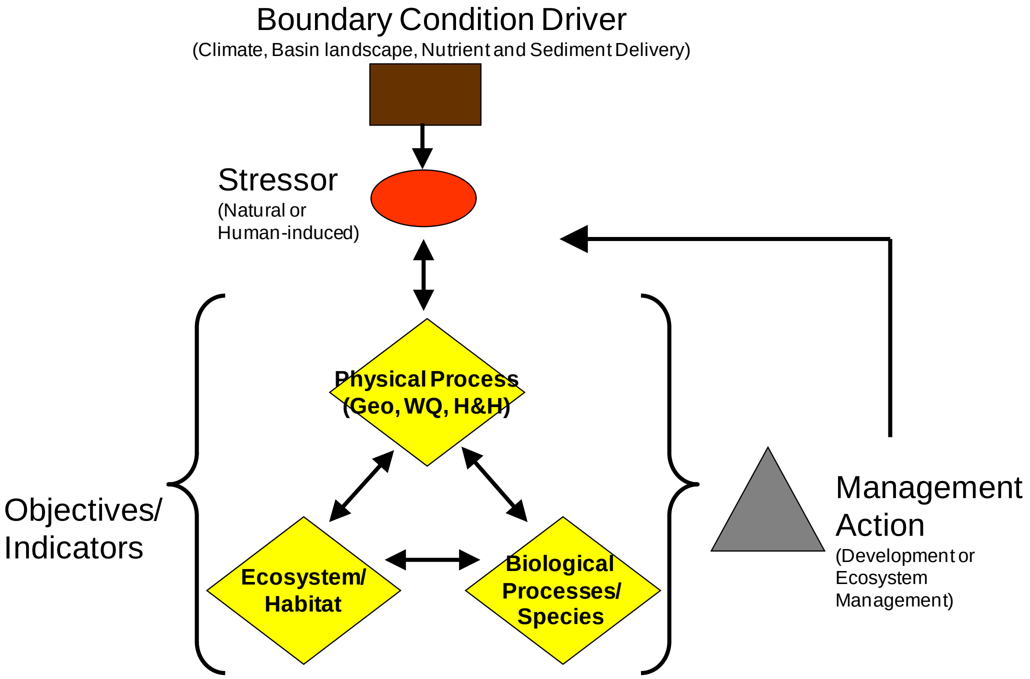
Upper Mississippi River System Ecosystem Restoration Objectives

Chapter 3

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
ENVIRONMENTAL DESIGN HANDBOOK

CHAPTER 3

ECOSYSTEM RESTORATION OBJECTIVES



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UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
ENVIRONMENTAL DESIGN HANDBOOK

CHAPTER 3

ECOSYSTEM RESTORATION OBJECTIVES

FIGURES

TABLES

UPPER MISSISSIPPI RIVER RESTORATION
ENVIRONMENTAL MANAGEMENT PROGRAM
ENVIRONMENTAL DESIGN HANDBOOK

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ECOSYSTEM RESTORATION OBJECTIVES

A. INTRODUCTION

Planning to identify Upper Mississippi River System (UMRS) ecosystem restoration program objectives has progressed from site specific project identification (DeHaan et. al. 2003) to a more comprehensive regional Habitat Needs Assessment (HNA; USACE, 2000), and most recently to the “Reach Planning” process which aspired toward adaptive management (USACE, 2011). The adaptive management philosophy first recommended by expert panels on the Upper Mississippi River Restoration Environmental Management Program (UMRR-EMP) System Ecological Team (EMP, 2003) and Navigation Study Science Panel (Barko et al., 2006) has been adopted by multiple UMRS ecosystem restoration programs and is now included in Corps policy (WRDA 2007; Section 2039; Appendix 3-A). The UMRS adaptive management process emphasizes several significant phases (Fischenich et al. 2012; figure 3-1):

1. System Scale Adaptive Management
2. Project Scale Adaptive Management Planning (e.g. Set-Up)
3. Adaptive Management Implementation.

Adaptive Management at the UMRS system scale includes large scale objectives and broad concepts for restoration, Williams et al. 2012 describe a “deliberative phase” that occurs infrequently in the duration of a program or agency planning. System scale ecosystem restoration planning occurred in 1986, 1997, 2003, and 2009. Adaptive management at the project scale was described as an “iterative phase” by Williams et al. 2012). Project planning includes: refined restoration criteria, preliminary design, and alternative analysis including physical process and ecological benefit assessment models. Adaptive management monitoring and evaluation may be emphasized for lesser known restoration techniques, but well known restoration actions proceed with less monitoring. Adaptive management implementation includes final design, construction, monitoring, and feedback loops that require assessment of project effects and learning objectives.

Several science review panels and program level planning exercises recognized the importance of restoration at multiple scales. Addressing restoration from a process and function perspective at ecologically relevant spatial scales (e.g., pool, reach, UMRS) in addition to the more traditional local project-based approach of directing efforts to restoring compositional and structural elements at individual sites is required for success at achieving social-ecological sustainability (Galat et al., 2007). A system-wide approach emphasizes restoring ecosystem functions and processes (e.g., landform evolution, plant community succession) over ecosystem structure (e.g., pattern of habitats, life forms) at individual project areas. A system-wide approach ensures logical connections among vision, goals, and objectives at different scales. This approach will strengthen the scientific basis for ecosystem restoration efforts, provide clear linkage across scales of the system, provide a logical basis for identifying and sequencing projects, and will support adaptive ecosystem management.

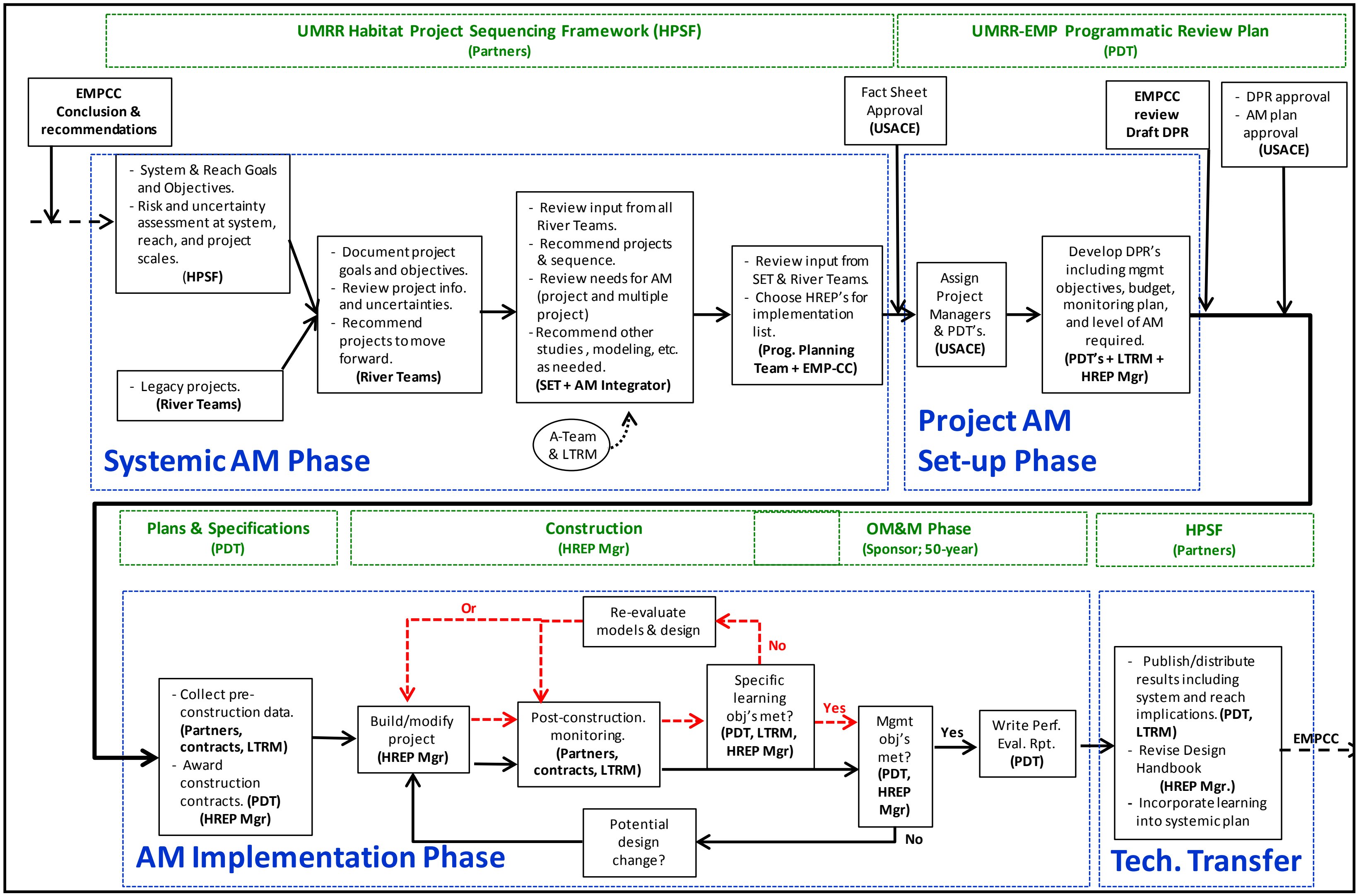


Figure 3-1. UMRS Adaptive Management (AM) Conceptual Model

Goals and objectives for condition of the river ecosystem are central to UMRS ecosystem restoration planning and adaptive ecosystem management (figure 3-2). Goals and objectives are logically linked to management actions, indicators of ecosystem conditions, monitoring activities, reporting on ecosystem conditions, and learning. System goals and objectives were codified by river managers first in *a River That Works and a Working River* (UMRCC, 2000), then during planning for adaptive management implementation (USACE, 2008) and most recently when establishing system-wide ecosystem restoration objectives USACE, 2011). Scientists supported the managers and helped refine planning strategies in *Establishing System-wide Goals, and Objectives for the Upper Mississippi River System* (Galat et al., 2007). The reach scale objectives are the product of river managers and scientists working as regional teams to emphasize unique physical and ecological characteristics and needs (USACE 2011).

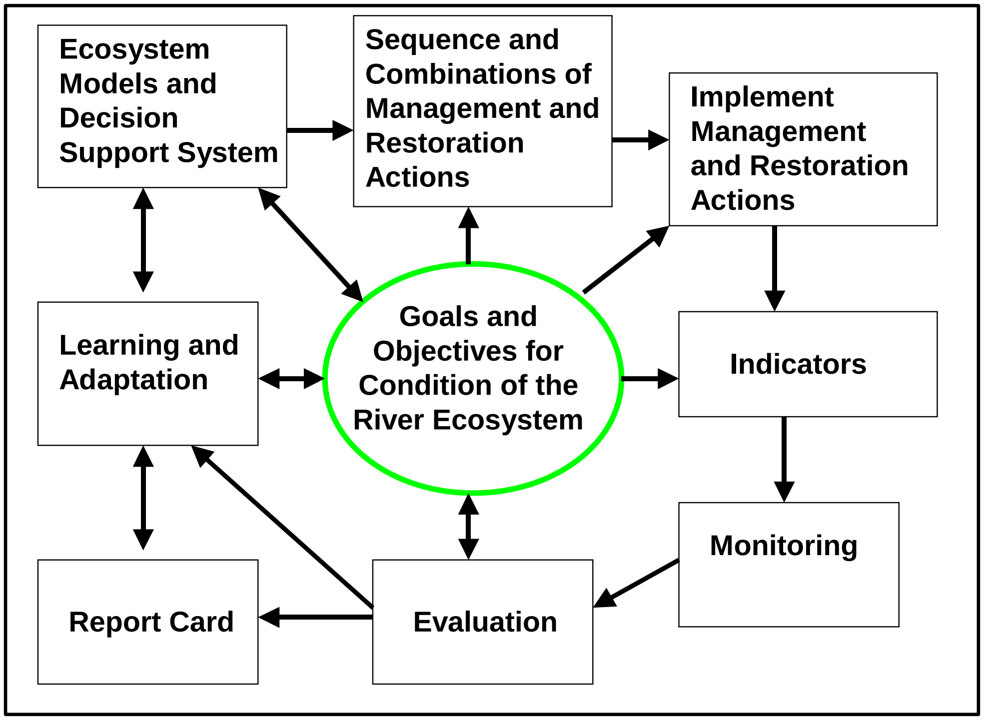


Figure 3-2. Goals and Objectives Central to the UMRS Adaptive Ecosystem Management

B. ADAPTIVE ECOSYSTEM MANAGEMENT

Adaptive management is a process that promotes flexible decision making that can be adjusted as outcomes from restoration actions and other events become better understood (Williams et al. 2007). Adaptive management is a process that uses management and restoration actions as tools to probe the functioning of an ecosystem. Kessler et al. (1992) note that in adaptive management, information from monitoring is used to continually evaluate and adjust management relative to predicted responses, management objectives, and predetermined thresholds of acceptable change. Partner derived goals and objectives are nearly always the recommended starting point for adaptive management (Galat et al., 2007). UMR System-wide goals established by the UMR Conservation Committee (UMRCC) in 2000 were reviewed and codified by a science review panel with the UMRR-EMP-Coordinating Committee in 2008 and future system scale planning will be reviewed by the

UMRR-EMP System Ecological Team. Established system goals make it easier for reach planning teams (i.e., Fish and Wildlife Work Group, Fish and Wildlife Interagency Committee, River Resources Action Team, and Illinois River Work Group) to identify locations that support the reach scale process and functions required to meet their regional objectives (USACE, 2011). Project objectives were established for many high priority sites recommended during the most recent collaborative planning process.

Adaptive management at the project scale begins with biologists and natural resource managers establishing restoration objectives and initial design criteria and engineers sizing structures, channels, dredging, etc. to achieve them. Project scale adaptive management increasingly uses process-based hydraulic models and wind-wave models to support project alternative analysis. Habitat suitability models are being refined by more closely integrating physical process models for better estimates of project effects. Habitat evaluation procedures, regional species models (bluegill overwintering), and regional community models (WHAG and AHAG) have been used most frequently for Habitat Rehabilitation and Enhancement Project (HREP) benefit analysis, but there has been increasing interest in improving regional models using Long Term Resource Monitoring (LTRM) data and prior HREP experience.

The project construction phase is an engineering led phase. Biologists have a role in construction monitoring to be sure constructed features are built according to plans, but also to take advantage of unique opportunities that might improve project features, ease operations, or save costs. Biologists monitoring construction can also observe early biological response, as some are immediate when river habitats are altered.

Monitoring is a critical learning phase that historically emphasized operation of constructed features and a few intensive biological response investigations. Adaptive management requires that monitoring is established to test hypotheses about the objectives developed during project design. Well known practices require less monitoring, new techniques need more monitoring to resolve uncertainty. Evaluation and assessment is an opportunity to “put it all together” and determine whether the actions achieved the desired outcome. Information learned during monitoring will ideally be used to modify existing restoration actions to improve future restoration efforts. Restoration actions deemed successful can be implemented efficiently using accepted criteria, as is the purpose of this Design Manual. Governance and program adaptation have been discussed in other documents, but it is important to be sure that learning is captured by the program and integrated into subsequent reviews of goals and objectives.

C. HIERARCHY OF VISION, GOALS, AND OBJECTIVES FOR THE RIVER ECOSYSTEM

Logical and scientifically-supported connections among vision, goals, and objectives are needed to ensure ecological and cost effectiveness of system management and restoration. Much effort has gone into establishing goals and objectives for the UMRS over the last 30 years. An initial Comprehensive Master Plan for the Upper Mississippi River Basin (UMRBA, 1982) established a baseline understanding of the condition of the entire system and system-wide economic, environmental, and recreational objectives. Since then iterative planning has emphasized different system components or was conducted in response to advances in knowledge or occurrence of extreme events, such as floods and droughts. The UMRS ecosystem restoration objectives have been reviewed many times in the context of multi-purpose navigation expansion and ecosystem restoration (USACE, 2004), ecosystem restoration (USACE, 2000), and river management (UMRCC, 2000) planning studies. Ecosystem restoration objectives were most recently stated as *Upper Mississippi River System Restoration Objectives 2009* (USACE, 2011) by interagency working groups representing state and federal natural resources agencies. These objectives evolved from the grassroots UMRCC 1994 Ecosystem Management Strategies (Grumbine 1984) in four separate river reaches to eventually be embraced by large river management programs including Navigation and Ecosystem Sustainability Program (NESP), UMRR-EMP, and Illinois River Basin Restoration, and the science community (Galat et al., 2007) as part of the NESP Science Panel. The cumulative work of many planning studies has resulted in a hierarchy of vision, goals, and objectives for the UMRS ecosystem developed with UMRS natural resource managers:

1. Vision Statement. The UMRS vision statement provides the foundation for goals and objectives and sets the broad direction and sideboards for future ecosystem restoration work (USACE, 2004). The vision statement is:

> *To seek long-term sustainability of the economic uses and ecological integrity*
> *of the Upper Mississippi River System*

Adopting *ecological integrity* as a part of a vision statement for the UMRS means targeting a system that resembles its natural state as much as possible with minimal influence from human actions. While guidance and policy emphasize restoring natural conditions, in many cases it may only possible to achieve a partial restoration of natural processes on the UMRS, since it is a highly altered ecosystem and many of the changes to the river, floodplain, and watershed are irreversible. A system-wide approach is also process based, rather than site based. Restoring ecosystem structure and function and using natural processes has been effective to achieve sustainable restoration projects that should be more resilient to human and natural disturbances. The success of restoration planning increased as experience and learning helped identify key ecological functions and processes within the UMRS which have been incorporated into project design and system goals and objectives at all levels.

2. Overarching Ecosystem-wide Goal. The NESP developed the following overarching ecosystem-wide goal.

> *To conserve, restore, and maintain the ecological structure and function*
> *of the Upper Mississippi River System to achieve the vision of the*
> *Navigation and Ecosystem Sustainability Program*

This goal implies conserving the UMRS' remaining structure and function while restoring the degraded components to realize a sustainable UMRS (Galat et al., 2007).

3. Ecosystem Goals. The following ecosystem goals address the five Essential Ecosystem Characteristics (EECs) suggested by Harwell et al. (1999) as being fundamental to ecosystem function. The EEC for each goal is shown in parentheses.

1) **Hydrology and Hydraulics (H&H):** Manage for a more natural hydrologic regime
2) **Geomorphology:** Manage for functions that shape diverse and dynamic channels and floodplain
3) **Biogeochemistry:** Manage for more natural materials transport and processing functions

4) **Habitat:** Manage for a diverse and dynamic pattern of habitats to support native biota
5) **Biota**: Manage for viable populations of native species and diverse plant and animal communities

4. Reach Scale Ecosystem Objectives. UMRS Ecosystem Objectives, ie. Reach Objectives, were developed by river management teams in four river reaches (summarized in table 3-1) as part of recent interagency reach planning (USACE, 2011). They are organized by EEC and the river reach for which they apply. Also, the objectives were drafted as statements of the future condition of the ecosystem, rather than statements about restoration actions. No attempt was made to designate primary versus secondary objectives, nor actions to achieve them. During more detailed planning at the project scale, factors such as habitat scarcity, area of influence, special status species (i.e., threatened and endangered species), sustainability, and national significance can be considered.

5. Project Scale Objectives. Project objectives derive from one or more of the larger scale goals and objectives described above. However, each project area has its own unique characteristics and is affected by different factors requiring that Project Delivery Teams (PDTs) develop objectives specific to that project area. Project objectives and criteria are developed by PDTs composed of interagency technical specialists familiar with project areas and restoration planning. Objectives should be specific, measurable, actionable, results driven, and time bound (SMART). SMART objectives ensure that sufficient information is collected to evaluate ecosystem response and increase system understanding in an adaptive management framework.

Table 3-1. Upper Mississippi River System Ecosystem Restoration Objectives Organized By Essential Ecosystem Characteristics (H&H, Biogeochemistry, Geomorphology, Habitat, and Biota in Four Floodplain Reaches)

Upper Impounded Floodplain Reach	Lower Impounded Floodplain Reach	Unimpounded Floodplain Reach	Illinois River
HYDRAULICS & HYDROLOGY: Manage for a More Natural Hydrologic Regime			
A more natural stage hydrograph	A more natural stage hydrograph		A more natural stage hydrograph
Restored hydraulic connectivity		Restored hydraulic connectivity	
	Naturalize the hydrologic regime of tributaries		
	Increase storage & conveyance of flood water on the floodplain		
BIOGEOCHEMISTRY: Manage for Processes That Input, Transport, Assimilate, & Output Material Within UMR Basin River Floodplains: e.g., Water Quality, Sediments, & Nutrients			
Improved water clarity	Increased water clarity		
Reduced nutrient loading	Reduced nutrient loading from tributaries to rivers		
Reduced sediment loading from tributaries & sediment resuspension in & loading to backwaters	Reduced sediment loading & sediment resuspension in backwaters		Reduced sediment loading & sediment resuspension in backwaters. **NOTE:** There are several objectives dealing with tributary loading
Reduced contaminants loading & remobilization of in-place pollutants			
		Water quality conditions sufficient to support native aquatic biota & designated uses	Water quality conditions sufficient to support aquatic biota
GEOMORPHOLOGY: Manage for Processes That Shape a Physically Diverse & Dynamic River Floodplain System			
Restore rapids			
	Restored backwater areas		Restored backwaters
	Restored lower tributary valleys		
Restore a sediment transport regime so that transport, deposition, & erosion rates & geomorphic patterns are within acceptable limits	Restored bathymetric diversity, & flow variability in secondary channels, islands, sand bars, shoals & mudflats	Restored bathymetric diversity, & flow variability in secondary channels, islands, sand bars, shoals & mudflats	Restored secondary channels & islands
	Restored floodplain topographic diversity		
			Restored lateral hydraulic connectivity

Table 3-1. Upper Mississippi River System Ecosystem Restoration Objectives Organized By Essential Ecosystem Characteristics (H&H, Biogeochemistry, Geomorphology, Habitat, and Biota in Four Floodplain Reaches)

Upper Impounded Floodplain Reach	Lower Impounded Floodplain Reach	Unimpounded Floodplain Reach	Illinois River
HABITAT: Manage for a Diverse & Dynamic Pattern of Habitats to Support Native Biota			
Restored habitat connectivity	Restored habitat connectivity		Restored habitat connectivity
Restored riparian habitat	Restored riparian habitat	Restored riparian habitat	
Restored aquatic off-channel areas		Increase the extent & number of sand bars, mud flats, gravel bars, islands, & side channels towards a more historic abundance & distribution.	
Restored terrestrial floodplain areas			
Restored channel areas			
	Diverse & abundant native aquatic vegetation communities (SAV, EAV, RFV)		
		Restored large contiguous patches of native plant communities to provide a corridor along the UMR	Restored floodplain areas
		Restored floodplain wetland areas	
		Restored degraded & rare native habitats	
			Restored lower tributary valleys
BIOTA: Manage for Viable Populations of Native Species Within Diverse Plant & Animal Communities			
Diverse & abundant native aquatic vegetation communities (SAV, EAV, R/F)			
Diverse & abundant native floodplain forest & prairie communities			
Diverse & abundant native fish community		Diverse & abundant native fish community	
Diverse & abundant native mussel			
Diverse & abundant native bird community			
	Restored diversity & extent of native communities throughout their range in the UMRS	Viable populations of native species throughout their range in the UMRS at levels of abundance in keeping with their biotic potential	Viable populations of native species throughout their range in the UMRS at levels of abundance in keeping with their biotic potential
	Reduced adverse effects of invasive species	Reduced adverse effects of invasive species	
			Restored diversity & extent of native communities throughout their range in the UMRS

D. ECOSYSTEM CONCEPTUAL MODELS

Modeling and understanding ecological mechanisms are important for all phases of restoration project planning, but especially early in project planning when objectives are established. Ecosystem conceptual models are important first steps in restoration project planning (Fischenich, 2008; Gentile et al., 2001; Ogden et al., 2005) to help define the system, identify important physical attributes, characterize system condition and potential, and to formulate project design and evaluation. Estimating environmental benefits and outcomes using models are important elements of adaptive management (Harwell, 1998) and project evaluation (USACE, 2000 Planning Guidance).
Simple conceptual models have been referenced on the UMRS formally since the Great River Environmental Action Teams (GREAT I and II, UMRBC, 1982) and at the early stages of UMRR-EMP (Lubinski, 1993). They have continued to be used to categorize system-wide objectives (USACE, 2011) and to focus in on specific reaches and subareas with more detailed models. Ideally planners and designers try to organize ecological parameters and relationships that can be manipulated in relevant spatial analyses using multiple historic, contemporary, and modeled reference condition data (Nestler et al., 2010, Theiling and Nestler, 2010).

A simple ecosystem conceptual model (figure 3-3) can be used to illustrate that the five UMRS ecosystem goals are interrelated and that the physical/chemical processes usually impact Habitat and Biota, but that there are also feed-back loops. Figure 3-4 is used to illustrate linkages among drivers, stressors, UMRS EECs (H&H, Geomorphology, Biogeochemistry, Habitat, and Biota) and indicators (Lubinski and Barko, 2003). The model considers boundary condition drivers like glacial geology and climate that establish general ecosystem characteristics at the larger scales. There are numerous natural and anthropogenic stressors that perturb ecosystems and cause spatial and temporal variation throughout the river-floodplain system. Some are minor seasonal stressors like floods or cold weather, others are extreme natural events like great floods, droughts, or fire that are uncommon but strongly influence ecosystems. Human caused stressors include large, permanent physical changes like dams, levees, and urbanization as well as smaller disturbances like local land clearing or channel modifications whose cumulative impacts may cause large change.

Eight conceptual models were developed by the NESP Reach Planning Team for Geomorphic Reach 1. Figure 3-5 illustrates the framework used for the conceptual models. These floodplain reach scale conceptual models illustrate the linkage among ecosystem objectives, performance criteria, and indicators categorized by EECs (H&H, Geomorphology, Biogeochemistry, Habitat, and Biota). Essentially, this was done by first listing the Biota objective, then stressors affecting biota, and then listing Biogeochemistry, H&H, Geomorphology, and Habitat objectives and performance criteria that need to be met to achieve the biota objectives. In some cases, the objective from table 3-1 was made more specific (e.g. diverse and abundant native fish objective was made specific to lentic fish or lotic fish).

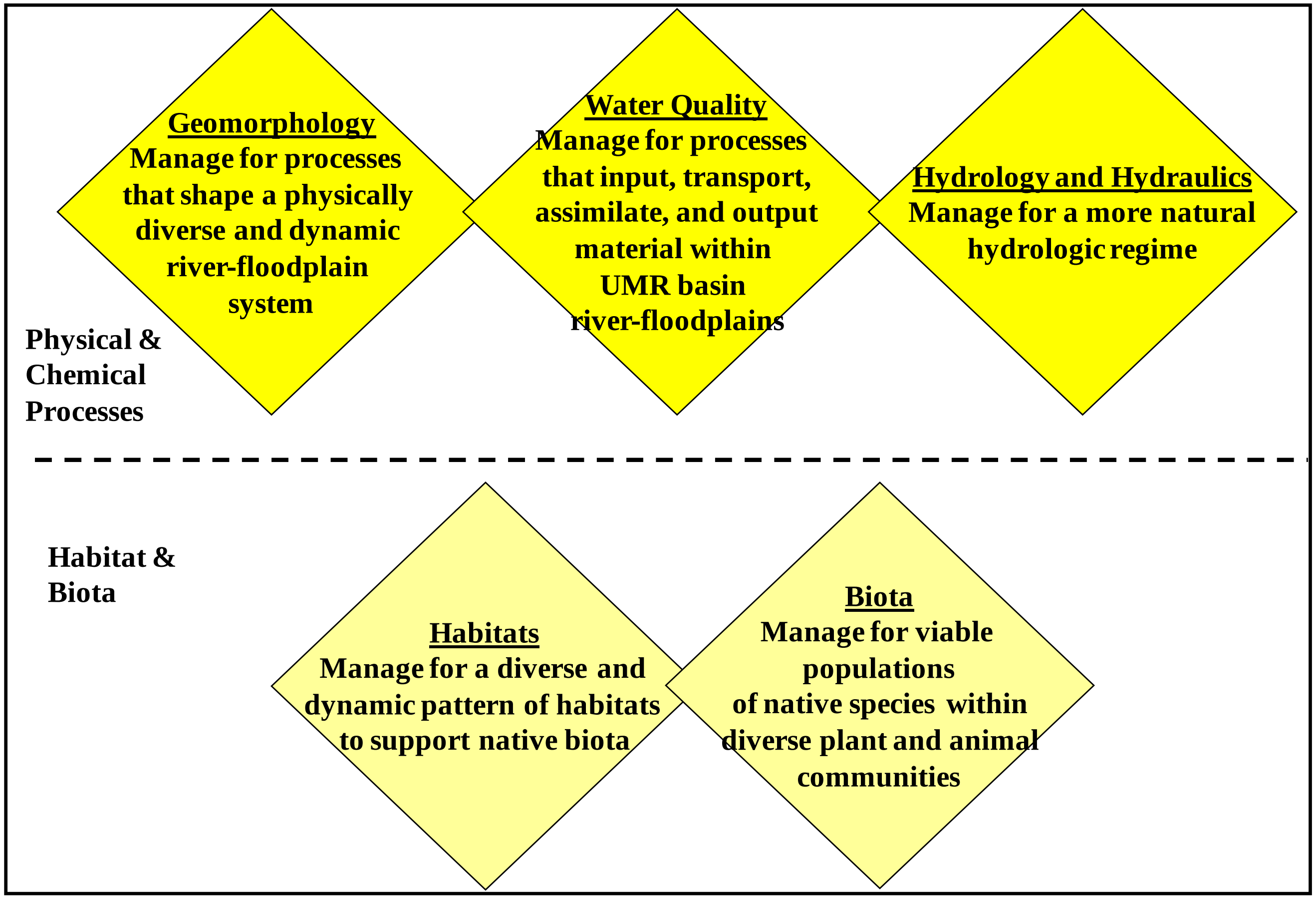


Figure 3-3. Upper Mississippi River System Essential Ecosystem Characteristics and objectives for their condition interact mostly as physical processes and structure (geomorphology, biogeochemistry, H&H) influencing habitat and biological outcomes.

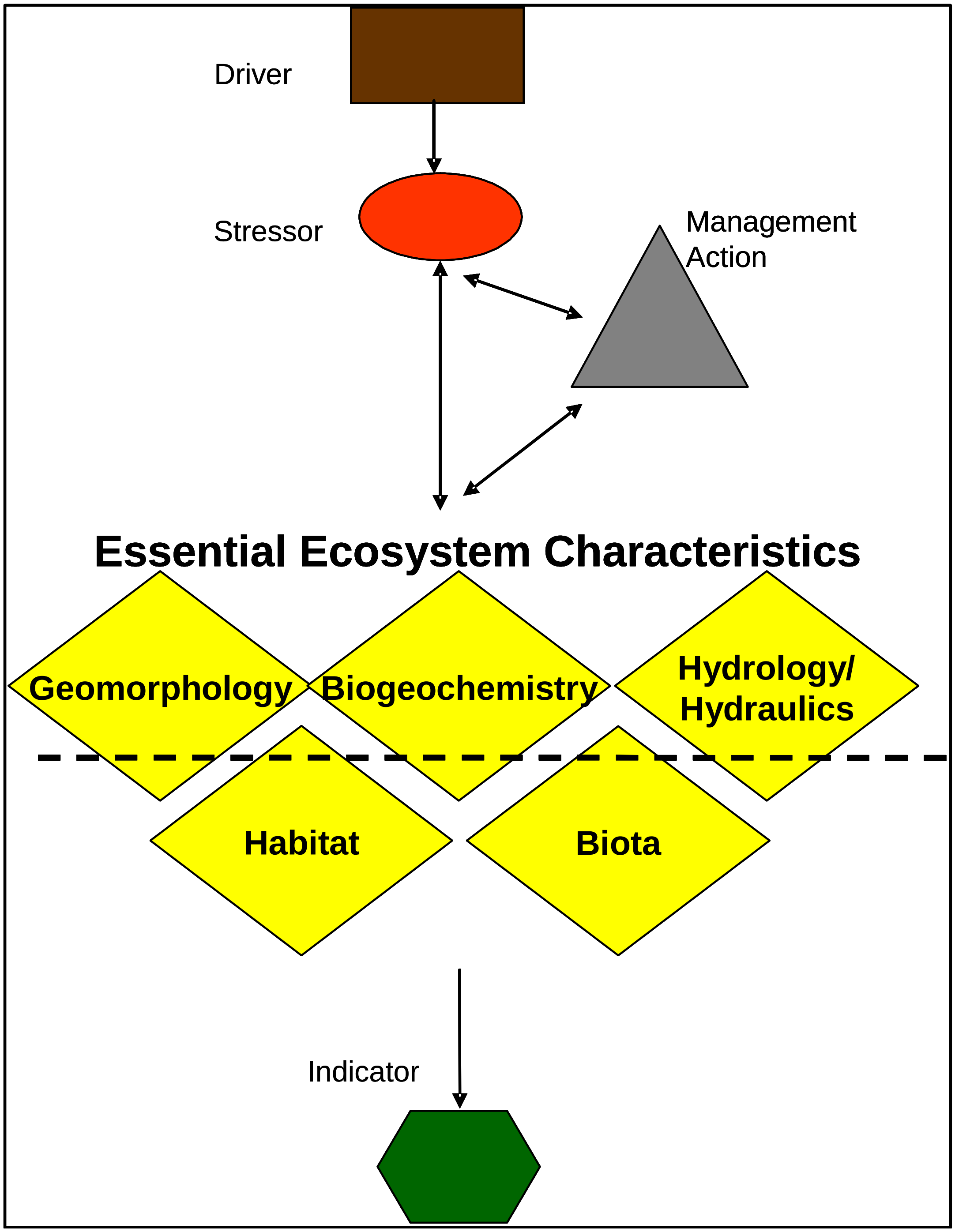
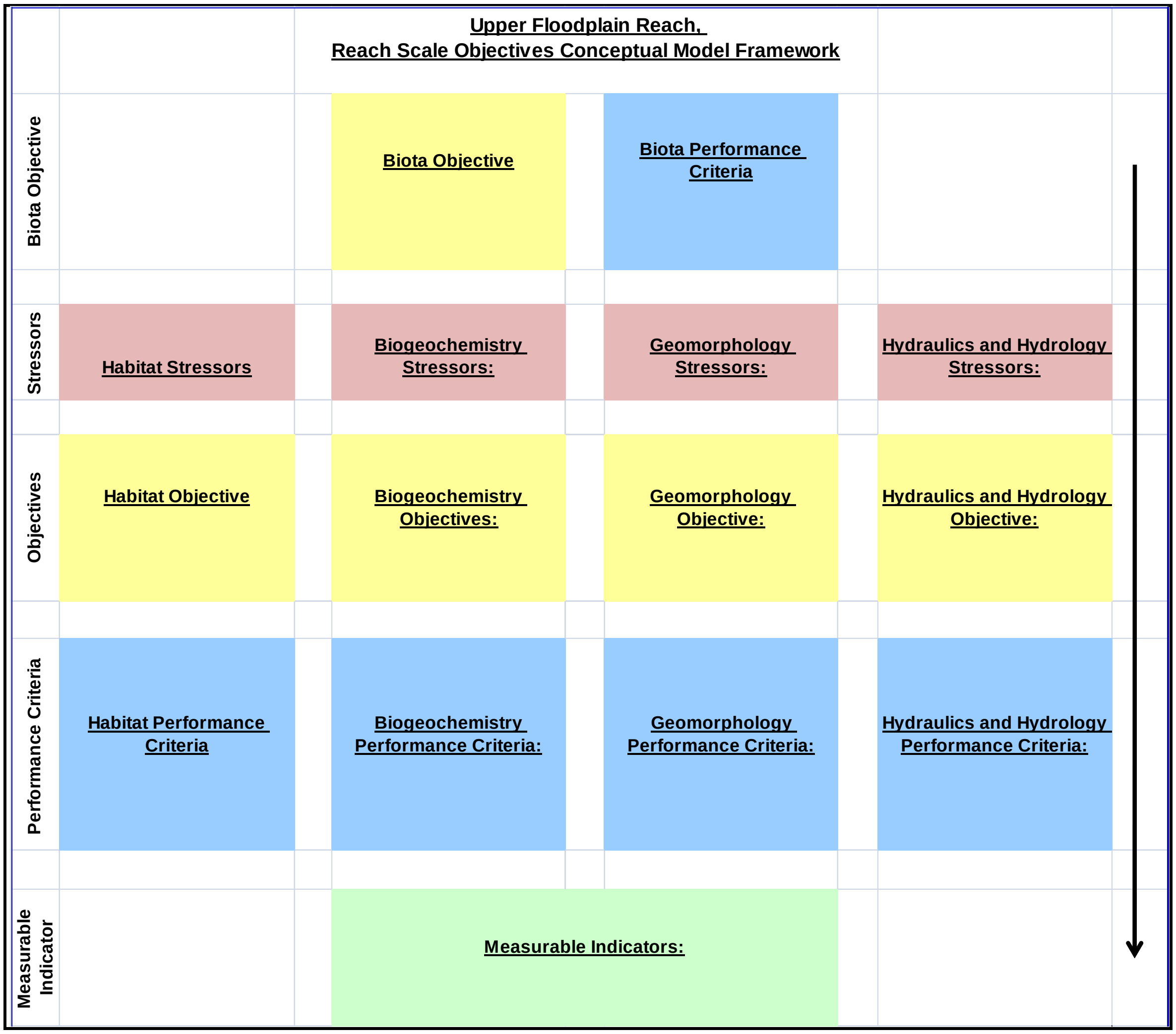


Figure 3-4. Upper Mississippi River System Ecosystem Conceptual Model



Upper Floodplain Reach,
Reach Scale Objectives Conceptual Model Framework

Biota Objective		**Biota Objective**	**Biota Performance Criteria**	
Stressors	**Habitat Stressors**	**Biogeochemistry Stressors:**	**Geomorphology Stressors:**	**Hydraulics and Hydrology Stressors:**
Objectives	**Habitat Objective**	**Biogeochemistry Objectives:**	**Geomorphology Objective:**	**Hydraulics and Hydrology Objective:**
Performance Criteria	**Habitat Performance Criteria**	**Biogeochemistry Performance Criteria:**	**Geomorphology Performance Criteria:**	**Hydraulics and Hydrology Performance Criteria:**
Measurable Indicator		**Measurable Indicators:**		

Figure 3-5. General Conceptual Model for Project Scale Use Helps Illustrate Planning and Analysis Detail

E. ADAPTIVE MANAGEMENT AT THE PROJECT SCALE

The relationship among habitat and biota and physical/chemical processes is partially captured within the conceptual models that have been developed, however the detailed analysis that is needed to improve on the conceptual models and previous spatial analysis will be done once planning and design is initiated on individual projects.

The physical/chemical parameters that consistently showed up in the conceptual models include water level variation (annual and daily), connectivity (both H&H and habitat), and sediment loads either from tributaries to the mainstem or from channels to off-channel areas. All of these parameters may be, and historically have been, altered using restoration actions. Quantifying the existing condition of each of these parameters in project areas and comparing these values to the target future condition is an important step in identifying restoration actions appropriate for a project area. Additional abiotic and biotic parameters will be considered at the project scale to describe habitats, biotic interactions, processes etc.

The linkage between the physical/chemical parameters and the habitat and biota objectives illustrated by the conceptual models helps to inform decision making. Any restoration action or combination of actions can be assessed as to whether the physical/chemical parameters would be moved in the desired direction and whether the desired response in biota is likely to be achieved. Figure 3-6 is a conceptual model illustrating the relationship among project scale habitat objectives, performance criteria, and management actions. In this figure, the project scale habitat objective (diving duck migratory habitat) can be achieved only if certain physical, chemical, and biological criteria are met. These criteria are organized by the EECs of geomorphology, H&H, biogeochemistry, and biota. Management actions that might be taken to meet the criteria and achieve the habitat objective are shown in the boxes on the right side of the diagram. Essentially the management actions alter the geomorphic (connectivity and wind fetch) or H&H (water level variation) characteristics of the project area, to improve biogeochemistry (water clarity) so that that aquatic vegetation will be at optimal levels and provide the needed food requirements for diving ducks during migration. For the sake of clarity, most of the detailed information was left out of this diagram. The PDT working on a project can develop information such as the number of acres of habitat to restore, or the required reduction of inflows or wind fetch. In this conceptual model, island construction could be used to meet several of the geomorphic and H&H criteria.

Conceptual models for islands and the associated biota have evolved through the 1990s to the present in the planning, design, construction, monitoring, and learning experience associated with the award winning Pool 8 Island HREP. Conceptual models were improved as ecosystem simulation models as LTRM and US Fish and Wildlife Service scientists developed a dabbling duck model in 1998 (Fox 1998) to estimate the benefits of islands from Phase I of the project. They then improved simulation models to incorporate other aspects of the conceptual model. The critical physical parameters were wind generated wave effects and river flow from hydraulic models. The improved models then informed the design of the final phase of construction and all the experience gained regarding design, construction, and management are immediately transferable to similar projects. The Pool 8 Islands HREP, and many other projects, has been a test bed for adaptive management implementation derived over 20 years of partnership among managers, scientists, engineers, and the public.

Figure 3-7 is a conceptual model for floodplain forests. It is formatted differently than figure 3-6, but is built on the same principle of linking project scale habitat objectives, performance criteria, and management actions. Determining a common conceptual model for the UMRS has been challenging because each team benefits from building their own models together. Variety drives diversity and innovation, but makes tracking and integration more difficult. This particular model is developed for Reno Bottoms, Minnesota (Pool 9) where hydrologic alterations to spillways and connecting channels could maintain forest diversity. This model and similar efforts at the Huron Island HREP assess the benefits of altering water table and tree elevation relationships. These objectives can be achieved by many actions associated with other Corps projects as well. Dam regulation can be altered to change groundwater stage and channel maintenance activity can generate fill to increase floodplain topographic diversity for example.

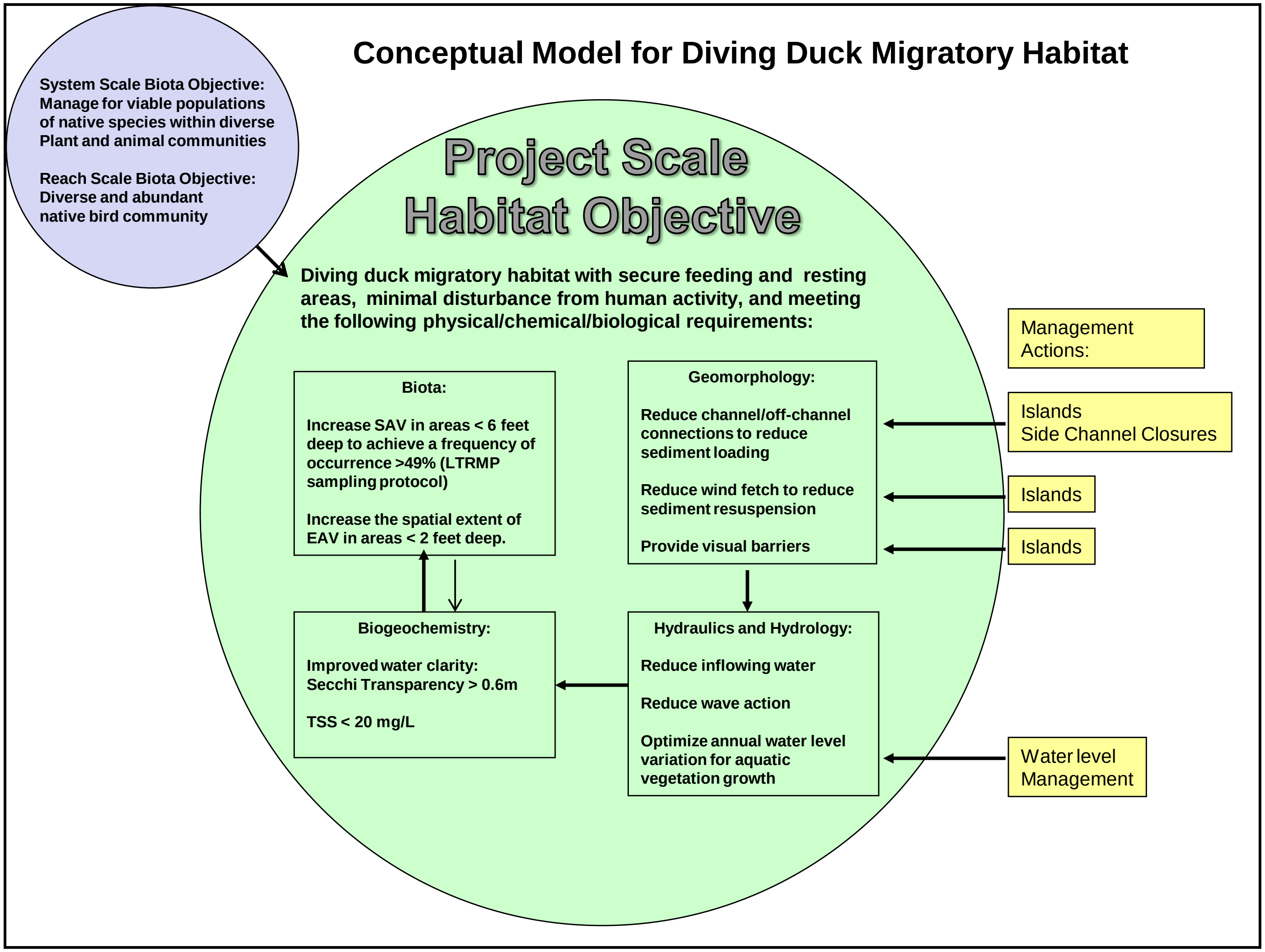
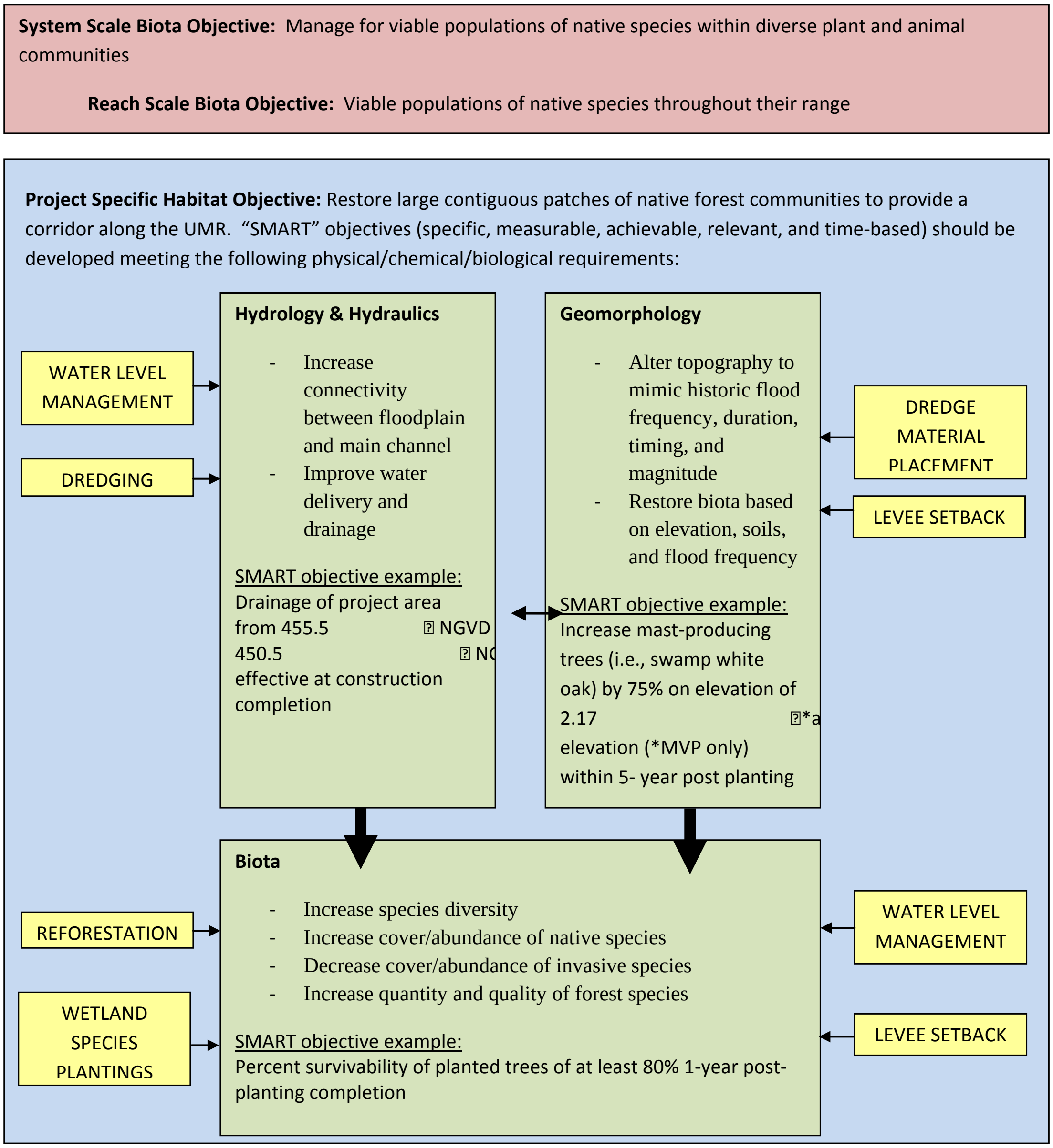


Figure 3-6. Conceptual Model for Diving Duck Migratory Habitat Used To Illustrate the Relationship Among Objectives, Performance Criteria, and Management Actions



System Scale Biota Objective: Manage for viable populations of native species within diverse plant and animal communities

Reach Scale Biota Objective: Viable populations of native species throughout their range

Project Specific Habitat Objective: Restore large contiguous patches of native forest communities to provide a corridor along the UMR. "SMART" objectives (specific, measurable, achievable, relevant, and time-based) should be developed meeting the following physical/chemical/biological requirements:

Hydrology & Hydraulics

- Increase connectivity between floodplain and main channel
- Improve water delivery and drainage

SMART objective example:
Drainage of project area from 455.5 ⍰ NGVD 450.5 ⍰ NC
effective at construction completion

Geomorphology

- Alter topography to mimic historic flood frequency, duration, timing, and magnitude
- Restore biota based on elevation, soils, and flood frequency

SMART objective example:
Increase mast-producing trees (i.e., swamp white oak) by 75% on elevation of 2.17 ⍰*a
elevation (*MVP only) within 5- year post planting

Biota

- Increase species diversity
- Increase cover/abundance of native species
- Decrease cover/abundance of invasive species
- Increase quantity and quality of forest species

SMART objective example:
Percent survivability of planted trees of at least 80% 1-year post-planting completion

Figure 3-7. Conceptual Model for Floodplain Forest Habitat Used To Illustrate the Relationship Among Objectives, Performance Criteria, and Management Actions

Widespread use of conceptual models can help identify relationships among organisms, habitats, and operations that go undetected without a broad perspective. Several recent UMRS adaptive management studies have emphasized conceptual models for large system-wide issues. A draft report for a Pool 18 adaptive management plan for water level management identified conceptual frameworks and studies that could support learning about ecosystem response to drawdowns (USACE 2010). Similarly, a science workshop regarding side channel management in the Middle Mississippi reach also relied heavily on conceptual modeling to illustrate stakeholder visions for the functions supported by side channel habitats (Nestler et al. 2011).

1. Management Actions. PDTs consider unique and important ecosystem characteristics, factors limiting natural processes and the distribution and abundance of biota, project objectives, and performance criteria to develop management actions. The list of objectives and performance criteria that have to be met often suggests that multiple actions need to be taken at spatial scales including the project area, navigation pool, and watershed scales, but UMRR-EMP authorizing language and implementation considerations focus on the project area scale. Physical/chemical parameters that can be directly altered by restoration actions include hydrologic connectivity, seasonal water level variation, topography & bathymetry, wind fetch, bed roughness, bank erodibility, and substrate size. Altering these parameters affects many other physical, chemical, and biological processes. For example, reducing wind fetch reduces sediment resuspension, increases light penetration, increases submerged aquatic vegetation growth, and feeds ducks. Other management actions may be taken that directly affect biota, such as reforestation, managing aquatic nuisance species, and regulating fish and game harvests. Since the project scale objectives and performance criteria describe a partial restoration of natural conditions (e.g., more water level variation, altered connectivity, reduced wind fetch, reduced constituent loads, restoration of habitat quality and distribution, etc.), attaining these objectives will directly contribute to restoring natural river processes. Table 3-2 lists some management actions that might be taken to achieve objectives.

Table 3-2. Linking Ecosystem Objectives and Restoration Actions

Objective	**Restoration Action**
A more natural stage hydrograph	Pool-wide drawdown Backwater drawdown Levee removal
Restored hydraulic connectivity	Backwater restoration Barrier island construction Levee removal Flow manipulation
Increase storage and conveyance of flood water on the floodplain	Levee removal Bridge approaches
Restored backwaters	Backwater dredging Plantings Island construction Flow manipulation Drawdown
Restored secondary channels and islands	Dike alteration Flow manipulation Woody debris Dredging Drawdown Island construction
Restore sediment transport regime so transport, deposition, and erosion rates and geomorphic patterns are w/ acceptable limits	Side-channel closures Seed island Tributary sediment traps Flow manipulation
Improved water clarity	Wave dampening Side-channel closures Drawdown sediment consolidation Plantings Island construction
Naturalize the hydrologic regime of tributaries	
Restored lower tributary valleys	
Reduced sediment loading and sediment resuspension in backwaters	Flow manipulation Wave dampening Drawdown sediment consolidation Sediment trap Plantings
Restored lateral hydraulic connectivity	See above
Water quality conditions sufficient to support native aquatic biota and designated uses	
Restored rapids	Channel border bar construction Side channel manipulation Dam removal Chain-of-Rocks
Restored bathymetric diversity, and flow variability in secondary channels, islands, sand bars, shoals and mudflats	Flow manipulation Dredging
Reduced nutrient loading from tributaries to rivers	
Reduced contaminants loading & remobilizing in-place pollutants	Use mechanical dredging rather than hydraulic
Restored floodplain topographic diversity	Dredged material mgmt Flow manipulation/scour Flow deflectors Island construction
Forest Plan, Floodplain Landscape	Timber stand mgmt Private lands mgmt Plantings Floodplain restoration

2. Project Performance Criteria. Performance criteria associated with each objective should be developed to make the objective more specific and quantitative (e.g., secchi depth should exceed 60 cm in backwaters). Performance criteria are measurable attributes of ecosystem objectives e.g. acceptable range, thresholds, or limits; based on scientific understanding of target future ecological conditions (adapted from Harwell et al. 1999). Performance criteria should be adaptive and adjusted as new information becomes available. Developing performance criteria describing the desired condition of ecosystem parameters is important because it:

a. makes the objectives SMART,

b. represents the accumulated knowledge of river managers and scientists,

c. requires the PDT to assess physical/biological relationships, and

d. promotes project consistency with variation based on site specific conditions and learning opportunities, as opposed to personal design philosophy.

The inability to develop criteria because of a lack of knowledge represents a data need, or the opportunity to learn through adaptive management.

Connectivity, annual water level variation, floodplain elevations, and sediment concentrations are a few parameters that might need to be altered to improve ecosystem conditions. At the project scales where detailed data can be efficiently collected and monitored, additional criteria (e.g. water depth, amount of connected habitat, distribution of aquatic vegetation) will be developed by PDTs. Existing literature and knowledge and the experience of PDT members can be used to quantify these parameters. As is typical in many ecosystems, less is known about the biota than the abiotic conditions, resulting in greater uncertainty with regards to the appropriate rates, magnitudes, and variations for describing processes associated with biota. Of particular importance for planning and designing restoration actions, is knowledge regarding the response of habitat and biota to changes in physical/chemical parameters (i.e. geomorphology, biogeochemistry, and H&H parameters). This is because restoration actions on the mainstem of the river directly alter these physical/chemical parameters to cause a desired response in habitat and biota.

3. Indicators. Ecosystem condition and response to management actions can be characterized by indicators (table 3-3) representing individual EECs or perhaps as a habitat or biological outcome reflecting the condition of several EECs. Physical structure and processes strongly influence habitat structure which supports plant and animal species, but there are also feedbacks (figure 3-3). The LTRM Status and Trends Report 2008 indentified the linkages among system-level objectives and the environmental parameters that they measure (Johnson and Hagerty 2008). LTRM data collection helps identify existing condition of H&H, Biogeochemistry, Geomorphology, Habitat, and Biota in the trend analysis reaches and beyond.

Table 3-3. Ecological Indicators Applicable At Several Spatial Scales For Upper Mississippi River System Essential Ecosystem Characteristics

	Boundary Condition	**Reach Scale**	**Local Scale**
Geomorphology	**Glacial Geology**	• land sediment assemblages • impoundment effects • levee effects • aquatic area change • geomorphic change	• elevation • soil • geomorphic change
H&H	**Climate/Discharge** • magnitude • frequency • timing • duration • rate of change	**Water Surface Elevation** • magnitude • frequency • timing • duration • rate of change	• flow distribution • direction • depth • velocity • inundation magnitude • frequency • timing • duration • rate of change • pool scale hydrologic gradient
Biogeochemistry	• basin geology • basin land cover • non-point pollution	**Major Watershed** • geology • land cover • non-point pollution	• nutrient abundance • water clarity • dissolved oxygen • sediment quality • point source pollution • non-point pollution
Habitat	• climate • biodiversity • geomorphology • hydrology	• regional climate • eco-regions • land use • ecosystem/community type • disturbance	• land cover • ecosystem/community type • geomorphology • hydrology • aquatic areas
Biota	• biodiversity • long distance migrants	• populations • communities	• species composition
Biotic Processes	• biochemistry	• climate • genetics	• production • growth

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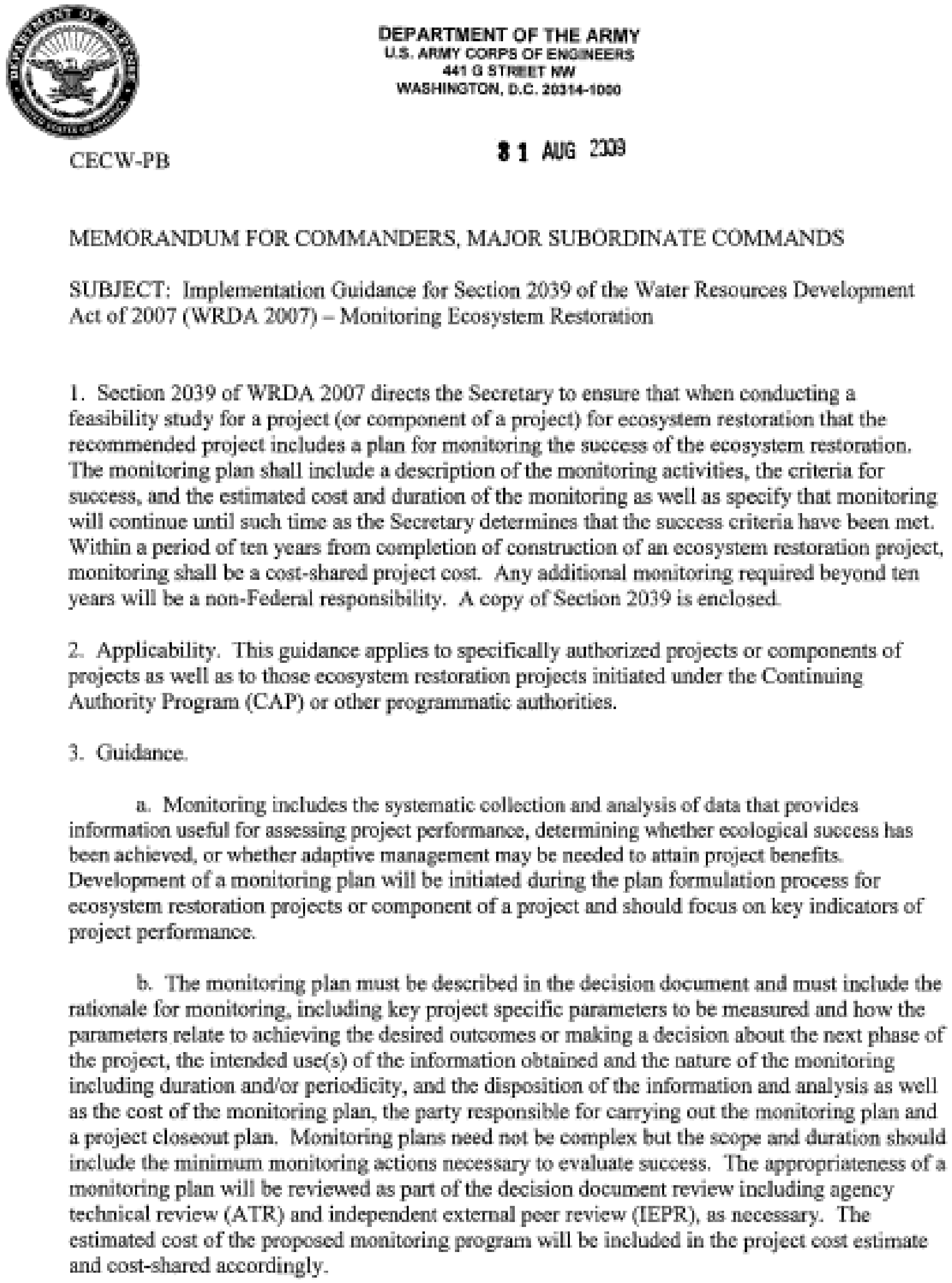
Appendix 3-A.



DEPARTMENT OF THE ARMY
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WASHINGTON, D.C. 20314-1000

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

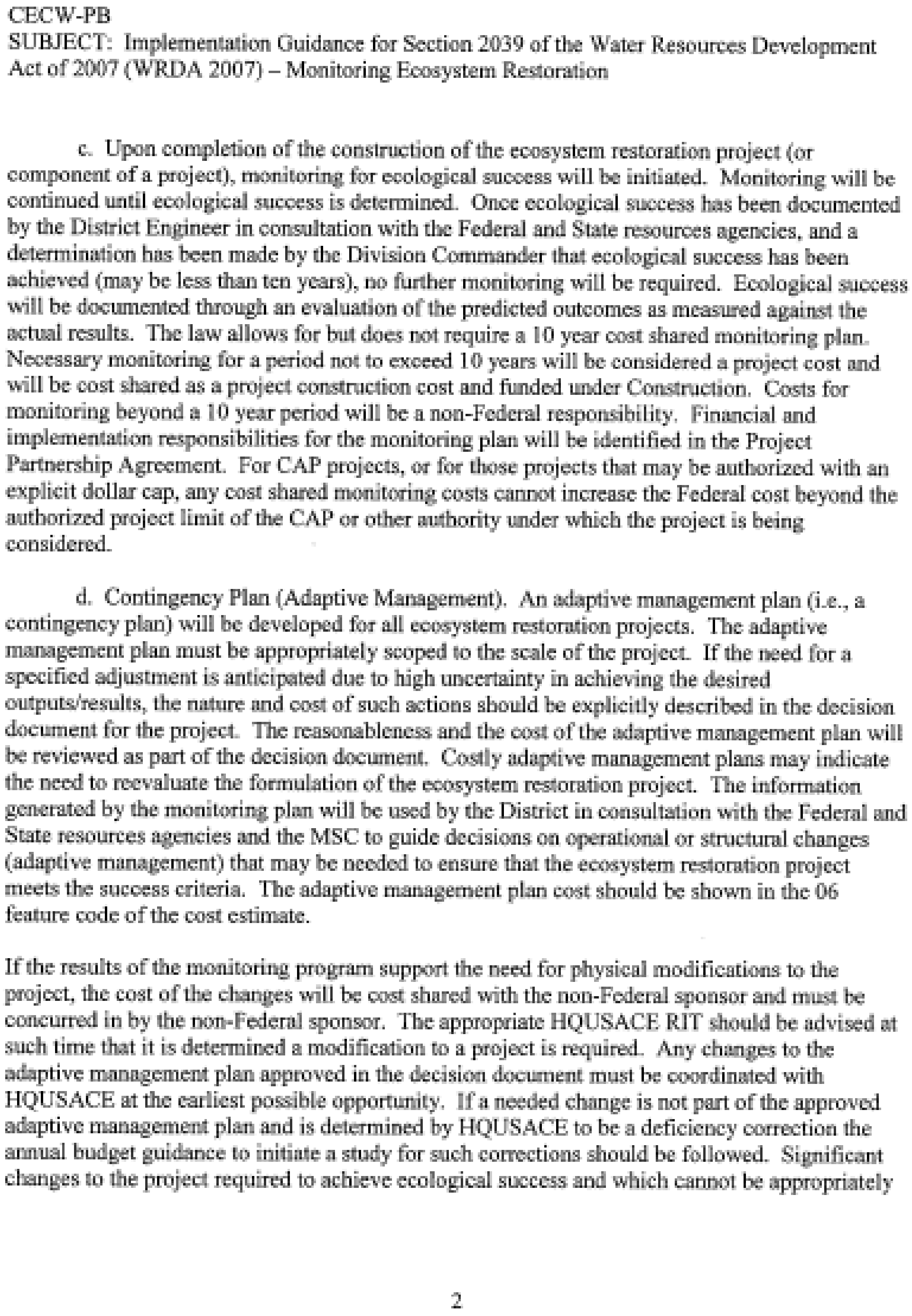
1. Section 2039 of WRDA 2007 directs the Secretary to ensure that when conducting a feasibility study for a project (or component of a project) for ecosystem restoration that the recommended project includes a plan for monitoring the success of the ecosystem restoration. The monitoring plan shall include 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.

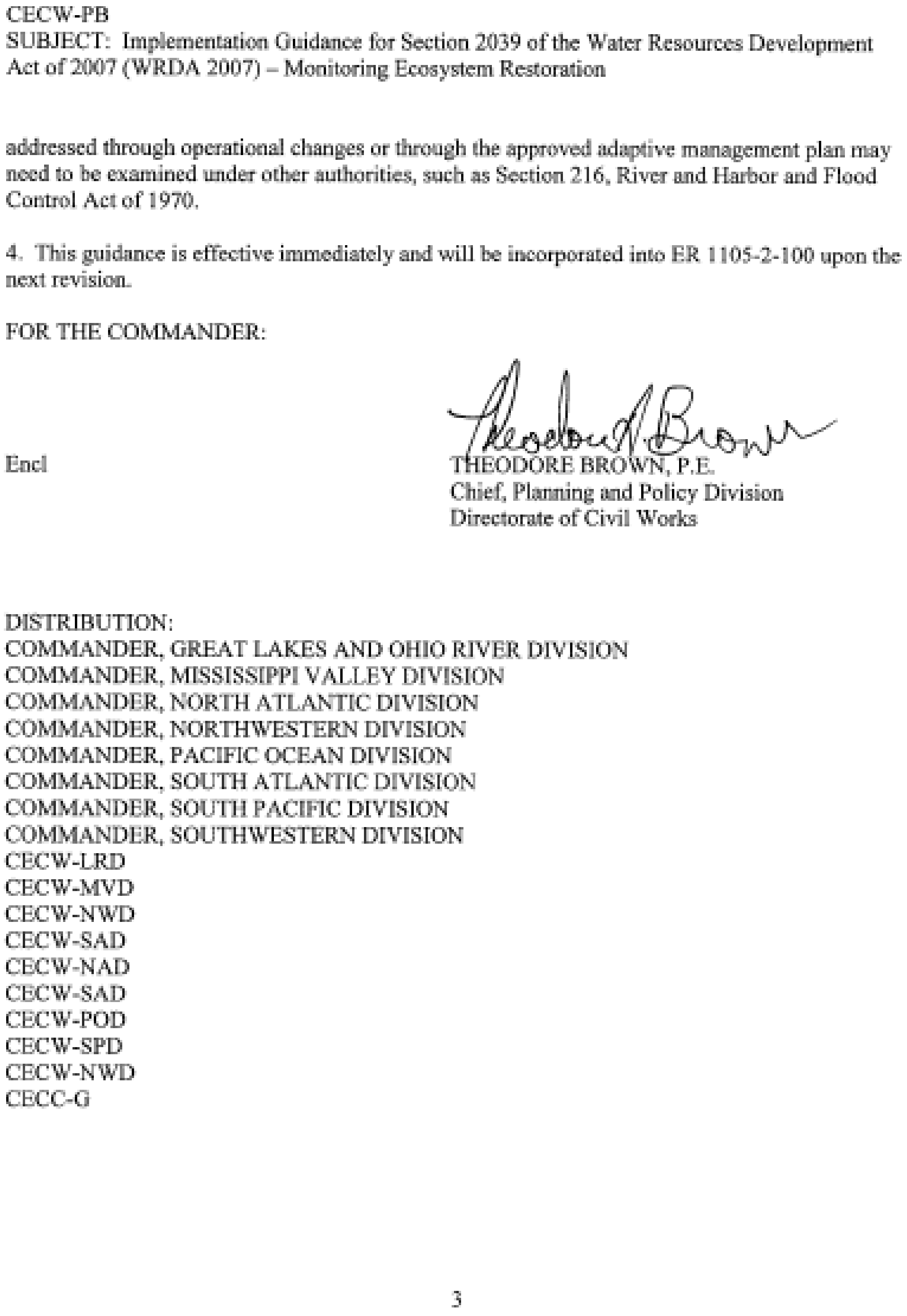
b. The monitoring plan must be described in the decision document and must include the rationale for monitoring, including key project specific parameters to be measured and how the parameters relate to achieving the desired outcomes or making a decision about the next phase of the project, the intended 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.



c. Upon completion of the construction of the ecosystem restoration project (or component of a project), monitoring for ecological success will be initiated. Monitoring will be continued until ecological success is determined. Once ecological success has been documented by the District Engineer in consultation with the Federal and State resources agencies, and a determination has been made by the Division Commander that ecological success has been achieved (may be less than ten years), no further monitoring will be required. Ecological success will be documented through an evaluation of the predicted outcomes as measured against the actual results. The law allows for but does not require a 10 year cost shared monitoring plan. Necessary monitoring for a period not to exceed 10 years will be considered a project cost and will be cost shared as a project construction cost and funded under Construction. Costs for monitoring beyond a 10 year period will be a non-Federal responsibility. Financial and implementation responsibilities for the monitoring plan will be identified in the Project Partnership Agreement. For CAP projects, or for those projects that may be authorized with an explicit dollar cap, any cost shared monitoring costs cannot increase the Federal cost beyond the authorized project limit of the CAP or other authority under which the project is being considered.

d. Contingency Plan (Adaptive Management). An adaptive management plan (i.e., a contingency plan) will be developed for all ecosystem restoration projects. The adaptive management plan must be appropriately scoped to the scale of the project. If the need for a specified adjustment is anticipated due to high uncertainty in achieving the desired outputs/results, the nature and cost of such actions should be explicitly described in the decision document for the project. The reasonableness and the cost of the adaptive management plan will be reviewed as part of the decision document. Costly adaptive management plans may indicate the need to reevaluate the formulation of the ecosystem restoration project. The information generated by the monitoring plan will be used by the District in consultation with the Federal and State resources agencies and the MSC to guide decisions on operational or structural changes (adaptive management) that may be needed to ensure that the ecosystem restoration project meets the success criteria. The adaptive management plan cost should be shown in the 06 feature code of the cost estimate.

If the results of the monitoring program support the need for physical modifications to the project, the cost of the changes will be cost shared with the non-Federal sponsor and must be concurred in by the non-Federal sponsor. The appropriate HQUSACE RIT should be advised at such time that it is determined a modification to a project is required. Any changes to the adaptive management plan approved in the decision document must be coordinated with HQUSACE at the earliest possible opportunity. If a needed change is not part of the approved adaptive management plan and is determined by HQUSACE to be a deficiency correction the annual budget guidance to initiate a study for such corrections should be followed. Significant changes to the project required to achieve ecological success and which cannot be appropriately



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

addressed through operational changes or through the approved adaptive management plan may need to be examined under other authorities, such as Section 216, River and Harbor and Flood Control Act of 1970.

4. This guidance is effective immediately and will be incorporated into ER 1105-2-100 upon the next revision.

FOR THE COMMANDER:

Encl

THEODORE BROWN, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works

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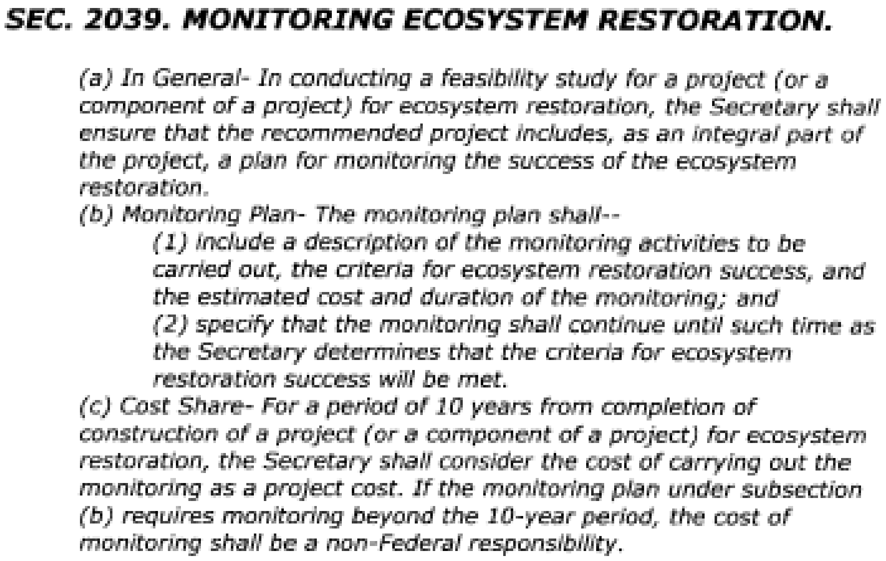

SEC. 2039. MONITORING ECOSYSTEM RESTORATION.

(a) In General- In conducting a feasibility study for a project (or a component of a project) for ecosystem restoration, the Secretary shall ensure that the recommended project includes, as an integral part of the project, a plan for monitoring the success of the ecosystem restoration.

(b) Monitoring Plan- The monitoring plan shall--

(1) include a description of the monitoring activities to be carried out, the criteria for ecosystem restoration success, and the estimated cost and duration of the monitoring; and

(2) specify that the monitoring shall continue until such time as the Secretary determines that the criteria for ecosystem restoration success will be met.

(c) Cost Share- For a period of 10 years from completion of construction of a project (or a component of a project) for ecosystem restoration, the Secretary shall consider the cost of carrying out the monitoring as a project cost. If the monitoring plan under subsection (b) requires monitoring beyond the 10-year period, the cost of monitoring shall be a non-Federal responsibility.