

A synthesis of linked paleoecological and regression model evaluations to simulate Everglades hydrology and Florida Bay salinity response for CERP restoration performance measures

Session: Paleoecology's Role in Decision-making: Adapting to Change Over Many Time-scales

CERF 2011 21st Biennial Meeting

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A Synthesis of Linked Paleoecological and Regression Model Evaluations to Simulate Everglades Hydrology and Florida Bay Salinity Response for Restoration Performance Measures

Principal Investigator: Frank Marshall, Cetacean Logic Foundation

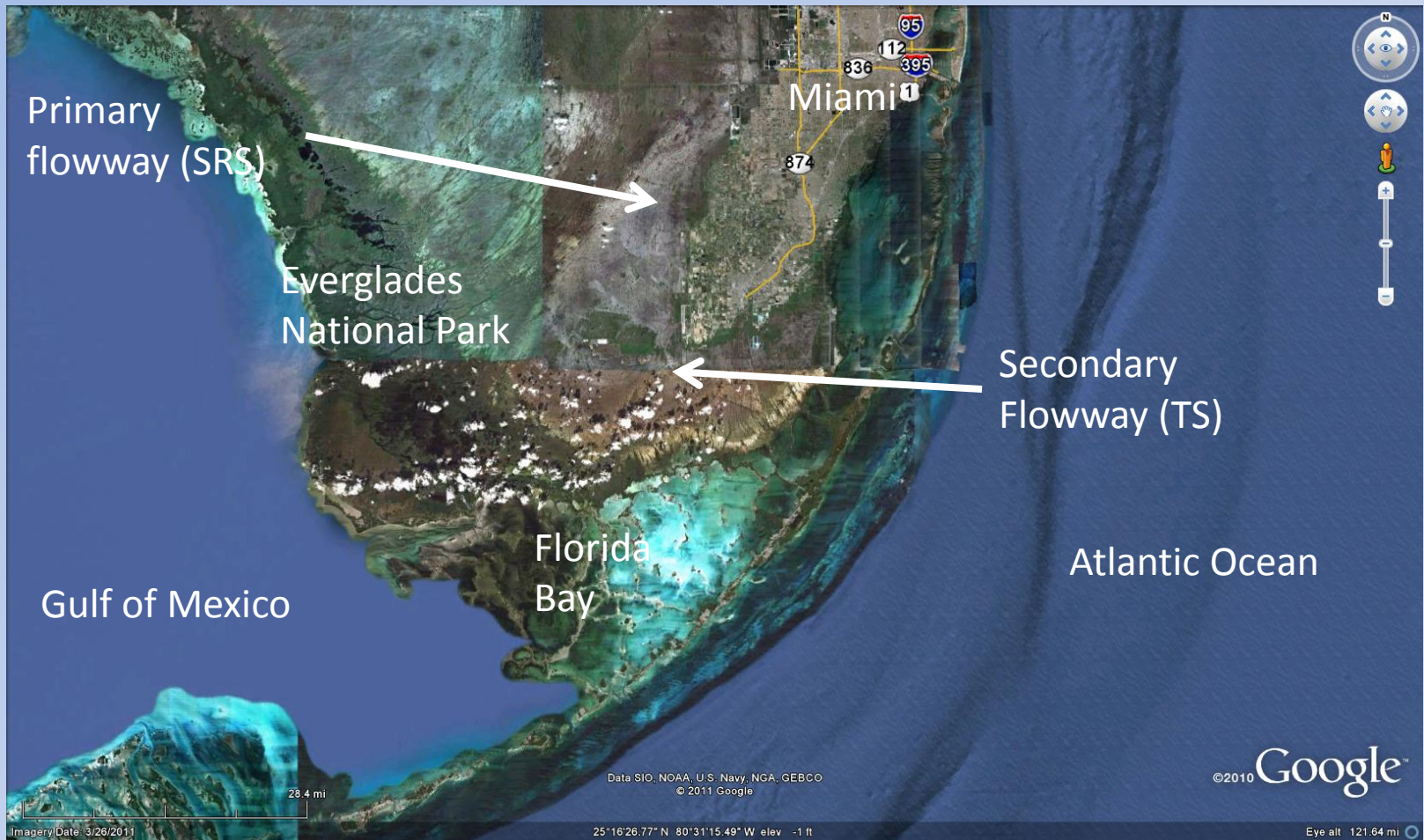
Collaborator: G. Lynn Wingard, USGS

Funding: USACOE RECOVER Branch, Susan K. Kemp

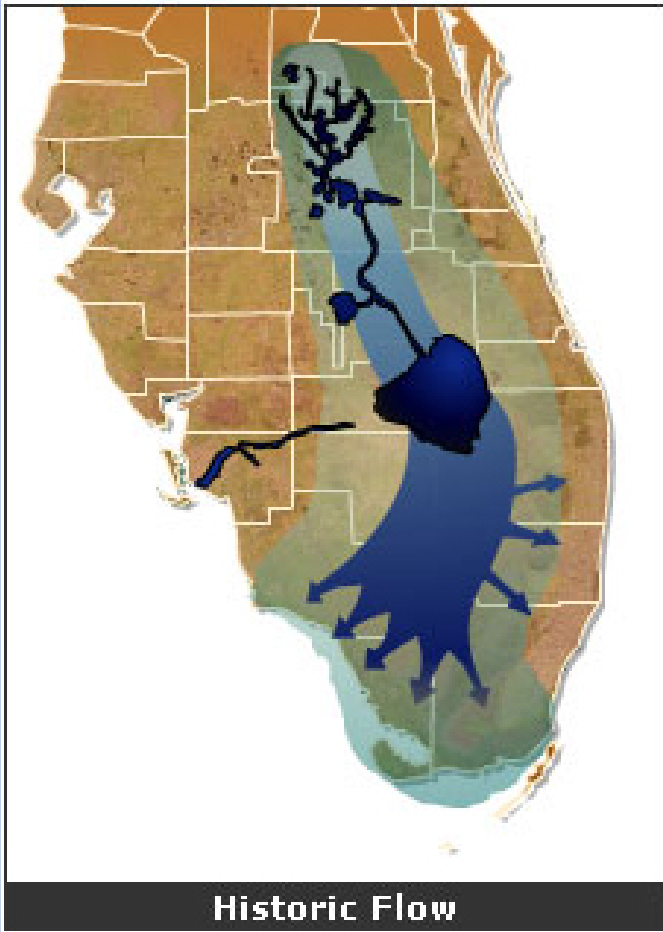
ABSTRACT

A primary goal of the Comprehensive Everglades Restoration Plan (CERP) is restoration of freshwater patterns delivered to Florida Bay resulting in a restored salinity regime. Performance measures (PM) developed by RECOVER (Restoration Coordination & Verification) are based on a linked method using paleoecologic characterizations and multiple linear regression models to simulate upstream freshwater flow and stage from paleo-based estimates of salinity (Marshall et al, 2009). In recent work, the system of models was improved to include the effects of sea level rise and non-linear relationships over the 36-year period of simulation. The updated procedure was applied using cores from Whipray Basin, Rankin Lake, Russell Bank, Little Madeira Bay, and Crocodile Point. The model outputs were synthesized using Optimal Linear Combiners into a combined estimate of stage and flow needed to produce the synthesized paleo-based salinity. When the results are interpreted, the combined paleo-based flows in Shark River and Taylor Sloughs are about 2.5-3 times and 3.5-4 times the average existing flow, respectively. The paleo-based increase in Shark River and Taylor Sloughs water levels are about 0.25m and about 0.31m, respectively. Paleo-based salinity values in Florida Bay are about 10 salinity units less than observed values in nearshore areas and about 5 salinity units less in outer regions. The freshwater flow currently discharged from the managed hydrologic system into tidal waters was found to be sufficient to make-up the estimated freshwater deficit. This newly synthesized picture of pre-drainage hydrology is being implemented in PMs for CERP alternative evaluations and monitoring data assessments. Future activities include a similar effort on the southwest Florida Gulf coast. Restoring the natural hydrology and salinity is thought to be the best management practice to allow the unique Everglades ecosystem to adapt to changes in climate, hydrology and sea level.

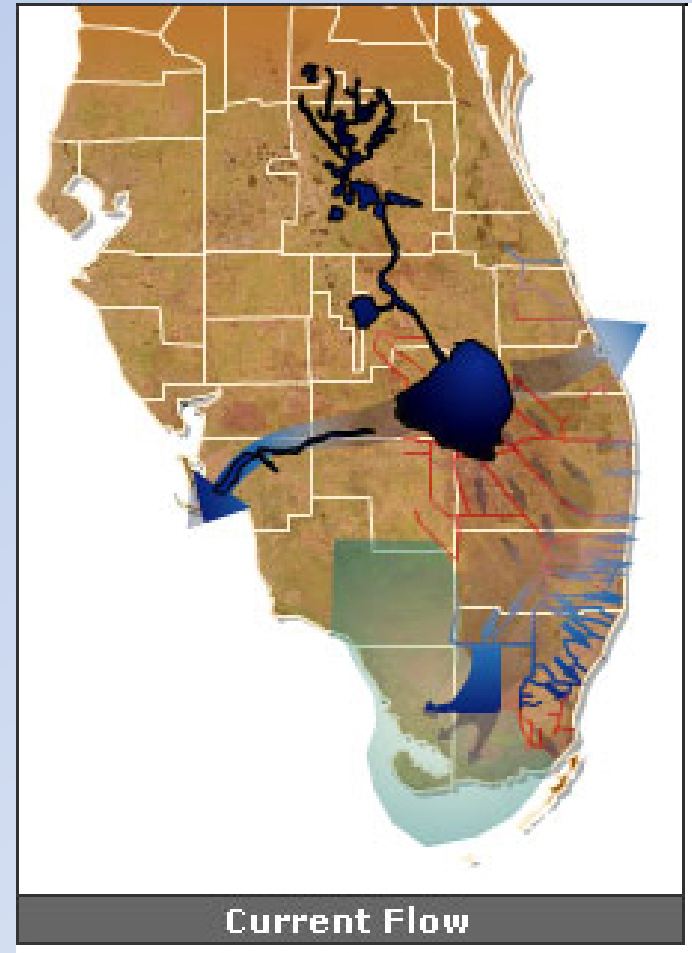
Overview of Study Area



The Problem – Freshwater Diversion From the Everglades



SOURCE: WWW.EVERGLADESPLAN.ORG



SOURCE: WWW.EVERGLADESPLAN.ORG

Take-home Message

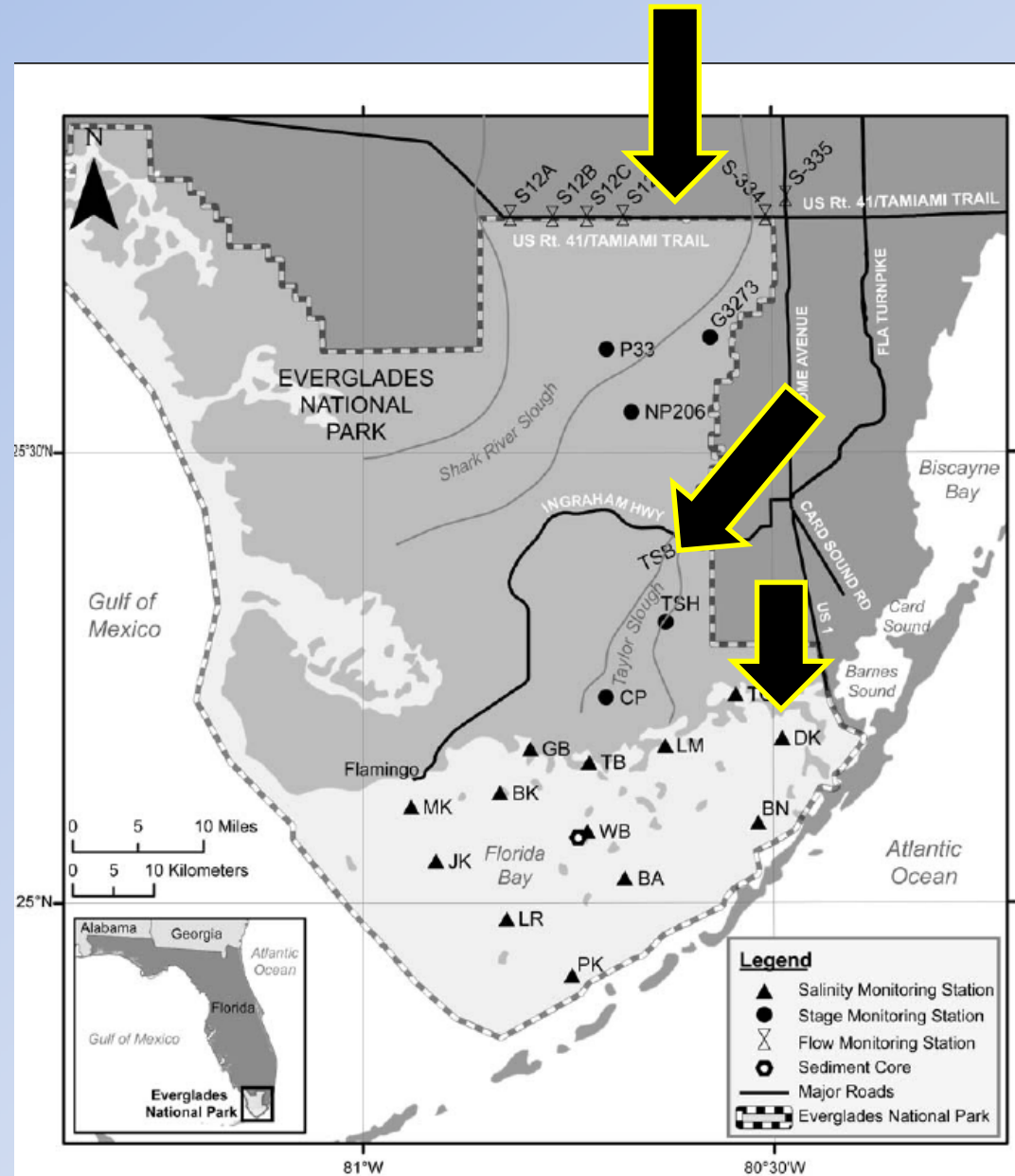
- To establish paleo-based salinity regime: about 2.5 times more freshwater needed
- Volume of water discharged to tide is sufficient
- Restored Florida Bay: mesohaline to polyhaline vs euryhaline current condition
- Restoring flow regime restores hydroperiod and pattern in freshwater marshes and mangroves

PM Briefing

- RECOVER Southern Coastal Systems sub-team
 - Responsible for developing Everglades restoration Performance Measures (PM)
 - Uses PMs to evaluate CERP water delivery alternatives
 - Uses PMs to assess monitoring data
 - Basis for SCS salinity and freshwater stage PMs is paleo-based conditions (salinity, freshwater stage, freshwater flow)

Important Features for This Study

Flow is key parameter in management of water in south Florida

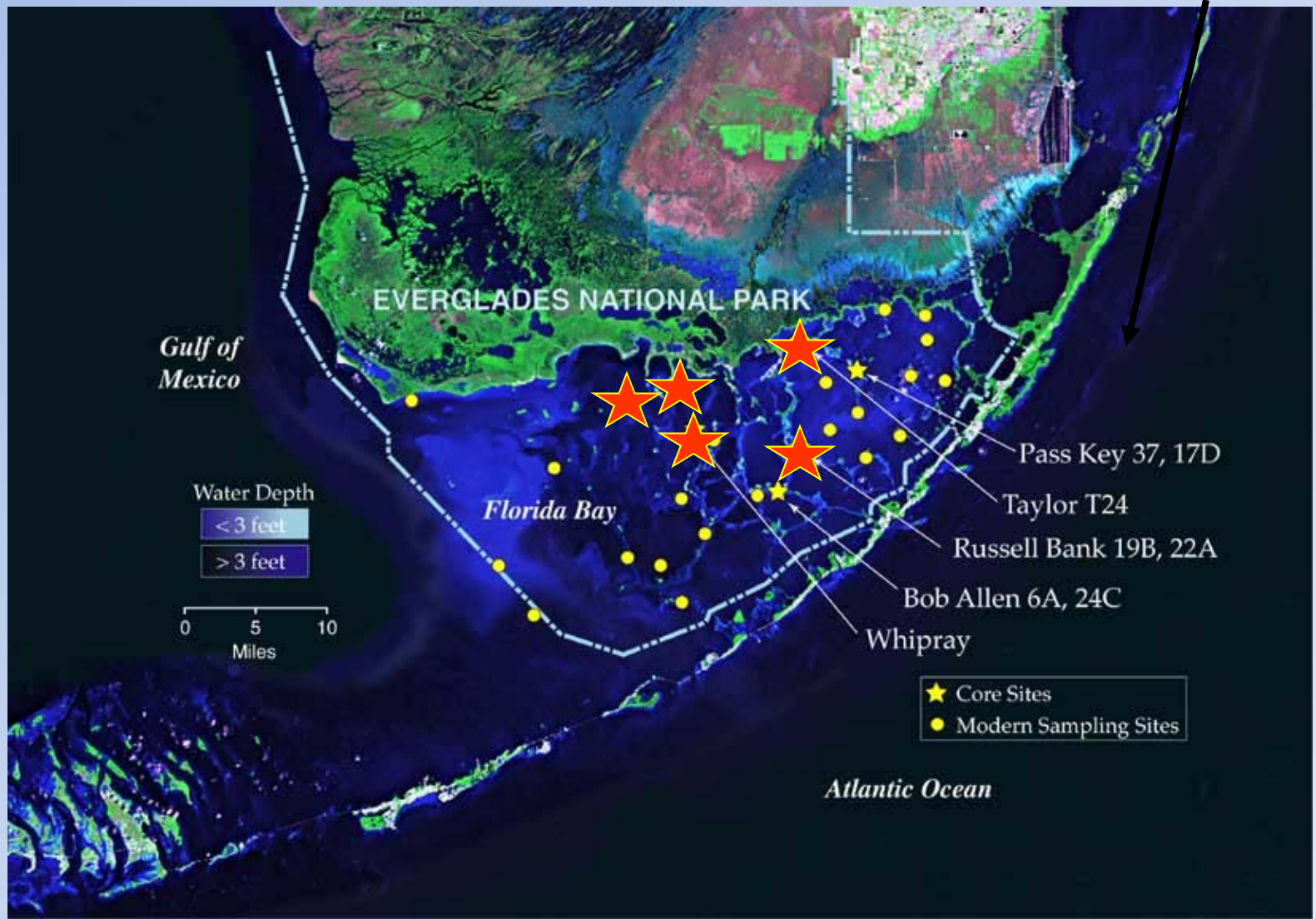


Current Status of Paleosalinity Analyses in Florida Bay

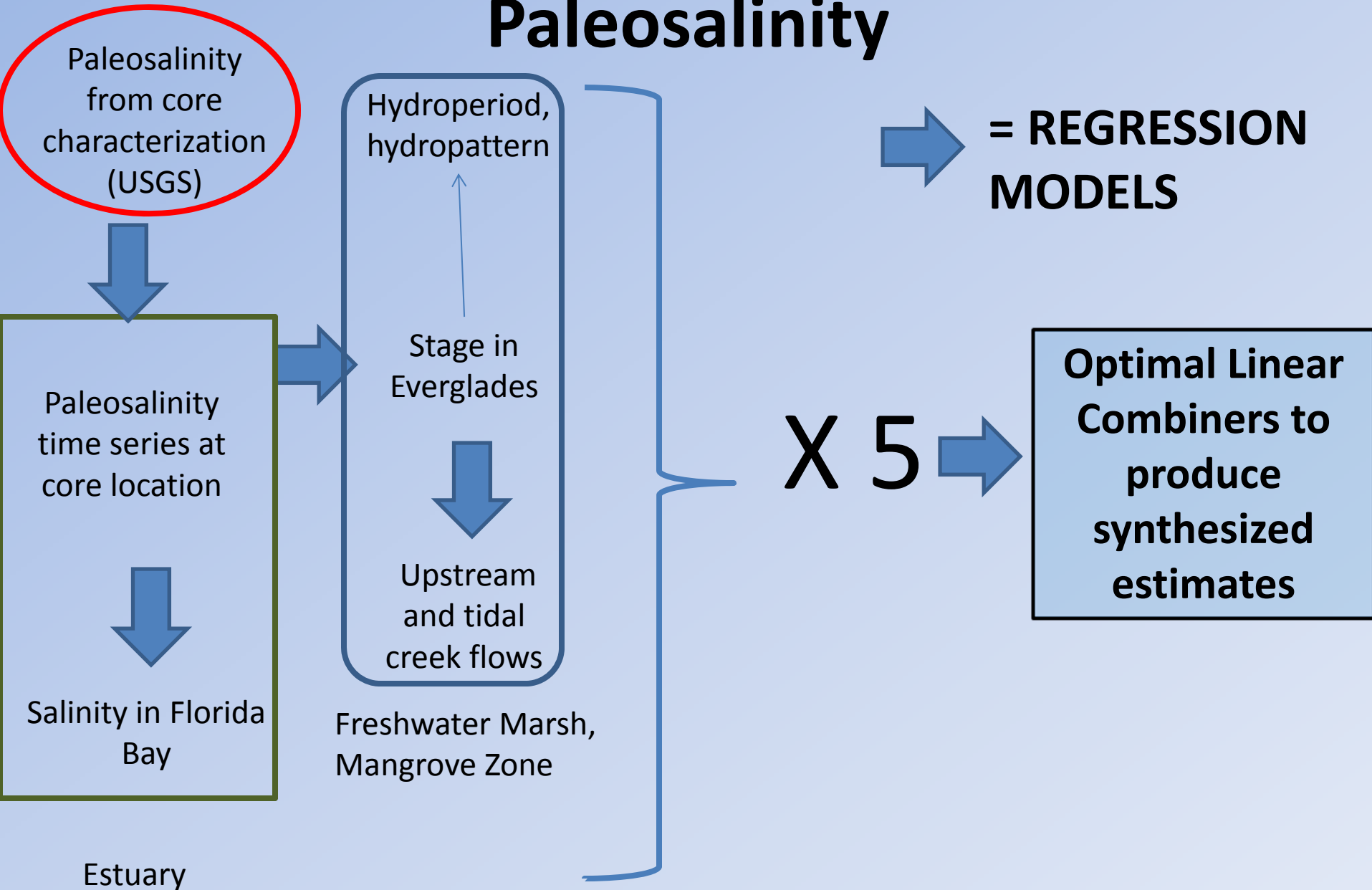
- 5 sediment core analyses in Florida Bay:
 - Whipray Basin
 - Rankin Lake
 - Taylor T24
 - Russell Bank
 - Crocodile Point
- Synthesis of all 5
- Funded has been provided by:
 - RECOVER
 - USGS
 - ENP



Florida Bay Paleoecological Data - USGS Sediment Cores



Procedure for Synthesizing Paleosalinity



Paleoecology Characterization

- Mollusks from core are identified and counted
- Salinity of fauna based on modern analogue data
- Average salinity for pre-drainage (circa-1900) core segment estimated = paleo-based salinity
- Paleo-based salinity used for coupling with hydrology and salinity regression models

Updated System of Hydrology/Salinity Regression Models

- Includes models for salinity, stage, and flow
- Trend in data (sea level rise, other effects) included where significant
- Flow models now include power terms
- Updates for synthesis produced a more robust system of hydrology/salinity models

Products For Each of the 5 Analyses

- Paleo-based stage throughout freshwater marshes and mangrove zone (12 stations)
- Upstream paleo-based flow (Shark River, Taylor River)
- Downstream paleo-based creek discharges (5 creeks)
- Paleo-based salinity throughout Florida Bay (17 stations)

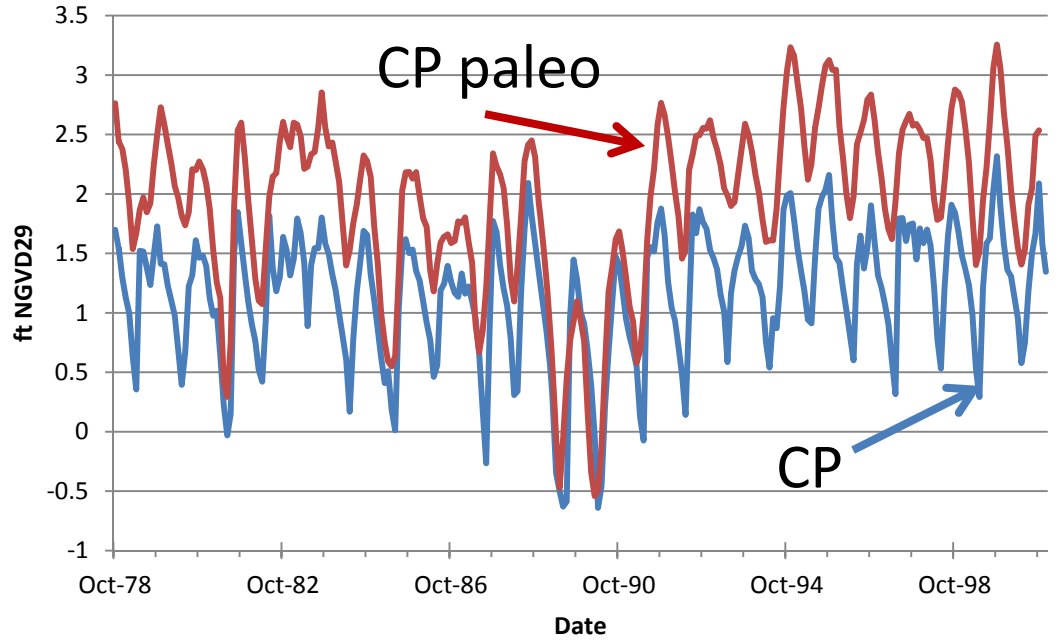
Synthesis of Output

- Output of all 5 analyses combined
- Optimal Linear Combiner methodology
- Output from each model system weighted by Mean Squared Error (MSE)
- Then they are combined (summed)
- Synthesized output: single time series for all parameters using information from all 5 analyses

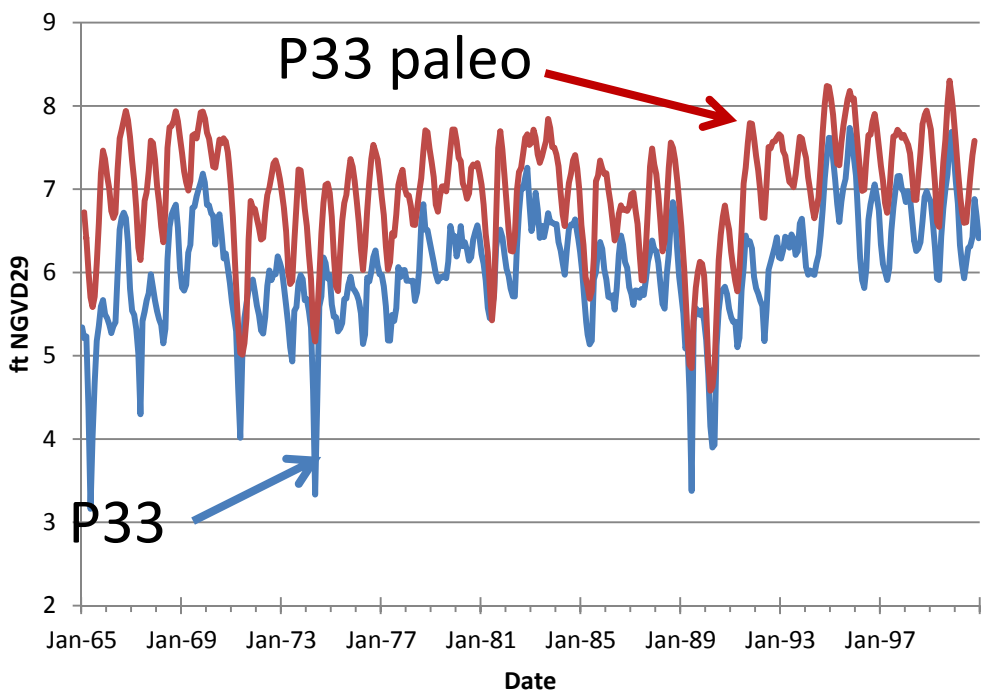
Example: CP Stage MSE Optimal Linear Combiner Procedure

Sediment Core	Model System MSE	Weight	Paleo-based CP avg
Whipray Basin	0.12	0.31	2.07
Rankine Lake	0.07	0.49	1.85
Taylor T24	1.78	0.02	2.11
Russell Bank	0.29	0.13	1.93
Crocodile Point	0.66	0.06	1.47

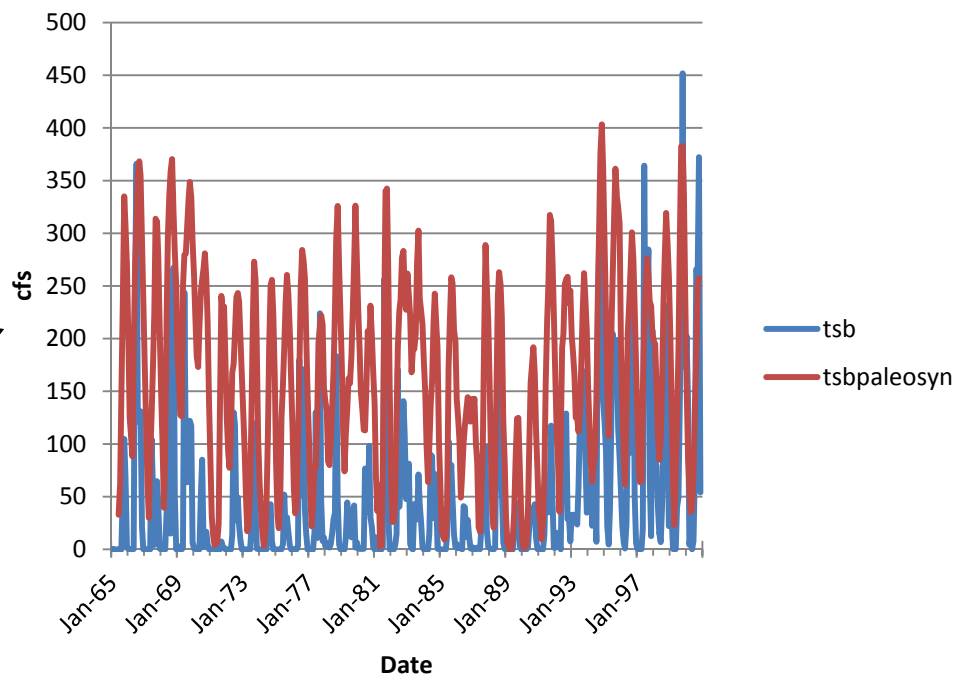
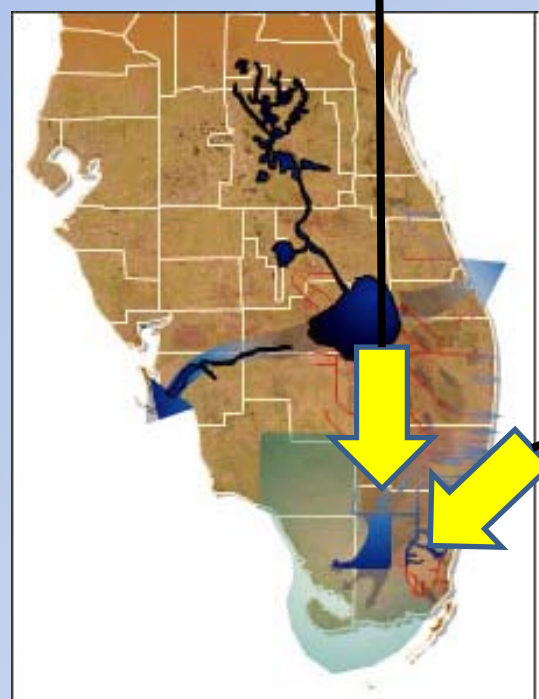
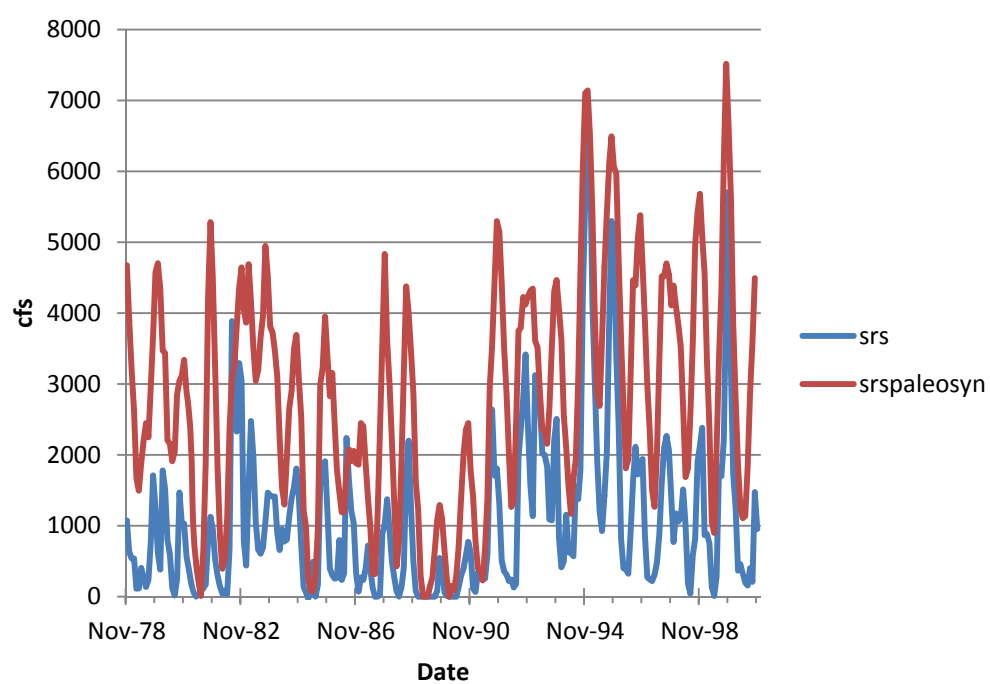
Synthesized CP = 1.91

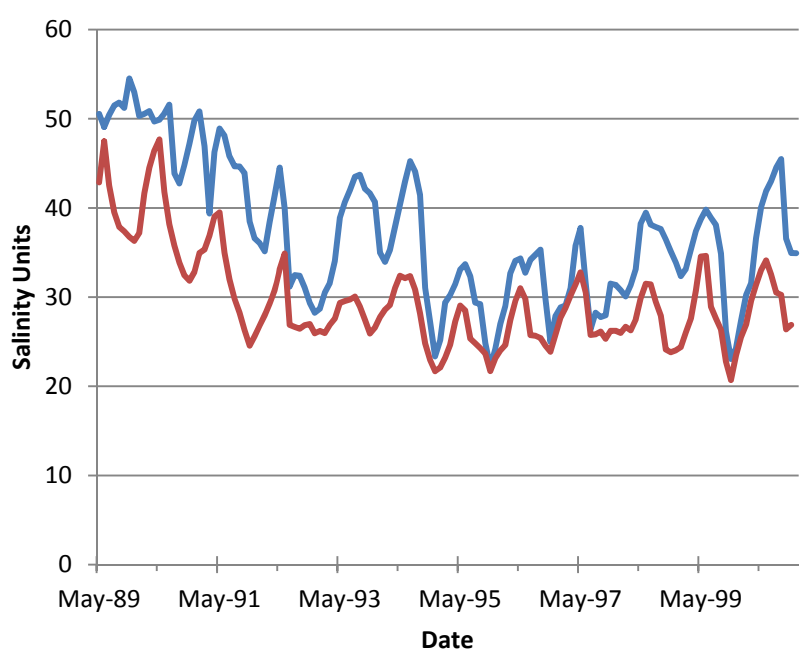


Synthesized Paleo-based Stage



Synthesized Paleo-based Flow



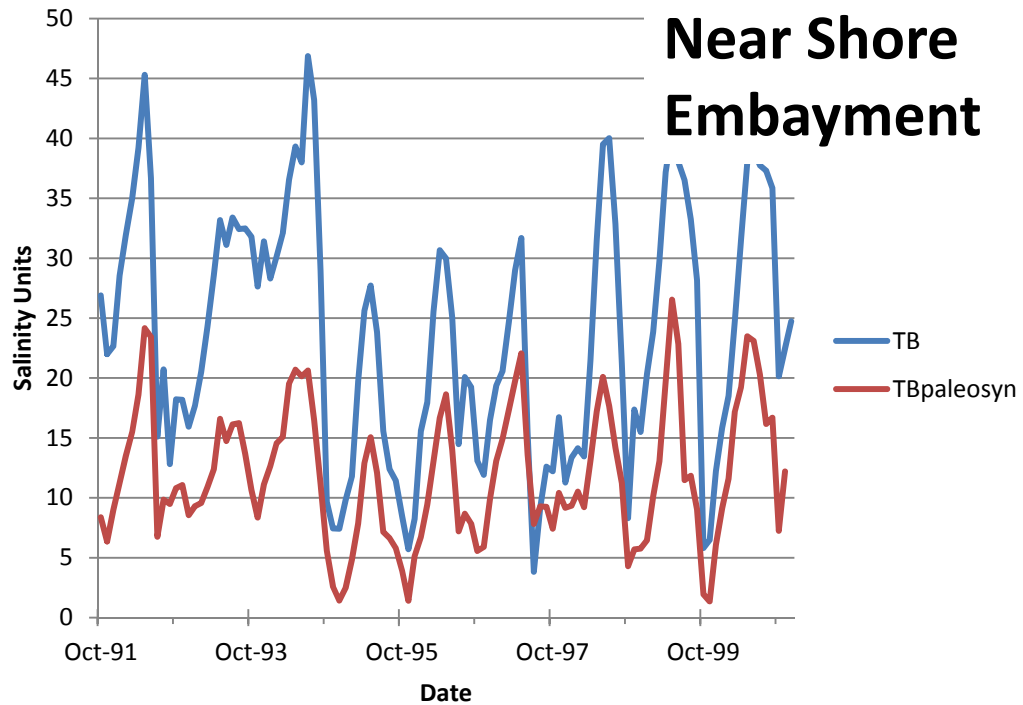


WB

WBpaleosyn

**Central
Bay**

Synthesized Paleo-based Salinity



Synthesized Paleo-based Salinity Regime in Terrapin Bay

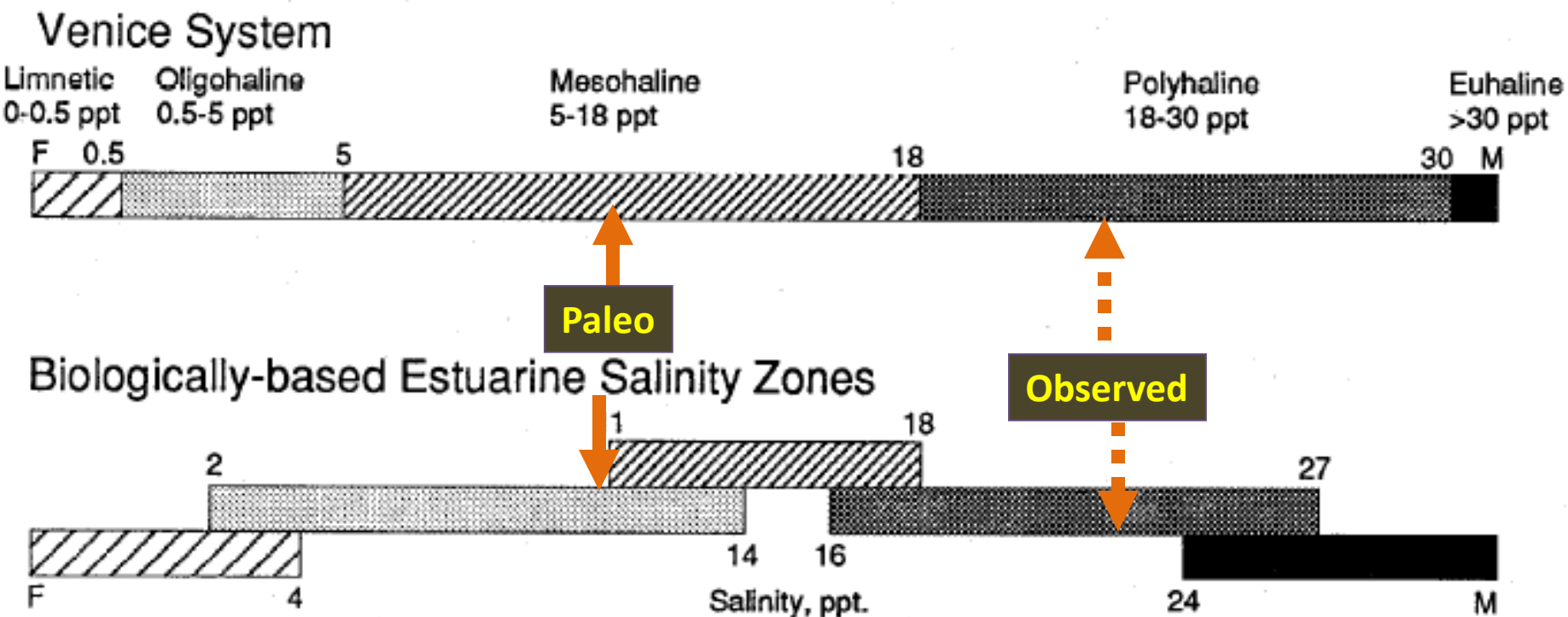
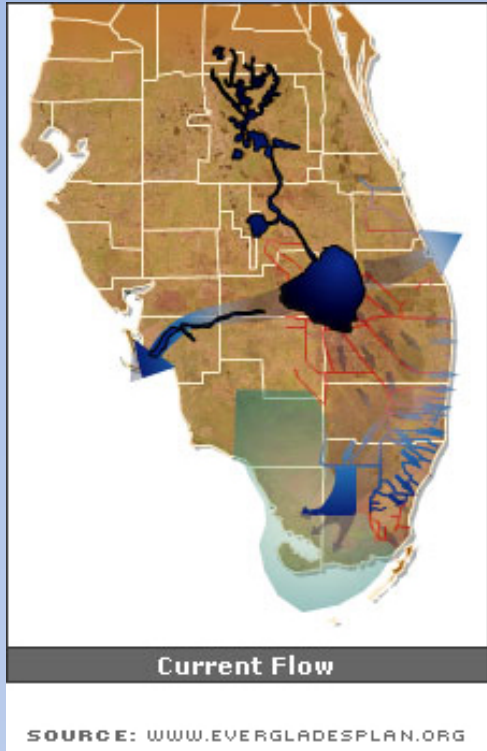


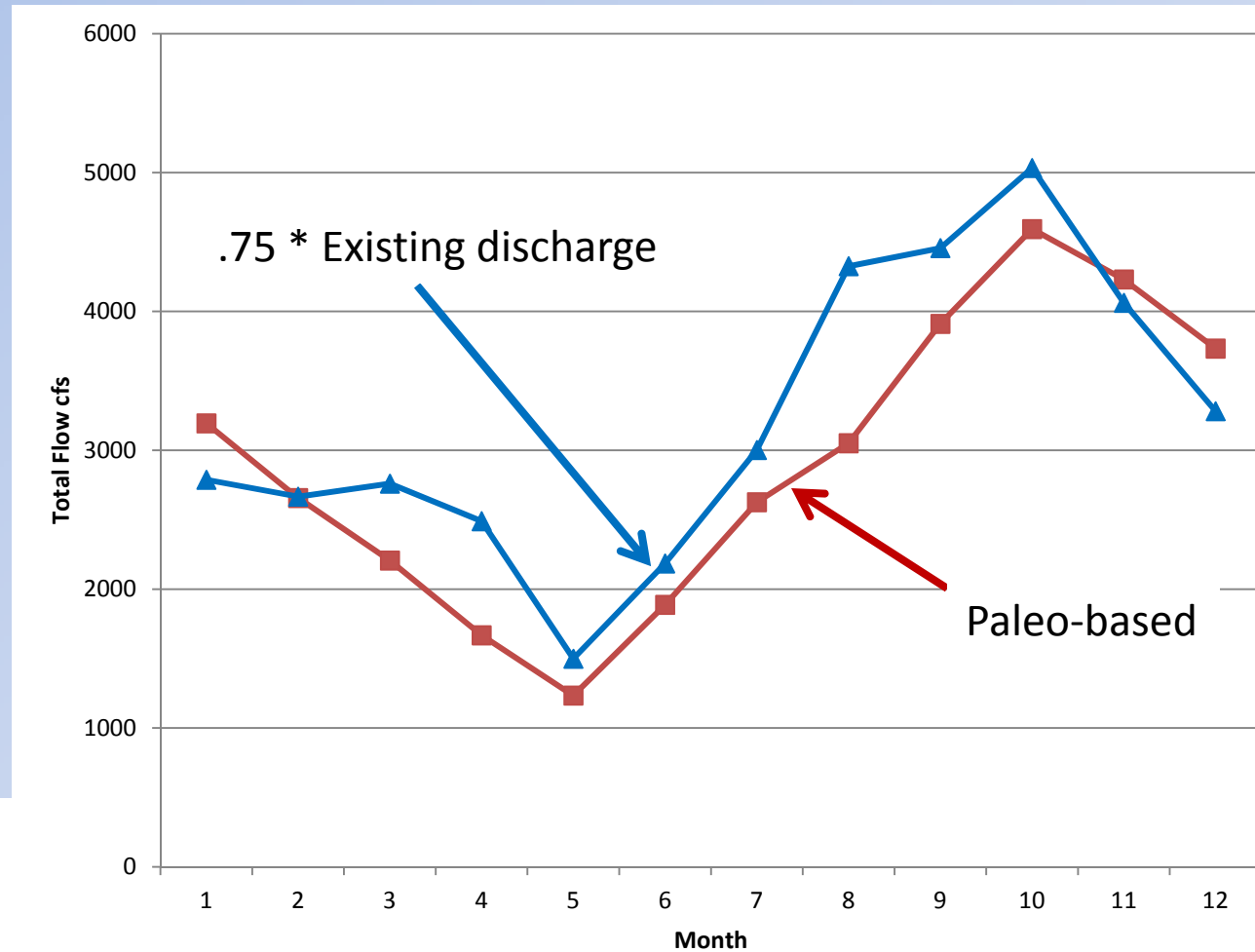
Fig. 1. Comparison of Venice System and estuarine salinity zones derived from multivariate analysis.

SOURCE: Bulger, Hayden, Monaco, Nelson, McCormack-Ray;
Estuaries Vol. 16, No. 2, p. 311-322 June 1993

Comparison of Synthesized Paleo-based SRS Flow and Existing SRS + Tide Discharge (75%)



N= 550 – 640
for each
month



Results of Total System Flow Analysis

- Paleo-based flow estimates agree favorably with available water
- Plenty of water discharged to tide to cover paleo-based needs
- Technical issues:
 - Storage
 - Treatment
 - Operations

Summary

- RECOVER SCS Sub-team has specified the use of paleo-based model data for PMs
- Consistent but slightly different results from all 5 paleo evaluations
- Optimal Linear Combiners allowed use of information from all cores in synthesis
- Upcoming work on west (Gulf) coast may validate or modify these findings

Summary

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Photo by A. Gelber via D. Deis



**THANK
YOU!**