Use of a Natural System Regional Simulation Model in Restoration Project Planning

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Topics

- **Natural System Models Background**

- **Model Evolution**

- **Overview**

- **Results**

- **Application**

- **Summary**

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Natural System Models Background

- **Restoration strategies for south Florida require an understanding of regional system hydrology prior to drainage and development.**

- **For this purpose, hydrologic simulation of the natural system using numerical models has been used, in combination with other adaptive management tools, to assist in restoration plan formulation.**

- **The first natural system model was released in 1991: A regional scale two-dimensional coupled surface/ground water model (NSM v3.4).**

Natural System Models Background

- NSM simulates the hydrologic response of an Everglades watershed in its pre-drainage condition.

- Vegetation, topography, and river courses used by the NSM are based on pre-drainage conditions.

- NSM uses the same climatic input, computational methods, and model parameters calibrated and verified by the SFWMM (e.g. ET, Manning's).

- Recent climatic data is used to simulate the pre-drainage hydrologic response to current hydrologic input allowing for meaningful comparisons between the current managed system and the natural system.

- The NSM evolved from its first release (1991, Version 3.4). Modifications were applied based on peer review comments, an improved knowledge of the natural system, and technical advancement.

- NSM supported from 1991 to 2012

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# Model Evolution – Regional Simulation Model

- **New generation computational tool that can be used to simulate a wide variety of hydrologic conditions - Regional Simulation Model (RSM).**

- **RSM was created and is maintained by the SFWMD: J. Obeysekera, W. Lal and R. Vanzee**

- **Currently composed of two principal components coupled within the RSM C++ object-oriented code**

  - **Hydrologic Simulation Engine (HSE) and the**

  - **Management Simulation Engine (MSE).**

- **Scientific Peer Review RSM theory - June 2005**

- **Natural System Regional Simulation Model (NSRSM) v2.0 released 2006.**

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Model Evolution – NSRSM

Natural System Regional Simulation Model (NSRSM)
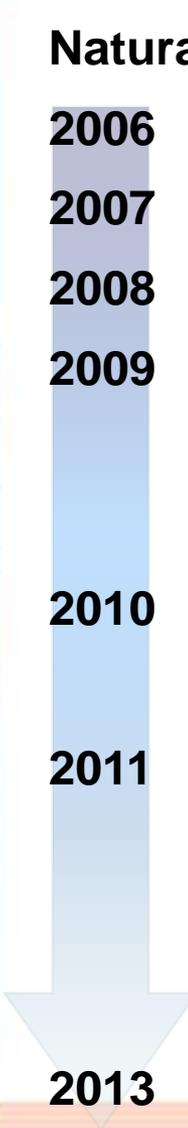
2006   **Initial Release (v2.0) with documentation**

2007   **Scientific Peer Review**

2008   **NSRSM v2.0 Revision**

2009   **Model Re-mesh and Parameter Update**

        Soft Calibration

        NSRSM v3.3 Release

2010   **Peer review by application (e.g. River of Grass Phase II)**

        Preparation of historical climate dataset

2011   **NSRSM v3.4 implementation**

        Soft-calibration

        Documentation

        Peer review by application

2013   **NSRSM v3.5.2 Release**

Model Evolution – NSRSM

Legend:
- NSRSM Domain
- NSM Domain
- SFWMM Boundary
- SFWMD Boundary
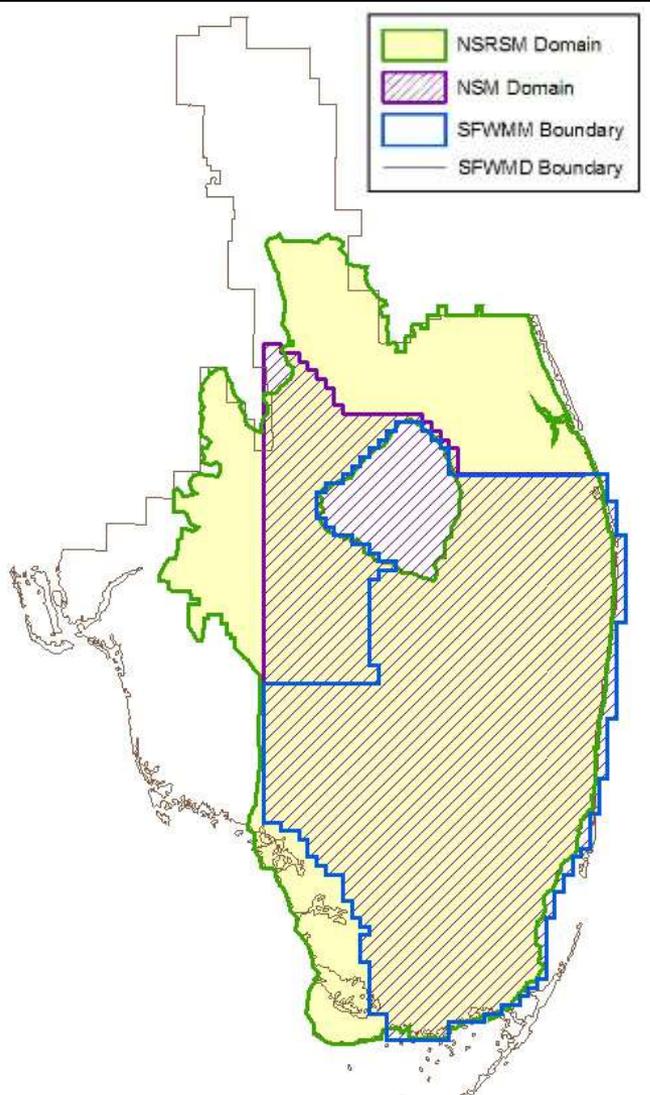
What's next?

- **Period of record extension**
- **On going dialogue with RECOVER**
- **Fully supported by the IMC**

Model Domain Evolution

- **NSM 9,000 mi^2**
- **2328 2x2 mile grid cells**

- **SFWMM 7,000 mi^2**
- **1,746 2x2 mile grid cells**

- **NSRSM 12,000 mi^2**
- **7,438 triangular cells averaging 1.6 mi^2**

NSRSM Overview – Model Domain

- **Lower Kissimmee Basin**
- **Lake Istokpoga/Indian Prairie**
- **Fisheating Creek Basin**
- **Caloosahatchee River Basin**
- **St. Lucie River Basin**
- **Okeechobee/Everglades Watershed**
- **Western Flatwoods**
- **Eastern Big Cypress**
- **Eastern Flatwoods**
- **Atlantic Coastal Ridge**
- **Southern Coast**

NSRSM Overview – Topography
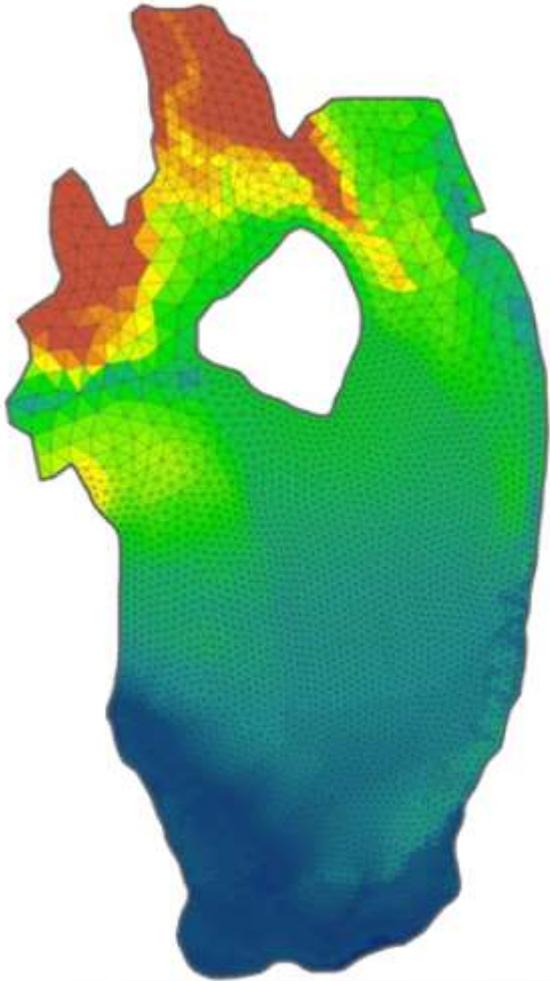
- **Sources include:**
    - **McVoy et al. (2011)**
    - **USDA-SCS (1940)**
    - **U.S. Army Corps of Engineers**
    - **Others….**
- **Improved land surface elevation and land cover data**
- **Some areas input most recent LIDAR with artifacts of development removed**

NSRSM Overview – Landuse
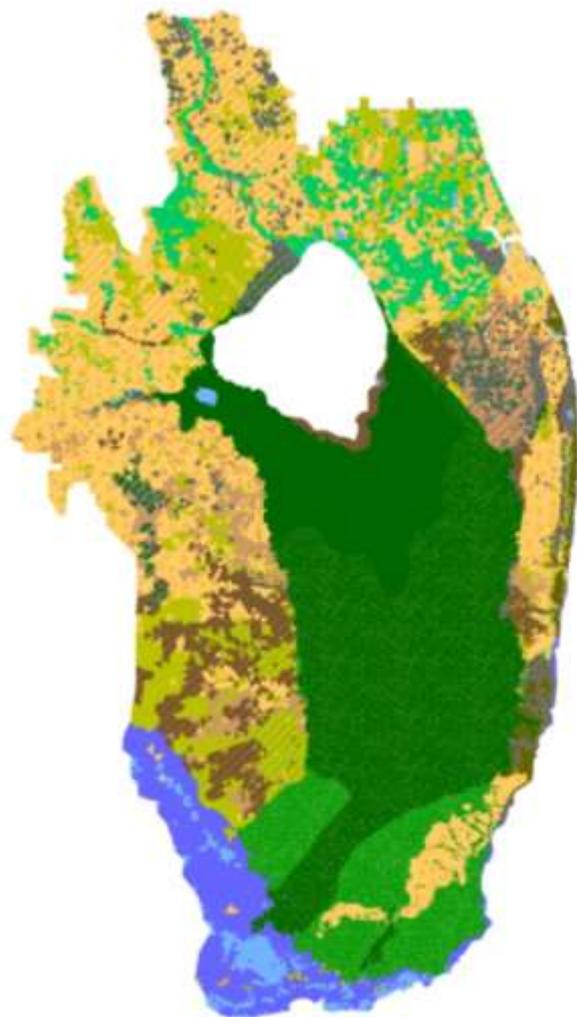
Legend:
- Water (1.00)
- Intra-tidal Wetland (2.00)
- Beach (3.00)
- Forested Freshwater Wetland (4.00)
- Cypress Swamp (4.10)
- Hardwood Swamp (4.20)
- Non-forested Freshwater Wetland (5.00)
- Long/Med-hydroperiod Marsh(5.10); (5.20)
- Ridge and Slough Marsh (5.11)
- Sawgrass Plains (5.12)
- Marsh with Scattered Cypress (5.21)
- Everglades Marl Marsh (5.22)
- Wet Prairie (5.30)
- Wet Prairie with Scattered Trees (5.31)
- Wet Prairie with Cypress (5.32)
- Hydric Uplands (6.00)
- Hydric Flatwoods (6.10)
- Hydric Hammock (6.20)
- Mesic Uplands (7.00)
- Dry Prairie (7.10)
- Mesic Pine Flatwoods (7.20)
- Mesic Hammock (7.30)
- Xeric Uplands (8.00)
- High Pines - Sandhills (8.10)
- Scrub (8.20)
- Coastal Strand (8.30)

- **NSRSM landcover is static ; does not attempt to simulate vegetation succession**

- **GLO (Government Land Office) verified**

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NSRSM Overview – Ridge and Slough
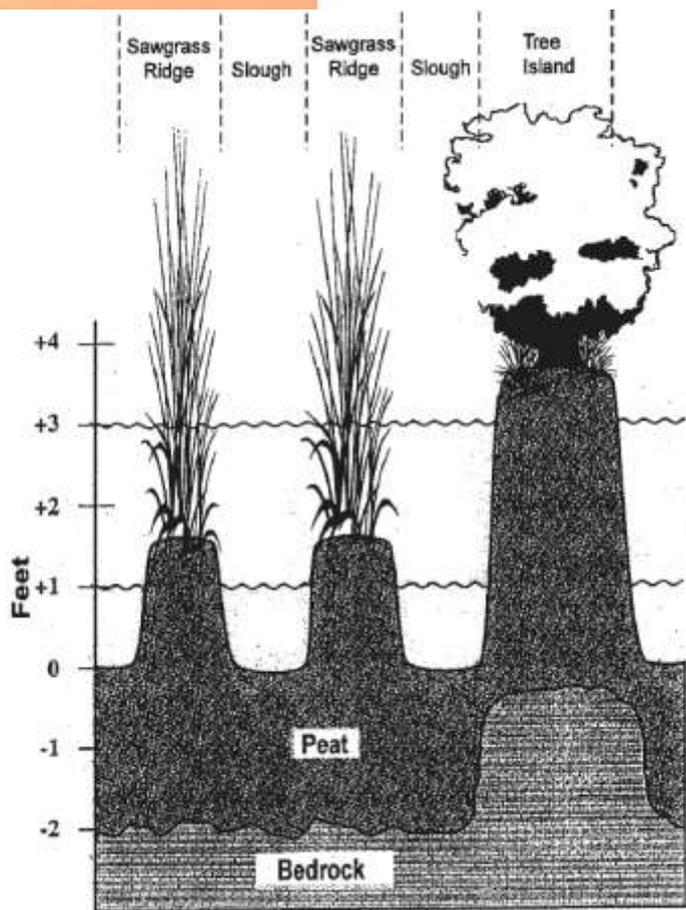
- **Ridge and Slough**
- **Averaged for all components**
 - **Sawgrass Ridge**
  - **Slough**
  - **Tree Island**

Location	Elevation	Percentage
Slough	0.0	46%
Ridge	1.5	46%
Bay Head	3.5	3%
Tree Island	3.5	5%

NSRSM Overview – Performance Measures

- Performance monitoring ranges from landscape scale to whole system

- Landscape Specific

- Greater Everglades and Big Cypress

- Box and Whisker Diagrams

- Inundation Duration

- Computed ET

- Transect Flow (Overland and Groundwater)

- Lake Okeechobee Budget

- Whole System Budget

- Natural River Flows and Stages

- Maps: Stage, Inundation Duration, Flow Direction Vector, Ponding Depth, Min/Max Stage, Max Daily Stage Diff

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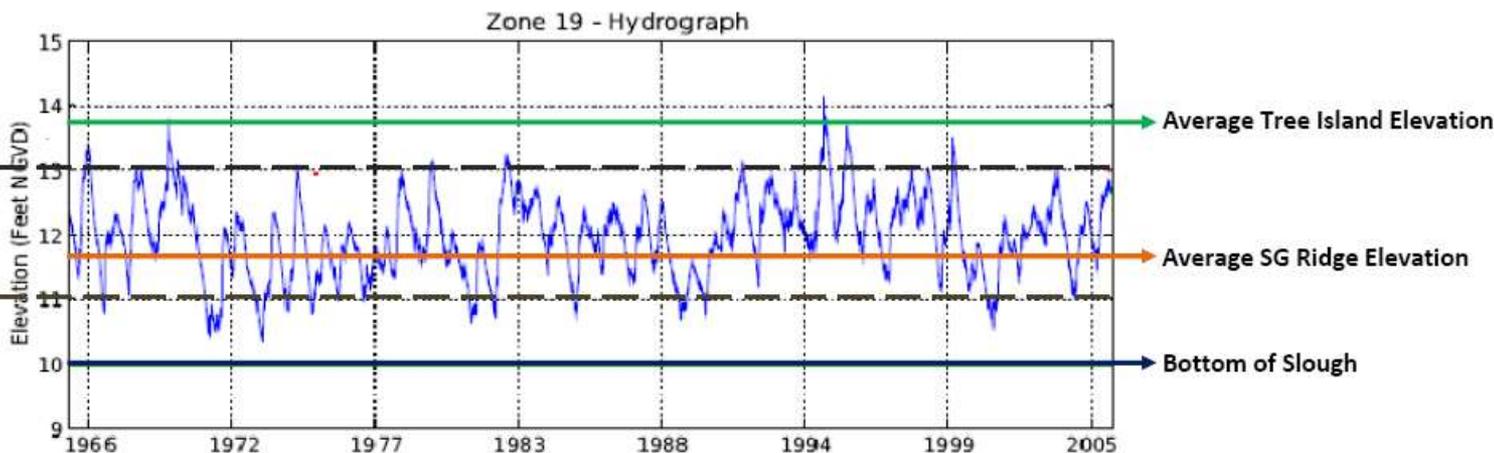# NSRSM Overview – Performance Measures
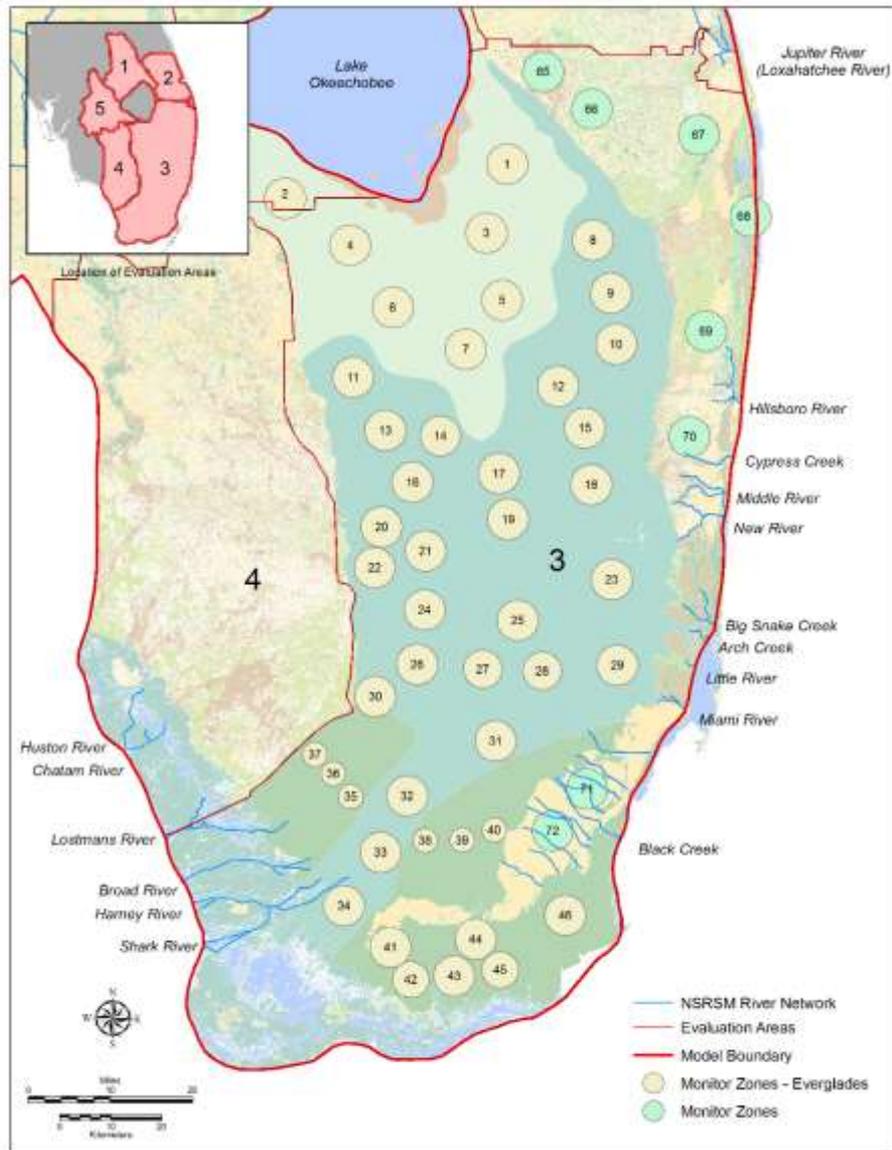
- **91 Monitor zones used to assess performance**

- **7 zones within sawgrass Plains**

- **39 zones within Everglades**

- **Each monitor zone consists of several cells**

NSRSM Results – Hydrograph and Inundation

Simulated Stage Hydrograph and Stage Duration Curve for Central Ridge and Slough
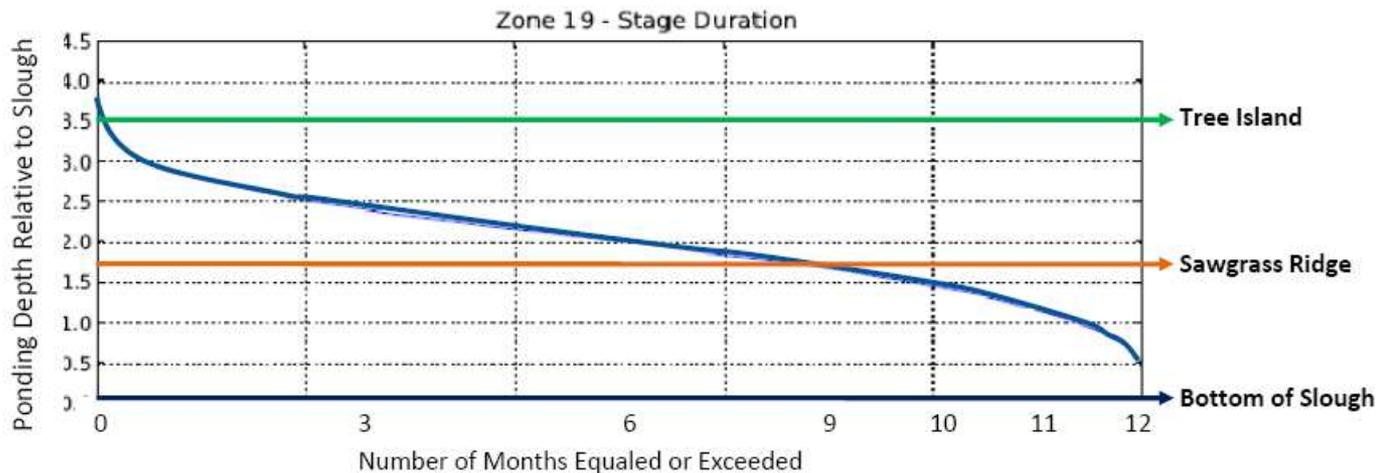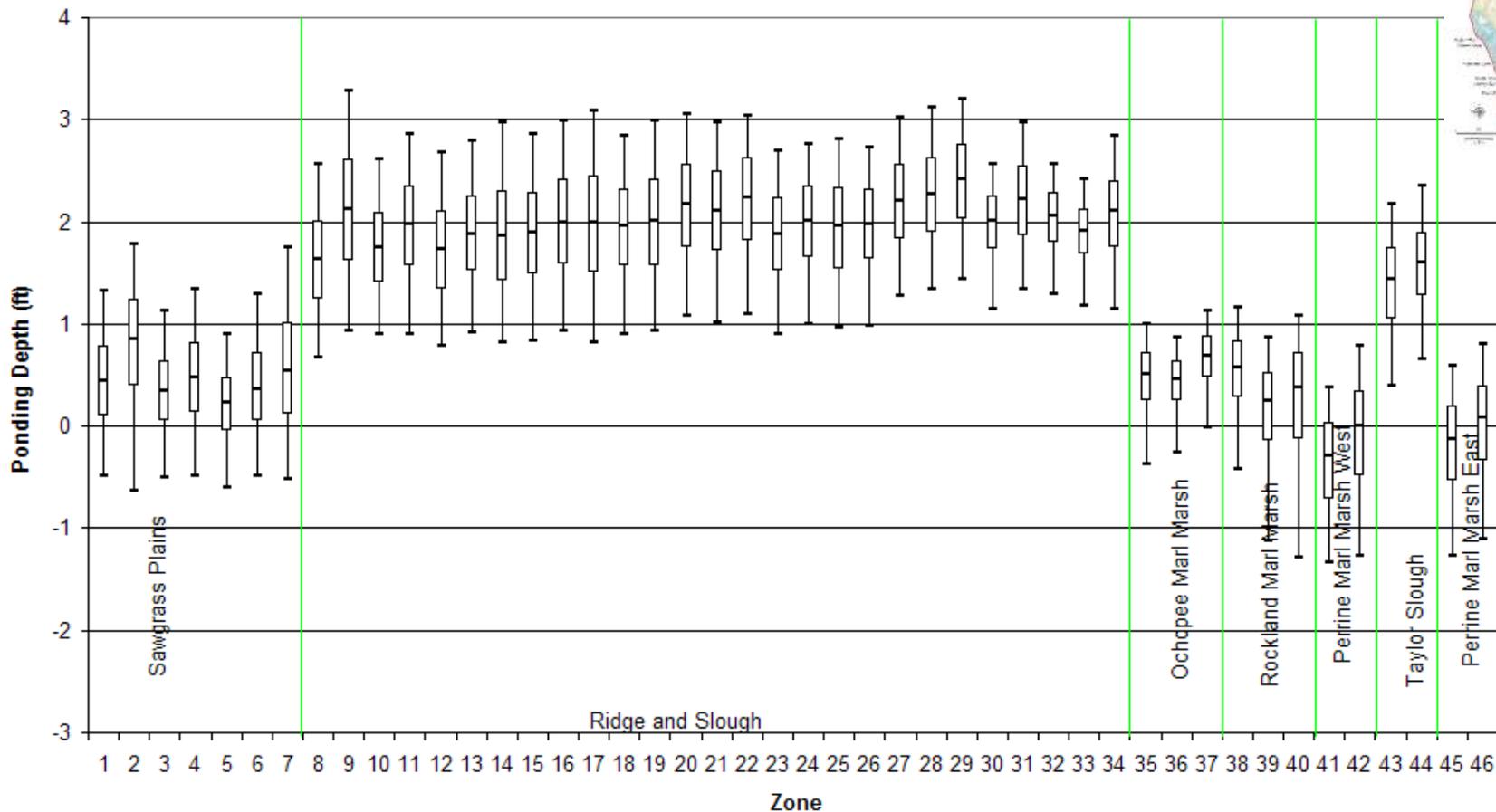
NSRSM Results – Everglades Ponding Depths

NSRSM v3.5 Ponding Depths
POR 1966-2005
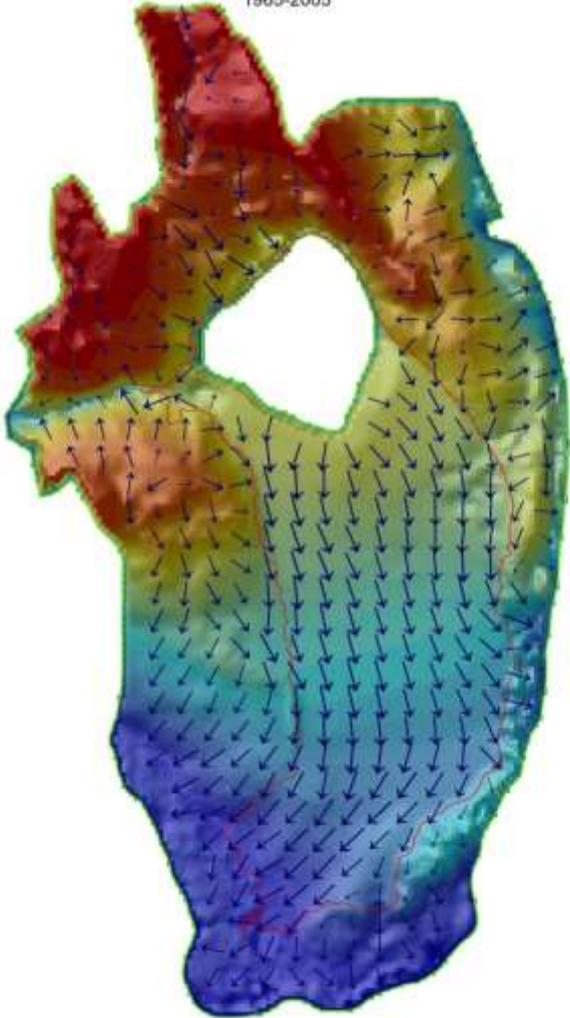Everglades Landscapes

NSRSM Results – Lake Okeechobee Stage
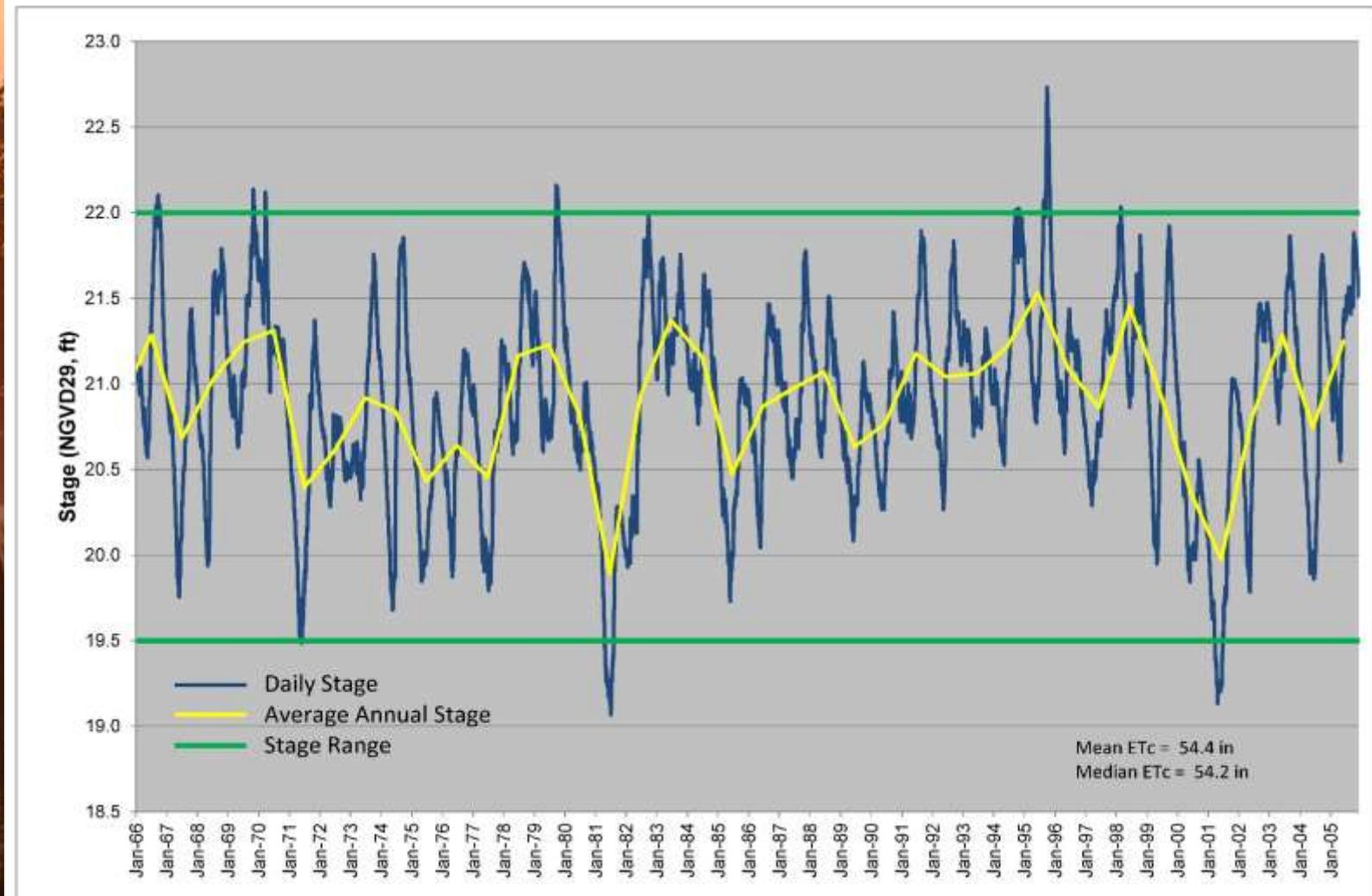
NSRSM Results – Overland Flow Vectors

Average Annual Overland Flow
1965-2005

- **NSRSM simulates natural system hydrology prior to drainage**

- **Hydrologic performance is soft calibrated to reference ranges from peer reviewed literature**

- **Performance has high correspondence to estimates of natural system hydrology**
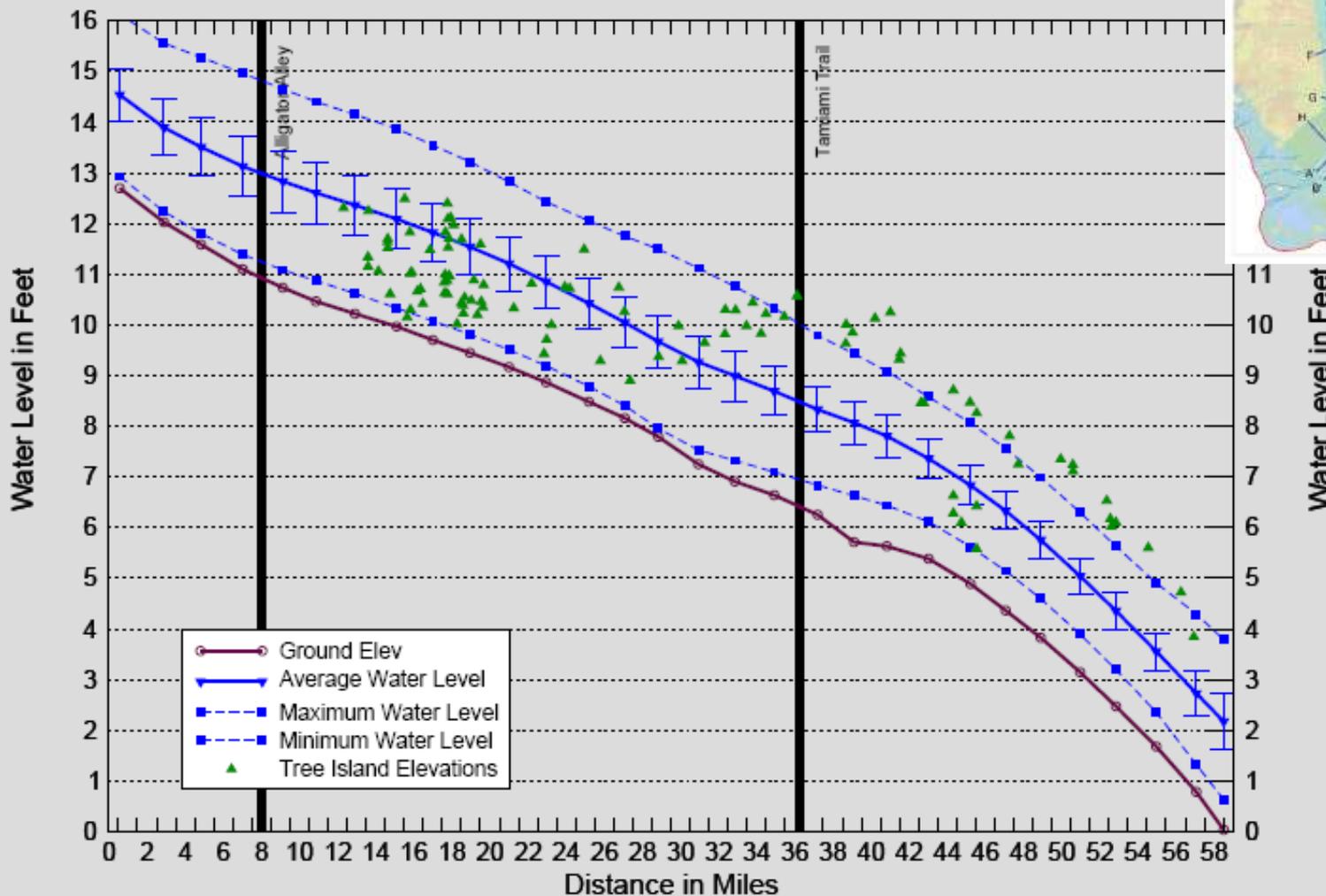
NSRSM Application

- **River of Grass (ROG) Phase II Planning**

- **RECOVER**

- **CEPP**

- **NSM 2x2 Update**

- **Other District Support**

  - **HSE troubleshooting to benefit RSM projects**

  - **Boundary conditions for Lake Okeechobee extreme event modeling**

- **WERP**

NSRSM Application - ROG

NSRSM – Peer Review Panel Summary

- **NSRSM should not be used to set hard targets or any other such prescriptions for restoration.**

- **Should be used to help estimate how the hydrology has changed and help design restoration experiments.**

- **Output from the NSRSM should be used in conjunction with other models, studies and information to suggest how flows across Tamiami Trail or hydrologic patterns in marl marshes might have changed.**

- **Should be used in an adaptive management framework to help guide management experiments aimed at restoring hydrologic regimes, and more importantly ecological function.**

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