Guidance on Monitoring Ecosystem Restoration Projects

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Overview

- Acknowledgements:
  - Environmental Benefits Analysis (EBA) and Ecosystem Management and Restoration Research (EMRRP) Programs
  - Ecosystem Restoration Focus Area Monitoring and Adaptive Management element—Dave Tazik, Craig Fischenich, Tim Lewis, and team members
  - Colleagues, esp. Tomma Barnes and Kyle McKay
- Presentation outline:
  - Problem definition and challenges
  - Definition of monitoring
  - Purposes of monitoring
  - Current guidance from HQ
  - Principles of monitoring
  - Categories and methods of monitoring
  - Future directions

Problem Definition and Challenges

- Kondolf and Micheli 1995, NRRSS publications, *Journal of Applied Ecology* 2005 forum on river restoration standards, Zedler 2007: monitoring is critical for multiple needs, ignored, and poorly executed
- OMB and WRDA 2007: benefits of ecosystem restoration activities must be documented; monitoring needs to be addressed
- USACE works in many ecosystem and project domains and at multiple scales

Monitoring Categories

- Large scale environmental monitoring for program or project prioritization, selection, and design—baseline, status and trend
- Programmatic review and design
- Project implementation compliance
- **"…assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed…"** for both restoration and mitigation activities
- Validation of conceptual models

GENERAL PROJECT MONITORING OBJECTIVES

- Determine and prioritize needs
- **To support adaptive management**
- **Assessing and justifying expenditures**
- **To minimize costs and maximize benefits**
- **To determine “ecological success”, document, and communicate it**
- **To advance state of practice**

WRDA 2007

Guidance documents for Sections 2036 (a) and 2039 issued on 31 August, 2009.

- USACE CECW-PB. Implementation Guidance for Section 2039—Monitoring Ecosystem Restoration. Memorandum.
- USACE CECW-PC. Implementation Guidance for Section 2036(a)-Mitigation for Fish and Wildlife and Wetlands Losses. Memorandum.

Project Monitoring--Definition

"…includes the systematic collection and analysis of data that provides information useful for assessing project performance, determining whether ecological success has been achieved, or whether adaptive management may be needed to attain project benefits."

USACE CECW-PB, 8/31/09

Section 2039-Monitoring Ecosystem Restoration

- Applies to CAP, specifically authorized projects, and other programmatic authorities
- Development of a monitoring plan will be initiated during plan formulation, focusing on key indicators of project performance.
- Description in the decision document must include rationale for monitoring, specific parameters, the relationship of those parameters to achieving desired outcomes or decision formulation, and uses of the information.

Section 2039-Monitoring Ecosystem Restoration

- The plan must specify nature, duration, and periodicity of monitoring, disposition of monitoring and analysis, costs, and responsibilities.
- Scope and duration should include the minimum monitoring actions necessary to evaluate success. Need not be complex.
- Monitoring plan will be reviewed during ATR and IEPR as necessary.
- Monitoring plan commences upon completion of construction.
- Monitoring will be continued until “restoration success” is documented by District Engineer in consultation with federal and state resource agencies and determined by Division Commander.

Section 2039-Monitoring Ecosystem Restoration

- Success determined by an evaluation of predicted outcomes vs. actual results.
- Financial and implementation responsibilities for monitoring will be included in the PPA.
- Cost-shared (under Construction) component not to exceed 10 years. Cost shared monitoring costs must be included as part of the project cost and cannot increase the Federal cost beyond the authorized dollar limit. Monitoring can end sooner if success is determined.
- Monitoring beyond 10 years is a 100% non-Federal responsibility.

Section 2039-Monitoring Ecosystem Restoration: Adaptive Management

- An adaptive management plan is required for all ecosystem restoration projects.
- It must be appropriately scoped to project scale.
- The rationale and cost of AM and anticipated adjustments will be reviewed as part of the decision document.
- Identified physical modifications will be cost-shared and must be agreed upon by the sponsor.
- Changes to the AM plan approved in the decision document must be coordinated with HQUSACE.
- Significant changes needed to achieve ecological success that can't be addressed through operational changes or the AM plan may be examined under other authorities.
- Costly AM plans may lead to re-evalution of the project.

Section 2036(a)-Mitigation for Fish and Wildlife and Wetlands Losses

Mitigation plans must include:

- A description of actions to achieve mitigation objectives
- The type, amount and characteristics of habitat being restored.
- Ecological success criteria
- A monitoring plan
- An adaptive management plan
- A description of land interests to be acquired

Section 2036(a)-Mitigation for Fish and Wildlife and Wetlands Losses

Monitoring plans must :

- Be developed during plan formulation and described in the decision document
- Include rationale, specific parameters (performance standards) for determining ecological success. Additional guidance on performance standards is under development by HQs.
- Include cost, periodicity of monitoring, and duration estimates
- Include the minimum actions necessary to evaluate success. Need not be complex.
- Determine monitoring responsibilities (preferably in the decision document, but if not possible, in the project partnership agreement).

Section 2036(a)-Mitigation for Fish and Wildlife and Wetlands Losses

- Most mitigation assessments will occur under periodic inspections as part of normal O&M, under sponsor responsibilities and costs.
- For some mitigation measures of documented risk, uncertainty, or complexity, cost-shared monitoring may be appropriate and must be justified and requested in the decision document.
- Monitoring costs for navigational projects will be shared consistent with apportioned O&M costs.
- Monitoring shall continue until mitigation has met ecological success criteria documented by the District Engineer in consultation with federal and state resource agencies and determined by the Division Commander.

Section 2036(a)-Mitigation for Fish and Wildlife and Wetlands Losses: Adaptive Management

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- It must be appropriately scoped to project scale.
- The rationale and cost of AM and anticipated adjustments will be reviewed as part of the decision document.
- Identified physical modifications will be cost-shared and must be agreed upon by the sponsor.
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Section 2036(a)-Mitigation for Fish and Wildlife and Wetlands Losses: Consultation

- Each Division Commander must establish an annual consultation process with appropriate Federal and state agencies and report to HQs.
- The District Engineer must prepare a report for each consultation evaluating:
  - the degree of ecological success of the mitigation as of the submittal date
  - the likelihood that the mitigation will achieve success as defined
  - the projected timeline for achieving that success
  - any recommendations for improving likelihood of success

Salient Points about Guidance

- The Policy has been established
- The profile, use, and importance of monitoring are increasing with project partners potentially playing a bigger role
- “Ecological success” is a central criterion and needs precise definition in individual project contexts
- Additional guidance on performance standards for ecological success is under development

Restoration process—monitoring roles (in bold)

1. **Define problem**
2. **Develop restoration objectives**
3. **Develop a conceptual model**
4. **Develop restoration hypotheses using model**
5. **Choose target parameters for specific goals**
6. **Evaluate and test hypotheses if possible**
7. Develop design
8. Develop feasibility, cost, and benefit analyses
9. Develop final design
10. **Perform monitoring and adaptive management**

Principles of Project Monitoring

The monitoring must be able to support:

- The ability to make timely, cost-effective, mid-course corrections or improvements(AM)
- The ability to demonstrate to others that the project is meeting or exceeding performance goals
- The “learning organization” and the states of practice and science

Characteristics of an Optimal Monitoring Program

- Clear monitoring program goals and objectives
- Appropriate scaling (temporal and spatial) and resource allocation for data collections, management, intrepretations, and analyses
- QA/QC procedures, possible peer review
- Programmatic and procedural flexibility when indicated
- Reasonable costs
- High implementation efficiency
- Reportability to diverse audiences

What does a good metric set look like? (McKay, 2009)

EPA (2000) – EMAP

1: Conceptual relevance
- 1.1: Relevance to the assessment
- 1.2: Relevance to ecological function

2: Feasibility of implementation
- 2.1: Data collection methods
- 2.2: Logistics
- 2.3: Information management
- 2.4: Quality assurance
- 2.5: Monetary costs

3: Response variability
- 3.1: Estimation of measurement error
- 3.2: Temporal variability (within-season)
- 3.3: Temporal variability (across-year)
- 3.4: Spatial variability
- 3.5: Discriminatory ability

4: Interpretation and utility
- 4.1: Data quality objectives
- 4.2: Assessment thresholds
- 4.3: Linkage to management action

NRC (2000) – National Ecological Indicators

General Importance	Conceptual Basis
Reliability	Statistical Properties
Data Requirements	Necessary Skills
Robustness	International Compatibility

Temporal and Spatial Scales of Applicability

Costs, Benefits, and Cost-Effectiveness

Keeney and Gregory (2005) – Decision Metrics

Comprehensive	Direct
Operational	Understandable
Unambiguous	

Desirable Metric Properties

Relevant

Unambiguous

Comprehensive

Direct

Operational

Understandable

Developing a monitoring program

1. Define the problem, goals, and objectives
2. Conduct baseline or comparative (e.g. reference) studies
3. Develop, review, or refine the conceptual model
4. Categorize and coordinate data needs
5. Choose monitoring parameters (controlling factors, structure, or functions? direct or indirect? abiotic and biotic? supplemental?), methods, and performance criteria
6. Specify sampling design (spatial limits, periodicity, frequency, sample numbers), processing, roles, duration
7. Determine analytic needs
8. Develop data management, storage, and flow paths
9. Identify action triggers for AM
10. Estimate cost and component costs
11. Modify M&AM as necessary

Technical Challenges

- Varying techniques for form or process-based restoration techniques
- System context—many projects are narrow in scope and goals
- Design and utilization of hierarchical or multi-scaled approaches
- Parsing of the restoration signal from exogenous influences, the "natural" range of variation, and direct from indirect effects of restoration actions
- Non-linear phenomena, e.g. critical thresholds
- The temporal or spatial roles of the target ecosystem's disturbance regime, stochasticity, and hysteresis (a specific response to restoration may not reflect the response to impact in rate or trajectory)
- Scalability of findings
- Numerical and statistical issues
- QA/QC

Factors in Choosing Monitoring Intensity

- Size of project
- Public profile of project
- Consequences for project success or failure
- Complexity of project and ecosystem
- Roles of disturbance regime
- Range of natural variation
- Diversity of project set and settings

Varying Ecosystems=Varying Drivers, Structural Characteristics, Functional Processes

- Freshwater wetlands
- Streams and rivers
- Lakes and reservoirs
- Subtidal estuaries
- Estuarine and coastal wetlands
- Open coastline and near coastal waters

Monitoring Design Categories

- Before-After (BA)
- Before-After-Control-Impact (BACI)
- Intensive Post-Treatment (one or few sites)
- Extensive Post-Treatment (many sites)
- Staircase (many sites implemented regularly over many years)

Statistical Tools

- Power analysis to help determine duration, number of sampling sites, and number of samples are needed to detect a change in a parameter of interest
- Testing tools (e.g., parametric, regression, non-parametric, bootstrap, multivariate, etc.)—select before monitoring design is completed
- In many smaller or simpler cases, descriptive statistics are adequate (see earlier slide on monitoring intensity)

Commonly used protocols and measures

- Biomonitoring (diatoms, algae, macroinvertebrates), including RBP
- HGM
- HEP
- Geomorphic measures
- Trophic state index
- Fish IBI
- Top carnivore (fish) index
- Water column bacteria
- Specific conductivity
- Eutrophication
- Acidification
- Salinity trends
- Thermal alteration
- Contaminant presence or nutrient loading

Case Study-CERP

http://www.evergladesplan.org/pm/recover/recover_docs/map/MAP_5.0_Implement.pdf

Criteria for selection:

- Criterion 1 - Does the monitoring component address a critical issue in the regional conceptual ecological models?
- Criterion 2 - Does the monitoring component have the ability to discriminate between CERP and non-CERP effects?
- Criterion 3 - Is this the most cost-effective manner in which to execute the monitoring component?
- Criterion 4 - Does this monitoring component complement, leverage, or utilize relevant ongoing monitoring programs or initiatives?
- Criterion 5 - Is the monitoring component a keystone element in assessing restoration expectations?

Case Study-CERP

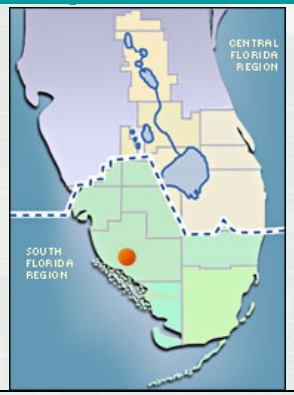
http://www.evergladesplan.org/pm/recover/recover_docs/map/MAP_5.0_Implement.pdf

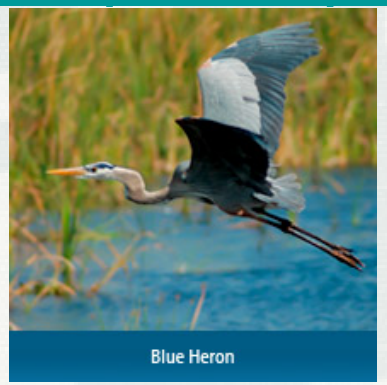
Criteria for selection:

- Criterion 6 - Is the monitoring component an intermediate link toward understanding why other important components have changed?
- Criterion 7 - Is there an adequate long-term record for the monitoring component?
- Criterion 8 - Does the monitoring provide supporting information for interim goal/interim target indicators?
- Criterion 9 - Does monitoring this component provide information that will be important to stakeholders in determining if the goals and objectives of the CERP are being achieved?
- Criterion 10 - Are data provided by this monitoring component necessary within: (1) 0-2 years,
- (2) 2-4 years, (3) 4-6 years, (4) more than 6 years?

Case Study-CERP

- >75 spatial, abiotic, and biotic elements
- Careful scaling
- Extensive WQ, hydrometeorological, and hydraulic measures
- Robust QA/QC program (http://www.evergladesplan.org/pm/qaot.aspx)





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- USACE CECW-PB. 2009. Implementation Guidance for Section 2039—Monitoring Ecosystem Restoration. Memorandum.
- USFS RMRS series

Questions and Feedback

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Environmental Benefits Analysis (EBA) Research Program Website
http://cw-environment.usace.army.mil/eba/

Ecosystem Management and Restoration Research Program (EMRRP) Website
http://el.erdc.usace.army.mil/emrrp/