Modeling at SFWMD

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Presentation for
ELM Peer Review Panel
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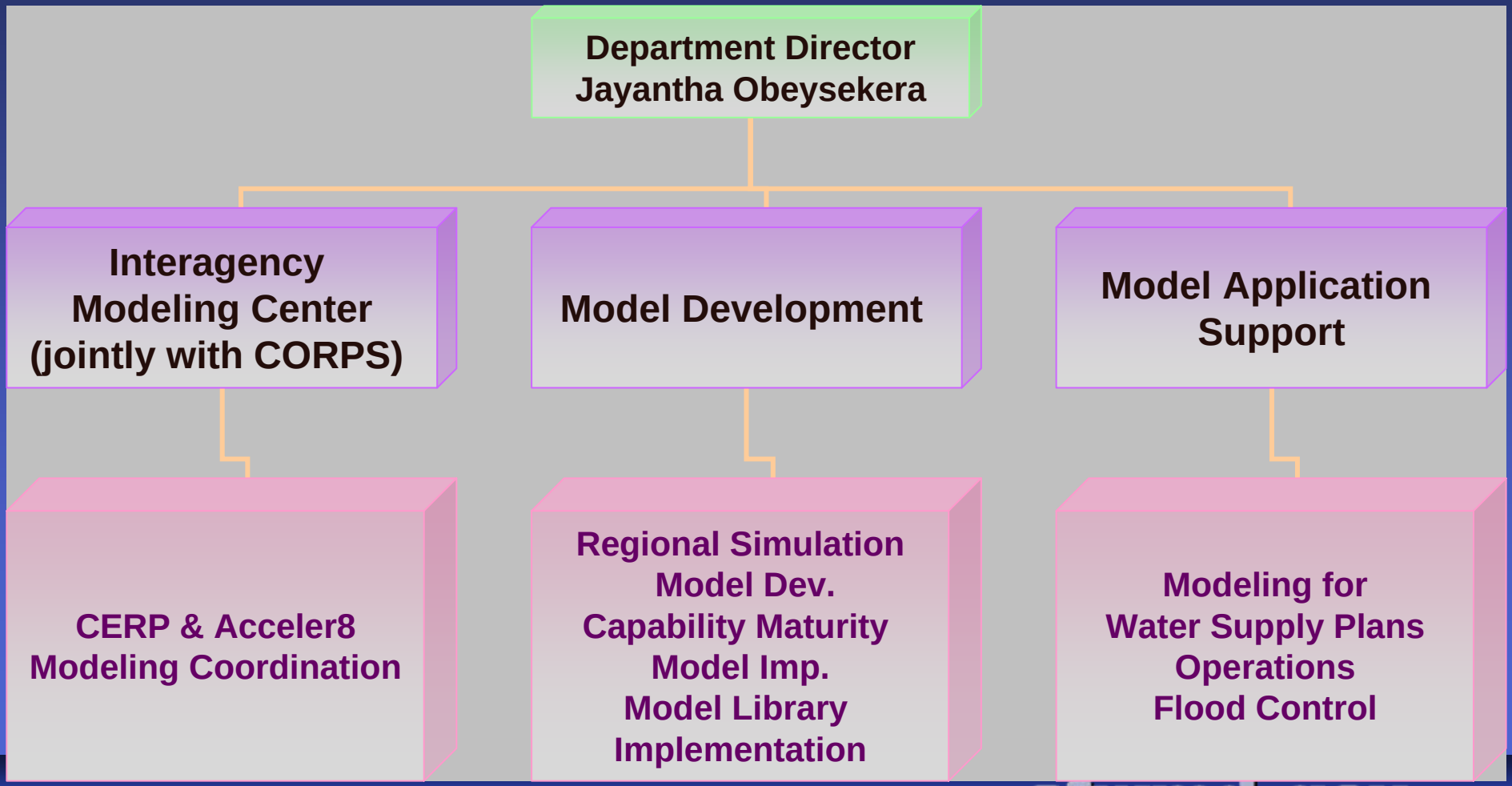
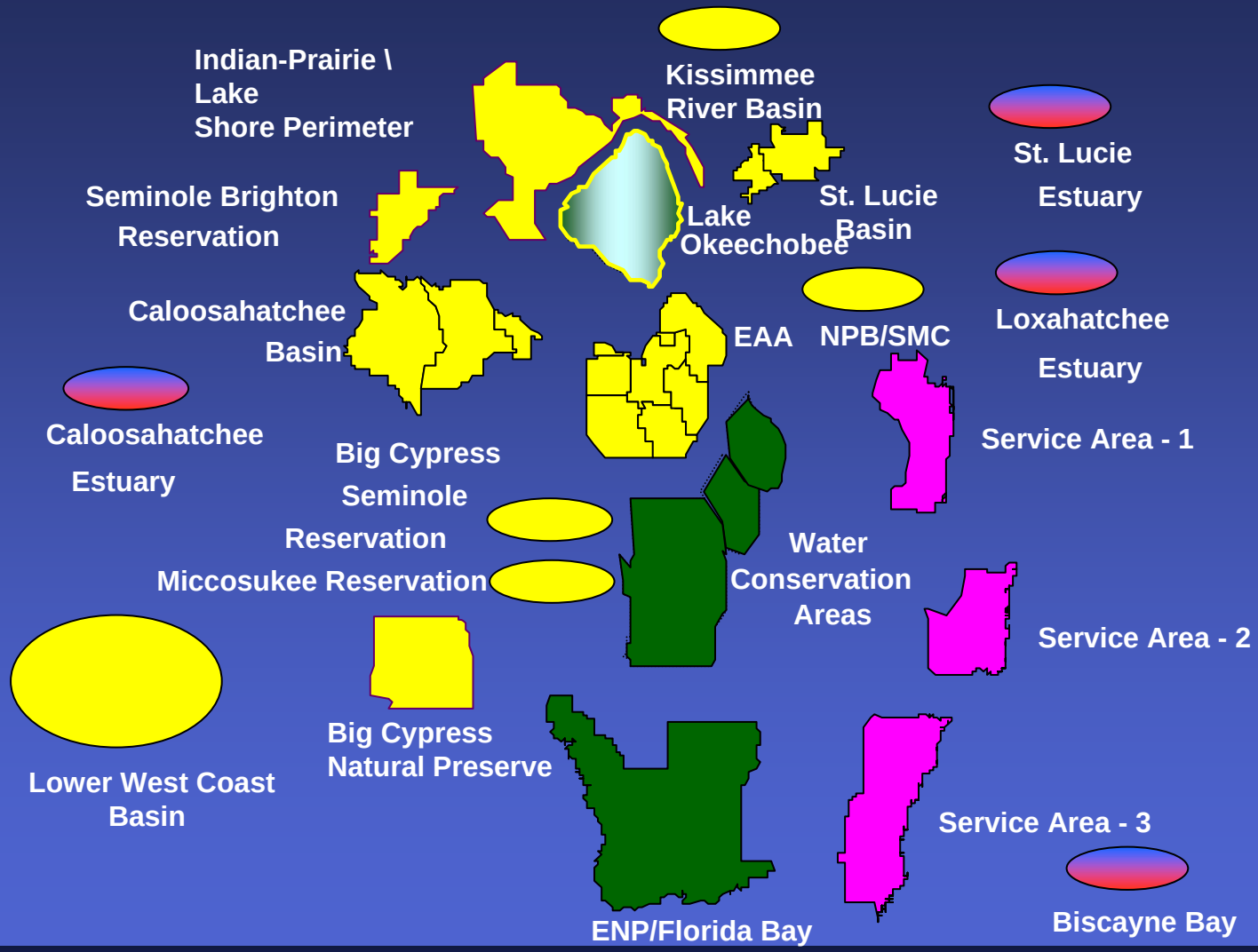
Modeling at the District

- Hydrologic & Environmental Systems Modeling Department
  - Centralized Model Development
  - Regional Modeling (Development, Implementation, Application)
- Other Departments
  - Model Implementation & Application

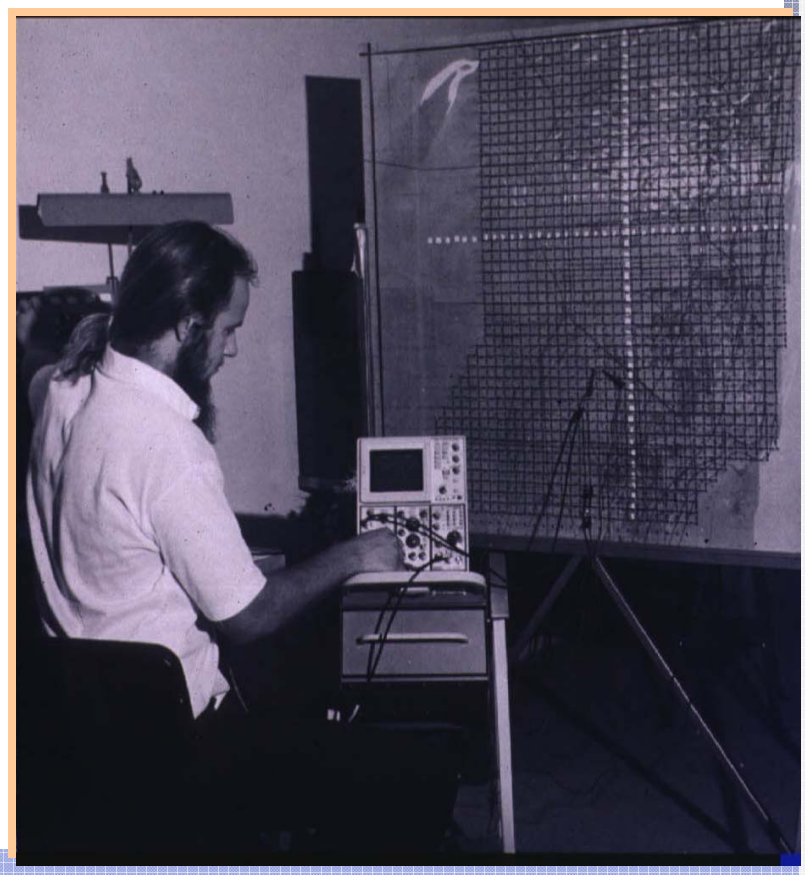
HYDROLOGIC & ENVIRONMENTAL SYSTEMS MODELING (HESM)



Complexities of the South Florida System



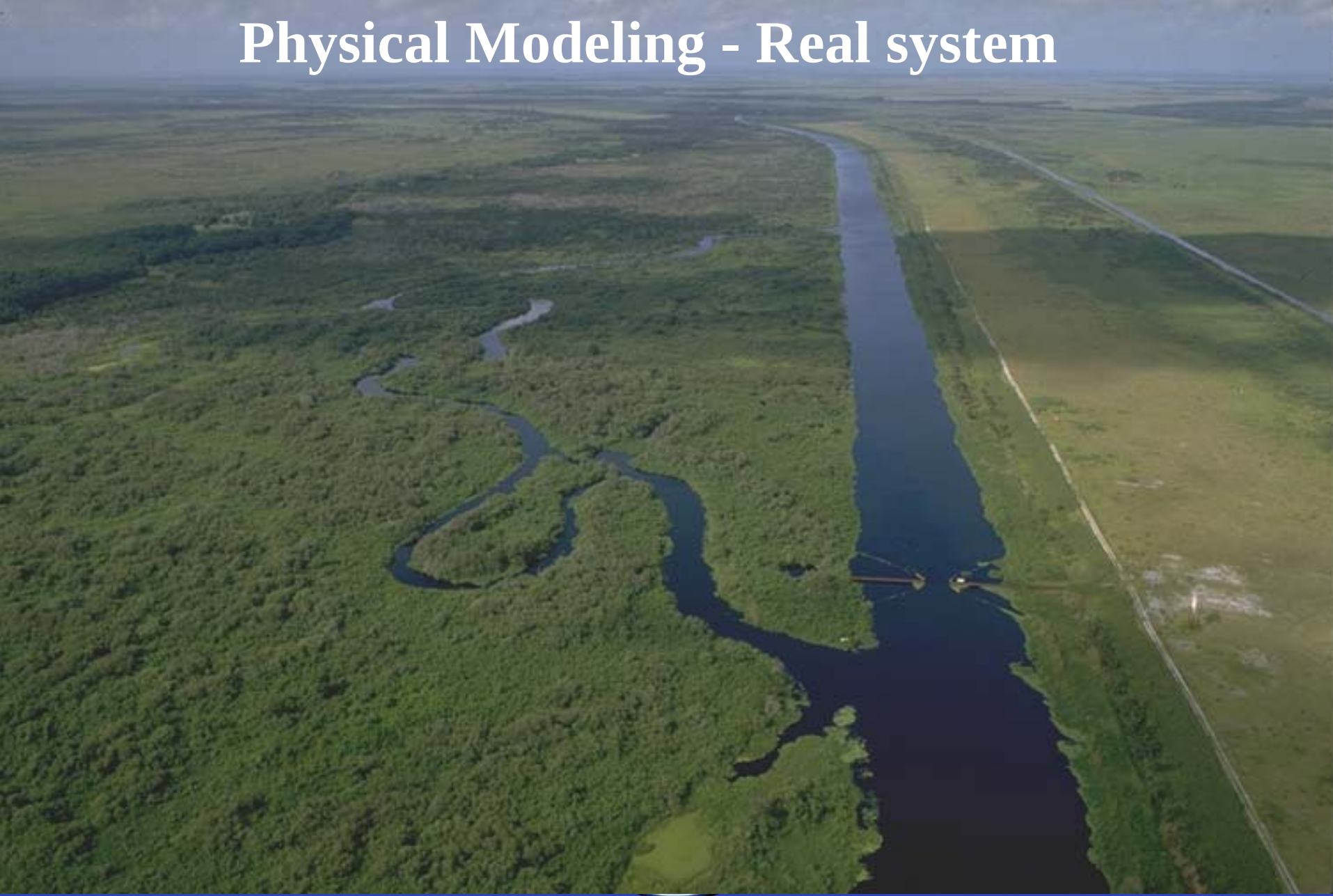
Decade of the 70s



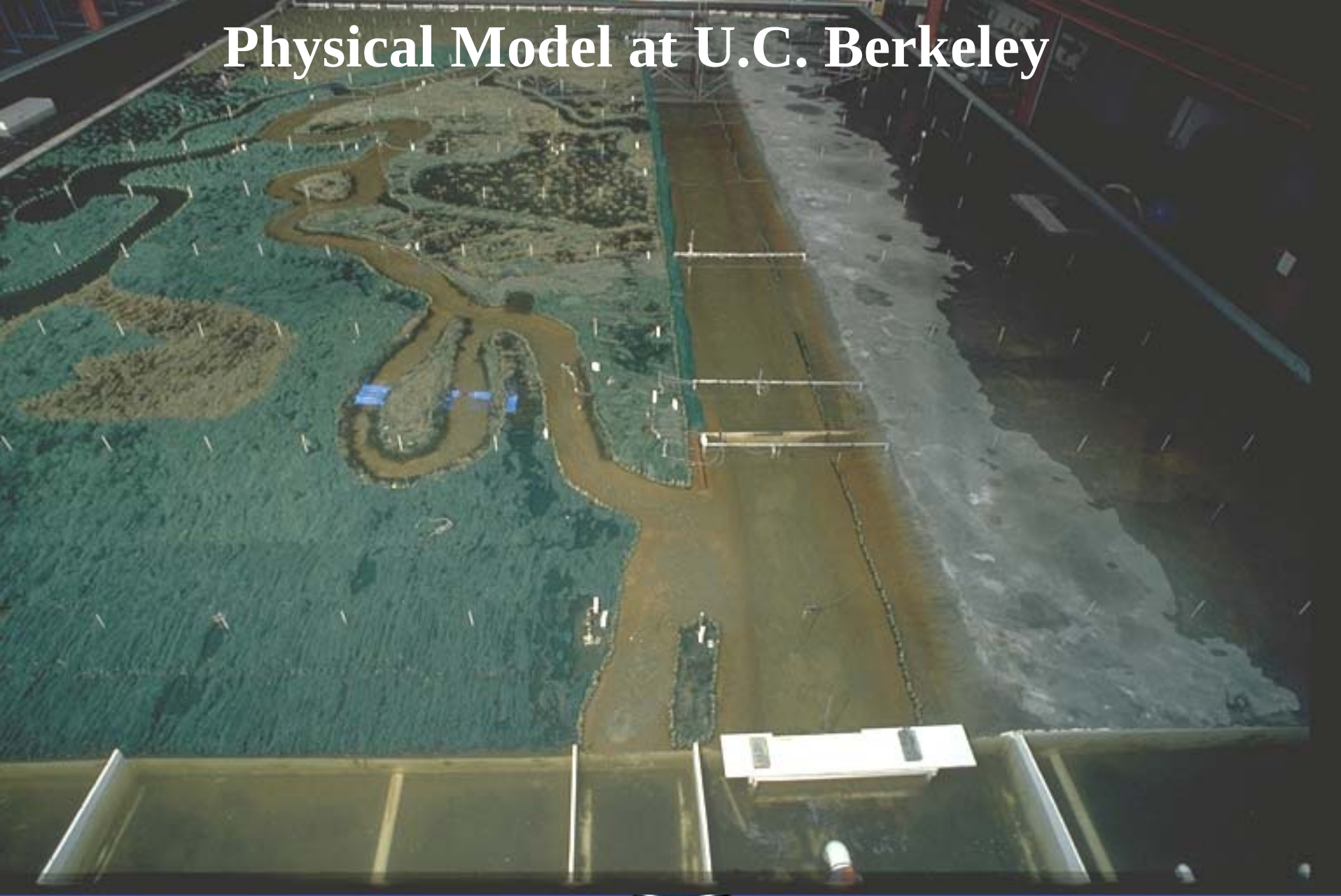
Analog Model

- Electric Analog Model
  - Simulated water levels and flows in coastal region
- Upgraded Regional Routing Model to include daily time step
- Initial development of SFWMM (2x2)- a regional-scale computer simulation model

Physical Modeling - Real system

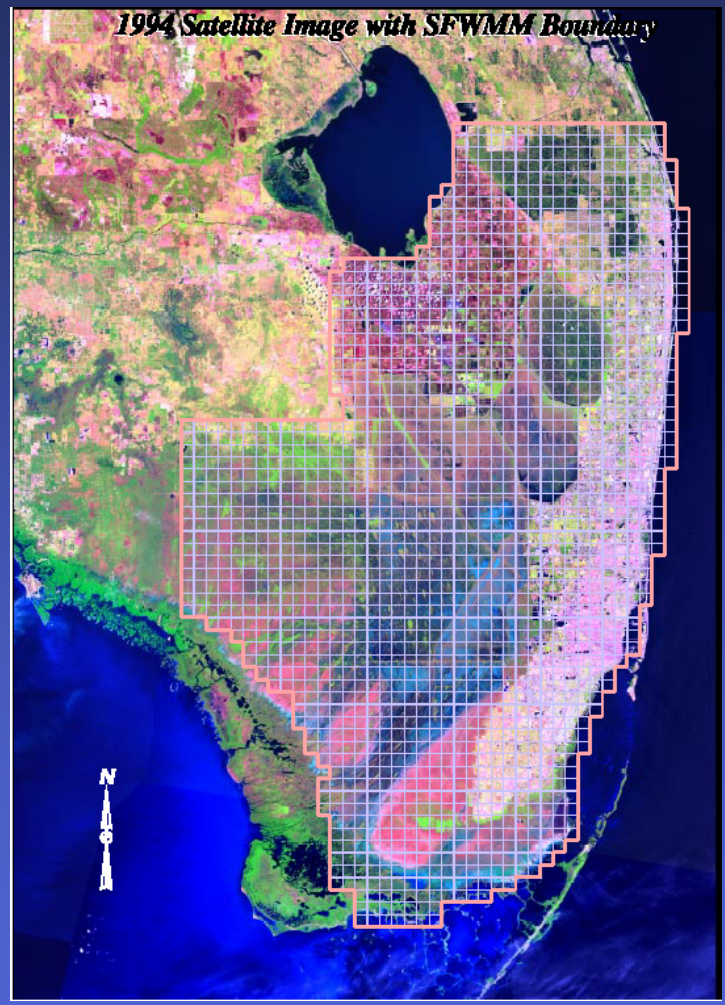


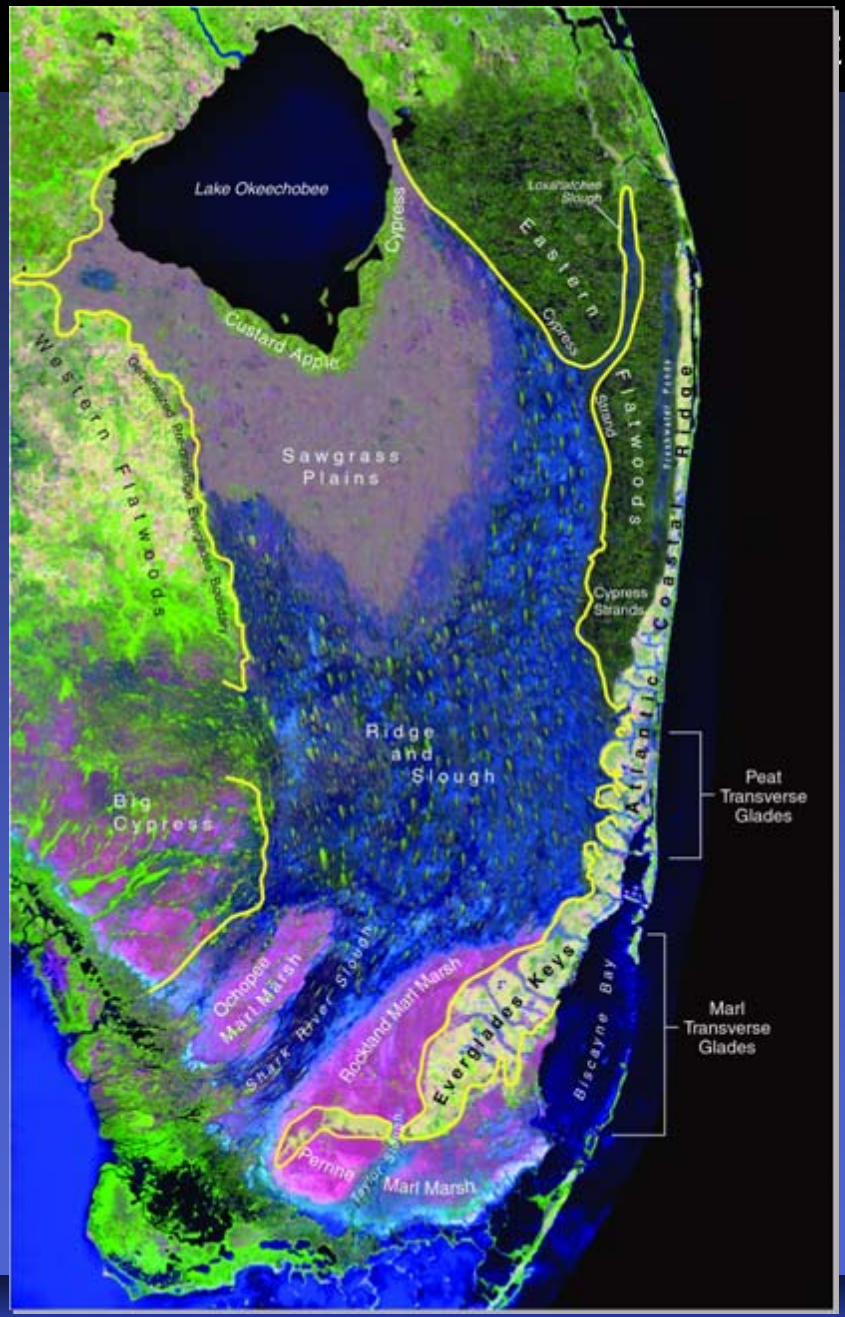
Physical Model at U.C. Berkeley



The SFWMM or 2X2

- Divides South Florida into 2 mile by 2 mile square grid cells
- Integrated surface water groundwater model
- Simulates:
  - Hydrology
  - Water Management





What is NSM?

- A computer model of the pre-drainage system
- Integrated surface and ground water hydrologic model
- 2,382 2 mile x 2 mile grid cells
- Lake Istokpoga to Florida Bay

Modeling Approach

SFWMM Model

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

Period of record: 1965-2000

Scenario

- Landuse/Landcover
- Water Demands
- Operating Criteria

Model Output

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

Performance Measures (Ag, Env, Urban)

RESTUDY PROCESS

Multi-Agency

US Army Corps of Engineers

NOAA

BROWARD COUNTY

MIAMI-DADE

USGS

USDA

FLORIDA

Inter-Disciplinary

Ecologists
Zoologists
Biologists
Public Affairs Specialists
Economists
Hydrogeologists
Geographers
Engineers
Hydrologists
Real Estate Specialist
Technicians
Resource Managers
Planners
Environmental Scientists

HYDROLOGIC MODELERS

ALTERNATIVE DESIGN TEAM

RESTUDY TEAM

WEB TEAM

ALTERNATIVE EVALUATION TEAM

PUBLIC COMMENT AND FEEDBACK

INITIAL SCREENING

ALTERNATIVE FORMULATION

ALTERNATIVE DESIGN

MODELING OF ALTERNATIVES

WEB PUBLISHING OF ALTERNATIVES

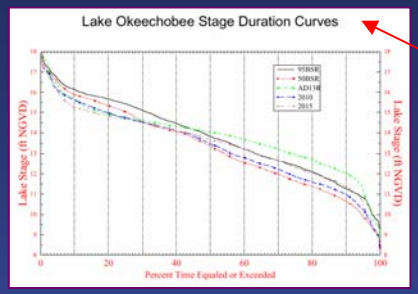
EVALUATION OF ALTERNATIVES

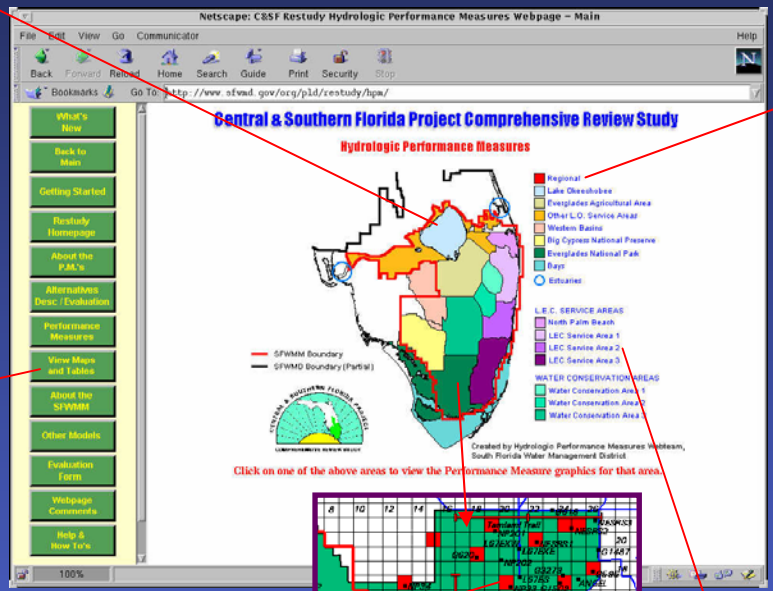
SELECT PREFERRED ALTERNATIVE

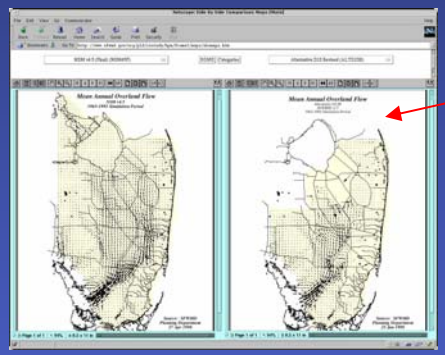
.gov

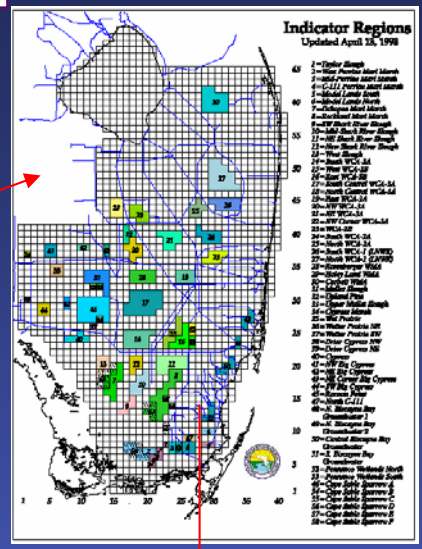
Hydrologic Performance Measures

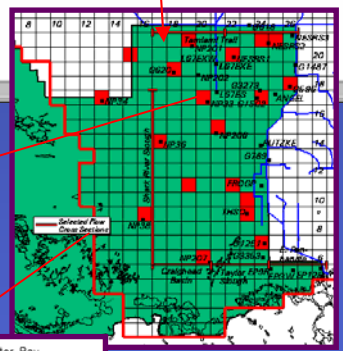
www.sfwmd.gov/org/pld/restudy/hpm

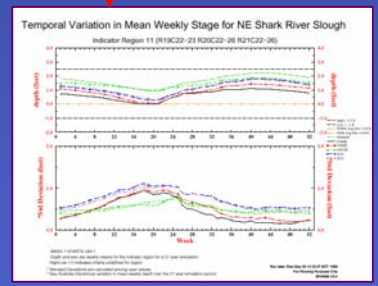


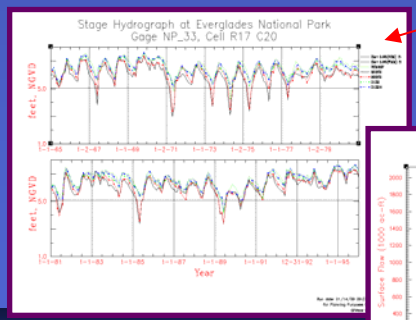


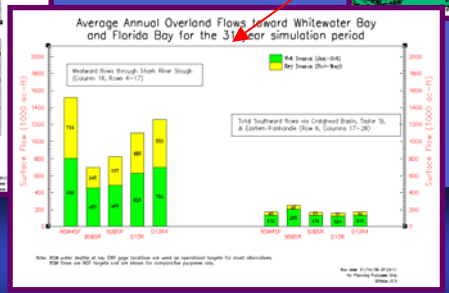


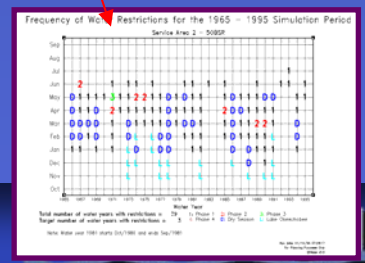




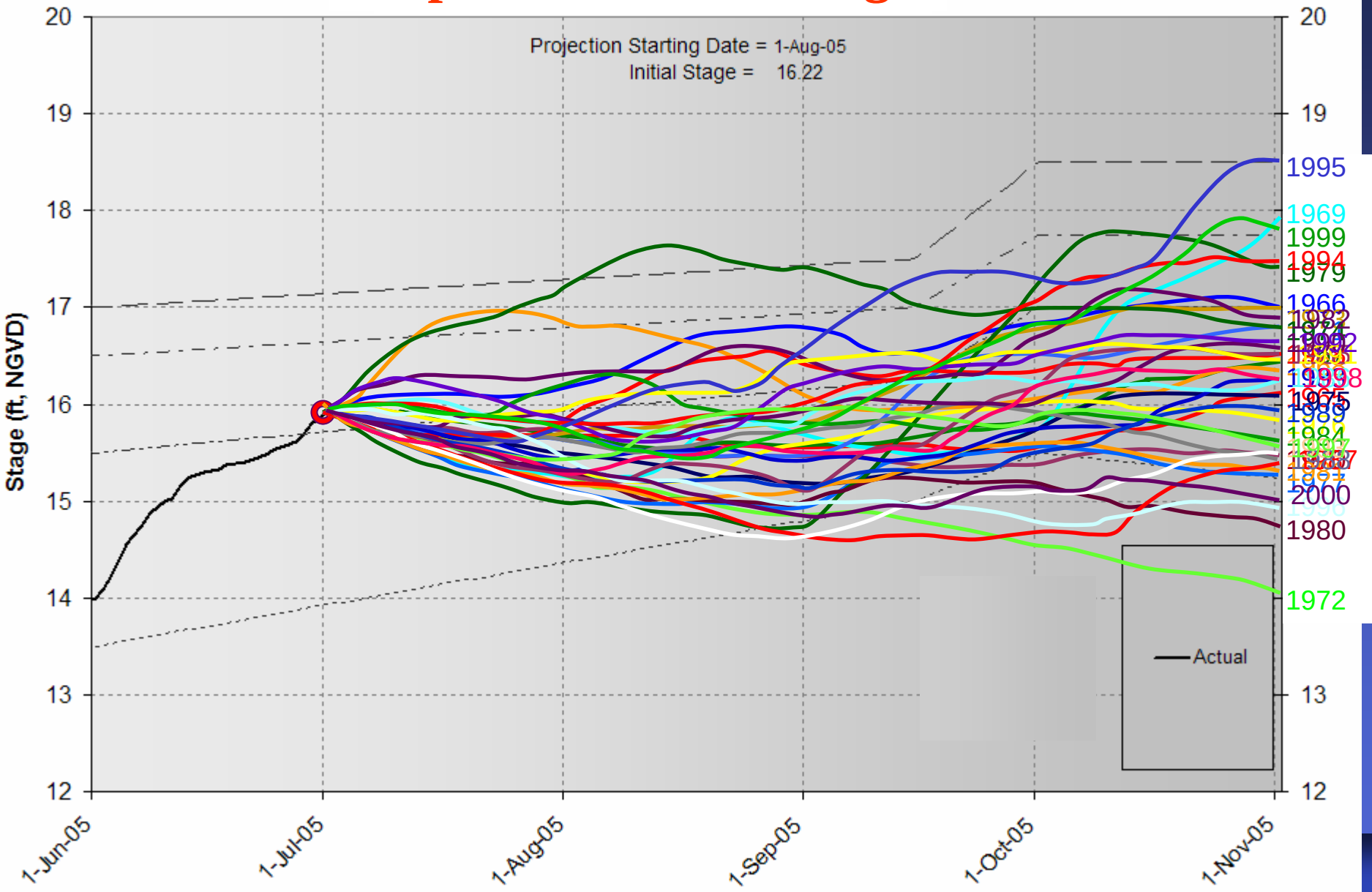




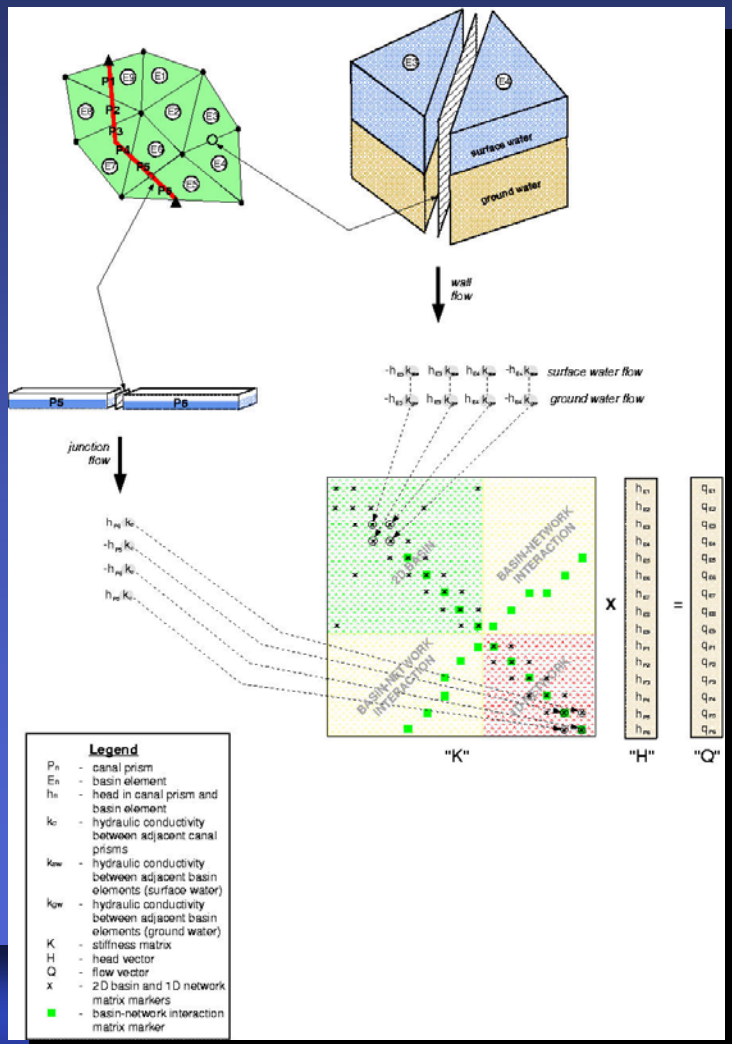




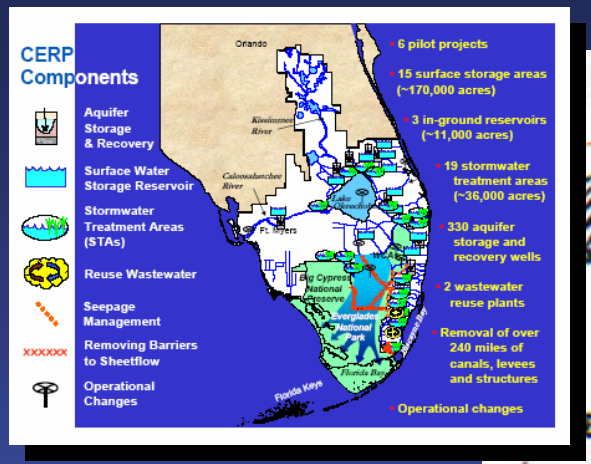
Operational Planning



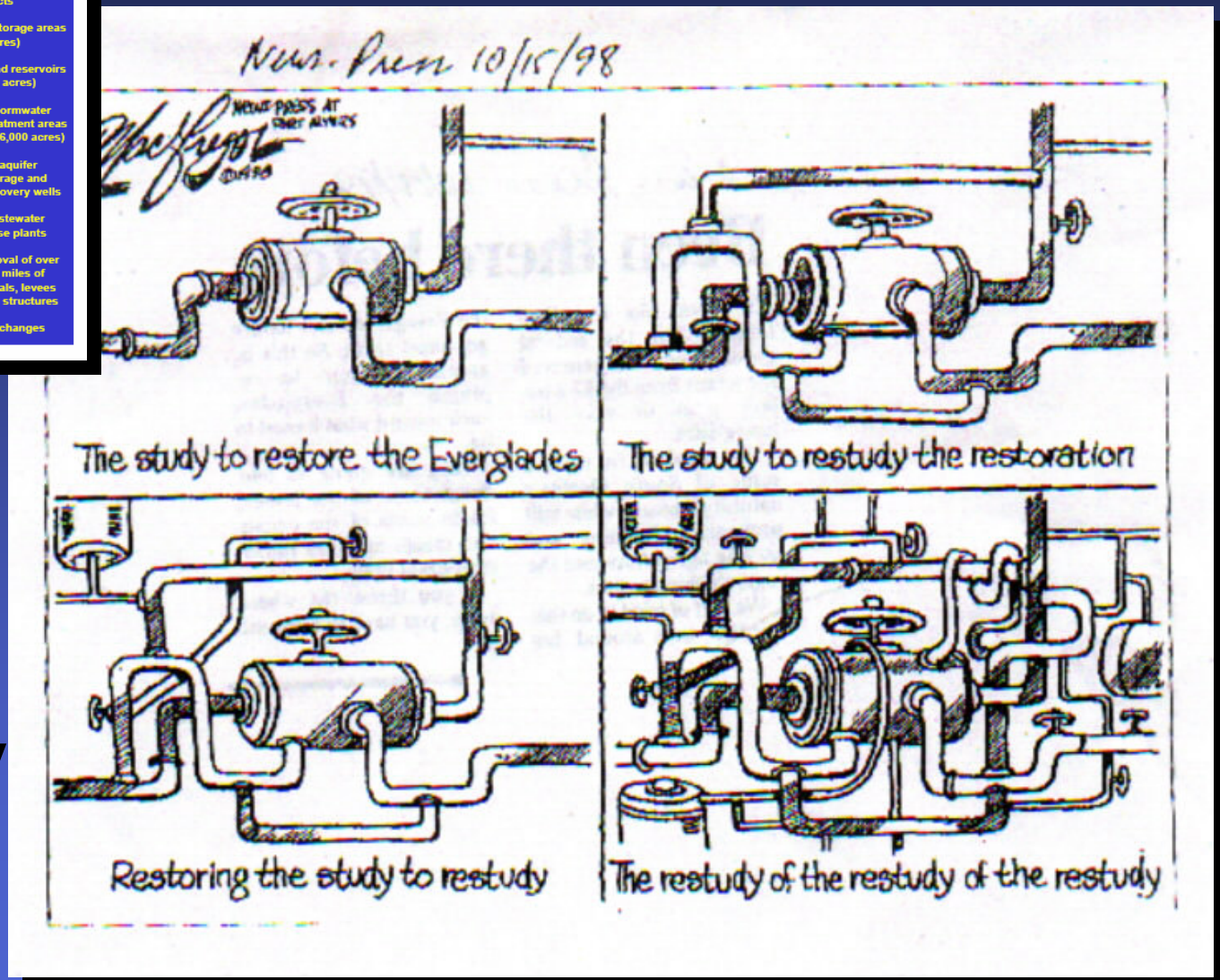
Decade of the 90s-Initial Development of RSM



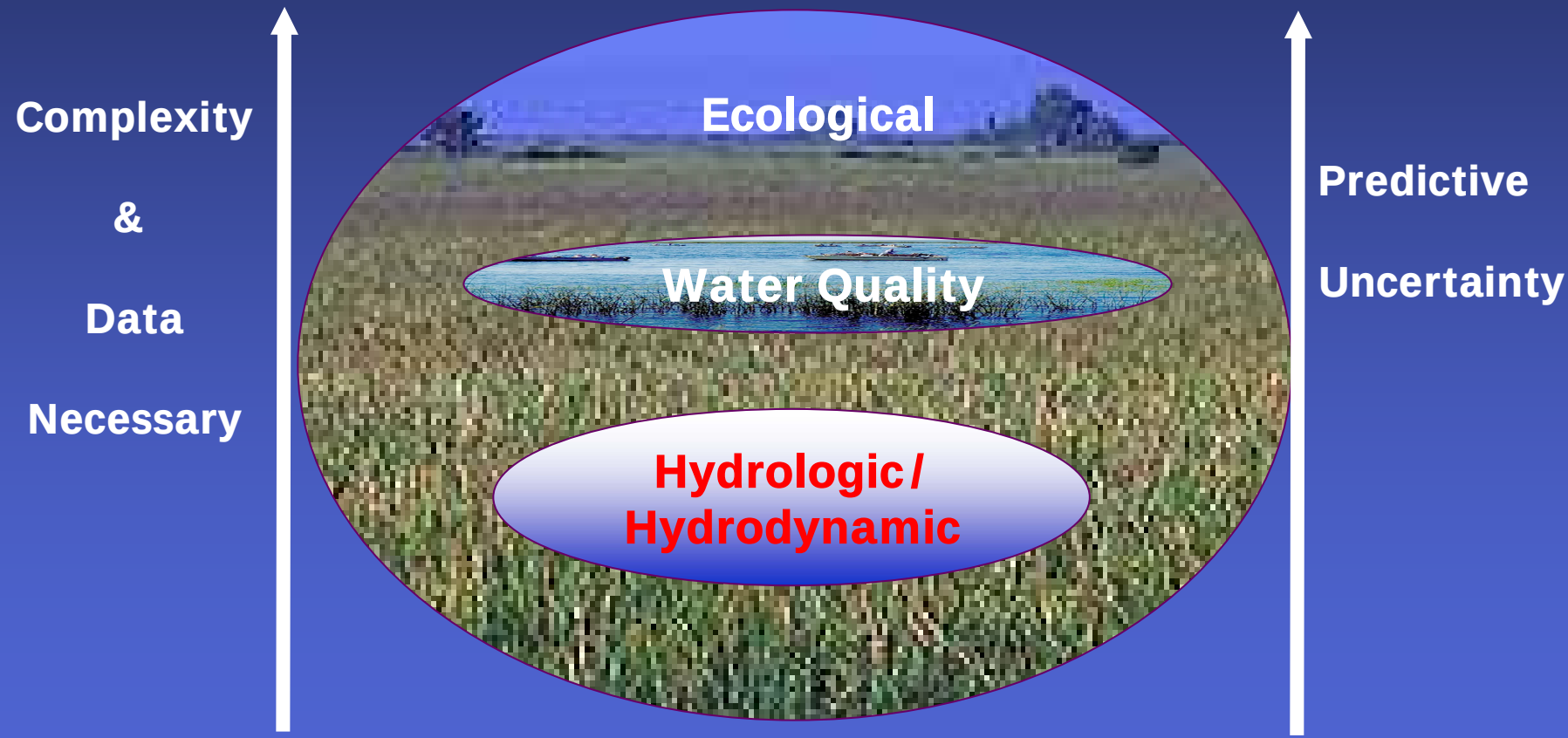
- Development of the next generation models initiated:
  - Object-Oriented
  - C++
  - Database interfaces
  - New modeling algorithms researched



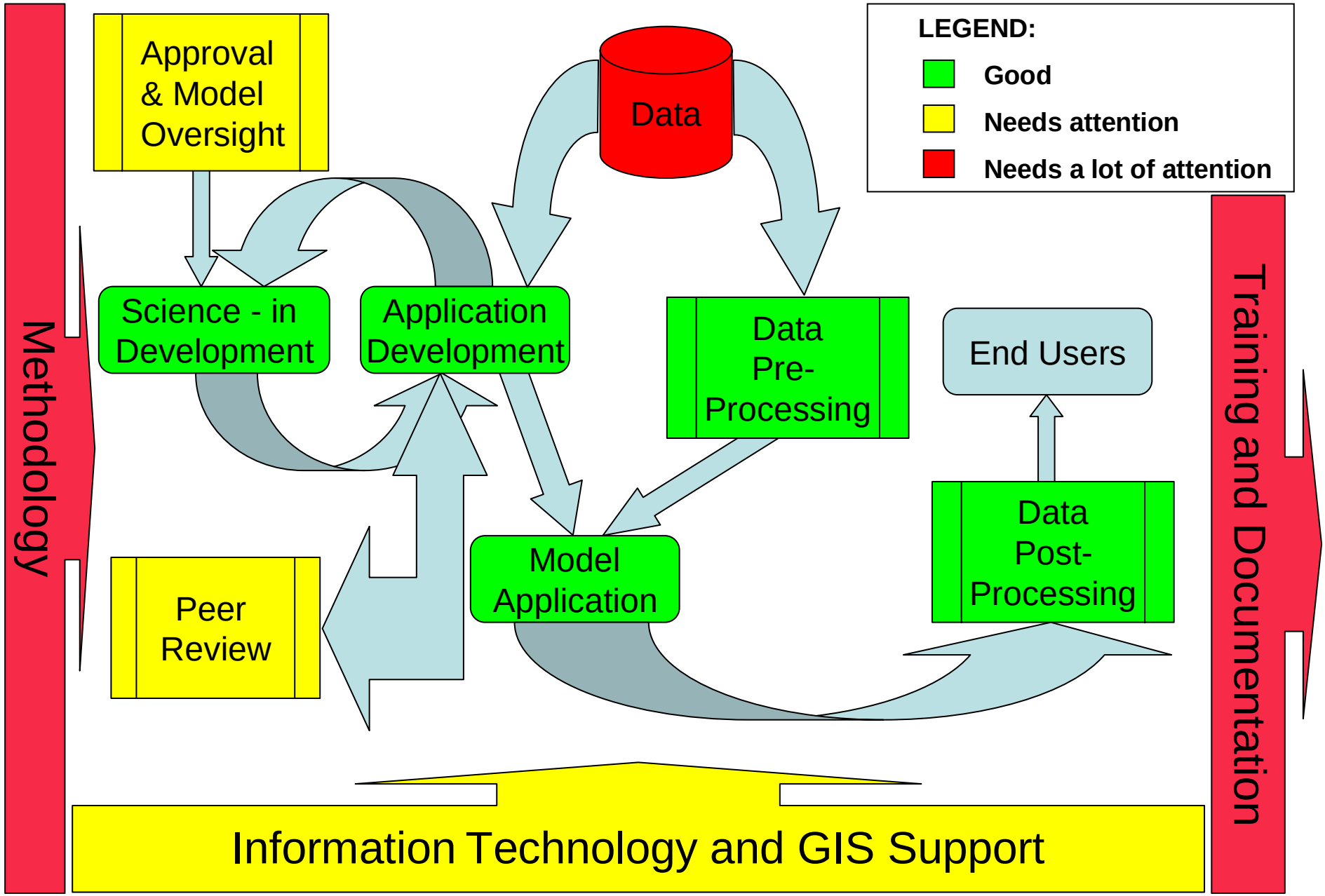
Water Resources Plans are becoming increasingly complex!



Classification of Models



MODEL PROCESSES AND AREAS OF CONCERN



Strategic Modeling Plan Implementation Progress

- Established the Office of Modeling (now HESM)
  - Model Development
  - Interagency Modeling Center (CERP)
  - Model Application (non-CERP)
- Established Modeling Oversight Team (MOT)
- Quality Assurance & Quality Control through implementation of a Modeling Methodology
  - Capability Maturity Model (CMM)

Peer Review

- A requirement of the new modeling methodology
- Status of peer reviews:
  - 2x2 model (1998, 2005)
  - RSM (Theory part reviewed in 2005)
  - LECsR (June 2006)
  - Everglades Landscape Model (ELM) (process initiated)

Regional Simulation Model (RSM)

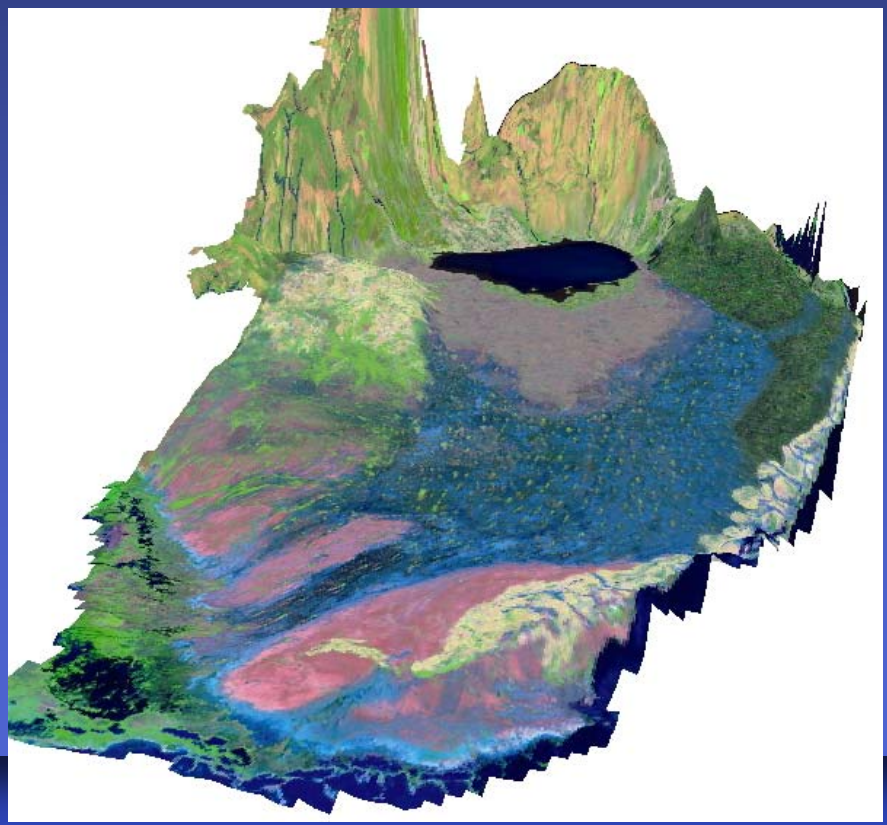
- Why we needed it?
  - 2x2 has served for about 25-years. Need a next generation regional-scale model
- Next generation tool needs to:
  - Minimize or eliminate “single person dependency”
  - Be well documented, easy to learn, flexible and transparent
  - Defensible. Meet requirements of additional scrutiny that we did not have 10-15 years ago –> Peer Review
  - Make use of new data, new technologies in computers and modeling methods.
  - Be efficient (reasonable run times), and accurate

RSM Development Approach

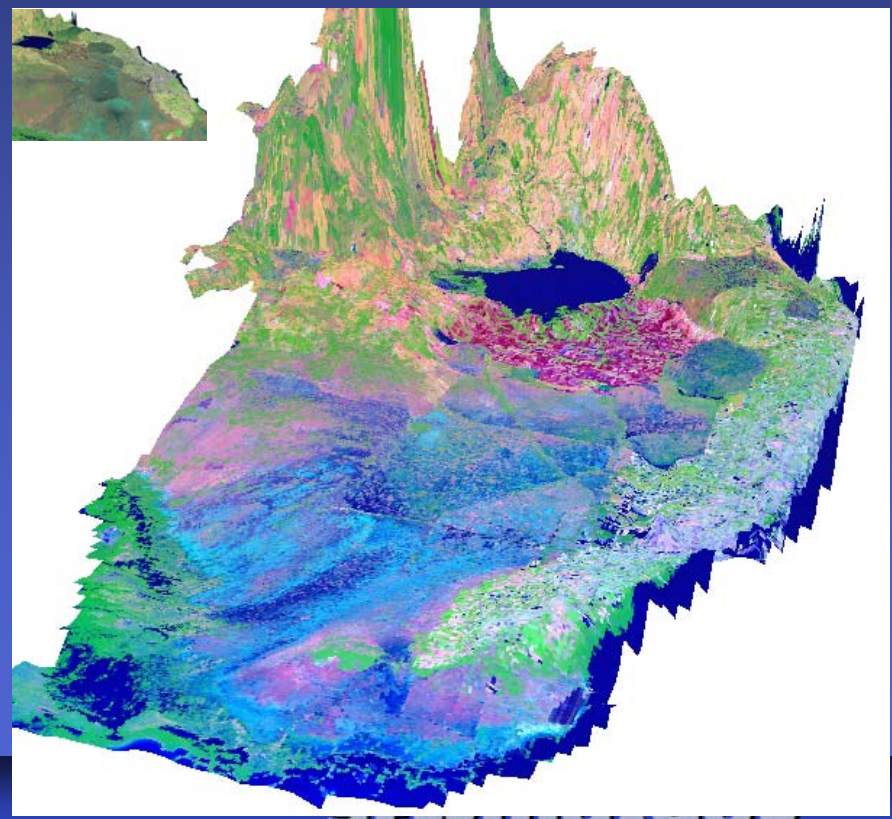
- Important tool for implementation of CERP and non-CERP projects
- Low-level effort used to design and begin the development of the next generation version of 2x2
- Higher priority on RSM during last two years - allocation of experienced 2x2 modelers in the development, contractual help
- A phased approach for completion
- Transition from 2x2 to RSM cannot happen overnight (due to unique differences)

RSM Versions

Natural System, NSRSM



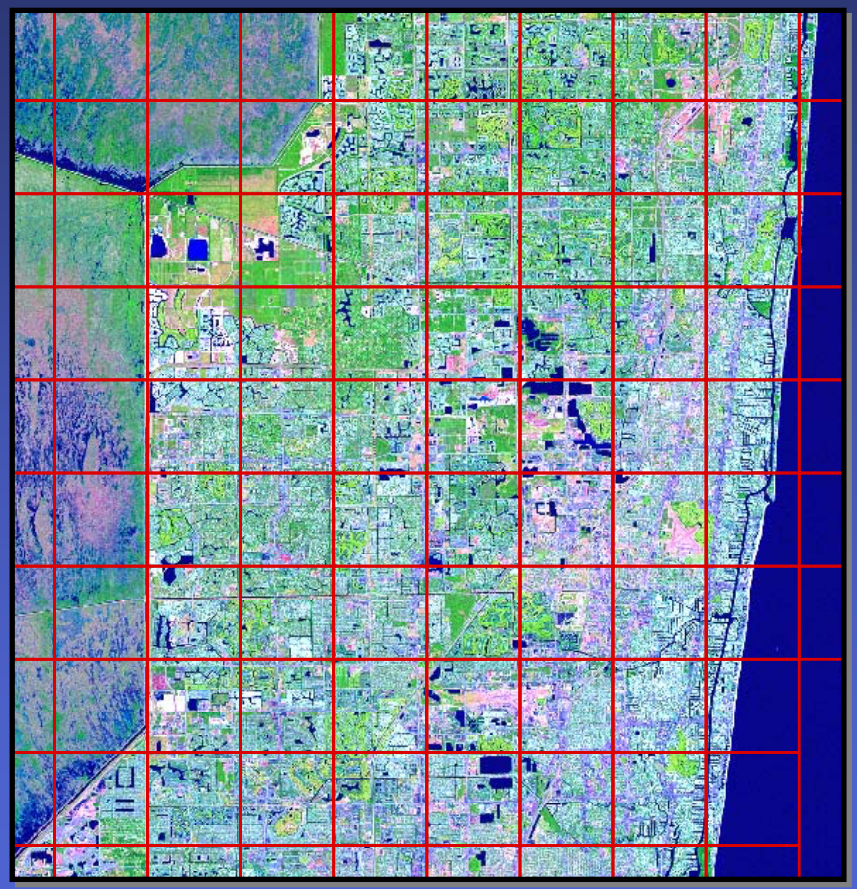
Managed System, SFRSM



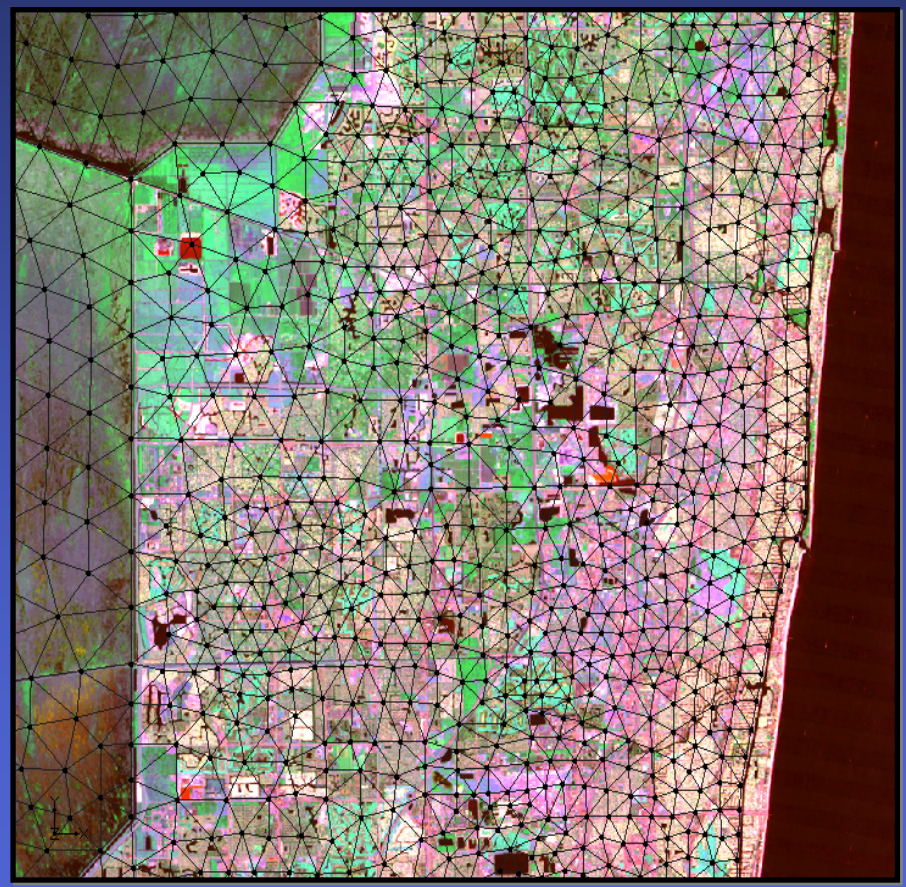
Surface exaggerated vertically for display

SFWMM (2x2) versus RSM

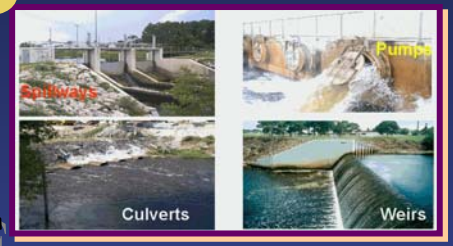
2x2



RSM



RSM Concepts



RSM

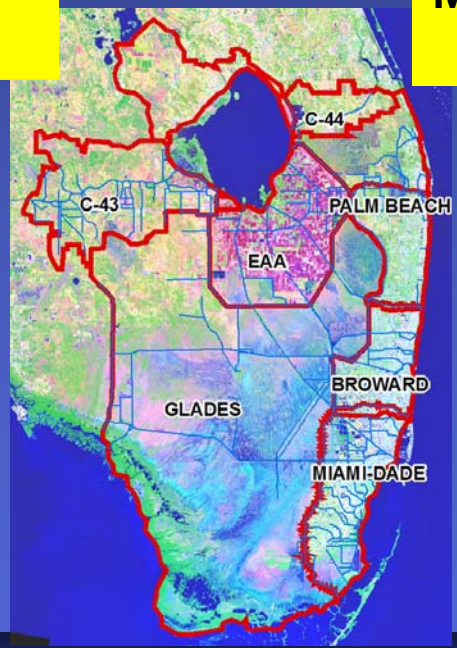
HSE

MSE

SFRSM

Hydrologic Simulation Engine (HSE)

- Simulates hydrologic processes
- Overland flow
- Groundwater flow
- Canal network
- Calibration/validation of model parameters



Management Simulation Engine (MSE)

- Simulate structure operations
- Implementation of operational rules
- Flood control rules
- Water supply policies
- Regional operational coordination

Natural System RSM

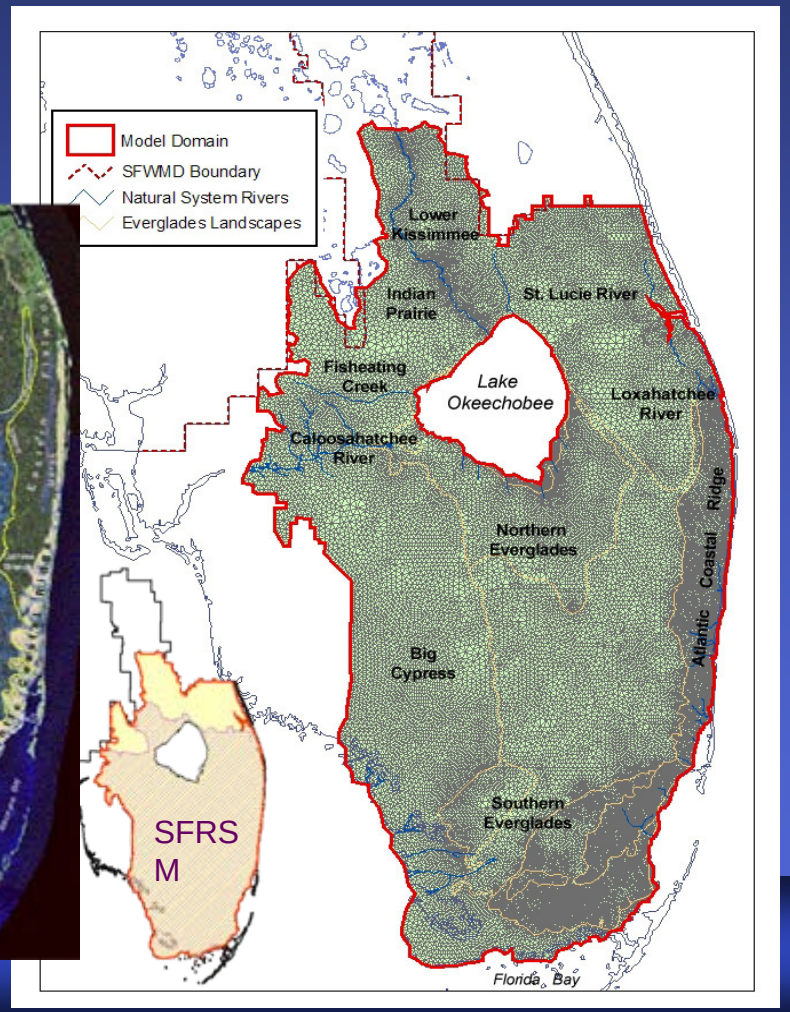
RSM

HSE

Hydrologic Simulation Engine (HSE)

Natural System RSM

- Pre-drainage physical setup
- Simulate hydrologic processes
- Overland flow
- Groundwater flow
- River network
- Validation against pre-drainage historical records & anecdotal information



RSM Achievements to Date

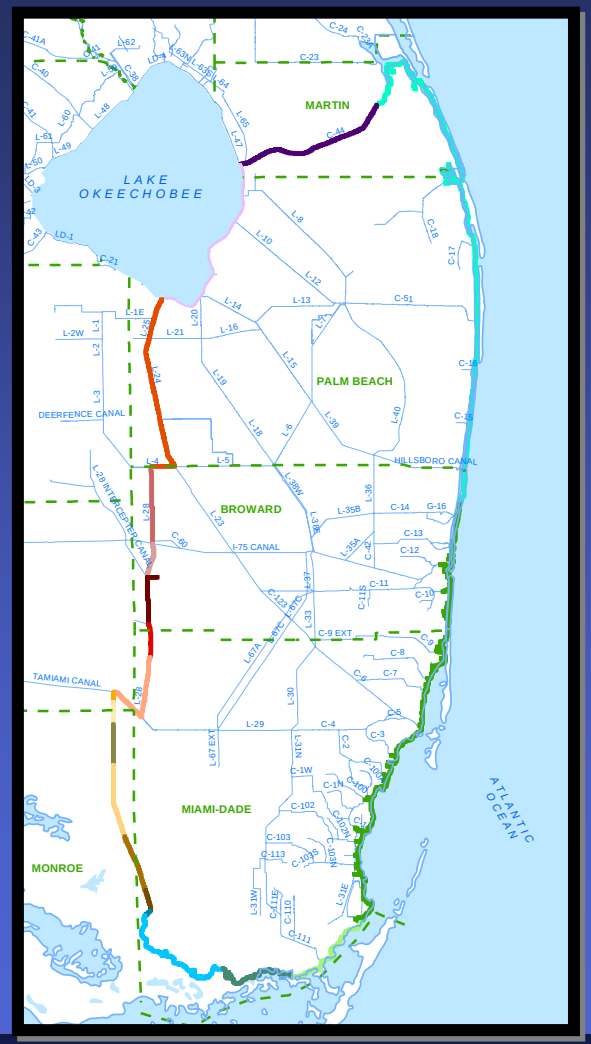
- Several applications during development and implementation
- Numerous refereed journal articles (peer review)
- External Peer review of RSM theory (by a panel)
- Calibrated sub-regional models for Everglades Agricultural Area, Palm Beach, Broward, Miami-Dade, Caloosahatchee and St. Lucie
- Natural System Regional Simulation Model (NSRSM)

Schedule - Phases

FY05	FY06	FY07	FY08
RSM Phase I	RSM Phase II	RSM Phase III	RSM Phase IV
• Hydrologic simulation calibration & validation • Peer Review – RSM Theory • Natural System RSM initial version	• Address peer review recommendations • Develop coupling of hydrology & water management • Develop selected subregional models (eg. Miami-Dade) • Initial Water Quality Development	• Apply subregional SFRSMs and NSRSM in selected projects • Peer Review of Natural System RSM • Complete management capabilities • Start migration from 2x2 to RSM • Enhance Water Quality features	• Apply SFRSM for priority Program needs • Continue migration from 2x2 to RSM • Finalize Water Quality features

Conceptual Model and Grid Design

- Covers the entire lower east coast region
- Three (3) model layers to account for heterogeneity in the surficial aquifer
- Spatial and temporal scales
  - Cells (704 ft. by 704 ft.) – 225 cells in each 2x2 cell
  - Daily time step



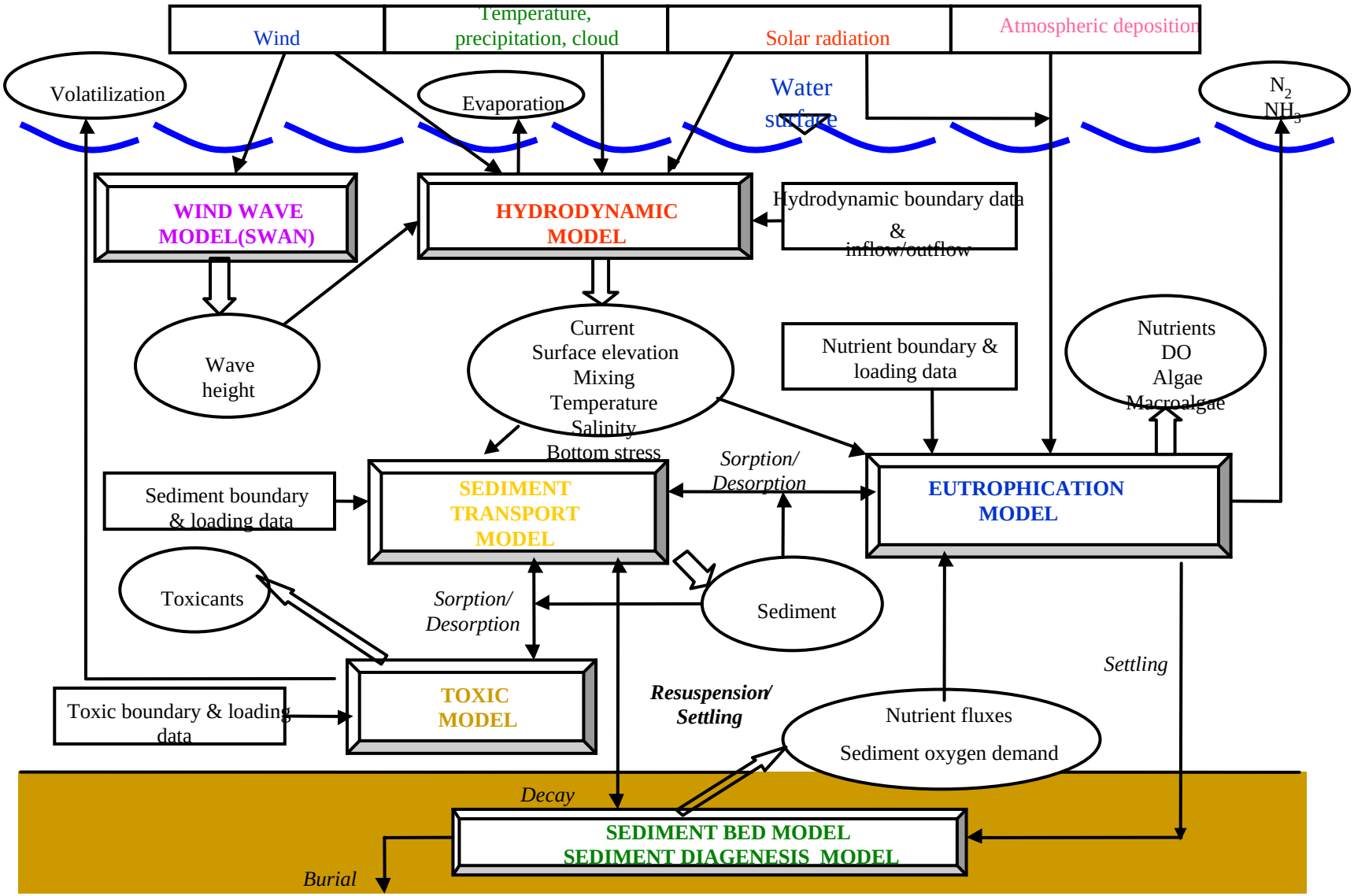
Lower East Coast SubRegional (LECsR) Model Overview

- Combines previous county-level models
- Three dimensional groundwater flow model of Surficial Aquifer System
- Based on the popular groundwater model developed by USGS (MODFLOW)
- Includes SFWMD developed enhancements
- Integrates surface water in wetlands
- Effect of system-wide operations to be obtained from 2x2 and RSM (in the future)
- Peer Review – complete June 2006

Lake Okeechobee

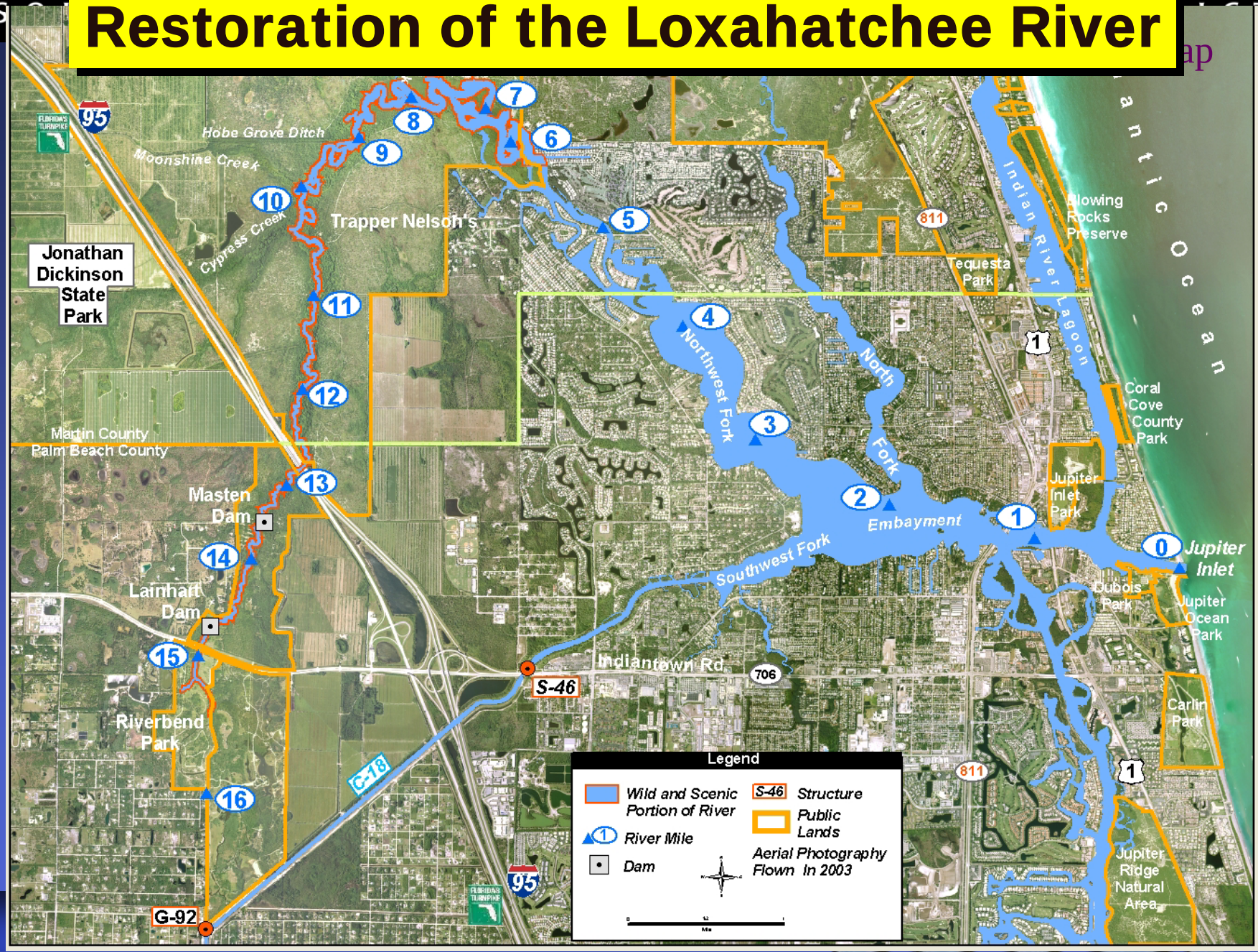
- Largest lake in southeastern US
- Area: 1730 km^2
- Average depth: 2.7 m
- Surrounded by dike
- Turbid, wind driven
- Eutrophic

LOEM

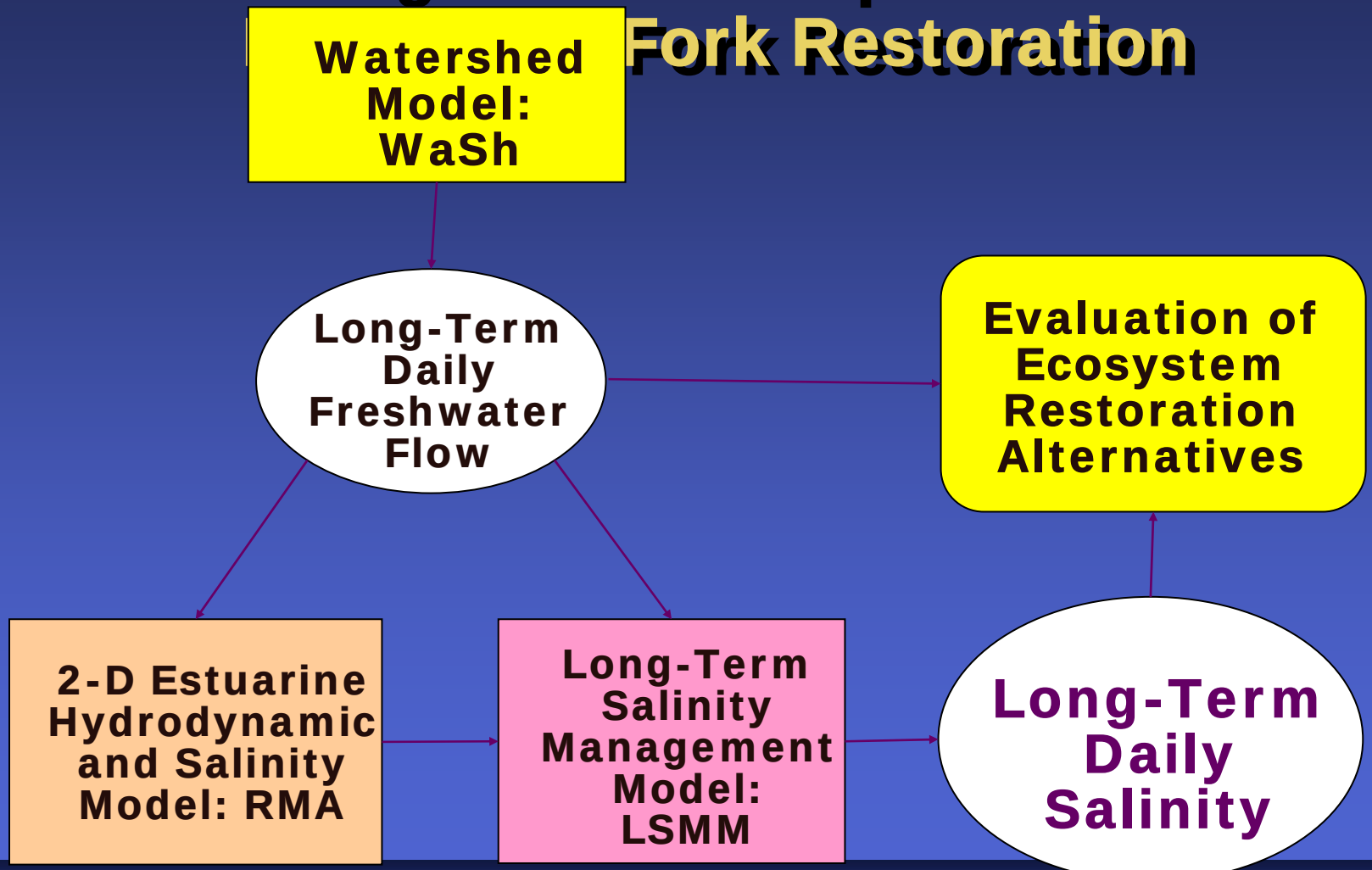


A Diagram of Major Processes in the LOEM

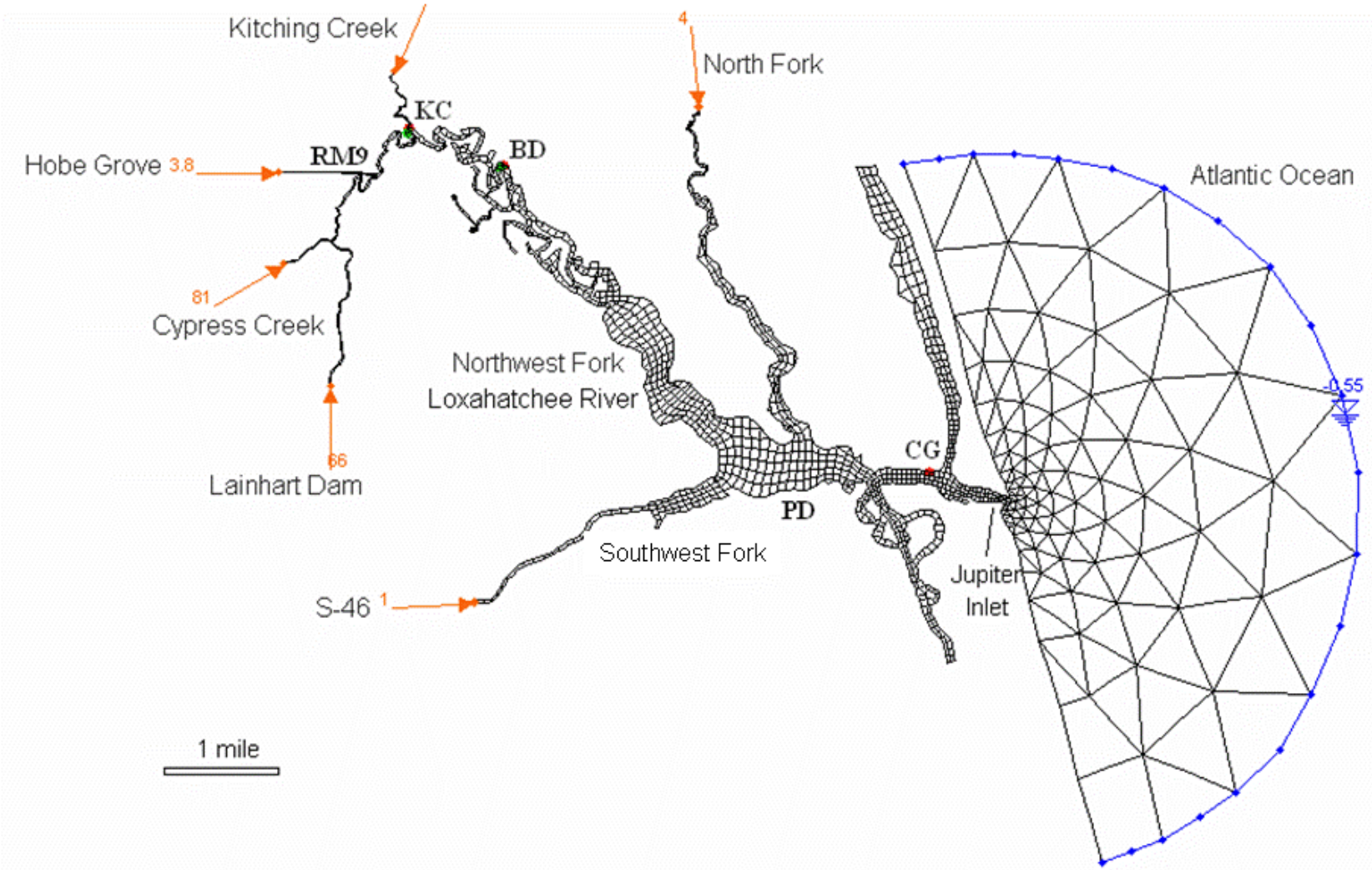
Restoration of the Loxahatchee River



Modeling Tool Development for the Fork Restoration



Loxahatchee River Salinity Model Domain



Everglades Landscape Model

- Integrate hydrology, biology and nutrient cycling in spatially explicit simulation
- Understand ecosystem dynamics at regional scale
- Develop predictions of landscape response to altered water & nutrient management


Thank You !
Questions ?

Development History of the Lake Okeechobee Hydrodynamic and Wind-wave Model

- Wind-wave Model (by wind-wave equations approach)

  Jiang, Wang, and Jin(1996). J. of Ocean Engineering.

  Ren, Wang, and Jin (1997). J. of Computers and Fluids.

  Ren, Wang, and Jin (1997). J. of Ocean Engineering.

  Jin and Wang (1998). J. of AWRA.

- Wind-wave Model (by Spectral Energy Approach)

  Mei, Fan,and Jin (1997). Journal of Geophysical Research .

  Jin and Ji (2001). Journal of Ocean Engineering ,

- 3-D Hydrodynamic Model (modified from EFDC)

  Jin, Hamrick, and Tisdale (2000). Journal of Hydraulic Engineering, ASCE. ,

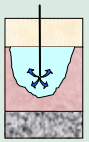
  Jin, Ji, and Hamrick (2002). Journal of Waterway, Port, Coastal, and Ocean Engineering , ASCE.

  Jin, and Ji (2005). Journal of Waterway, Port, Coastal, and Ocean Engineering, ASCE,

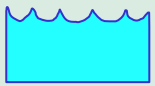
- 3-D Sediment Model (modified from EFDC)

  Jin and Ji (2004). Journal of Hydraulic Engineering ,ASCE.

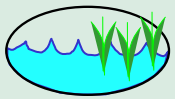
CERP Components



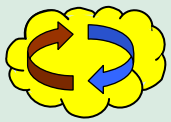
Aquifer Storage & Recovery



Surface Water Storage Reservoir



Stormwater Treatment Areas (STAs)

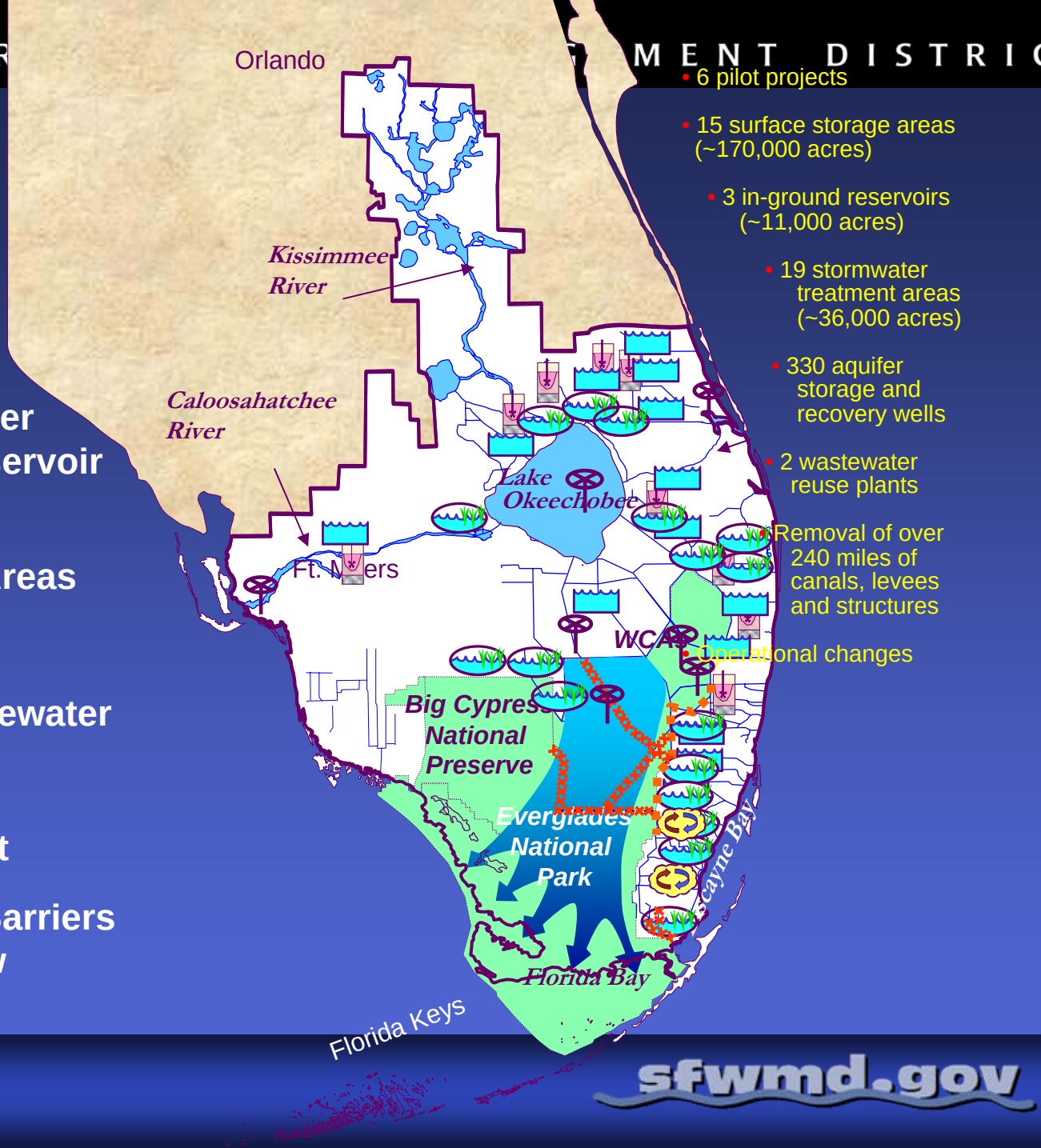


Reuse Wastewater

Seepage Management

Removing Barriers to Sheetflow

Operational Changes



- 6 pilot projects
- 15 surface storage areas (~170,000 acres)
- 3 in-ground reservoirs (~11,000 acres)
- 19 stormwater treatment areas (~36,000 acres)
- 330 aquifer storage and recovery wells
- 2 wastewater reuse plants
- Removal of over 240 miles of canals, levees and structures
- Operational changes

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