Adapting restoration performance measures to the A.R.M. Loxahatchee National Wildlife Refuge

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Objectives

• Present Refuge specific potential performance measures (PM) perceived to assess restoration progress or evaluate restoration strategies
• Discuss research needs to develop PMs
• Demonstrate the effectiveness of an existing PM
Introduction

- Refuge 144,000 ac marsh system impounded by a canal network which transport high nutrient and mineral waters
- Refuge developed as an oligotrophic, low mineral wetland
- The marsh habitat is characterized by a mosaic of ridges and sloughs, sawgrass plains, and tree islands
- These habitats support a variety of threaten and endangered birds, mammals, and reptiles
2011 Loxahatchee Science Workshop

- Lead scientist throughout the Everglades gathered to
  - Determine the most appropriate ecosystem components to use in
    - **assessing** restoration progress and
    - **evaluating** restoration strategies
  - Identify data needs: monitoring and research
  - Define application methods for ecological components used as PM
Performance Measures

- PM are specific representations of a capacity, process, or outcome deemed relevant to an ecosystems status
- Prior to workshop several PMs were already developed and applied for the Refuge
  - **High water (stage)**
  - *Periphyton metric based on hydroperiods*
  - *Periphyton metric based on tissue phosphorus concentration, mass, and composition*
  - *Wading bird system-wide indicator*
Performance Measures

• Workshop participants proposed several additional PMs:
  - Ridge-slough-tree island
  - Prey-based freshwater fish
  - Aquatic invertebrates
  - Wading birds
  - Alligator
Proposed PM – Ridge, Slough, and Tree Islands

- **Sloughs** – lowest marsh features
  - submersed to saturated year round
  - supports submerged plants & water lilies

- **Ridges** – long stretches of marsh landscape elevated 60 to 90 cm above surrounding sloughs
  - populated with sawgrass
  - too wet for tree species

- **Tree Islands** – highest elevation marsh feature
  - exposed soil that flood infrequently
  - high plant and animal diversity
Proposed PM – Ridge, Slough, and Tree Islands

- **Tree Island** – basic types
  - Circular islands form in slower moving water
    - cover has increased with reduction in sheet flow
  - Elliptical islands form in faster moving water
    - Cover has shifted spatially and declined with hydropattern shifts
  - Hydrologic alterations in the Refuge altered
    - the balance of tree islands types and
    - the original shape and orientation
  - Exotics smothering and collapsing entire islands

- Ridge-slough-tree island communities defines the Refuge habitat structure and should be the highest priority for Refuge restoration
Proposed PM – Ridge-Slough-Tree Islands

- **Drivers**
  - rainfall driven sheet flow (1.4 m d^{-1})
  - hydroperiod and water depth
  - sediment deposition controlled by sheet flow
  - slough and ridge decay rates

- **Inhibitors to restoration**
  - canal bounding the marsh
    - many years rainfall not enough to drive sheet flow or sustain desired water levels
  - loss of peat
  - loss of elevational difference between ridge and slough
  - nutrient and mineral enrichment
Proposed PM – Ridge-Slough-Tree Islands

• Working Group Feedback
  - Lack of restored flow limits restoring the historic north-south sheet flow pattern
  - Need to focus PM on maintaining tree island-slough pattern and prevent conversion to tree island-sawgrass pattern
    • Tree island-sawgrass pattern promotes destabilization of tree islands
  - Need to focus PM on maintaining tree islands pattern and prevent further deterioration

• Potential PMs to be developed
  - Hydroperiod: assessment or evaluation
  - Water depth: assessment or evaluation
  - Number and spatial cover of tree island: assessment
  - Tree island tree size classes: assessment
  - Tree island plant types and diversity: assessment
  - Tree island percent cover of Lygodium: assessment
Proposed PM – Ridge-Slough-Tree Islands

- Research needs
  - Determine tree island-slough required hydroperiod
  - Determine water depth that promotes tree island-slough dynamic and supports prey-base (i.e., small fish)
  - Determine the number tree islands presently connected to sloughs versus sawgrass plains
  - Determine number, type, spatial extent of tree island
  - Determine plant species composition/diversity
  - Determine peat/soil and nutrient composition
  - Determine wildlife usage of the tree islands
Proposed PM – American Alligators

- American alligator –
  - abundant in pre-drainage Everglades
  - presently, greatest density in Refuge
  - sculpt the landscape with nest and alligator holes
  - nesting success linked to hydrology

- Drivers
  - hydroperiod and water depth
  - ridge-slough-tree islands

- Inhibitors to restoration
  - loss of peat
  - loss of ridge-slough-tree island habitat

![Image of American Alligator]

**Existing Density PM**

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Proposed PM – American Alligators

- Working Group Feedback
  - Need to focus PM on density and body condition
- Proposed PM to be developed
  - Density
    - presently tracking alligator density (~ 6 alligators km⁻¹)
    - metric should track density relative to 2011 numbers
  - Body condition
    - length and weight
    - model not developed for the Refuge
- Research Needs
  - Synthesize recent years of research
  - Link body condition to hydrology
Existing PM – High Stage

PM Target – reach high stage 3 to 4 weeks annually at least 3 of 4 or 4 of 5 years

Metric assumes most of Refuge flooded at stage > 16.4 ft and almost all marsh submerged at stage ≥ 17.4 ft

- 1 point every day stage ≥ 17.4 ft
- stage – 16.4 ft points every day between 16.4 and 17.4 ft
- 0 points every day stage ≤16.4 ft
- Water year (May – Apr) daily score tallied; ≥ 55 acceptable
Protecting the Everglades
One step at a time

Existing PM – High Stage

High Stage Performance Measure - Evaluation

Acceptable score = 55

25th percentile of PM scores for 35 year simulations designed to reduce phosphorus concentrations to the Everglades

Modeled restoration scenarios

High Stage Performance Measure - Assessment

Acceptable score = 55

Period of Record PM score = 66.2

S-155A Diversion monitored
Phase I

✓ Identified several PMs to assess ecosystem response to restoration
✓ Identified research needs to make these PMs applicable to the Refuge

Phase II

• Perform research to actualize conceptual PMs
• Synthesize present alligator data to generate body condition PM
• Incorporate the suite of PMs into one tool management can easily use