Hydrologic Needs of Florida Bay

Hydrologic Targets Workshop

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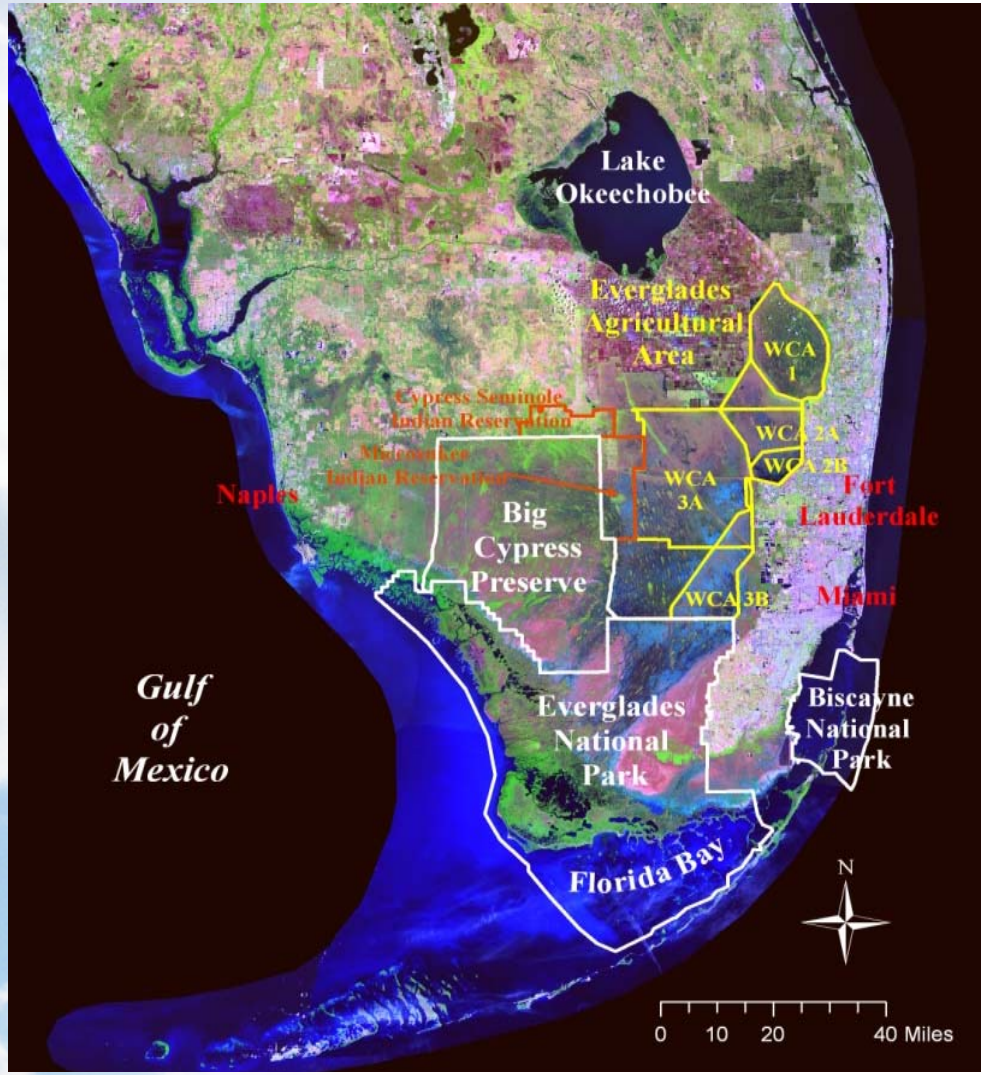
David T. Rudnick, Everglades Division, SFWMD

Florida Bay Hydrologic Needs: Outline

- Background on Florida Bay
- Long-term decreases in freshwater flow and ecological change
- Adequacy of current restoration efforts: performance measures and evaluations
- Re-evaluating targets: an historical basis for estimating hydrologic needs

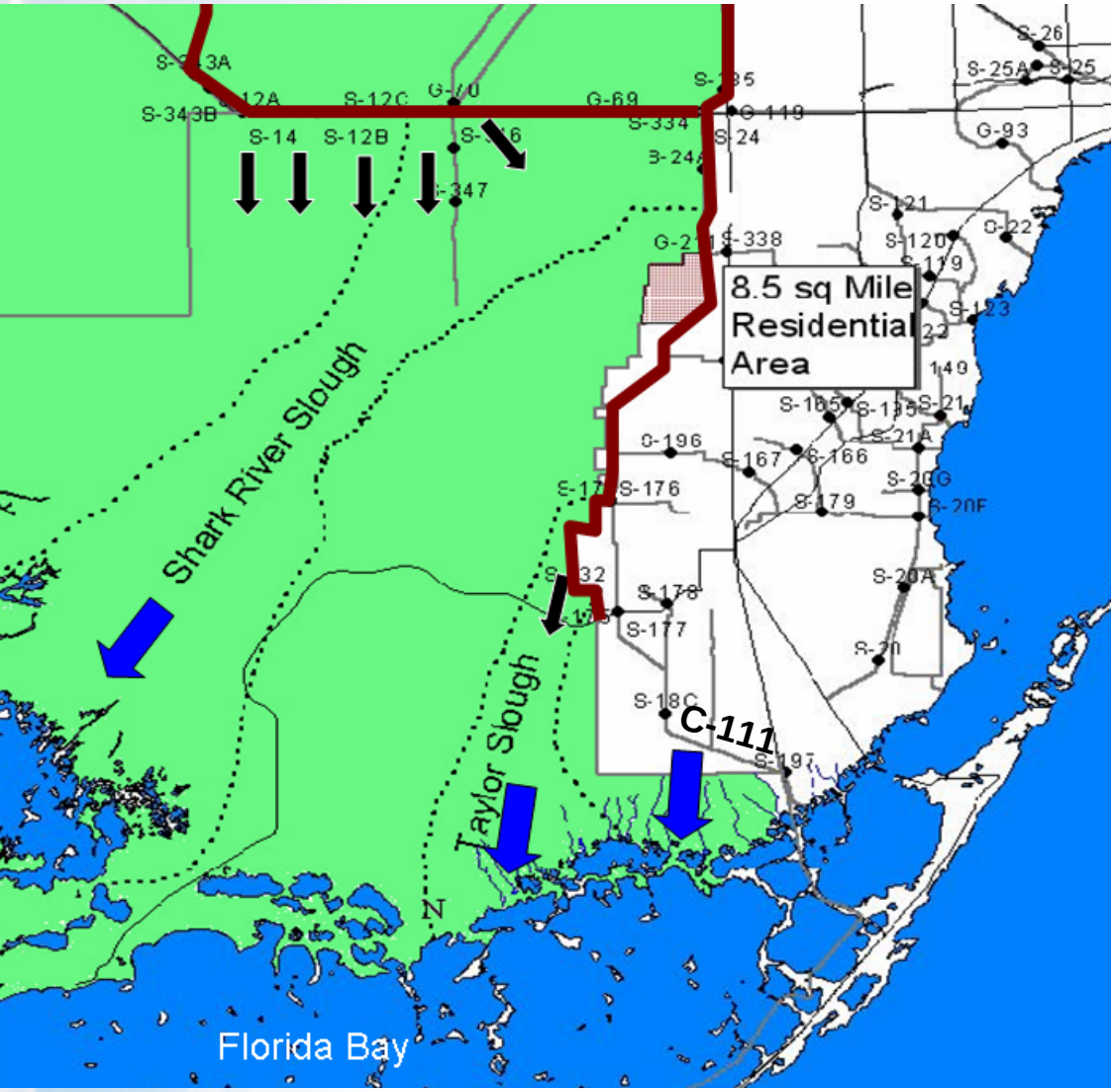
……the bottom line: need more water!

Florida Bay: background



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

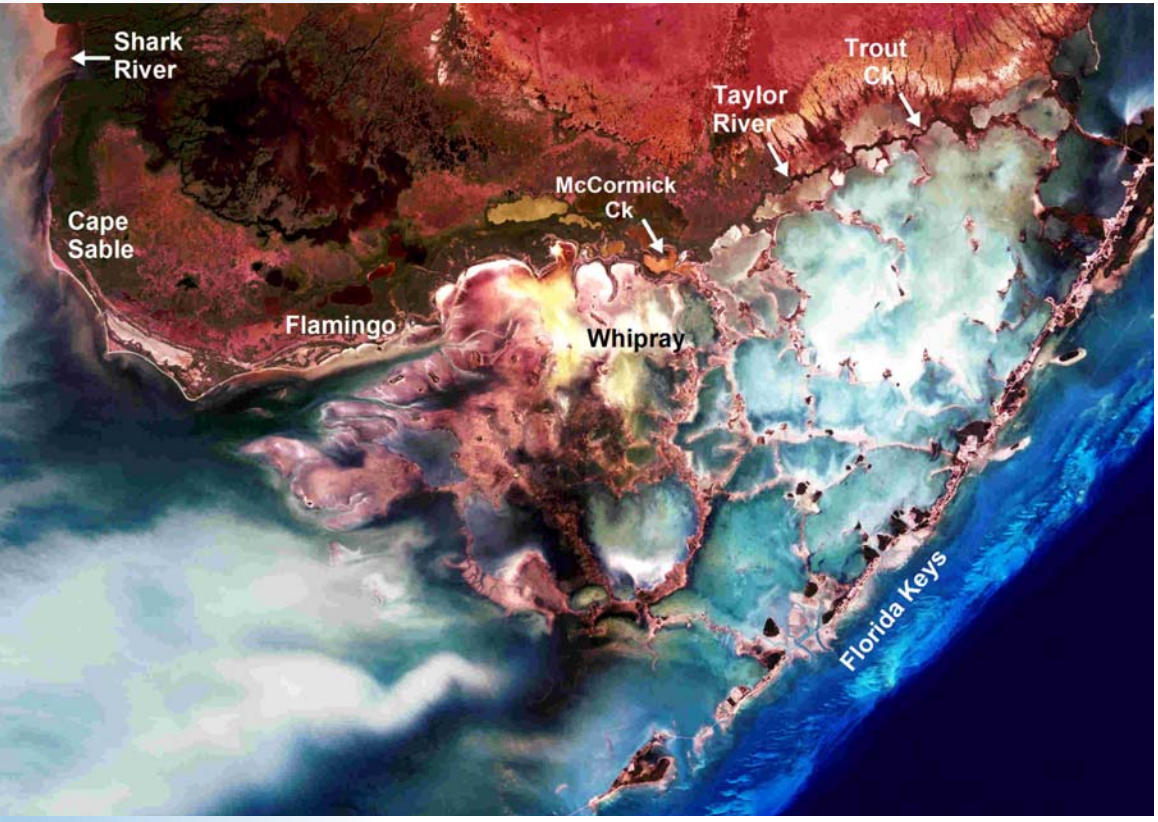
Florida Bay: background



Managed freshwater inflow currently via three main routes:

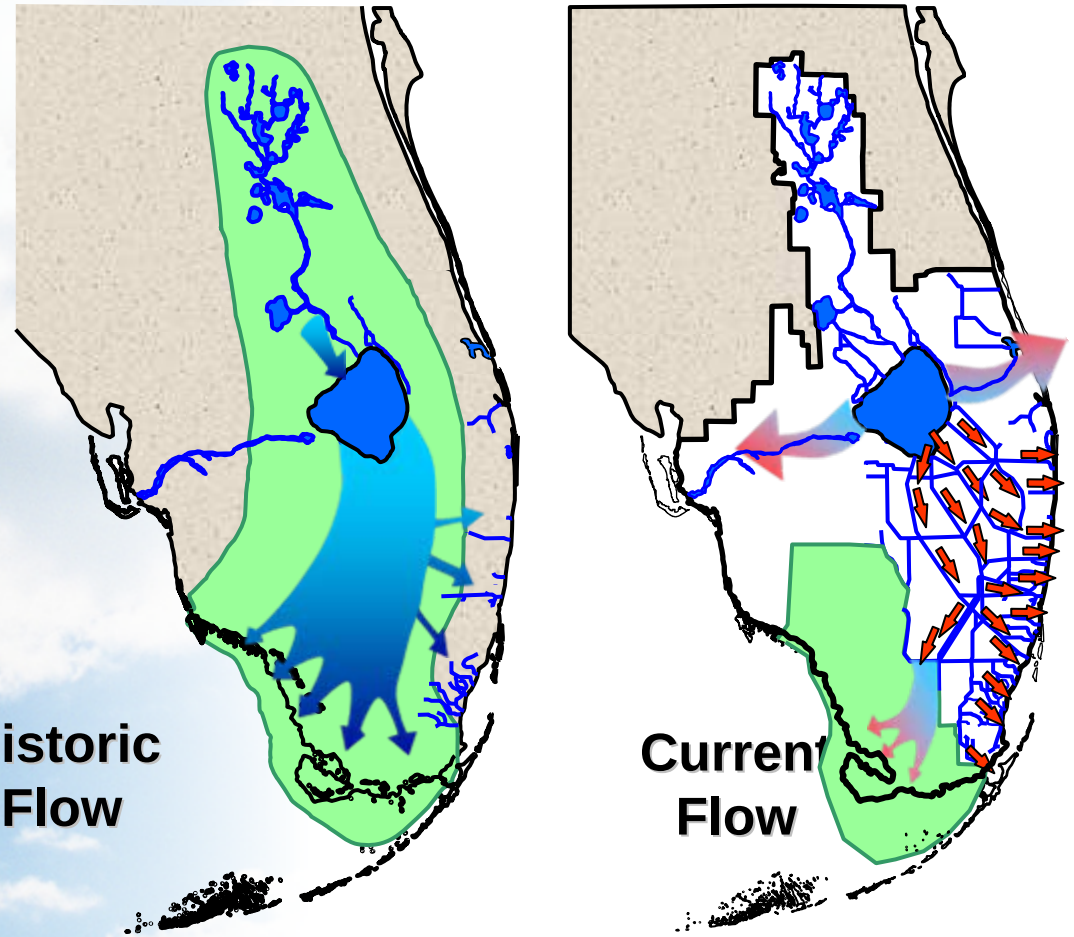
- Shark River Slough
- Taylor slough
- C-111 canal

Florida Bay: background



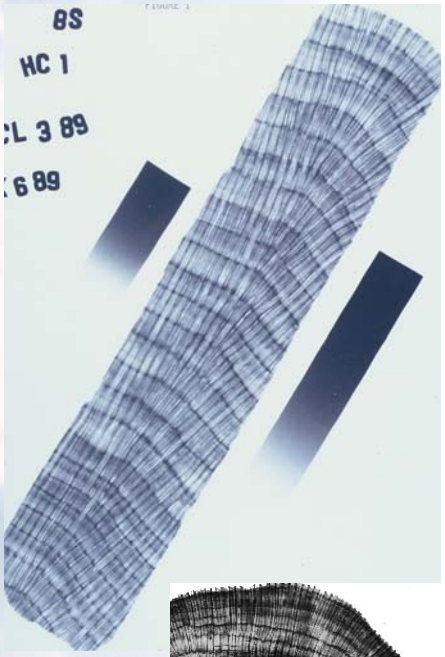
- Shallow depth (about 1 m)
- Mud banks & low tidal energy restrict water mixing / ocean exchange (creates “lakes”)
- Seagrass throughout bay further decreases mixing
- Depth & limited exchange enable salinity to rise to 70 ppt (double seawater salinity!)

Florida Bay: Hydrologic Change & Effects

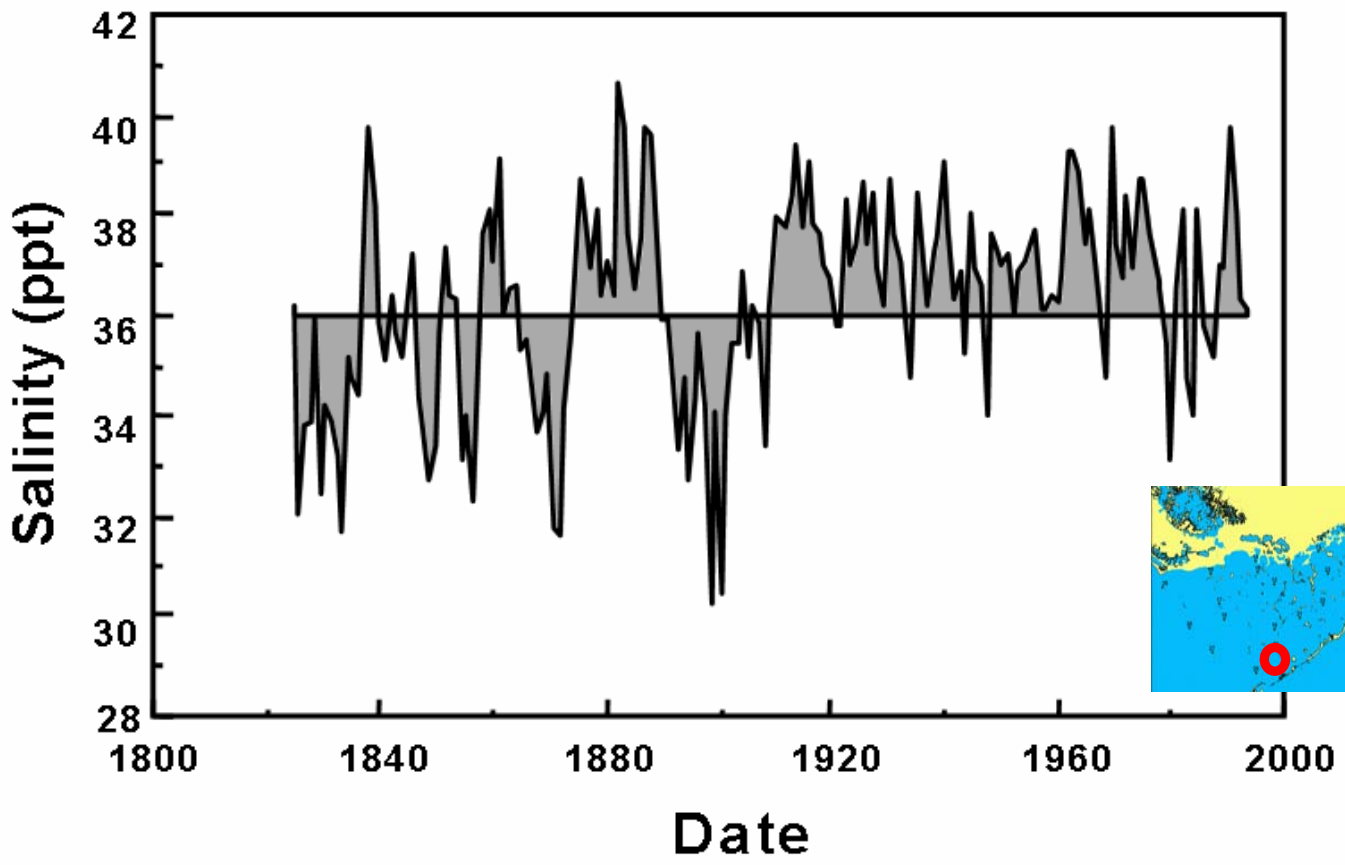


Water management has diverted freshwater that historically flowed to Florida Bay and other southern estuaries

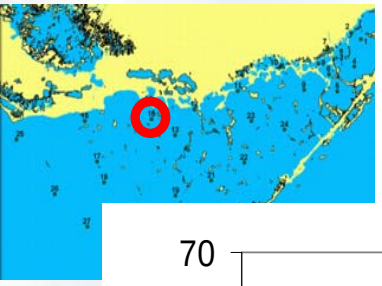
Florida Bay: Hydrologic Change & Effects

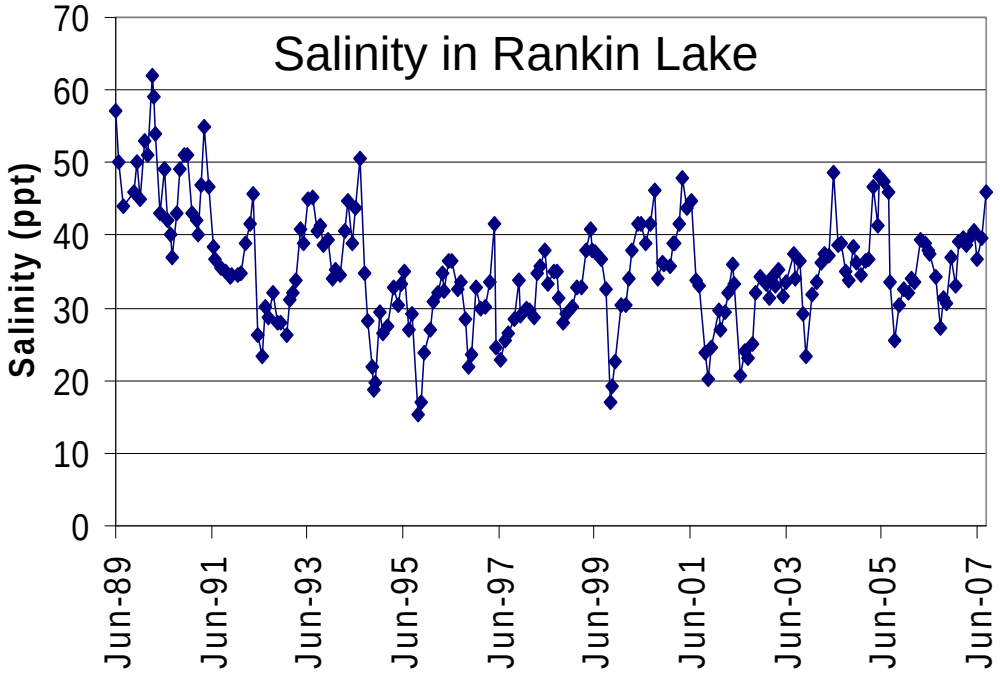


Historical loss of low salinity periods in southern Florida Bay estimated from the isotopic record of a coral skeleton (after Swart et al. 1999)



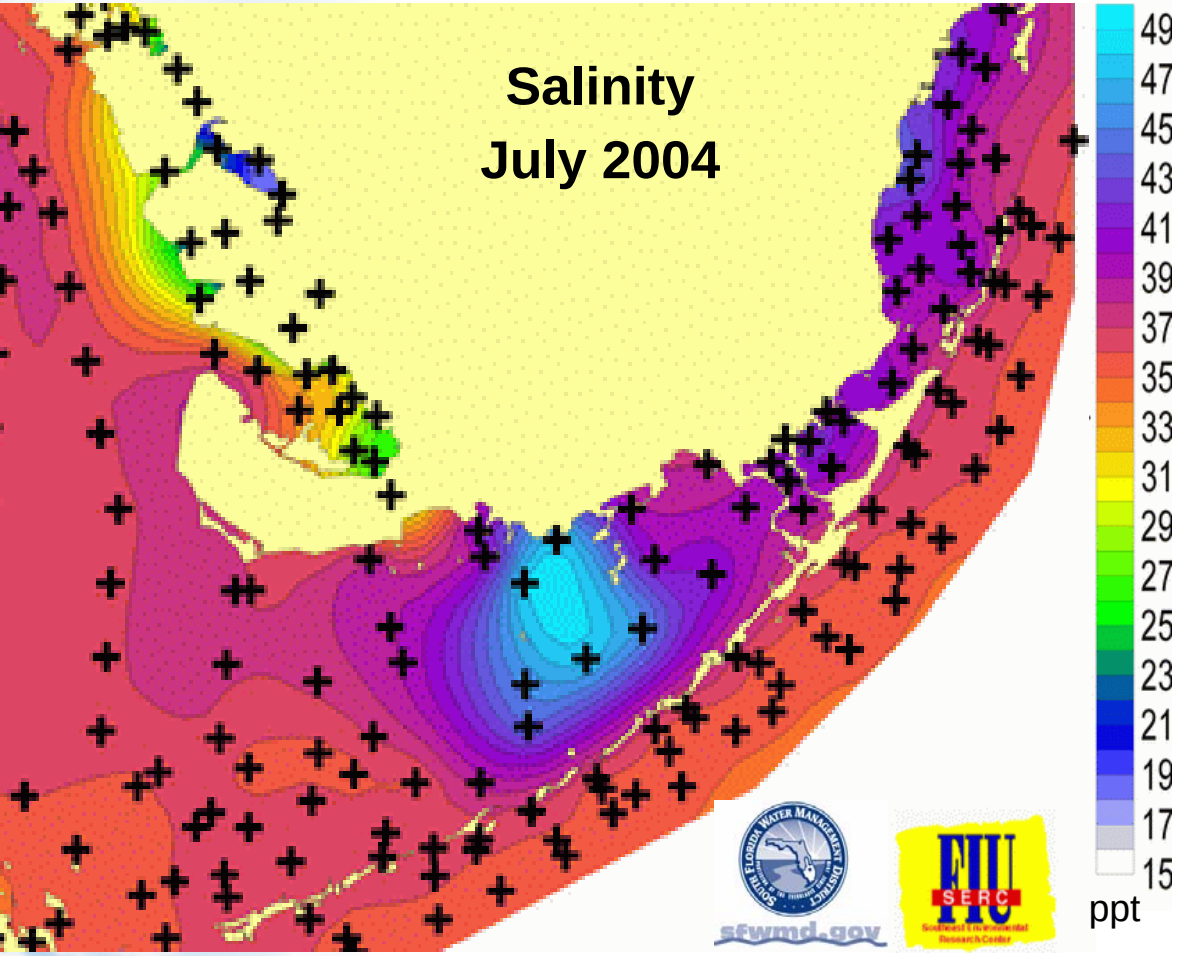
Florida Bay: Hydrologic Change & Effects





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

Florida Bay: Hydrologic Change & Effects



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

Florida Bay: Hydrologic Change & Effects

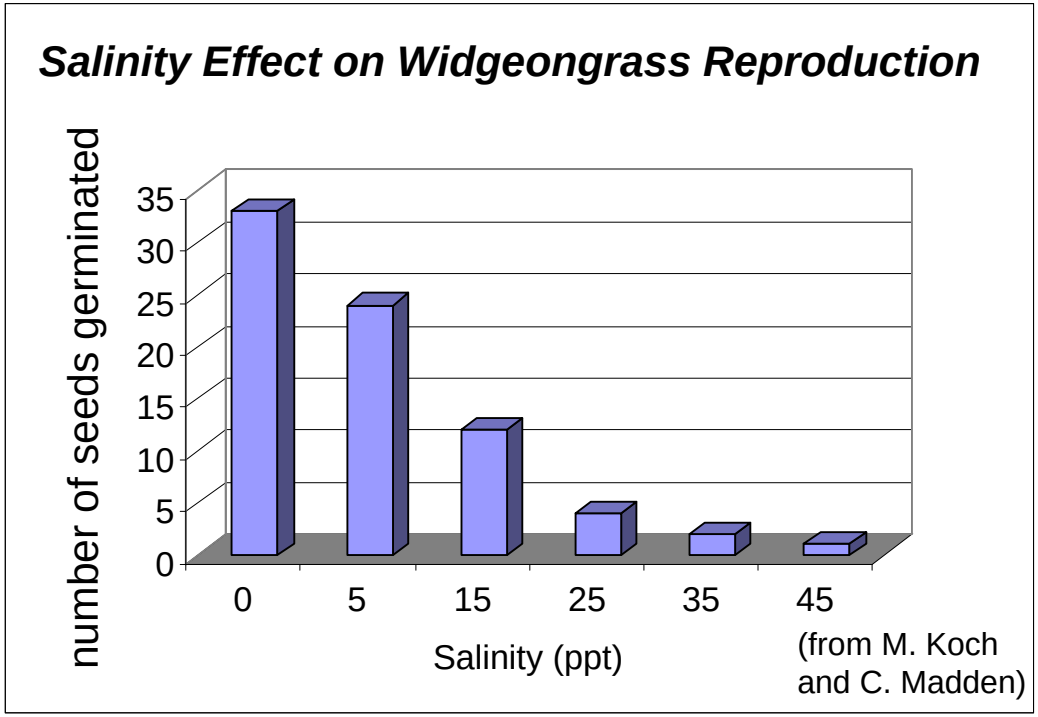
Freshwater diversion and increased salinity: factors causing ecological change

- 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

Florida Bay: Hydrologic Change & Effects

Examples of direct effects of increased salinity:

- ***decreased seagrass habitat diversity and distribution***
- ***"white zone" expansion***



Florida Bay: Hydrologic Change & Effects

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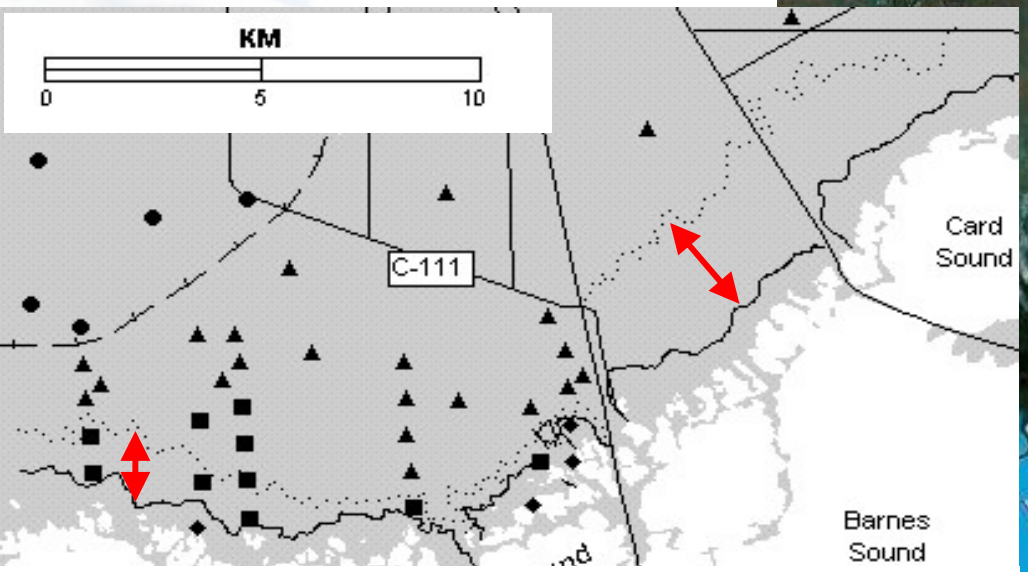
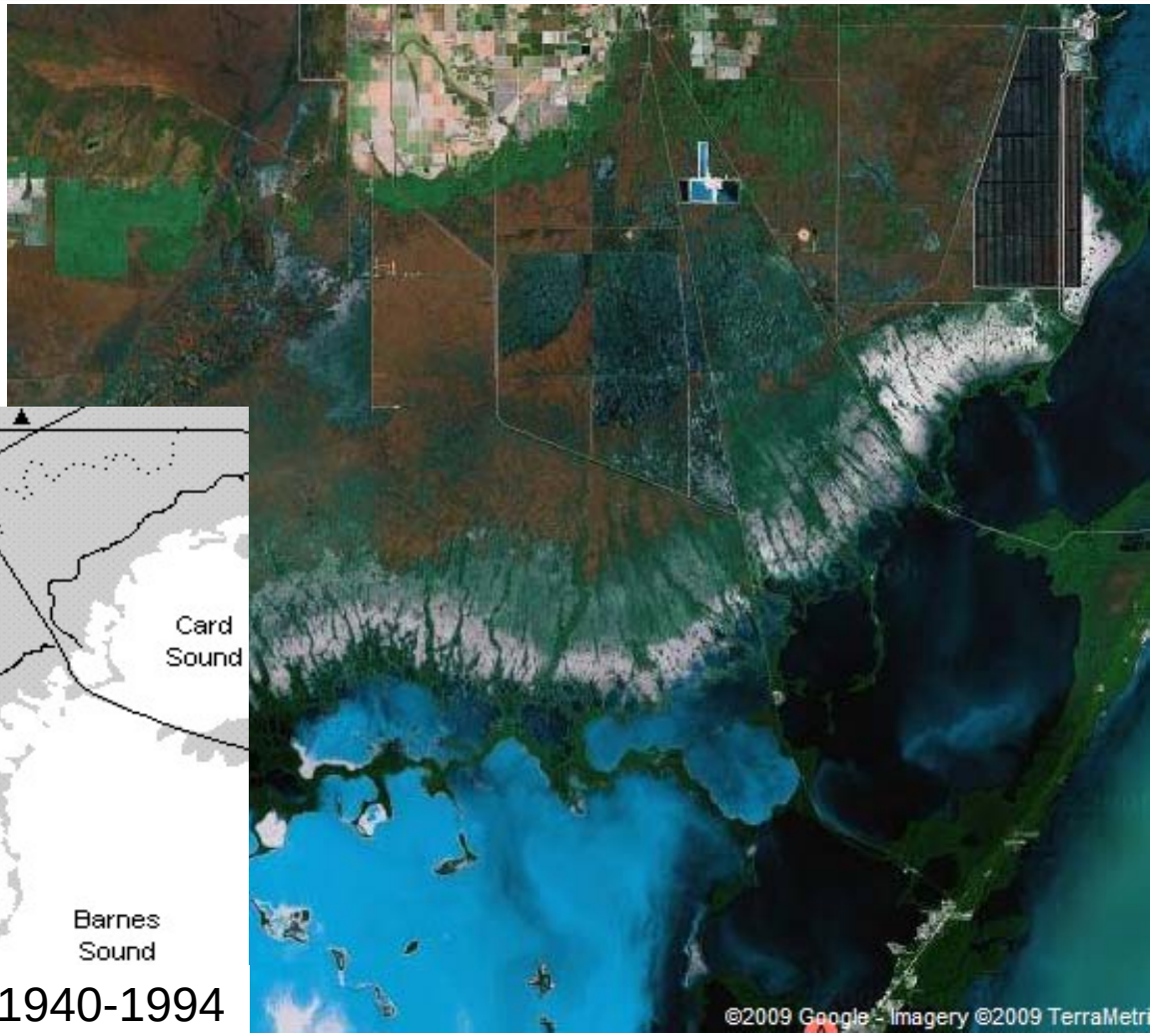




White zone expanded 1-3 km from 1940-1994 (from Ross et al. 2000)

Florida Bay: Restoration Targets & Evaluations

Salinity as the Primary Performance Measure and Target

Basis (within Restudy, RECOVER, Florida Bay and Florida Keys Feasibility Study, Florida Bay MFL):

- **Retrospective (paleoecology) analysis**
- **NSM (modeling)**
- **Biological (seagrass, fauna) analysis**
- **Best professional judgment**

Key Considerations:

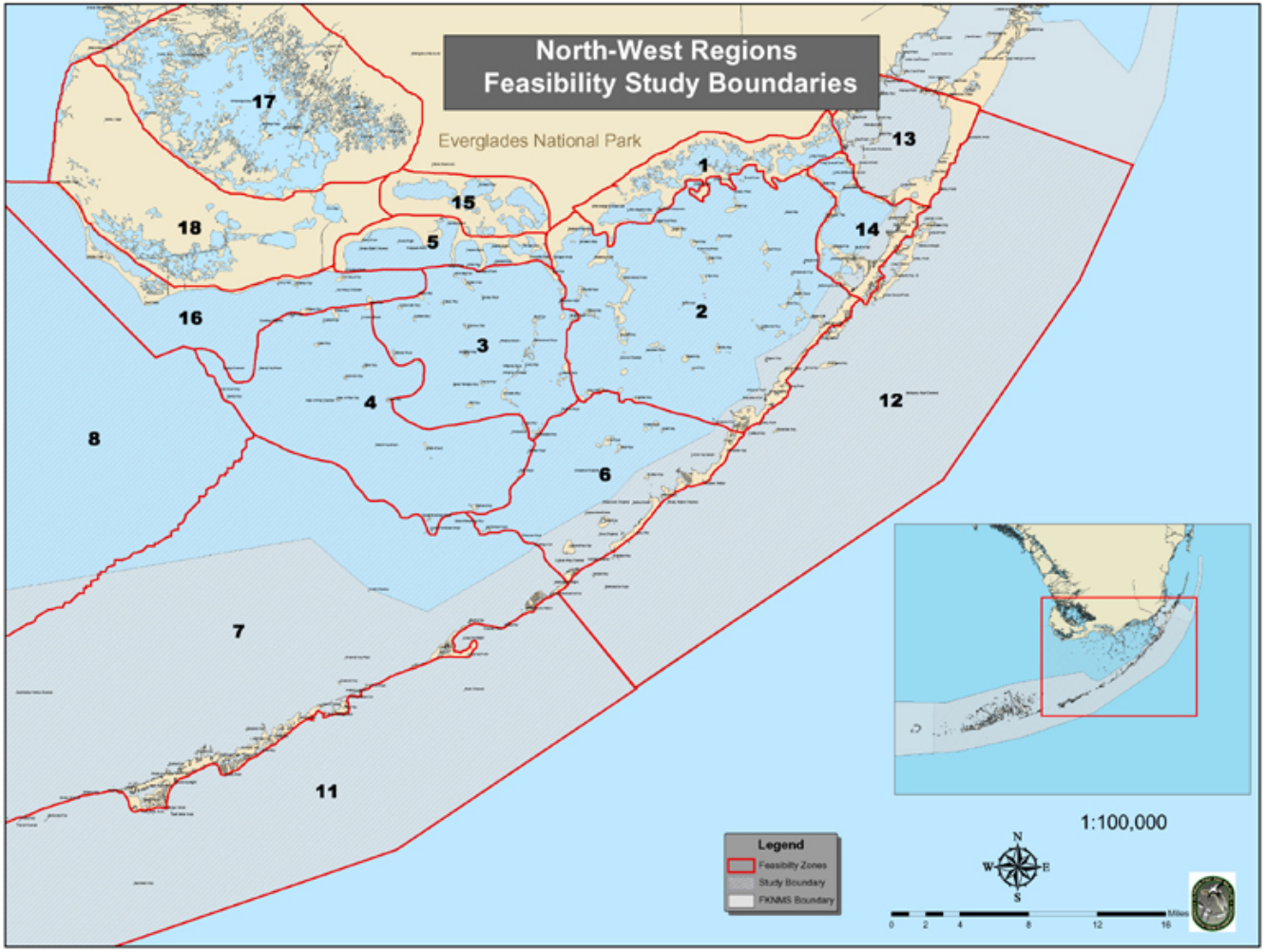
- **Spatial and temporal variability**

Components:

- **Salinity magnitude – defining the annual range per zone**
- **Occurrence of rapid (harmful) salinity decreases**
- **Timing of seasonal change – extending the wet season**

Florida Bay: Restoration Targets & Evaluations

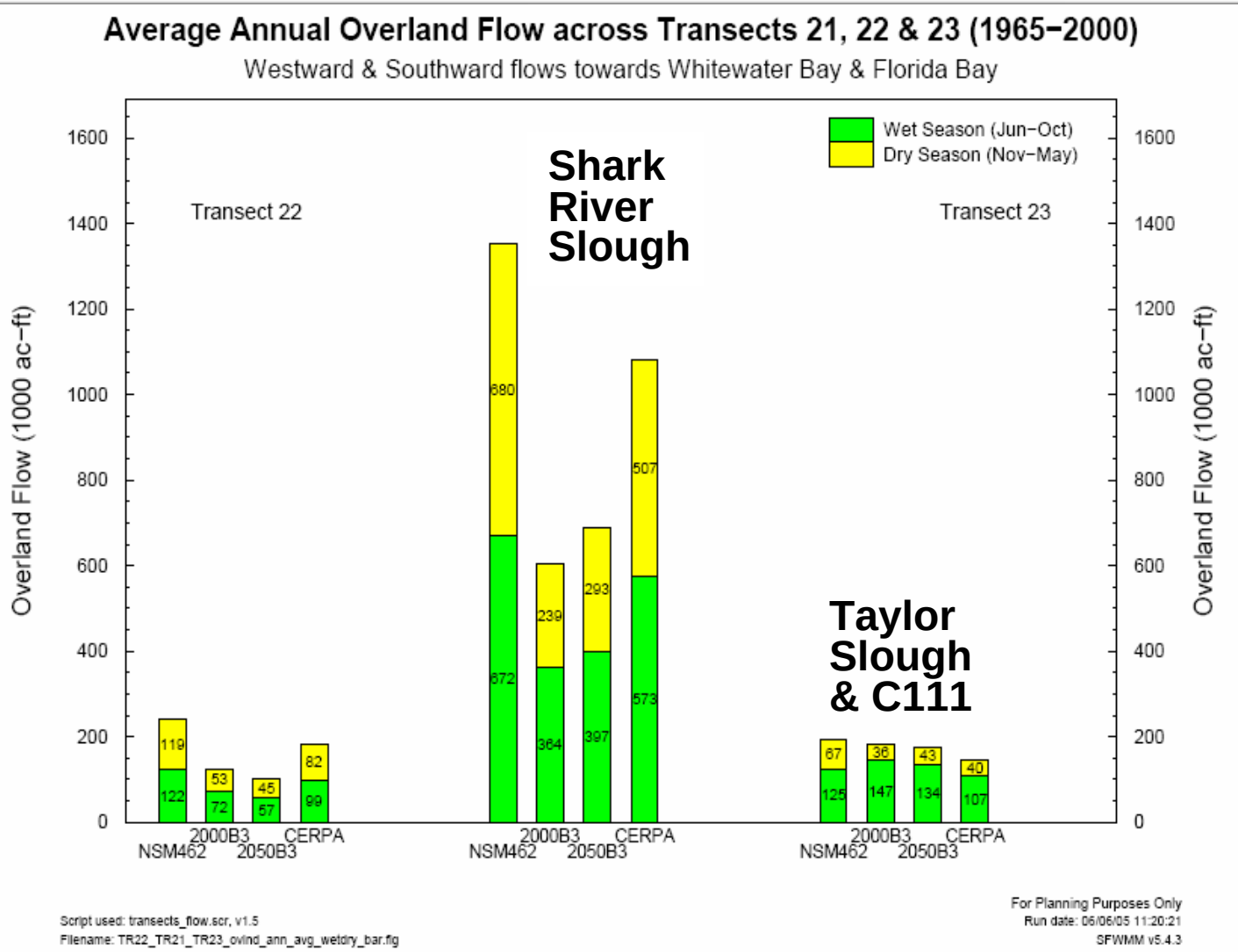
Florida Bay and Florida Keys Feasibility Study: evaluation zones



Florida Bay: Restoration Targets & Evaluations

Restoration scenarios: overland flow

- CERP likely to increase Shark River Slough flows, but not Taylor Slough flows



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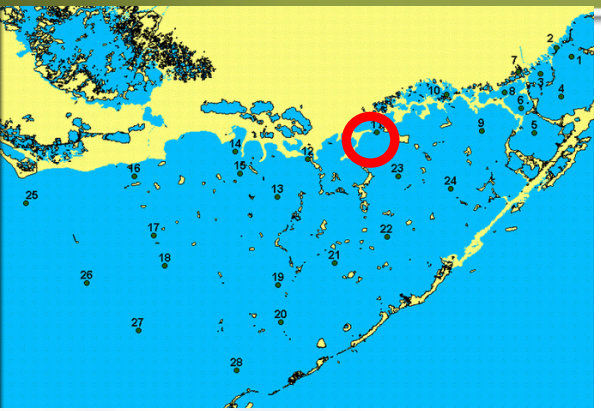
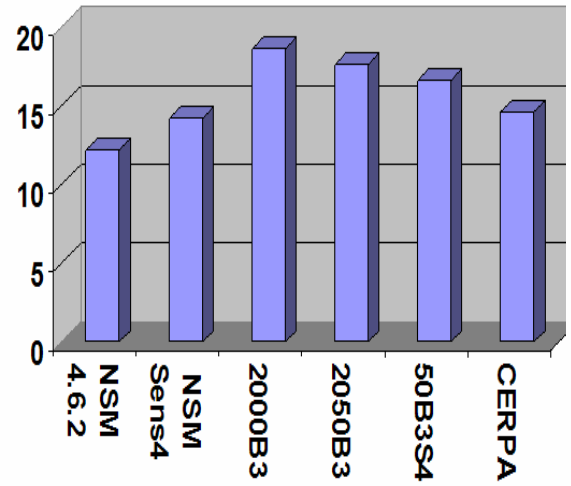


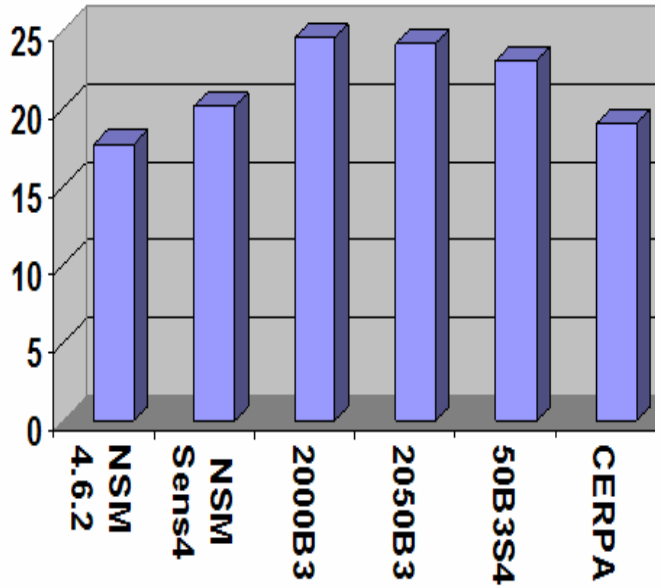
Little Madeira Bay:

Restoration scenario salinity results (from Initial CERP Update)

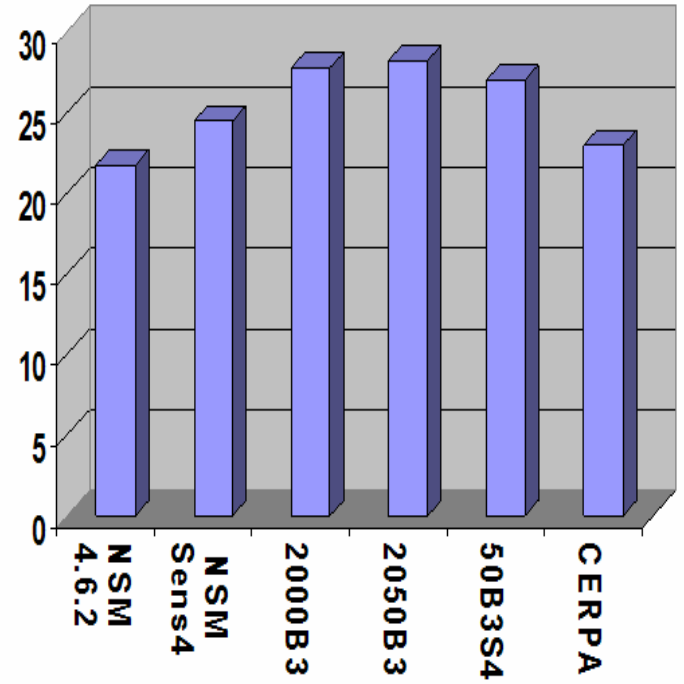
25th percentile Salinity (ppt)



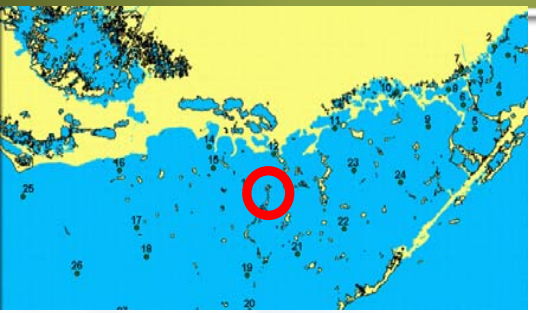
50th percentile salinity (ppt)



75th percentile salinity (ppt)



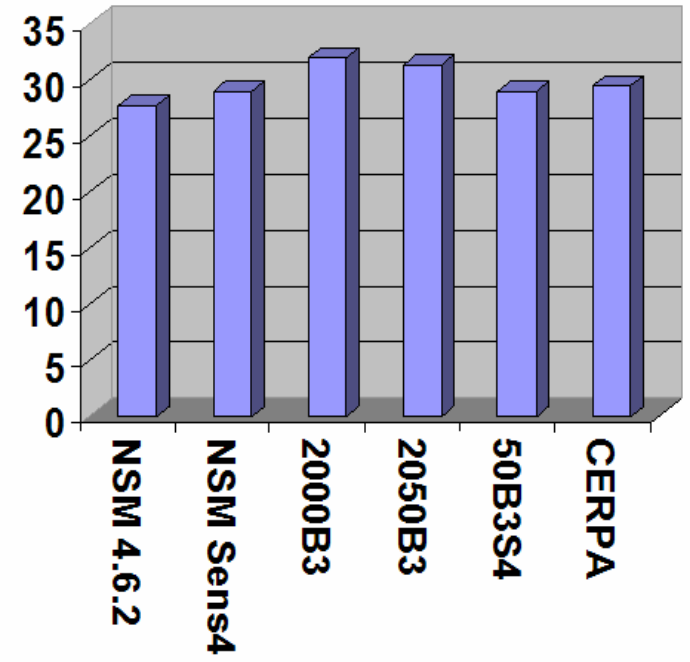
Florida Bay: Restoration Targets & Evaluations



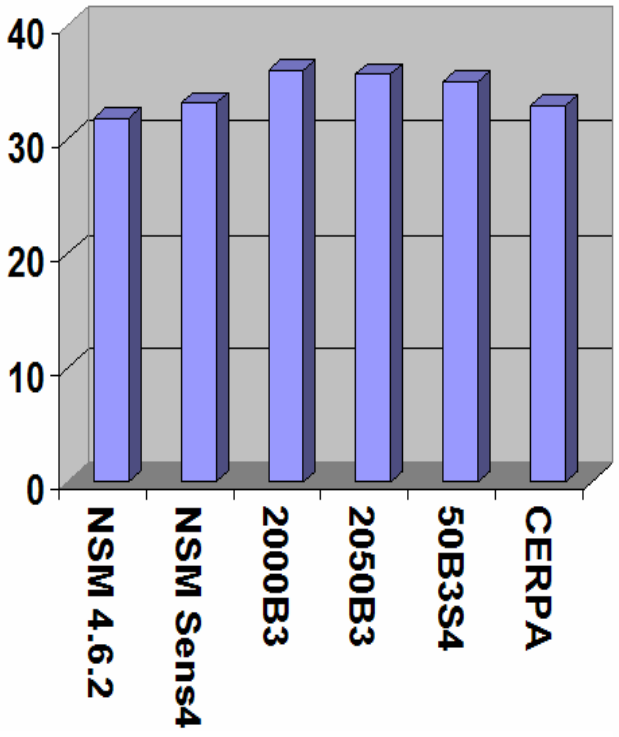
Whipray Basin:

Restoration scenario salinity results (from Initial CERP Update)

25th percentile Salinity (ppt)



50th percentile salinity (ppt)



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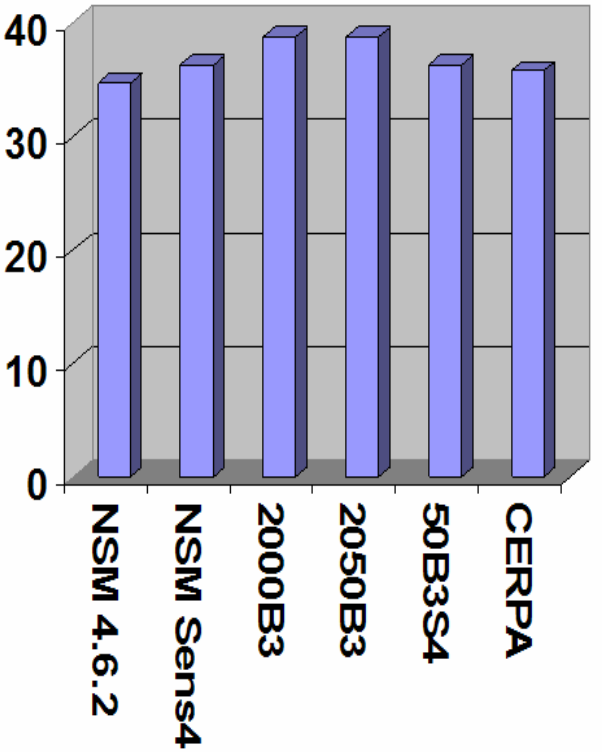


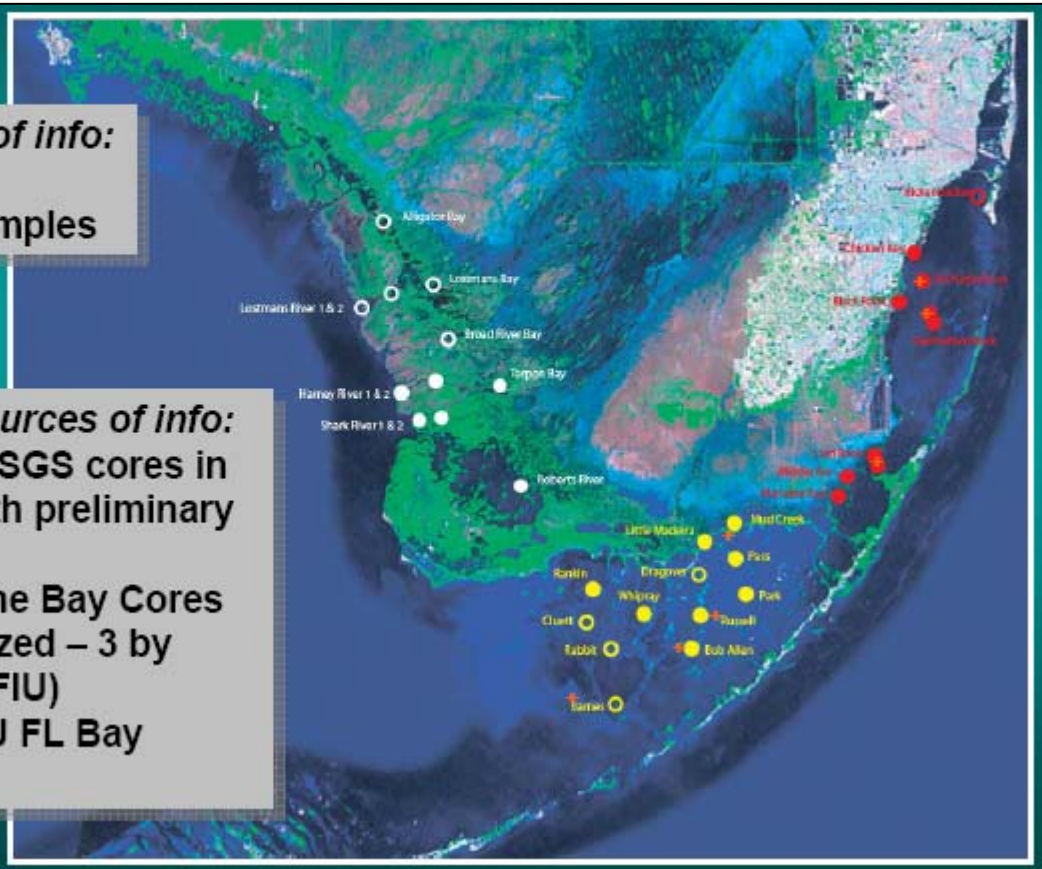
Historical Analysis to Define Florida Bay Targets

Multiple Sediment Coring and Coral Sampling Sites for Paleoecological Analysis

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

+

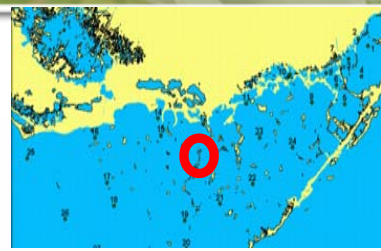
2008 new sources of info:
- 11 new USGS cores in SW (6 with preliminary results)
- 8 Biscayne Bay Cores (all analyzed – 3 by USGS & FIU)
- 4 new FIU FL Bay Cores



USGS

Historical Analysis to Define Florida Bay Targets

Whipray Basin down-core assemblage analyses



from: L. Wingard (USGS)

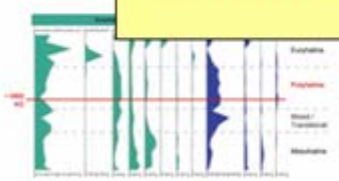
Historical Analysis to Define Florida Bay Targets

An approach to estimating historic stages and flows developed and published by:

- Lynn Wingard (USGS)
- Frank Marshall (CLF),
- Patrick Pitts (USFWS)

Linear Regression Model based on Paleoecology Data: 3 Phases

Phase I: Paleoecology



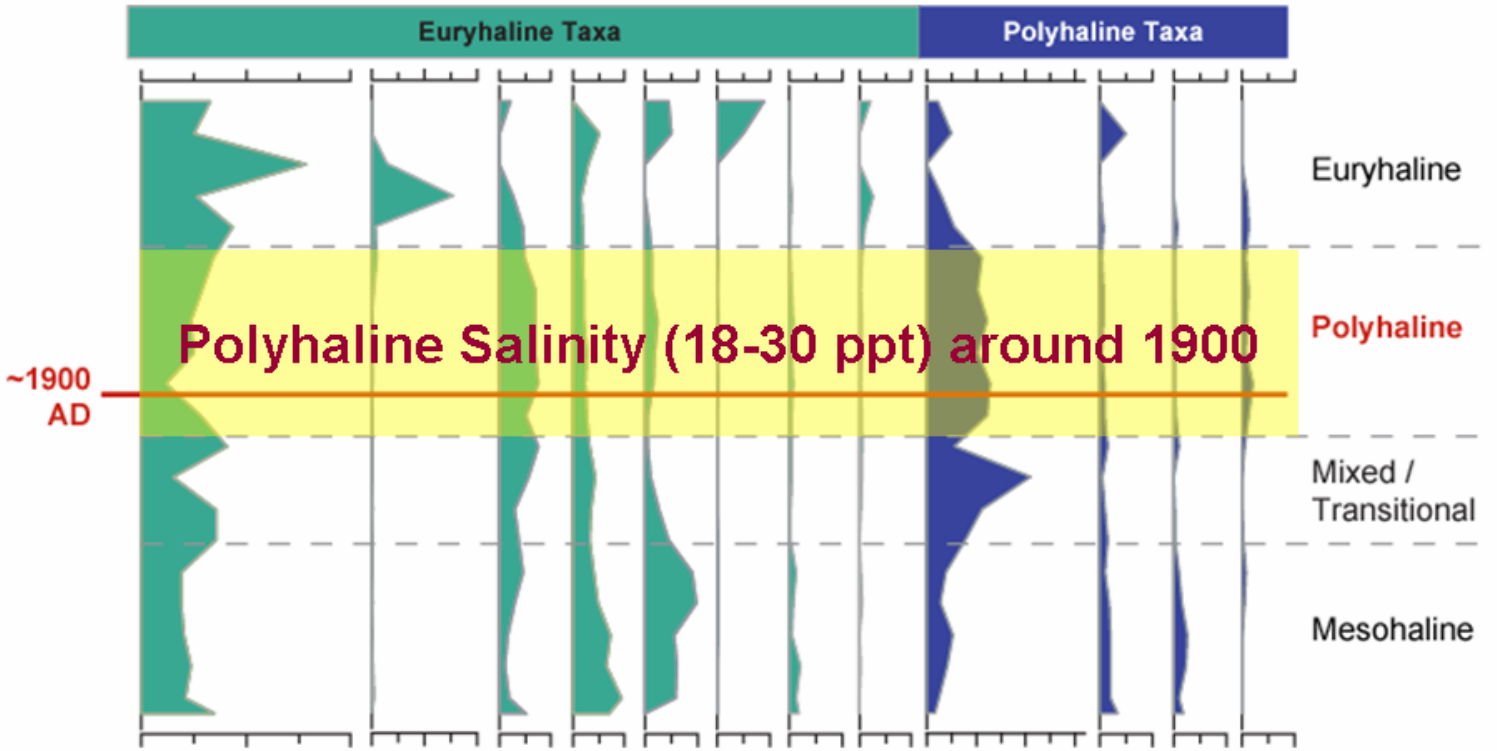
Phase II: Linear Regression Models developed based on observed instrumental data from stations in the wetlands and the estuaries

Phase III: Couples the simulated paleosalinity regime with the LRM to produce estimates of flow, stage, and hydro-period.

from L. Wingard

Historical Analysis to Define Florida Bay Targets

Linear Regression Model: Phase I
Develop Paleo-based Salinity Regime

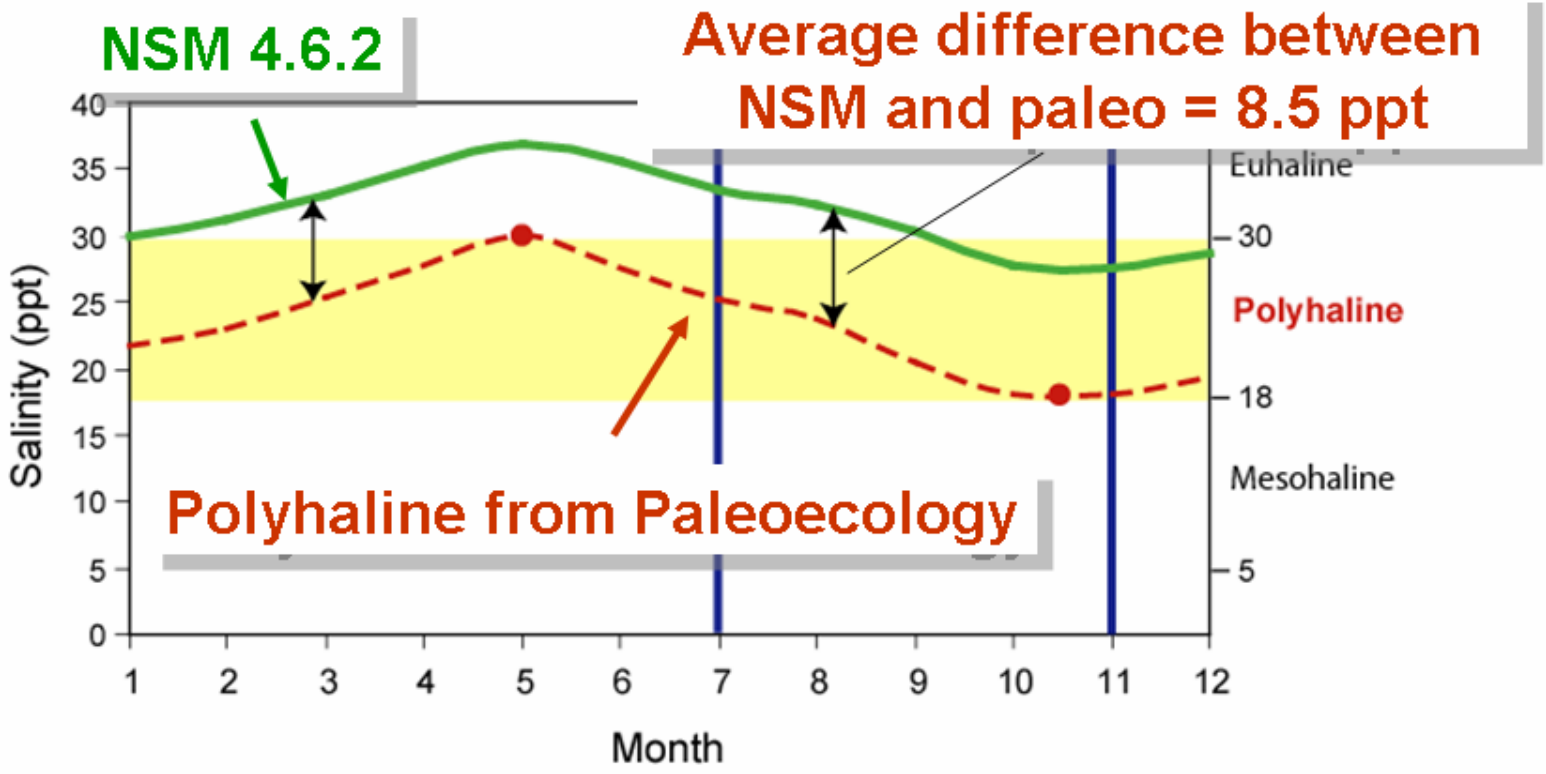


Percent Abundance of Key Salinity Indicators in Whipray Basin Core

from L. Wingard

Historical Analysis to Define Florida Bay Targets

Linear Regression Model: Phase I
Develop Paleo-based Salinity Regime

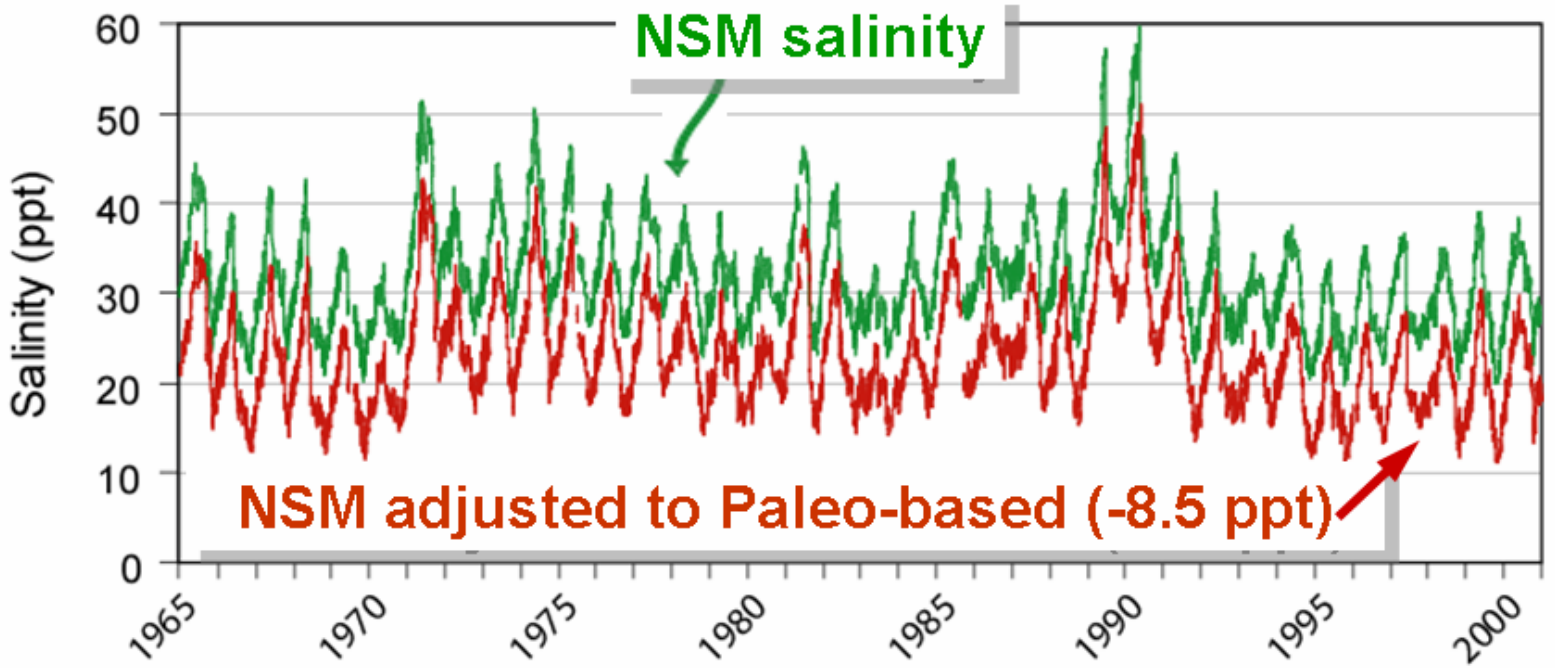


Determining Offset between Paleo-salinity and NSM

from L. Wingard

Historical Analysis to Define Florida Bay Targets

Linear Regression Model: Phase I
Develop Paleo-based Salinity Regime



Developing Paleo-based Simulated Time Series
Using Observed Climate Data for 1965 to 2000

USGS

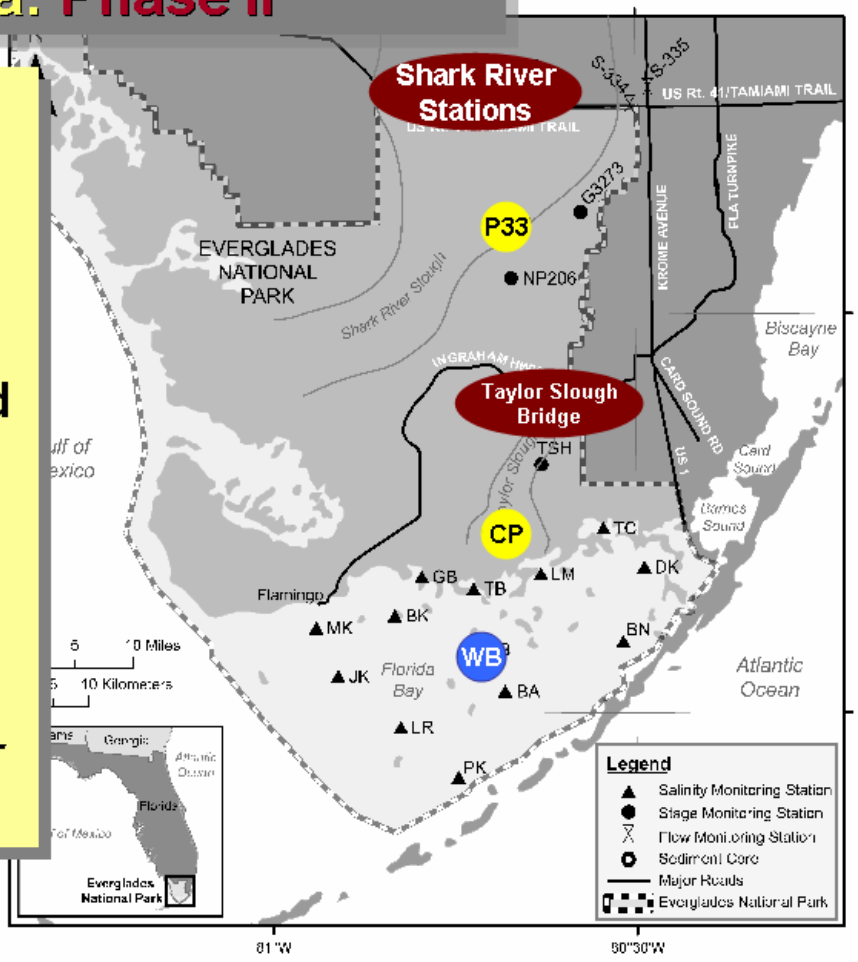
from L. Wingard

Historical Analysis to Define Florida Bay Targets

Linear Regression Model based on Paleoecology Data: Phase II

Develop LRMs that predict:

1) salinity at WB based on stage at CP & P33
2) flow at SRS and TSB based on stage at CP & P33
3) stage at other locations
4) salinity at other locations



from L. Wingard

Historical Analysis to Define Florida Bay Targets

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

Stage in m
Flow in million acre-feet/y

USGS

from L. Wingard

Historical Analysis to Define Florida Bay Targets

Linear Regression Model Results: Historical salinity estimates in Florida Bay

Florida Bay Station	Observed Average	Paleo Average	Difference (Obs - Paleo)
Peterson Key	35.8	30.5	5.3
Little Rabbit	34.4	27.3	7.1
Murray Key	33	24.8	8.2
Johnson Key	35.3	27	8.3
Buoy Key	32.8	22.2	10.6
Bob Allen	33.2	21.1	12.1
Duck Key	29	16.8	12.2
Joe Bay	15.36	2.73	12.63
Butternut Key	31.3	17.7	13.6
Little Madeira Bay	23.83	8.2	15.63
Garfield Bight	28.9	10.3	18.6
Terrapin Bay	23.6	3.5	20.1

Results indicate that restoring to pre-1900 condition would need 12-20 ppt decrease in nearshore areas

USGS

from L. Wingard

Florida Bay Hydrologic Needs: Conclusions

- Historic freshwater diversion and salinity change have been major factors contributing to ecological change
- Implementing current restoration plans will benefit Florida Bay, but not achieve NSM or paleoecology-based targets
- Based on paleo+regression analysis, pre-drainage Florida Bay likely was much less saline that current system or NSM hindcast
- To meet pre-drainage salinity target: need > 2x current Shark Slough flow and nearly 4x more flow in Taylor Slough
- Pre-drainage target problematic because watershed area lost
- Substantial progress toward restoration requires more water than is currently available to CERP

Hydrologic Needs of Florida Bay

Questions?