Adaptive Management for Ecosystem Restoration - Principles and Practice

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Water Operations Technical Support (WOTS)
Monitoring and Adaptive Management
Webinar Series

US Army Corps of Engineers
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Purpose

- Introduce/discuss different types of adaptive management
- Describe methods to develop and implement adaptive management plans
- Pass along lessons learned
- Establish a foundation for the remaining presentations in this webinar series

Terminology

- Objectives
- Hypotheses
- Performance Measures (Metrics)
- Decision Criteria (Targets)
  - Success Criteria
  - Triggers
- Contingency Actions

Origins of AM

Walters, C. 1986
Adaptive management of renewable resources.
New York: MacMillan Publishing Co

NRC. 2004
Adaptive Management for Water Resource Planners
The National Academies Press, Washington, D.C.

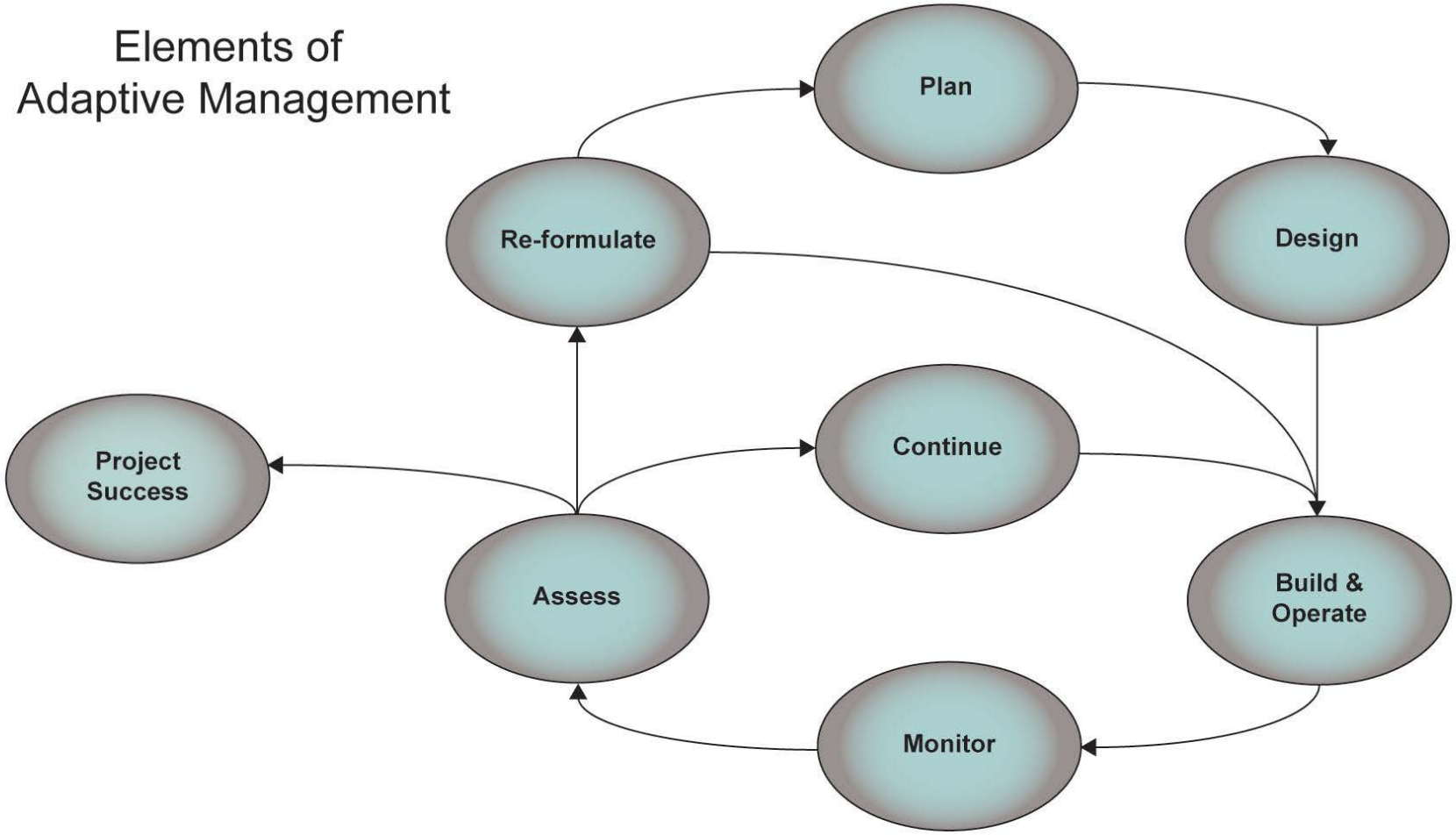
Holling, C.S., 1978.
Adaptive environmental assessment and management.
New York: John Wiley & Sons

Lee, K. 1993
Compass and gyroscope: Integrating science and politics for the environment.
Washington D.C.
Island Press.

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2007.
Adaptive Management: US Department of the interior Technical Guide.
Adaptive Management Working Group, US Department of the Interior, Washington, DC

Nyberg, B. 1999.
An introductory guide to adaptive management for project leaders and participants.
Victoria, British Columbia: BC Forest Service.

Traditional View of AM Process



AM Strategies

Passive Adaptive Management :

-Use monitoring to iteratively update knowledge, policies, and operations

-Actions related to system state and historical constraints

-Typically involves wide monitoring efforts

-Fails due to conservatism in face of uncertainty and no decision structure

Active (Hypothesis-Driven) Adaptive Management :

-Deliberate experimentation (perturb system for response)

-Requires trade-off between objectives and learning

-Requires ability to control actions, partition factors

-Adequate design is critical (controls and replication)

Objective-Based Adaptive Management :

-Requires careful consideration of alternative outcomes

-Identification of performance criteria and triggers for each objective

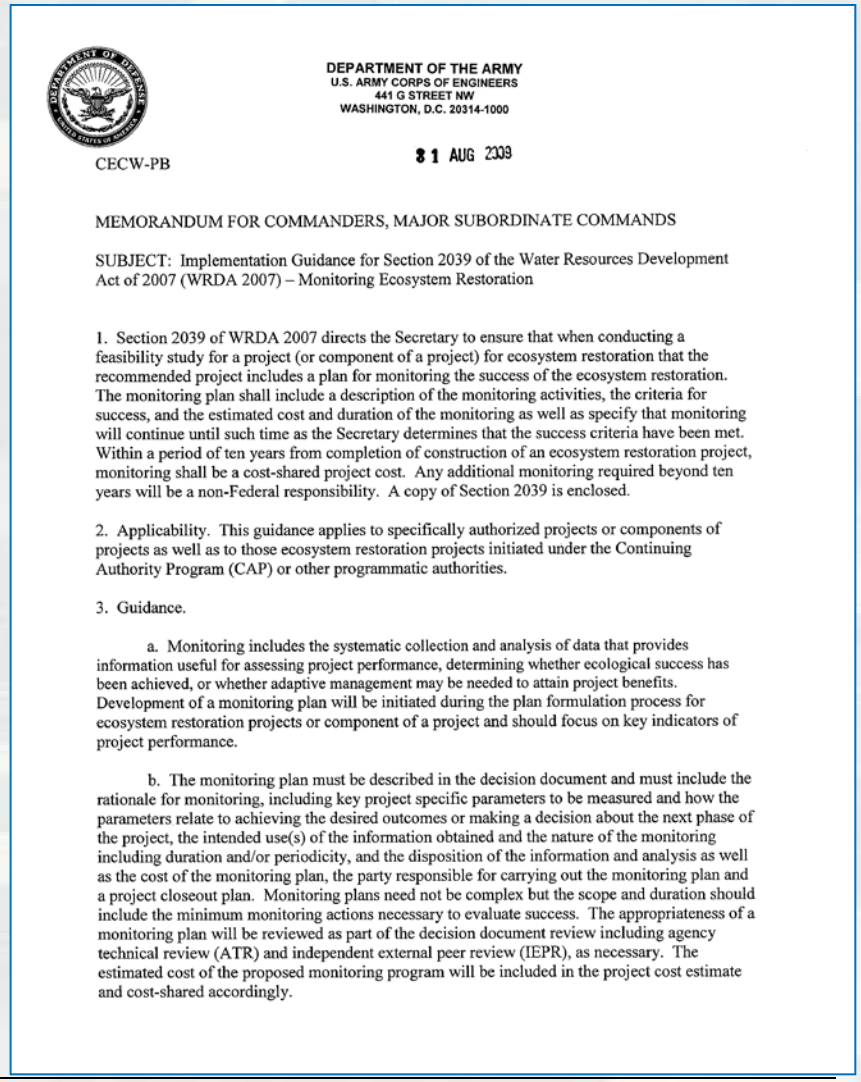
-Employs pre-defined “Planning Contingencies”

Common Elements

- Embracing risk and uncertainty as a way of moving forward
- Explicit characterization of system uncertainty through conceptual and numerical model inferences
- Iterative decision-making (evaluating results and adjusting actions on the basis of what has been learned)
- Feedback between monitoring and decisions (learning)
- A governance & decision process coupled with a willingness and ability to change

Implementation Guidance for §2039 and §2036 of WRDA '07

- For ER Feasibility Studies:
  - Monitoring Plan (to determine success)
  - Contingency Plans (AM)
- Must be appropriately scoped to project scale and address:
  - Rationale for monitoring & AM
  - Metrics for success
  - Performance standards
  - Nature of planned AM measures
  - Cost
  - Duration
  - Disposition of information
  - Responsible Parties
- AM is not required



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CECW-PB

31 AUG 2009

MEMORANDUM FOR COMMANDERS, MAJOR SUBORDINATE COMMANDS

SUBJECT: Implementation Guidance for Section 2039 of the Water Resources Development Act of 2007 (WRDA 2007) – Monitoring Ecosystem Restoration

1. Section 2039 of WRDA 2007 directs the Secretary to ensure that when conducting a feasibility study for a project (or component of a project) for ecosystem restoration that the recommended project includes a plan for monitoring the success of the ecosystem restoration. The monitoring plan shall include a description of the monitoring activities, the criteria for success, and the estimated cost and duration of the monitoring as well as specify that monitoring will continue until such time as the Secretary determines that the success criteria have been met. Within a period of ten years from completion of construction of an ecosystem restoration project, monitoring shall be a cost-shared project cost. Any additional monitoring required beyond ten years will be a non-Federal responsibility. A copy of Section 2039 is enclosed.

2. Applicability. This guidance applies to specifically authorized projects or components of projects as well as to those ecosystem restoration projects initiated under the Continuing Authority Program (CAP) or other programmatic authorities.

3. Guidance.

a. Monitoring 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. Development of a monitoring plan will be initiated during the plan formulation process for ecosystem restoration projects or component of a project and should focus on key indicators of project performance.

b. The monitoring plan must be described in the decision document and must include the rationale for monitoring, including key project specific parameters to be measured and how the parameters relate to achieving the desired outcomes or making a decision about the next phase of the project, the intended use(s) of the information obtained and the nature of the monitoring including duration and/or periodicity, and the disposition of the information and analysis as well as the cost of the monitoring plan, the party responsible for carrying out the monitoring plan and a project closeout plan. Monitoring plans need not be complex but the scope and duration should include the minimum monitoring actions necessary to evaluate success. The appropriateness of a monitoring plan will be reviewed as part of the decision document review including agency technical review (ATR) and independent external peer review (IEPR), as necessary. The estimated cost of the proposed monitoring program will be included in the project cost estimate and cost-shared accordingly.

When Should Adaptive Management be Used?

- Management choices are available.
- There is an opportunity to apply learning.
- Management objectives can be identified.
- Information value is high.
- Uncertainty can be expressed as testable models/hypotheses.
- A monitoring system can be established.
- Decisions to change can be made.

Is Adaptive Management Needed?

QUESTIONS

Is there sufficient flexibility within the project design and operations that permits adjustment of management alternatives?

If No, adaptive management is not possible If Yes, continue with questions

Is the managed system well understood and are management outcomes readily predictable?

Do participants agree on the most effective design and operations to achieve goals and objectives?

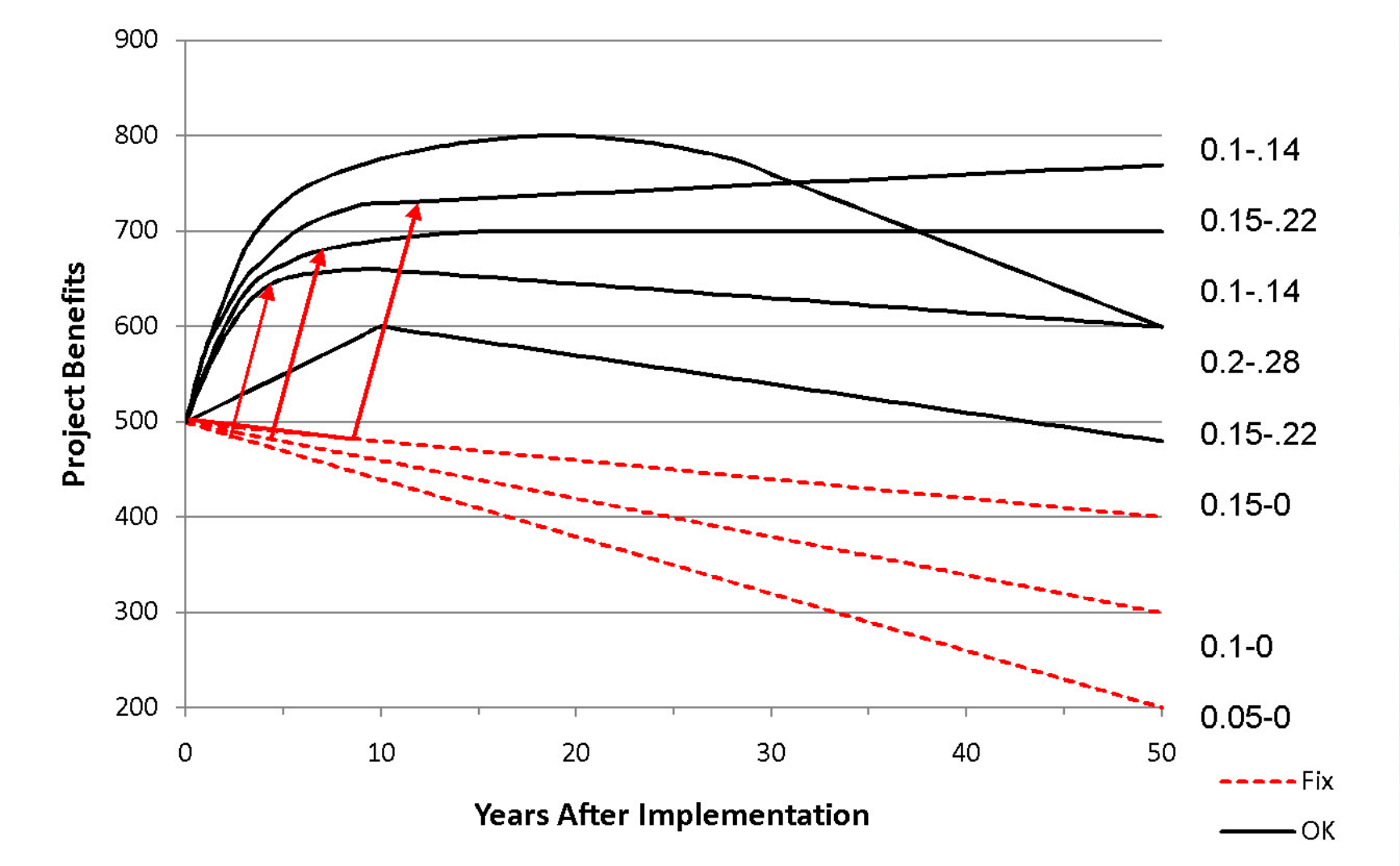
Are the project/program goals and objectives understood and agreed upon?

ANSWERS

Yes to all → Adaptive Management is not needed

No to any → Adaptive Management can probably improve success

Return on the investment

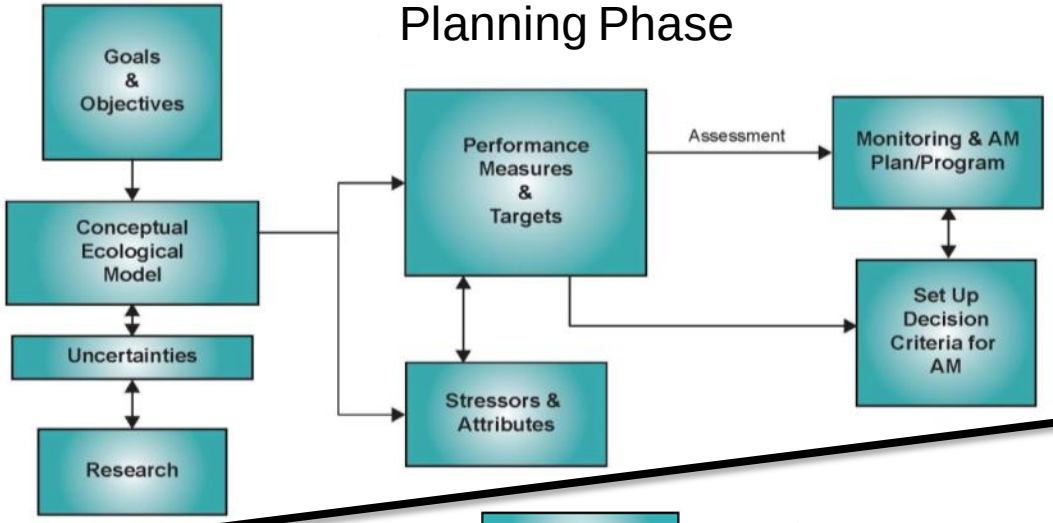


Developing the Plan

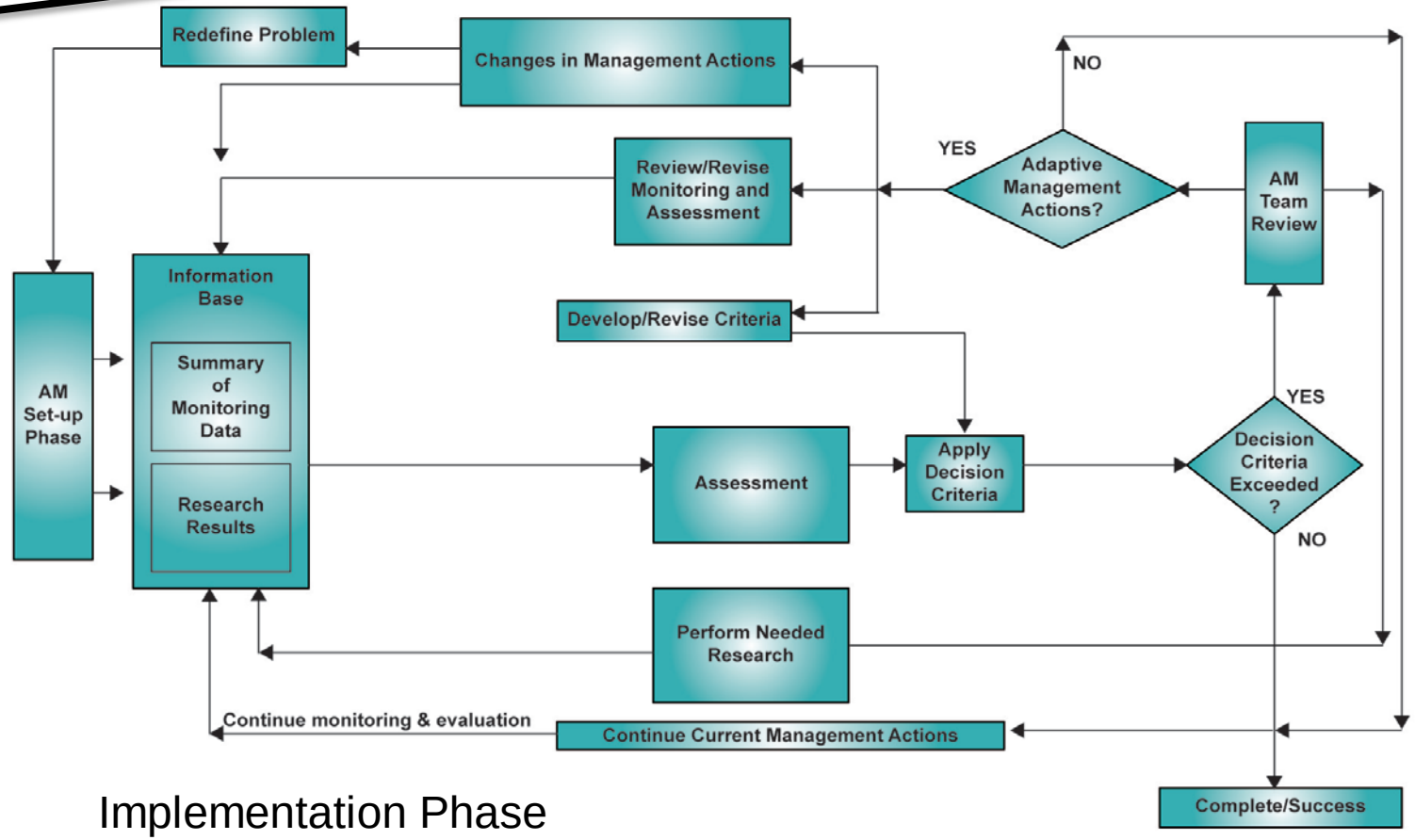
1. Establish the adaptive management team
2. Develop objectives and identify key uncertainties
3. For each objective:
   a. Identify one or more appropriate metrics
   b. Specify sampling design (spatial limits, periodicity, frequency, sample numbers), processing, roles, duration
   c. Identify performance standards and success criteria
   d. Identify any risk endpoints and action criteria
   e. Describe contingency plans
4. Identify baseline or comparative (e.g. reference) study needs
5. Determine analytic (modeling) needs
6. Establish data management, storage, and access protocols
7. Describe governance structure and operation
8. Estimate costs

Objective-Based Adaptive Management: A Two Phased Approach

Planning Phase



Implementation Phase



Planning Phase

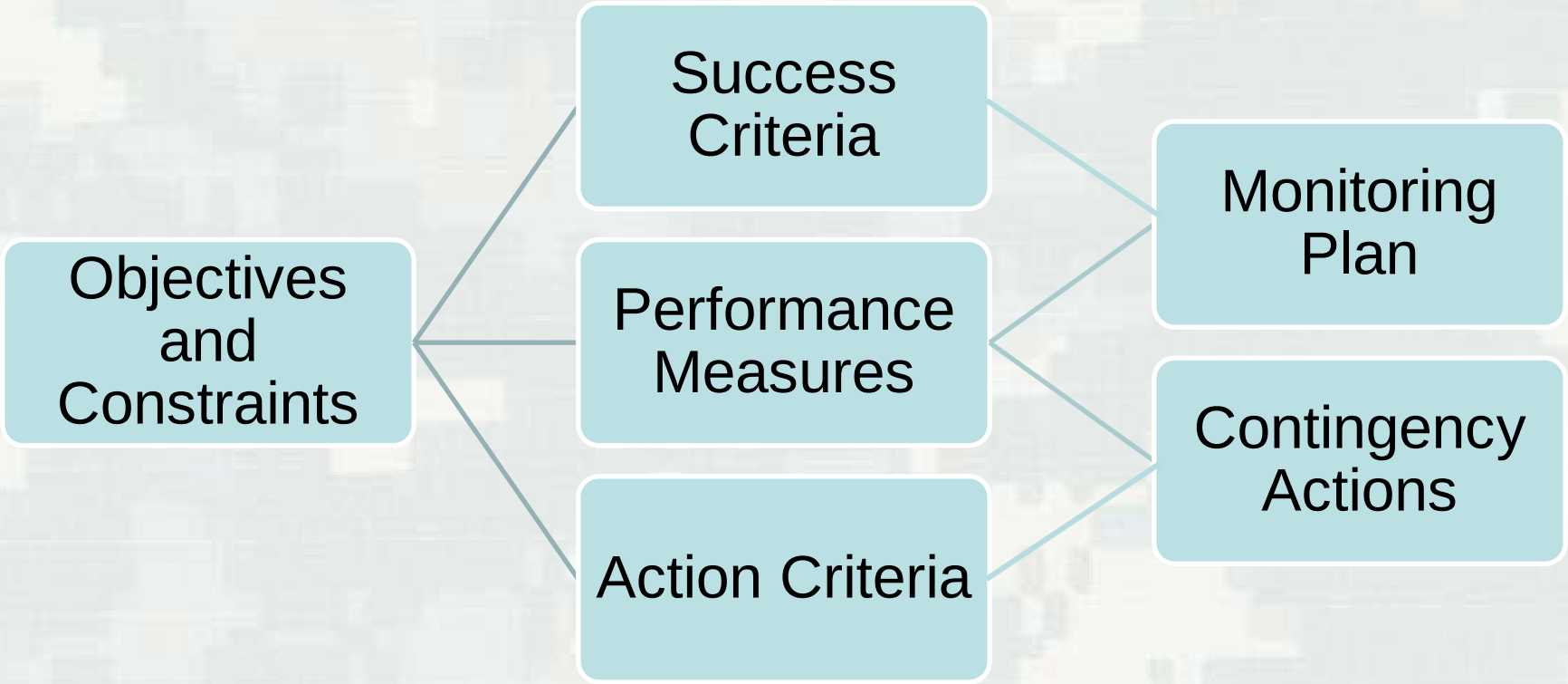
- Adaptive Management Team
- Goals and Objectives
- Management and Restoration Actions
  - Conceptual Ecological Models
  - Stressors and Attributes
  - Critical Uncertainties
  - Performance Measures and Targets
- Decision Criteria
- *Monitoring Program*
- *Assessment*
- *Decision-making Process*
- *Contingency Actions*
- *Reporting and Communications*

Italicized information part of plan, but executed in implementation

Questions

- What are the project goals and objectives?
- What are the expected project benefits and/or project outcomes? What would you regard as success?
- What are the key metrics, indicators and measures?
- How would you assess progress toward goals?
- What are the key constraints?
- What are the sources of significant uncertainty? How would you address these (monitoring, research, AM)?
- Can you anticipate any unintended consequences? Are there alternative project trajectories or project outcomes?
- Do all parties agree on the most effective design and operation to achieve project goals and objectives?
- What would you do if (fill in blank)?

Linkages


Objectives and Constraints
Success Criteria
Performance Measures
Action Criteria
Monitoring Plan
Contingency Actions

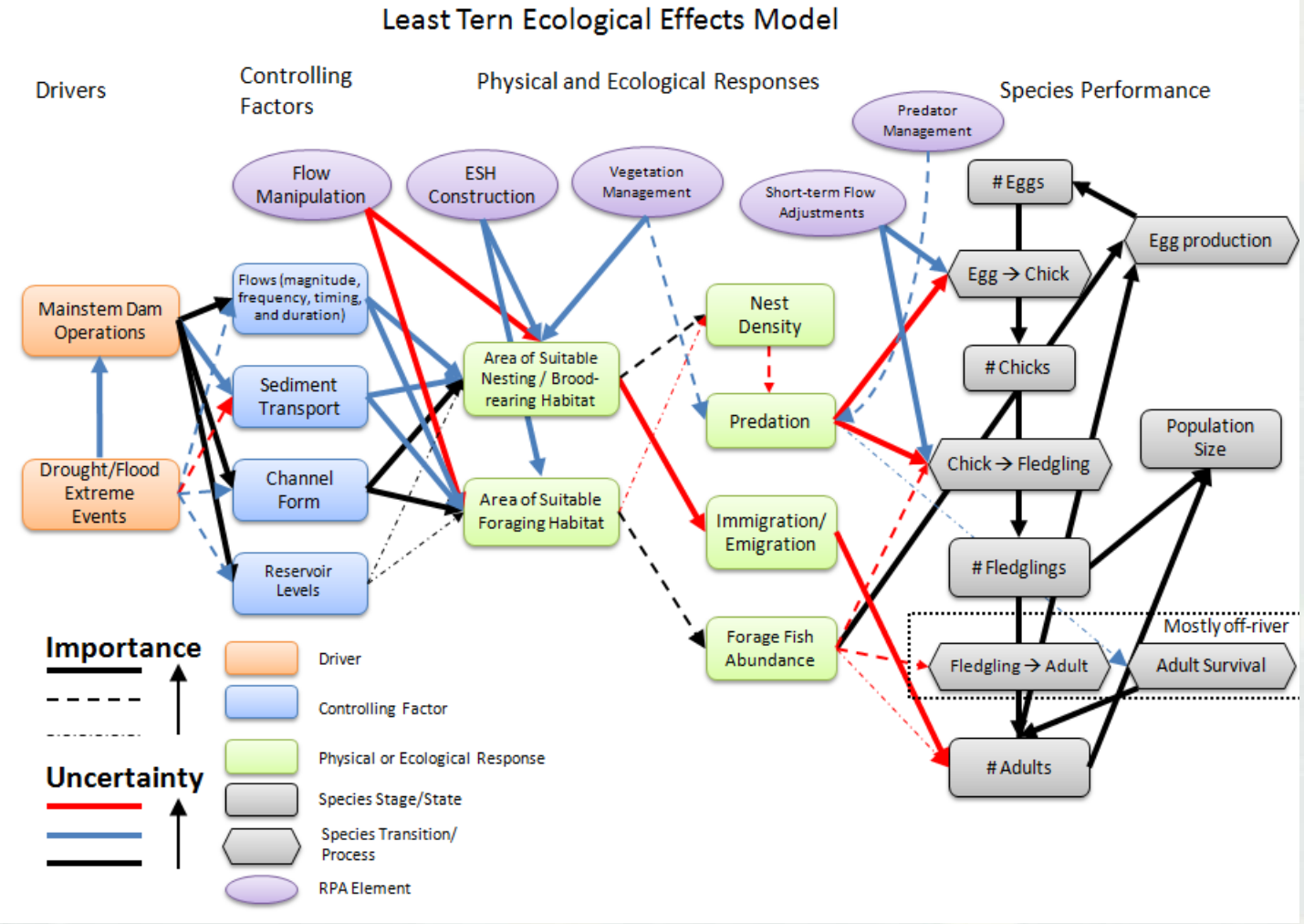
Example Metrics

Objectives/Constraints	Units Measured	Action Criteria
Performance Measures		
Wetland hydrology	Days inundated	>30 days during Jul-Sep
Population size of species	# individuals or biomass	50% incremental increase
Plant community diversity	Simpson diversity	15% incremental increase
Risk Endpoints		
Establishment of an Invasive species	Presence/absence	No invasive species
Nutrient violations	Molar concentration	State WQ standards
Dissolved oxygen	mg/L	> 4.5 mg/l

Objective-Based Example

<u>Objective 3:</u> Establish swamp hydroperiod with dry period of sufficient length to improve baldcypress and tupelo productivity, seed germination and survival.
Performance Measure 3a: Depth, duration, and frequency of flooding in the swamp
Targeted Outcome: Maintain dry periods (moist soils) in the swamp for a minimum 7-35 days during summer and early fall for seed germination and maintain water levels below seedling height to promote seedling survival.
Monitoring Design: Hourly hydrologic recorders will be deployed to measure stage/depth.
Trigger: Depth of inundation fails to drop below target levels for less than 7 days in any one year or less than 10 days for two successive years.
Contingency Action: Modify gate operation to reduce inflow to project area.
Performance Measure 3b: Number of baldcypress and tupelo seedlings and saplings
Targeted Outcome: A 25% increase in the number of baldcypress and tupelo saplings per acre five years after project implementation and 50% increase after 10 years.
Monitoring Design: Understory vegetation will be measured to determine numbers of baldcypress seedlings and saplings in order to assess regeneration.
Trigger: No measurable increase in baldcypress and tupelo saplings after 5 years.
Contingency Action: None specified. Will evaluate conditions and determine appropriate course of action, if any.

Role of Conceptual Models



Uncertainty

- **Program Uncertainty**
  - Landscape-scale questions applicable to program implementation
    - ✓Which actions to implement, when and where?
    - ✓Cumulative effects of the individual projects?

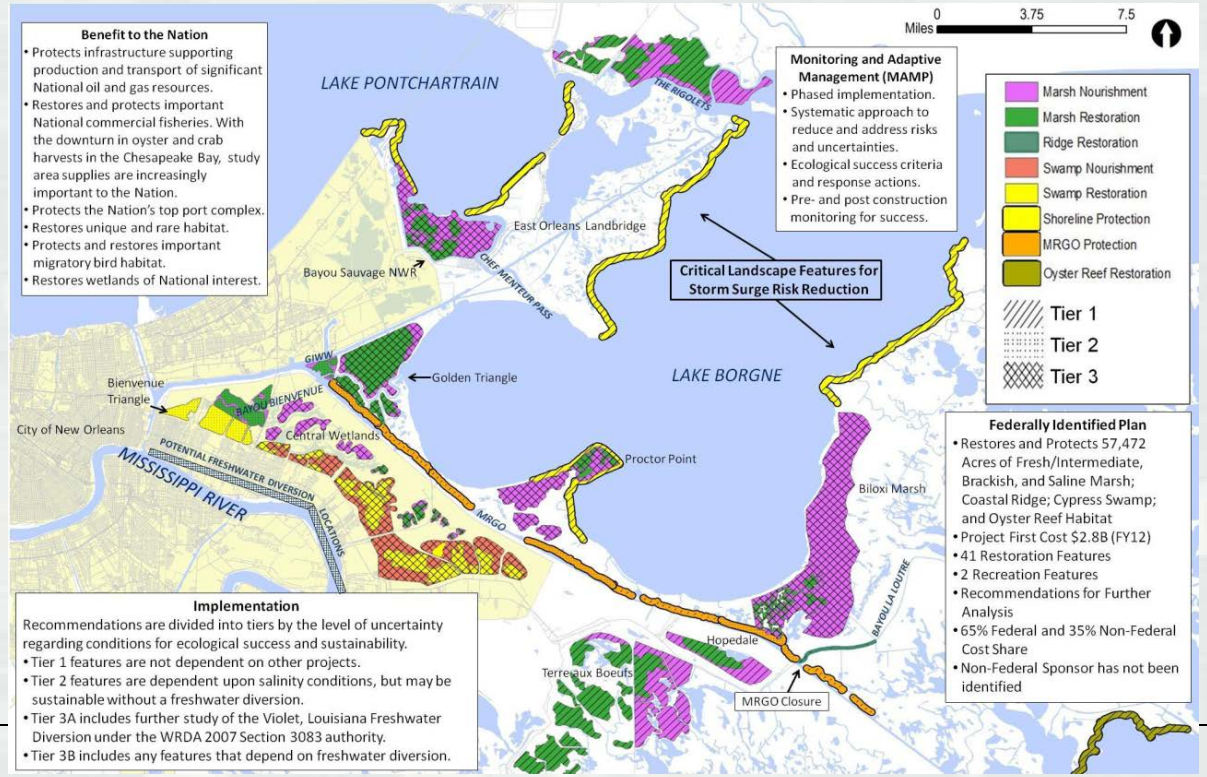
- **Project Uncertainty**
  - Project-specific questions related to project design & construction
    - ✓Does the action create the desired habitat or provide the necessary ecosystem functions?

- **Evaluate Uncertainties Through Hypothesis-Driven Actions**
  - Hypotheses underlying the conceptual models
    - ✓ Which alternative yields the best performance?
    - ✓How do we optimize operations?

- **Risk vs Uncertainty**
  - Risk = Uncertainty * Consequences
    - ✓Focus on uncertainties with high associated risk

Project vs Programmatic AM

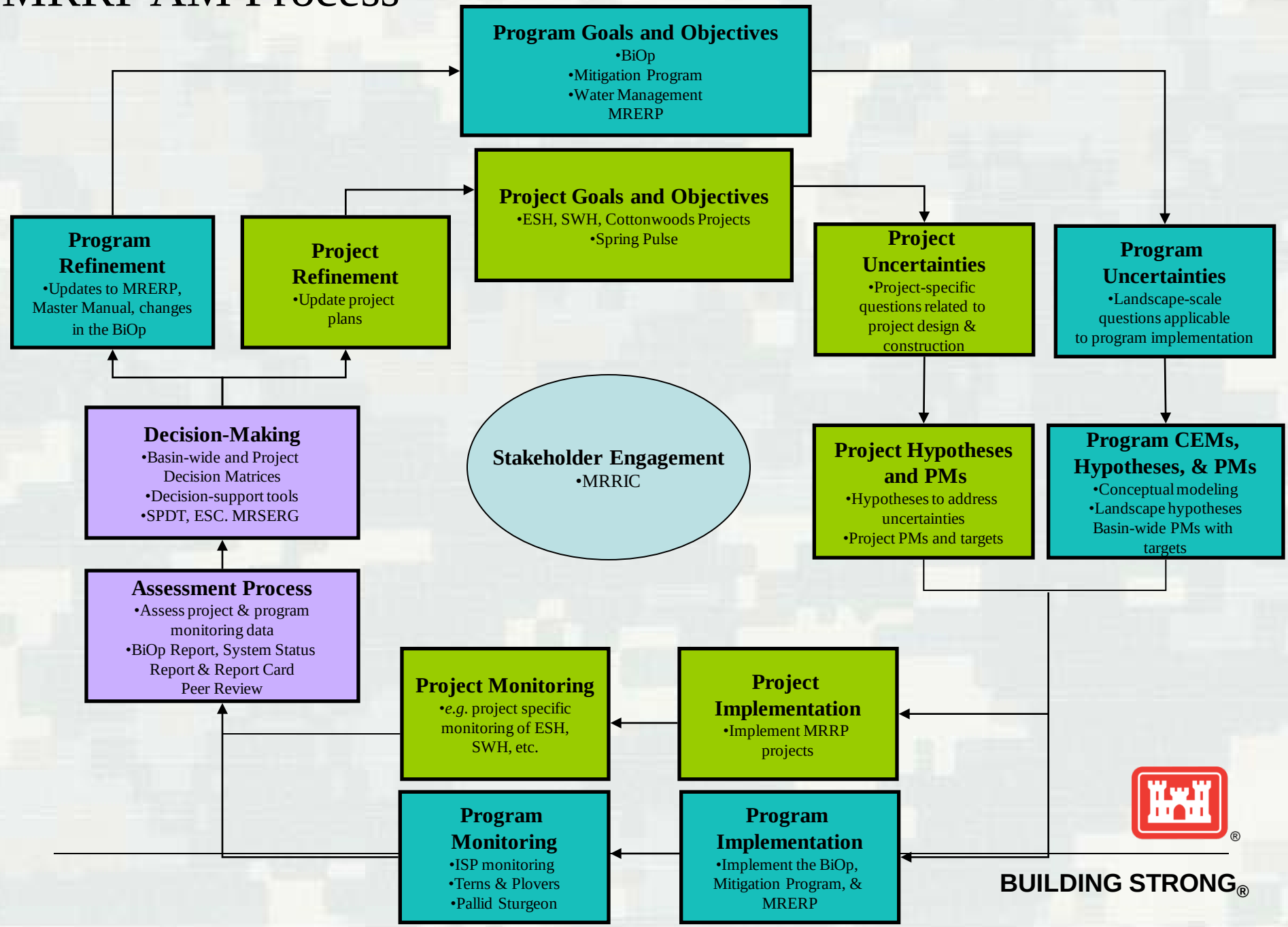
- Different Objectives
- Different Uncertainties
- Different Suite of Adaptive actions



Programmatic vs. Project Scale (Generalized for the Louisiana Coast)

	Programmatic/System View	Project View
Objectives	• Maintain a diverse array of fish & wildlife habitats • Reduce economic loss from storm-based flooding • Sustain Louisiana's unique culture & heritage	• Reduce salinity by X-ppt • Create X-acres salt marsh • Reestablish cypress recruitment in 1 of 3 years
Uncertainties	• Funding source & availability • Community/population changes	• River sediment load • Subsidence • Sea level rise
Performance Measures	• Aquatic community/population health • Basin-wide land loss rate • X-area able to support a variety of commercial and recreational activities	• Marsh accretion rate • Vegetation community structure • Average annual damages avoided
Management Adjustments	• Adjust project priorities or implementation schedule • Change discharges at multiple diversions	• Fill a channel to alter local drainage pattern • Adjust timing, duration or magnitude of a diversion

MRRP AM Process



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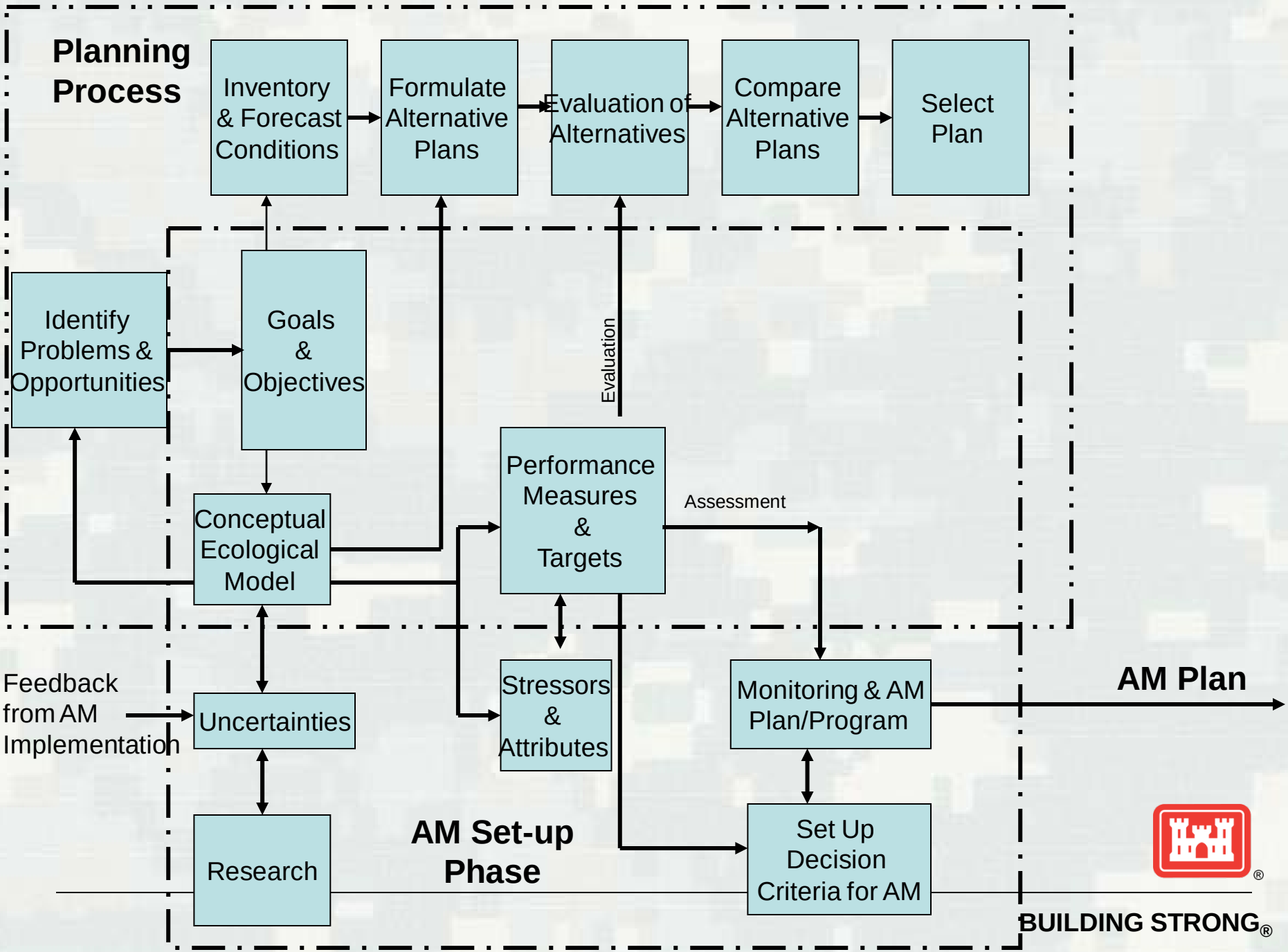

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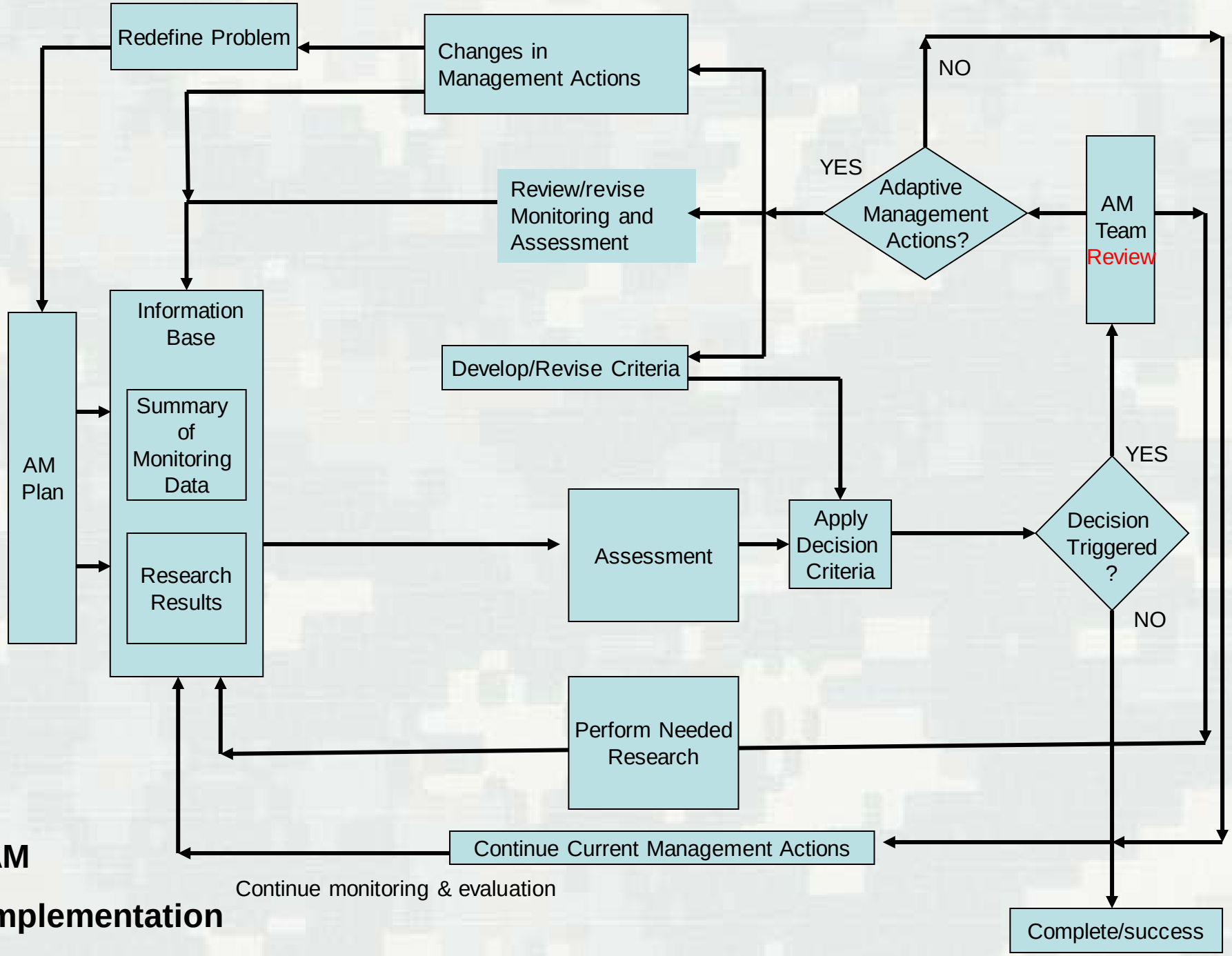
Implementation Phase

- Builds from objectives & associated decision criteria
- Define process - how results of the assessment will be used to make decisions concerning project management
- Identify process by which the results of monitoring efforts will be compared to the desired project performance measures/acceptable risk endpoints that reflect the goals and objectives of actions
- Process for decision making and WHO makes the decisions should be clearly documented
- Address the frequency and timing for comparison of monitoring results
- May require a charter or other vehicle that documents how AM plan will be put into action

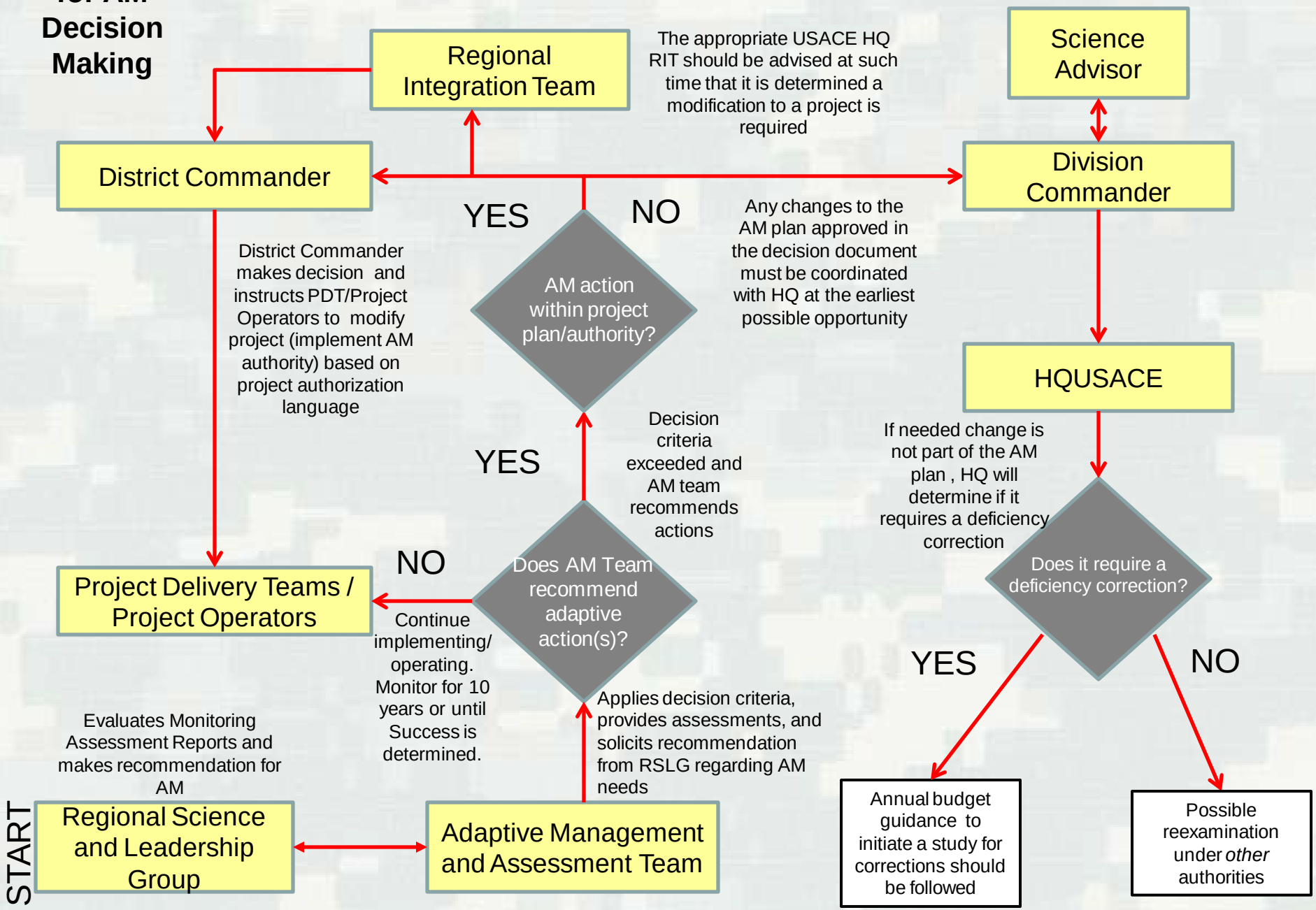


AM Implementation

Governance & Decision-Making

- Most common source of AM failure
- Process for decision making should be documented as part of overall AM plan
- Engage stakeholders and seek transparency
  - ►Build trust in the process – not necessarily detailed understanding
- Should have built in flexibility and periodic review; adapt the adaptive management

Processes for AM Decision Making



Modeling in Support of AM

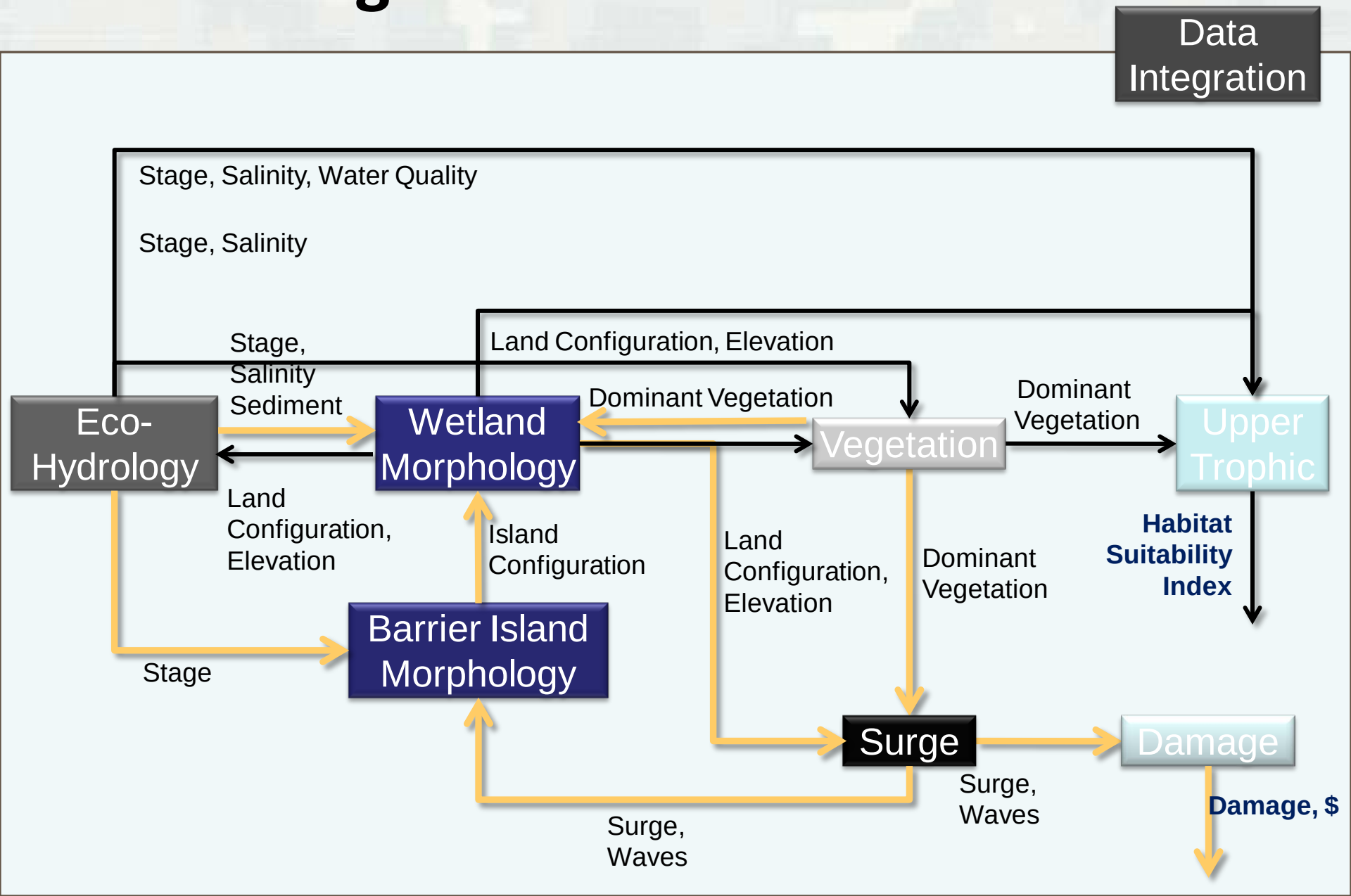
Modeling provides:

- Common forum for “how we think”
- Framework for assessing “consequences”
- A mechanism to quantify uncertainty

Approach:

- Invite critical thinking
- Engage the experience of stakeholders
- Build from conceptualizations
- Identify uncertainties and treat explicitly
- Encourage alternative predictions (hypotheses)
- Document the process and decisions

Modeling for AM & Plan Formulation



Definition of Project Monitoring

"…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

Policy on Monitoring
Sec 2039 Guidance

- Applies to All Eco Rest Projects - 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 (success).
- 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.

Monitoring

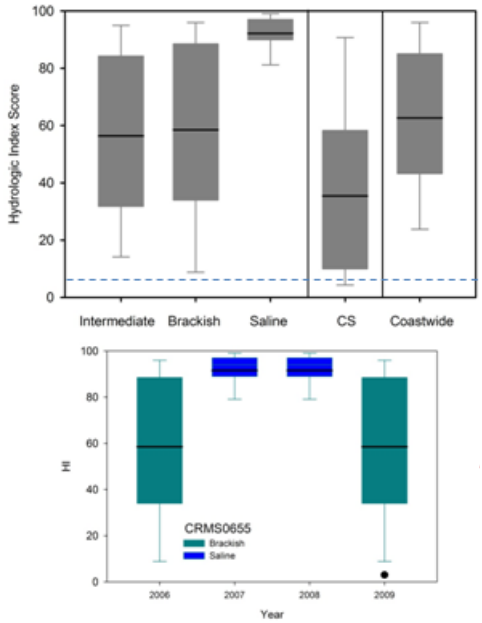
- Don’t underestimate the desire to monitor without application
- NOT a research effort
- Focused on management decisions (or hypotheses being tested)
- Stick with metrics from objective statements
- Develop & follow clear protocols
- Use effective documentation and communication of results

Documenting and Communicating

DRAFT
Hydrology Report Card
Evaluation at the Site Scal

CRMS site scores for a given year are comp distribution of scores for sites within the sa and hydrologic basin as the site of interest a distribution of scores. HI scores for a CRM over time as well.

The figure displays the 2009 HI score for the site CF line) relative to all other CRMS sites within the sam and hydrologic basin and to all other CRMS sites co



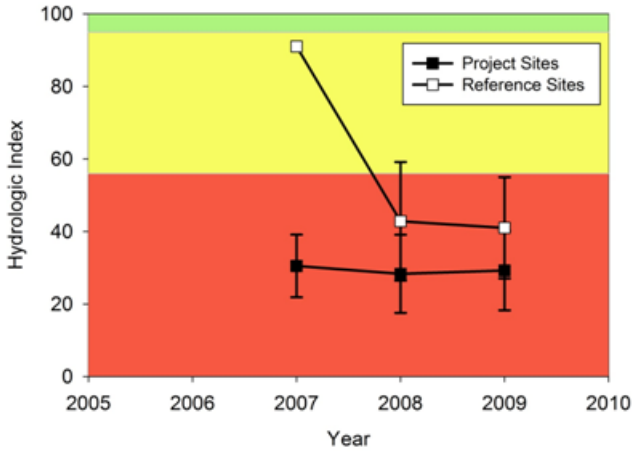
DRAFT
Hydrology Report Card
Evaluation at the Basin Scale

CRMS sites that are within the same hydrologic basin are compared over time

Project Sites = CRMS sites located within the boundary of a constructed CWPPRA project

Reference Sites = CRMS sites not located within the boundary of a constructed CWPPRA project

The figure displays HI scores within the Calcasieu/Sabine basin over time. Project and reference site scores are the mean (± SE) HI scores by year for all sites within Calcasieu/Sabine basin.



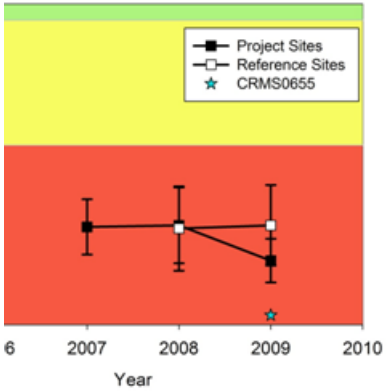
DRAFT
Hydrology Report Card
uation at the Project Scale

t are within the same marsh type and he project of interest are used for

sites located within the boundary of a .project

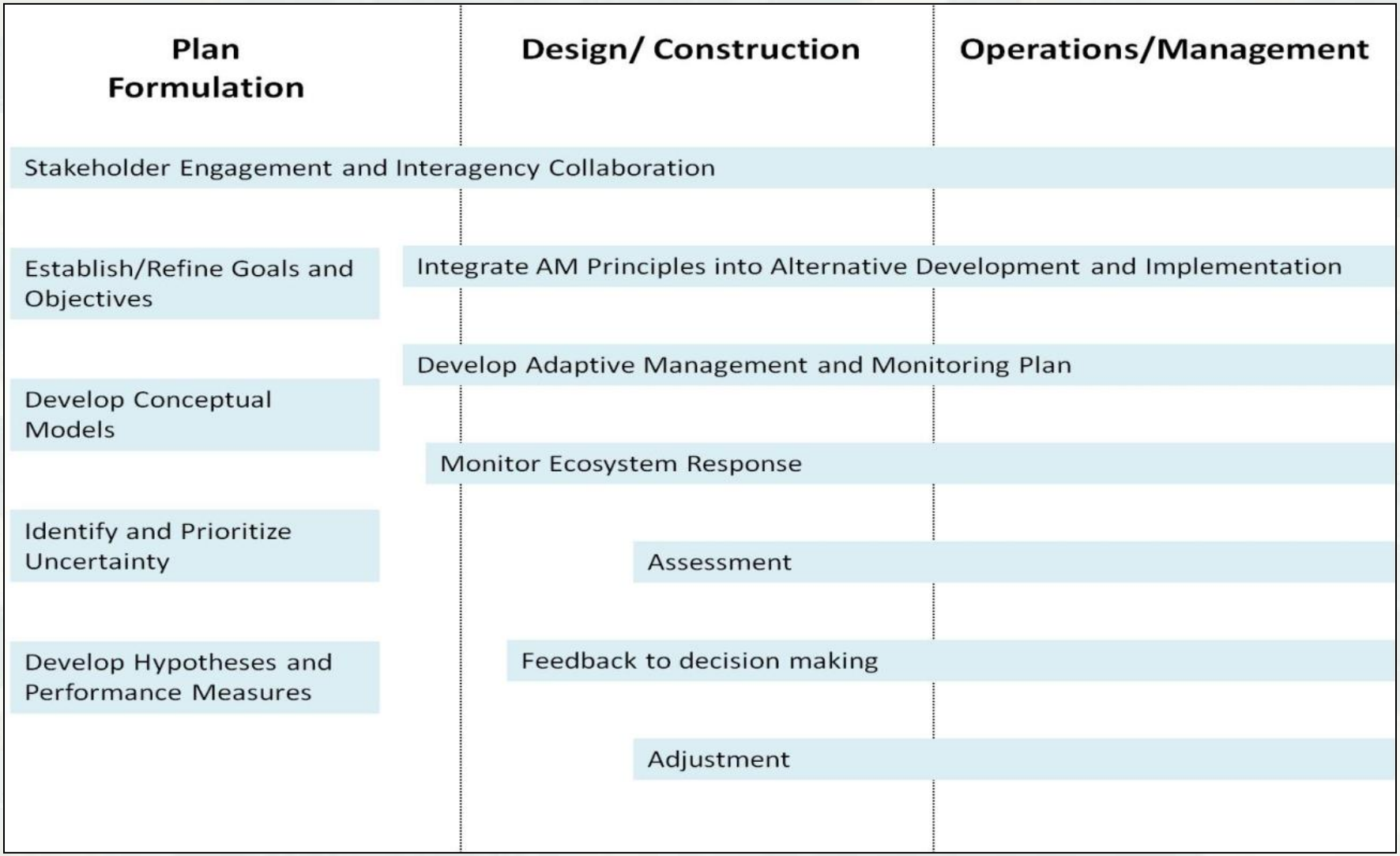
MS sites not located within the boundary of a .project

cores within C20 (i.e., CRMS sites within CS20 tars) over time relative to all other CRMS sites ition type and hydrologic basin. CS20 is classified ntermediate marsh. Project and reference site SE) HI scores by year for all brackish and in Calcasieu/Sabine Basin.



Figures from Greg Steyer – CRMS Data Network

Integrating AM into the Project Life Cycle



Slide from Tomma Barnes, Bill Klein, & Craig Fischenich "LCA Lessons Learned"

Policy on Adapt Mgmt - Funding

- Historic Guidance
  - 3% of the total project cost excluding monitoring costs [ER 1105-2-100 Para. 3-5 b. (8)] and EC 1105-2-409. Adaptive management will be cost-shared with the local Sponsor.
  - For constructed projects may also be appropriate to provide for AM through coordinated changes to the O&M responsibilities of the local sponsor or utilizing Section 1135 [EC 1105-2-210, Para. 21 b (4)].
- Current Guidance – Sec 2039
  - No specific limit, but the nature and cost of AM actions should be explicitly described in the decision document. The reasonableness of the cost of the AM plan will be reviewed as part of the decision document.
  - Costly AM plans may indicate the need to reevaluate the formulation of the ecosystem restoration project
  - AM plan cost should be shown in the 06 feature code of the cost estimate.

AM Authorities for Large Ecosystem Restoration Efforts

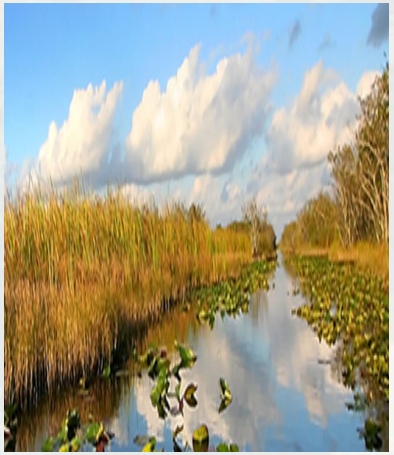
- Comprehensive Everglades Restoration Plan (CERP),
- Louisiana Coastal Area (LCA),
- Missouri River Recovery Program (MRRP),
- Columbia River Channel Improvement Project (CRCIP)
- Upper Mississippi River and Illinois Waterway System (UMR)

Culture Change Underway?

	Perceived Threat	Lost with AM	Gained with AM	Needed for Success
Policy- Makers	Cost Risk - fear of a wrong decision	Can't change objectives outside the process	Clear process for moving forward	Dedication to the process Funding
Managers	Complexity	Management flexibility	Confidence in management decisions	Willingness to employ contingency actions
Technical Experts	Loss of control Risk - fear of wrong recommendation	"Status" as single expert	Broader support for relevant work	Willingness to engage other experts
Stakeholders	Dealt out of the process	Use of "Trump Cards"	A voice at the "table"	Trust in the process and people involved

Adapted from a Ducks Unlimited presentation (no author cited)

Indicators of Success



- Use of quantitative, measurable goals
- Explicit management and policy decisions
- Models to frame the problem (conceptual to predictive)
- Explicit identification of uncertainties
- Risk assessments and tradeoffs
- Full range of stakeholders involved
- AM processes are implemented across corporate boundaries
- Budget specifically allocated to monitoring and feedback
- Active consideration of learning in the process
- Staff can communicate AM
- Active use of feedback in decision-making
- AM evident in planning
- AM initiated by managers
- Ownership by others than researchers
- AM expected by policy makers
- AM an active part of high priority decisions

What are the benefits of AM?

- Improved probability of project/program success
- Incorporates flexibility and robustness into project/ program design, implementation, and operations
- Provides a precautionary approach to act in the face of uncertainty
- Promotes collaboration and conflict resolution among agencies and stakeholders, scientists and managers
- Moves the state of science and understanding of ecosystem restoration forward in a deliberate way
- Cost effectiveness

Common Reasons for Failure

- Lack of an effective decision-making process
- No internal buy-in
- Inadequate engagement or collaboration with stakeholders
- Poor objectives, metrics, or monitoring program design
- The monitoring was never completed and/or the data not analyzed
- The analyzed results are not conclusive
- The decision makers do not use the results because of internal or external factors

Overarching Lessons

- AM has a critical planning component that requires careful consideration of uncertainties and outcomes; it is not strictly a post-construction consideration.
- Development of an AM plan is as much about the *process* as it is the *product*.
- Not all projects lend themselves to AM.
- Governance is crucial and may be difficult to assure for some projects.
- Cost estimates are complicated by uncertainties.
- Refinement during PED is likely, and flexibility in implementation is probably needed.

Adaptive Management

A structured, purposeful strategy to optimize actions, make informed decisions and achieve objectives in the face of uncertainty. A good AM strategy uses:

- Clearly stated objectives
- Explicit listing of uncertainties
- Purposeful information gathering
- Assessment against pre-defined criteria
- A decision process to implement change

References

Fischenich, C., et al. 2012. *The application of Adaptive Management to ecosystem restoration projects. EBA Technical Notes Collection. ERDC TN-EMRRP-EBA-10. Vicksburg, MS: U.S. Army Engineer Research and Development Center.* www.wes.army.mil/el/emrrp

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Questions?

Presentation recording: http://el.erdc.usace.army.mil/wots/wots.html

Next Presentation: Kyle McKay and Jock Conyngham
Monitoring Plans for Adaptive Management
1:00 CDT, 19 Sept., 2013

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