What Managers Need to Know About System-wide Science to Improve Restoration Planning and Maximize Adaptive Management

Chairs of RECOVER Assessment Team, Integrative Assessment Sub-team, and MAP Module Groups

Matt Harwell

Effective Use of Science in South Florida

Effective Science
- Content
- Quality

Effective Use of Science
Institutional process where science is:
- Generated
- Evaluated
- Applied

Themes Covered

- History of the Monitoring and Assessment Plan (MAP)
- System-wide monitoring and assessment for AM
- MAP and project planning and implementation
- Lessons-learned
- Long-term monitoring, sustainability, and thresholds
- MAP future
- Synthesis of key messages for managers
History of the Monitoring and Assessment Plan
Purpose of the MAP

• Document restoration-induced change and status of system
  – Measure hydrology, water quality, ecology responses

• Confirm/develop scientific information

• Feedback loop integrating science and management

• Informed decision-making
  – Provide science to guide implementation, operation, and maximize benefits, i.e., Adaptive Management
  – Sound science to reduce risk and uncertainty
Conceptual Ecological Models

Ridge & Slough
Marl Prairies
Mangrove Estuaries
Big Cypress
Florida Bay
Biscayne Bay
Caloosahatchee Estuary
St. Lucie Estuary/IRL
Lake Okeechobee
Loxahatchee R.
Lake Worth Lagoon

Total System Model
Conceptual Ecological Models

Southern Estuaries

Drivers & Sources

WATER STORAGE and WATER QUALITY

Stressors

Salinity Patterns and Nutrient Inputs

Attributes

Algal Blooms

Seagrass

Pink Shrimp

Reservoir pump station

Stormwater treatment area

Florida Bay salt marsh zone
MAP Implementation

• Capture baseline info for monitoring components that do not have adequate existing information

• Fill gaps in existing networks
  • hydrology
  • water quality
  • biology

• Initiate high priority new biological monitoring

• Initiate priority supporting ecological research

• Develop guidance for assessment protocols
Ability to Detect Change
Establish Reference
Measure Change
Integrate & assess hypotheses
Integrate & Scale Up

Performance measure

Hierarchical Assessment

Ecosystem
Metrics for Assessment

- Was >> than 100 PMs
- Combined across CEMs
- Distilled CEMs
  - 17 major organizing hypothesis clusters

Figure 1. The total South Florida ecosystem has 11 regions for which conceptual ecological models have been developed. These regions combined form the boundary of the Total System Conceptual Ecological Model.
## System-wide Assessments

**GEER 2008  System-wide Assessment workshop**

<table>
<thead>
<tr>
<th>Components</th>
<th>N. Estuaries</th>
<th>L. Okeechobee</th>
<th>G. Everglades</th>
<th>S. Estuaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Status</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to Detect Change</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference Condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measure / Assess Change</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apply to AM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lessons Learned</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
System-Wide Monitoring and Assessment for Adaptive Management
CERP AM Definition

“Adaptive management is a science- and performance-based approach to ecosystem management in situations where predicted outcomes have a high level of uncertainty. Under such conditions, management anticipates actions to be taken as testable explanations, or propositions so the best course of action can be discerned through rigorous monitoring, integrative assessment, and synthesis. Adaptive management advances desired goals by reducing uncertainty, incorporating robustness into project design, and incorporating new information about ecosystem interactions and processes as our understanding of these relationships is augmented and refined. Overall system performance is enhanced as AM reconciles project-level actions within the context of ecosystem-level responses.”

- CERP AM Strategy, 2006
Nine Activities in CERP AM

**Plan Formulation**

Activity 1: Engage Stakeholders and Collaborate

Activity 2: Establish or Verify Program Goals and Objectives

Activity 3: Identify and Prioritize Unanswered Questions

Activity 4: Use Conceptual Models, Hypotheses, and Performance Measures

**Design/Construction**

Activity 5: AM Integration into Restoration Plan

Activity 6: Monitoring

**Operations**

Activity 7: Assess

Activity 8: Decision-Making

Activity 9: Implement and Refine
A structured process of learning by doing

Other Information and Extrinsic Factors

Plan Assess Act

Monitor

Adaptive Management Cycle

Plan

Assess

Act

Monitor

Time
Framework for Synthesis and Interpretation

- **Insufficient Data or Time**
  - Continue Monitoring
  - Modify MAP
- **Inconsistent Results**
  - Modify Hypotheses, CEMs, PMs
  - Modify Tools
- **Consistent Results**
  - Identify Hydro/Ecol Needs
  - No Action Required
Improve salinity patterns, water quality and habitat to restore
Oyster Performance Measure Example

- Substrate Suitability
- Nutrient Reductions
- Flow/Salinity Envelope

IRL-S Implementation

Adaptive Management Entry Points

Monitoring designed to assess the success of implementation over time

Oyster Distribution, Quantity and Health

Time

Acres Live Beds

2000 2015 2030 2045
Application of MAP as it relates to project planning and implementation
Oyster Performance Measure Example

HSI to predict suitable Oyster Habitat based on differing flow/salinity scenarios that will occur as an outcome of implementation.
# Linkage of oyster HSI metrics to management actions

<table>
<thead>
<tr>
<th>Stressor metric</th>
<th>Target</th>
<th>Management Action OPTION 1</th>
<th>Management Action OPTION 2</th>
<th>Management Action OPTION 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity</td>
<td>Salinity range of 10-25 ppt</td>
<td>Change operations to meet flows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recruitment</td>
<td>Presence Absence adults and larvae</td>
<td>Stock larvae</td>
<td>Stock adults</td>
<td>Operations to avoid too much or too little flow in key months</td>
</tr>
<tr>
<td>Substrate</td>
<td>Acres of Suitable habitat</td>
<td>Add oyster shell cultch</td>
<td>Try different substrate e.g., concrete</td>
<td>Dredge muck</td>
</tr>
</tbody>
</table>
## Linkage of oyster HSI metrics to management actions

<table>
<thead>
<tr>
<th>Stressor metric</th>
<th>Target</th>
<th>Management Action OPTION 1</th>
<th>Management Action OPTION 2</th>
<th>Management Action OPTION 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oyster reef development</td>
<td>Presence / absence of 1 m² reefs</td>
<td>Add additional cultch</td>
<td>Adjust flows to attain salinities similar to creeks where oyster growth is optimal</td>
<td>Excessive predation may require salinity adjustments through operations</td>
</tr>
<tr>
<td>Juvenile growth and mortality</td>
<td>Attain natural levels of growth and mortality</td>
<td>Adjust operations to eliminate or minimize events</td>
<td>Lower salinity threshold and adjust operations</td>
<td></td>
</tr>
<tr>
<td>Disease</td>
<td>Elimination</td>
<td>Operate flows to maintain salinity below maximum threshold</td>
<td>Lower salinity threshold and adjust operations</td>
<td></td>
</tr>
</tbody>
</table>
Application of lessons-learned to better aid managers’ efforts to maximize restoration
Types of System-wide Lessons Learned

- Science
- Assessment
- Integration of science for AM
- Application of system-wide perspectives to project planning and implementation

MISTAKES

It could be that the purpose of your life is only to serve as a warning to others.

www.despair.com
Lessons Learned – Science and Assessment

• Science
  – Specific to monitoring components
    • e.g., network efficacy
  – Applicable among systems
    • sampling protocols

• Assessment
  – Collaboration among scientists and agencies critical
  – Data Management:
    • Additional structure and integration
    • Improved efficiency through automation
Lessons Learned – Science and Assessment

• Integration of science for AM
  – Continued efforts needed to develop structured process to integrate science and management decisions

• Application of system-wide perspectives to project planning and implementation
  – Communication
  – System-wide science should be expressed as:
    • A means of reducing risk
    • A means of reducing uncertainty
Long-term monitoring, sustainability, and thresholds
Ecosystem Response

Stressor

Quick response variable
Medium response variable
Long-term response variable
Overall restoration expectations

Yearly
5-10 years
10+ years
25-50 years
From Thresholds to Action

Modified from: B. Scholes
Most needs are resource related

Sustainability

- $$$
- Resources
- Expectations Management
Future of the Monitoring and Assessment Plan
MAP 2004

- well-received
- guidepost for current monitoring

MAP Part 2 (2006)

- documented strategy to conduct monitoring assessments
MAP 2008 Implementation Process

MAP Module Refinement

Project-Level Components

Monitoring Component and PM Refinement

MAP 2008 “Workshop Series”

Update inventory of all monitoring

IG update

Management Perspectives

System-wide Perspective

Science Influences

MAP 2008

Management Influences
CERP Applied Science Strategy

1. Societal Values → Goals and Objectives → Research and Modeling
2. Societal Values → Conceptual Ecological Models
5. Performance Measures → Monitoring Plan & Assessments
6. Monitoring Plan & Assessments → Comprehensive Plan

Diagram Flow:
- Societal Values leads to Goals and Objectives, which leads to Research and Modeling.
- Societal Values also leads to Conceptual Ecological Models.
- Conceptual Ecological Models further leads to Alternative Plan Evaluations.
- Additionally, Conceptual Ecological Models lead to Performance Measures, which in turn lead to Monitoring Plan & Assessments.
- Finally, Monitoring Plan & Assessments lead back to Comprehensive Plan.
Key Messages for Managers Relevant to Restoration
Themes Covered

- History of the Monitoring and Assessment Plan (MAP)
- System-wide monitoring and assessment for AM
- MAP and project planning and implementation
- Lessons-learned
- Long-term monitoring, sustainability, and thresholds
- MAP future
- Synthesis of key messages for managers
Key Messages

• MAP evolution
  – Early implementation → current ecosystem health
    • And next steps for MAP and AM program
• System-wide science directed to output relevant for managers
• Restoration benefits coupled to system-wide science based ecosystem monitoring/assessment
• Focus on linkages between traditional science and CERP AM program
• Information coupled to reporting requested by NRC, Congress, etc.
Thank You and Questions