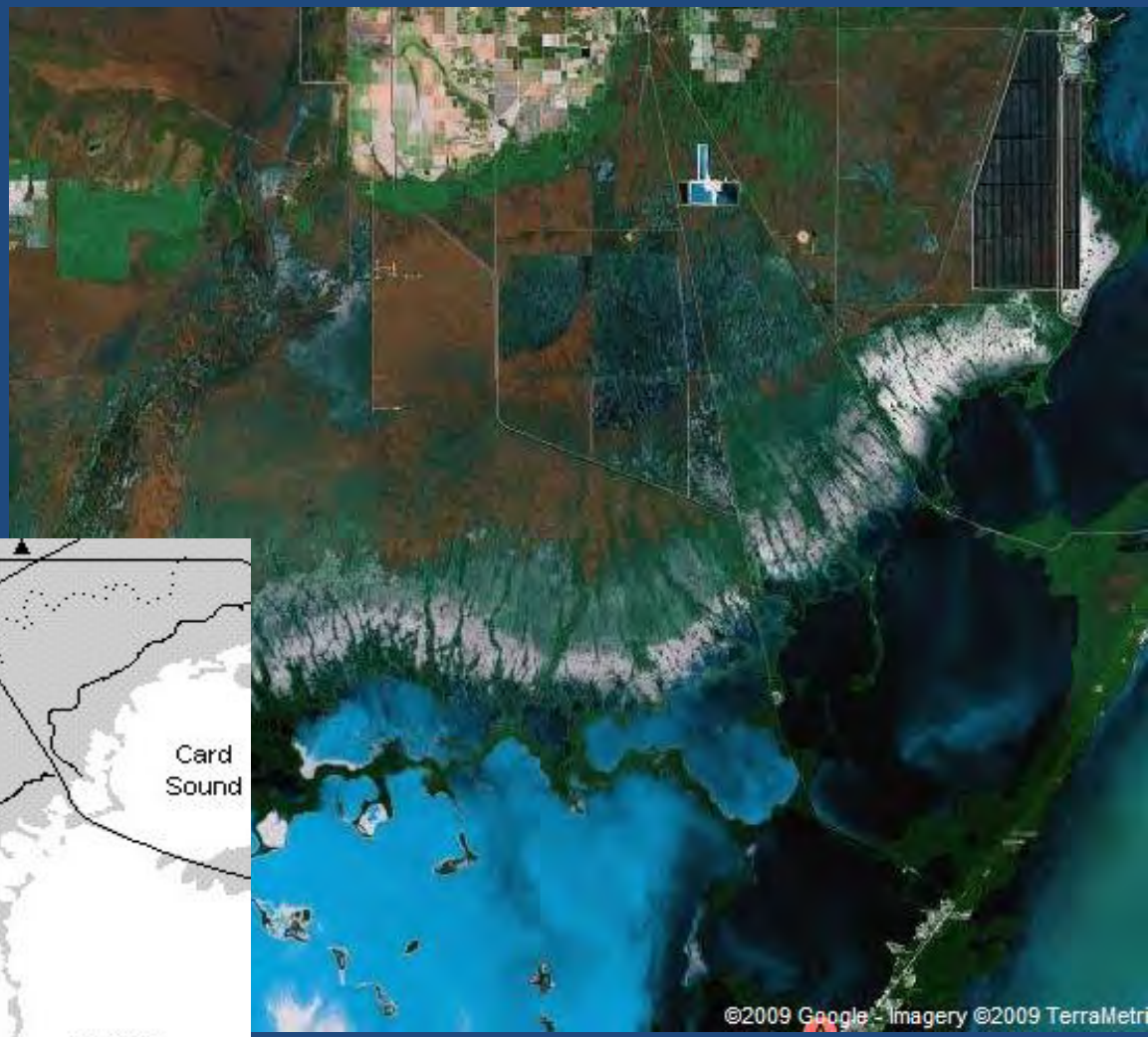
From E. Stabenau

Saltwater Intrusion Caused by Freshwater Diversion and Sea-Level Rise

Saltwater intrusion with expanding “white zone” is more extensive east of Everglades National Park



White zone expanded 1-3 km from 1940-1994 (from Ross et al. 2000)



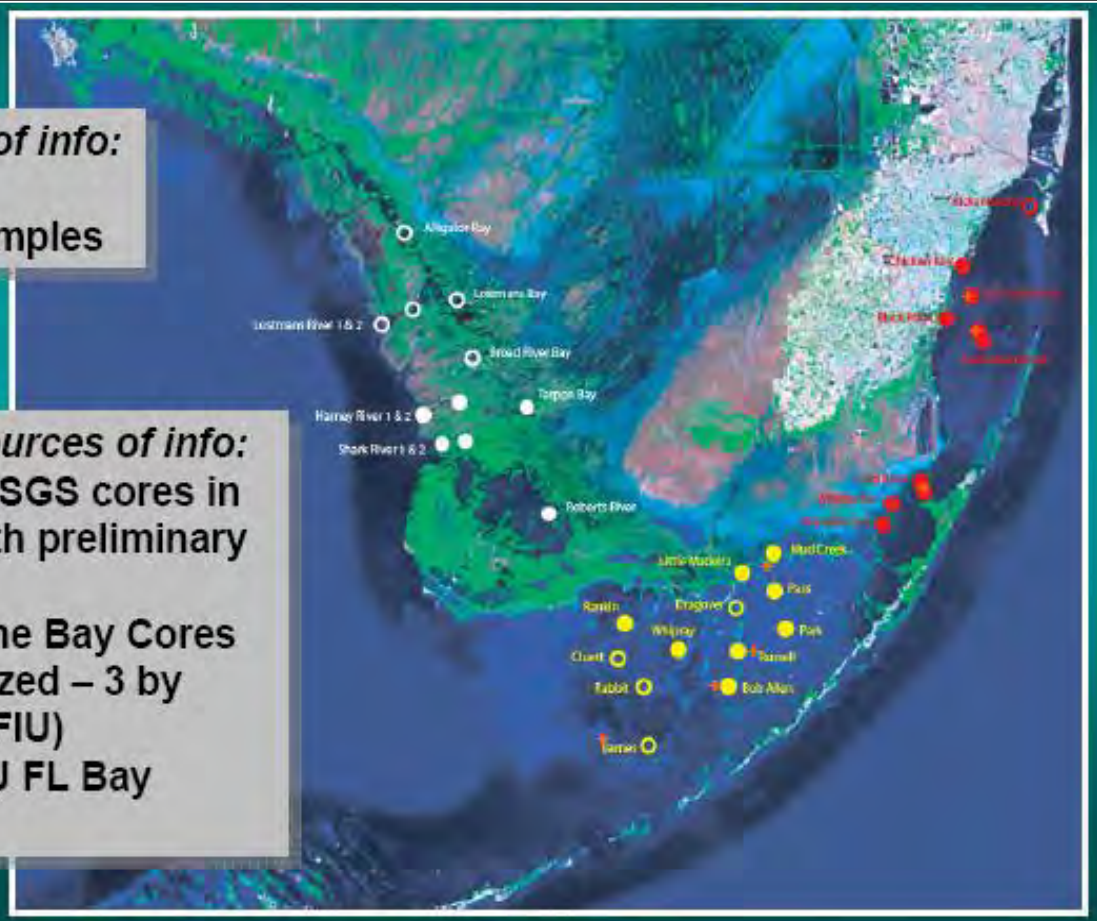
Analyses to Quantify Florida Bay Historic Conditions

Multiple Sediment Coring and Coral Sampling Sites for Paleoecological Analysis

2003 sources of info:
- 11 cores
- 10 coral samples

+

2008 new sources of info:
- 11 new USGS cores in SW (6 with preliminary results)
- 8 Biscayne Bay Cores (all analyzed – 3 by USGS & FIU)
- 4 new FIU FL Bay Cores

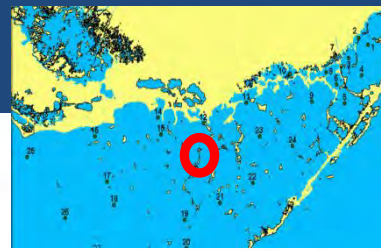


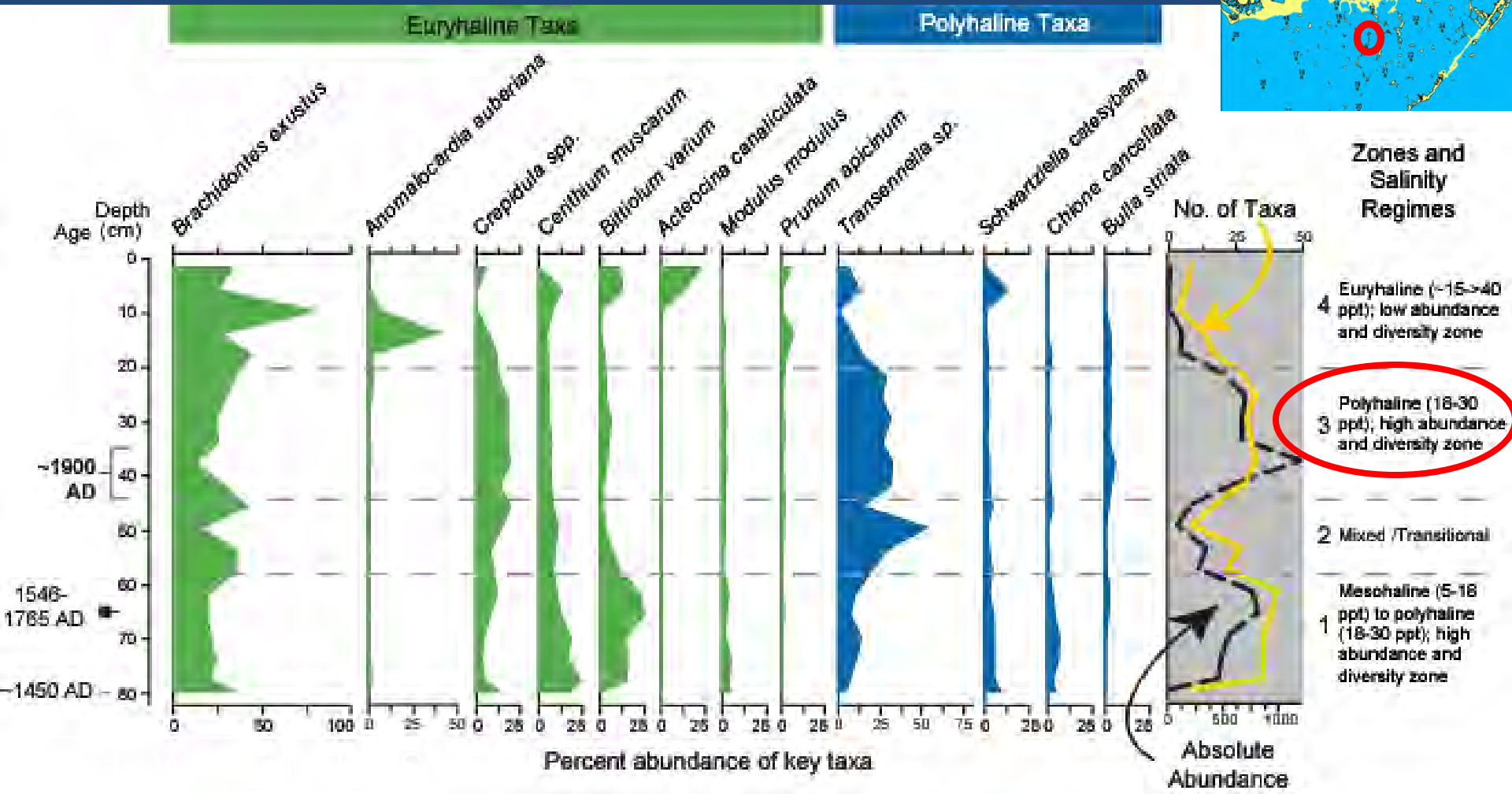
USGS

From L. Wingard

Sediment Analysis to Reconstruct Bay History

Down-core assemblage (e.g. molluscs) analyses





From L. Wingard

Process to Estimate Historic Salinity, Flows, & Stages

Methods:

- Described in Marshall, Wingard and Pitts. 2009. Estuaries and Coasts 31:37-53.
- Determine salinity relationships of current fauna.
- Date sediment core layers and identify and quantify “fossil” fauna to estimate salinity.
- Statistically estimate current relationship between Everglades water stage and Florida Bay salinity and between stage and freshwater flow.
- Estimate historic stage and flow corresponding to historic salinity.

Pre-Drainage Stages and Flows based on Whipray Basin Fauna

Linear Regression Model Results: Historical paleo-based stage and flows

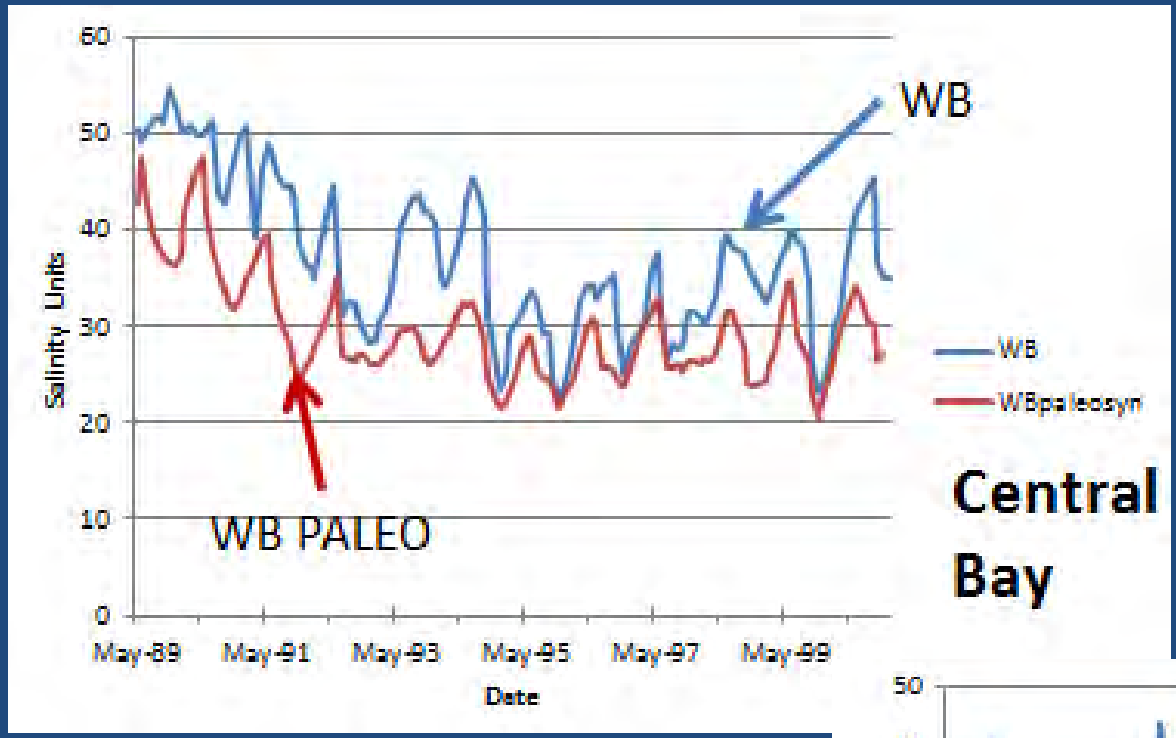
	Station	Observed Mean	Paleo-based Mean	Difference (paleo-obs)	Paleo: obs
Stage	P33 (stage)	1.93	2.48	0.55	1.28
	CP (stage)	0.39	0.99	0.6	2.54
Flows	SRS (flow)	1.1	2.9	1.8	2.7
	TSB (flow)	0.06	0.23	0.17	3.8

USGS

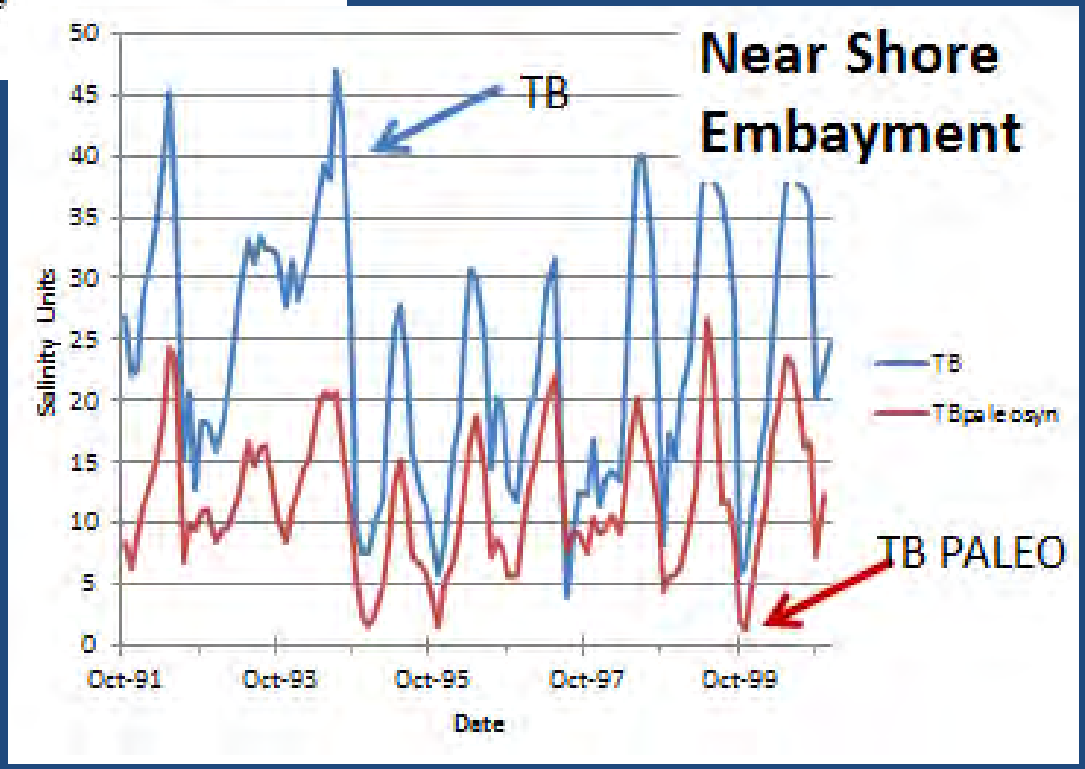
Stage in m
Flow in million acre-feet/y

From Marshall et al. 2009

Note: revision of estimates, based on more regions, pending (SRS flow > 2X current)



Estimated Florida Bay Historic Salinity (Paleo – based): most stations 5 to 10 ppt fresher than now



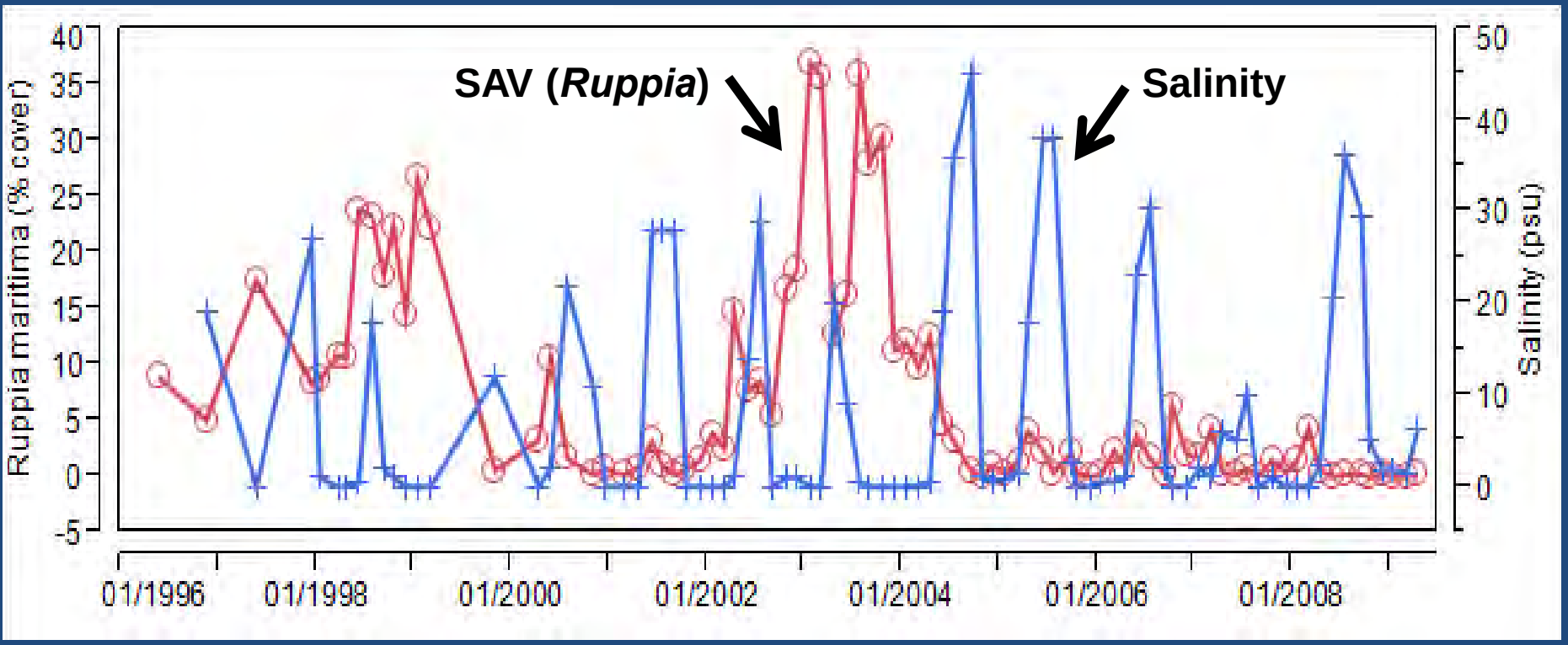
From: F. Marshall and L. Wingard.

Florida Bay: Ecological Change

Freshwater diversion and increased salinity: factors causing ecological change (but not only factors)

- Seagrass die-off events (starting 1987)
- Algal blooms and elevated turbidity since 1991
- Sponge die-offs in early 1990s and 2007
- Fisheries declines (pink shrimp, lobster, finfish)
- Other animal population declines (roseate spoonbills & other birds, crocodiles, manatees)
- Salinity intrusion and mangrove expansion in coastal marshes

Loss of SAV Habitat in Mangrove Zone Ponds and Creeks with High Salinity

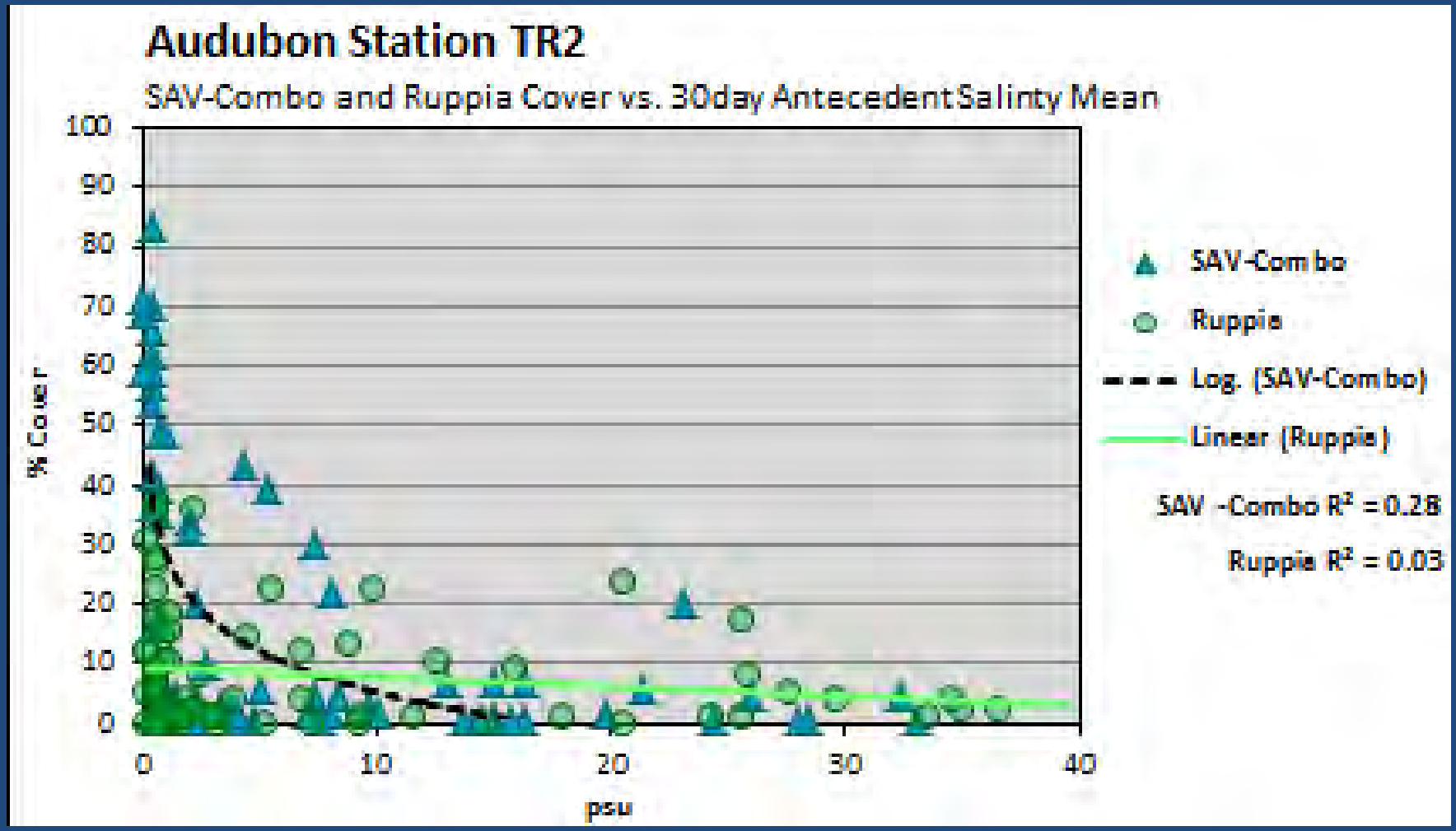


From P. Frezza and A. McDonald

Ruppia maritima
(widgeon grass)

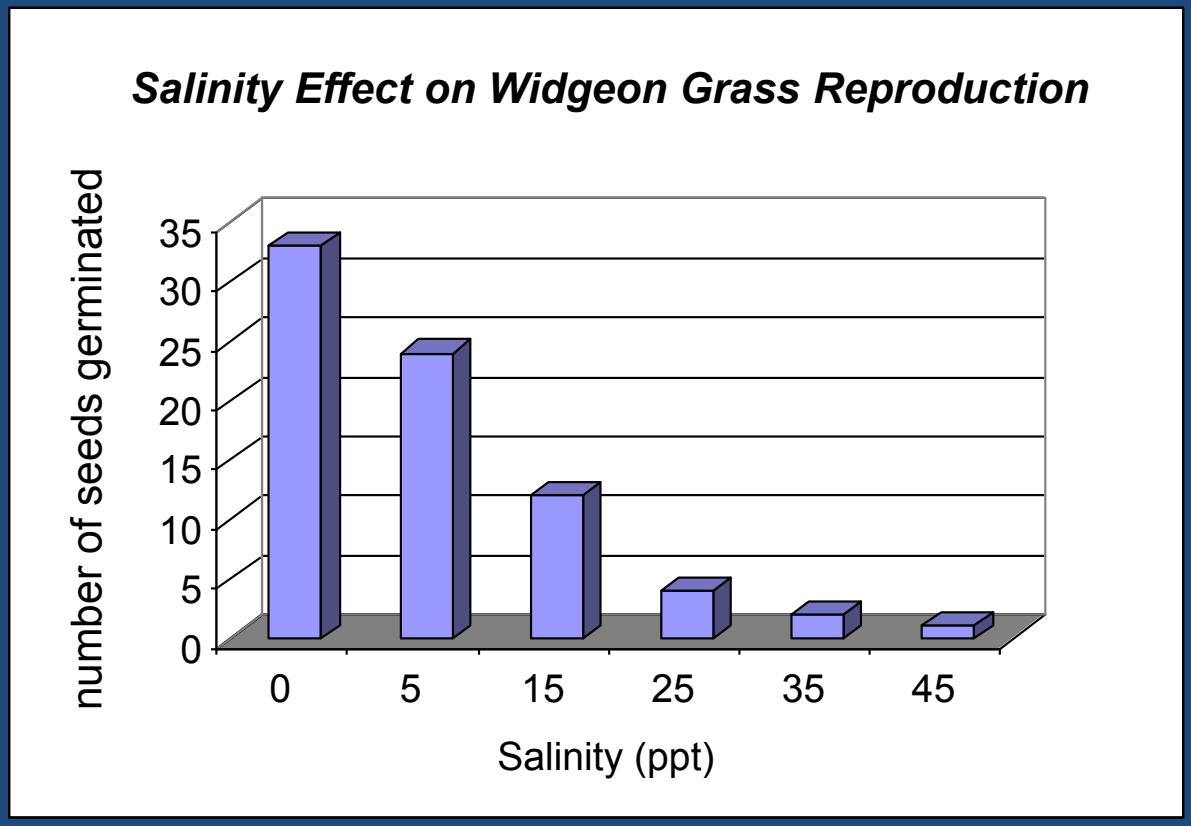
From T. Stazisar and M. Koch

Loss of SAV Habitat in Mangrove Zone Ponds and Creeks with High Salinity



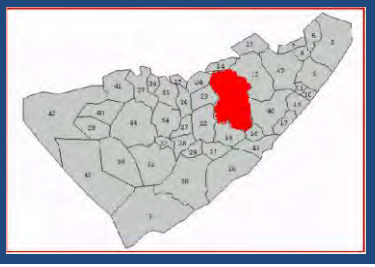
From C. Avila and P. Frezza

Ruppia Reproductive Success Experiments: seed germination best at low salinity

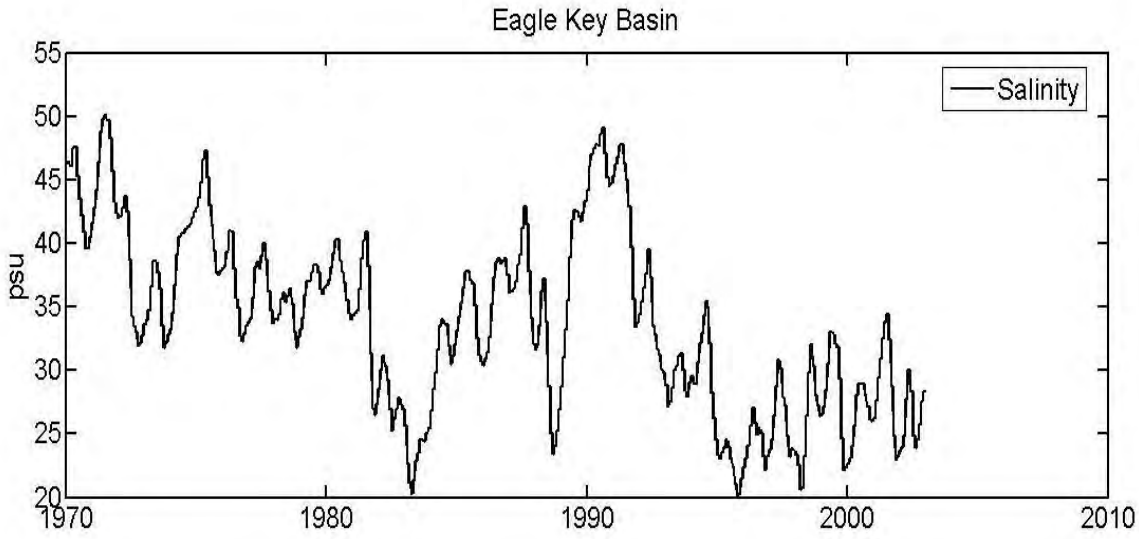


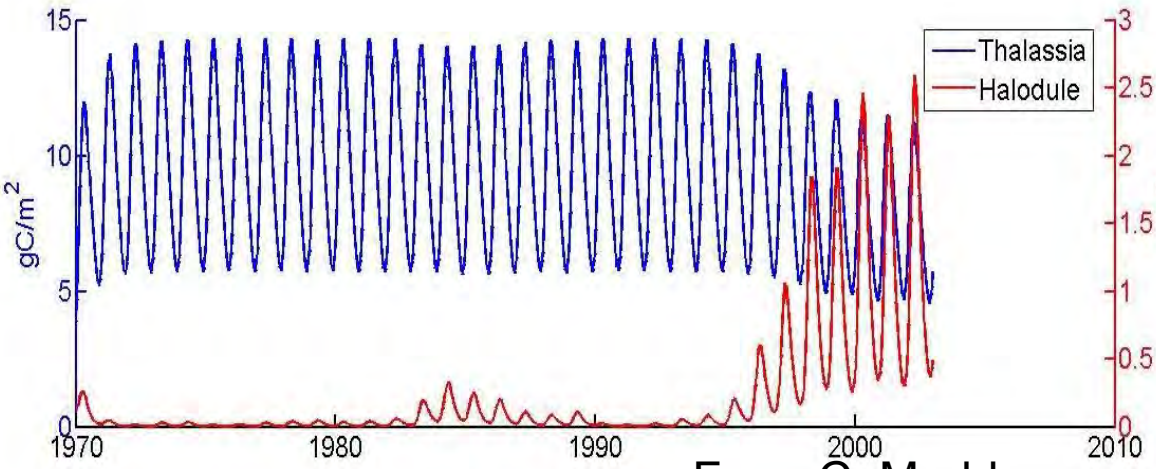
Calculated from data in Koch et al. 2009

Model Development and Application: Salinity Effects on Seagrass Habitat



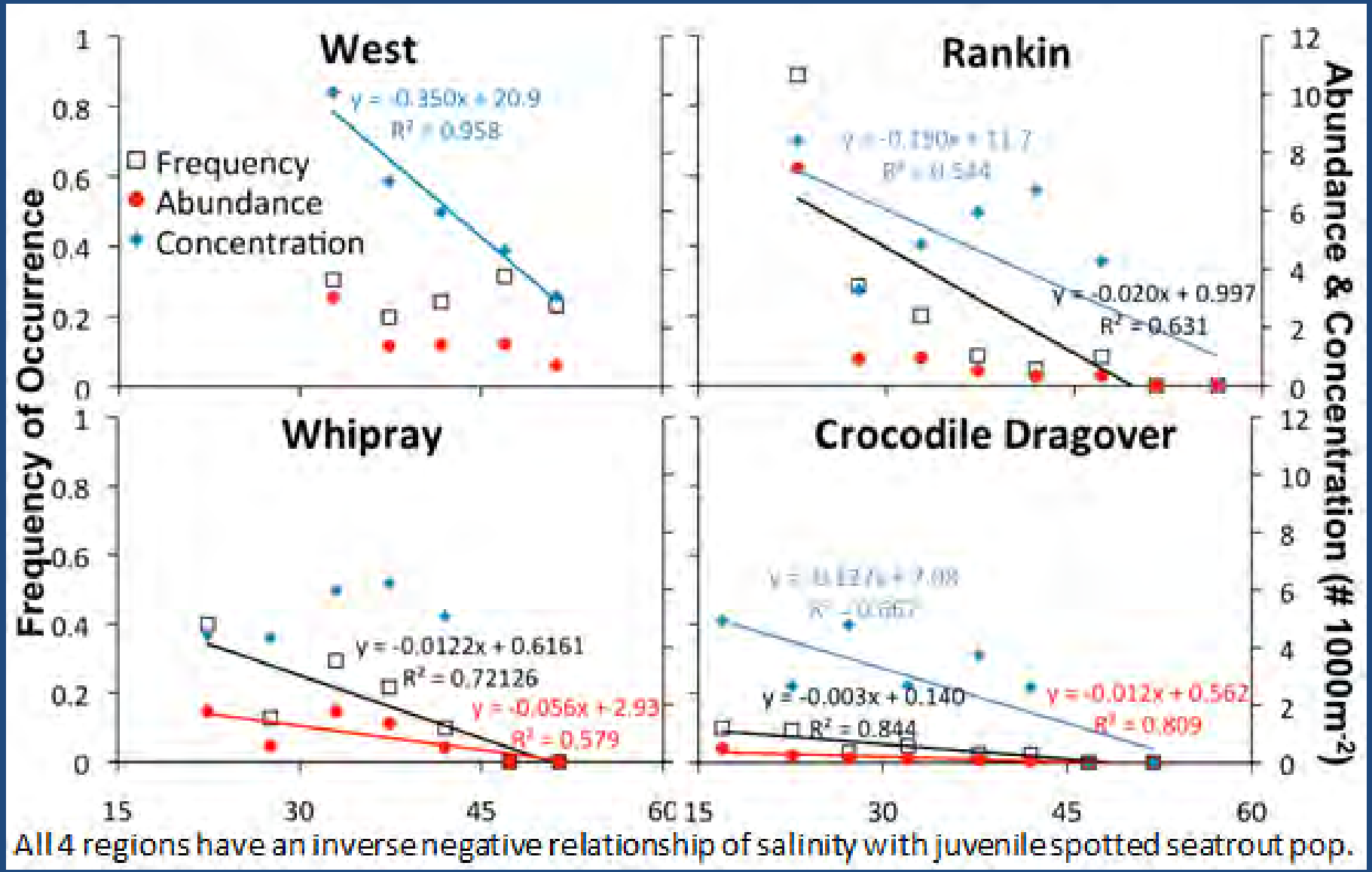
- Salinity hind-cast from the FATHOM model (1970-2003)
- SAV (*turtle grass and shoal grass*) response from the SEACOM model
- Increased fresh water flow increases species diversity





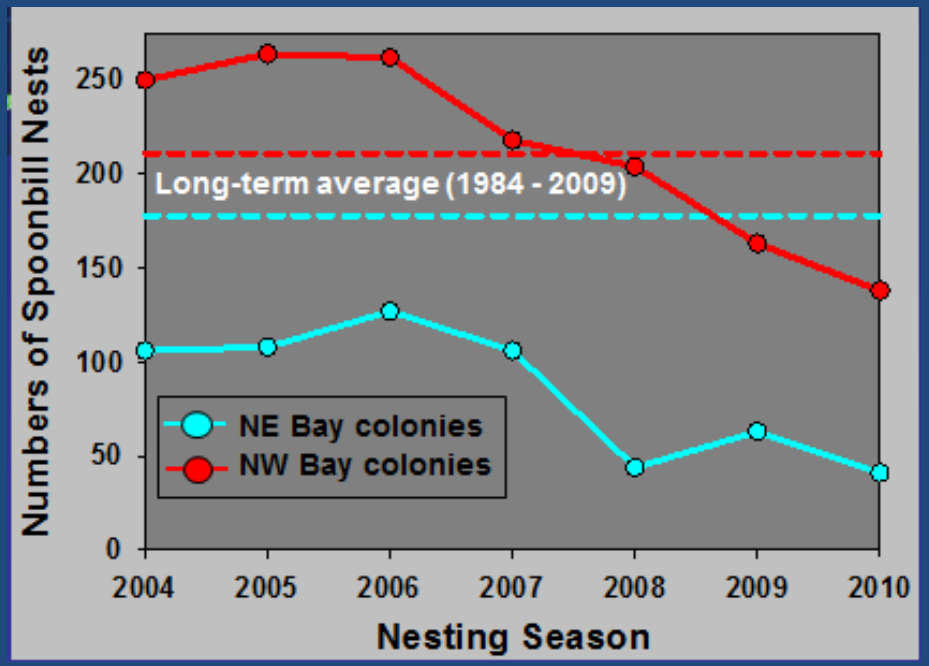
From C. Madden

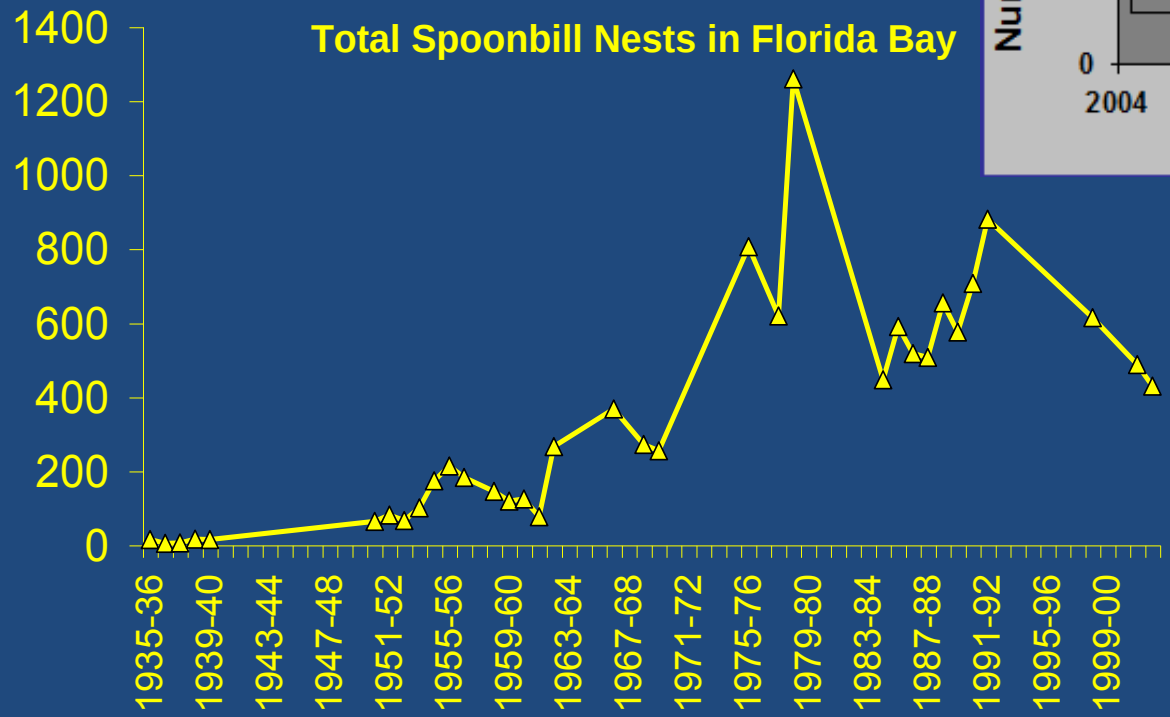
Juvenile Spotted Seatrout Monitoring in Florida Bay: a negative relationship with salinity

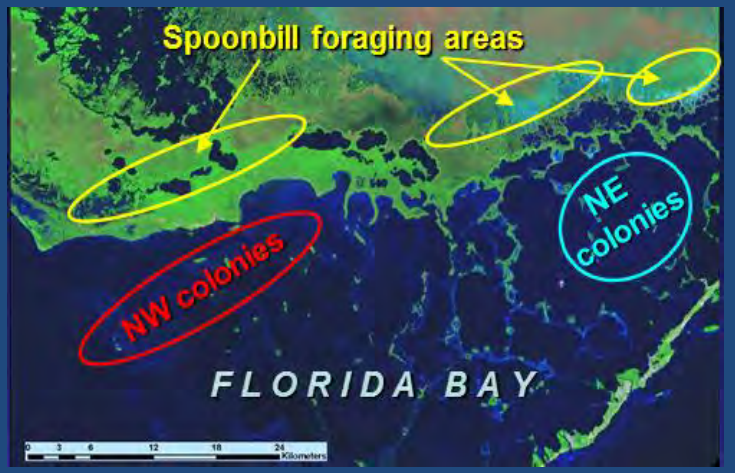


From C. Kelble; RECOVER

Decreases of Roseate Spoonbill Nesting



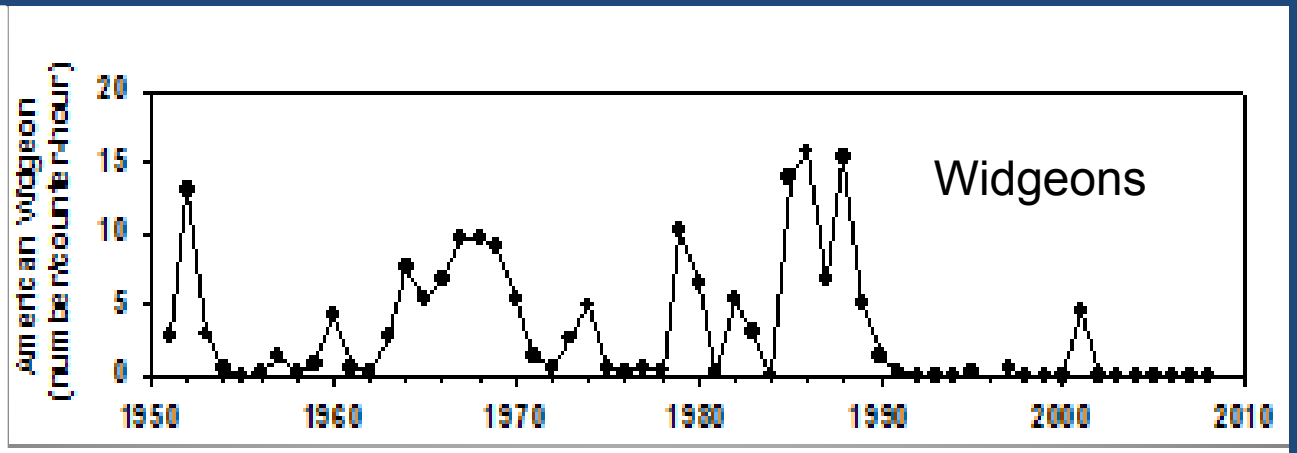


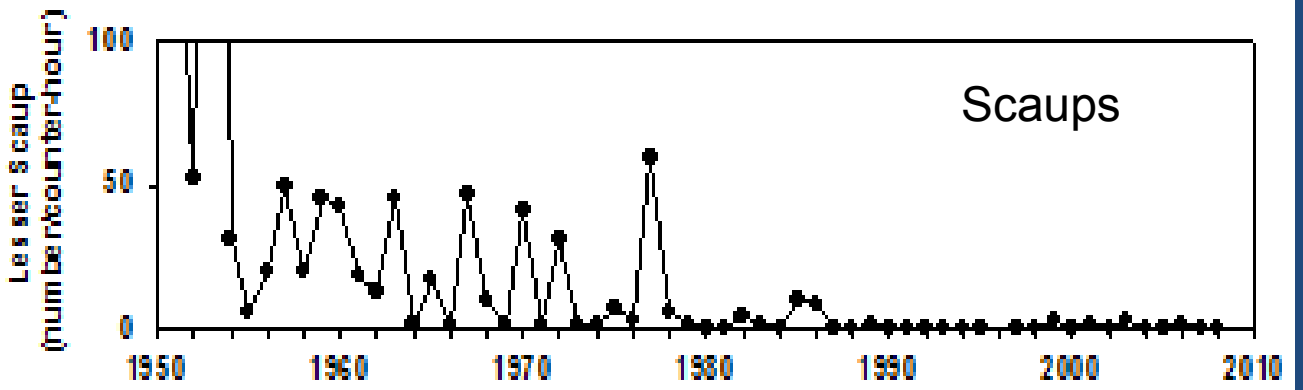


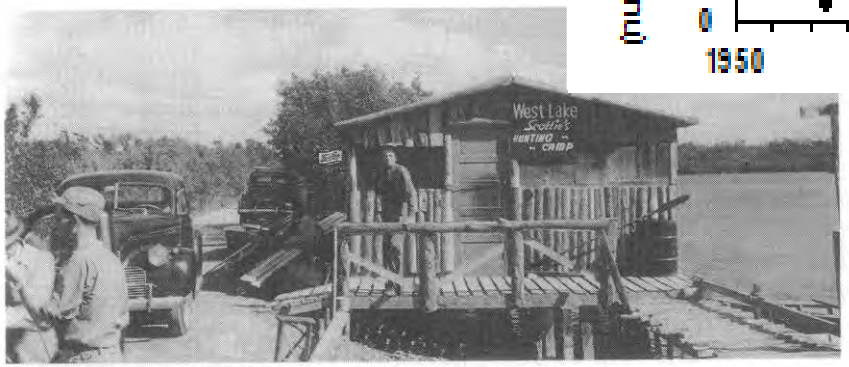
All data from Lorenz & Langan)

Decreases in Waterfowl in Lakes and Ponds of the Florida Bay Transition Zone

Coot Bay





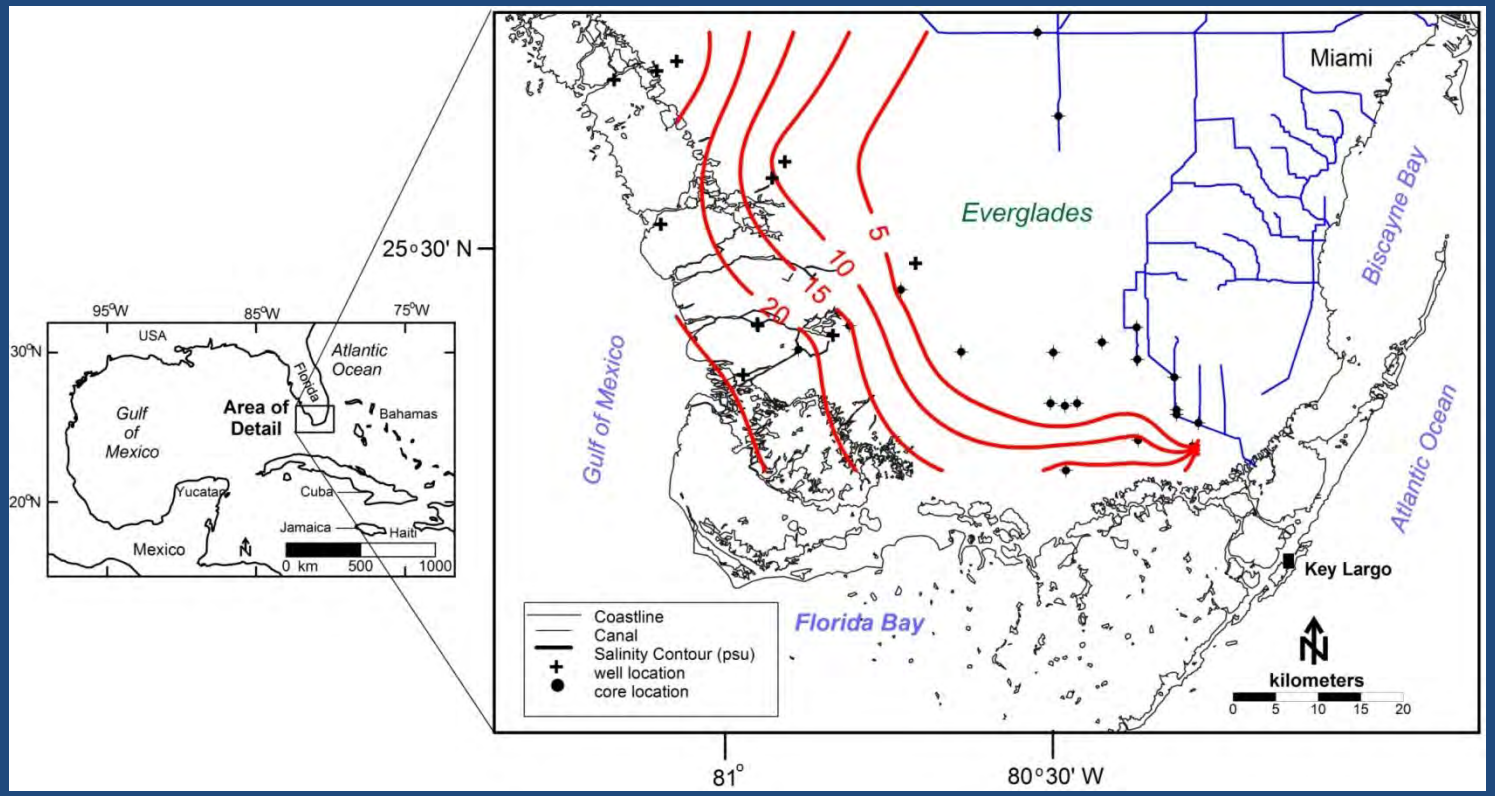


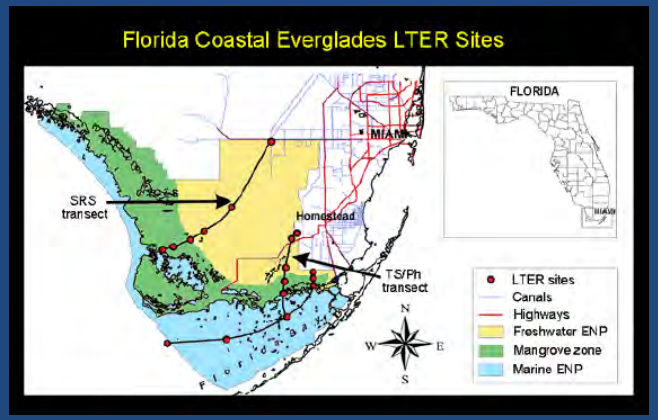
West Lake hunting camp, late 1930s. Courtesy Alexander Sprunt IV.

Audubon Christmas count data (standardized; R. Bennett)

Duck hunters' traffic jams occurred in the 1930s (Simmons and Ogden 1998)

Saltwater Intrusion: Shallow Groundwater (<25 m) Salinity

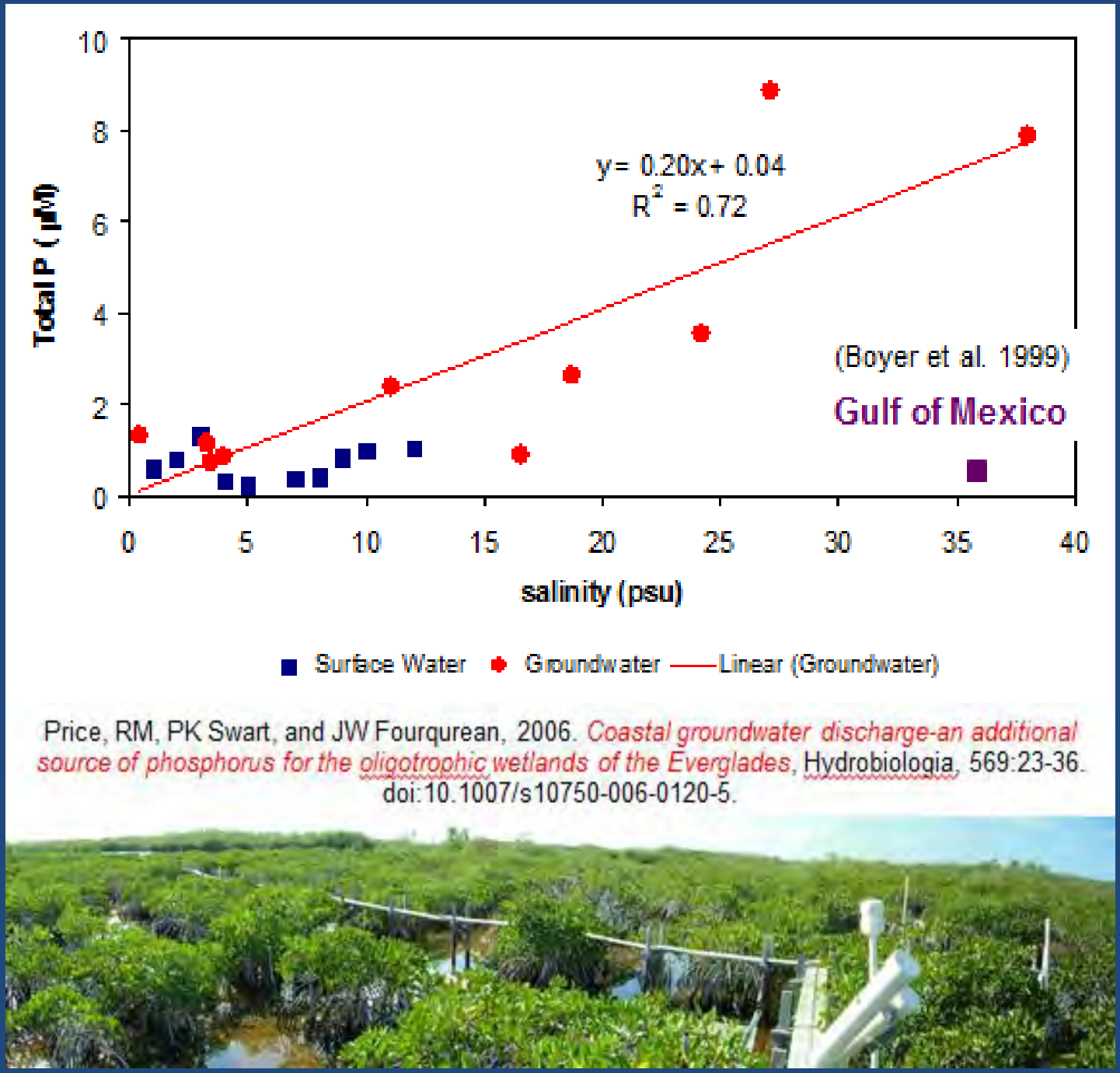




From R. Price

The 5 ppt salinity contour line corresponds with the mangrove ecotone (Green area)

Phosphorus Input from Groundwater?



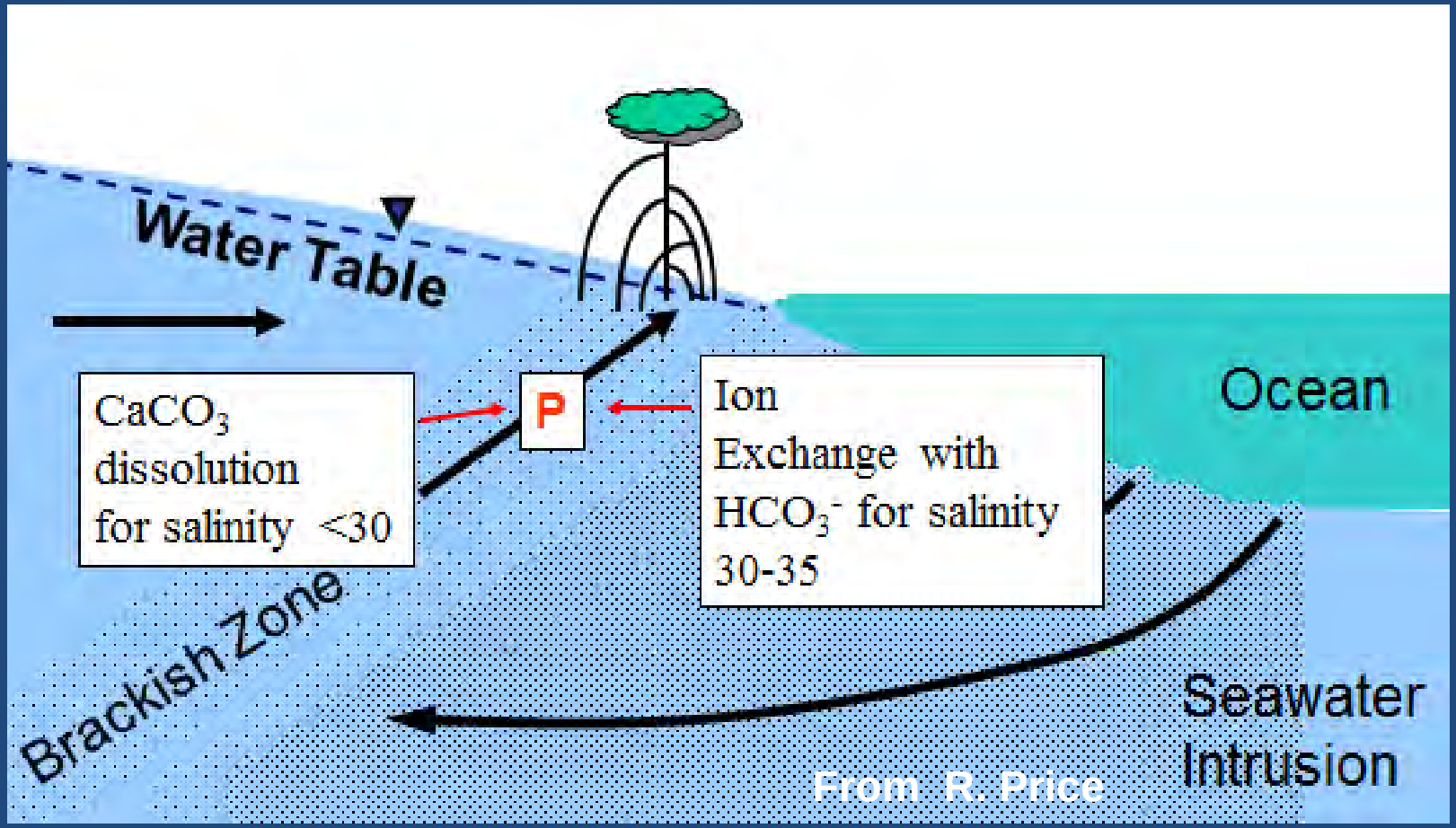
Price, RM, PK Swart, and JW Fourqurean, 2006. *Coastal groundwater discharge-an additional source of phosphorus for the oligotrophic wetlands of the Everglades*, Hydrobiologia, 569:23-36. doi:10.1007/s10750-006-0120-5.

Evidence that saltwater intrusion may cause the release of phosphorus from bedrock to the mangrove zone and estuaries

From R. Price

Conceptual Model of Effect of Saltwater Intrusion on Phosphorus Mobility

May be major P contributor to mangrove zone and near-shore waters (algal blooms?)



Price, RM, MR Savabi, JL Jolicoeur, S Roy. 2010 *Adsorption and desorption of phosphate on limestone in experiments simulating seawater intrusion, Applied Geochemistry,* 25:1085–1091.

Florida Bay History, Conditions, Needs: Conclusions

- Pre-drainage Florida Bay was much less saline than the current system, which is commonly hypersaline
- Pre-drainage salinity values were associated with > 2x current Shark Slough flow and about 4x more flow in Taylor Slough
- In the past 2 to 3 decades, there have been major declines in habitat and fauna
- Saltwater intrusion is an ecological driver of change and may have a strong water quality impact
- Historic freshwater diversion and salinity change have been major factors contributing to ecological change