Central Everglades Tools & Techniques

Presented by:

Walter Wilcox

Hydrologic & Environmental Systems Modeling

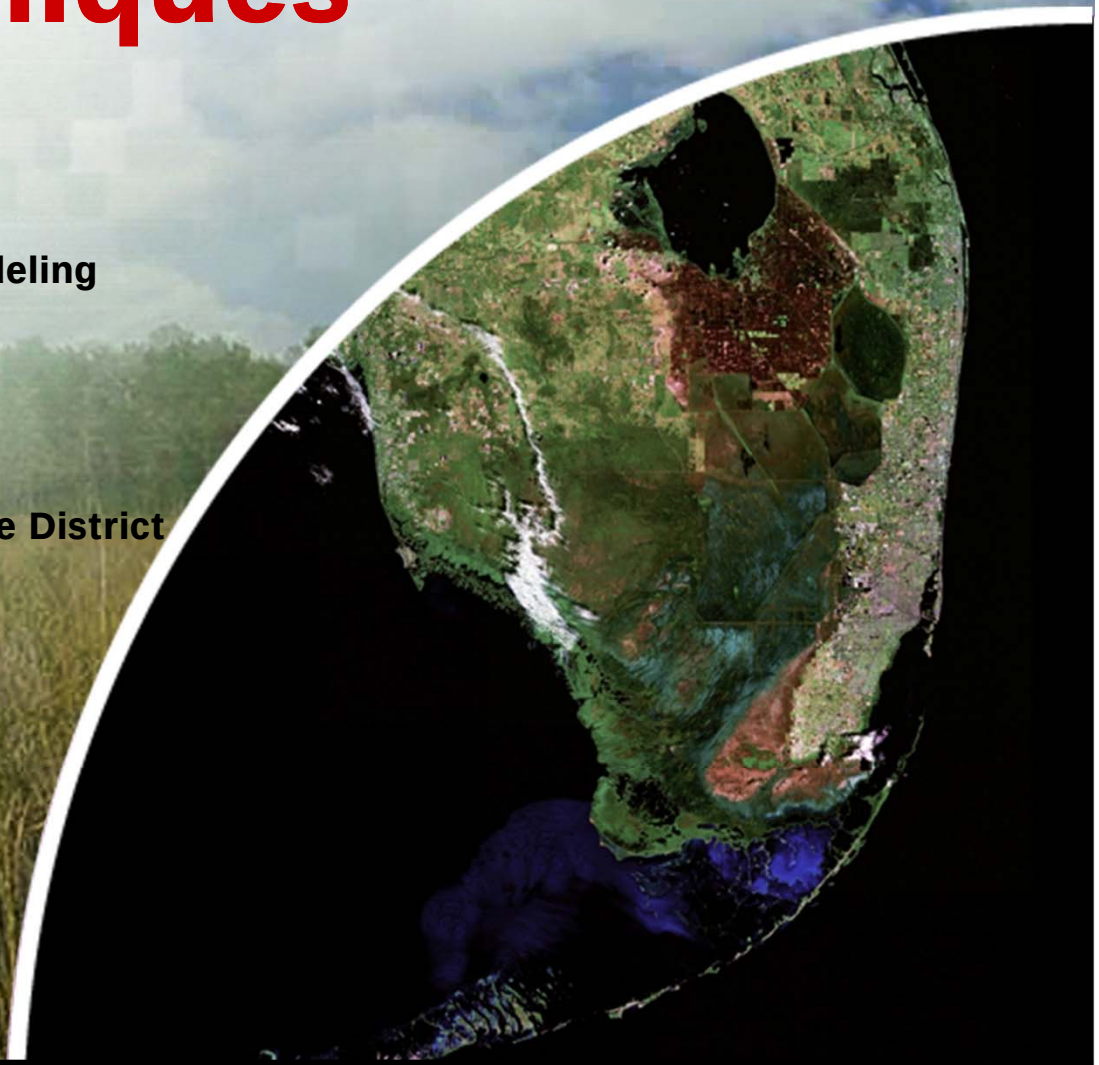
South Florida Water Management District

Melissa Nasuti

Central Everglades Study Branch

U.S. Army Corps of Engineers, Jacksonville District

November 30, 2011



Topics

- Modeling Tools Overview
  - Regional Hydrologic Models
  - Sub-regional & Detailed Models
  - Screening Tools and Techniques
- Ecological Evaluation Tools and Techniques Under Consideration
- Everglades Viewing Windows

Modeling Tools Overview

Modeling Toolbox

Regional Hydrologic Models

- Primary modeling tools for Central Everglades assessment. The models provide daily, detailed estimates of hydrology across the planning domain.

Sub-regional & Detailed Models

- Smaller scale, more detailed models to help analyze specific areas of interest (e.g. water quality, conveyance of water, etc...)

Screening Tools and Techniques

- Simplified models and data processing techniques to analyze a broad range of options and to screen ideas for further in-depth analysis.

Regional Hydrologic Modeling

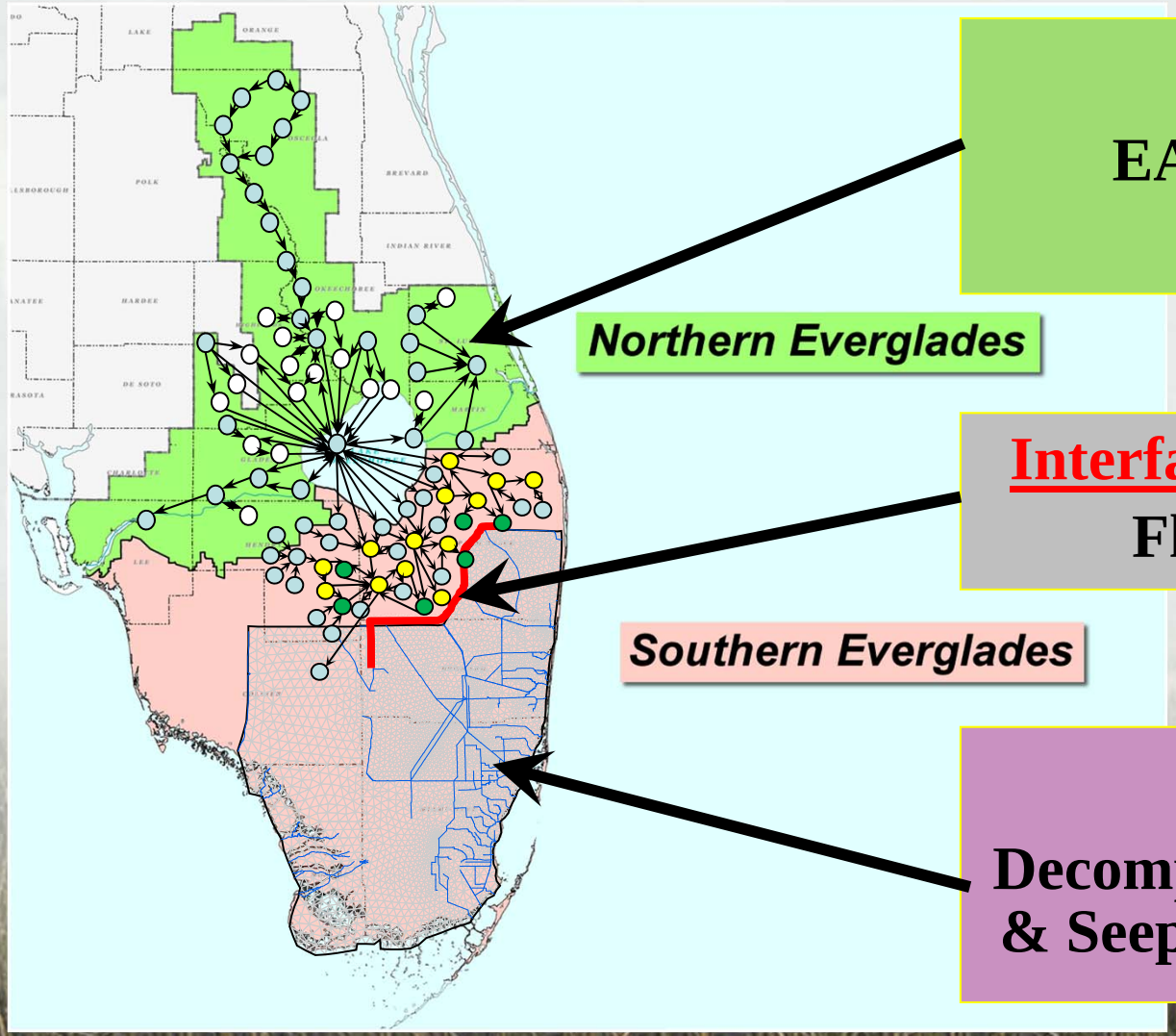
Purpose:

- Simulate detailed daily rainfall-runoff processes and flow routing within the Central Everglades planning region as a function of existing infrastructure and proposed configurations.

Strategy:

- Use a decoupled link-node model for the EAA, STAs and northern areas in combination with a detailed meshed model for the Everglades-Lower East Coast areas.

Decoupled Modeling Approach



RSMBN:
EAA Storage & Treatment

Interface ("Red Line"):
Flow Volumes

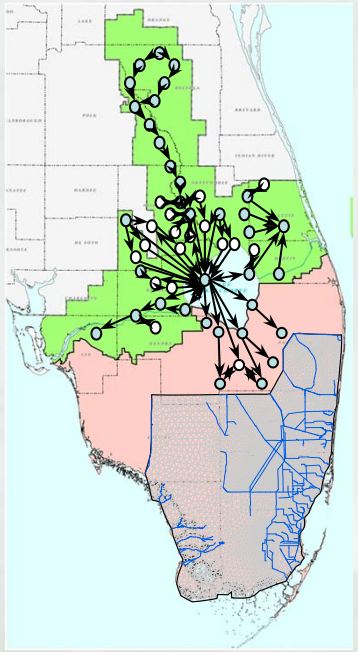
RSMGL:
Decompartmentalization & Seepage Management

Regional Modeling Approach

- **Climatic Input**
  - Rainfall
  - ET
- **Boundary Conditions**

Period of record:
1965-2005

Scenario



- **Project Features**
- **Land Use/Land Cover**
- **Water Demands**
- **Operating Criteria**

Model Output

- **Daily time series of water levels, flows**
- **Demands not met**

Evaluation (Environmental, Water Supply, etc…)

Regional Hydrologic Modeling

RSMBN (Basins)

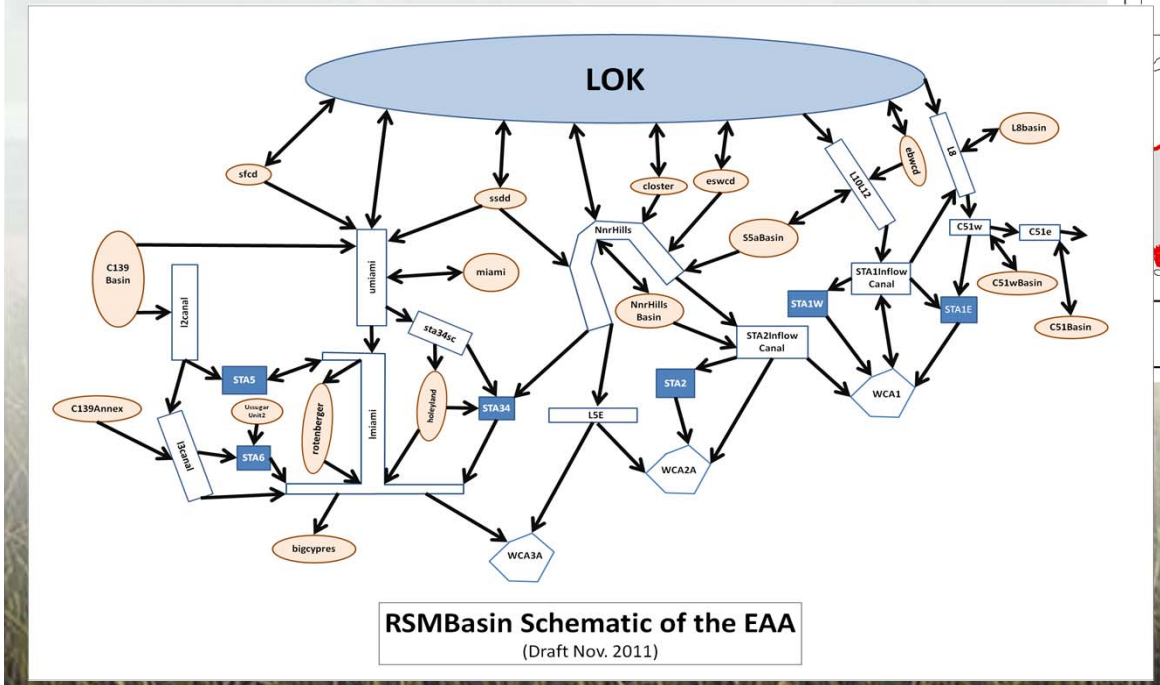
- A link-node application of the Regional Simulation Model (RSM) specific to Lake Okeechobee and basins in its vicinity, i.e., north of the “Red Line”
- Previously utilized for the SFWMD Northern Everglades planning initiatives (Lake Okeechobee Phase 2 Technical Plan and River Watershed Protection Plans)
- Will provide hydrologic representation of Lake Okeechobee, the Kissimmee Basin, the EAA and other northern watersheds including the Caloosahatchee and St Lucie Estuaries.

RSMBN (Basins)

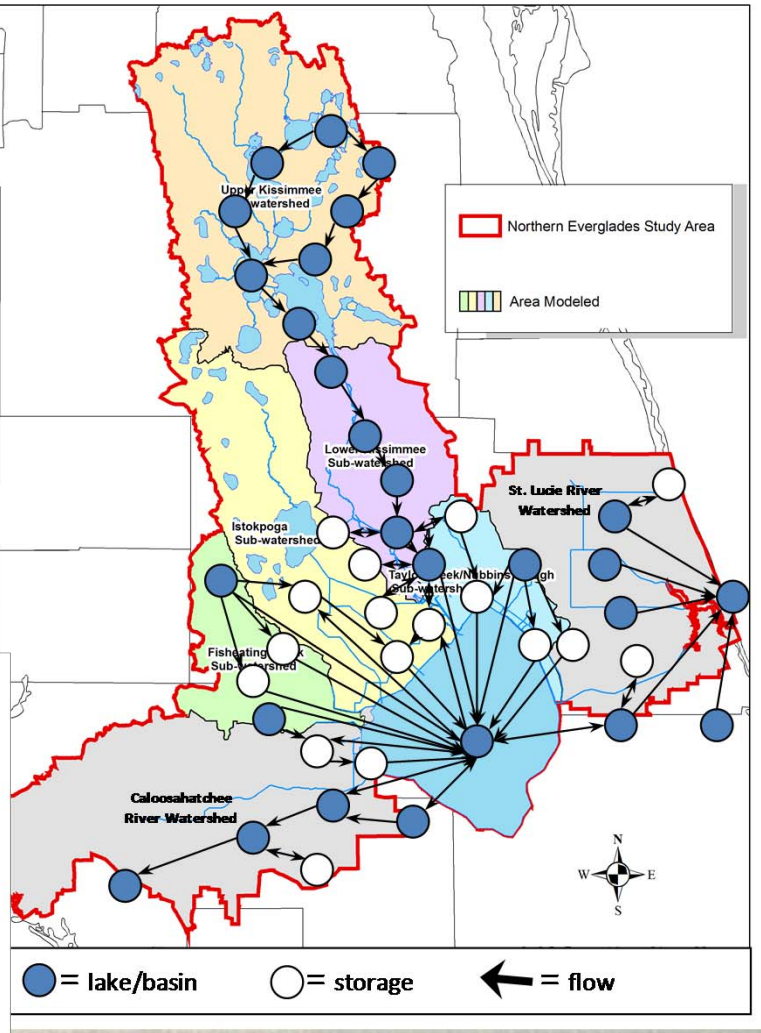
Node Information:
total number of basins/lakes/canals represented: ~110

Link Information:
total number of connections represented: ~155

Run Time:
~ 10 minutes



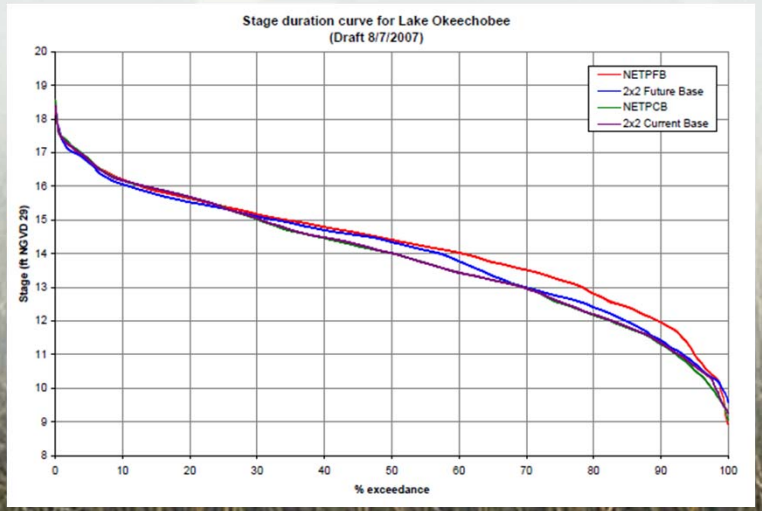
RSMBasin Schematic of the EAA
(Draft Nov. 2011)

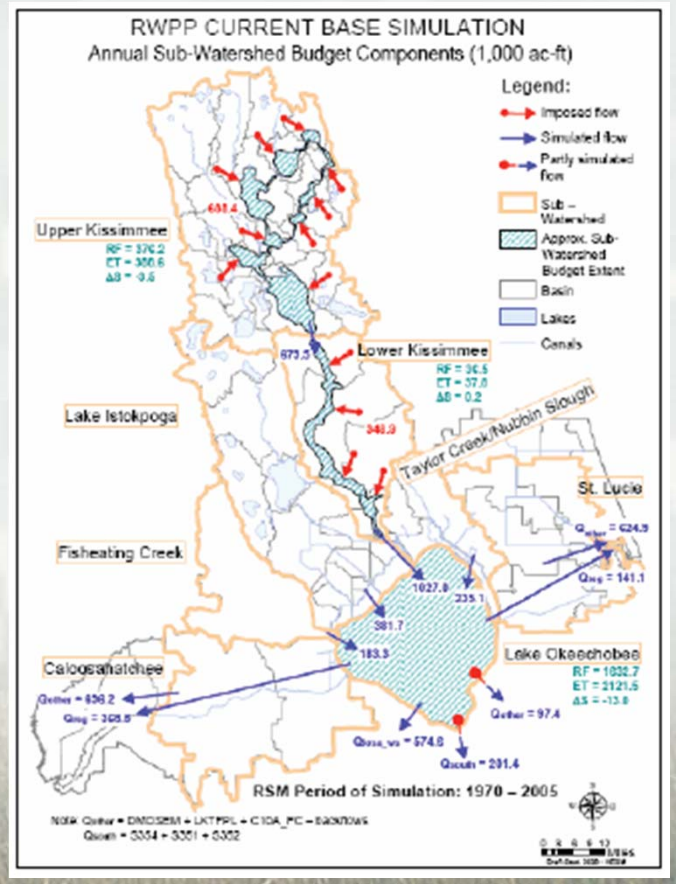


Domain Information:
EAA area represented: ~690 sq. miles

RSMBN Modeling Products

- Stages / Head
- Stage Duration Frequency Curves
- Hydrographs
- Flow Distributions
- Basin Water Budgets
- Water shortage indicators





Regional Hydrologic Modeling

RSMGL (Glades-LECSA)

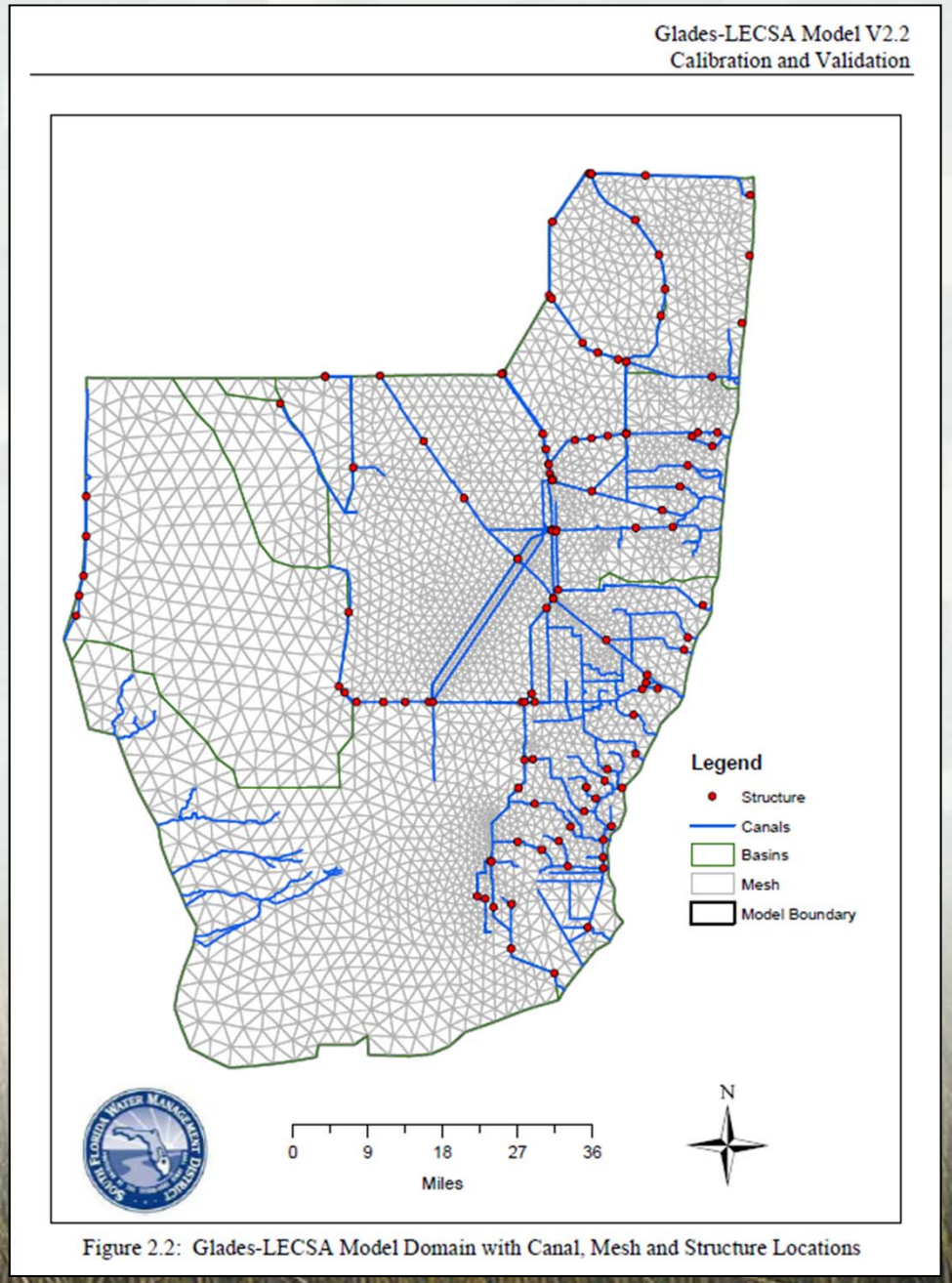
- A full mesh and canal network application of the Regional Simulation Model (RSM) specific to the Everglades and Lower East Coast service areas, i.e., south of the “Red Line”
- Previously utilized for the CERP DECOMP project
- Will provide detailed (cell-based) stage and flow information on a regional scale and account for current or proposed changes in southern system infrastructure and operations.

RSMGL (Glades-LECSA)

Mesh Information:
Number of cells: 5,794
Average size: ~ 1 s. mile
Domain size: 5,825 sq. miles

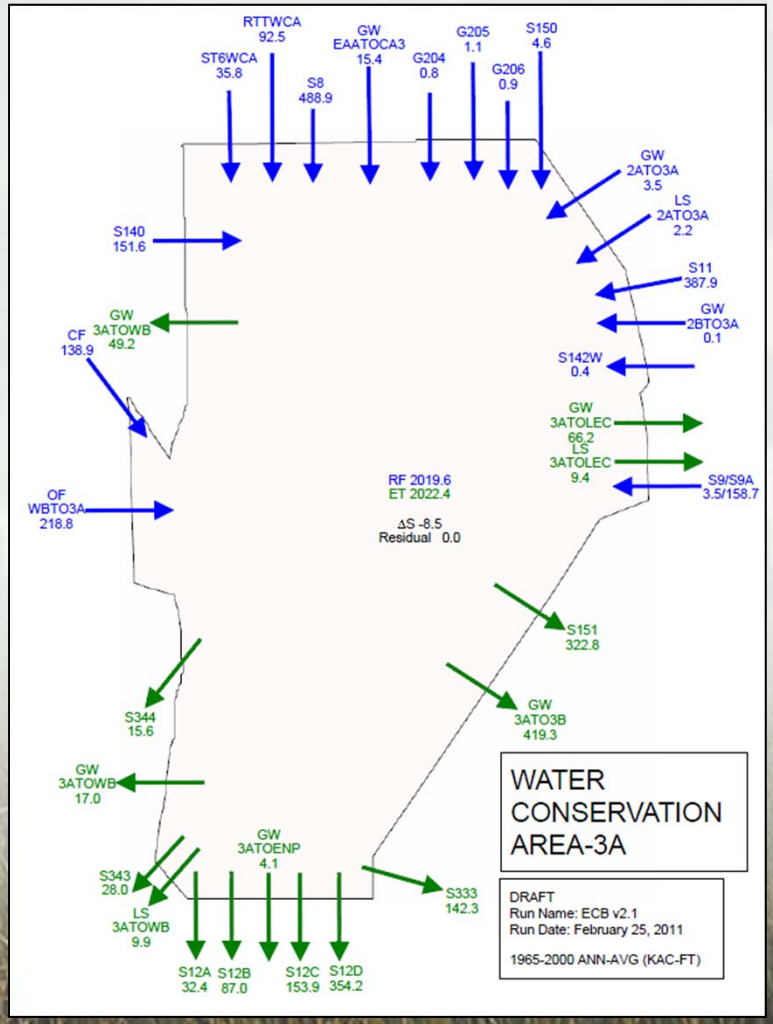
Canal Information:
Number of segments: 979
Average length: ~ 1 mile
Total length: 1,043 miles

Run Time:
~ 1 day



RSMGL Modeling Products

- Stages / Head
- Ponding Depths
- Hydroperiods
- Stage Duration Frequency Curves
- Hydrographs
- Groundwater Flow Vectors
- Overland Flow Vectors
- Transect Flows
- Basin Water Budgets

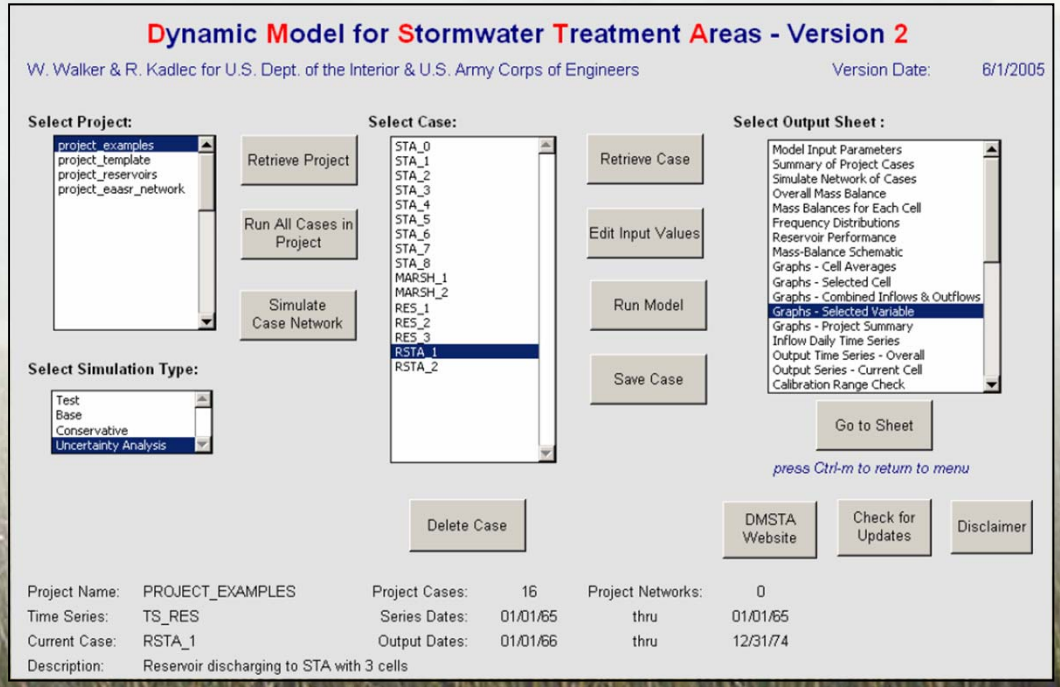


Sub-regional & Detailed Models

- On an as-needed basis, additional models may be applied to complement or assist the regional hydrologic models in analyzing system features.
- Examples of this type of model application will be shown for assessing water quality considerations and conveyance of water.
- Detailed flood assessment modeling is not envisioned within the Central Everglades Planning Project.

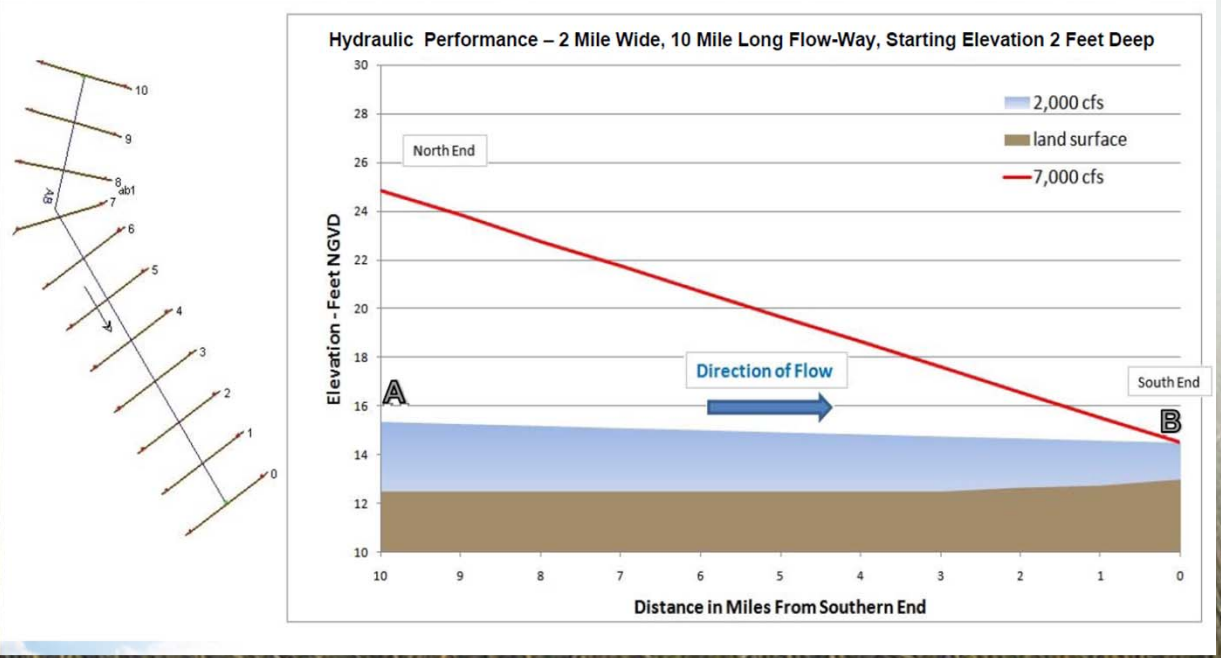
Example: Dynamic Model for Stormwater Treatment Areas (DMSTA)

- Developed for the U.S. Department of the Interior and the U.S. Army Corps of Engineers (Walker and Kadlec 2005)
- Extensively used in south Florida to analyze Stormwater Treatment Area design, operation & management



Example: HEC-RAS Hydraulic Tool

- **Hydrologic Engineering Center River Analysis System (HEC-RAS)**
  - Developed by the U.S. Army Corps of Engineers
  - Used nation-wide for design and analysis of conveyance systems

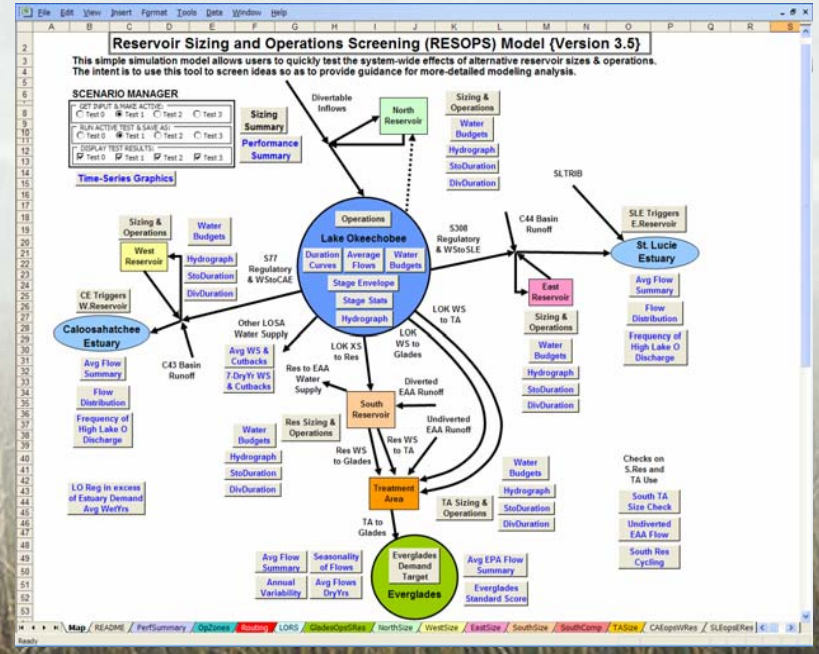


Screening Tools and Techniques

- The benefit of screening is to quickly test the performance of alternative configurations and scenarios to identify feasible ideas for further in-depth analysis.
  - Not a replacement for the detailed regional models
  - Can reduce the burden on the more complicated regional models (RSM) and inform project decision making efforts.
- Optimization techniques can be used to automatically evaluate thousands of operating rules and select the best performers.

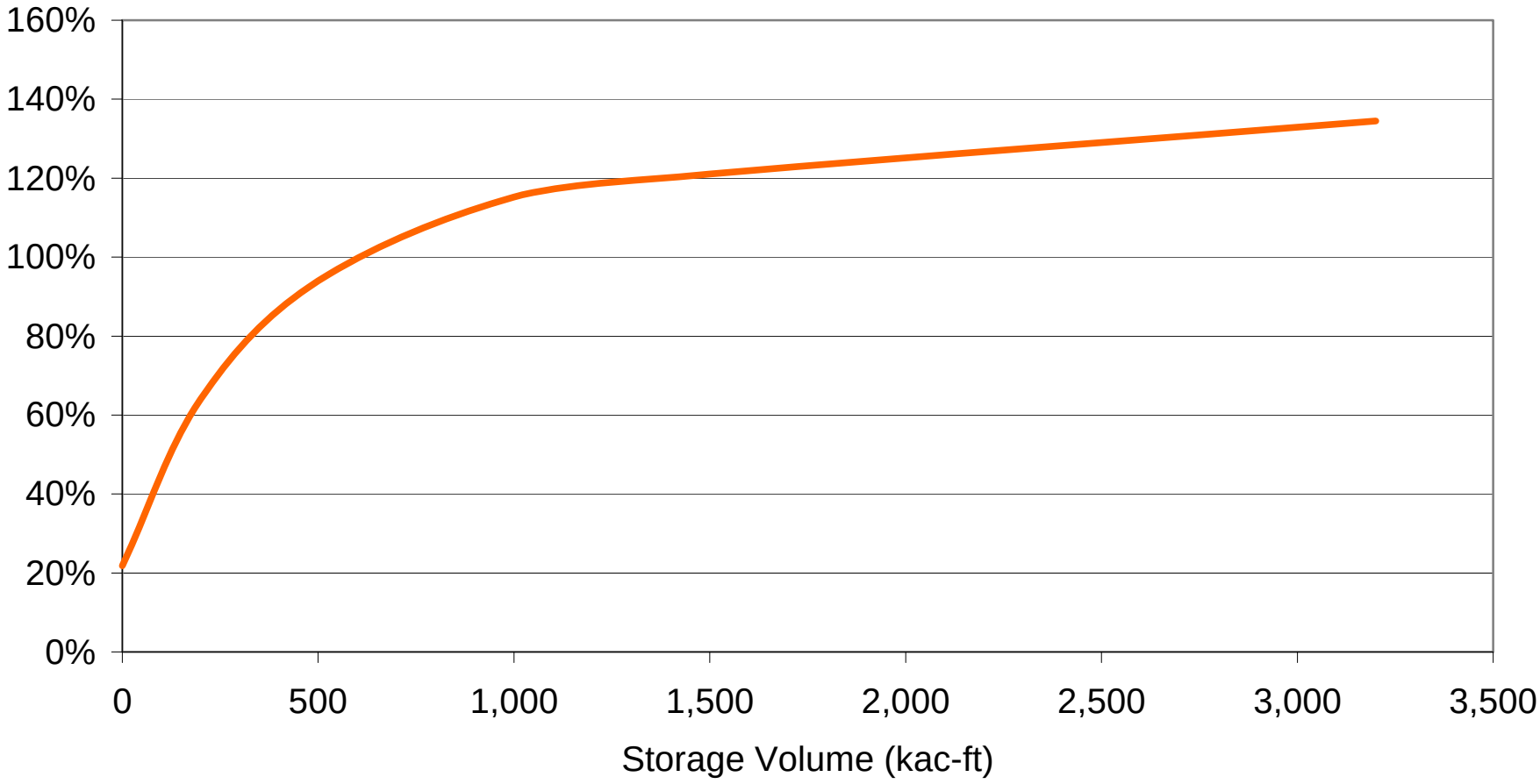
Example: REservoir Sizing and OPerations Screening (RESOPS) Model

- Coarse-scale Water Management Simulation Model
- Provides rapid screening-level testing of the integrated effects of alternative reservoir sizes and proposed operating rules for...
  - Lake Okeechobee,
  - EAA Storage
  - Other Northern Everglades Storage
  - Flows to the Everglades
- Performs 41-year continuous simulations (monthly time-step) of the hydrology and operations of the water management system
- Runtime = ~ 1 second

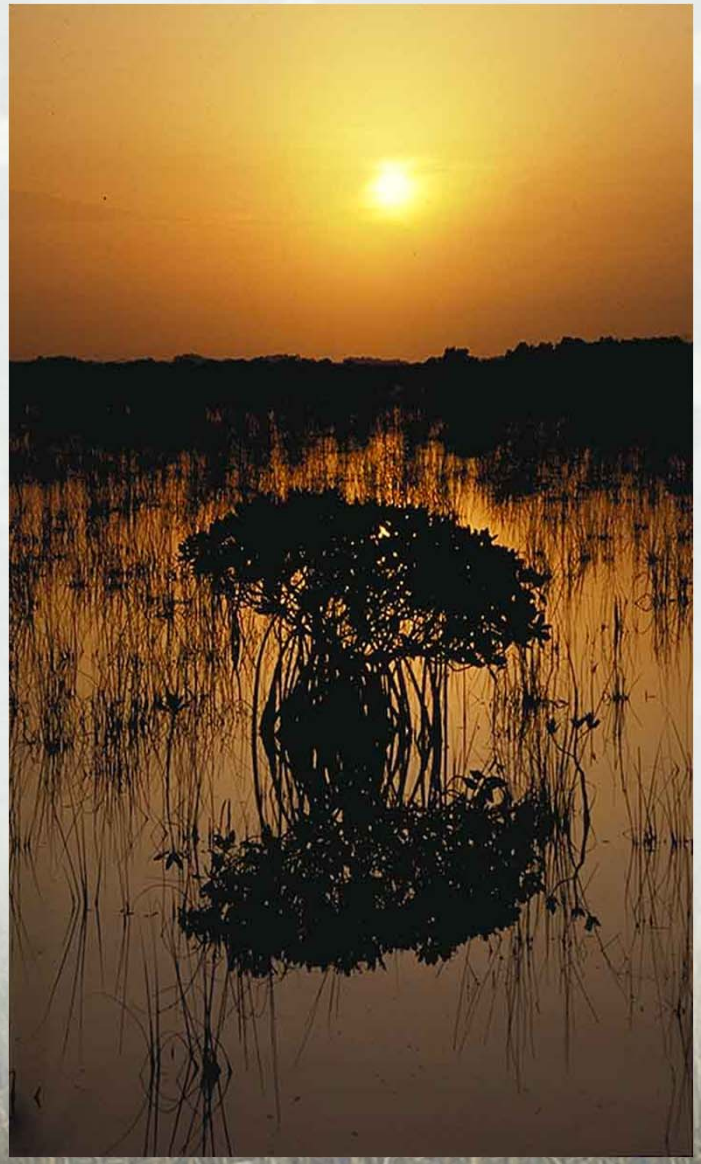


Example: Screening Techniques

Percentage Increase in Dry Season Flows to the Everglades with the Addition of Storage South of Lake Okeechobee



Based on RESOPS Screening Analysis of November to May Deliveries During the 1965 to 2005 Period.



DISCUSSION

Ecological Evaluation Tools and Techniques Under Consideration

Ecological Evaluation Tools and Techniques Under Consideration

- Performance measures are indicators of conditions in the natural system that have been determined to be characteristic of a healthy, restored ecosystem. Performance measures are used to predict performance of alternative plans.
- Identified preliminary list of project performance measures to be used in planning effort.
- Reviewed performance measures used previously for CERP projects to quantify ecosystem benefits. Included system-wide performance measures reviewed by RECOVER.
- Intent is to comprehensively evaluate all aspects of system in a concise manner.

Ecological Evaluation Tools and Techniques Under Consideration

Performance Measure	Description
Sheet flow in the Everglades Ridge and Slough Landscape	Measure of the timing and distribution of sheet flow across the landscape.
Number and Duration of Dry Events in Shark River Slough	Measure of the number of times and mean duration in weeks that water level drops below ground.
Inundation Pattern in Greater Everglades Wetlands	Measure of the number and duration of inundation events used to calculate the percent period of record of inundation.
Slough Vegetation Suitability	Measure to evaluate the hydrologic suitability for slough vegetation.
Hydrologic Surrogate for Soil Oxidation	Measure of cumulative drought intensity to reduce exposure of peat to oxidation.
Extreme High and Low Water Levels in Greater Everglades Wetlands	Measure of the number and duration of extreme high and low water depth events.
Prey-Based Freshwater Fish Density Performance Measure	Measure of small-sized fish density based on frequency of dry downs.
Northern Estuaries Oyster Habitat and Submerged Aquatic Vegetation	Measure of oyster and sea grass habitat based on frequency of flows from S-79 and S-80.

Ecological Evaluation Tools and Techniques Under Consideration

- **Path forward to confirm list of project performance measures at next PDT and Working Group Workshop.**

- **Further identify a standard list of evaluation methods/metrics used to evaluate Project Constraints and CERP Saving Clause requirements**

Everglades Viewing Windows

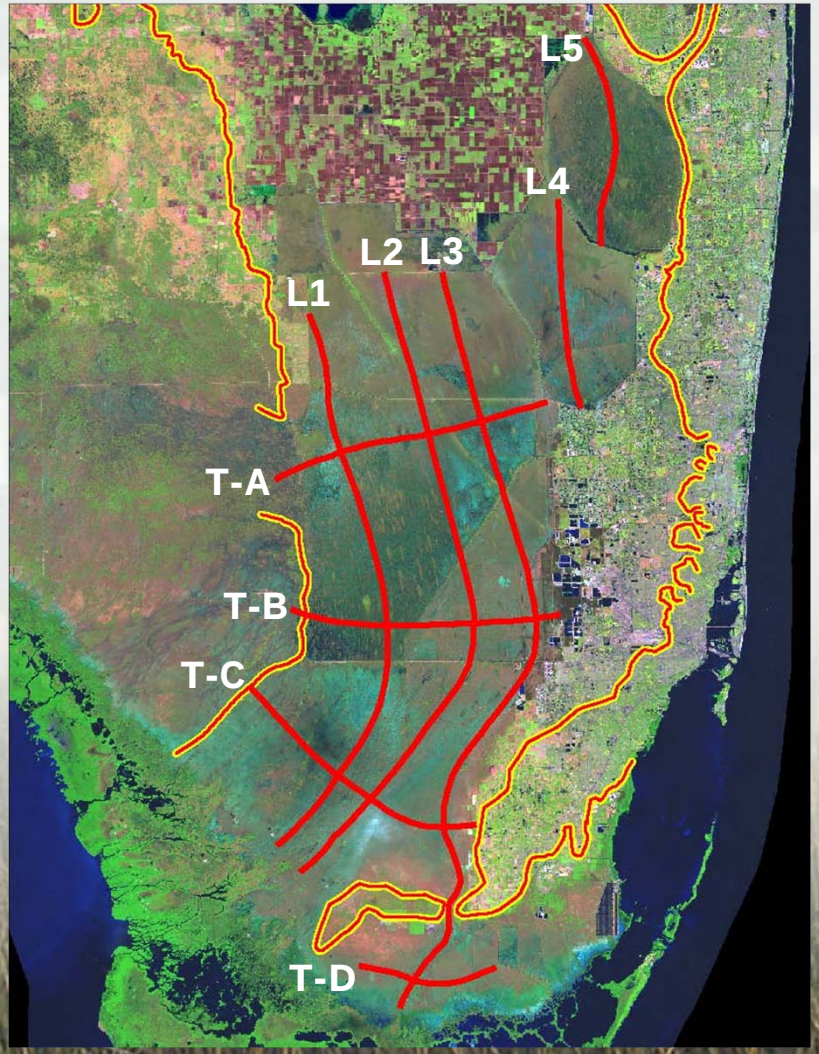
Supplemental Evaluation Tools - "Ever Views"

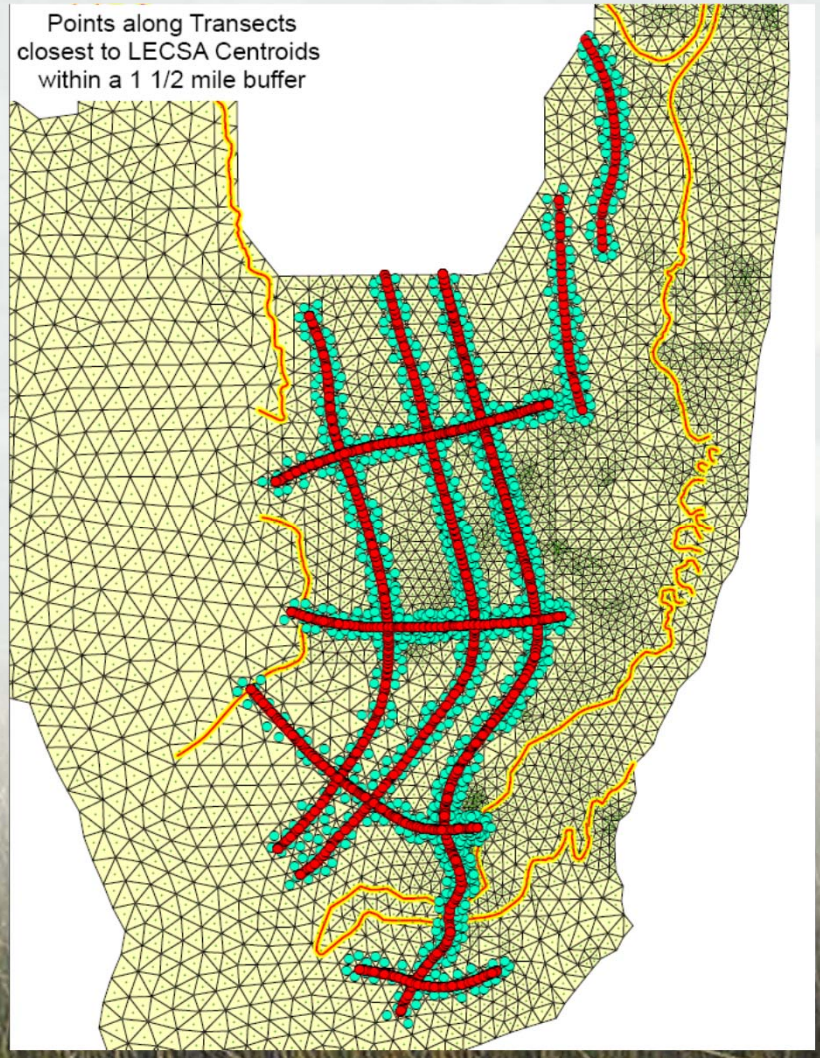
- **Viewing window concept**
  - Tools to link hydrology and ecology
- **<u>Neither</u> performance measures, <u>nor</u> targets**
  - But do facilitate whole system viewing
- **Applied equally across all Everglades models**
  - Pre-drainage, Current, Future

Supplemental Evaluation Tools - "Ever Views"

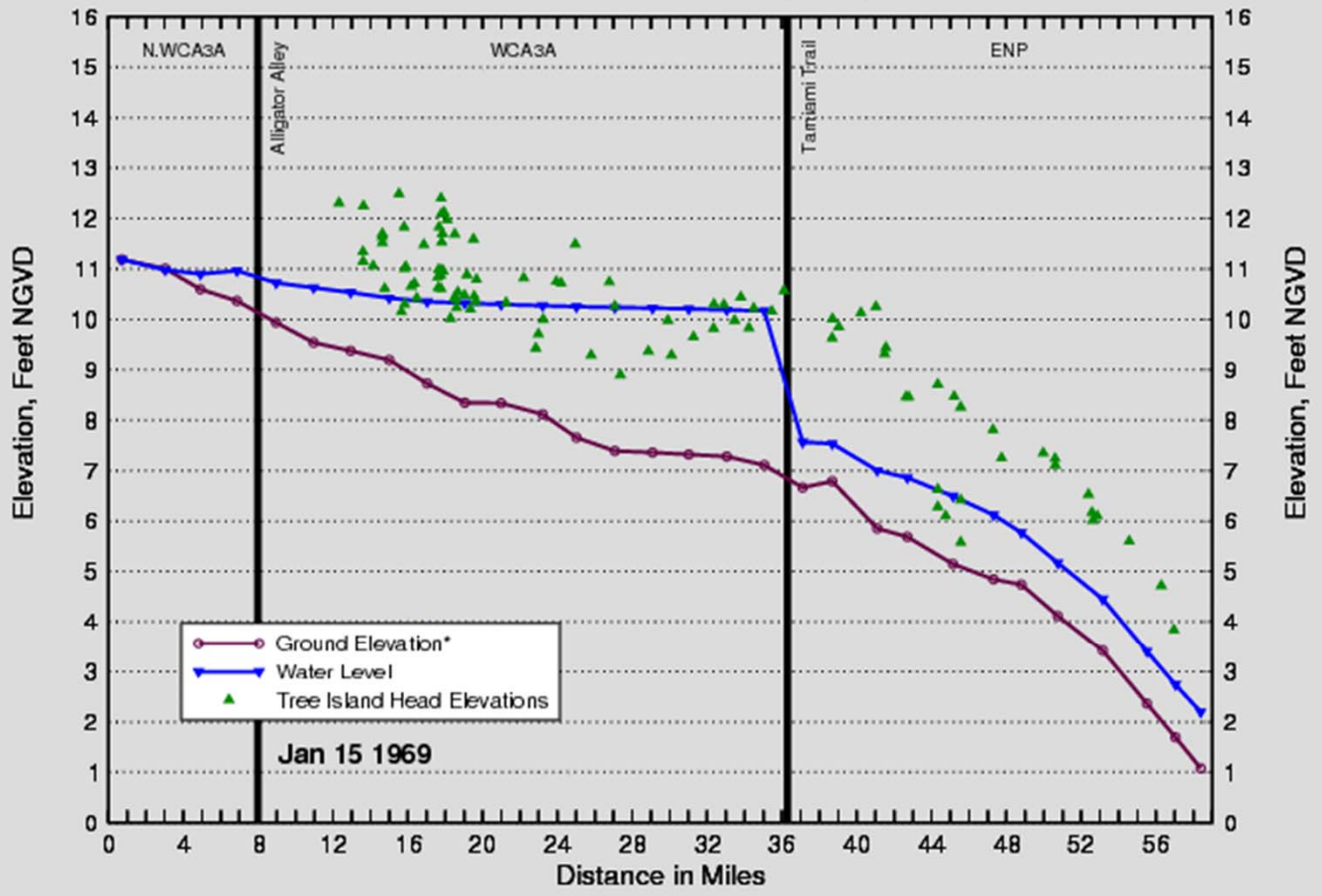
- Depth - Longitudinal and Transverse Transects
- Duration - Longitudinal and Transverse Transects
- Discharge - Transverse Transects
- Seepage - Transects
- Flow Directions
- Spatial Component

“Ever Views” Transects
Aligned with Landscape Directionality





CURRENT L1 Transect



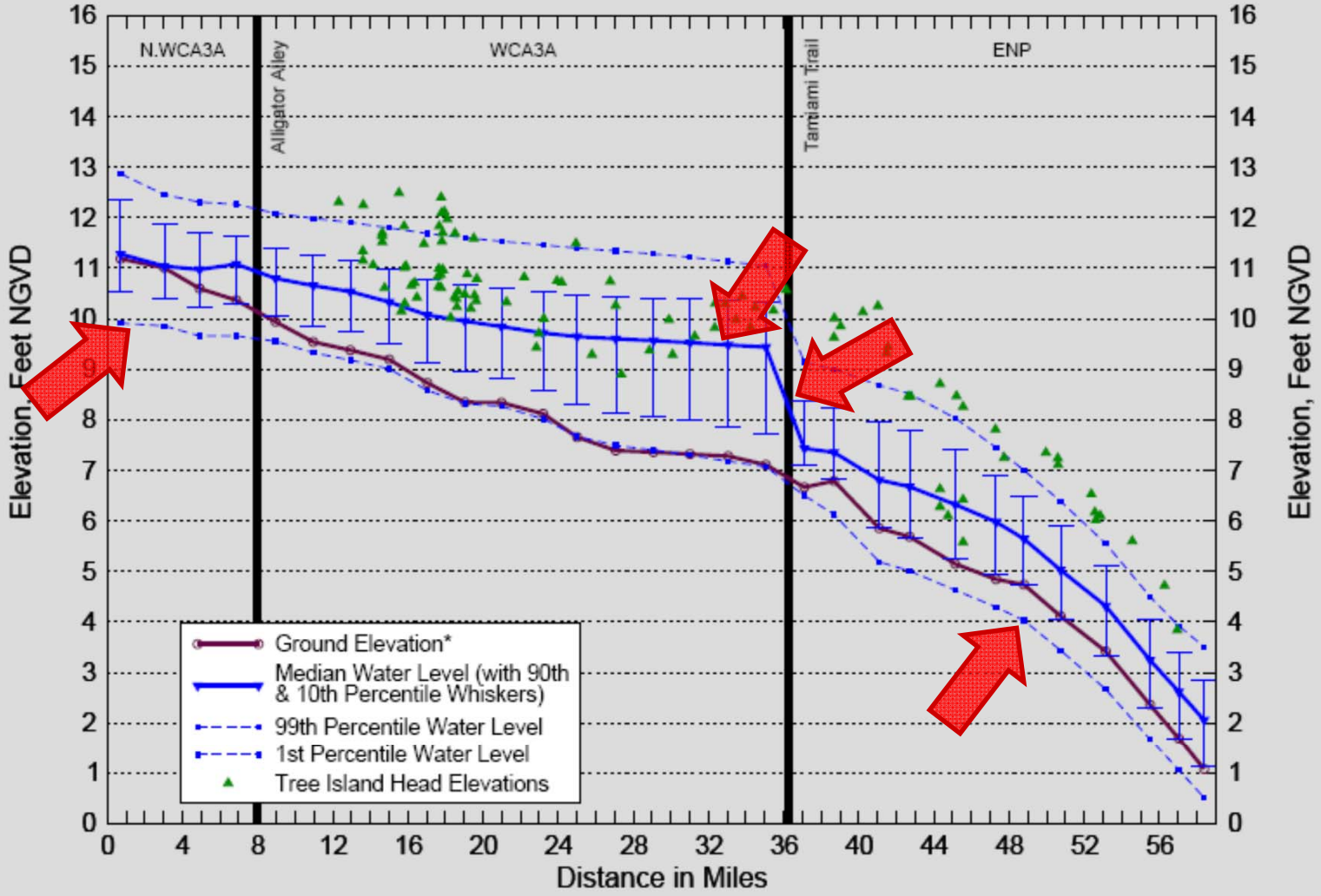
* Within the ridge & slough landscape, ground elevation = slough bottom.
For other landscapes, ground elevation = average model ground surface.

Script used: depth_transects.scr
Filename: depth_transects_L1_RSM_PCB1_GLD_rev_4848.agr

CURRENT
L1 Transect

Water Depth Viewing Window

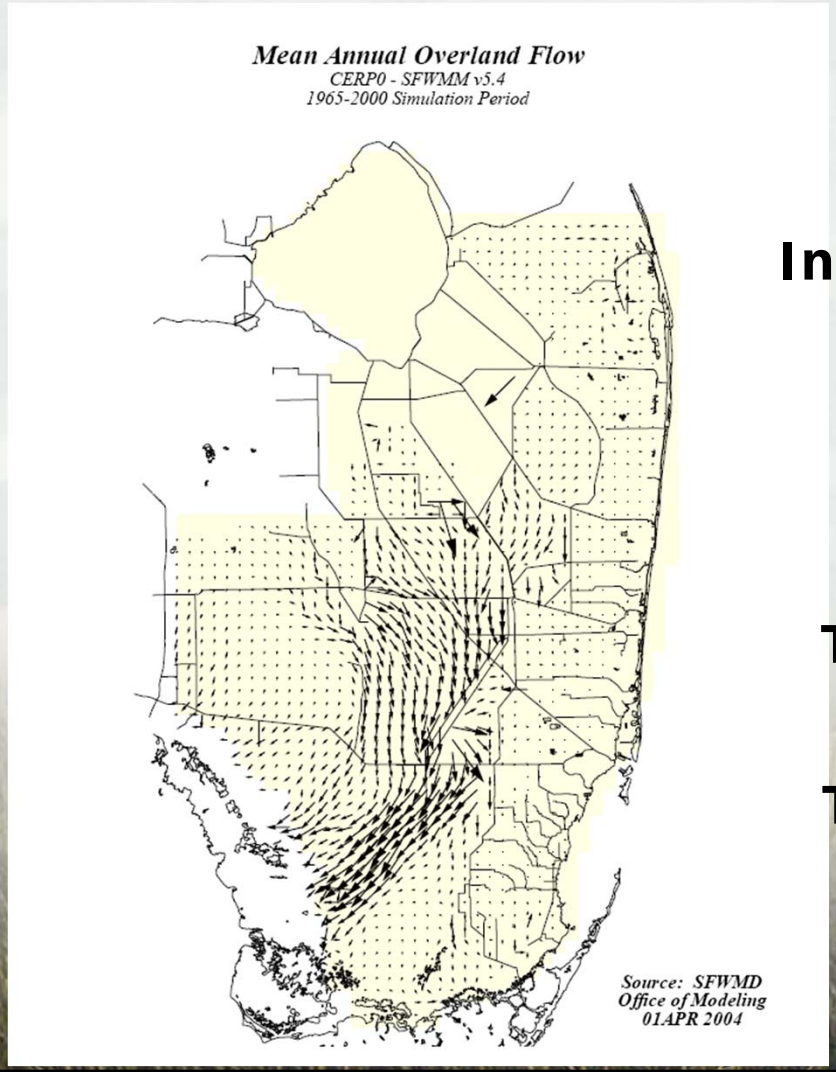
Transect L1 for Scenario RSM_PCB1_GLD_rev_4848



* Within the ridge & slough landscape, ground elevation = slough bottom.
For other landscapes, ground elevation = average model ground surface.

P.O.S. = 01-01-1965 to 12-31-2000
Script used: depth_transects.scr
Filename: depth_transects_L1_RSM_PCB1_GLD_rev_4848.agr

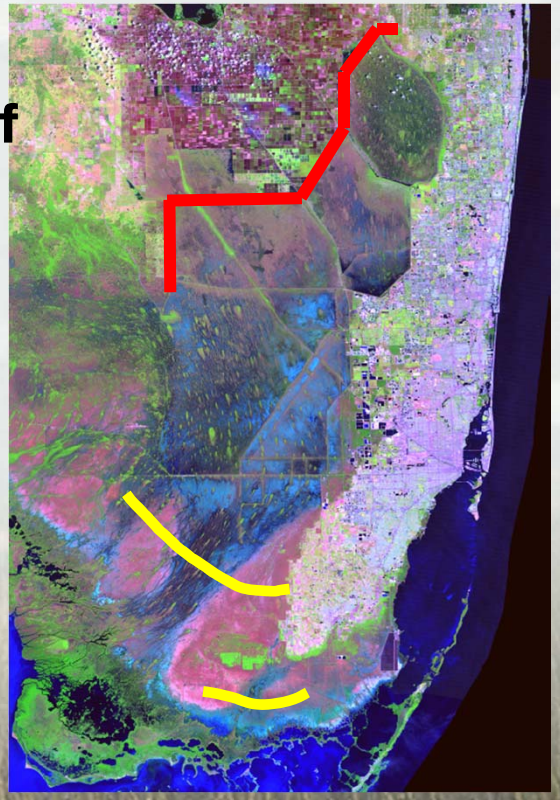
Flow Direction & Discharge Windows "CERP0" Future Restored Condition



Inflows = 1.72 mAf

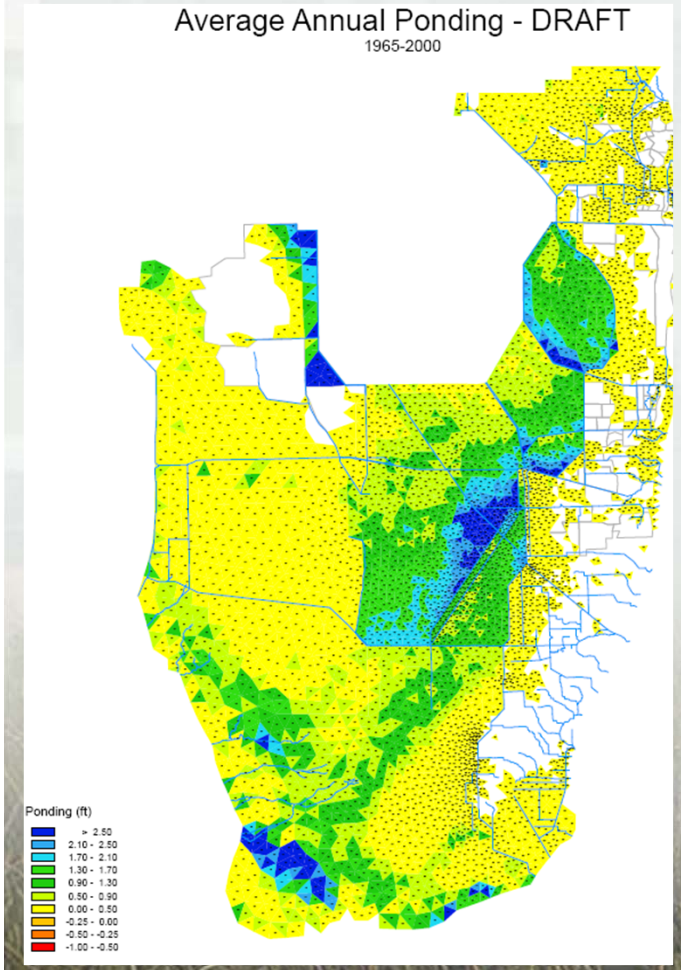
T-C = 1.38 mAf

T-D = 0.11 mAf

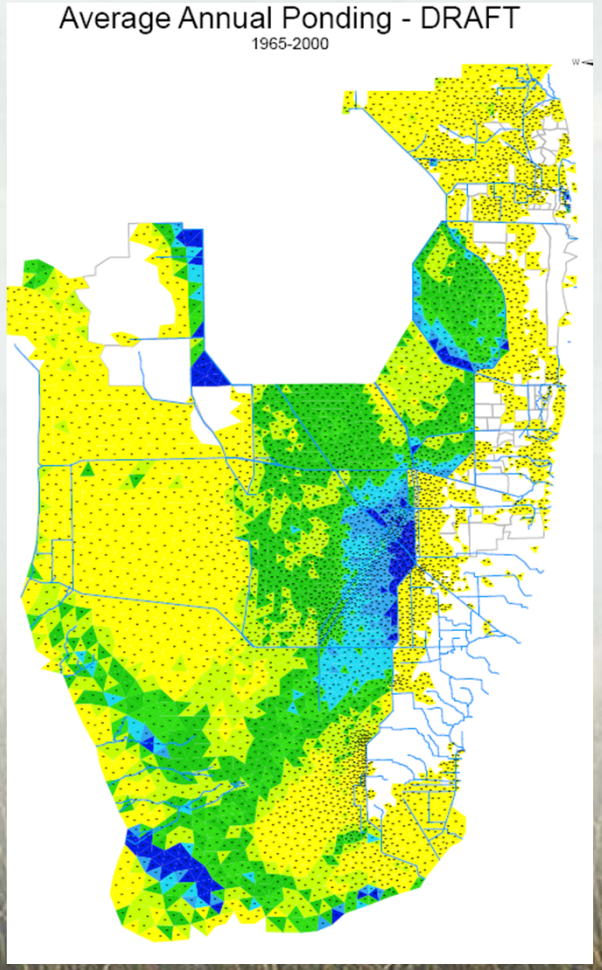


Spatial Viewing Window (Ponding)

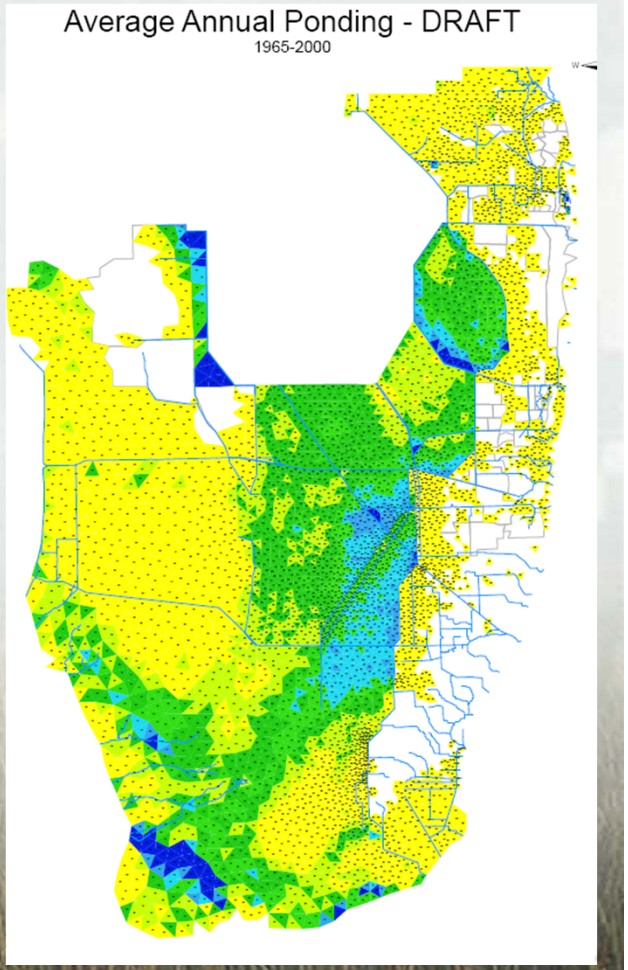
Current

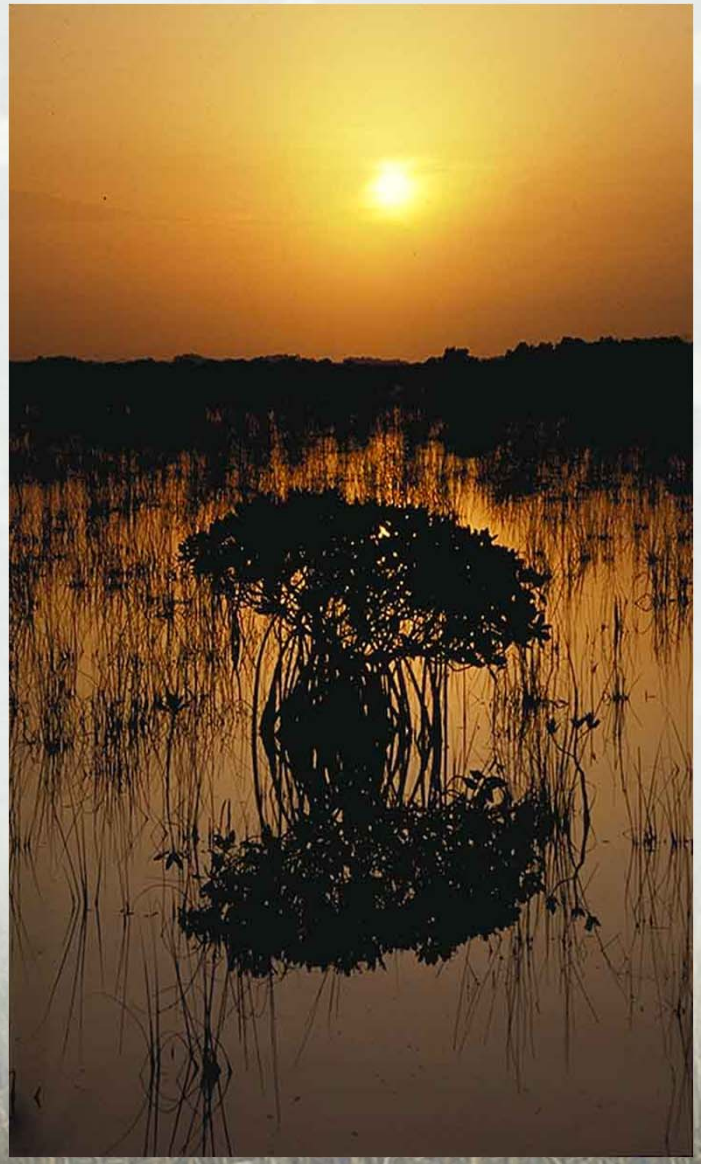


Example 1



Example 2





DISCUSSION