Adaptive Management Planning: Coastal Louisiana Lessons

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Ecosystem Restoration Webinar
July, 2012

US Army Corps of Engineers
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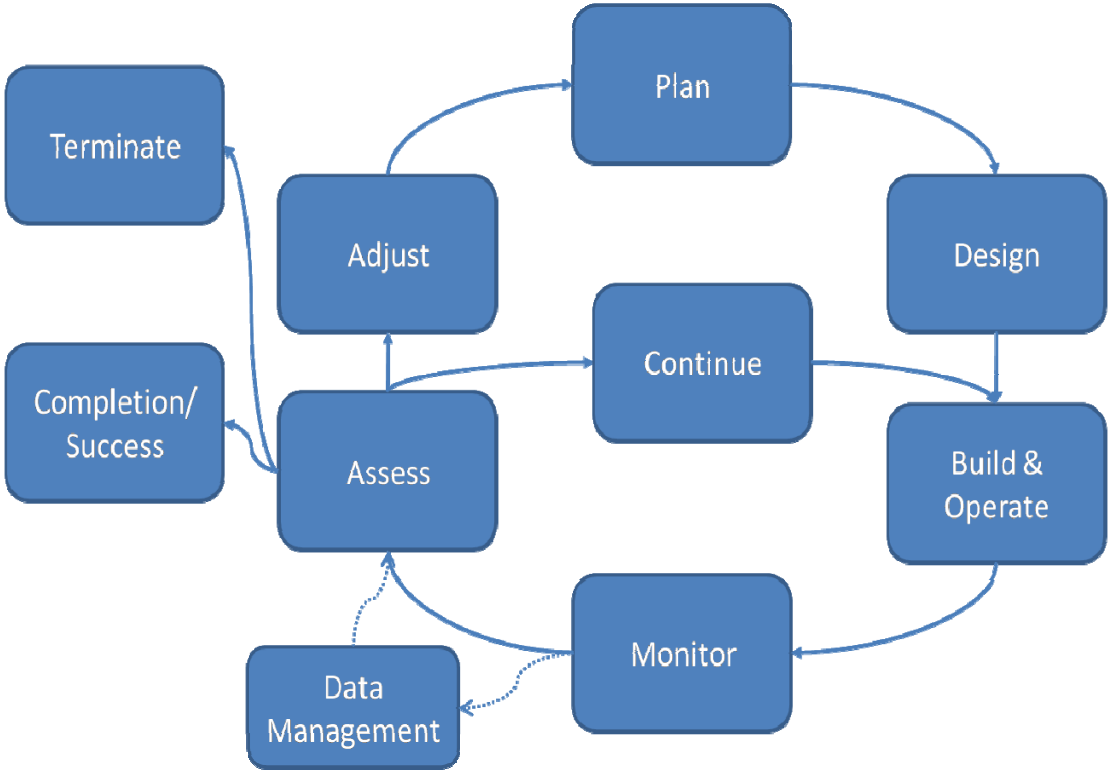
According to the **National Research Council's 2004** *Adaptive Management for Water Resources Project Planning*, "Adaptive management promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood.

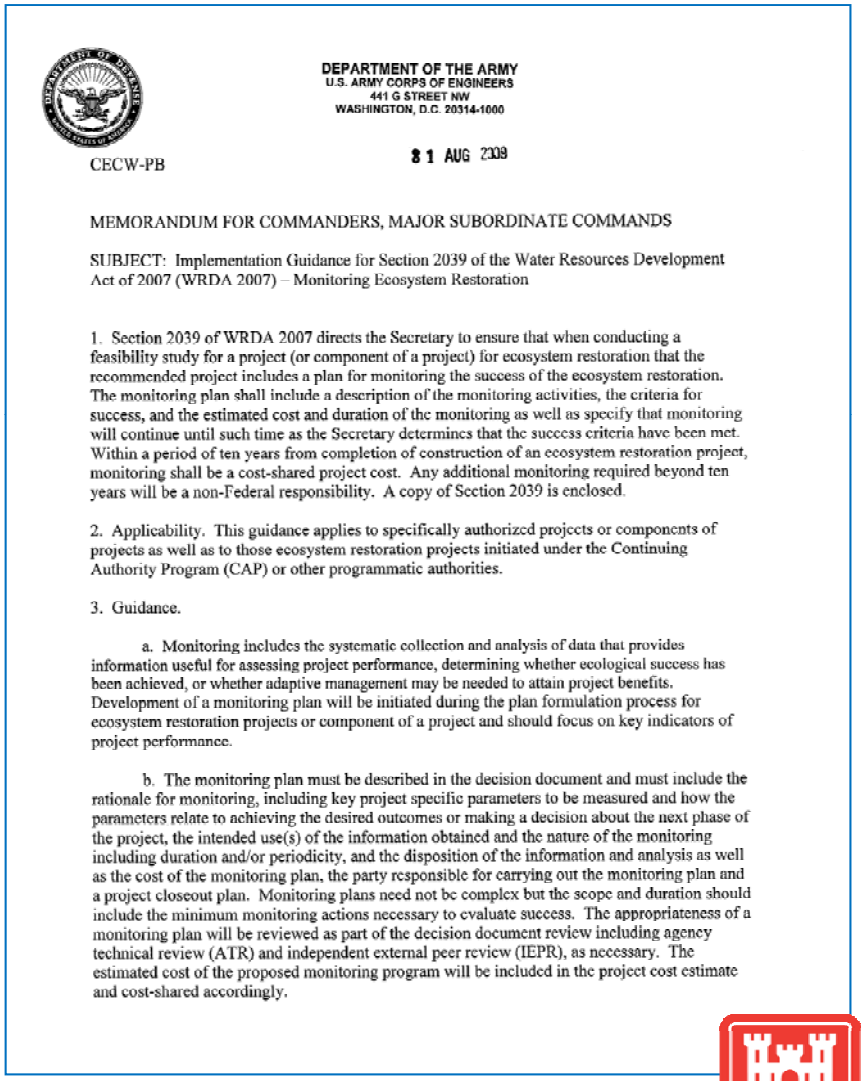


Adaptive Management and Monitoring for Louisiana Coastal Area (LCA)

Background

Implementation Guidance for §2039 of WRDA '07

- For ER Feasibility Studies:
  - Monitoring Plan (to determine success)
  - Contingency Plan (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



DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
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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.

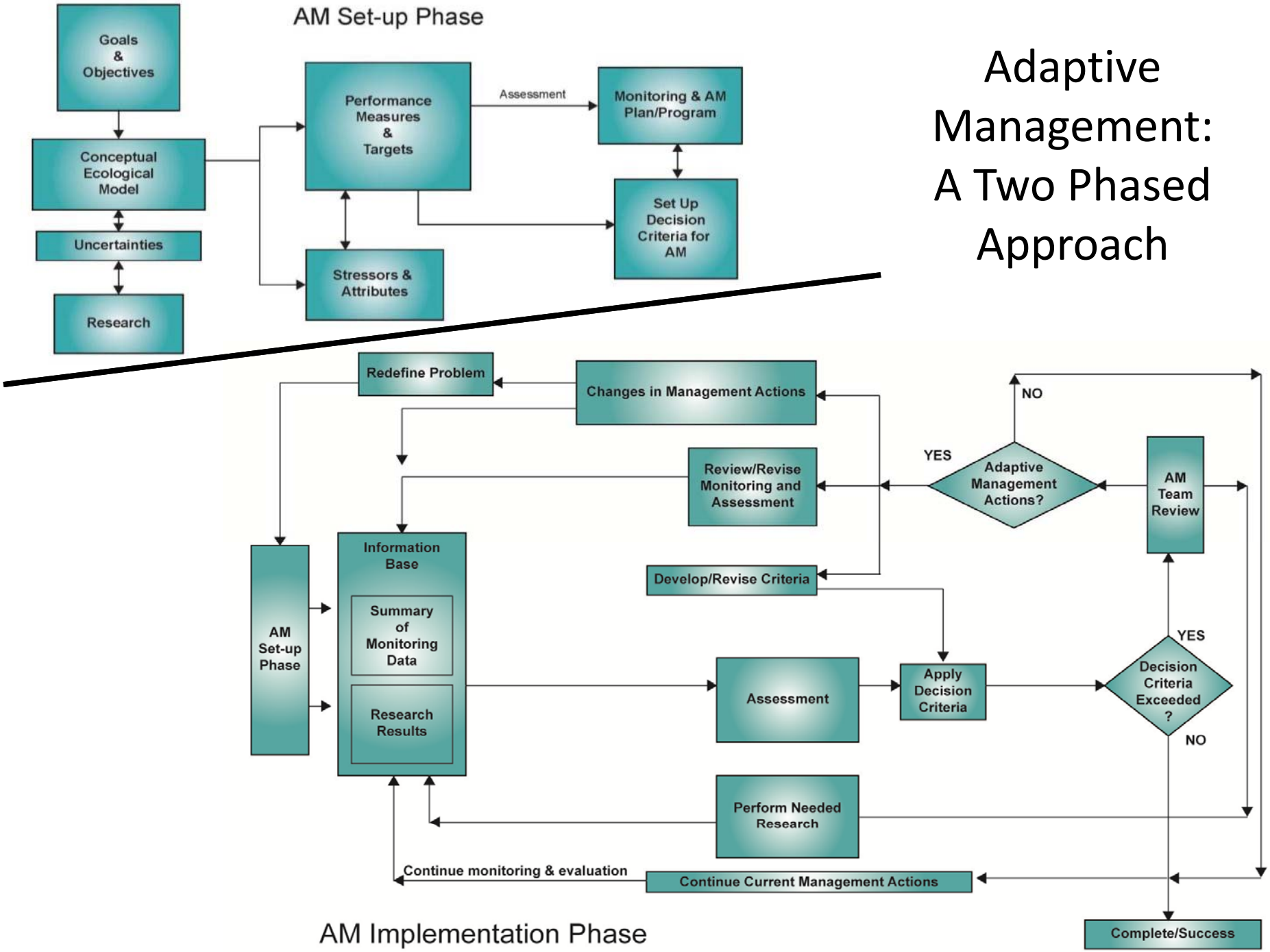
“to ensure that LCA ecosystem restoration objectives are realized, monitoring and adaptive management must be a critical element of the LCA projects”

(*LCA Chief’s Report 2005*)

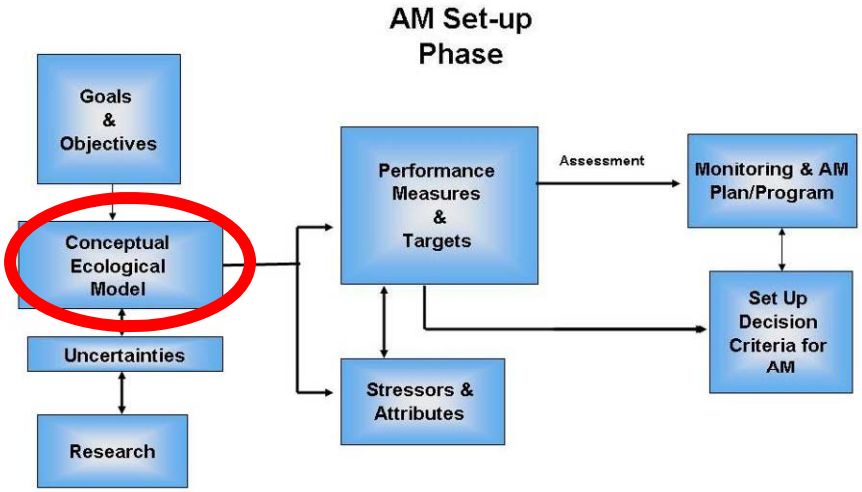
HOW?

- LCA AM Team created
  - Included members of National AM Team
- Established a process for AM Set-up & Implementation
- Worked with PDTs to determine need for adaptive management & monitoring
  - Identify Key Project Uncertainties
  - Established criteria for project success
  - Triggers for adaptive management
- Develop “Feasibility Level of Detail” AM Plans

Adaptive Management: A Two Phased Approach



Conceptual Ecological Model (CEM)

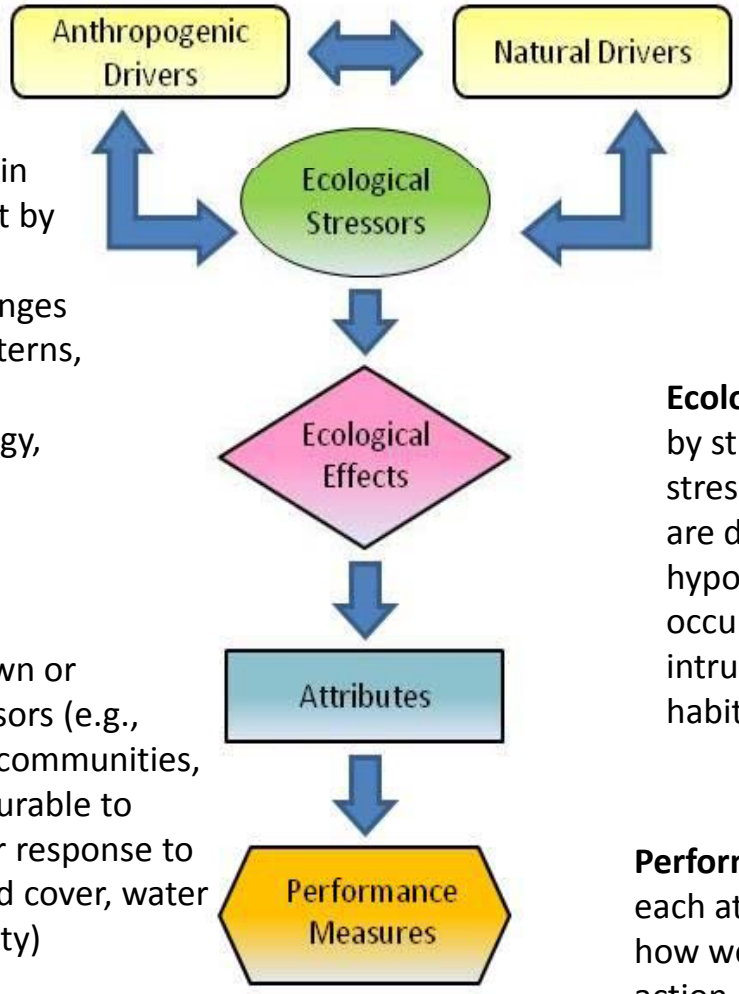


Simple, non-quantitative models, represented by a diagram that shows a set of relationships between major anthropogenic and natural stressors, biological indicators, and target conditions for the indicators.

Conceptual Ecological Model (CEM)

Drivers/Sources: Major external driving forces, both natural & anthropogenic, that have large-scale influences on natural systems. (e.g., sea level rise, Mississippi River levees, oil/gas/navigation canals, hurricanes & storms)

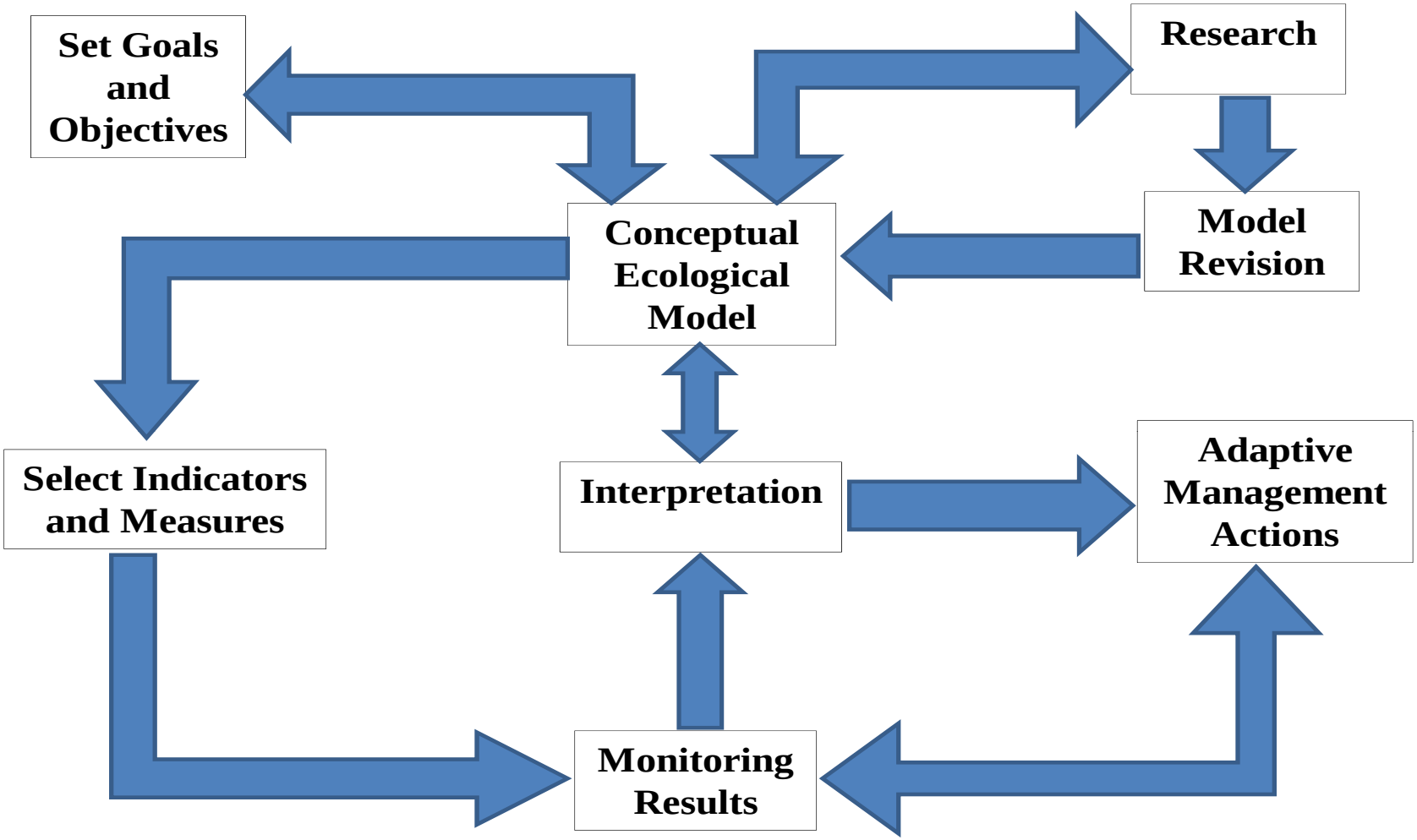
Ecological Stressors: Physical and/or chemical changes within natural systems brought about by drivers that are, in turn responsible for significant changes to biological components, patterns, and relationships in natural systems. (e.g., altered hydrology, longshore transport, erosion)



Ecological Effects: Biological responses caused by stressors. CEM linkages between one or more stressors and ecological effects and attributes are diagrammatic representations of working hypotheses that explain changes that have occurred in ecosystems. (e.g., saltwater intrusion, lack of sediment, increased land loss, habitat switching)

Attributes: indicators of known or hypothesized affects of stressors (e.g., populations, species, guilds, communities, or processes). Must be measurable to enable interpretation of their response to restoration actions. (e.g., land cover, water quality, vegetative productivity)

Performance Measures: specific features of each attribute to be monitored to determine how well attribute is responding to restoration action. Indicator of success or progress towards meeting objectives or targets. (e.g., salinity, vertical accretion, marsh type)

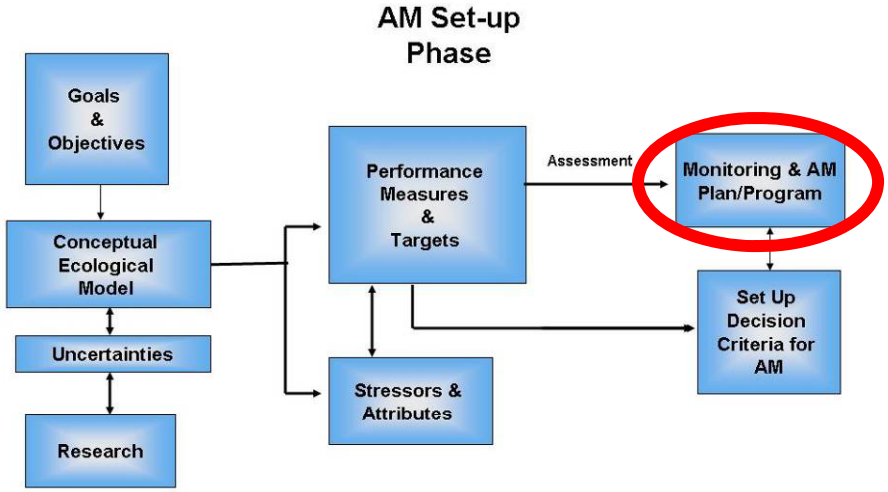


Linkages between CEM and AM&M Activities—Hypotheses about interactions can be tested and CEM revised through research and/or adaptive management.

LCA Project Challenges and Uncertainties

LCA AM Plans

- Feasibility level of detail
- Describes & justifies whether AM is needed
- Identifies how AM would be conducted
- Responsibility for AM
- What should be monitored
- Outlines how results of monitoring would be used to adaptively manage project
- Defines project success
- Estimates costs for Monitoring & AM program



Plan Content

Louisiana Coastal Area Program:
Medium Diversion at White Ditch
Monitoring and Adaptive Management Plan

March 8, 2010
DRAFT

OFFICE OF
Coastal Protection
and Restoration

US Army Corps
of Engineers
New Orleans District

LCA Medium Diversion at White Ditch

Feasibility Level Adaptive Management Plan

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LCA AM Plan Uncertainties

- Exact project features or design
- Monitoring elements
- Adaptive management actions or costs

Uncertainties will be addressed in preconstruction, engineering, and design (PED) and a detailed monitoring and adaptive management plan, including a detailed cost breakdown, will be drafted as a component of the design document.

Role of Advisory Team

- Review available information and help identify appropriate metrics, monitoring needs, and adaptive management actions
- Assist PDTs in preparing Monitoring and Adaptive Management Plans

Critical Questions

- Is adaptive management warranted?
- What are the monitoring needs?
- What are the adaptive management actions?
- What are the costs (and benefits)?

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 ecosystem restoration goals and objectives understood and agreed upon?

Are the goals and objectives for other USACE mission area applications understood and agreed upon?

ANSWERS

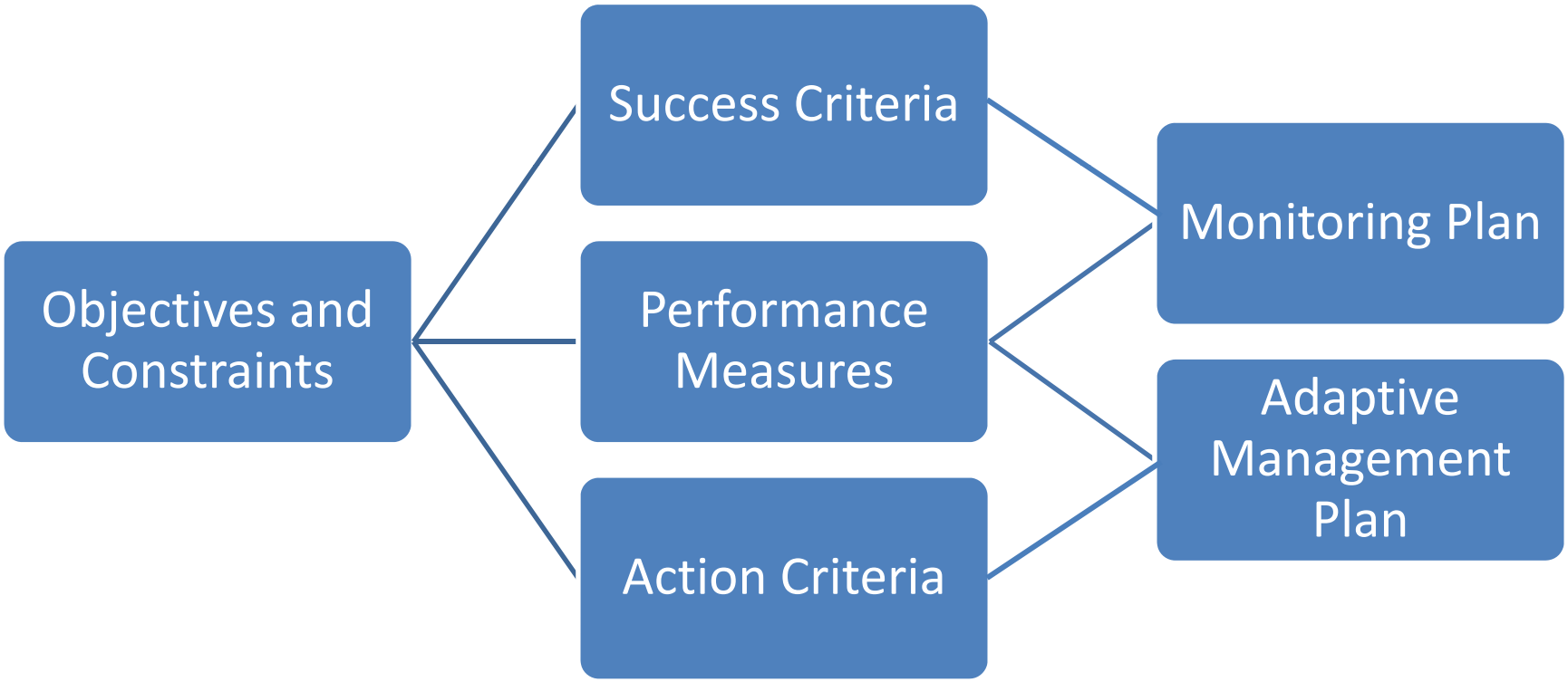
Yes to all

Adaptive Management is not needed

No to any

Adaptive Management can probably improve success

Linkages


Objectives and Constraints
Success Criteria
Performance Measures
Action Criteria
Monitoring Plan
Adaptive Management Plan

Example Metrics

Objectives/Constraints	Units Measured	Action Criteria
Performance Measures		
Wetland hydrology	Days inundated	>30 days during Jul-Sep
Population size of desired 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	Water quality standards
Dissolved oxygen	mg/L	> 4.5 mg/l

Example 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)?

Developing the Plan

1. 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
2. Identify baseline or comparative (e.g. reference) study needs
3. Determine analytic needs
4. Establish data management, storage, and access protocols
5. Describe governance structure and operation
6. Estimate costs

Evaluate Existing Monitoring Criteria

Monitoring - CRMS

1) Land:water
2) Landscape fragmentation (edge)
3) Vegetation vigor (NDVI)
4) Vegetation classification
5) Vegetation (%cover, richness, ht)
6) Forested Vegetation (canopy cover, DBH)
7) Vertical accretion
8) Marsh elevation
9) Soil bulk density, OM, salinity
10) Water salinity, level, temp

Monitoring - Waters

1) Water salinity, level, temp
2) pH
3) Dissolved oxygen
4) Turbidity
5) Streamflow
6) Nitrate (few)
7) Chlorophyll (few)

Monitoring - BICM

1) Shoreline position
2) Topography
3) Bathymetry
4) Vegetation classification
5) Sedimentology

Model Inputs

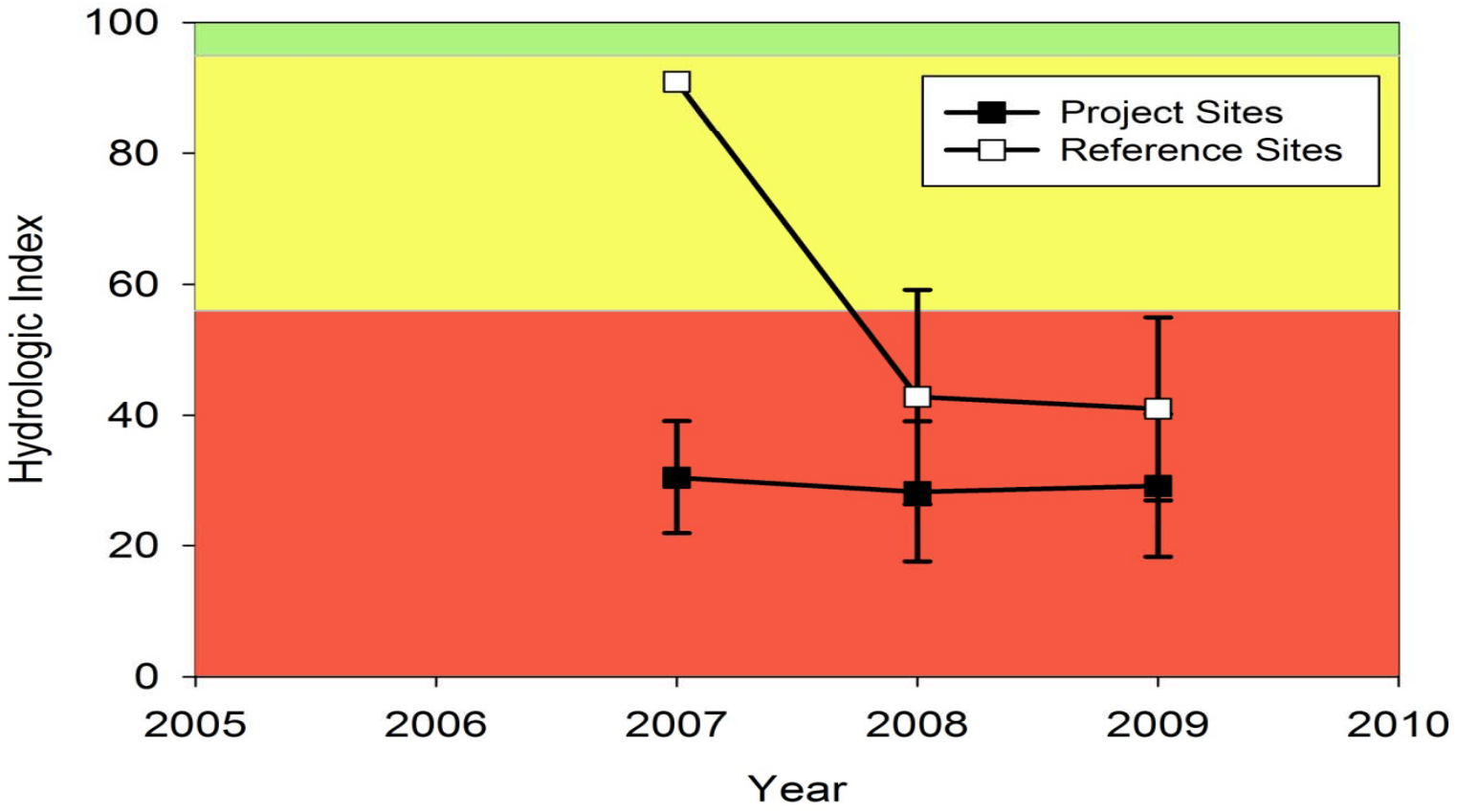
1) Water level, salinity, temp
2) Nitrate, nitrite, ammonium
3) TSS*
4) Land:water
5) Landscape edge
6) Vegetation classification
7) Vegetation cover & density
8) Vertical accretion
9) Marsh elevation
10) Soil bulk density, OM, mineral matter, carbon, SSC, shear strength*, salinity
11) Shoreline position
12) Topography
13) Bathymetry
14) Residence time*
15) Wind, ET and precipitation*
16) Wave & current velocity*

* - *from other programs*

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

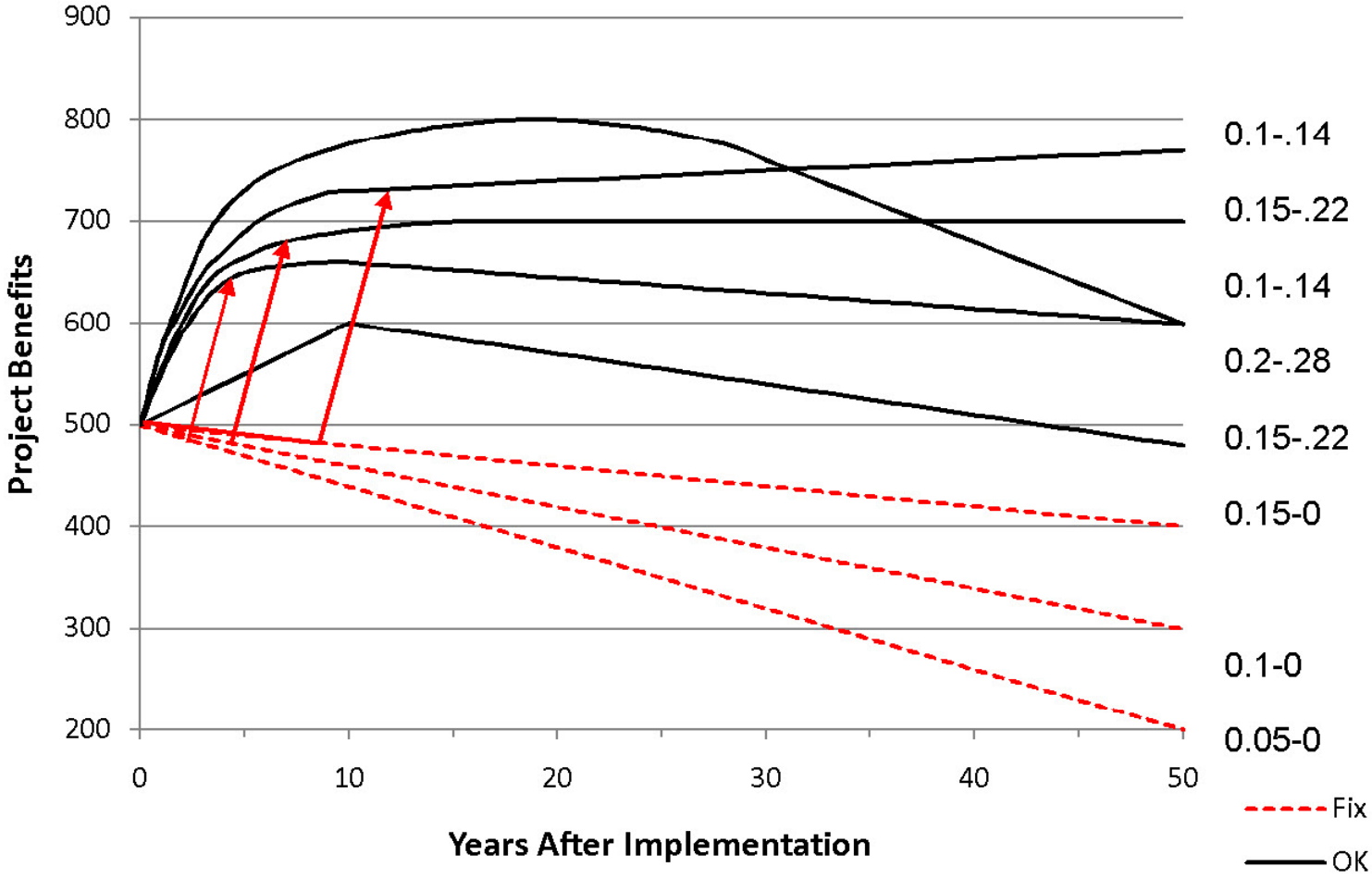
	Programmatic/System View	Project View
Objectives	• Maintain a diverse array of fish & wildlife habitats • Reduce economic loss from storm-based flooding • Sustain Louisiana's unique culture & heritage	• Reduce salinity by X-ppt • Create X-acres salt marsh • Reestablish cypress recruitment in 1 of 3 years
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

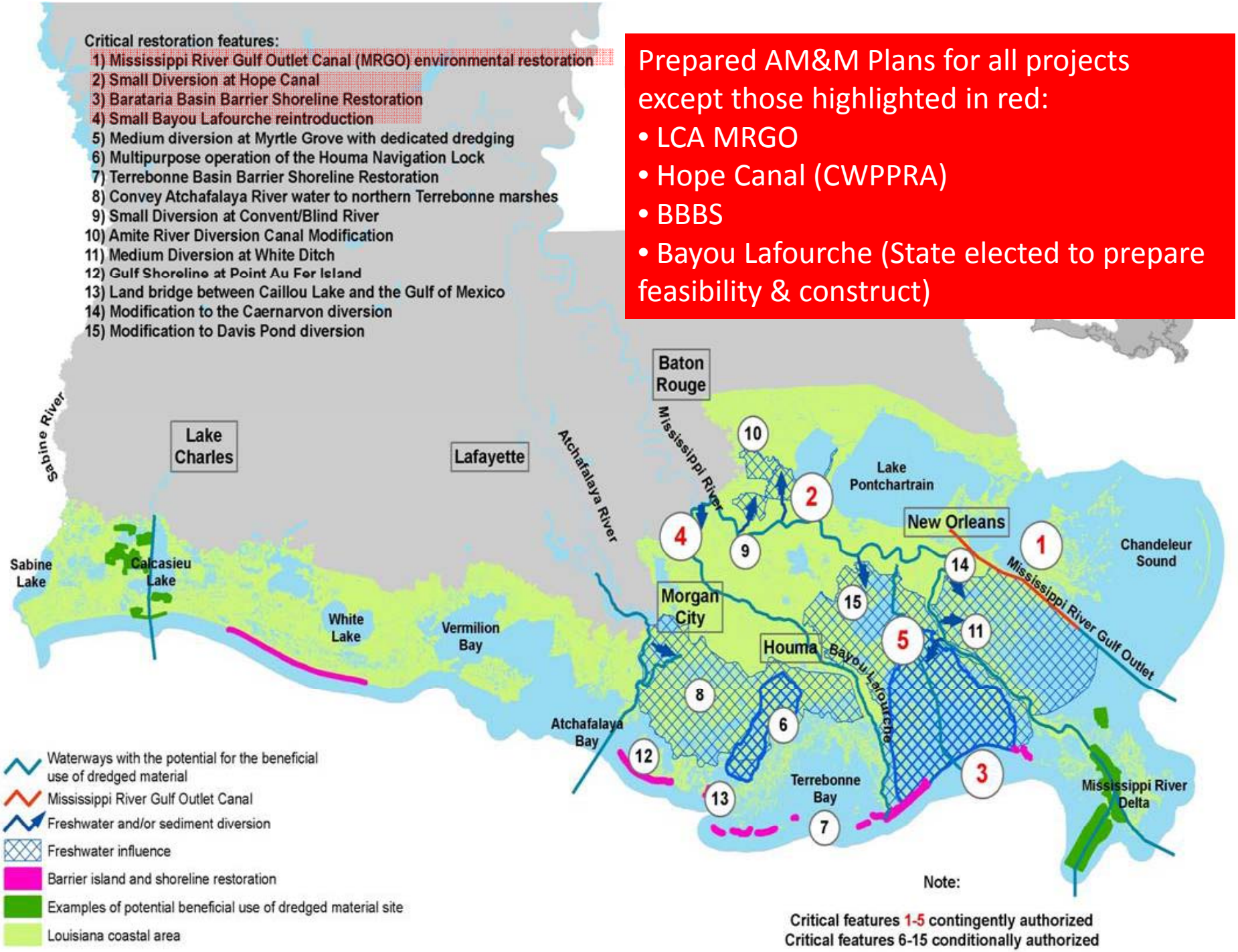
Data Management and Reporting



Project Sites = Sites located within the boundary of a constructed restoration project
Reference Sites = CRMS sites not located within the boundary of a project, but within that hydrologic basin, that serve as a comparison standard and basinwide trend indicator

Return On Investment




Critical restoration features:
1) Mississippi River Gulf Outlet Canal (MRGO) environmental restoration
2) Small Diversion at Hope Canal
3) Barataria Basin Barrier Shoreline Restoration
4) Small Bayou Lafourche reintroduction
5) Medium diversion at Myrtle Grove with dedicated dredging
6) Multipurpose operation of the Houma Navigation Lock
7) Terrebonne Basin Barrier Shoreline Restoration
8) Convey Atchafalaya River water to northern Terrebonne marshes
9) Small Diversion at Convent/Blind River
10) Amite River Diversion Canal Modification
11) Medium Diversion at White Ditch
12) Gulf Shoreline at Point Au Fer Island
13) Land bridge between Caillou Lake and the Gulf of Mexico
14) Modification to the Caernarvon diversion
15) Modification to Davis Pond diversion
Prepared AM&M Plans for all projects except those highlighted in red:
• LCA MRGO
• Hope Canal (CWPPRA)
• BBBS
• Bayou Lafourche (State elected to prepare feasibility & construct)
Sabine River
Lake Charles
Lafayette
Atchafalaya River
Baton Rouge
Mississippi River
Lake Pontchartrain
New Orleans
Chandeleur Sound
Mississippi River Gulf Outlet
Sabine Lake
Calcasieu Lake
White Lake
Vermilion Bay
Morgan City
Houma
Bayou Lafourche
Atchafalaya Bay
Terrebonne Bay
Mississippi River Delta
Waterways with the potential for the beneficial use of dredged material
Mississippi River Gulf Outlet Canal
Freshwater and/or sediment diversion
Freshwater influence
Barrier island and shoreline restoration
Examples of potential beneficial use of dredged material site
Louisiana coastal area
Note:
Critical features 1-5 contingently authorized
Critical features 6-15 conditionally authorized

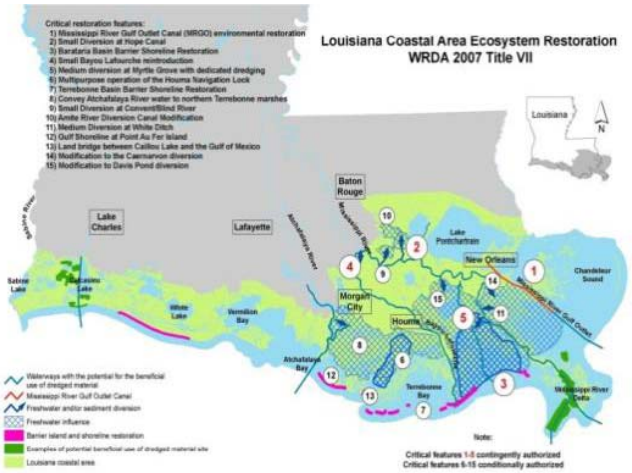
LCA Challenges and Lessons Learned

Challenge: during Feasibility phase, AM plans for all LCA 6 projects were prepared, but cost estimates for AM measures were deferred until PED phase.

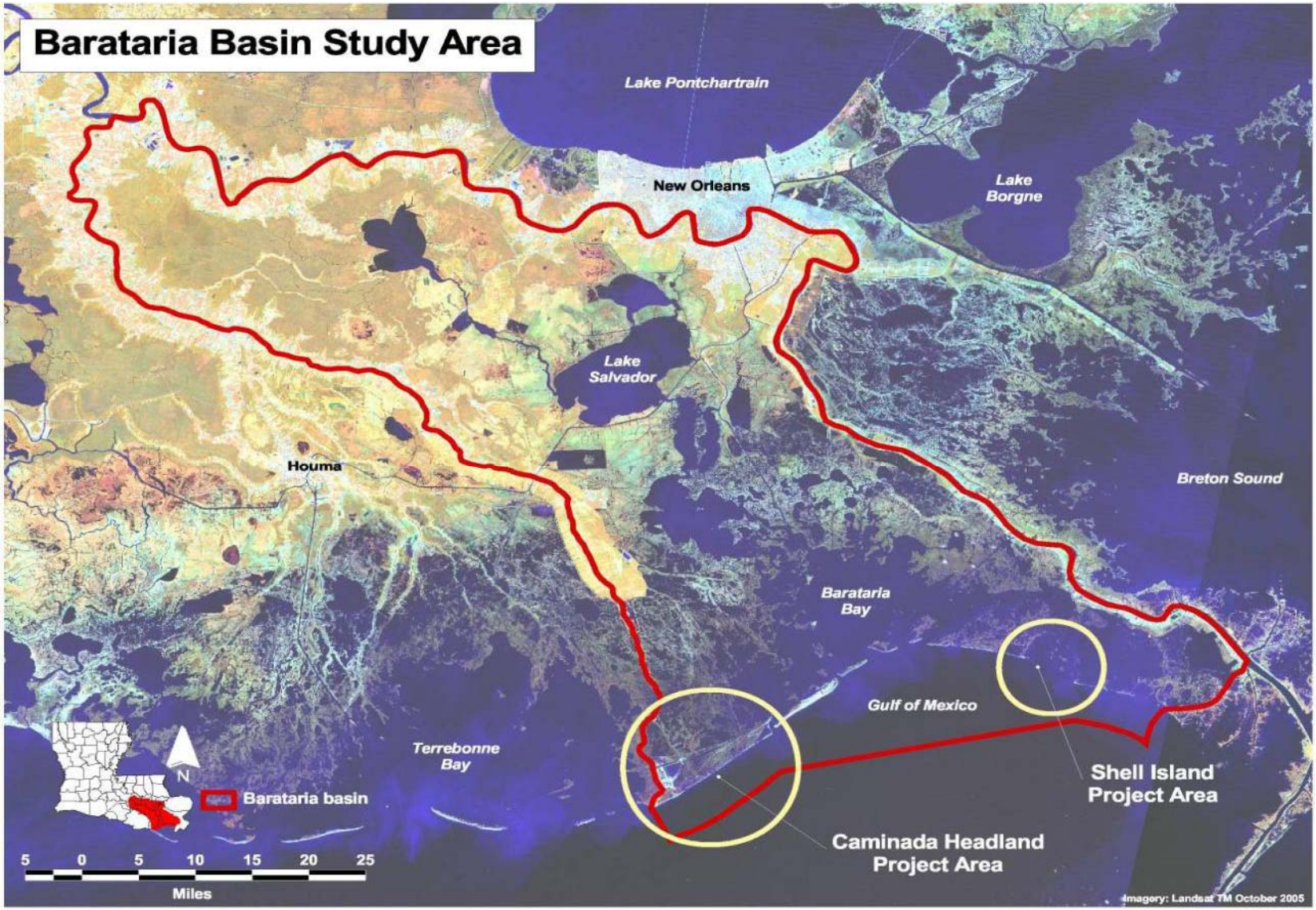
Challenge: Feasibility-level AM plans for several LCA 6 projects required revision in PED to address details not known or available during Feasibility.

Lesson Learned:

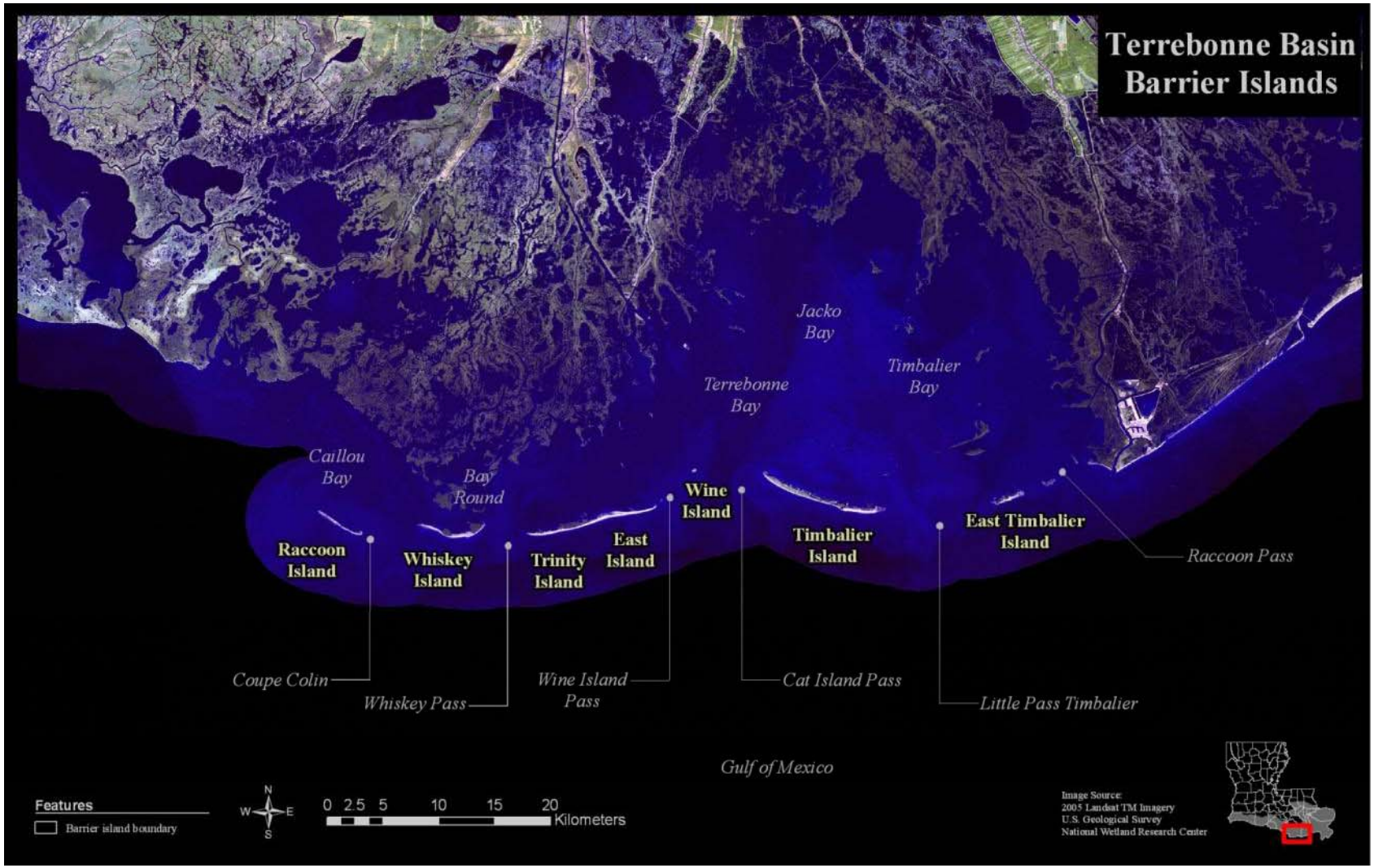
- At the Feasibility level, determine whether AM is applicable, identify metrics and performance measures, and if possible, develop preliminary AM measures, but be prepared to revise in PED.
- Develop AM&M cost estimates; should be shown in the 06 feature code of the project cost estimate.



LCA Barataria Basin Barrier Shoreline Restoration (LCA BBBS)



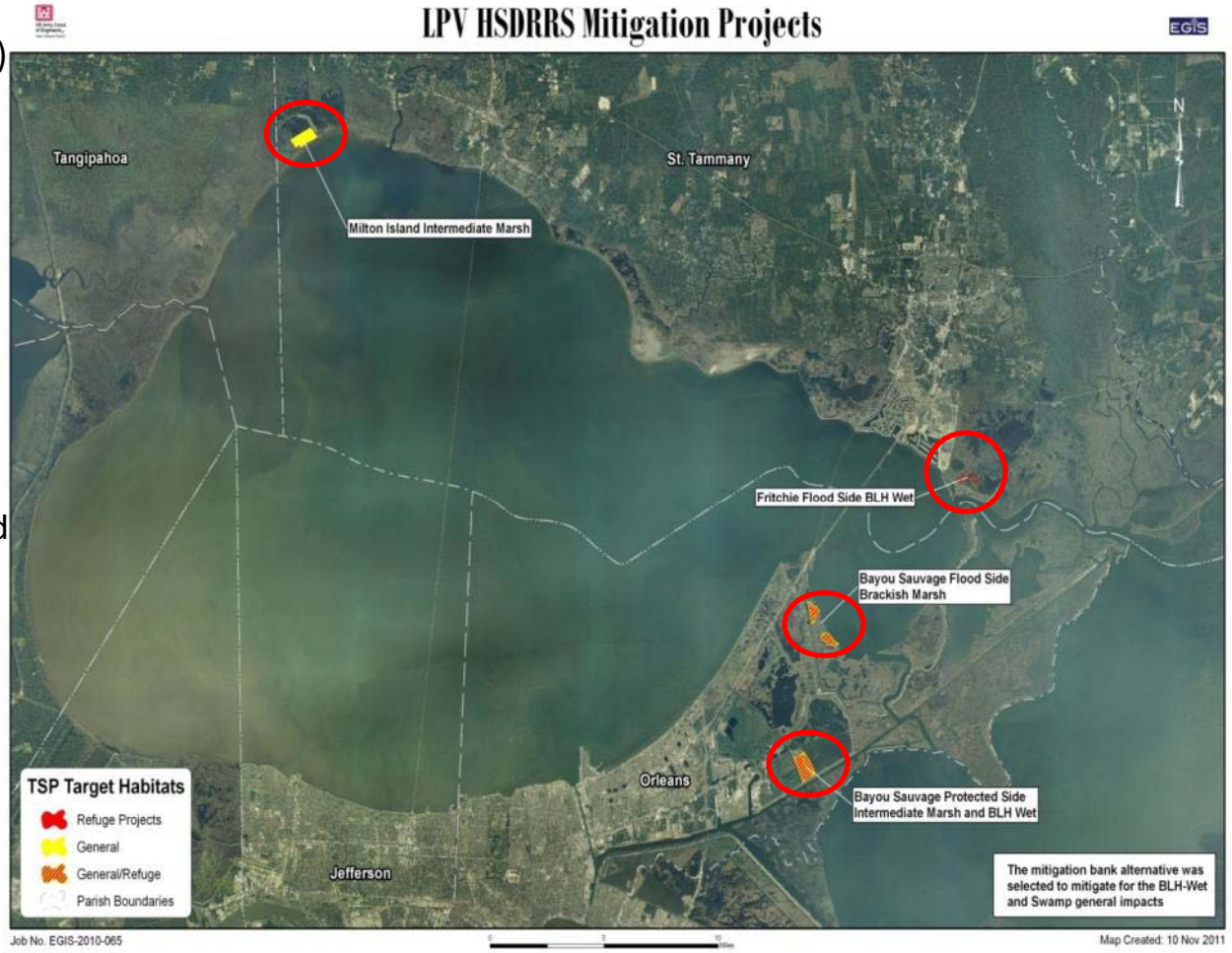
LCA Terrebonne Basin Barrier Shoreline Restoration (LCA TBBS)



LPV HSDRRS Mitigation Projects

The Lake Pontchartrain and Vicinity (LPV) Mitigation TSP includes the following sites chosen from 11 mitigation sites/project groups screened and ranked:

- **Milton Island** was selected mitigating for Intermediate Marsh general impacts
- **Fritchie Area** was selected mitigating for BLH-Wet refuge impacts
- **Bayou Sauvage Flood Side** was selected for mitigating for Brackish Marsh general and refuge impacts
- **Bayou Sauvage Protected Side** was selected for mitigating for BLH-Wet and Intermediate Marsh refuge impacts
- **Mitigation Banks** were selected mitigating for BLH-Wet and Swamp general impacts



LPV HSDRRS Mitigation Projects

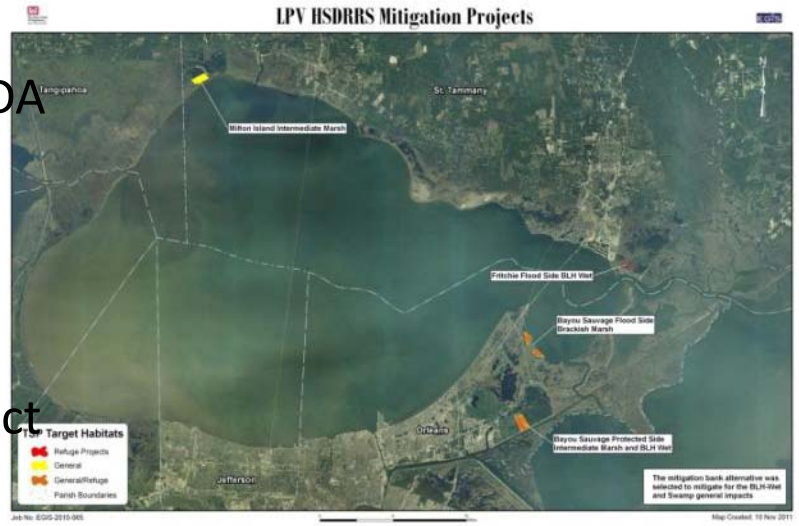
Challenge: Several separate mitigation projects for Lake Pontchartrain & Vicinity Projects.

Challenge: swamp habitat mitigation and managing hydrologic conditions is problematic

Lessons Learned: PDT and AM&M Tear worked together to enable the PDT to include sufficient funding for mitigation actions to succeed ecologically and repeated actions

LPV HSDRRS Mitigation Projects

Challenge: misunderstanding of implementation guidance (Section 2036 WRDA 2007) regarding project turnover (including AM&M) to local sponsor immediately upon completion of construction.



Lesson Learned: per OC interpretation, project is turned over to the local sponsor upon completion of construction; however, monitoring shall continue until it has been determined that the mitigation has met ecological success criteria as documented by the District Engineer in consultation with Federal and state resource agencies and determined by the Division Commander.

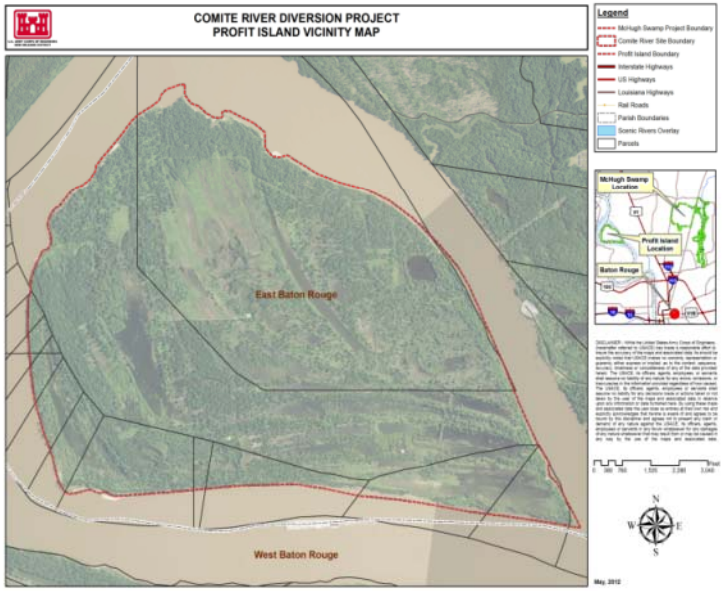
Comite River Diversion Mitigation

Challenge: only 1 week allotted for analysis and preparation of AM&M Plans

Challenge: PDT preparing EA and Mitigation Plan concurrent with AM&M Plans

Challenge: Profit Island mitigation area within Mississippi River subject to repeated flooding

Challenge: no costs provided for EA/Mitigation Plan



Lessons Learned:

•AM&M Team assistance to PDT

•AM&M Team contacts USFS for BLH plantings guidance on Profit Island—provided info to PDT.

Alternative Site	Action	Description	Available Acres	AAHUs
Expansion of Current Mitigation Area	Restoration	Tallow removal, planting BLH species	53.0	15.7
	Restoration	Planting BLH species in pasture	456.9	277.0
	Restoration	Planting BLH species in sand/gravel mine	173.4	34.1
	Preservation	Mature BLH forest	2211.9	380.5
Profit Island	Restoration	Zone 1: low-quality cottonwood/BLH forest	373.5	66.4
	Restoration	Zone 2: planting of BLH in agricultural field	134.9	81.9
	Restoration	Zone 2: low-quality cottonwood/BLH forest	483.6	115.2
	Enhancement	Zone 1: enhancement of low-quality BLH habitat	115.6	0.0
	Preservation	Zone 1: mature BLH forest	10.0	2.8
	Preservation	Zone 3: low-quality cottonwood forest	787.1	153.5
	Preservation	Zone 3: agricultural field	12.5	6.4
	Preservation	Zone 3: open water/unvegetated	400.8	0.0
McHugh Swamp	Restoration	Tallow removal, planting BLH species	558.1	118.4
	Restoration	Planting BLH species in pasture	484.8	294.0
	Restoration	Pine plantation harvest, planting BLH species	160.4	45.0
	Preservation	Mature BLH forest	2139.3	341.8

CAP Sect 206 Aquatic Ecosystem Restoration- Bayou Grosse Tete

Objective 1 – Reestablish water levels and flow**.**

Objective 2 – Reestablish important fish habitat and populations.

Objective 3- Reduce point source pollution .

Objectives need further discussions

***Project no longer funded.**

Conceptual Ecological Model for the CAP 206 Bayou Grosse Tete

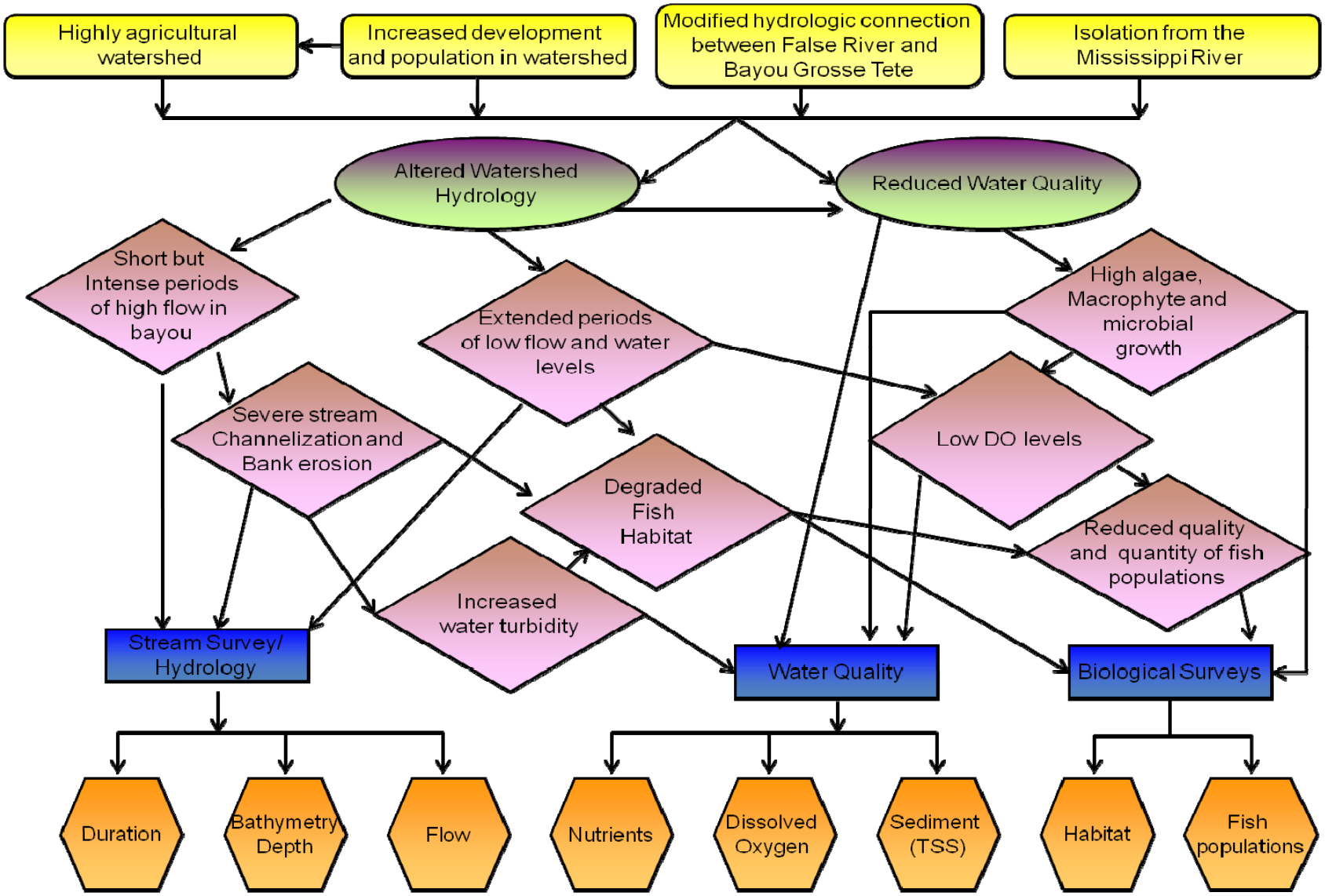
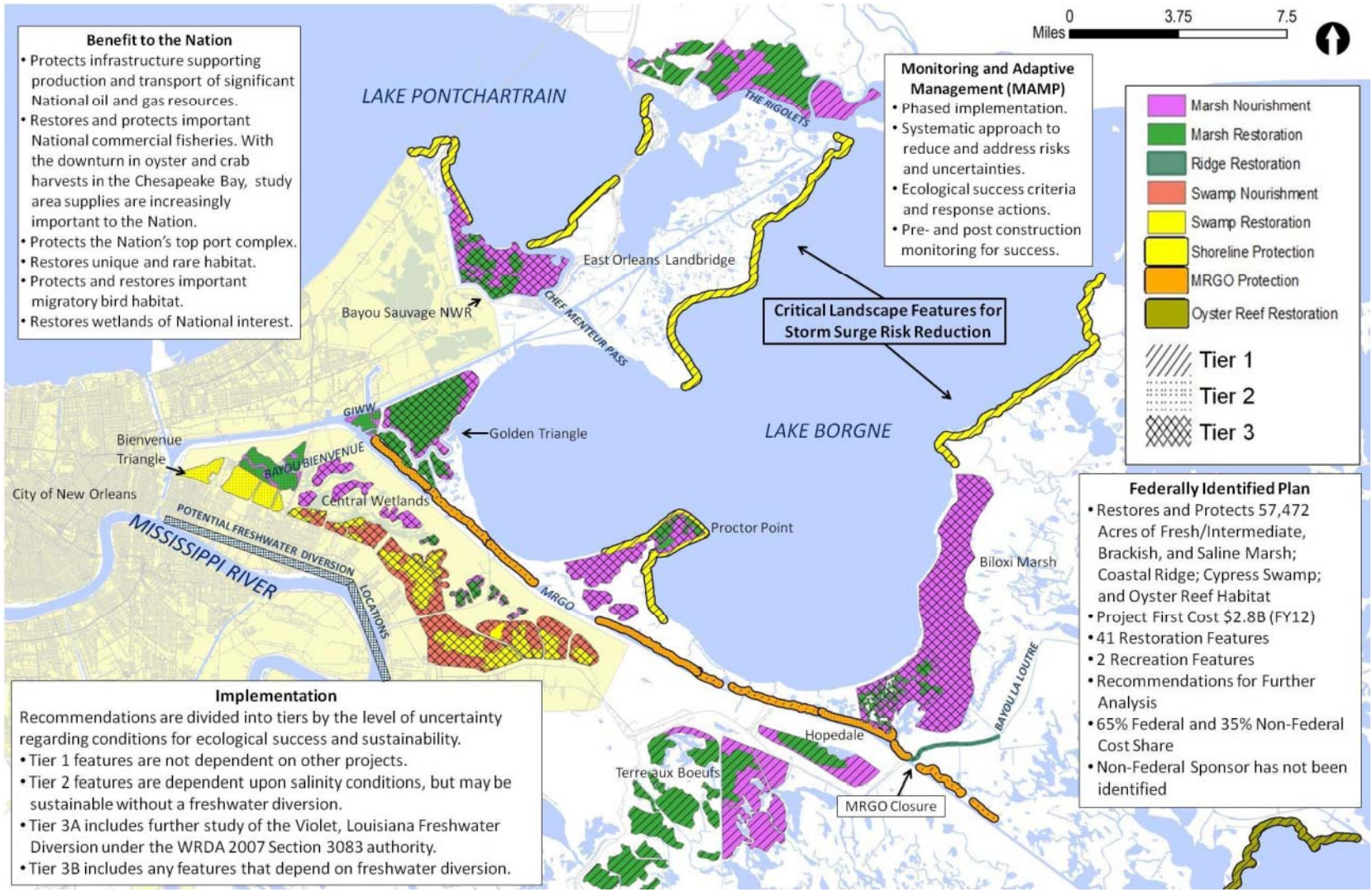


Table 1. CEM and Monitoring "Report Card"
Effects of MRGO and Selected Ecosystem Restoration Measures on Selected Issues and Drivers in the MRGO Study Area.

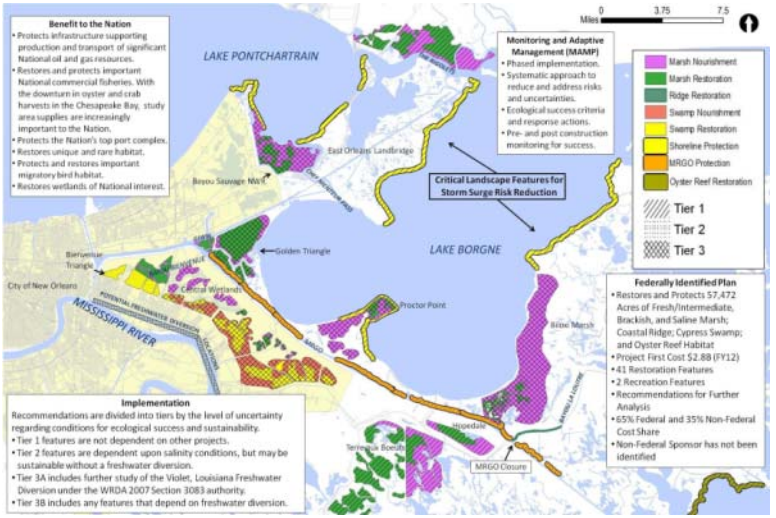
Measure / Issue/ Driver	MRGO Before Closure [1]	FWOP+ MRGO Closure [2]	FWOP+ Additional Measures[3]	River Diversion [4]	Hydrologic Restoration	Marsh Creation Dredging	Shoreline Protection [5]	Ridge Restoration	Barrier Islands Restoration	SAV Restoration	Oyster Reefs Creation	Swamp Restoration
Reduced Freshwater, Nutrients, Sediment Input	NA	NA	D□ I□	D□	D-/□ I-/□	NA	NA	NA	NA	NA	NA	NA
Wetland Losses	D- I-	D- I-	D- I-	I□	I□	D□	D□	I□	D□ I□	I□	I□	D□
Saltwater Intrusion	D-	I□	D□ I□	D□	D□ I□	I□	NA	I-/□	D□	NA	NA	I□
EFH Degradation	D- I-	D- I□	D- I□	I-/□	D-/□ I-/□	D□	D-/□	I-/□	D□	D□	D□	D□
Natural Hydrologic Process Degradation	D-	D-[6]	D-[6]	D□	D□	I□	NI	I□	D□	NI	NI	I□
Ridge Habitat Degradation	D-	D□	D- I-	NA	I□	I□	NI	D□	I□	NI	NI	I□
Barrier Islands Degradation	I-	I□	NA	NA	NA	NA	NI	NA	D□	I□	NI	NA
Shoreline Erosion	I-	I-	I-	I□	I□	I□	D□	D□ I□	I□	I□	I□	I□
Subsidence	NA	NA	NA	I□	I□	I-/□	NA	I-	NA	NI	NI	I-/□
Sea Level Rise	NA	NA	NA	NA	NA	NA	NA	NA	NA	NI	NA	NA
Storm Surge	NA	NA	NA	I□	I□	D□	NA	D□	D□	I□	NA	D□
Marine Habitat Degradation	D- I-	I□	D□ I□	D□I□	D-/□ I-/□	D-/□ I-/□	I	D-/□ I-/□	D□	D□	D□	D-/□ I-/□
Freshwater Habitat Degradation	D- I-	I□	D□I□	D□	D□	D□	I□	I□	I□	D□	NA	D□
Lake Pont. Dead Zone Expansion	D- I-	D□I□	D□I□	I□	I□	NI	NI	NI	NI	NA	NA	NI

Mississippi River Gulf Outlet Ecosystem Restoration Plan



MRGO Ecosystem

Lessons Learned:



•Phased construction:

Tier 1, 2, 3,… project features less dependent on other project features to be constructed first.

•Restoration feature sequencing:

- Features in each Tier with greatest associated uncertainty constructed first
- Enables greater learning and understanding of restoration performance measures.
- Lessons learned are utilized in modifying subsequent restoration features.

•Adaptive design:

- Design variability incorporated into restoration features.
- Enables PDT and AM&M Team to learn which restoration feature components best achieve Project objectives and maximize benefits.
- Restoration feature designs will be modified during each Project planning and implementation phase as PDT and AM&M Team learns (via monitoring and other) which designs have had the greatest success with minimal adverse impacts.
- As restoration features are constructed, monitoring results are expected to contribute to a better understanding of ecosystem complexities and dynamics thereby reducing uncertainty.

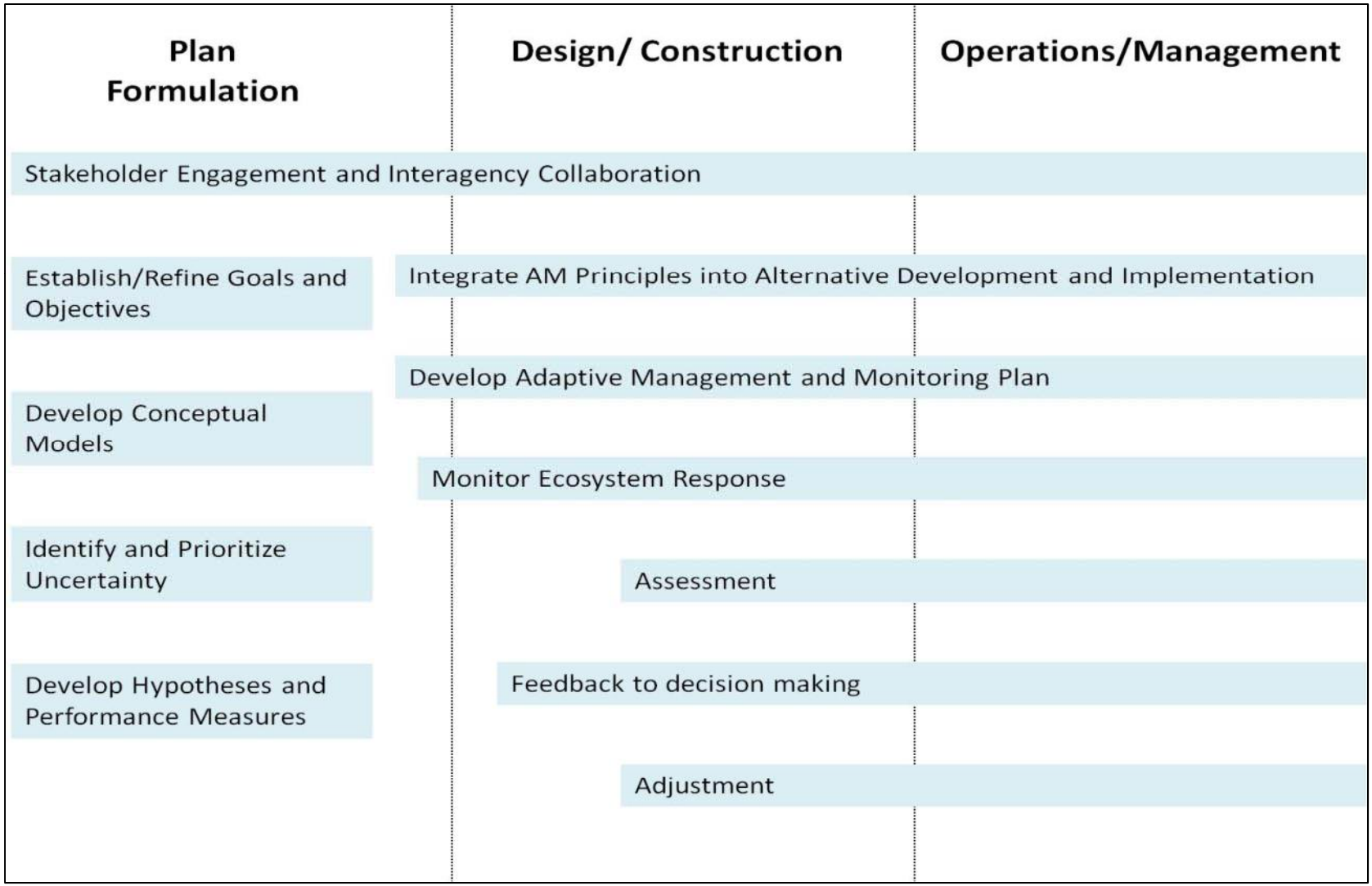
ADAPTIVE MANAGEMENT

VS

PLANNING SMART

3X3X3

Integrating AM into Project Life Cycle



P&G Six-Step Planning Process	CEQ Cumulative Impacts Analysis Framework
Step 1 – Problems and Opportunities Step 2 – Inventory & Forecast Resources	Step 1 – ID **significant resources**/effects,
	Step 2 – ID **geographic** scope/boundaries
	Step 3 – **Time Frame**; ID past, present & reasonably foreseeable future conditions for each resource
	Step 4 – ID other actions affecting resources,
Step 3 – Formulate Alternative Plans Step 4 – Evaluate Alternative Plans	Step 5 – Characterize the resources in terms of response to change capacity to withstand stresses
	Step 6 – Characterize stresses affecting resources and relation to regulatory thresholds.
	Step 7 – Define "**baseline**" conditions (future without project conditions) for resources.
	Step 8 – ID important cause & effect relationship
Step 5 – Compare Alternative Plans	Step 9 – Determine **magnitude** and **significance** of cumulative effects.
Step 5 – Compare Alternative Plans Step 6 – Select Recommended Plan	Step 10 – Modify/add alternatives to avoid, minimize or mitigate.
	Step 11 – **Monitor / adaptively manage**.

AM & M (uncertainty)

Conceptual Ecological Model

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.