



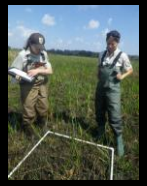

Protecting the Everglades
One step at a time

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

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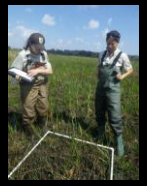
Objectives

- 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



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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

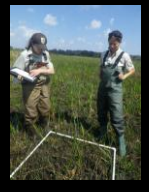
- Lead scientist throughout the Everglades gathered to
  - Determine the most appropriate ecosystem components to use in
    - **assessing** restoration progress and
    - **evaluating** restoration strategies
  - Identify data needs: monitoring and research
  - Define application methods for ecological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





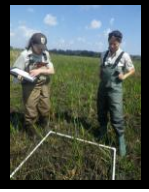


Performance Measures

- Workshop participants proposed several additional PMs:
  - **Ridge-slough-tree island**
  - *Prey-based freshwater fish*
  - *Aquatic invertebrates*
  - *Wading birds*
  - **Alligator**







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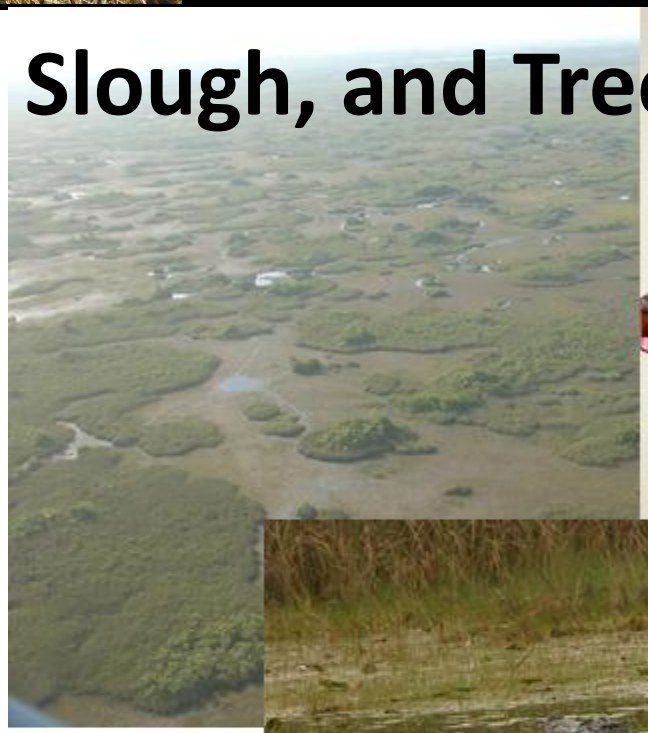
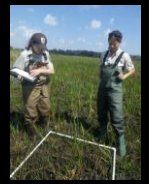
Proposed PM – Ridge, Slough, and Tree Islands

- **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







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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

Lygodium
(Old World Climbing Fern)





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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

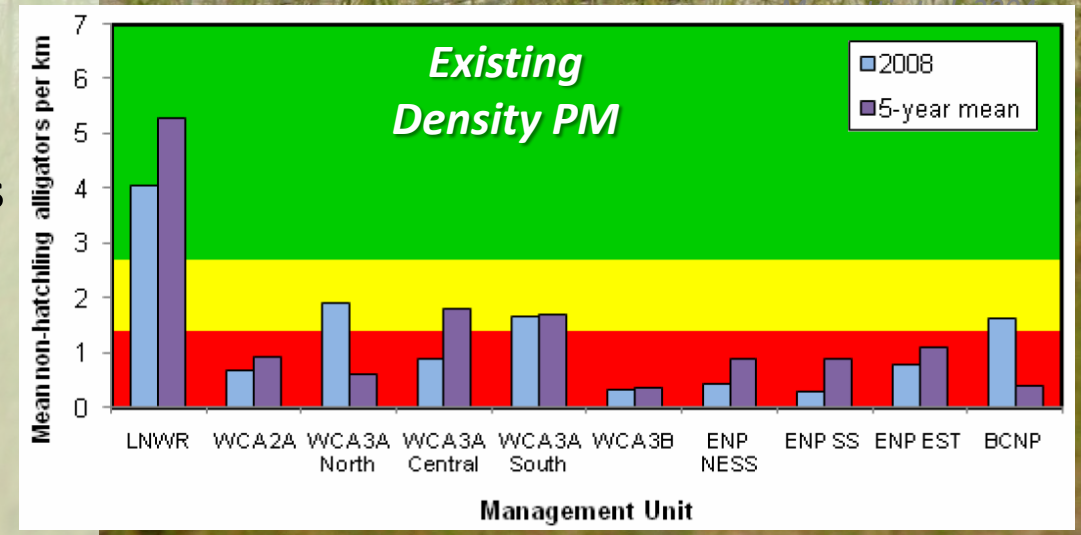
- **Working Group Feedback**
  - Lack of restored flow limits restoring the historic north-south sheet flow pattern
  - Need to focus PM on maintaining tree island-slough pattern and prevent conversion to tree island-sawgrass pattern
    - Tree island-sawgrass pattern promotes destabilization of tree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

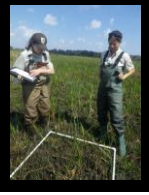


Proposed PM – American Alligators

- **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







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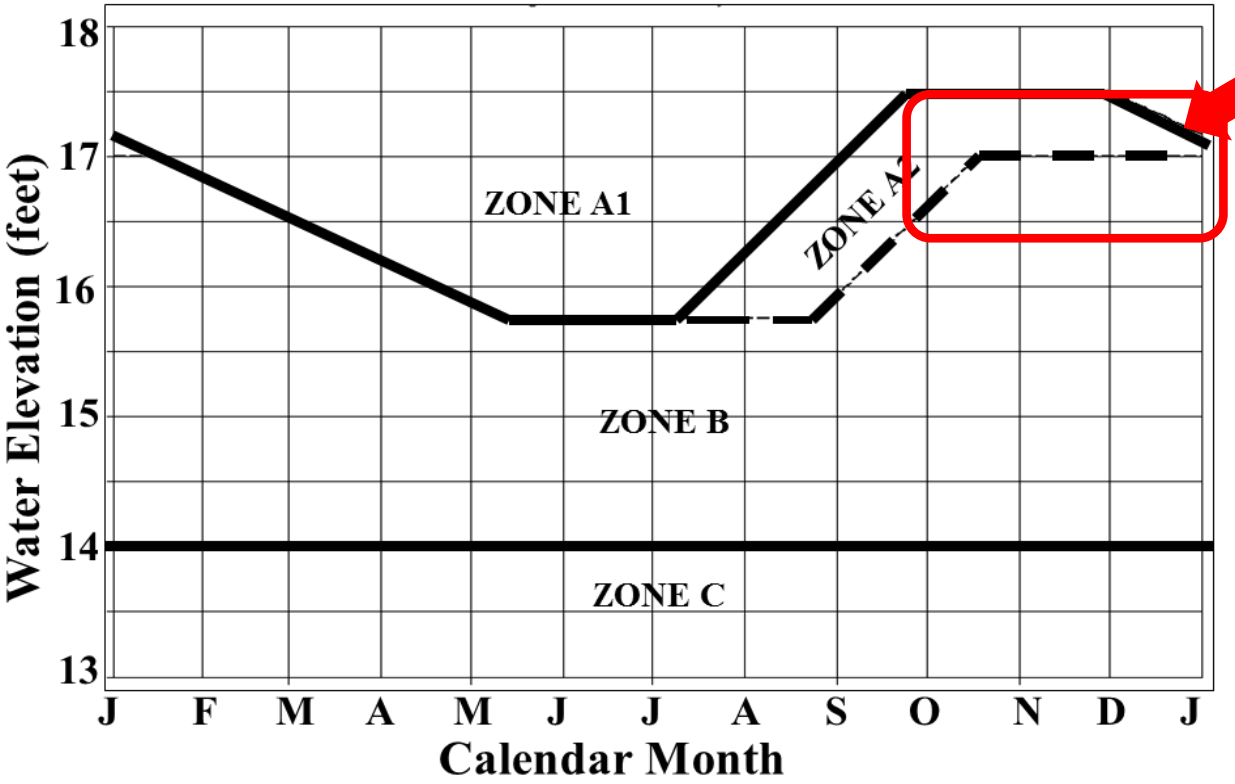
Existing PM – High Stage



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





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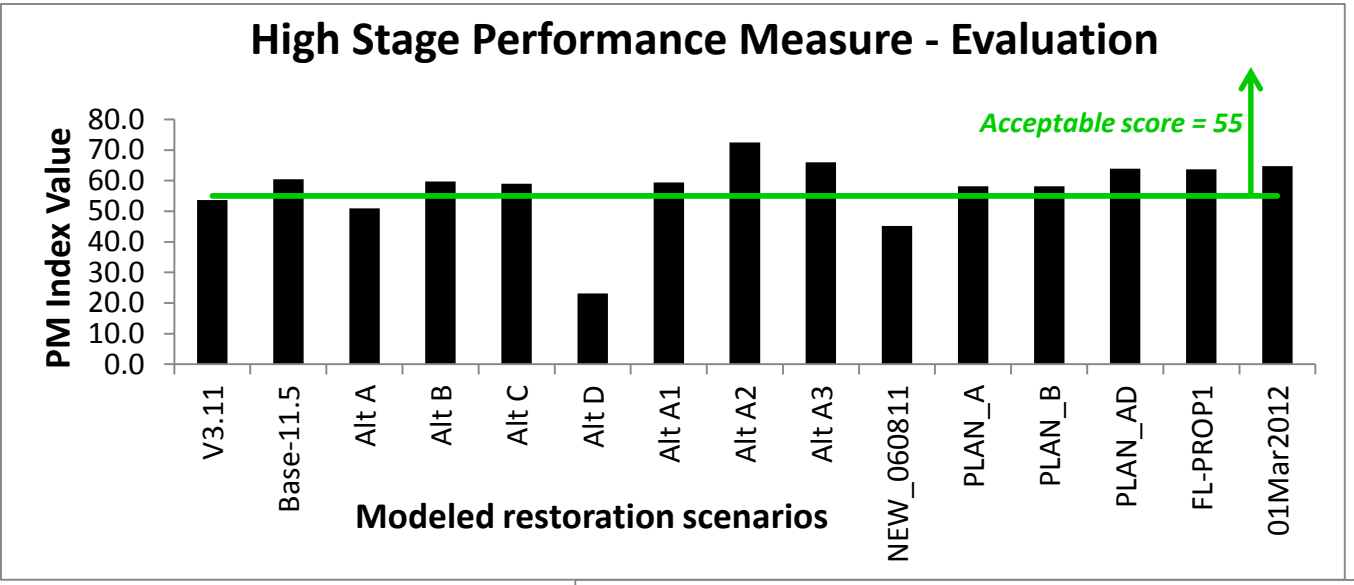
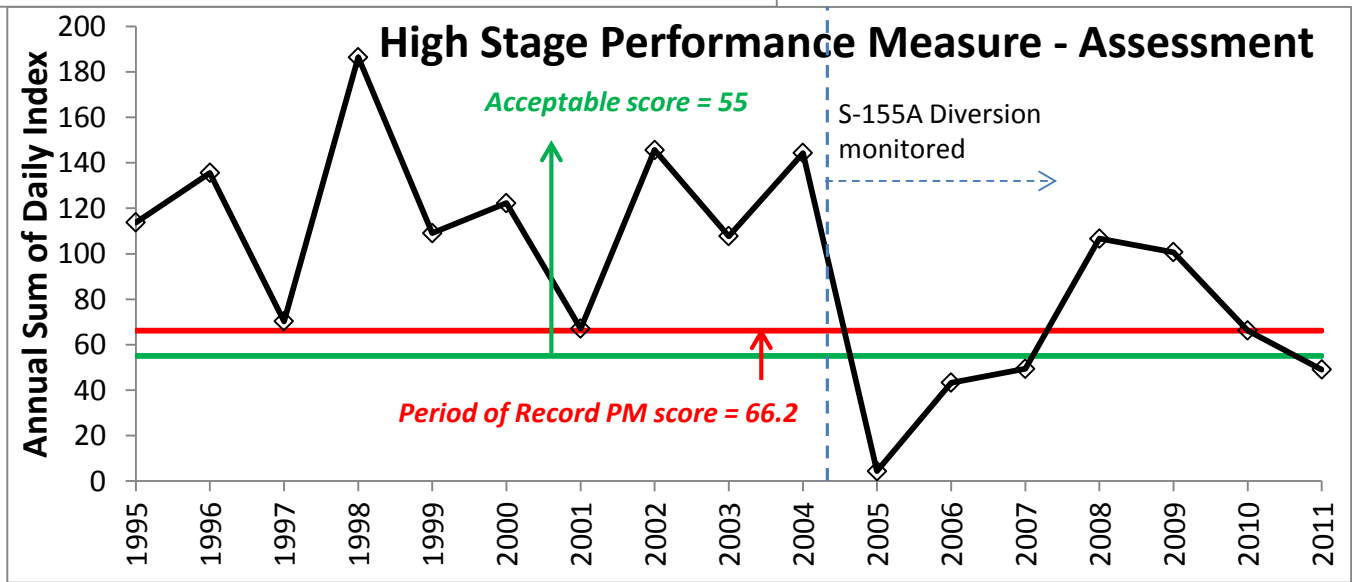
Existing PM – High Stage



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



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