SOUTH FLORIDA WATER MANAGEMENT DISTRICT

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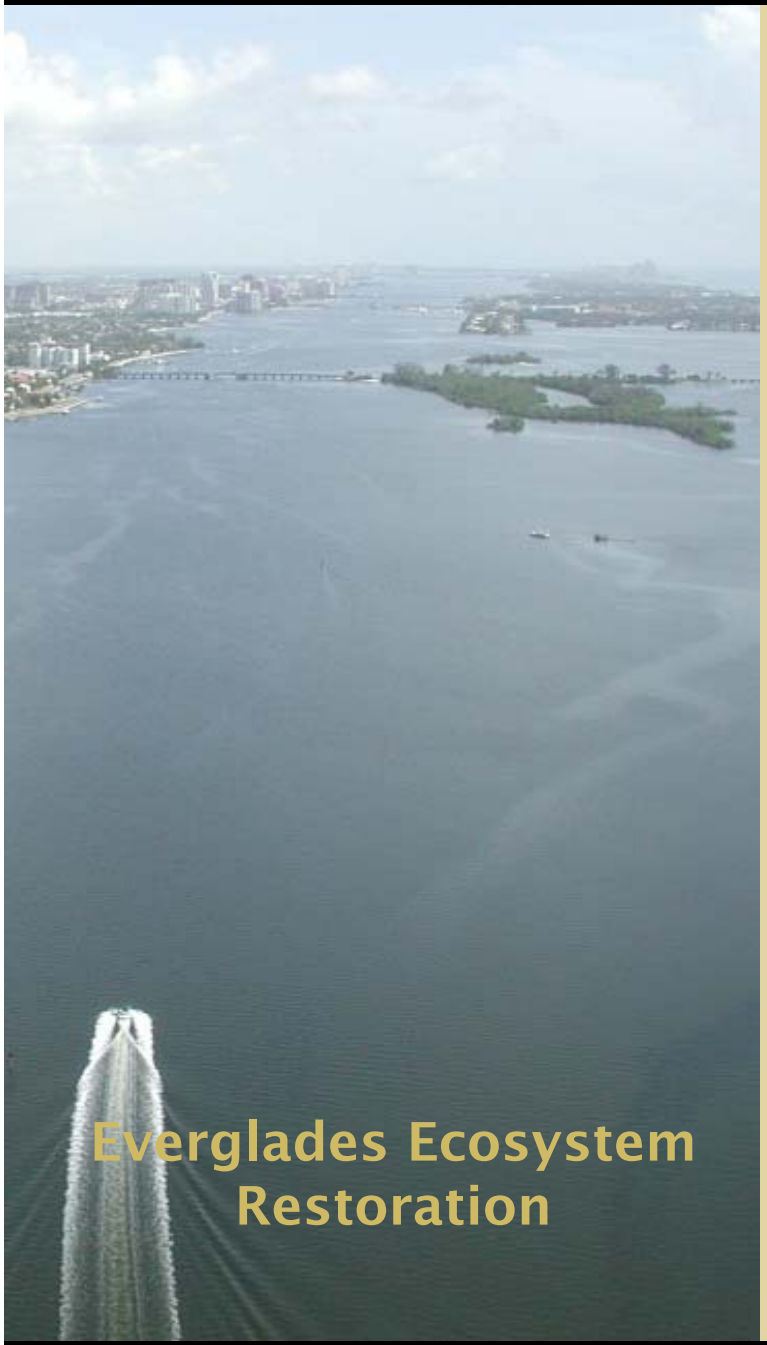
Rapid Prediction of Estuarine Salinity for Everglades Ecosystem Restoration

Yongshan Wan
Section Leader
Coastal Ecosystems Section

sfwmd.gov



Co-Authors

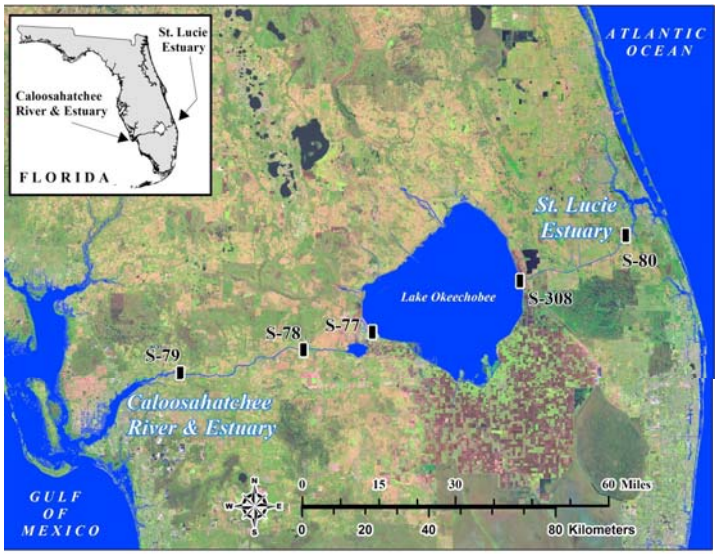
- Peter Doering
- Christopher Buzzelli
- Patricia Gorman
- Zhiqiang Chen

Integrated models serve as an essential tool for predictive management and informed decision making

Watershed Models
(predict freshwater inflow and loading)

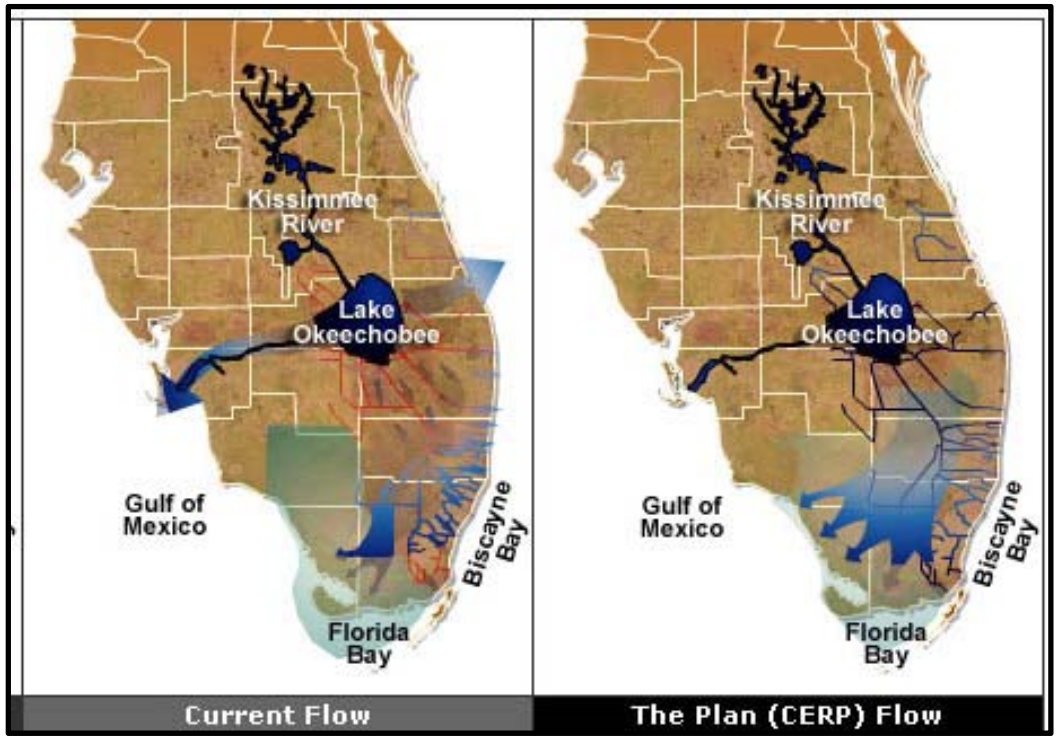
Estuarine Physical Models
(predict salinity & water quality)

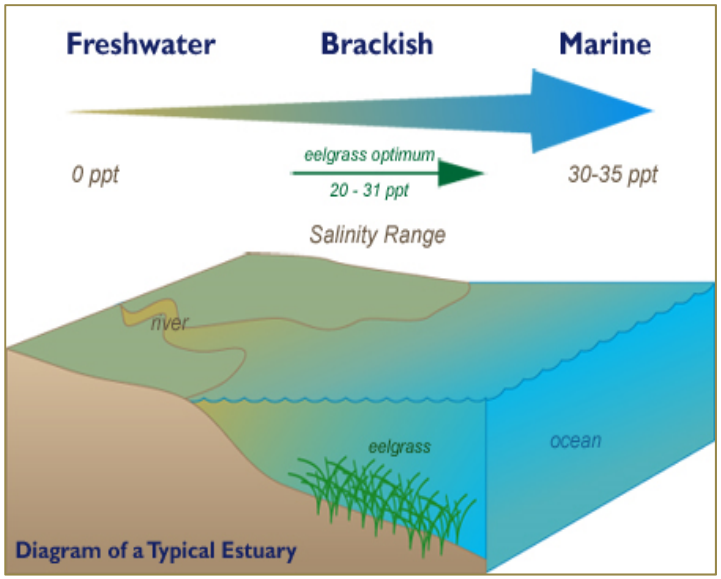
Estuarine Ecological Models
(predict ecological responses)



Integrated modeling mirrors the Alber conceptual model of estuarine inflow management

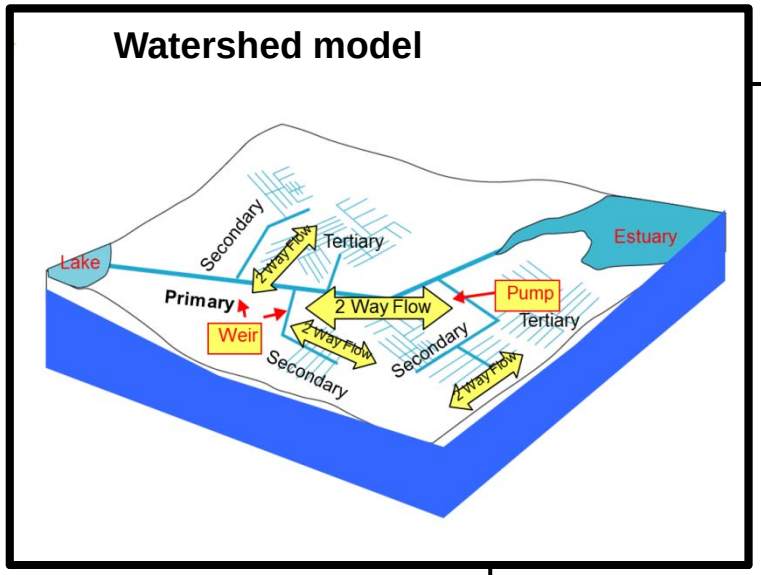
Freshwater Inflow → **Estuarine Conditions** → **Estuarine Resources**

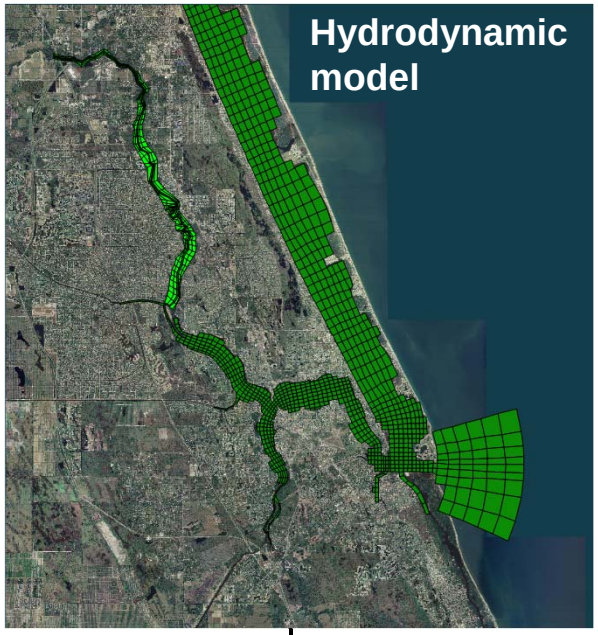


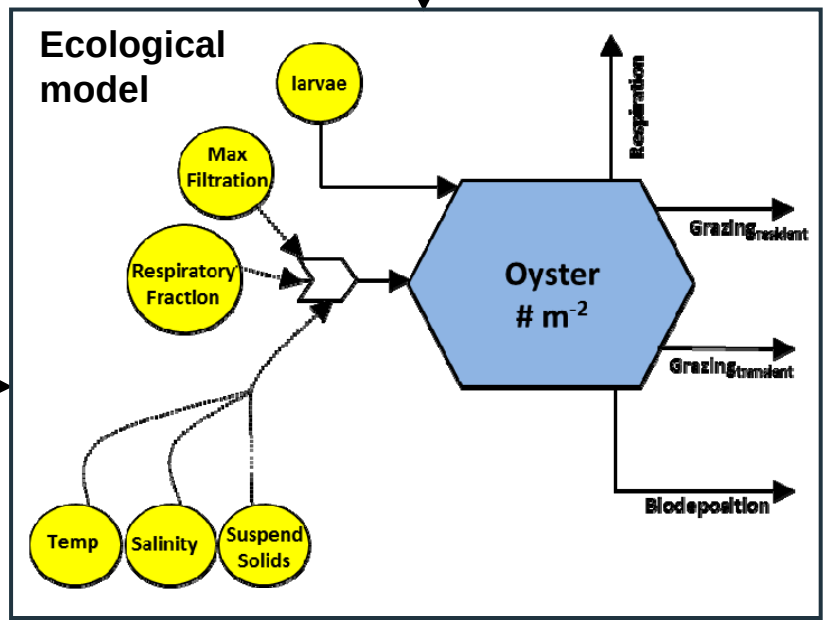


Alber, M (2002), A conceptual model of estuarine inflow management. *Estuaries 25*: 1246-1261.

Application of integrated modeling requires practical consideration of time step

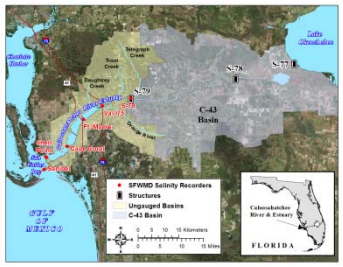


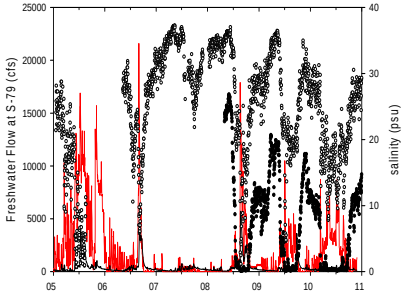


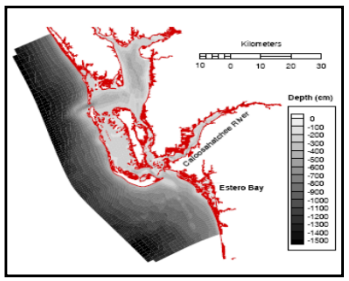


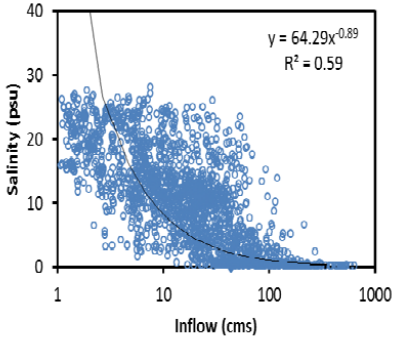
OBJECTIVE: To develop an alternative salinity model based on time series analysis

Spatial/Temporal Data & Hydrodynamics



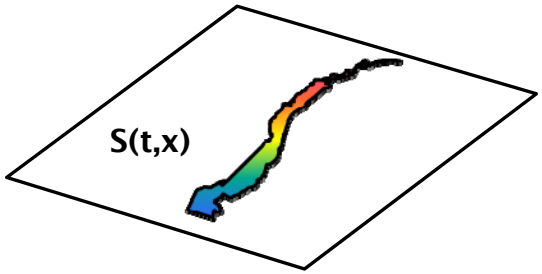




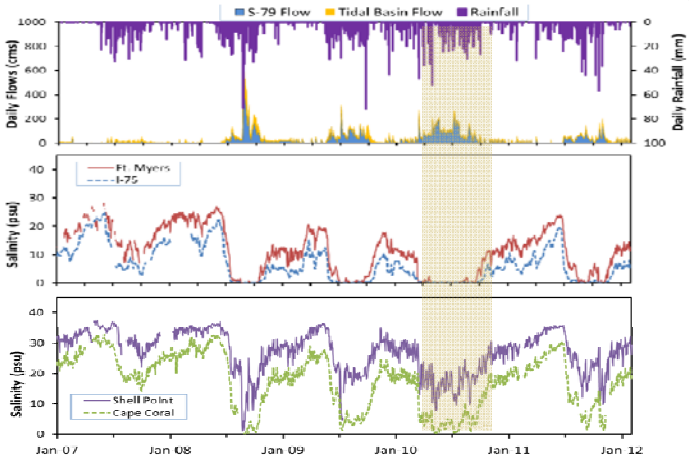


Time Series Analysis

- Transport processes



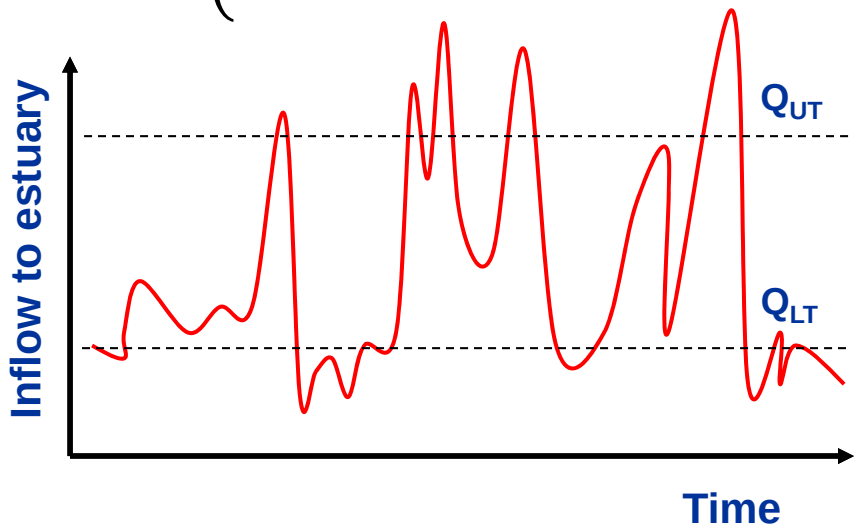
- Transport lag time

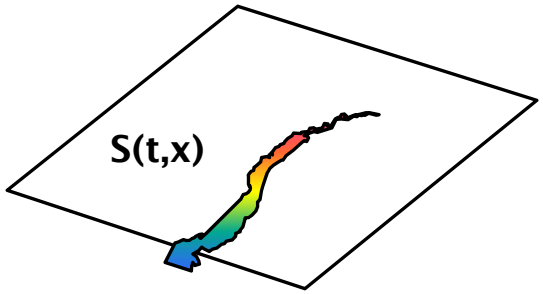


The time series salinity model features
(i) three inflow regimes
(ii) an auto-regressive term
(iii) exogenous factors (inflow, rainfall, water level)

Time series salinity model (Qiu and Wan, 2013)

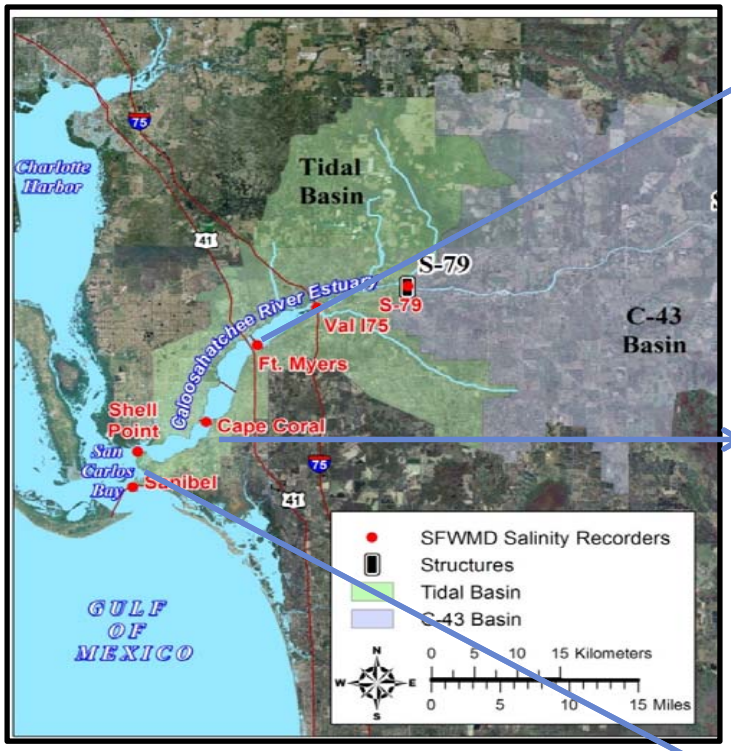
$$S_t = \begin{cases} \alpha_1 + \beta_1 S_{t-1} + \delta S_t\,(Q,R,H) & Q_t \geq Q_{UT} \\ \alpha_2 + \beta_2 S_{t-1} + \delta S_t\,(Q,R,H) & when\ Q_{LT} < Q_t < Q_{UT} \\ \alpha_3 + \beta_3 S_{t-1} + \delta S_t\,(Q,R,H) & Q_t \leq Q_{LT} \end{cases}$$



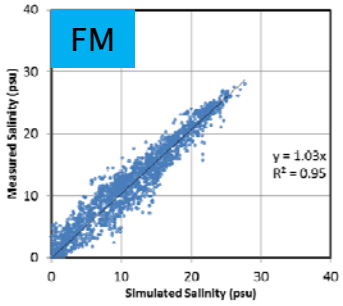


Qiu C. and Y. Wan. 2013. Time series modeling and prediction of salinity in the Caloosahatchee River Estuary. *Water Resources Research* 49: 5804–5816.

The time series model performs well with simulation of salinity on a daily time step



FM



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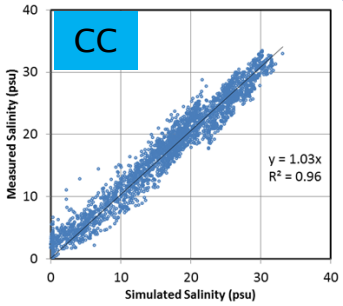

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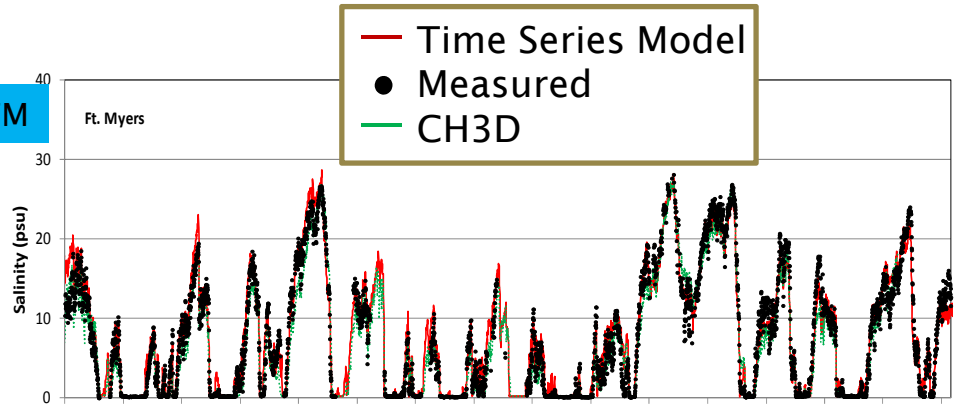

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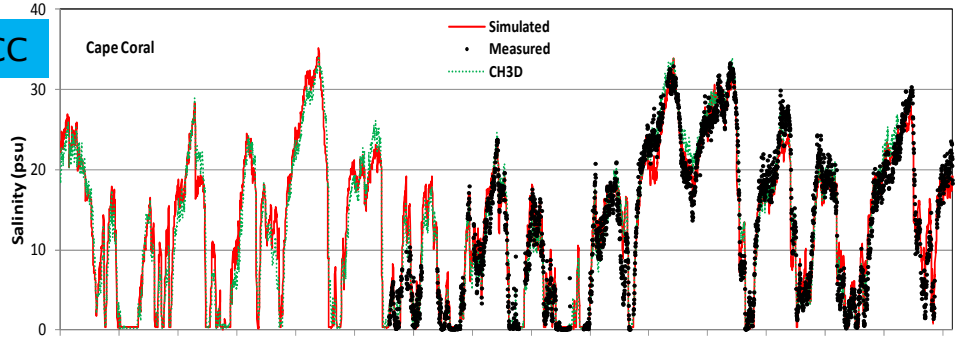

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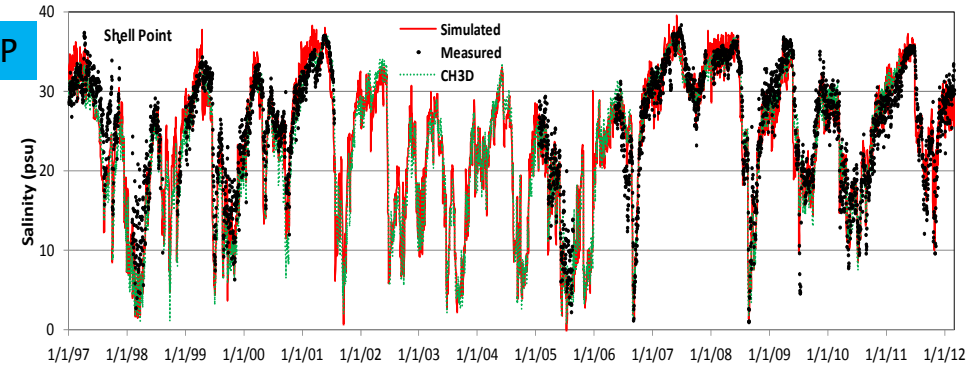
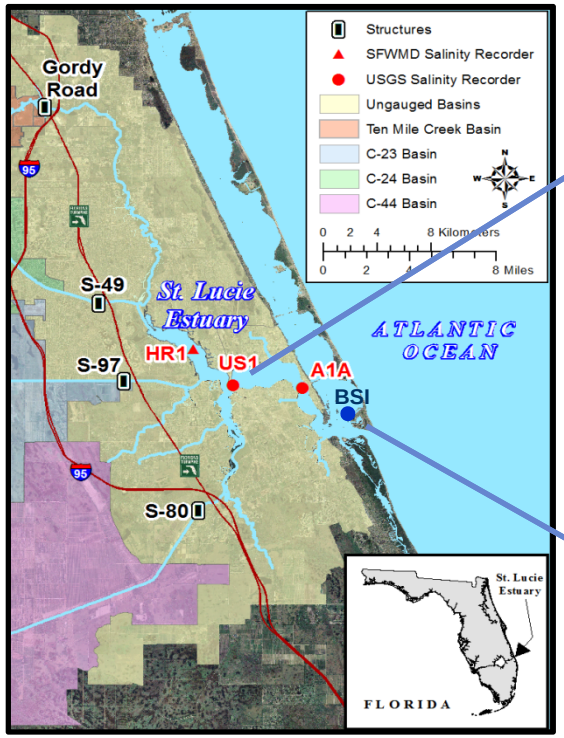
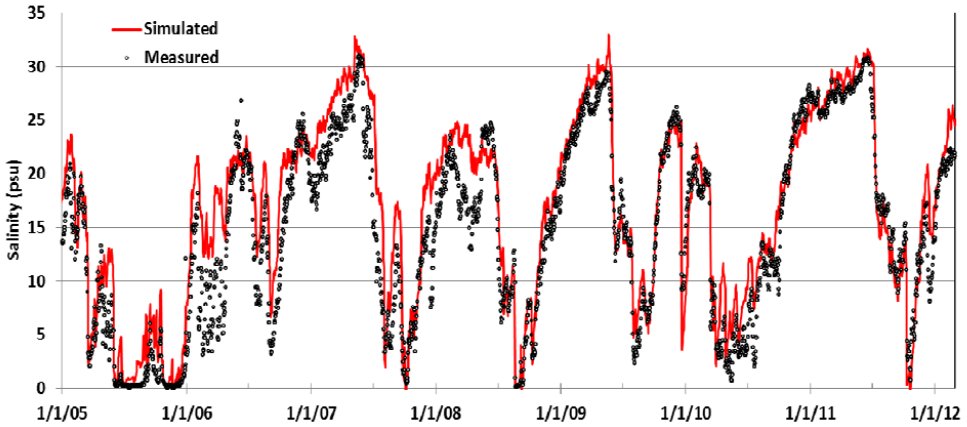


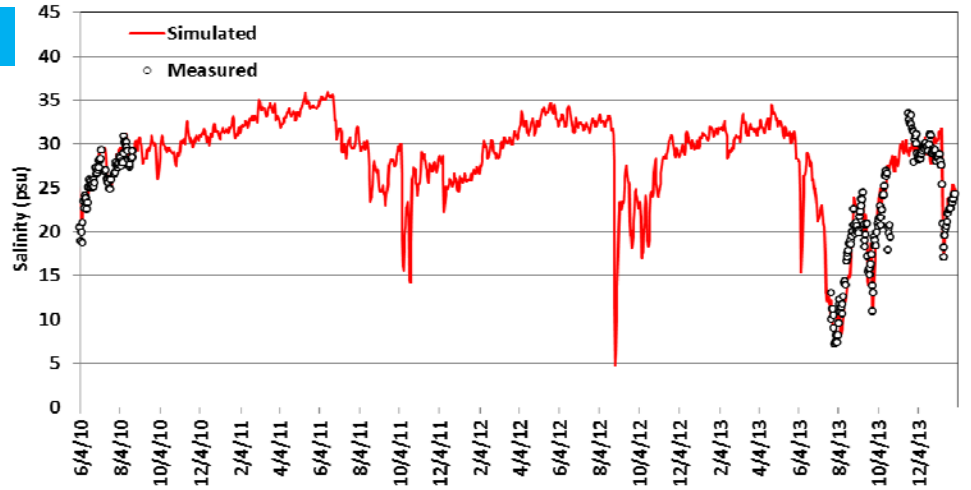
The time series model performs well with simulation of salinity on a daily time step

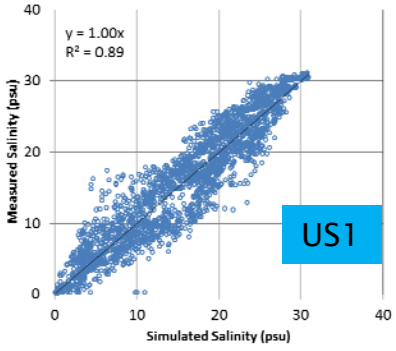


US1



BSI





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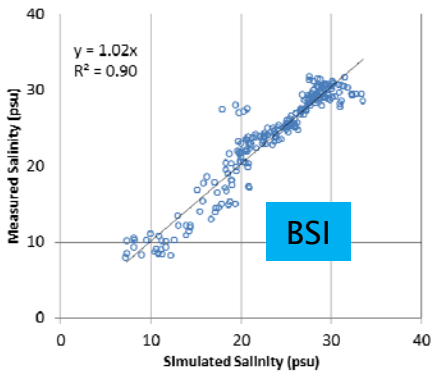


BSI

CEPP INFLOW SCENARIOS

- **CEPP = partnership between the USACE and the SFWMD with publicly owned lands to redistribute water**
- **Regional-scale hydrology with 259 million m^3 of water to be captured and redirected southward**
- **Includes Indian River Lagoon South (SLE) and C-43 Reservoir (CRE)**
- **41 y daily inflow scenarios (1965-2005) ECB, FWO, ALT4R**
  - **ECB: Existing Base Condition = present water system configuration**
  - **FWO: Future Without Project = future water system without CEPP but includes IRL-South (SLE) and C-43 Reservoir (CRE)**
  - **ALT4R: Alternative 4R = FWO including CEPP projects to capture water**

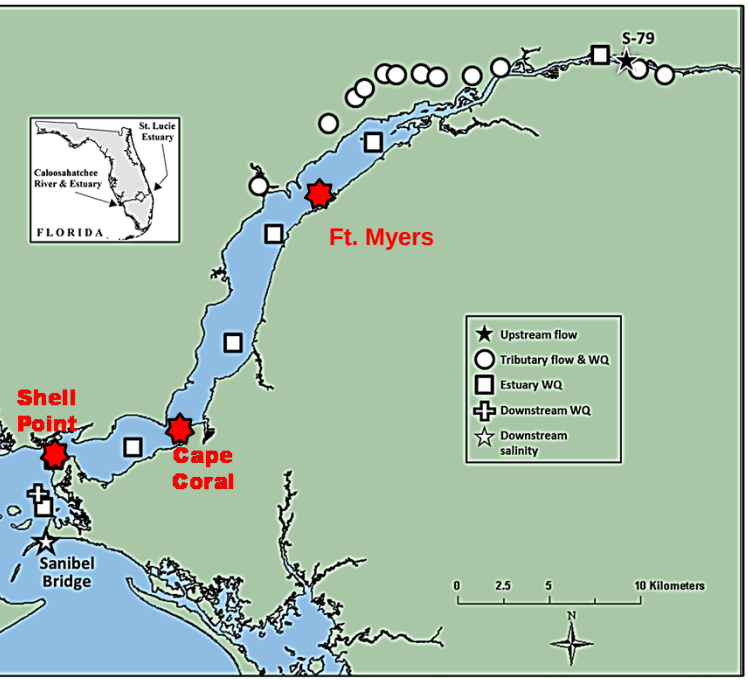
ESTUARINE SALINITY PREDICTIONS

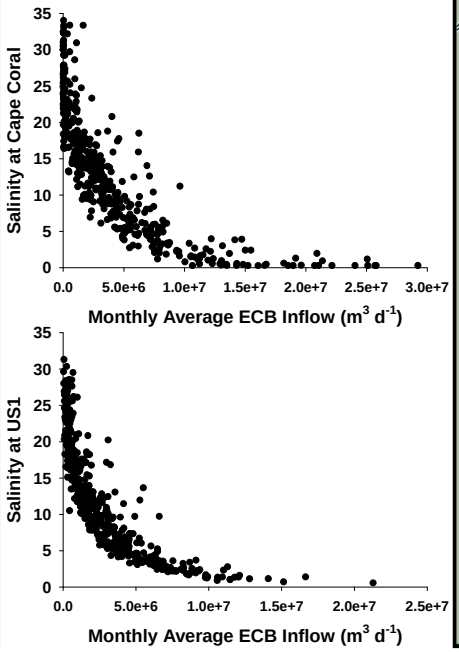
Multivariate salinity time series modeling for CRE & SLE

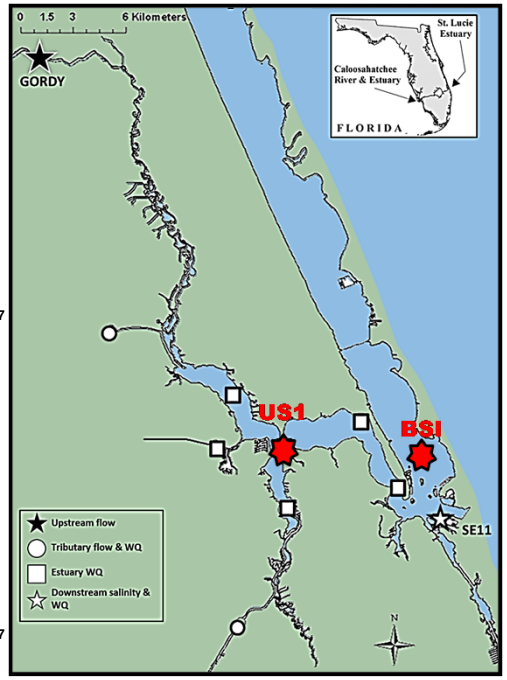
Freshwater inflow from RSM along with inflow from tidal basin, rainfall, and tidal water level fluctuations as the input

Predict daily salinity at multiple locations for 41 y (1965-2005)

- **CRE = Ft. Myers, Cape Coral and Shell Point;**
- **SLE = US1 and Boy Scout Island (BSI)**





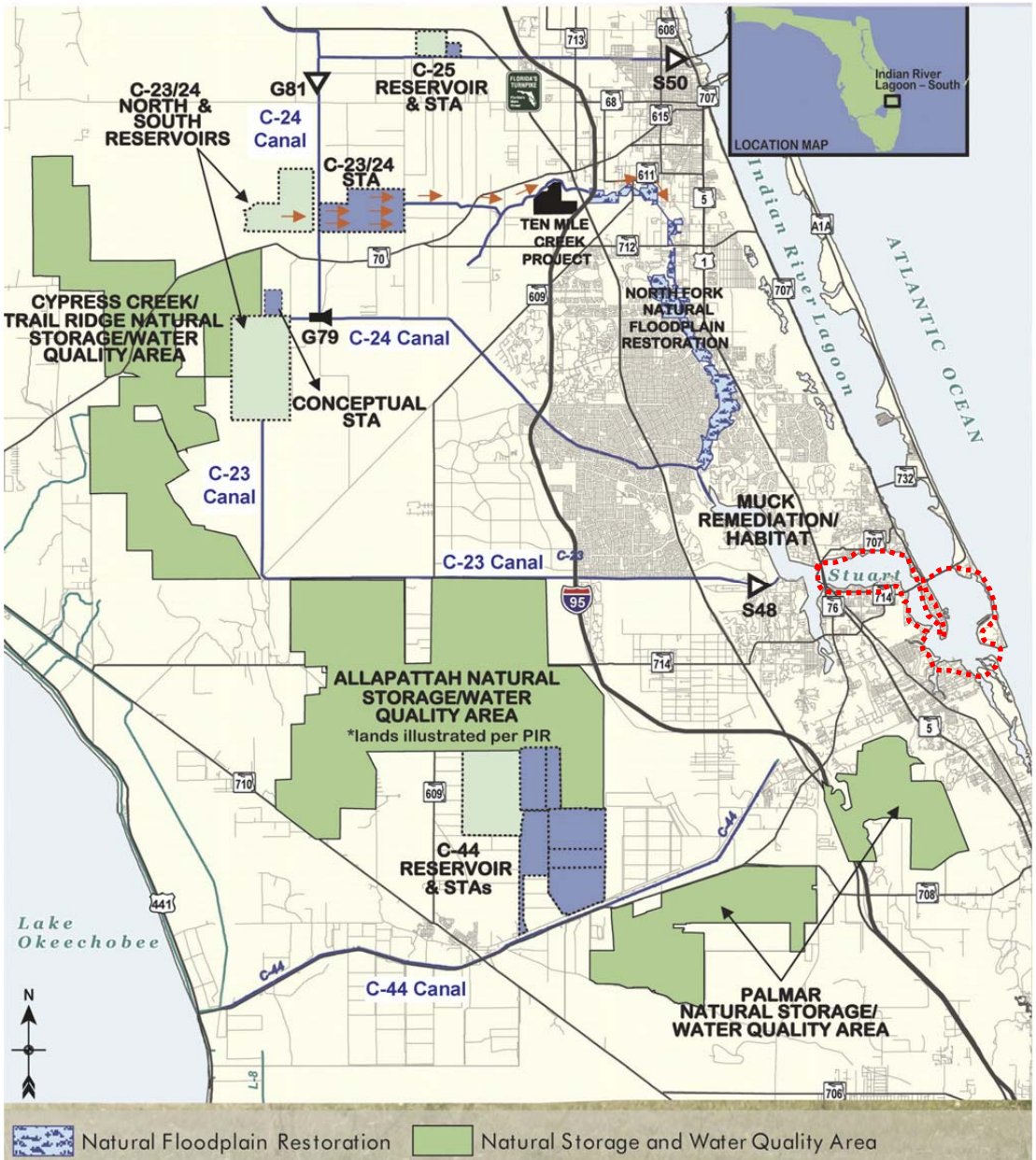


Caloosahatchee River Estuary

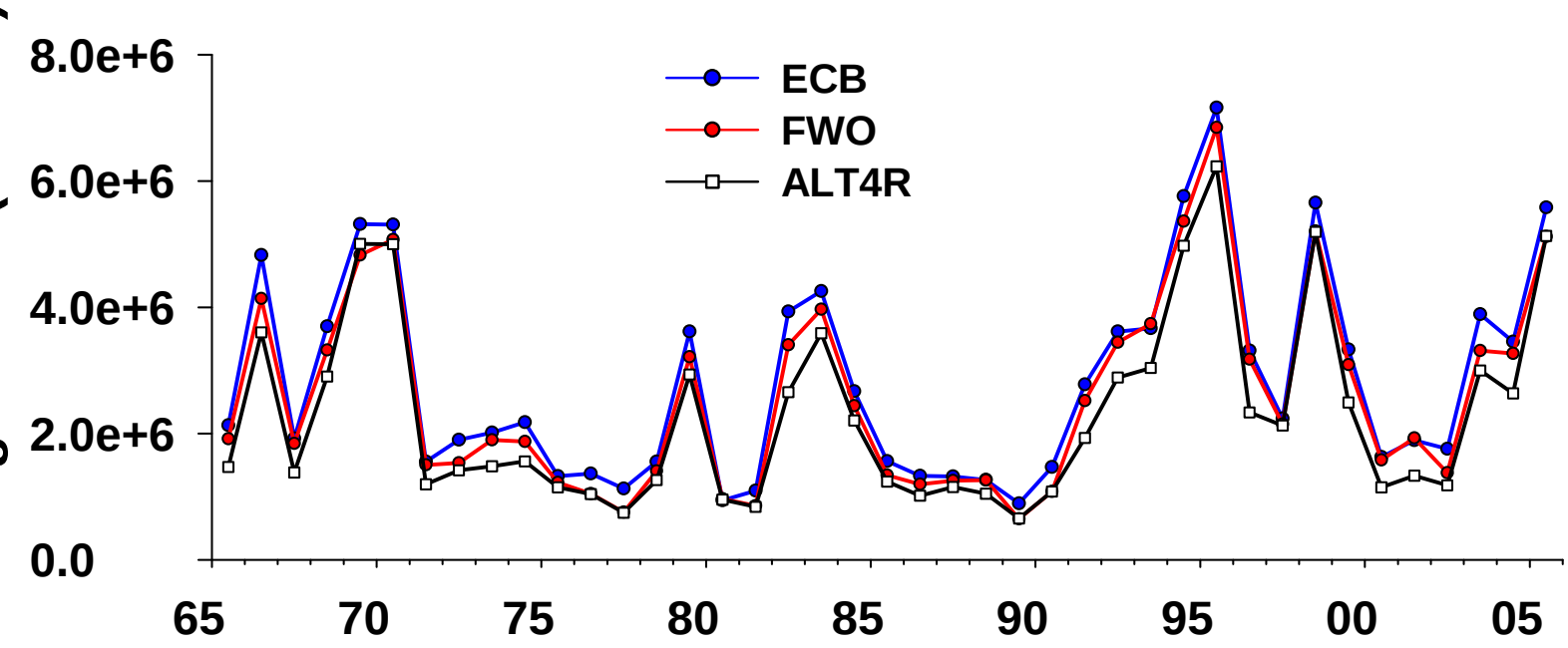
St. Lucie River Estuary

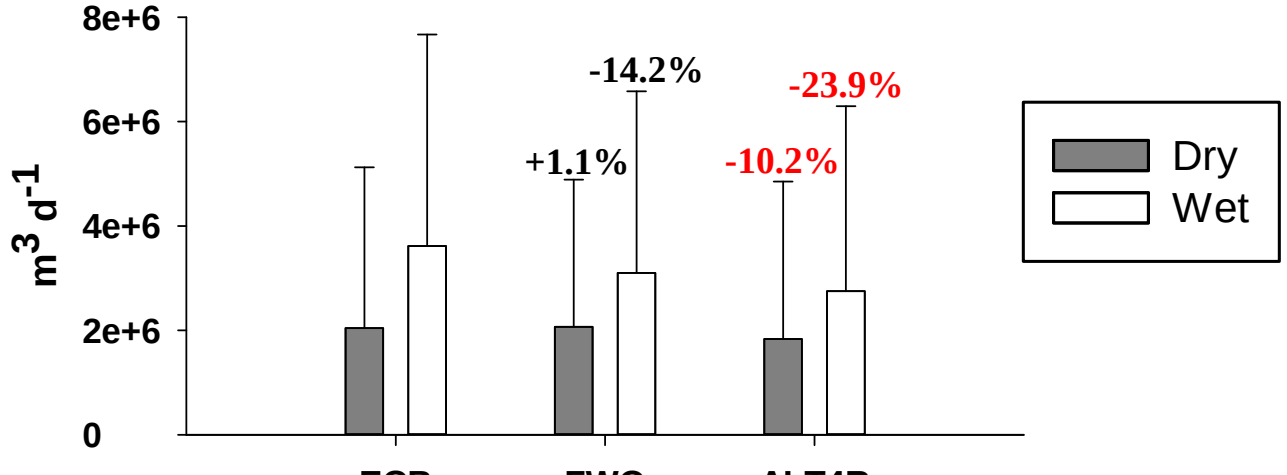
Protection of uarine resources the SLE is a main objective of Everglades Restoration

- Oysters in the mid-estuary
- Seagrasses in the RL
- Low salinity biota in he North Fork



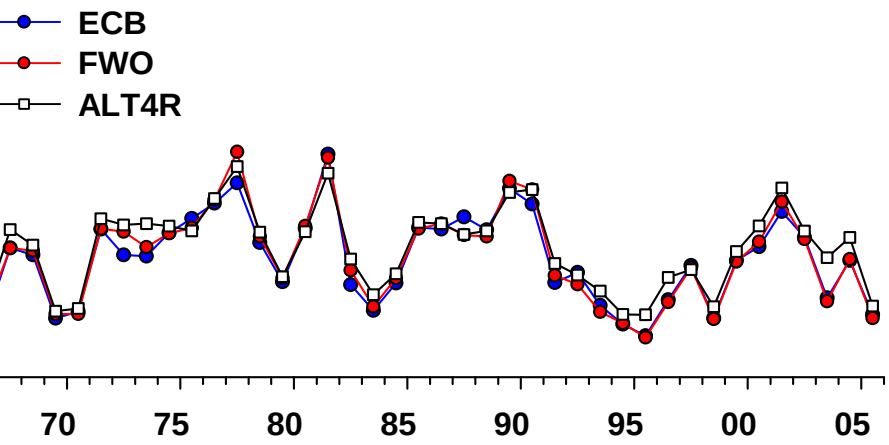
CEPP INFLOWS - SLE

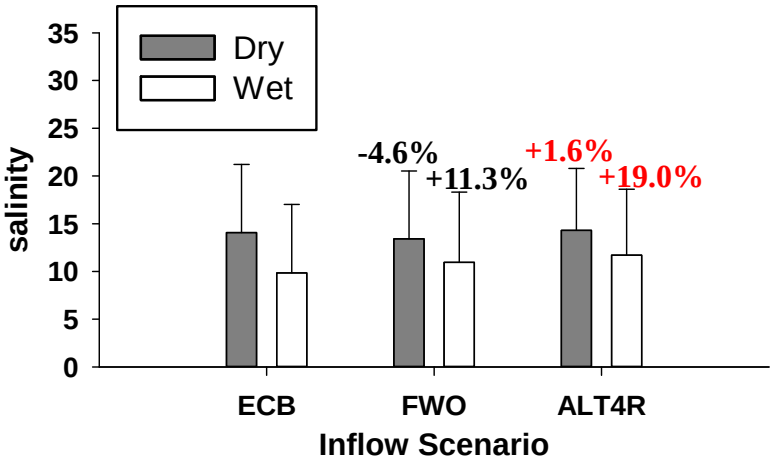




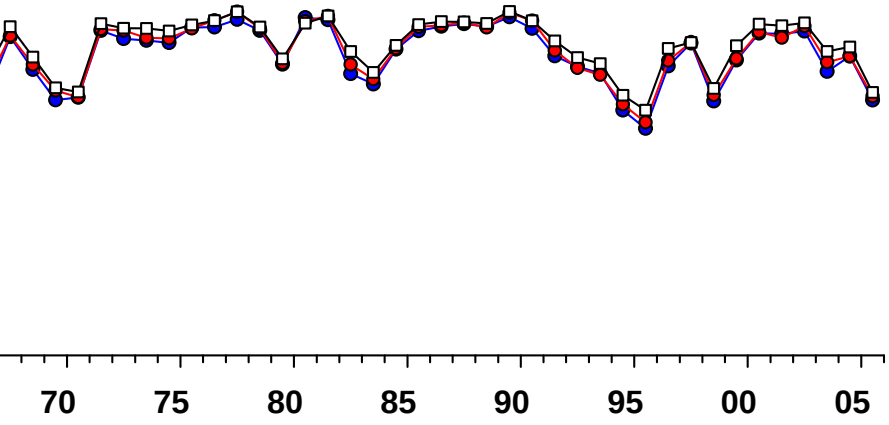
CEPP SALINITY PREDICTIONS - SLE

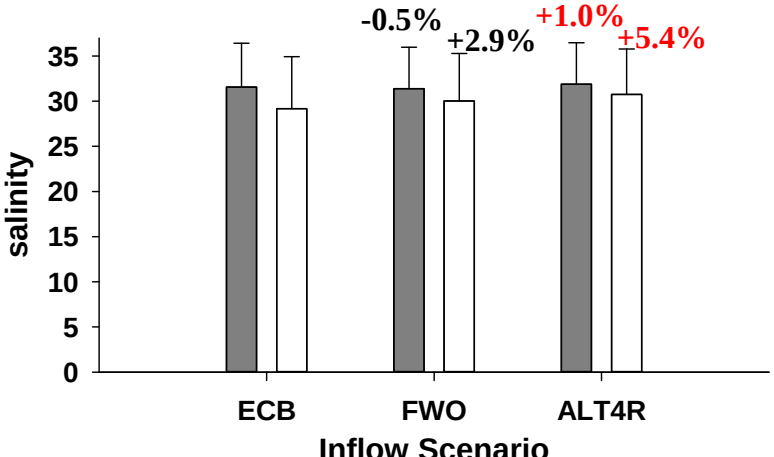
US1 Bridge



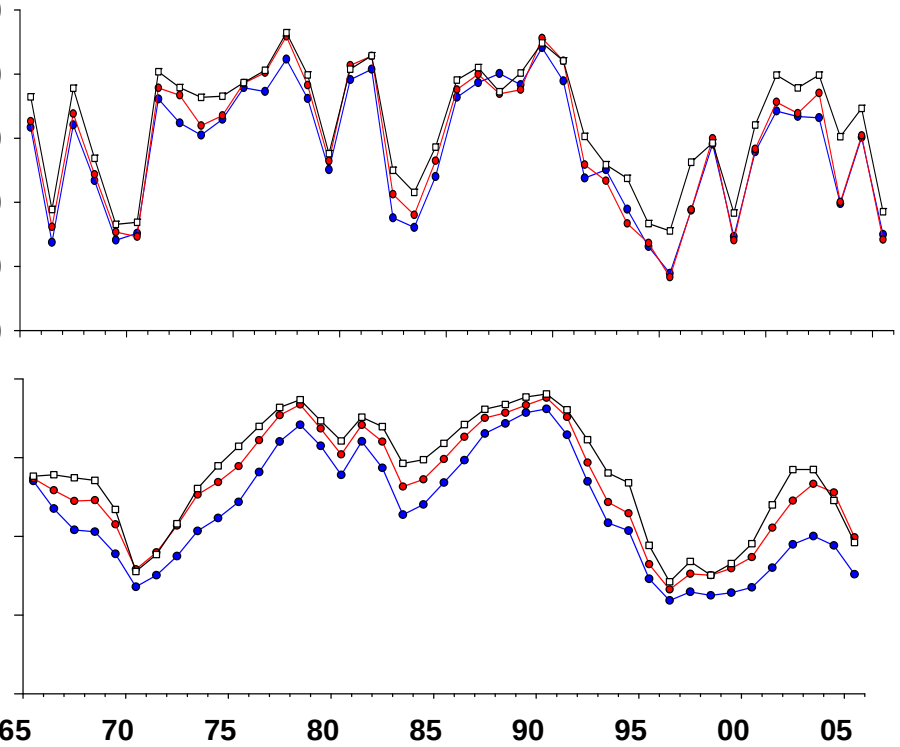


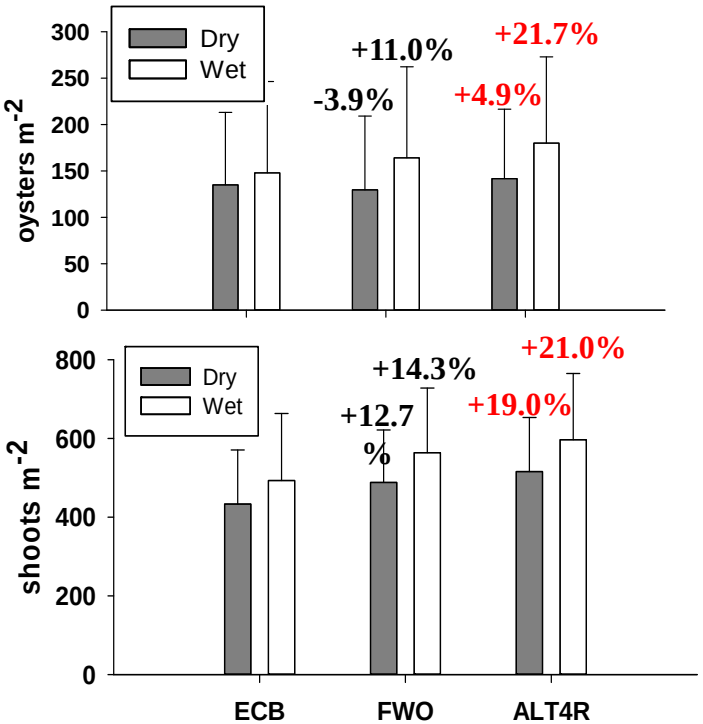
Boy Scout Island



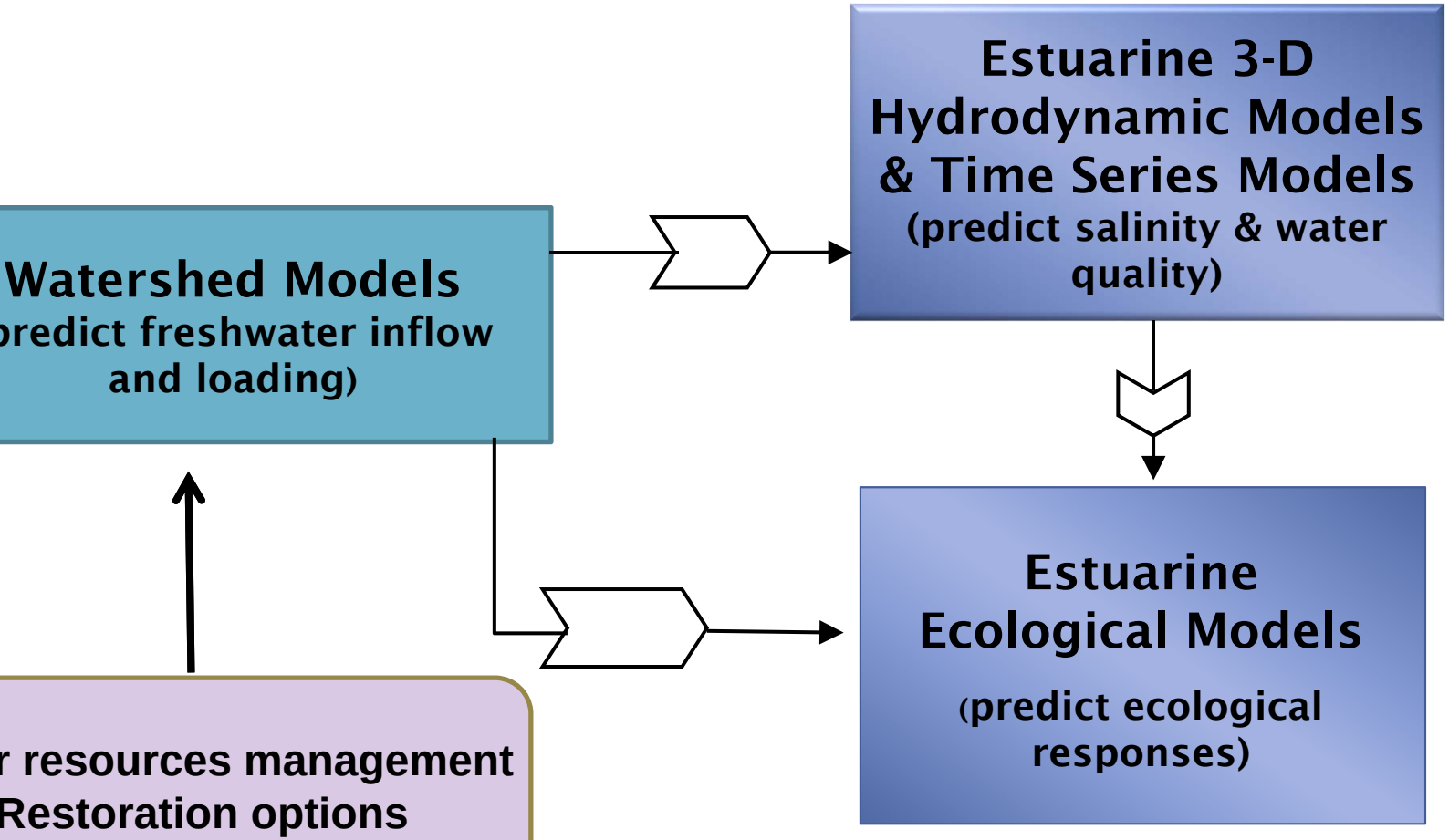


CEPP enhances the growth of oysters in the mid-estuary and *Syringodium* in the IRL





A modeling tool for rapid prediction of estuarine salinity for Everglades ecosystem restoration



SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Questions?