

Using Multi-Criteria Analysis and Analytical Hierarchy Process to Facilitate Everglades Restoration Decision Making

Presented By:

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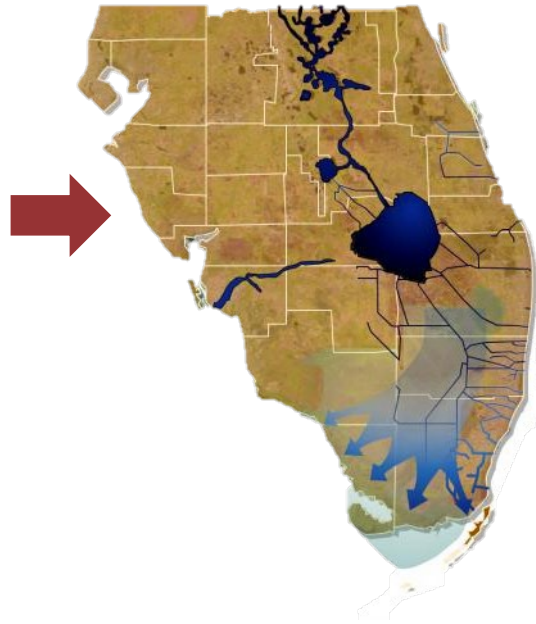


Social Challenges Associated With Everglades Restoration

Current Flow



Restored Flow



1. Series of ecological, economic, and social trade-offs with every proposed restoration scenario.

2. Large number of stakeholders with vastly different needs, restoration ideologies, and influence on decision-making.

3. Need for quantification of stakeholder preferences.

Stakeholders

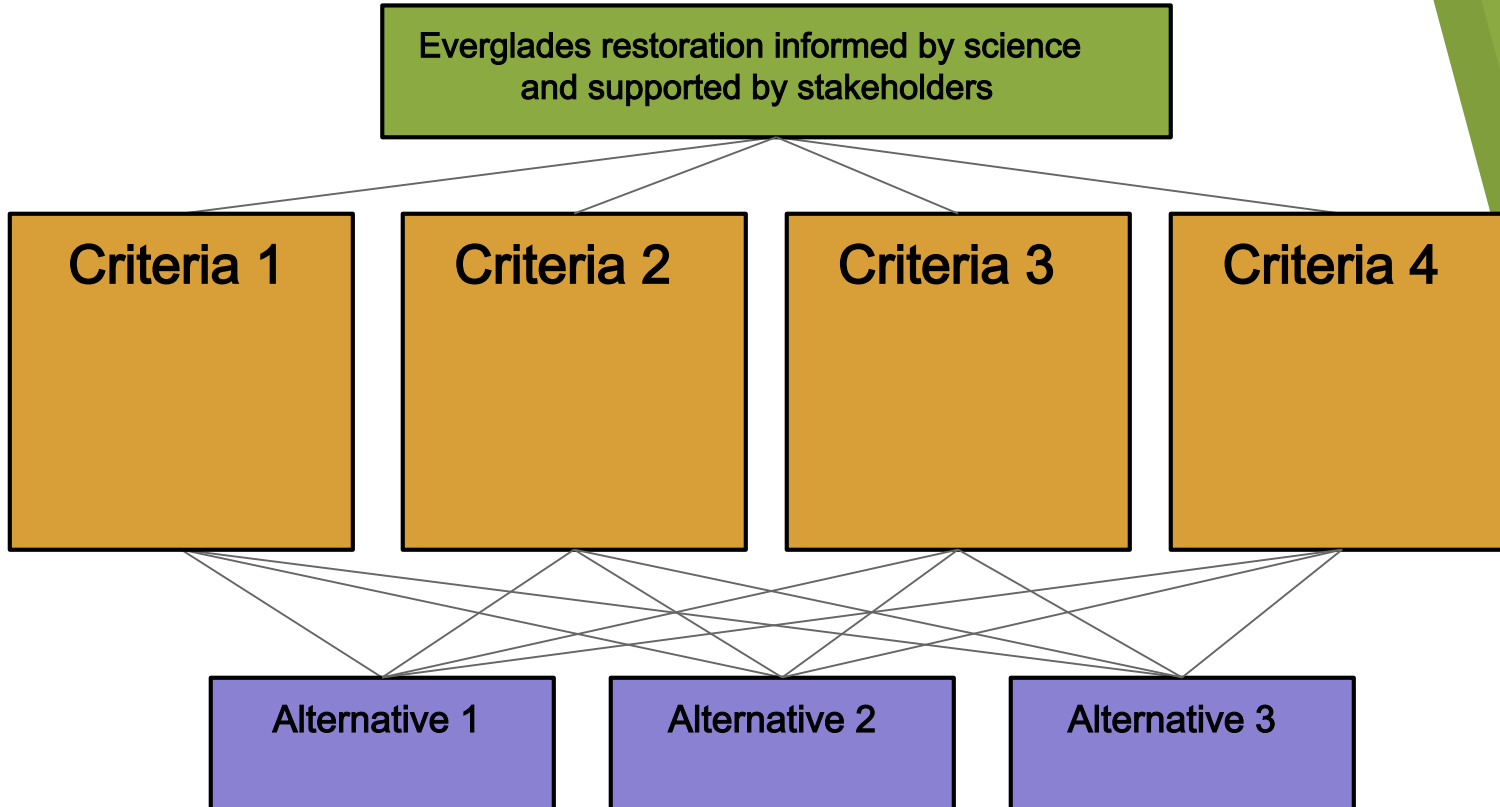
- ❖ Government Agencies (state and federal)
- ❖ Indigenous groups
- ❖ Environmental Advocacy Organizations
- ❖ Business Community
- ❖ Agricultural interests
- ❖ Tourism industry
- ❖ Real estate interests, homeowners (Northern estuaries, Florida Bay)
- ❖ General Public
- ❖ Many more!

Questions:

1. What are individual stakeholder preferences for Everglades restoration?
2. How do these preferences rank against one another?
3. How do they relate to restoration scenarios?



Method: Multi -Criteria Decision Analysis

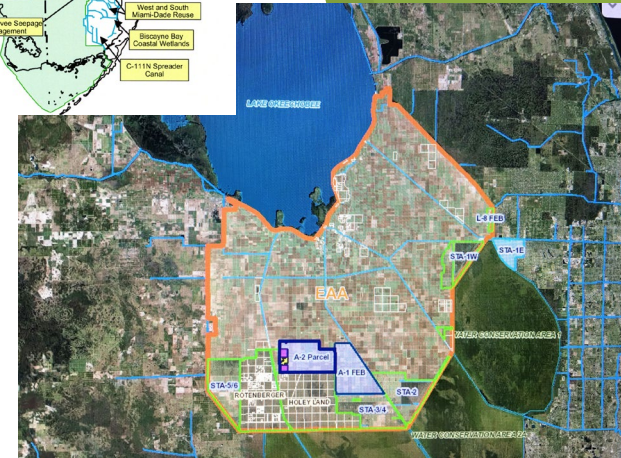
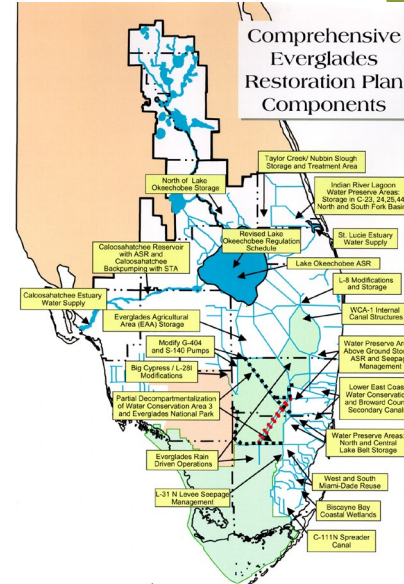


Multi -Criteria Decision Analysis

- ❖ Dividing high -stakes decisions into main outcomes, or criteria, and using those criteria to make decisions and compare decision -making alternatives.
- ❖ Steps:
 1. Define restoration alternatives - *Ecological modeling*
 2. Select the criteria or indicators to measure performance of each alternative – *Expert, stakeholder input*
 3. Choose a jury for weighing the criteria – *Stakeholder and Expert Identification*
 4. Weigh criteria – *Analytical Hierarchy Process*
 5. Aggregate the criteria for each option - *Multi-Attribute Value Theory*

Defining Restoration Alternatives

- ❖ Defined with help from Everglades Foundation ecological modeling based on available data
- ❖ Based on current potential restoration scenarios such as:
 - Various water storage volumes in the EAA reservoir south or north of Lake Okeechobee
 - Implementation of CERP
 - Implementation of CEPP
- ❖ Focus groups to define incremental differences between alternatives.



Selecting Criteria

1. Reducing polluted discharges from Lake Okeechobee into the St. Lucie and Caloosahatchee estuaries



2. Improving seasonal flow of freshwater through Everglades National Park

3. Increasing freshwater storage for public water supply, agricultural, and industrial needs.

4. Improving seasonal flow of freshwater into Florida Bay

Weighing Criteria: Analytical Hierarchy Process

- ❖ Compares criteria using weighted pair-wise (one to one) comparisons.
- ❖ Allows calculation of *how much more* some criteria are valued over others.
- ❖ Places values along an internally comparative matrix, useful for identifying inconsistencies.
- ❖ Will be completed using individual online surveys.

Criteria	The Fundamental Scale for Pairwise Comparisons			
	Intensity of Importance	Definition	Explanation	
	1	2	3	4
1	1	RECIPROCAL	RECIPROCAL	RECIPROCAL
2	COMPARISON	1	RECIPROCAL	RECIPROCAL
3	COMPARISON	COMPARISON	1	RECIPROCAL
4	COMPARISON	COMPARISON	COMPARISON	1

Weighing Criteria: Survey Instrument

The following questions are designed to understand which Everglades restoration outcomes you find the most important. In order to answer these questions accurately, be aware that your responses should make *logical sense*.

For example, if you are expressing your preferences for different fruits, you may *strongly* prefer **apples** over **oranges**, but *slightly* prefer **oranges** over **grapes**. Logically, you could **not** prefer **grapes** over **apples**, because you prefer **grapes** only slightly more than **oranges** and you prefer **apples** strongly more than **oranges**.

- ❖ Challenge: Analytical Hierarchy Process can be confusing to some respondents, with potential for inconsistent responses.
- ❖ Important to include a clarification statement.

Weighing Criteria: Survey Instrument

- ❖ Information statement about each criteria
- ❖ Followed by a prior knowledge question to explain potential motivations behind responses.

Reducing Polluted Discharges from Lake Okeechobee into the St. Lucie and Caloosahatchee Estuaries

In the rainy season, sharp influxes of water into Lake Okeechobee force a release water west into the Gulf of Mexico through the Caloosahatchee estuary and east into the Atlantic Ocean through the St. Lucie estuary. Water from Lake Okeechobee is inundated with chemicals and nutrients due to agricultural and urban land use upstream, causing algal blooms to spread into both freshwater and saltwater ecosystems. Algal blooms cause economic damage through the reduction of property values and tourism earnings, social damage through negative human health impacts associated with algae contact, and ecological damage through disruption of the water oxygen cycle. Reducing the volume of polluted water traveling through the northern estuary systems has the potential to reduce the negative impacts of algal blooms.

How much did you know about reducing polluted discharges from Lake Okeechobee into the St. Lucie and Caloosahatchee estuaries before taking this survey?

A lot

A moderate amount

A little

Weighing Criteria: Survey Instrument

Which criteria to you regard as more important in terms of Everglades restoration?

Reducing polluted discharges from Lake Okeechobee is more important than improving flow of water through Everglades National Park into Florida Bay

Improving flow of water through Everglades National Park into Florida Bay is more important than reducing polluted discharges from Lake Okeechobee

Both are equally important

- ❖ Pair-wise comparison of all criteria
- ❖ Five trade-offs made between four criteria

Weighing Criteria: Survey Instrument

- ❖ Use of importance statements for AHP in lieu of numbers for ease of trade-offs.

How much more important is reducing polluted discharges from Lake Okeechobee than improving flow of water through Everglades National Park into Florida Bay?

A little more important

Moderately more important

Much more important

Extremely more important

Aggregating Criteria for Each Scenario: Multi -Attribute Value Theory (MAVT)

- ❖ Method for aggregating the weights across stakeholder and expert group trade-offs to rank
- ❖ Importance of *measurable* alternatives with unique assemblages of criteria.

$$V_i(x_{i,j}) = w_1 * v_{i1}(x_{i1}) + w_2 * v_{i2}(x_{i2}) + \dots + w_n * v_{in}(x_{in}) \text{ for each } i$$

V_i = Unitless aggregate index for restoration alternative i

$x_{i,j}$ = Physical value of attribute j under restoration alternative i

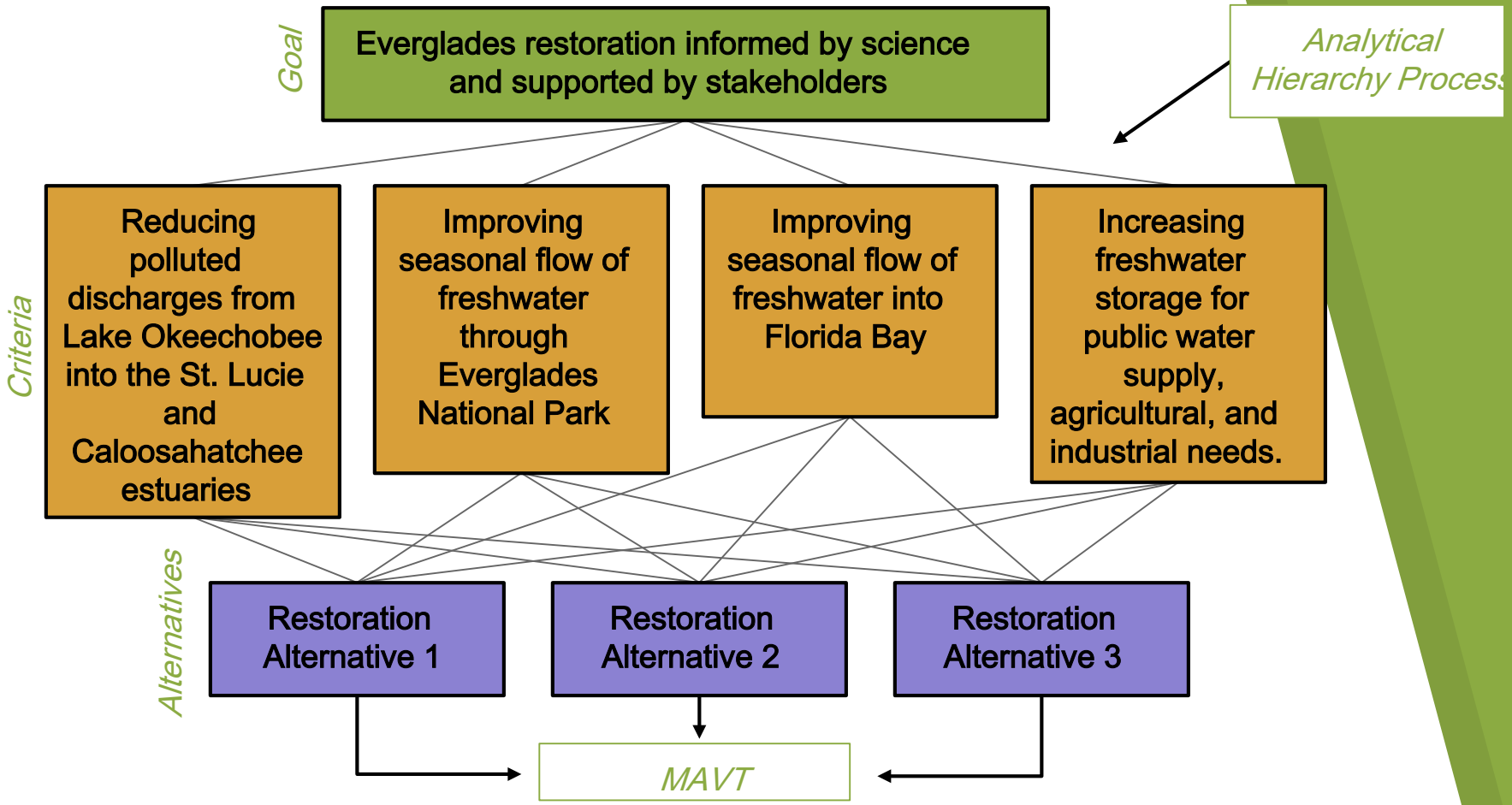
w_j = Stakeholder-generated weight of the attribute j

V_{ij} = normalized value of attribute j under alternatives

$i = 1, 2, \dots, M$ alternatives

$j = 1, 2, \dots, N$ attributes

MDCA Conceptual Model



Additional Information Gathering

- ❖ Use of online surveying gives opportunity to collect additional data for analysis and understanding of potential motivations for trade-offs:
 - Use of “New Ecological Paradigm” (NEP) questions to quantify environmental attitudes of stakeholders.
 - Provide an open-ended response question regarding challenges associated with Everglades restoration and changes in Everglades restoration over time.
 - Opportunity to list additional stakeholders to find potential respondents.
- ❖ Currently testing survey for functionality and clarity, will be distributed Summer 2019.

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