Everglades Restoration – A Case Study

Adapted from Stu Appelbaum (USACE) and Ken Tarboton et al. (SFWMD).
The Original Everglades Ecosystem

“River of Grass”

- Water connected the system, from top to bottom
- 9 million acres of wetlands providing a variety of habitat
- Diverse mosaic of landscapes and seascapes
Central & Southern Florida Project

- **Authorization**: Flood Control Act of 1948 +
- **Purposes**: Flood Control, Water Conservation & Control, Salt Water Intrusion, Fish and Wildlife, Water Supply to ENP, and Environmental Restoration
- **Features**: 46 bridges, 10 locks, 670 miles of canals, 809 miles of levees, 130 control & diversion structures, & 16 pump stations
- **Project Cost**: $2.9B
- **Cost Share**: Varies
- **Local Sponsor**: Various
Ever expanding population with demands for land, flood control, and water supply
A Stressed Ecosystem …

- Too much / too little / too polluted water distributed over space and time
- Salt water intrusion
- 50 percent reduction in spatial extent of natural system
- Reductions in populations of various species
- Declining estuary biodiversity
Competing Interests

- Environment
- Agriculture
- Urban
Water Management? Building A Consensus - A Shared Vision -

“Realtime” data sharing

Interagency team

Public Workshops

Active Public Involvement

Working Group Task Force

Governor’s Commission
On December 11, 2000, the President signed the Water Resources Development Act of 2000, approving:

**Comprehensive Everglades Restoration Plan (CERP)**

A program providing for the restoration, preservation and protection of the south Florida ecosystem while providing for other water-related needs of the region.
The principal goal of CERP is to deliver the right amount of water, of the right quality, to the right places, and at the right time.
Surface Water Storage Reservoirs – 180,000 acres
Aquifer Storage & Recovery – 330 wells
Stormwater Treatment Areas (STAs) – 36,000 acres
Reuse Wastewater – 2 Regional plants
Seepage Management
Removing Barriers to Sheetflow – 240 miles
Operational Changes
Everglades Case Study

Hydrology Based Ecological Habitat Suitability Indices for Evaluating Alternative Water Management Strategies for the Everglades
## Multi-Agency, Interdisciplinary Team

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### Ecology

#### Periphyton
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#### Alligators
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- Ken Rice

#### Ridge & Slough
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#### Tree Islands
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- Yegang Wu
- Carl Fitz
- Fred Sklar
- Chris McVoy

#### Wading Birds
- Dale Gawlik
- Gaea Crozier

#### Fish
- Joel Trexler
- Bill Loftus
Suitability Indices are presented here to obtain feedback from experts on the response of each species or landscape. The indices have not been calibrated yet and are not intended to replace more detailed ATLSS modeling of several of these species. Use of information herein constitutes acceptance of our disclaimer.

Alligators
Fish
Periphyton
Ridge & Slough
Tree Islands
Wading Birds
Overview

- Objectives
- Development of Indices
  - Concepts and examples
  - Periphyton, Fish and Alligators
  - Wading Birds
  - Topography: Tree Islands and Ridge and Slough
- Comparison and Combination
- Management Scenarios
Objectives

- Create linkage between hydrologic stressors and ecological response
- Create “broad brush” simple but useful indices to quantify ecological response to different water management alternatives
- Verify, calibrate and refine indices to increase their usefulness
Objectives continued...

- Use indices to provide more information on...
  - To what degree did we get the water right?
  - Opportunities for changing hydrology to improve ecology. If so, where, when, how much?
  - “What if” scenarios and their effect on habitat.

- Potential tool for use in regional evaluations during detailed project design and implementation
Development of Indices

1. Identify appropriate habitat indicators.

2. Define habitat suitability indices in terms of hydrologic stressors.

3. Use hydrologic model output (stressor) and habitat suitability indices to obtain time series of suitability values.

4. For each habitat combine individual HSI time series to get overall habitat suitability time series.

5. For each habitat compute summary statistics from combined habitat suitability time series.
1. Identify appropriate habitat indicators.

- Periphyton
- Fish
- Wading Birds
- Alligators
- Tree Islands
- Ridge and Slough landscape
Development of Indices

2. Define habitat suitability indices in terms of hydrologic stressors.

Sample Hydrologic Stressors

- **Water Depth**
  - average

  - min, max, above / below thresholds

- **Flow Direction**

- **Flow Velocity**

- **Time related**
  - hydroperiods - discontinuous/continuous
  - time since last drydown
  - period below / above thresholds
  - rates of recession
3. Use hydrologic model output (stressor) and habitat suitability indices to obtain time series of suitability values.

\[ \text{Stressor}(t) = \text{fn}(\text{Hydrologic Variables}(t)) \]

\[ \text{Suitability} = \text{fn}(\text{Stressor}) \]

\[ \text{Suitability}(t) = \text{fn}(\text{Stressor}(t)) \]
Habitat Suitability Indices

Obtained For

Individual cells

Indicator Regions

Landscapes

South Florida Water Management Model
Periphyton
4. For each habitat combine individual HSI time series to get overall habitat suitability time series.
Alligators

Shark River Slough Current Conditions

BREEDING

DAYS PONDING < 0.5 ft
(16 MAY to 15 APRIL)

Nest Construction

Water Depth ~ ft
Mid April to Mid May

Nest Construction
**Survival and Condition**

**NOT FLOOD NESTS**

- **Max depth (1 July to 31 August)** above
- **Avg. depth (15 June to 1 July)** ~ ft

**NOT FLOOD NESTS**

- **SI nest flood**

**SURVIVAL and CONDITION**

- **Min. Monthly Water Depth ~ ft**

\[ S_{I_{\text{SI}}} = S_{I} \times (\text{yrs since drydown to } < 0.3 \text{ ft})/3 \]

**Shark River Slough Current Conditions**

**Survival & Condition**

- **SI**


**Alligators**

- **Shark River Slough River Slough Current Conditions**
- **Alligators**
\[ \text{SI}_{\text{Alligator}} = \frac{3(\text{SI}_{\text{breed}}) + 3(\text{SI}_{\text{nest constr}}) + 2(\text{SI}_{\text{nest flood}}) + (\text{SI}_{\text{surv+cond}})}{9} \]
5. For each habitat compute summary statistics from combined habitat suitability time series.
Shark River Slough, Indicator Region 110

Suitability Index

NSM, Alligators
CERP, Alligators
Current, Alligators

Shark River Slough, Indicator Region 110

Probability

NSM, Alligators
CERP, Alligators
Current, Alligators

Shark River Slough, Indicator Region 110
Wading Birds

Wading Bird Suitability Sub-Indices

- **Weekly Average Water Depth, Nov to April ~ cm**
  - Scale: 0.0 to 1.0
  - Axis: Depth
  - Values: -10, 0, 10, 20

- **Average Weekly Change in Water Depth cm/week**
  - Scale: 0.0 to 1.0
  - Axis: Recession
  - Values: -30, -20, -10, 0, 10
Grid Cell Suitability

\[ SI_{WB} = \min(SI_{\text{depth}}, SI_{\text{recession}}) \]

Landscape Level Suitability

\[ SI_{\text{land}} = \text{avg. } SI_{WB} \text{ of highest 23 percent of cells for each of} \]
- Remnant Everglades
- Coastal Zone
- Interior Zone
Ridge and Slough - Sensitivity to Depth

Average Water Depth in Ridge and Slough

SI

0.0 0.5 1.0 1.5 2.0 2.5 3.0

Average Water Depth (SFWMM cells) ~ft

0.9 1.6 2.0 2.6 3.1 3.6

SI

0.0 0.5 1.0 1.5 2.0 2.5 3.0
Current System - 1995 Base

Optimum 1.50 ft
Optimum 1.75 ft
Optimum 2.00 ft
Optimum 2.25 ft

Note: Following areas are drier than optimal: NWC, NWCA-2A, NE WCA-2B, N WCA-I. Other areas are wetter than optimal: N side SW WCA-2B, and S WCA-
Habitat Suitability Comparisons

Restoration Plan

Periphyton
SI = 0.62

Fish
SI = 0.82

Alligator
SI = 0.53

Tree Islands
SI = 0.50
Habitat Suitability Comparisons

Natural System

Combined Habitat Index (Fish+Alligator+Tree Islands)

Shark River Slough, Indicator Region 110

Fish
Mean = 0.92

Alligator
Mean = 0.76

Tree Islands
Mean = 0.19

NSM
Mean=0.62

Current
Mean=0.67

CERP
Mean=0.81
Management Scenarios

- “Getting the Water Right” is a surrogate for “Getting the Ecology Right”.
- How do different water management strategies effect ecology?
- Scenarios
  - CERP without any ASR’s
  - CERP without and Lakebelt Storage
Scenarios: CERP with and without ASR

Aquifer Storage and Recovery (1665 MGD)

- Caloosahatchee River ASR (220 MGD)
- Lake Okeechobee ASR (1000 MGD)
- Lower East Coast Region ASR (445 MGD)
  - C-51 Regional Groundwater ASR (170 MGD)
  - West Palm Beach Water Catchment Area ASR (50 MGD)
  - Palm Beach County Agricultural Reserve ASR (75 MGD)
  - Hillsboro Site 1 ASR (150 MGD)
Scenario Comparisons

Shark River Slough, Indicator Region 110

CERP Mean = 0.81
No Lakebelt Mean = 0.64
No ASR Mean = 0.81
Summary

- Habitat SI's are simple, yet robust and useful indicators of ecological response to hydrologic stressors.
- Provide system-wide indication of ecological habitat response to alternative water management strategies.
- Can be used in regional analysis and possibly to provide indication of when and where more detailed ecological modeling is needed.
- HSI’s are not a substitute for geo- morphological and ecological modeling, but rather a relatively simple intermediate step prior to this more detailed analysis.
Can be generated fairly quickly and in future could be automated directly from hydrologic model output. (Currently part of the hydrologic model of the Everglades.)

Functionality should be enhanced in future by using water quality stressors in addition to hydrologic stressors.

Process has enhanced inter-disciplinary and inter-agency communication and increased understanding of the Everglades.
Summary

Water Resource Systems Approaches and Models for:

• Predicting economic, environmental, social, and ecological impacts

• Identifying efficient tradeoffs among conflicting objectives

• Providing information for, not a replacement of, political decision making processes.
Questions?

Thank you