Caloosahatchee Estuary in Fort Myers

# Northern Estuaries Regional Team Webinar:
## Salinity Envelope Performance Measure
## Draft Results & Applications

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# 2007 Salinity Envelope PM

## ST. LUCIE ESTUARY (350–2000 cfs)

**To maintain salinities 12–20 at US-1 Roosevelt Bridge**

### Low flow criterion

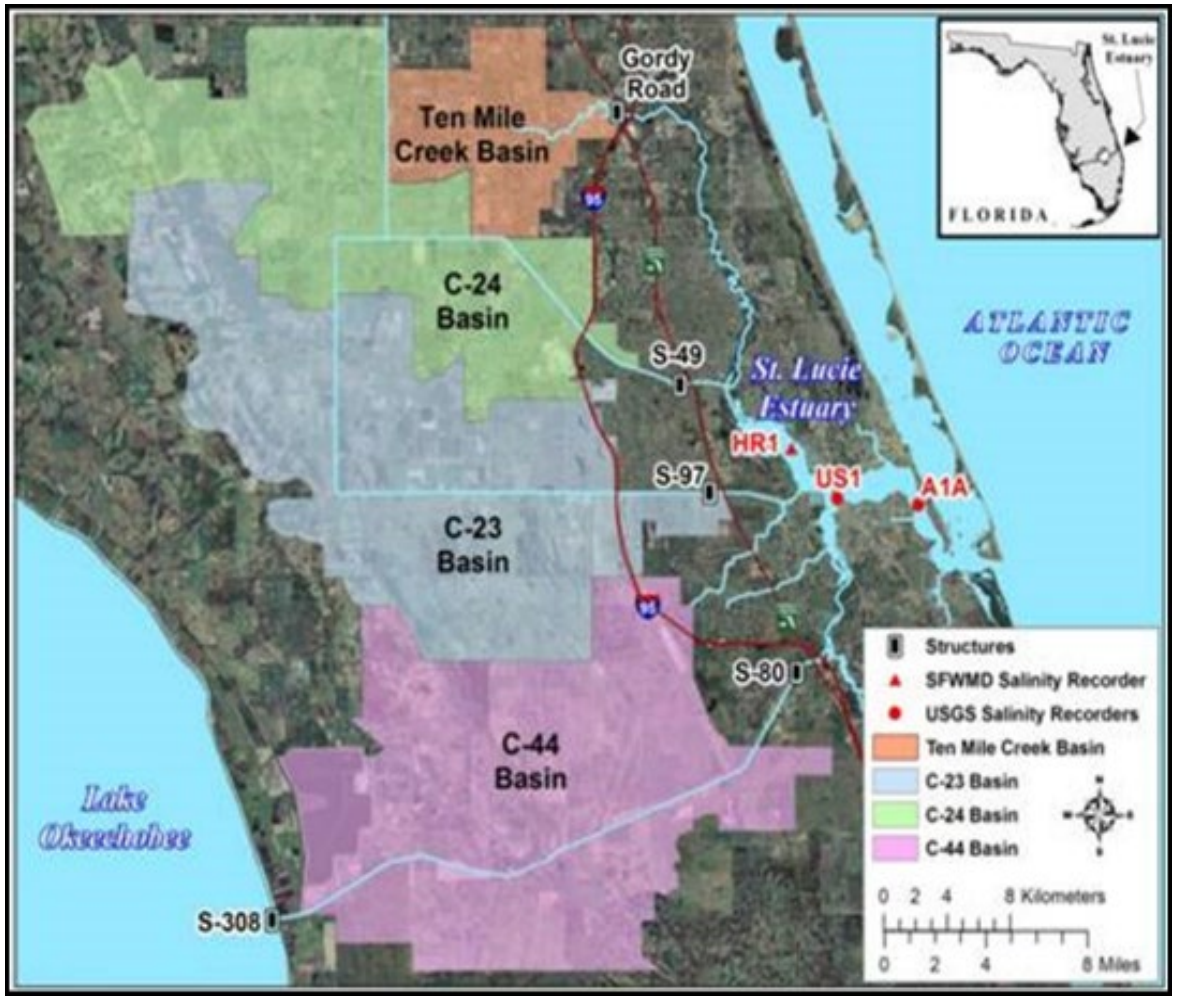
Mean monthly inflows <350 cfs from all sources including groundwater and surface water tributaries

### High Flow Criterion

Flows >2000 cfs from all sources based on 14-day moving average

### Lake Regulatory Releases Criterion

Regulatory discharge events >2000 cfs from Lake O based on 14-day moving average



# 2007 Salinity Envelope PM

## CALOOSAHATCHEE ESTUARY (450–2800 cfs)

**To maintain salinities <10 in the upper estuary while not impacting estuarine organisms downstream**

### Low flow criterion

Mean monthly inflows less than 450 cfs as measured at S-79

### High Flow Criterion

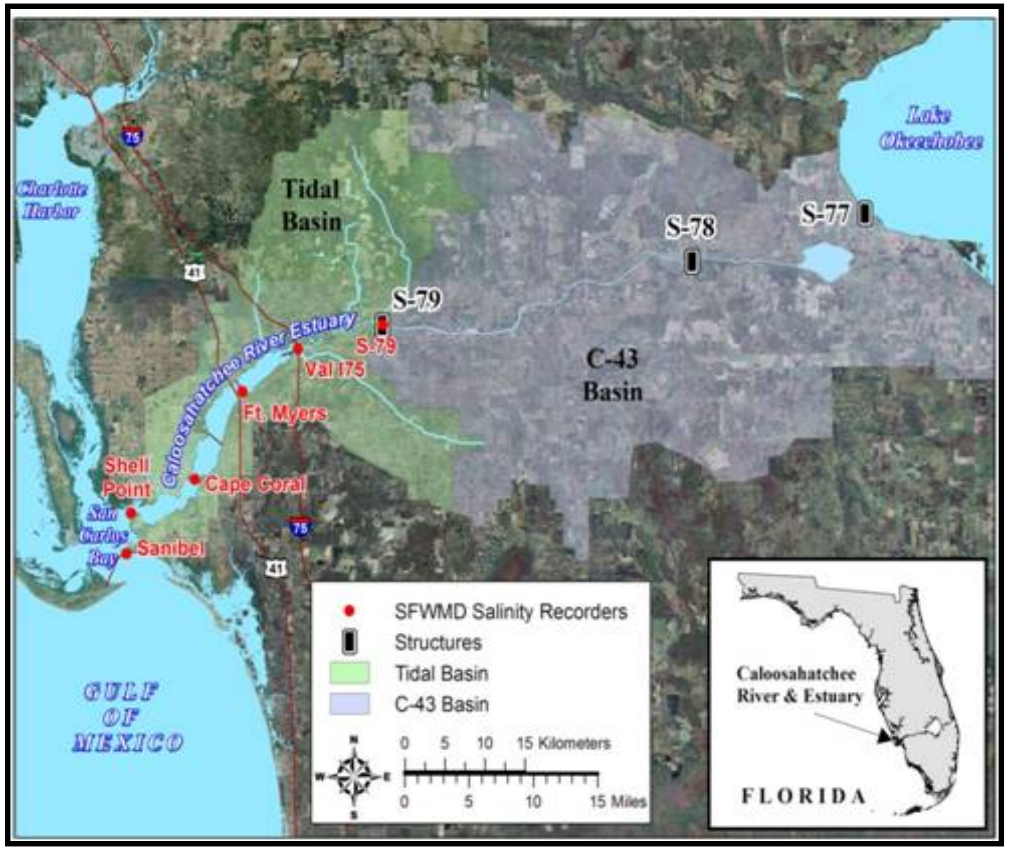
Mean monthly inflows >2800 cfs (**Target***: zero events [out of 452])

### Frequency of Flows

~75% of flows through S-79 within 450–800 cfs

### Lake Regulatory Releases Criterion

Alternatives with least daily discharge volume, fewest number of total days discharge, fewest number of consecutive days preferred; exception for pulse releases beneficial to estuary

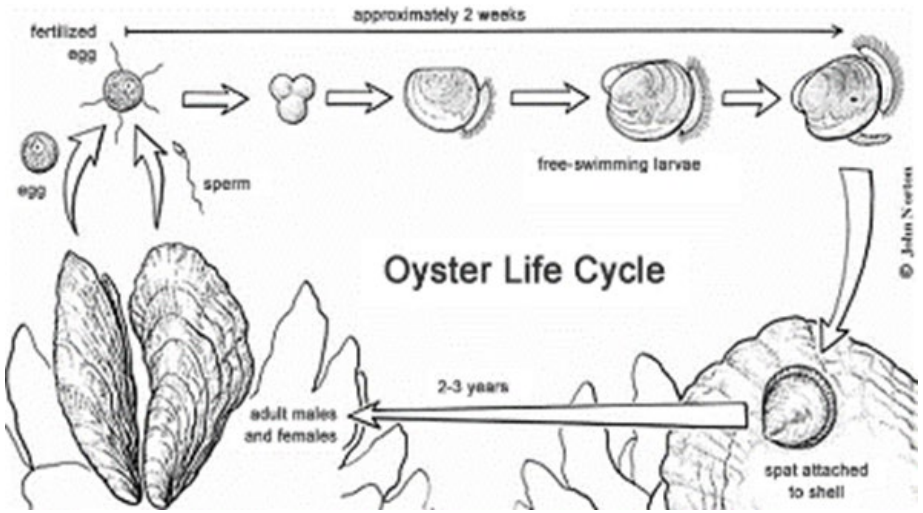


# Categorizing Salinity Envelope

## Literature Review

**Synthesis of field observation and experimental studies, lab experimental studies, and regional subject experts**

- Categorize salinity ranges for each of the eco indicators
  - **Optimum** – yielding highest response variables (e.g. growth, density, recruitment, photosynthesis, etc.)
  - **Stress** – decline in some response variables (e.g. growth), but tolerable; survivability and persistence possible or likely for a time
  - **Damaging** – significant declines in all response variables; survivability and persistence low, and loss over the long-term likely




Modeling ecosystem processes with variable freshwater inflow to the Caloosahatchee River Estuary, southwest Florida. II. Nutrient loading, submarine light, and seagrasses

Christopher Buzzelli*, Peter Doering, Yongshan Wan, Detong Sun

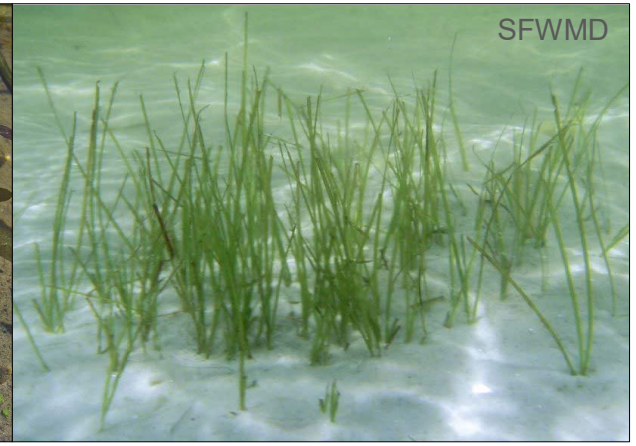
*Coastal Ecosystems Section, South Florida Water Management District, 3301 Gun Club Rd., West Palm Beach, FL 33406, USA*

# Salinity Envelope

## Ecological Indicator Species

**Eastern oyster**
(*Crassostrea virginica*)
Mesohaline/Marine bivalve

**Tape grass**
(*Vallisneria americana*)
Freshwater/Oligohaline SAV



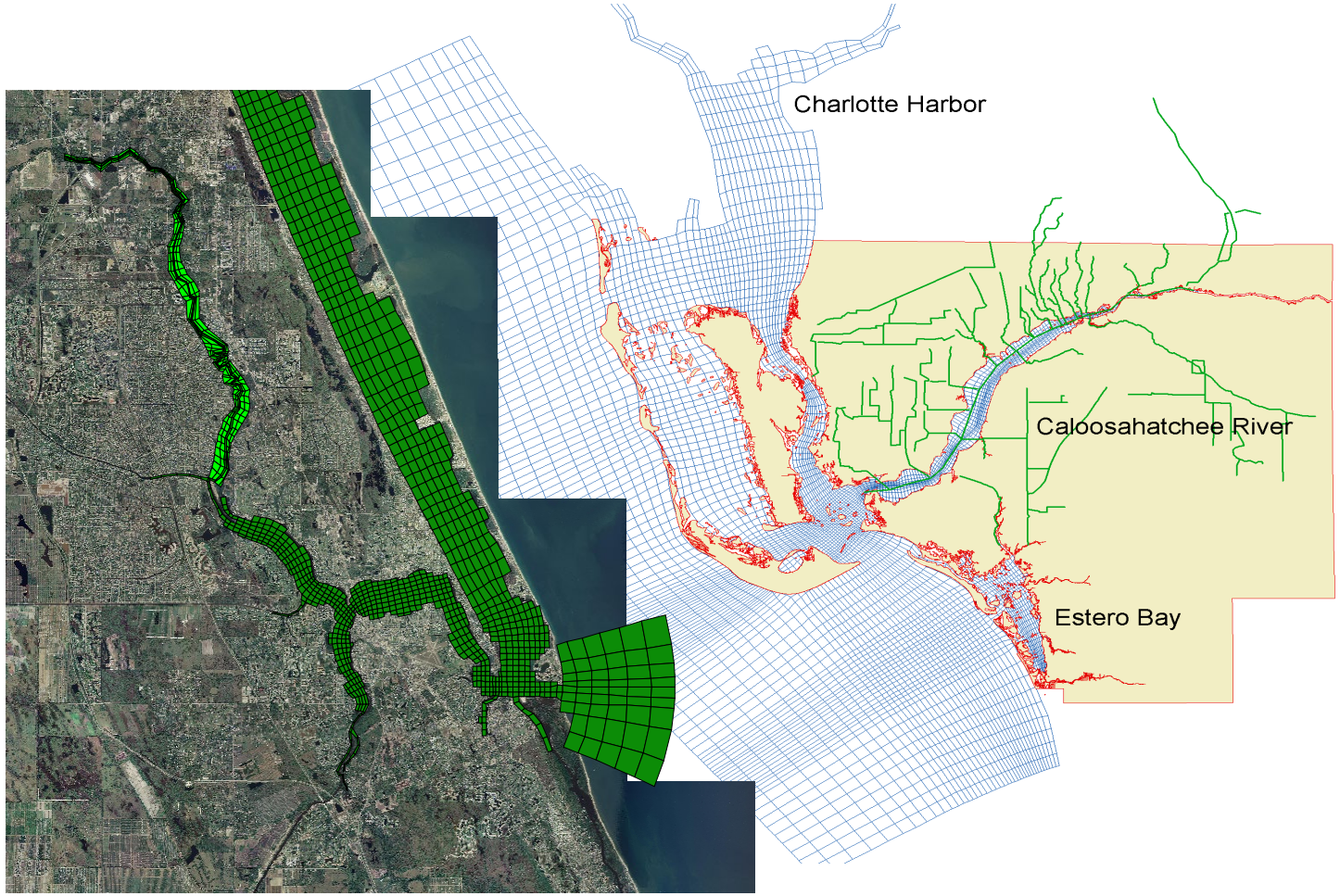

**Shoal grass**
(*Halodule wrightii*)
Mesohaline/Marine SAV

| Species | 2007 PM Targets | 2020 PM Targets SLE & CRE | | |
|---|---|---|---|---|
| | | Optimum | Stress | Damaging |
| Eastern oyster (adult) | 12–20 (SLE) | 10–25 | 5–9; >25 | <5 |
| Tape Grass | <10 (CRE MFL) | <10 | 10–15 | >15 |
| Shoal Grass | 12–20 (SLE) | 15–45 | 5–14; >45 | <5 |

# CH3D Hydrodynamic Salinity Model

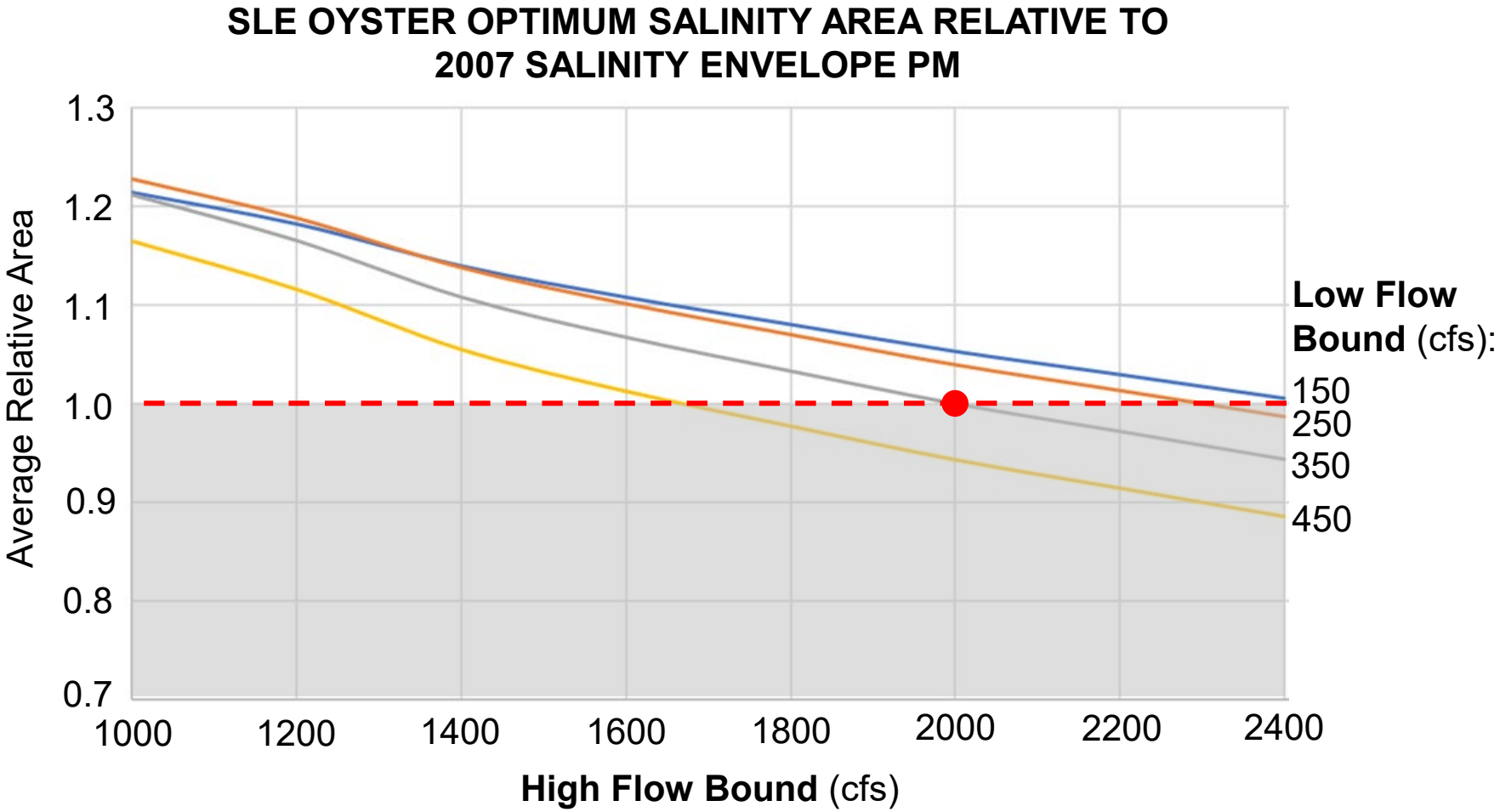
## CH3D Model Application

- CH3D Models Flow-to-Salinity relationship
- 50-year period of record [POR 1965–2015] of daily historic flow and modeled salinity
- Iterative testing of variety of flow ranges, and resultant 14-day moving average salinity (deemed ecologically-relevant)



# Sensitivity Analysis

**Eastern oyster** (*Crassostrea virginica*)



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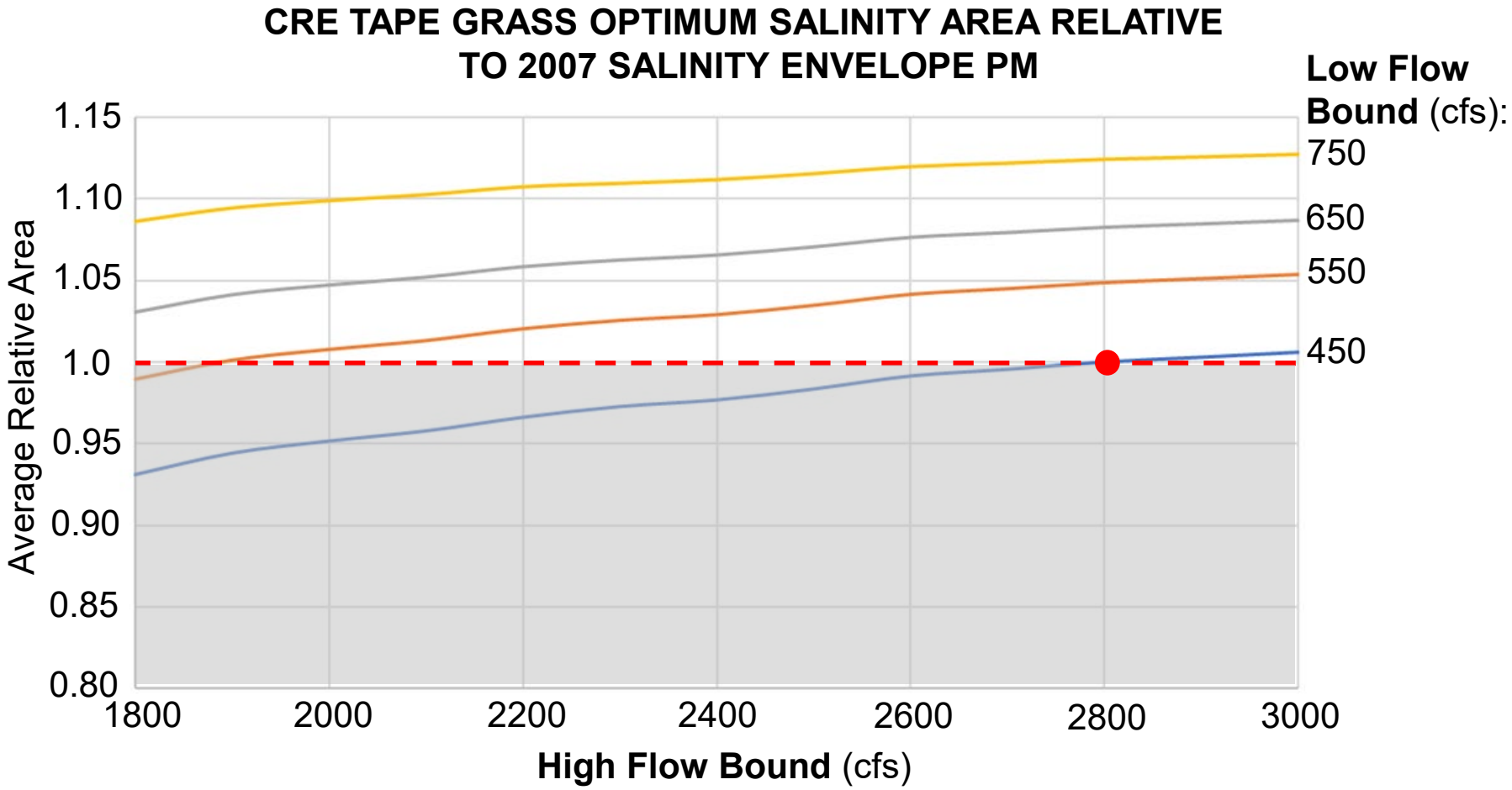
**Tape grass** (*Vallisneria americana*)



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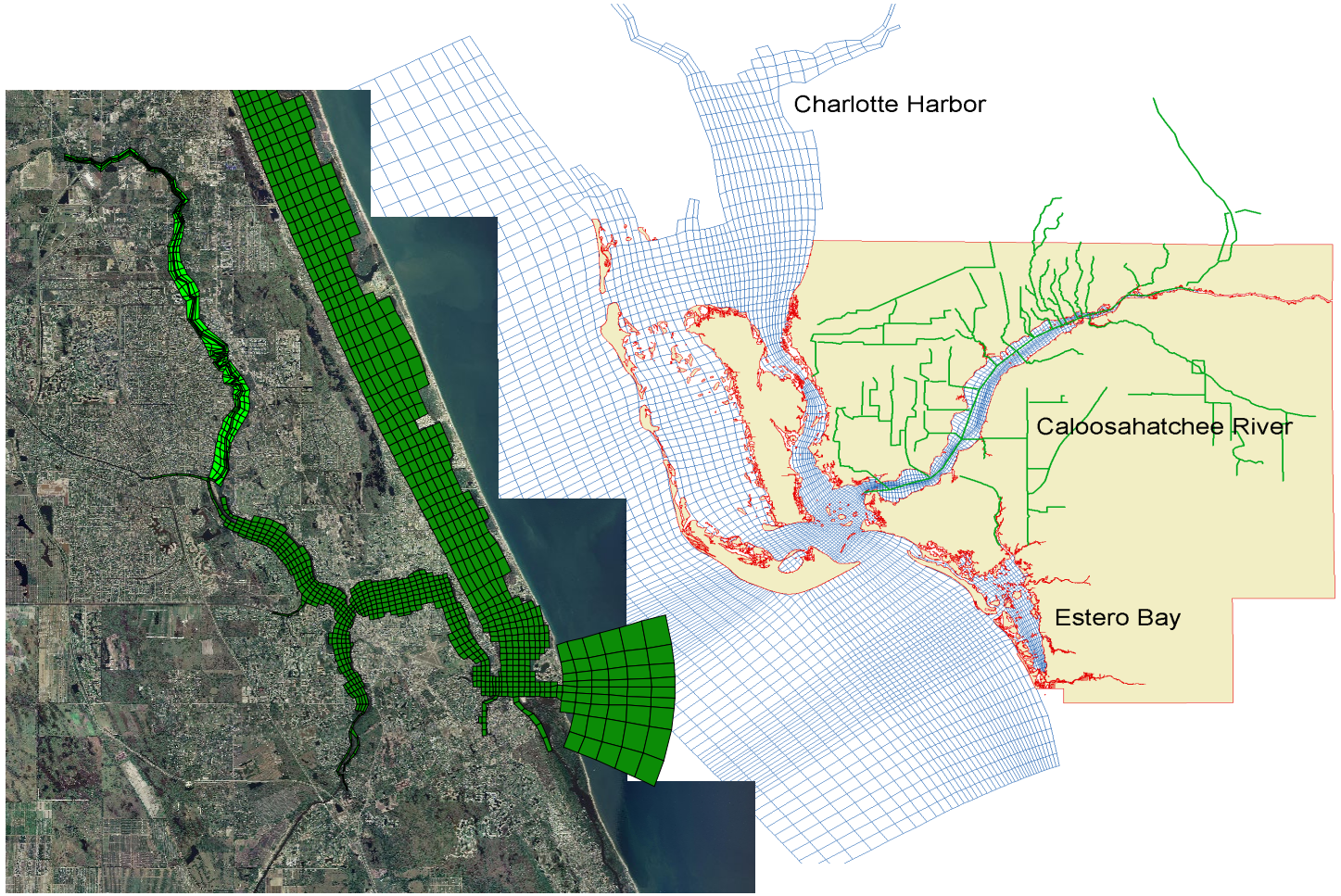
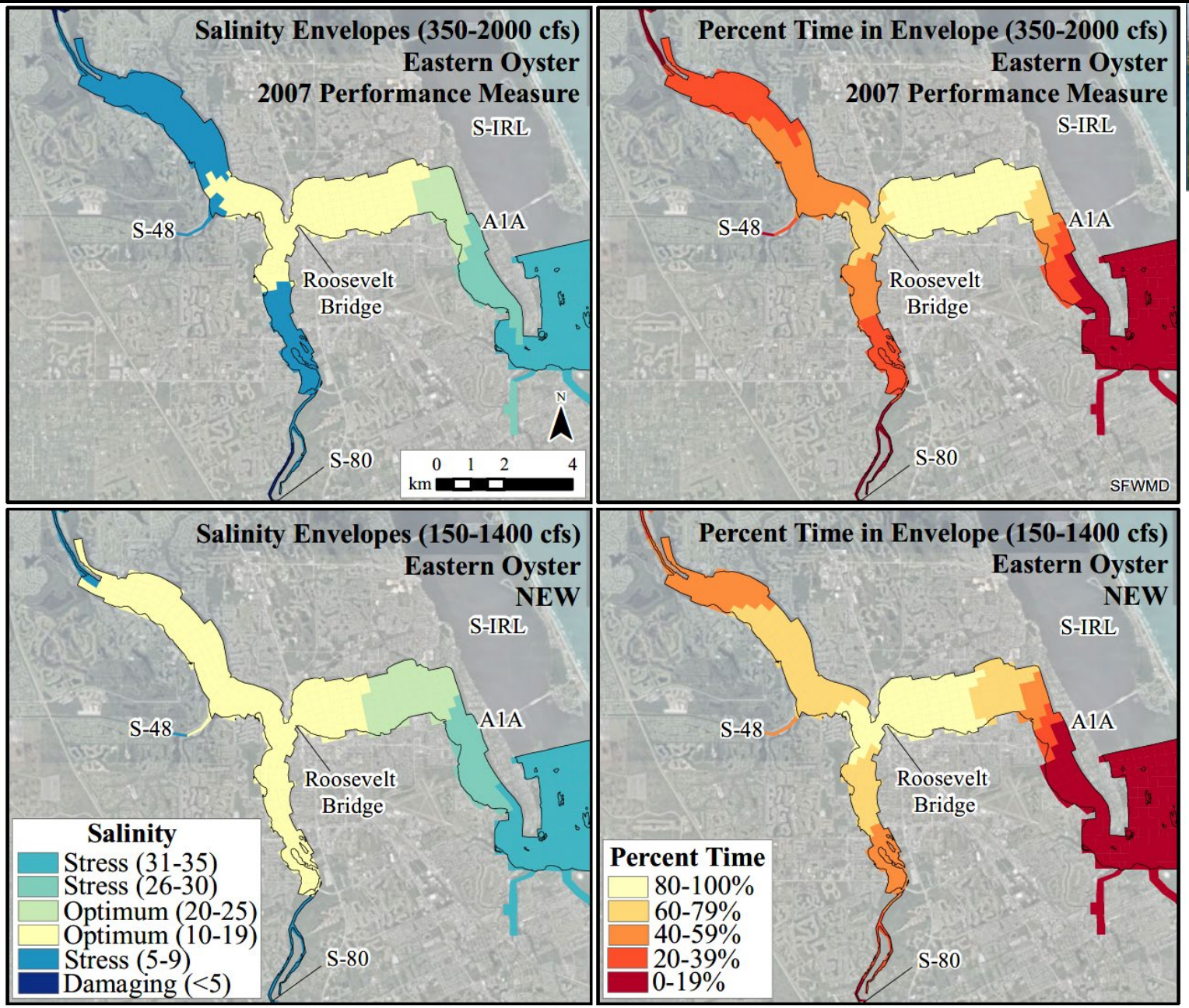
- 50-year period of record [POR 1965–2015] of daily historic flow and modeled salinity
- Iterative testing of variety of flow ranges, and resultant 14-day moving average salinity (deemed ecologically-relevant)
- Outputs include salinity gradient and percent time within salinity envelope for each indicator

**Flow Envelopes in cubic feet per sec (cfs)**

| Estuary | Optimum | Stress | Damaging |
|---|---|---|---|
| SLE | 150–1400 | 1400–1700 | >1700 |
| CRE | 750–2100 | 2100–2600 | >2600 |





# SLE Optimum Flow

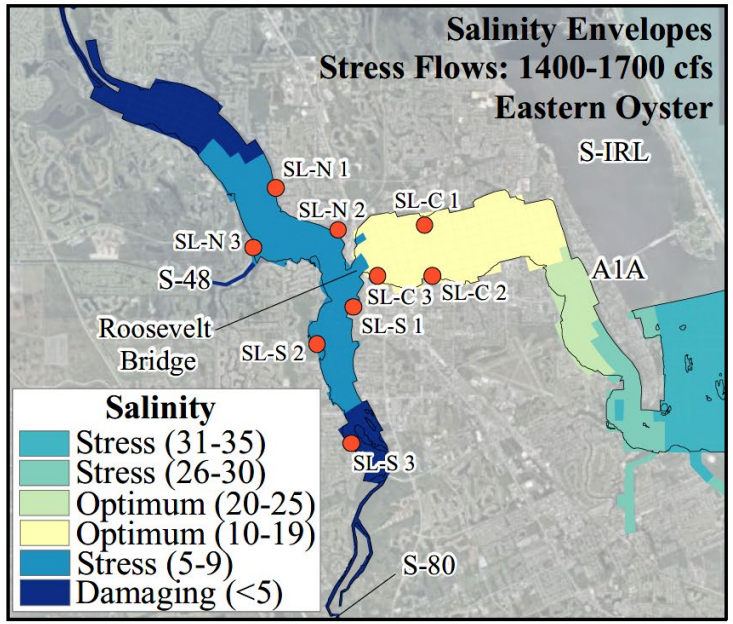
**SLE Flow Envelopes (2020)***

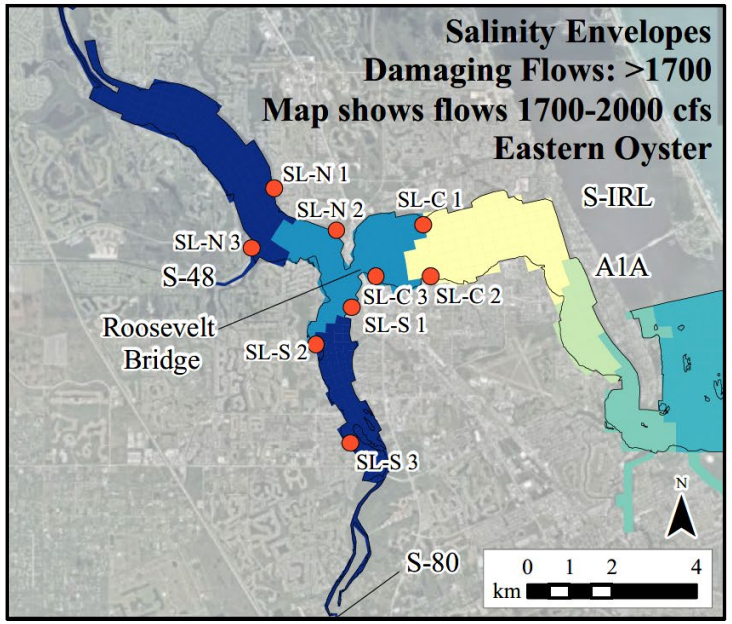
| Optimum | Stress | Damaging |
|---|---|---|
| 150–1400 cfs | 1400–1700 cfs | >1700 cfs |

*Based on optimum salinities for shoal grass ***and*** oysters

**Eastern oyster** (*Crassostrea virginica*)

# SLE Stress and Damaging Flows

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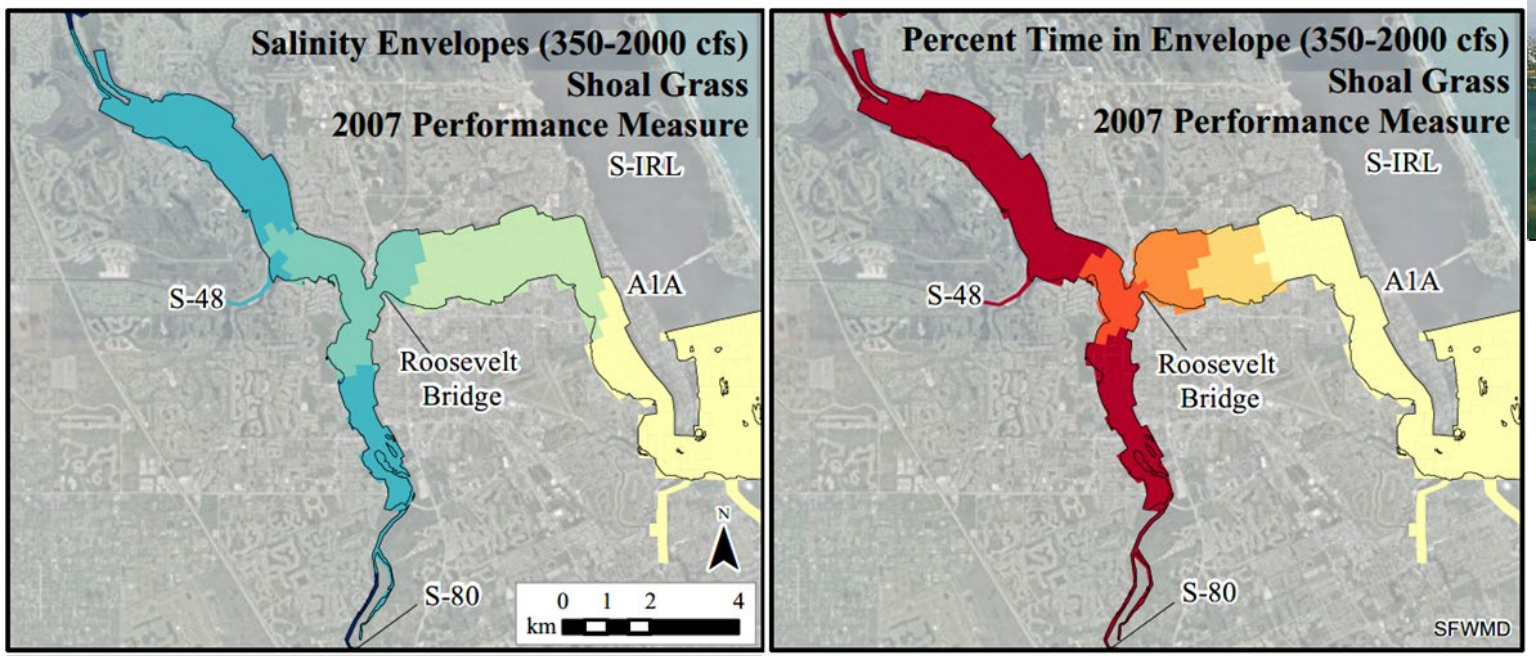





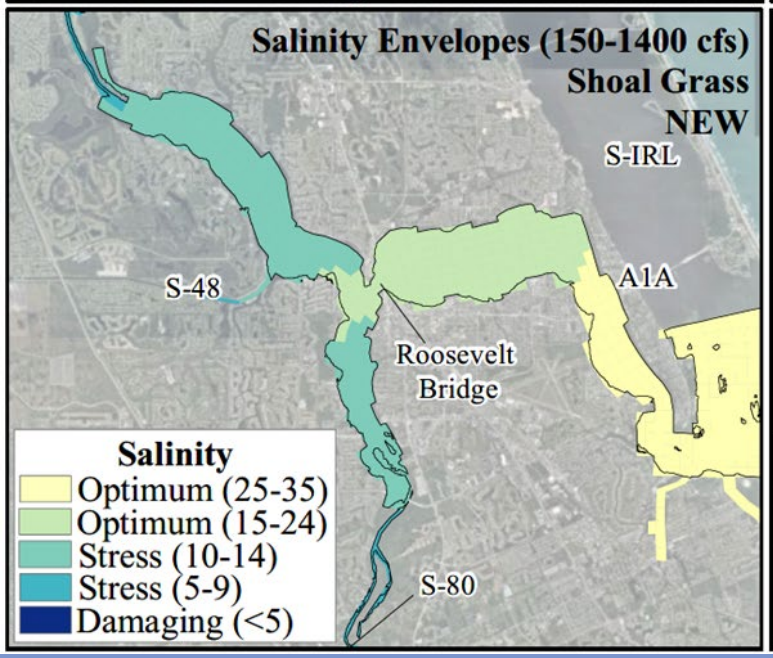


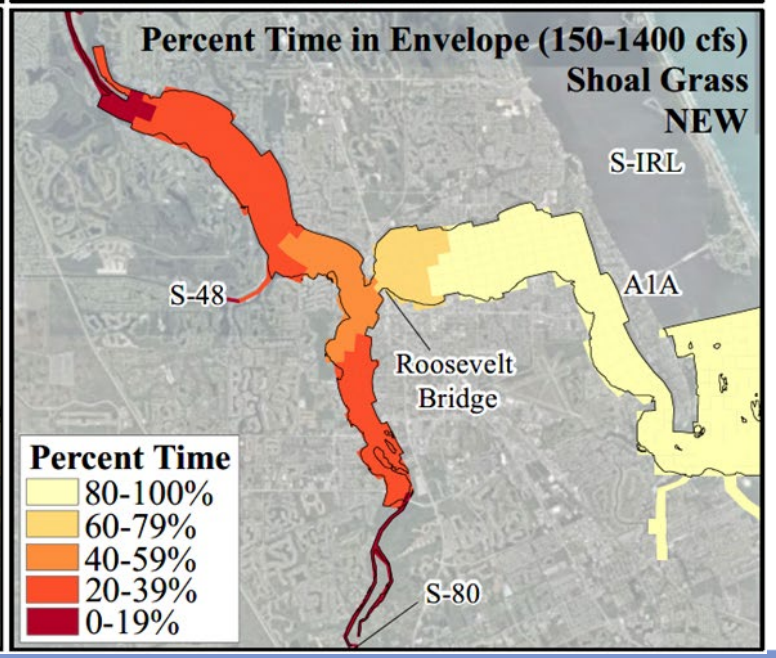

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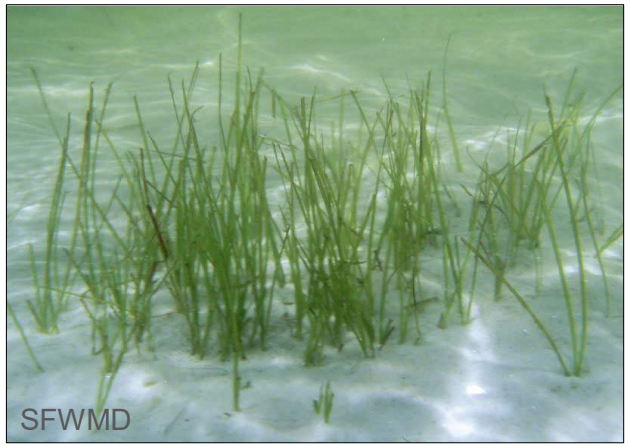


**Shoal grass** (*Halodule wrightii*)

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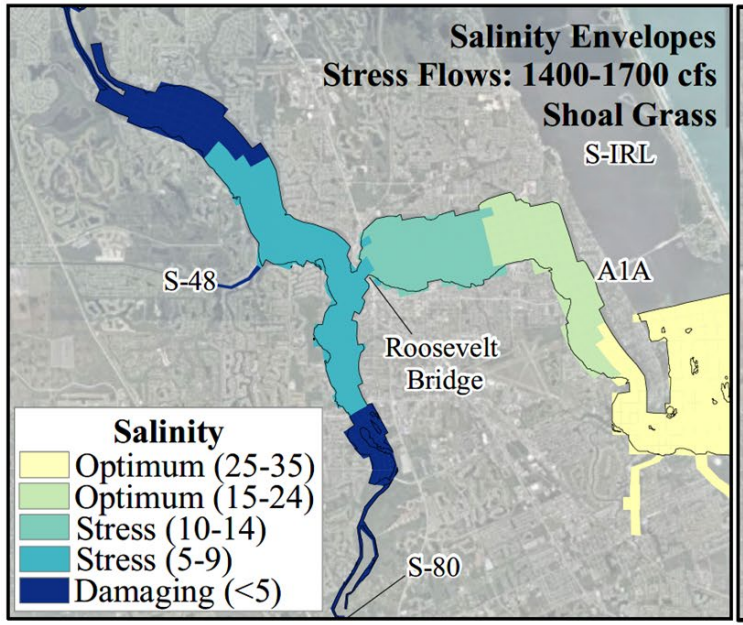


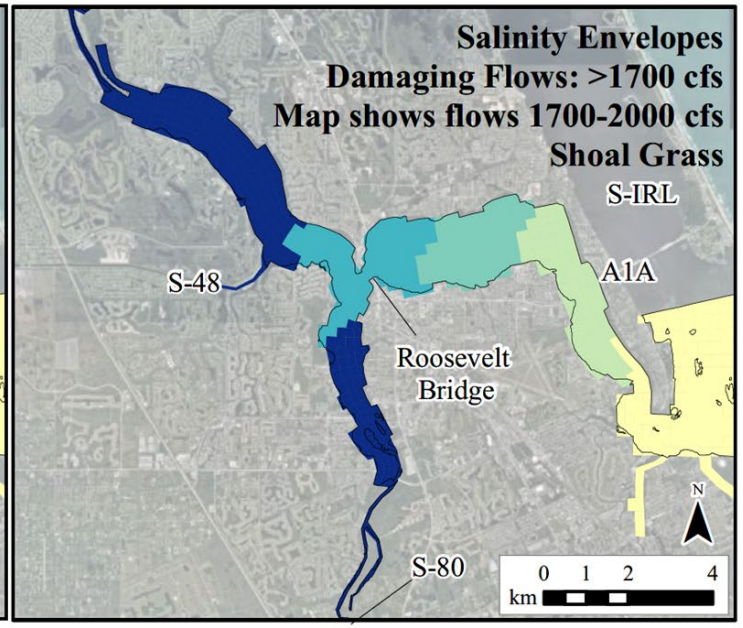


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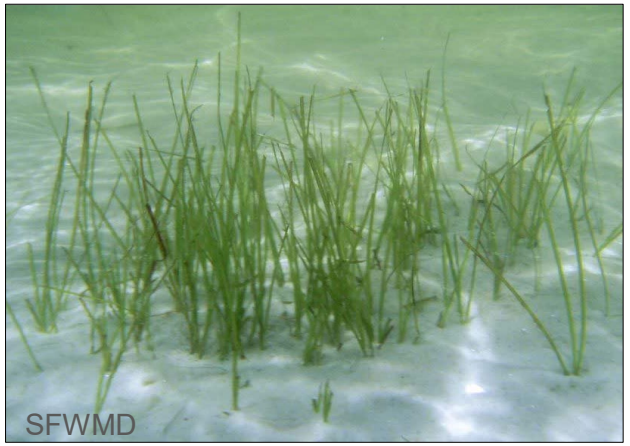


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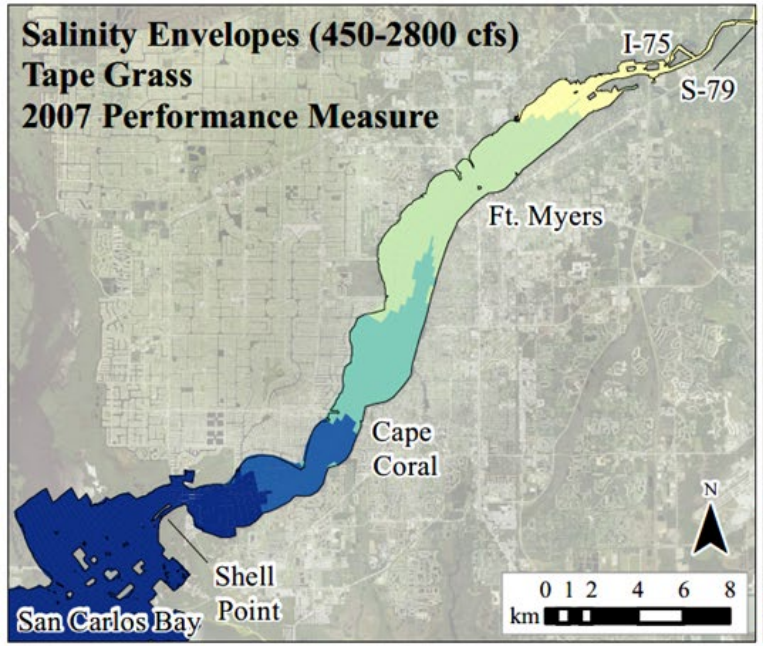


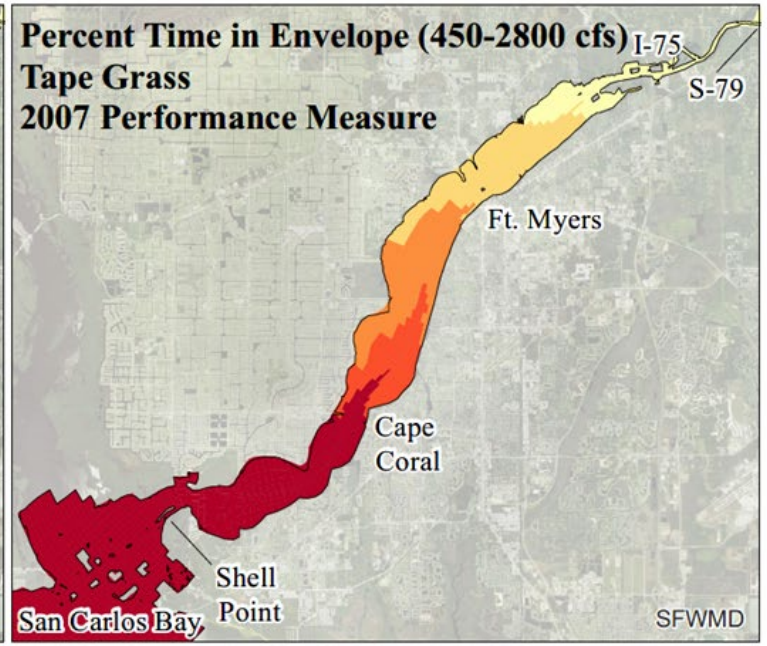


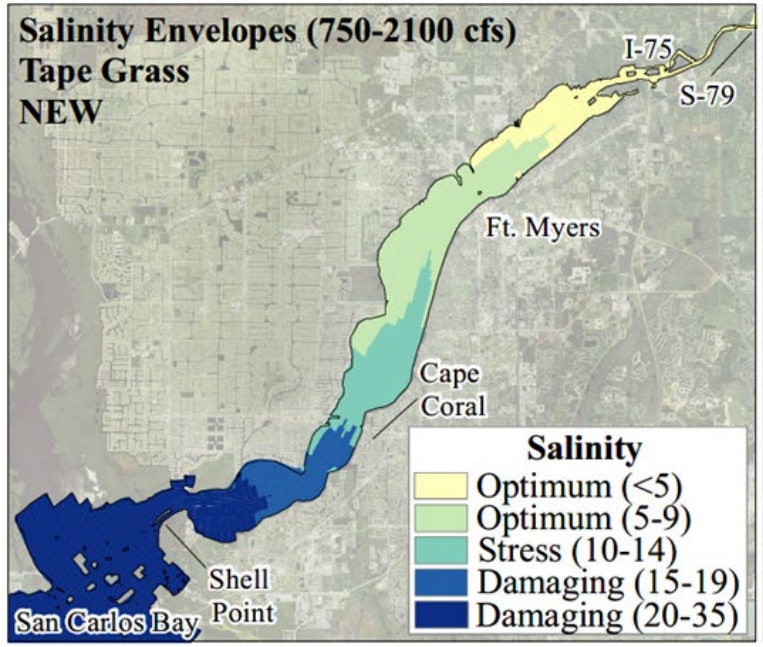


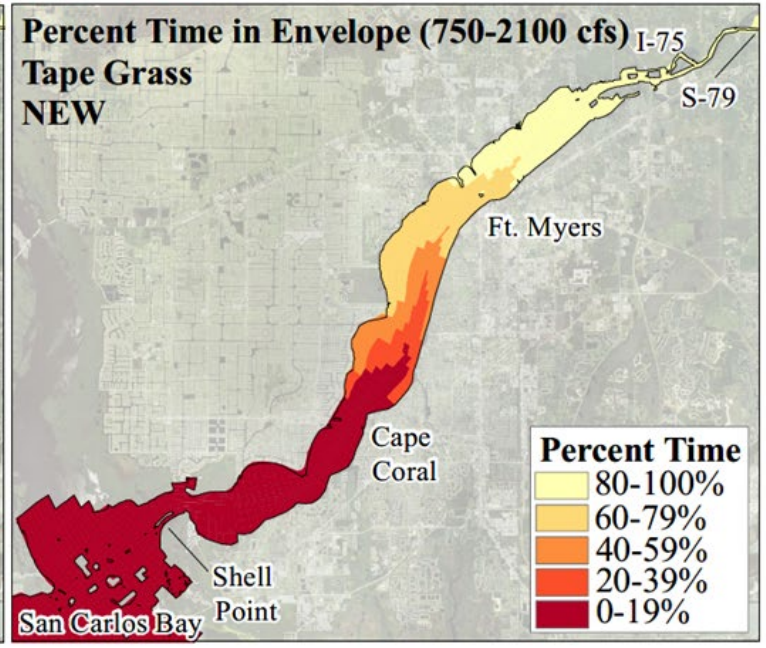

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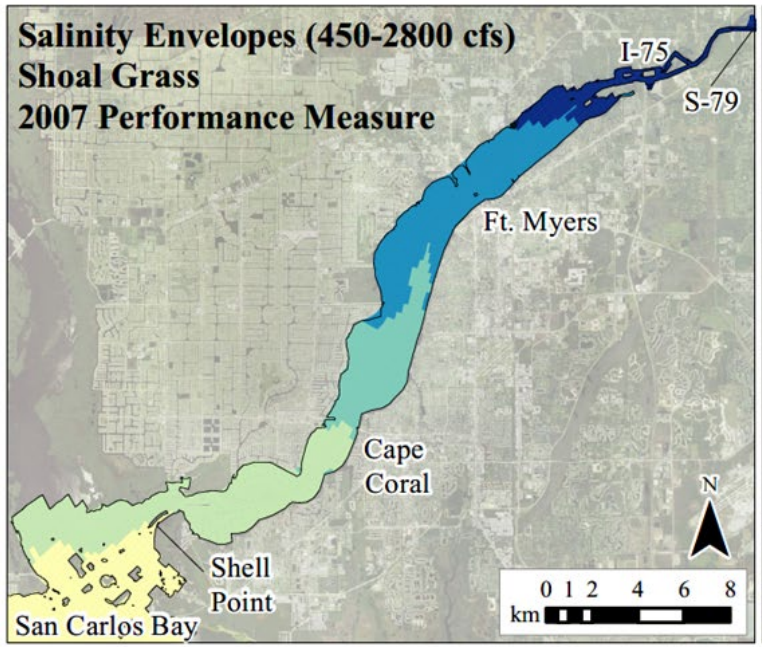


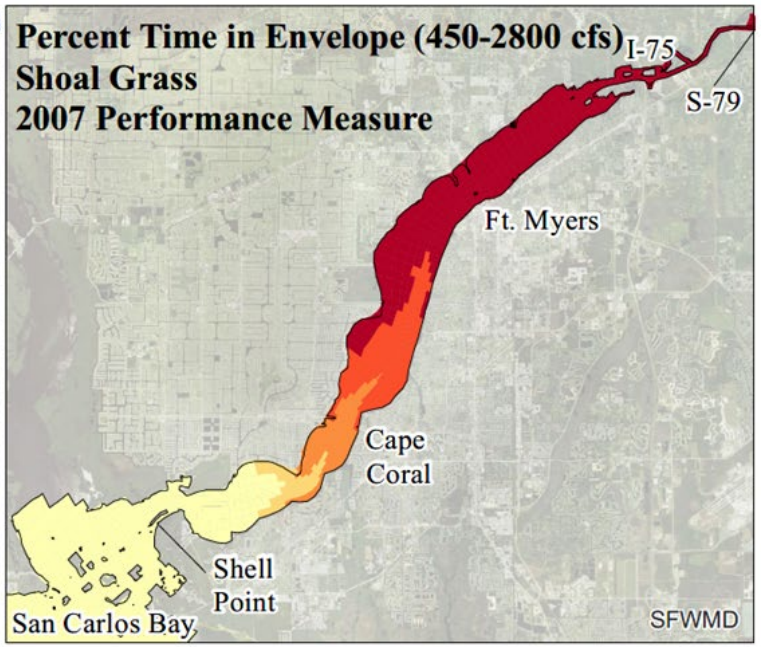


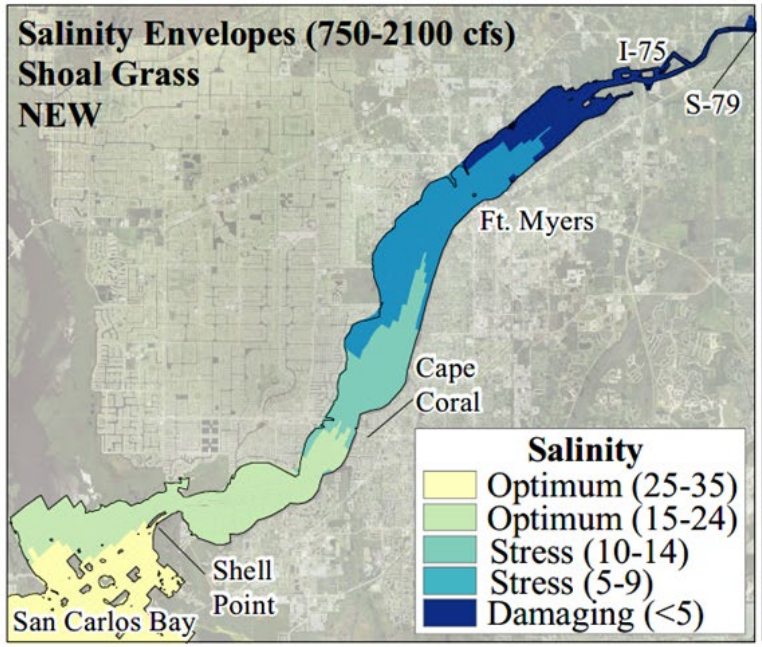


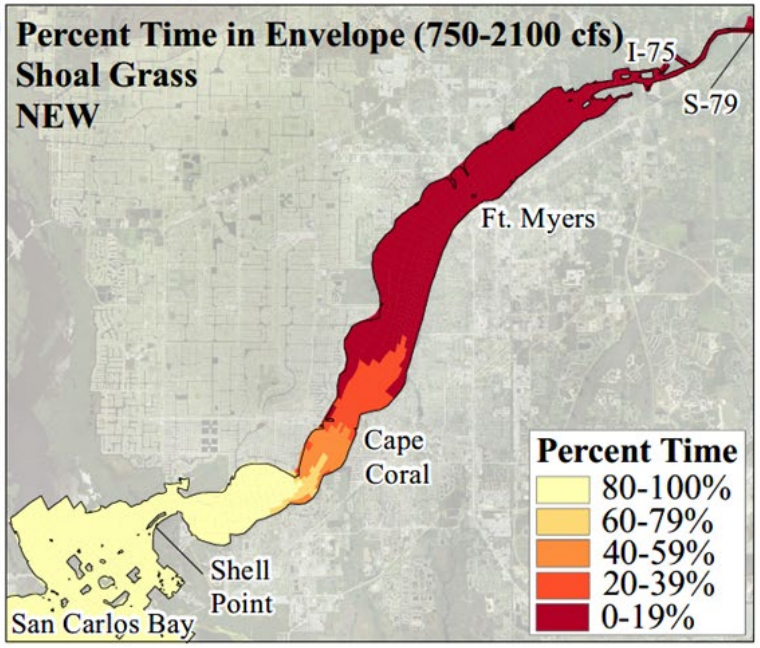

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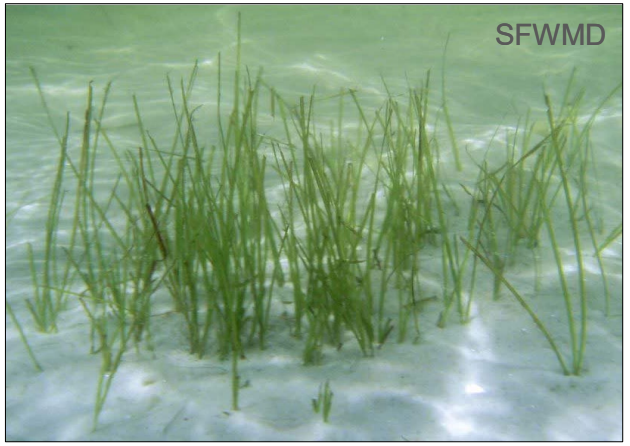


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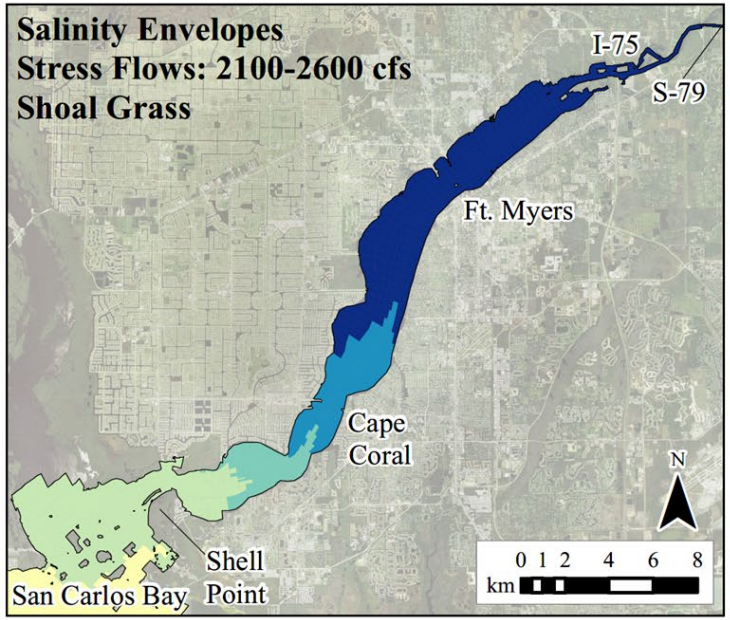


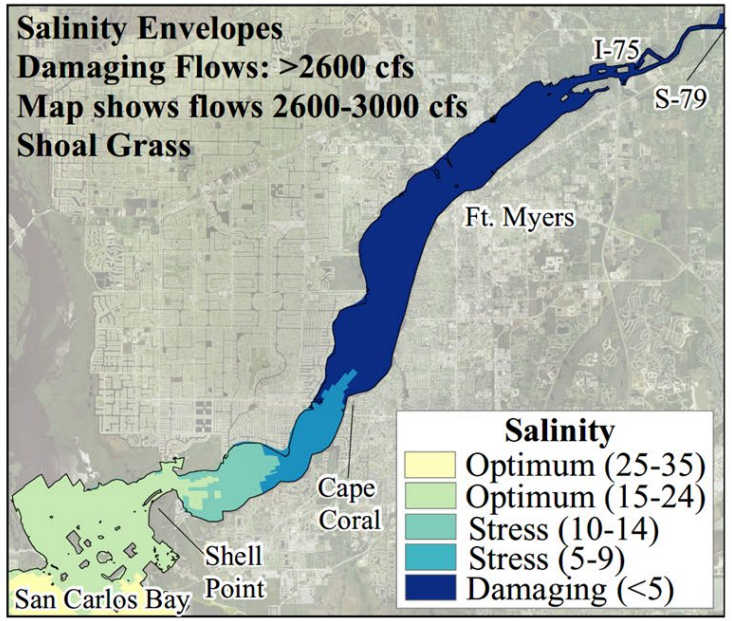


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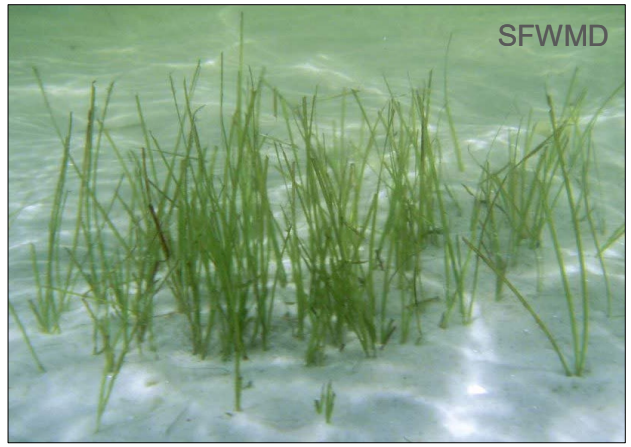


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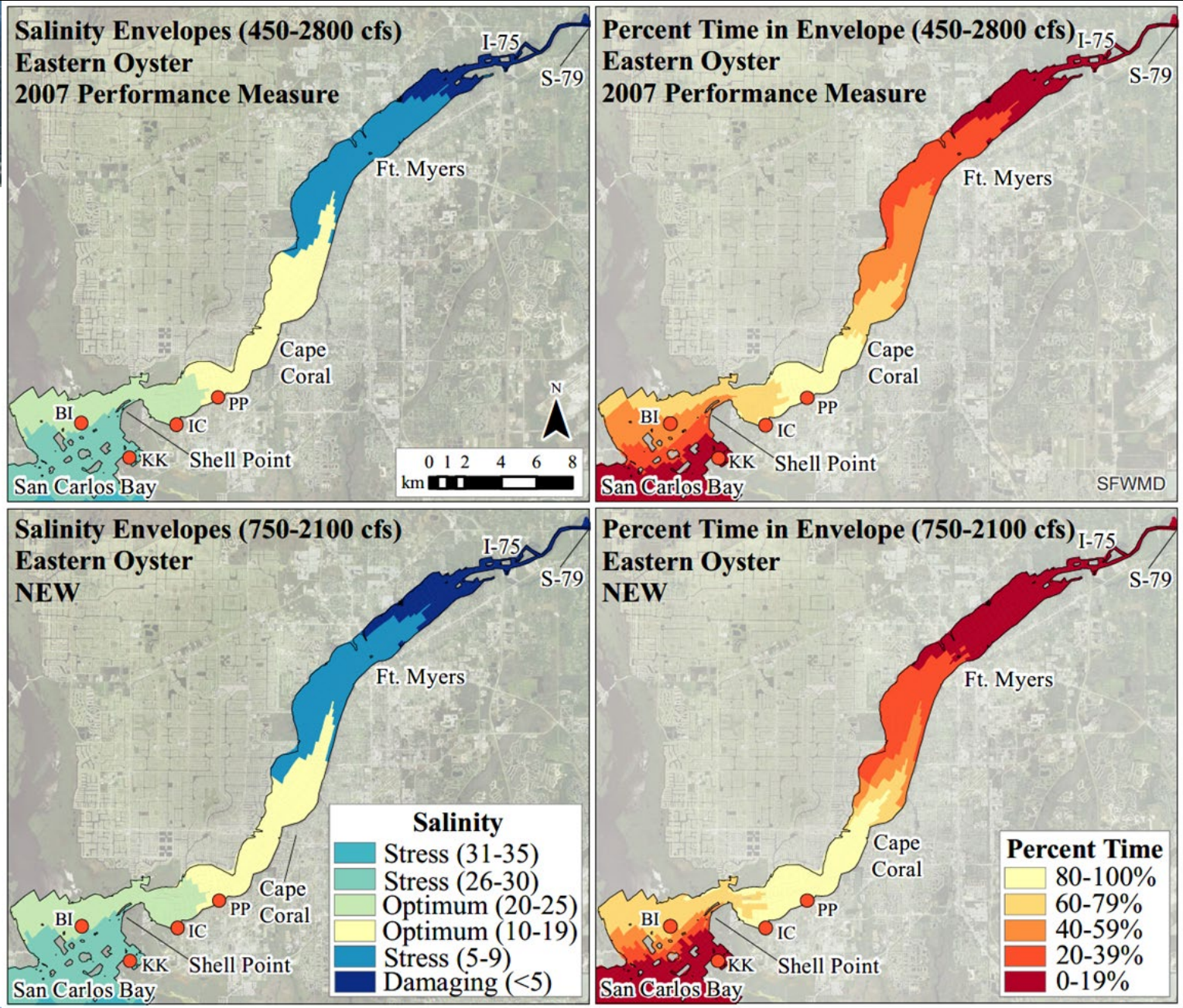

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**Eastern oyster** (*Crassostrea virginica*)

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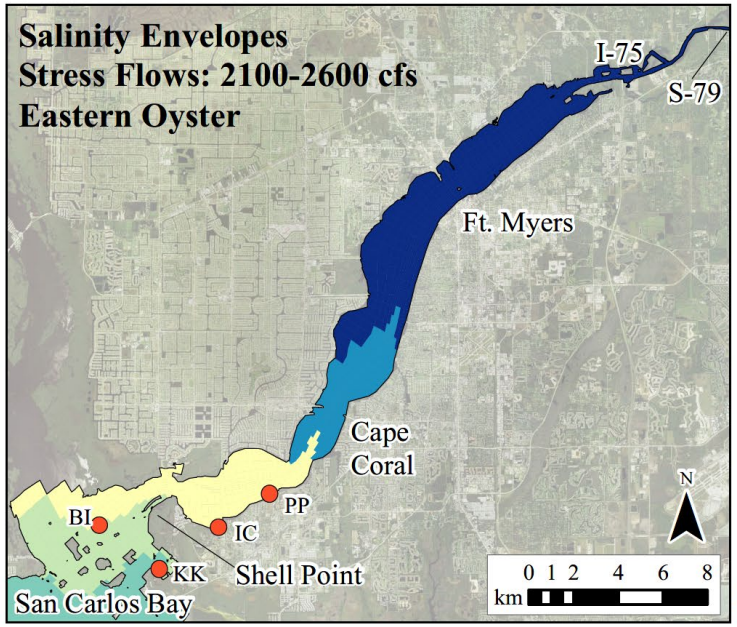


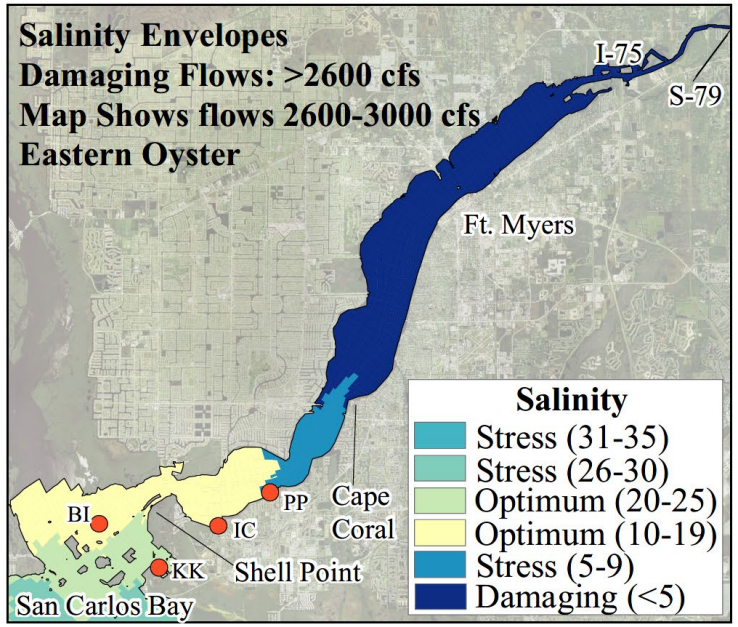


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# CERP

## PM Applications to CERP

- As restoration of the Everglades progresses, important to estimate the ecological response to restoration projects, water control plans, operation plans, and CERP as a whole
- Performance Measures (PMs) are tools used to evaluate the impact and effectiveness of CERP
- PMs used to document linkage between hydrologic output from models and ecosystem response to evaluate the degree to which alternative plans meet project objectives

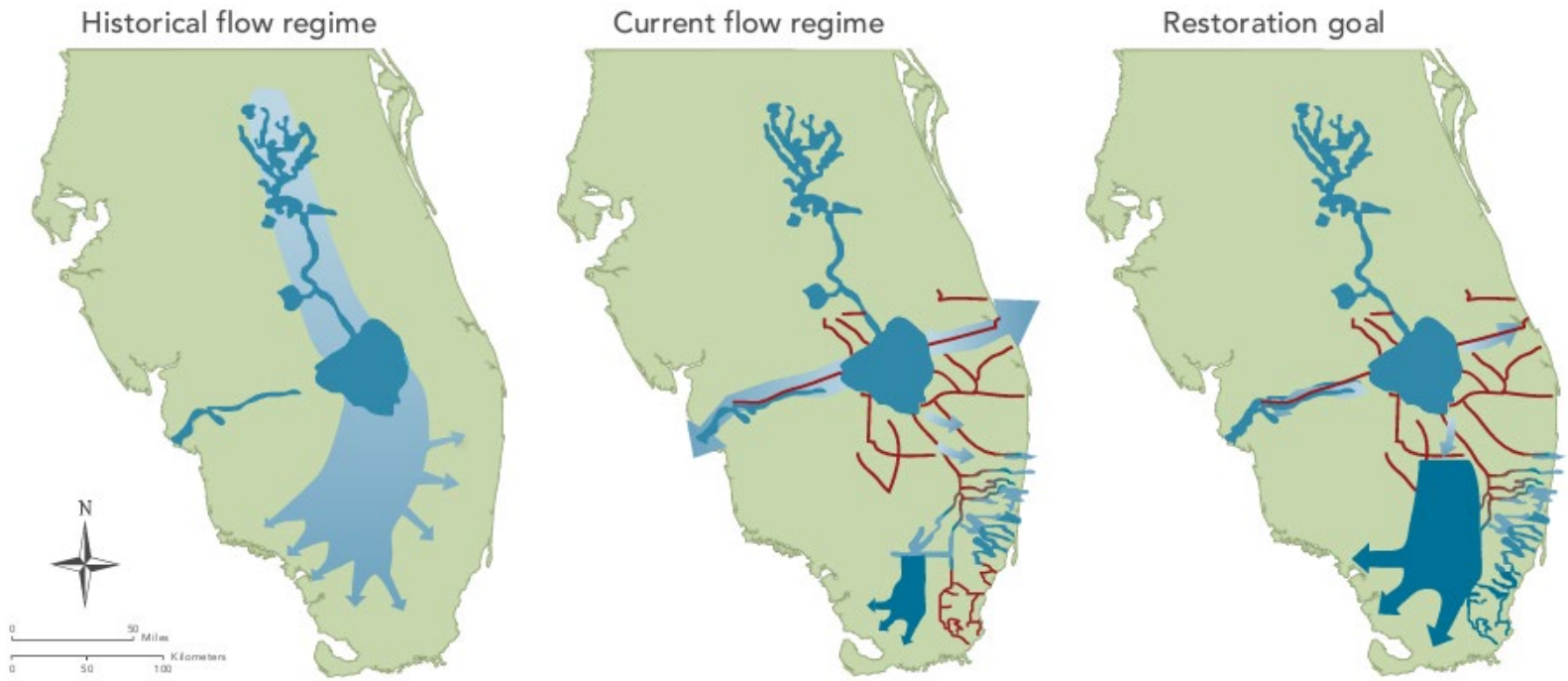
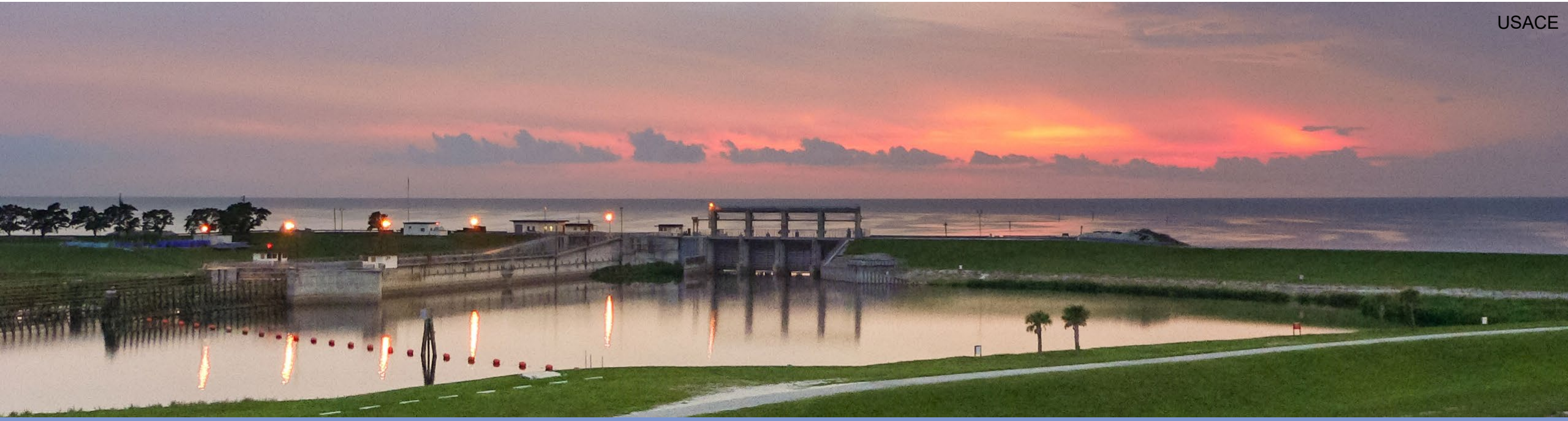



*Figure 1.1. The removal of water in the Everglades through a system of drainage canals (red lines) converted wetlands into areas suitable for farming and land development. Reestablished freshwater flows in the future will improve hydrologic conditions throughout south Florida and decrease salinity levels in Florida Bay and Biscayne Bay.*

# Application to LOSOM

- Northern Estuaries Salinity Envelope PM will be used as an ***ecological tool*** for Lake Okeechobee System Operating Manual (LOSOM) alternative scenarios – just one of many tools/metrics used in evaluation of alternatives


USACE

# Performance Measures

- Each PM has a predictive target or comparable performance scores and process for how to **measure predicted performance of alternatives**
- Targets are based on peer-reviewed relationships between hydrology and ecological species or communities, and technical synthesis reports of multiple data sources identifying restored conditions
- **PM scores are displayed as a function of restoration potential or achievement of the target**
- **Habitat Units (HU)** are used by projects to determine benefits of different alternatives (RECOVER does not use HUs, but their PMs can be scaled to calculate HU by a project team)
  - Habitat unit scores are produced by indexing the scores 0–1
  - The indexed scores are then multiplied by their proportion of the total index score for a given ecological zone and then multiplied by the area to get the HUs
- HUs are then evaluated for the **Existing Base Condition (ECB), Future-Without Project (FWO) condition, and each project alternative** to identify the best performer for each zone and the whole project area

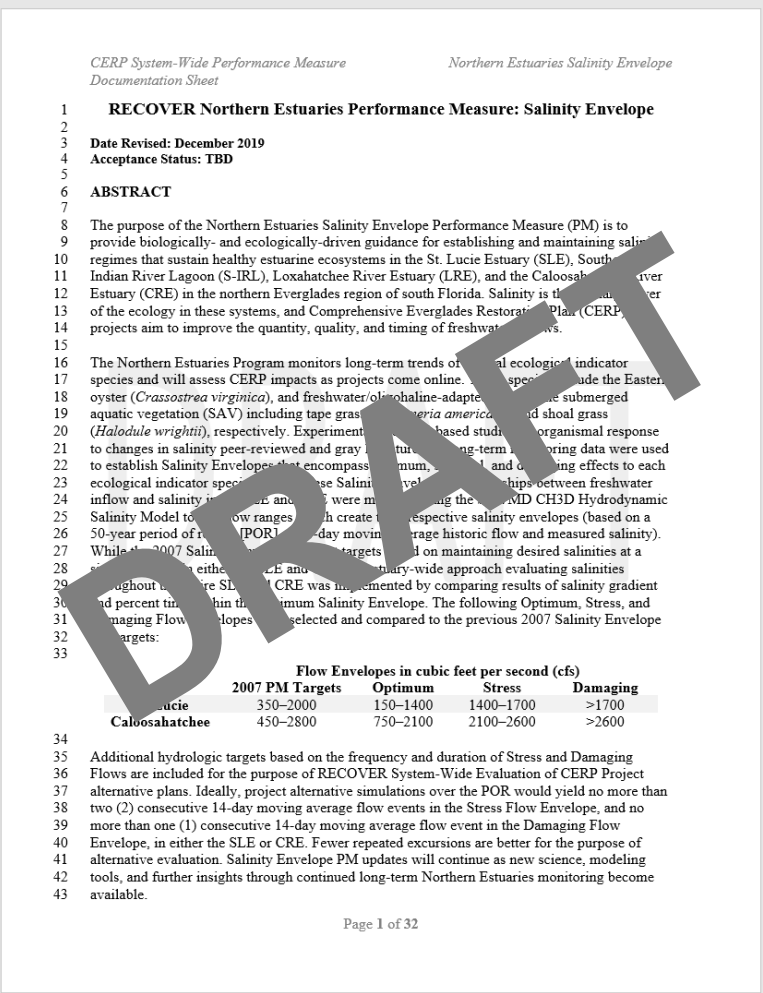
# PM Review Timeline

**RECOVER PM Review Process**
Northern Estuaries Regional Team Review
RECOVER Executive Committee (REC) Review

## RECOVER-Wide and Public Review April 28–May 28

****30 days**; longer than the usual 10 days for RECOVER PMs**
Revisions and response to RECOVER and Public comments 14 days

## REC Second Review and Approval early June



*CERP System-Wide Performance Measure Documentation Sheet* — *Northern Estuaries Salinity Envelope*

**RECOVER Northern Estuaries Performance Measure: Salinity Envelope**

**Date Revised: December 2019**
**Acceptance Status: TBD**

**ABSTRACT**

The purpose of the Northern Estuaries Salinity Envelope Performance Measure (PM) is to provide biologically- and ecologically-driven guidance for establishing and maintaining salin[illegible] regimes that sustain healthy estuarine ecosystems in the St. Lucie Estuary (SLE), South[illegible] Indian River Lagoon (S-IRL), Loxahatchee River Estuary (LRE), and the Caloosah[illegible]iver Estuary (CRE) in the northern Everglades region of south Florida. Salinity is th[illegible]er of the ecology in these systems, and Comprehensive Everglades Restorat[illegible] Plan (CERP) projects aim to improve the quantity, quality, and timing of freshwat[illegible]ws.

The Northern Estuaries Program monitors long-term trends of [illegible]al ecologic[illegible] indicator species and will assess CERP impacts as projects come online. [illegible] spec[illegible]ude the Easter[illegible] oyster (*Crassostrea virginica*), and freshwater/oligohaline-adapte[illegible]e submerged aquatic vegetation (SAV) including tape gras[illegible]*eria america*[illegible]d shoal grass (*Halodule wrightii*), respectively. Experiment[illegible] based studi[illegible] organismal response to changes in salinity peer-reviewed and gray [illegible]tur[illegible]ng-term [illegible]oring data were used to establish Salinity Envelopes that encompass [illegible]mum, [illegible] and [illegible]ing effects to each ecological indicator spec[illegible]se Salini[illegible]vel[illegible]ships between freshwater inflow and salinity i[illegible]E and [illegible] were m[illegible]ng the [illegible]MD CH3D Hydrodynamic Salinity Model to [illegible]ow ranges [illegible]h create t[illegible]espective salinity envelopes (based on a 50-year period of r[illegible] [POR] [illegible]-day movin[illegible]rage historic flow and measured salinity). While th[illegible] 2007 Salin[illegible] targets [illegible]d on maintaining desired salinities at a si[illegible] either [illegible]LE and [illegible]tuary-wide approach evaluating salinities [illegible]ughout t[illegible]re SL[illegible] CRE was im[illegible]emented by comparing results of salinity gradient [illegible]d percent tim[illegible]hin th[illegible]imum Salinity Envelope. The following Optimum, Stress, and [illegible]maging Flow [illegible]lopes [illegible]selected and compared to the previous 2007 Salinity Envelope [illegible]argets:

**Flow Envelopes in cubic feet per second (cfs)**

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| [illegible]ucie | 350–2000 | 150–1400 | 1400–1700 | >1700 |
| Caloosahatchee | 450–2800 | 750–2100 | 2100–2600 | >2600 |

Additional hydrologic targets based on the frequency and duration of Stress and Damaging Flows are included for the purpose of RECOVER System-Wide Evaluation of CERP Project alternative plans. Ideally, project alternative simulations over the POR would yield no more than two (2) consecutive 14-day moving average flow events in the Stress Flow Envelope, and no more than one (1) consecutive 14-day moving average flow event in the Damaging Flow Envelope, in either the SLE or CRE. Fewer repeated excursions are better for the purpose of alternative evaluation. Salinity Envelope PM updates will continue as new science, modeling tools, and further insights through continued long-term Northern Estuaries monitoring become available.

Page 1 of 32

Caloosahatchee Estuary in Fort Myers

# Thank you!

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