USACE Adaptive Management Workshop

July 25-28, 2017

Meeting Materials:

Adaptive Management Workshop Packet

MRGESCP Overview [presentation]

RGSM Conceptual Models

Adaptive Management Plan Development (Step 2 Plan/Design) [presentation]

Adaptive Management Workshop Presentation

Conceptual Models [presentation]

Adaptive Management Governance, Data Management, Reporting and Communications [presentation]

Facilitation and Communication and Adaptive Management [presentation]

Team Conceptual Ecological Models

Missouri River Recovery Program Adaptive Management [presentation]

Step 1 – Evaluation (Related Topics) [presentation]

Adaptive Management Basics [presentation]

Upper Mississippi River Adaptive Management [presentation]

Adaptive Management Plan Development – Basics [presentation]

Adaptive Management Costs [presentation]

Step 3 – Planning for Implementation of Adaptive Management [presentation]

Adaptive Management in Civil Works [presentation]

Monitoring in Adaptive Management for USACE Ecosystem Restoration and Natural Resource Management [presentation]

Adaptive Management Evaluation [presentation]

Adaptive Management for Ecosystem Restoration and Natural Resource Management: USACE Projects, Programs and Installations [poster]

Adaptive Management for USACE Ecosystem Restoration & Natural Resource Management: Programs, Projects and Installations

25-28 July, 2017
Albuquerque, NM

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Adaptive Management Implementation Workshop

July 25-28, USACE Albuquerque District

Adaptive Management (AM) is a systematic, practical approach to improving actions, procedures, and policies related to ecosystem restoration and natural resource management. AM provides a structured process for learning which management actions best meet objectives and for reducing the most important management uncertainties. In its most effective form, an experimental approach is used to test clearly formulated hypotheses about important, though uncertain, ecological responses to management actions.

This interactive workshop provides participants with guidance and tools for rigorous AM implementation with the goal of stimulating interest in the approach and providing ideas on how the principles of AM can be integrated into day-to-day activities and longer- term planning around ecosystem restoration and installation management. This workshop is created, presented and facilitated by Dr. Craig Fischenich, Sarah Miller and Courtney Chambers of ERDC Environmental Laboratory (EL), with Michael Porter of USACE Albuquerque District, Craig Fleming of USACE Omaha District, Dr. Chuck Theiling of USACE Rock Island District and Jeff Trulick of USACE Headquarters, Office of Water Project Review. Selected regional partners are also providing key concept presentations (see Teaching Team and Contributors, page 5). Presentations will provide examples from existing projects and programs to illustrate challenges and approaches for successful implementation of AM.

Workshop Objectives

(1) Provide knowledge for effective participation in AM processes
(2) Learn what AM is [*and what it isn't*] and when AM is most useful [*and when it may not be useful or appropriate*]
(3) Understand the policies, basic process and key elements of AM
(4) Convey examples of AM [*who is doing AM, where, why and how*]
(5) Discover enabling and inhibiting factors related to governance and decision making
(6) Learn relevant techniques and standards of practice [*focus on developing an AM Plan*]
(7) Explore new tools and guidance to support AM implementation

Strategy

Facilitators will use Lectures, Handouts and targeted Exercises to present key principles and practices for AM. Case studies will serve as examples and demonstrate that alternative approaches are sometimes warranted. Classroom exercises allow participants to apply concepts to relevant current projects, while promoting dialogue and cross-learning among participants.

Agenda

Day One – Half Day, PM Start

Session 1 - AM Basics		
12:30-1:00	*Arrival, Sign In, Pick Up Materials*	
1:00-1:30	Opening Remarks, Exercise #1	Welcome; Introductions; Logistics; Agenda; Handout 1: Adaptive Management Definition
1:30-1:45	AM Basics - Non-Federal Partners	Non-Federal partners perspective
1:45-2:05	AM Basics - USACE District SPA	Corps Districts and SPA-specific perspective
2:05-2:45	AM Basics - USACE Nationwide	ERDC/HQ perspective; AM Definition; History; Role & Benefits; AM Cycle; Key Principles; Guidance & Resources
2:45-3:00	Exercise #1, continued; Discussion	Refer to Handout 1 and presentations
3:00-3:15	*Break*	
3:15-3:45	Corps Policy Overview	WRDA '07, Sec. 2036 & 2039
3:45-4:15	Case Study: Upper MS River	AM Cycle as applied to UMRR, Handout 2: Adaptive Management Steps
4:15-4:30	Exercise #2	See Handouts 1 and 2
4:30-4:45	Fieldtrip Orientation	Description & Logistics
4:45-5:00	*Review & Wrap Up*	Key Points; Self-Assessment

Day Two – Full Day

Session 2 - Field Trip		
7:45-8:00	*Arrive, Sign In, Board Vans*	
8:00-8:30	Travel to Rio Grande Nature Center	Description en route
8:30 - 12:00	Rio Grande Nature Center	Recreation features, floodplain restoration
	Visit USACE, ISC, USBR sites	Recreation features, channel restoration, levee restoration
	Tingley Ponds and Wetlands	Habitat restoration for wetlands, ponds, floodplain
12:00-1:00	*Picnic Lunch, Return to District*	Jason's Deli Box Lunch or Pack your own

Session 3 - Evaluate/Plan/Design Phase		
1:00-2:00	Evaluations Preceding AM	Objectives; CEMs; Identifying Uncertainties; Role of Modeling; Requirements for AM; Applicable Programs; Tools
2:00-3:00	Exercise #3, break into groups	Handout 3: MRG Conceptual Model Elements
3:00-3:15	*Break*	
3:15-4:00	Planning and Design Considerations	When to Consider AM; Passive vs. Active; AM & Corps Planning Process; AM & NEPA or ESA; Institutional Barriers
4:00-4:30	Exercise #4	Handout 4: Enabling and Inhibiting Factors
4:30-5:00	*Review & Wrap Up*	Key Points; Self-Assessment

Day Three – Full Day

Session 4 - AM Plan, Implementation, Monitoring & Assessment		
7:45-8:00	*Arrive, Sign In*	
8:00-9:00	AM Plan Development	Content; Development Approach, Resource Requirements; Review & Coordination; Examples; Handout 5
9:00-10:00	Case Study: Missouri River Recovery	AM Cycle as applied to MRRP
10:00-10:15	*Break*	
10:15-11:00	Cost of AM	Estimating and Reporting Costs; Considerations
11:00-11:30	Lessons from other AM Programs	Review Handout 5
11:30-1:00	*Lunch on your own*	
1:00-2:00	Implementing and Monitoring	Phased Implementation; O&M vs AM; Monitoring Program Development; Level of Detail; QAPPs
2:00-2:30	Assessment	Evaluation Needs (Project vs. Program); Tools & Techniques; Assessing AM Effectiveness
2:30-2:45	*Break*	
2:45-4:30	Exercise #5	Applying Adaptive Management
4:30-5:00	*Review & Wrap Up*	Key Points; Self-Assessment

Day Four – Half Day, AM Start

Session 5 - Decision Phase, Information Management		
7:45-8:00	*Arrive, Sign In*	
8:00-9:15	Governance and Decision Making	Alternative Structures; Collaborative AM; Lessons Learned
9:15-10:15	Data Management, Reporting and Communications	Alternative ways to manage and share information; Requirements and Limitations
10:15-10:30	*Break*	
Session 6 - Wrap Up		
10:30-11:30	Summary, Review, Q&A	Workshop overview; open dialogue
11:30-11:45	Workshop Evaluation	Complete forms from all participants
11:45	*Adjourn*	

Logistics

Attendance

Please RSVP to Michael Porter at Michael.D.Porter@usace.army.mil by Friday July 21st.
The list of attendees will be provided to security for issuing a visitor badge.

Arrival

Please make sure to arrive 15-30 minutes early to check in to the building, locate the classroom, pick up materials and sign in so we can begin promptly.

Location

The course will be held in Room 119C at the U.S. Army Corps of Engineers Albuquerque District Office, 4101 Jefferson Plaza NE, Albuquerque, NM.

Food & Refreshments

- Vending machines are located across from the classroom
- Lunch for the Wednesday fieldtrip TBD
- Thursday lunch on your own

Teaching Team & Contributors

Sarah J. Miller

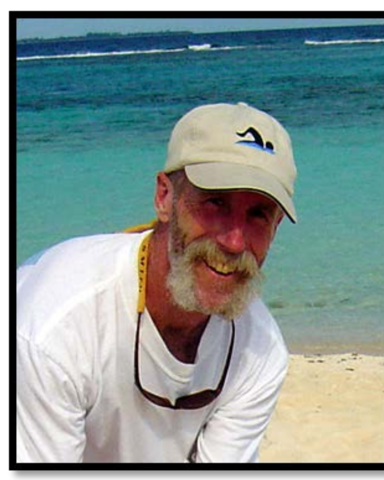
Office: 601-634-5247, Sarah.J.Miller@usace.army.mil

Sarah is an ERDC Environmental Laboratory Principle Investigator with 20 years combined professional experience in stream and watershed management and research. Sarah joined ERDC as a Research Ecologist and Fluvial Geomorphologist for the U.S. Army Engineer Research and Development Center (ERDC) Environmental Laboratory nine years ago. Her work has included technical lead for watershed assessment studies, applied research including appropriate identification, development and use of reference condition information in ecosystem restoration, identifying stability thresholds and performance standards for flexible lining materials in stream and slope restoration applications, and targeted field and laboratory research and technical assistance for location optimization and development of shoreline stabilization and stormwater best management practices in support of the USEPA's Chesapeake Bay Sediment and Nutrient TMDL.

Sarah is currently pursuing a PhD in Ecohydrology in the Department of Earth and Environmental Science at New Mexico Institute for Mining and Technology, NM, using coupled hydrodynamic surface water and vegetation succession models to study the interactions between riparian vegetation community characteristics and flood dynamics in the Jemez River, a perennial mountain stream in semi-arid northern NM.

J. Craig Fischenich, PhD, PE

601-634-3449, Craig.J.Fischenich@usace.army.mil



Craig Fischenich is a Senior Research Civil Engineer with the Engineer Research and Development Center's (ERDC) Environmental Laboratory in Vicksburg, MS. He has over 35 years of experience in water resources engineering and specializes in research, design and implementation of aquatic ecosystem restoration projects. Dr. Fischenich has authored several publications on adaptive management and is a lead author for the Corps' Adaptive Management Implementation Guidance. He has served in a lead role in the development of the adaptive management programs for the Louisiana Coastal Authority and the Missouri River Recovery Program, has prepared the AM plans for a number of CAP projects and for non-DOD clients, and currently sits on the Adaptive Management Board for the ACF.

Charles H. Theiling, Ph.D.

309-794-5636, Charles.H.Theiling@usace.army.mil

As a Corps project biologist Dr. Theiling supports multiple Upper Mississippi River navigation, ecosystem restoration, and flood control projects. He specializes in environmental modeling and benefits analysis. Recent projects included studies to assess impacts of navigation expansion, watershed restoration and management of environmental flows, and beneficial use of dredged material. As a Corps Regional Technical Specialist Dr. Theiling works as a research scientist seeking innovative solutions environmental management. He focuses on reference condition analysis and conceptual modeling to establish environmental management objectives and then develop projects and adaptive management monitoring to evaluate their effectiveness. Current research considers levee setbacks for climate adaptation, ecosystem goods and services, and regional sediment management.

Jeff Trulick

202-761-1380, Jeff.Trulick@usace.army.mil

Jeff Trulick is a biologist who has been with the Corps for 25 years. He began his career in Baltimore District's Regulatory Branch in 1992 and moved to their Planning Division in 1998, serving in a variety of roles including NEPA Specialist, Lead Planner, project manager and Environmental and Economics team leader. Jeff also has over a year of experience with south Florida restoration projects. Since 2008, Jeff has been at USACE Headquarter (HQ) in the Office of Water Project Review, conducting policy reviews on major Civil Works projects. He is also the current President of the Society of Wetland Scientists Mid Atlantic Chapter.

Courtney Chambers

601-988-5318, Courtney.E.Chambers@usace.army.mil

Courtney Chambers joined the U.S. Army Engineer Research and Development Center (ERDC) Environmental Laboratory in 2009 as a research ecologist to support technology transfer for ecosystem restoration research. She supports a variety of projects in web content development, webinar series hosting, workshop coordination and facilitation services. In addition, she coordinates and administers the annual reporting of USACE Threatened and Endangered Species costs and works with USACE Invasive Species Management Leadership Team to estimate the costs of invasive species to the Corps. Courtney holds a Bachelor of Science degree in Rangeland Ecology and Management and a Master's degree in Agricultural Economics from Texas A&M University.

Craig Fleming

402-667-2880, Craig.A.Fleming@usace.army.mil

Craig has worked for the USACE Threatened and Endangered Species Section and Integrated Science Program for the Missouri River Recovery Program (MRRP) since 2003. In his position Craig works with state and federal entities, and stakeholders to develop processes and products to facilitate learning and progress towards recovery program objectives.

Craig is a member of the Integrated Science Program (ISP) and leads the Adaptive Management Team, and is a member of the MRR Management Plan PDT. In this role Craig works closely with Corps of Engineers personnel, U.S. Fish &Wildlife Service staff, and academics (as well as other important stakeholders) to further the development and implementation of the MRRP adaptive management strategy. Before working in the Missouri River Basin, Craig worked for the U.S. Fish & Wildlife Service in California on endangered species management, habitat restoration and monitoring. As a Habitat Restoration Coordinator for the Anadromous Fish Restoration Program (AFRP), Craig was involved in working with partners and stakeholders to establish new ways of doing business in the resource management world to facilitate both the economic and ecological needs of the watersheds.

Michael Porter

505-342-3264, Michael.D.Porter@usace.army.mil

Mick Porter is a Certified Fishery Professional with the Environmental Resources Section in the USACE Albuquerque District. He has worked on the understanding habitat and the ecology of the endangered Rio Grande Silvery Minnow since 2001. He previously worked with the US Bureau of Reclamation prior to his current position.

Mick is currently focused on ecosystem restoration and management emphasizing Adaptive Management, Climate Change, and Habitat Restoration on the Rio Grande. This includes evaluating how the Rio Grande silvery minnow use of floodplain habitat for spawning and rearing, the interaction of hydrology and fluvial geomorphology on floodplain habitat, and ultimately leading to population dynamics. Mick earned his doctorate is in fisheries biology from the University of Oklahoma, with a Bachelor of Science and Master's degrees from Eastern New Mexico University.

Todd Caplan

505-830-6074, Todd@gsanalysis.com

Todd Caplan is the Restoration Program Director for GeoSystems Analysis. He has over 20 years of experience integrating scientific disciplines of vegetation ecology, soil science and hydrology in the design, implementation, monitoring and adaptive management of large-scale river and arid-land restoration programs. Prior to working as a consultant, Todd served as the Natural Resources Director for a 90,000 acre American Indian reservation where he initiated and managed grant funded watershed restoration programs. Since 2002, he has worked as a consultant to support federal, state and private sector clients with addressing complex watershed management and restoration challenges. His work has included burned area rehabilitation on wildlife refuges in Arizona and New Mexico, developing tropical forest restoration programs in Papua New Guinea, and leading large-scale floodplain habitat restoration programs throughout the Southwest. Much of Todd's experience over the past 12 years has involved managing interdisciplinary teams of scientists with applying existing data and implementing new research to advance endangered species habitat restoration along the Middle Rio Grande (MRG) in New Mexico.

Debbie Lee

(505) 219-53090, dlee@west-inc.com

Debbie Lee is the Program Manager for the Middle Rio Grande Endangered Species Collaborative Program, and a Facilitator/Mediator with WEST, Inc. Ms. Lee has over 10 years of experience in the stakeholder and public engagement field, focusing on facilitation of highly technical and complex policy issues. She has a broad range of project management experience related to collaborative and deliberative processes, and has managed a range of projects, from one-off engagement meetings to ongoing group facilitation. She understands and is committed to the integrity of each project, and adheres to the principles of best available science, impartiality, and transparency. She is adept at translating scientific and academic language of varying disciplines, and facilitating the conversation amongst scientists, decision-makers, managers, and the public. Her work has been in many different issue areas, including safe drinking water, watershed planning and management, food safety, natural resource policy, and toxicology.

Handout 1: Defining Adaptive Management

Selected definitions of Adaptive Management. Full citations are in the reading list (HO #6).

Definitions	Source / Citation
AM is a structured process of learning by doing that involves more than simply better ecological monitoring and response to unexpected management impacts. It should begin with a concerted effort to integrate existing interdisciplinary experience and scientific information into dynamic models that attempt to make predictions about the impacts of alternative policies.	Walters, 1997. Challenges in Adaptive Management of Riparian and Coastal Ecosystems.
AM is an approach to managing complex natural systems that builds on learning – based on common sense, experience, experimenting, and monitoring – by adjusting practices based on what was learned.	Bormann et al., 1999. AM. In: Ecological Stewardship: A common reference for ecosystem management.
AM is a systematic process for addressing the uncertainties of resource management policies by implementing the policies experimentally and documenting the results.	MacDonald et al., 1999. AM Forum: Linking Management and Science to Achieve Ecological Sustainability.
AM is a structured method for "learning by doing" that includes establishing clear goals, defining practices to achieve those goals, implementing the practices, monitoring the outcome of the practices, assessing how those practices are succeeding relative to the goals, and adjusting management in response to the assessments. It is designed to address questions such as: Where do we want to go? How do we get there? How do we know if we're there? If we're not there, how do we change to improve?	Kremsater, Perry and Dunsworth. 2002. Forest Project Technical Project Summary: Adaptive Management Program.
AM treats actions and policies as experiments that yield learning (it mimics the scientific method: specifies hypotheses, highlights uncertainties, structures actions to expose hypotheses to field tests, processes and evaluates results, and adjusts subsequent actions in light of those results), and embraces risk and uncertainty as opportunities for building understanding that might ultimately reduce their occurrence.	Stankey et al., 2003. Adaptive Management and the Northwest Forest Plan: Rhetoric and Reality.

Definitions	Source / Citation
AM is an approach to management that demands: (a) explicit forecasts of system behavior under a chosen action set; (b) systematic monitoring during action implementation; (c) analysis of reasons for discrepancies between expected and actual systembehavior in response to the implemented actions; (d) re-planning with a new forecasting exercise, etc.	Duinker, P.N. and L.M. Trevisan. 2003. Adaptive Management: Progress and Prospects for Canadian Forests.
AM is "learning by doing" with the addition of an explicit, deliberate and formal dimension to framing questions and problems, undertaking experimentation and testing, critically processing results, and reassessing the policy context that originally triggered investigation in light of the newly acquired knowledge. The concept of learning is central to AM. It is a process to accelerate and enhance learning based on the results of policy implementation that mimics the scientific method: experimentation is the core of adaptive management, involving hypotheses, controls and replication. It is also irreducibly socio-political in nature.	Stankey, Clark and Bormann, 2005. Adaptive Management of Natural Resources: Theory, Concepts, and Management Institutions.
AM is a formal process for continually improving management practices by learning from the outcomes of operational and experimental approaches. Four elements of this definition are key to its utility. First, it is adaptive, and intended to be self-improving. Second, it is a well-designed, formal approach that connects the power of science to the practicality of management. Third, it is an on-going process for continually improving management, so the design must connect directly to the actions it is intended to improve. Fourth, although experimental approaches can be incorporated into adaptive management effectively, operational approaches and scales are emphasized to permit direct connection to the efforts of managers	Bunnell et al., 2007. Forestry and biodiversity - learning how to sustain biodiversity in managed forests.

Exercise 1: Defining Adaptive Management

Q1: How would you describe/define Adaptive Management based on your current understanding?

Q2: Based on the presentations and definitions on Handout 1, what are some of the key characteristics of Adaptive Management? What makes Adaptive Management unique?

Q3: Looking back on your response to Q1, how has your understanding about Adaptive Management changed since then? What key things have you learned so far?

Exercise 2: Managing Uncertainties

Q1: Below are examples of management uncertainties (phrased as questions). Go through this list and note whether you believe each question is a good candidate for Adaptive Management with a Y (yes) or N (no). If not, make a note why you think AM would not be appropriate.

Management Question	AM? Y / N	If NO, note why
(1) Where are salmon spawning gravel impacts by forestry most significant, and what can be done to minimize them?		
(2) How effective are access management strategies (e.g., road deactivation) at reducing angling pressure on lake trout populations?		
(3) What is the rate of expansion or decline in invasive species in different areas and ecosystems?		
(4) What is the effectiveness of alternative management practices in dealing with invasive alien species, and what factors lead to the most consistent and lasting results?		
(5) Where will climate change have the largest impacts on marine ecosystems along the Atlantic coast? Where might we expect the greatest shift in habitats and species assemblages?		
(6) What is the best climate-based riparian restoration strategy to increase resiliency of lotic ecosystems to the impacts of climate change?		
(7) Can an endangered whale population tolerate increased whale- watching pressure (number/density/proximity/movement of boats)?		
(8) What alternative management strategies for harvesting salmon in mixed-stock fisheries are best to protect population diversity and weak stock health?		
(9) What is the biodiversity baseline (to inform limits of acceptable change and future targets) of a key marine ecosystem?		
(10) What is the optimal flow management strategy for a hydropower system to protect downstream fish spawning and rearing habitat?		

Exercise 2 Continued: Considerations for AM Uncertainties

Q2: Based on your responses in the previous table, what are some of the cross-cutting considerations of situations when you would want to apply Adaptive Management? Alternatively, what are some of the considerations of situations when you would NOT want to apply Adaptive Management?

Q3: Describe a management uncertainty relevant to you and your work, and for which it would be appropriate to apply Adaptive Management. Use a real or hypothetical example.

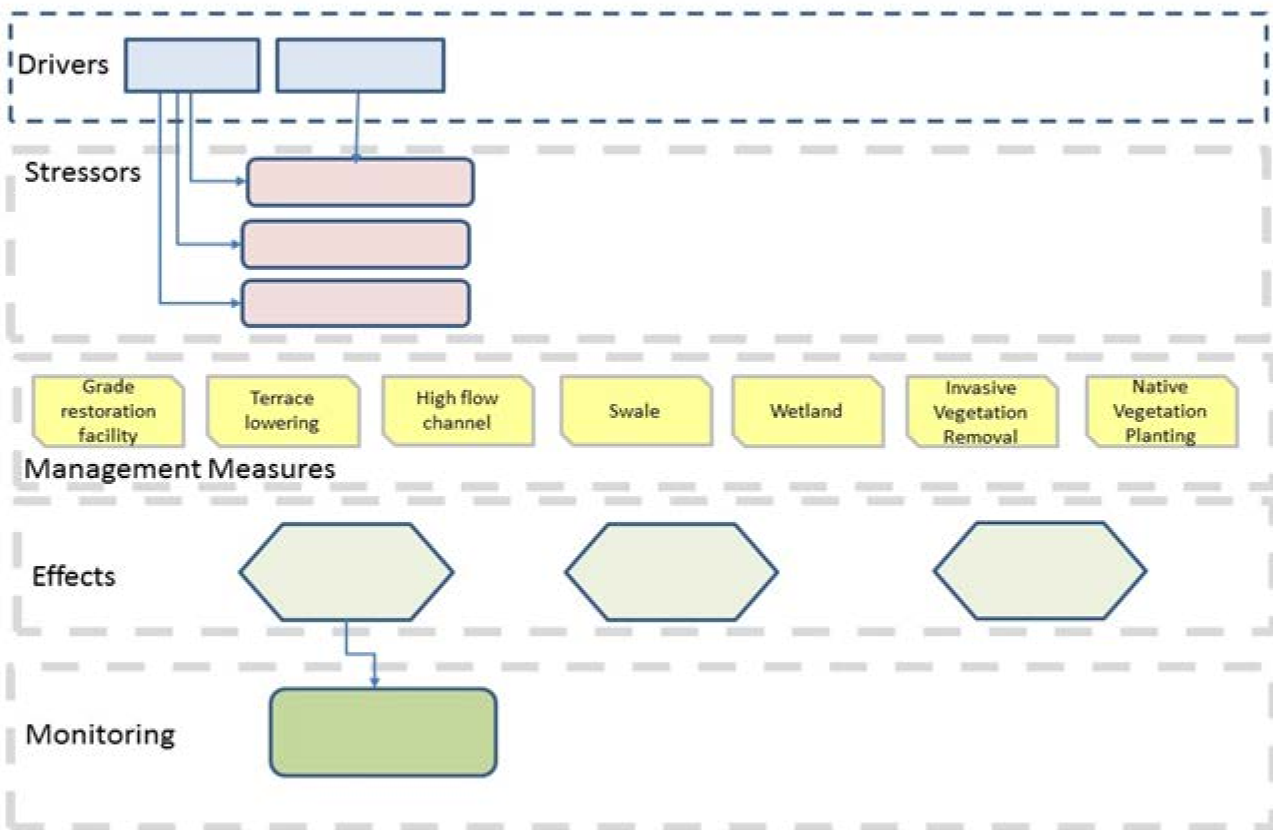
Note: To help you identify a management uncertainty, think about the alternative management actions available to a decision maker, management objectives that a decision maker is trying to achieve, the knowledge gaps that affect a decision maker's ability to make the best choice when seeking to achieve those objectives, and the ability of the decision maker to affect adjustments to the management action.

Handout 2: Steps and Elements of Adaptive Management[1]

AM Steps	Ideal Elements within each Step
Step 1: Assess and Define the problem	• Clearly state management goals and objectives • Involve scientists, stakeholders, managers • ID spatial / temporal bounds • Build conceptual models • ID key uncertainties (what are the management questions?) • Consider need/potential for AM (three screening criteria) • Articulate hypotheses to be tested • Explore alternative management actions (experimental "treatments") • ID relevant metrics and measurable indicators • Explicitly state assumptions • State up front how what's learned will be used
Step 2: Plan & Design	• Consider implications of AM to NEPA • Formulate alternatives (involve stakeholders) • Use active AM when possible; passive AM is OK • Predict outcomes using metrics related to objectives • Estimate costs (including AM costs considering contrasts, replications, controls, monitoring, assessment, and potential remedial actions) • Consider contingency plans and next steps under alternative outcomes • Compare alternatives, contrasting with and without AM • Develop a formal AM plan (determine governance structure, develop a monitoring plan with statistical advice, develop a data management, communications & reporting plan, etc.) • Get the plan peer-reviewed • Obtain multi-year budget commitments
Step 3: Implement	• Implement contrasting treatments • Implement as designed (or document unavoidable changes) • Monitor the implementation
Step 4: Monitor	• Implement the Monitoring Plan as it was designed • Undertake baseline ("before") monitoring • Undertake effectiveness monitoring
Step 5: Evaluate results	• Compare monitoring results against objectives, assumptions, uncertainties, & hypotheses • Compare actual results against model predictions • Consider outside sources of information (e.g. new science) • Ensure data analysis keeps up with data generation • Get statistical/analytical assistance and review as needed
Step 6: Continue/ Adjust/ Success	• Ensure meaningful learning occurred, was documented, communicated to decision makers (and others as needed), etc. • Decision criteria/triggers indicate need to implement contingency plans • Decision makers consider whether to continue as planned, or make changes to actions or instruments based on what was learned • Declare success and suspend monitoring if objectives are met

[1]Adapted from Fischenich et al. 2012; updated to reflect details developed from experiences on AM efforts 2012-2017.

Handout 3: Conceptual Modeling Exercise



Exercise 3: Conceptual Modeling

Q1: Construct a conceptual model from the given materials with your group. Based on your group's expertise/experience and the discussion thus far, how could the model or supporting information be improved to support decisions regarding adaptive management?

15-20 minutes. Arrange your model on the paper provided on a table top or flip chart. Record your group's notes and responses in bullet form to report out at the end of the exercise. List 1 to 3 possible improvements once you have constructed your model.

Exercise 3 Continued: Critically Managing Uncertainties, Hypotheses, Metrics

Q2: Based on the previous exercises and what you have learned, identify one element of the conceptual model (a driver, stressor, effect, etc.) for which you would want to apply Adaptive Management. Explain why you feel AM is appropriate. Alternatively, your group may identify a component of the model for which you definitely would NOT want to apply Adaptive Management, and explain the rationale.

5 to 10 minutes. Record your group's responses and report out at the end of the exercise. Spend about 10 minutes on this question so you have at least 20 minutes remaining for Question #3.

Q3: For one component of the conceptual model that might warrant Adaptive Management (it doesn't have to be the same as what you selected for Q2), discuss its management relevance and in general how one would go about exploring that uncertainty. Have your team identify and describe the following for the element of the model you selected:

a. The source of uncertainty and how the project outcome may be at risk because of it,

b. What information would be required to resolve the uncertainty to a satisfactory level,

c. How one would go about obtaining the needed information, and

d. What you might do once you have the needed information (include alternative outcomes if time permits).

15+ minutes. Record your group's responses and report out at the end of the exercise, discuss among groups.

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Handout 4: Enabling and Inhibiting Factors

Table 1. *Summary of factors that have been identified to enable or inhibit effective governance of Adaptive Management programs drawn from Fischenich et al. 2017.*

Factors Enabling Good Governance	Factors Inhibiting Good Governance
Collaborative, interdisciplinary working environment with free-flowing communication and easy access to well-synthesized information.	Communication among components/departments hindered by different mandates or between disciplinary specialists (i.e, stovepiping). Difficult to access required information.
Frequent re-examination of management and restructuring as needed.	Management done the same way for a very long period of time.
Leaders deliberately challenge themselves and staff to recognize change, innovatively adapt to challenges, and take calculated risks.	Leaders resist change, discourage risk and innovation, and create organizational culture of status quo.
Collaborative inputs to decision making over sustained period, generating buy-in and trust, allowing stakeholders to move from positions to interests, clarifying areas of agreement and disagreement.	Institutions isolated from public/stakeholders; very limited and inconsistent consultation. “Inform” rather than listen.
Recognize critical uncertainties and plan experiments to test alternative hypotheses/actions.	Plan based on past experience, practices, procedures established by senior staff.
Stress high-quality science at appropriate scales, with independent review panels. Data made available; different interpretations of data welcomed, used to postulate alternative hypotheses and design management experiments. Wide publishing of scientific findings.	Science discouraged or use of “advocacy science” to support agency’s position. Data kept internal; selective evidence used; insist on single, dogmatic agency position regarding data analysis.

Table 2. *Factors that enable or inhibit effective governance of Adaptive Management programs based on a summary compiled by Marmorek et al. 2016 based on published experiences from Alverts et al. 2001, Olsson et al. 2004; 2006, Walters 1997; 2007, Greig et al. 2013, Childs et al. 2013, and Loftkin 2014.*

Factors related to attitude/philosophy	
Historical context	Context can cause AM to develop in very different ways. Its proper consideration will help ensure that AM is applied in the appropriate historic and local context. Context can strongly influence in positive and negative ways the institutional drivers motivating the need for AM and the relationships among individuals/organizations involved.
Trust and commitment	Trust and commitment relate to the strength of the relationships among individuals/organizations, and affects their ability to participate, interact, and engage in the AM process.
Mindset (around uncertainty, risk, and AM)	There can be aversions to acknowledging or dealing with uncertainties in decision making which relate to the risk tolerance of stakeholders and willingness of decision makers to invest in management actions that may be seen as surprises. Embracing uncertainty and learning from mistakes can enable success.
Factors related to process	
Problem definition	Ensures there is agreement among parties and focus on the correct problem, which includes how the problem is expressed. Problem definition needs to be durable and capture the larger context otherwise the focus can be lost or lead to crisis management.
Executive direction/ support	A clear and strong commitment from executives is required, backed up by regulatory authority to do AM, to ensure success.
Leadership and vision	Leadership is essential, but not sufficient for success. This attribute involves effective communication to gain broad support regardless of the level at which leadership is rooted; though local level leadership may be important in some cases where top down leadership will not work.
Planning	AM actions are inevitably implemented within exiting planning processes. The dominant planning paradigm can affect inhibit success, if they are too restrictive, or enable it if they are sufficiently flexible.
Communication and organizational structure	Effective, broad-based and two way communication is necessary within and outside the organizational structure governing AM. This attribute includes a consideration of the choice of language, world view being represented, and venues for communication. There is also a need to maintain flexibility in organizational structure to respond to unexpected events.

Community involvement	The need for community involvement depends on context, which affect the decision about whether to involve the community, who to involve, and how to do it. For public/shared resources, a participatory approach that involves varied stakeholders in knowledge generation, deliberation, and decision making can enable success. The most effective AM programs have a small number of stakeholders who trust each other and can make decisions in an agile manner.
Facilitation, bridging, and team building	To enable trust and learning, it is important that those individuals involved are supported through neutral facilitation, team building, and a bridging organization that seeks to bring disparate interests together to explore preferences, interpret information, and make decisions.
Knowledge generation and flow	Decision making and participation should be based on a strong foundation of rigorous science in the formulation and evaluation of management actions, that can also include local and/or traditional knowledge. Knowledge should flow through the governance network in a transparent way which can be important for building mutual trust.
Knowledge interpretation and sense-making	It is important to have a transparent and inclusive process for interpreting the information generated through AM, translating the science into a form that facilitates decision making.
Integration of AM	It important that the administrative/logistical aspects of AM are embedded into existing management structures and processes rather than in their own isolated institutional structure. People working within institutions should be rewarded for activities that advance AM.
Factors Related to Resources	
Funding/ management resources	AM requires sufficient funding and management resources to be successful. Level of funding can be an indicator of the presence, or lack, of executive support.
Staff training	In some cases there may be a need for staff/those involved to receive AM training to learn new skills that facilitate successful implementation. Key areas include training around basic concepts of AM, details of the AM program, and the knowledge gained to inform future actions/decisions.
Capacity	Implementation of AM requires sufficient capacity across all entities involved. Governance structures should be realistic in reflecting the available and projected capacity of participating entities.
Legislation	A strong legislative driver is an important enabling condition to initiate and sustain AM.

Exercise 4: Organizational Learning Evaluation[2]

Please evaluate your organization's learning capacity based on your professional experience and/or impression of your organization using nine categories of factors that reflect the ability of organizations to succeed or fail to learn and adapt. Circle a score on a scale from 1 to 5, where 1 means you strongly agree with Statement (A) and 5 means you strongly agree with Statement (B). The score should most closely represent your experience of your organization. Add notes to explain your scores under each category, and prepare to discuss. ***30 minutes.***

Historical Context						
(A) High level of contention between organization and external parties around science and individual interests. Policy disputes resolved through legal proceedings or other confrontational avenues. Organization has low levels of trust with external partners and/or stakeholders.	1	2	3	4	5	(B) Constructive debate around scientific evidence. Conflicts around policy positions resolved through facilitated exploration of tradeoffs among competing demands and interests of external parties. Organization has a high level of trust with external partners and/or stakeholders.
(A) Management done the same way for a very long period of time, creating inertia.	1	2	3	4	5	(B) Frequent re-examination of management (actions, products, delivery mechanisms) revitalizes the agency and prevents institutional inertia from being established.
Notes:						

[2]Adapted from: Murray, C. and D. Marmorek. 2001. Organizational Learning: Adaptive Management for Salmon Conservation. Draft Synthesis Report from a conference sponsored by the Olympic Natural Resources Center; Bellevue, Washington, December 2-4, 2001. 65 pp.

Funding						
(A) Entities providing funding (e.g. legislature, Congress) do not want to see money spent on experimental management. Funders expect positive results in return for dollars invested, and consider monitoring and evaluation of management actions to be a waste of $, and an exposure to the risk that evidence might show some management actions didn't work or were 'failures'.	1	2	3	4	5	(B) Funders recognize uncertainty and are involved in designing intelligent management experiments with 'safe- fail' outcomes, and opportunities for revision of both current and future actions. Funders buy into learning approach and agree to a contract regarding experimentation so that surprises aren't judged as failures.
(A) Insufficient human resources and funding to carry out Adaptive Management experiments.	1	2	3	4	5	(B) Sufficient human resources and funding to carry out Adaptive Management experiments.
(A) Policy makers want scientists to provide answers without having to do Adaptive Management experiments that acknowledge ignorance, and may be risky.	1	2	3	4	5	(B) High level political support for Adaptive Management experiments. Uncertainty accepted publicly.
Notes:						

Leadership						
(A) Leaders resist change, discourage risk taking and innovation, and repeat past actions. Create organizational culture in which staff are expected to do the same.	1	2	3	4	5	(B) Leaders deliberately challenge themselves to recognize change, innovatively adapt to current challenges, and take calculated risks. Create organizational culture in which staff are expected to do the same.
(A) Staff who show existing actions aren't working are criticized, and evidence suppressed.	1	2	3	4	5	(B) Staff rewarded for generating information that demonstrates existing actions aren't working.

(A) Leaders are cautious and defensive to the public.	1	2	3	4	5	(B) Leaders are self-confident, willing to explain and defend Adaptive Management approaches.
(A) Leaders treat unexpected events as abnormal outcomes that don't negate traditional approaches.	1	2	3	4	5	(B) Leaders treat unexpected events as catalysts to rethink approaches.
(A) Leadership frequently changing, lack of continuity.	1	2	3	4	5	(B) Leadership maintained for longer periods.
(A) Inconsistent political leadership and wavering support.	1	2	3	4	5	(B) Consistent political support.
Notes:						
Problem Definition and Potential Management Actions						
(A) See problems as linear and break them down into small pieces. Focus on details of the parts over short time horizons and restricted spatial scales.	1	2	3	4	5	(B) See both ecosystems and institutions as non-linear systems that respond dynamically to disturbances. Focus on dynamics of the whole system over long time horizons and large spatial scales.
(A) Rely on engineering technology not designed for dynamic ecological systems.	1	2	3	4	5	(B) Rely on management actions that emulate natural disturbances, rather than technological fixes.
Notes:						

Community Involvement						
(A) Institutions isolated from public, or very limited consultation at random intervals. Frequent court cases, advocacy, arbitration.	1	2	3	4	5	(B) Collaborative inputs to decision making over sustained period, generating buy-in and trust, allowing stakeholders to move from positions to interests, clarifying areas of agreement and disagreement.
(A) Agency decides what actions should be implemented at local level. Monitoring done by agency if funds available.	1	2	3	4	5	(B) Explain goals, and then delegate to local level the task of working out how to achieve them, encouraging experimentation within a framework of consistent monitoring and guidance.
(A) Staff science and data predominant.	1	2	3	4	5	(B) Citizen science, traditional knowledge incorporated into decision making.
Notes:						

Planning						
(A) Plan based on past experience, practices, procedures established by senior staff.	1	2	3	4	5	(B) Recognize critical uncertainties and plan experiments to test alternative hypotheses / actions.
(A) Collected information stored, but most not analyzed due to lack of incentives and resources to take a critical look at outcomes of actions.	1	2	3	4	5	(B) Use frequent analyses of information (at least annually) to produce cognitive change in formulation of issues, maintaining critical reflection over policy-relevant time frames (e.g., > 10 years)
Notes:						

Communication and Organizational Structure						
(A) Poor internal communication between departments with different mandates, between disciplinary specialists. Difficult to access required information. 'File merge' approach to synthesis.	1	2	3	4	5	(B) Collaborative, interdisciplinary working environment with free-flowing communication and easy access to well-synthesized information. Focus on interdisciplinary problem solving, exploration of cumulative effects and dynamics.
(A) Focus on management and emergency response rather than learning.	1	2	3	4	5	(B) Use management teams to help create time, resources, opportunities for learning teams, whose main job is learning.
(A) No institutional memory.	1	2	3	4	5	(B) Institutional memory is important.
(A) Hidden decision processes.	1	2	3	4	5	(B) Clarity of decision processes.
Notes:						

Staff Training						
(A) Staff not trained to accept change, to deal with surprises or to focus on learning.	1	2	3	4	5	(B) Staff trained to embrace change and to focus on learning.
(A) Staff not trained to design and implement Adaptive Management.	1	2	3	4	5	(B) Staff well trained to design and implement Adaptive Management.
Notes:						

How Adaptive Management Science is Conducted						
(A) Advocacy science to support agency's position (selective evidence). Data kept internal; insist on single, dogmatic agency position regarding data analysis.	1	2	3	4	5	(B) Stress on high quality science at appropriate scale, with independent review panels. Data made available; different interpretations of data welcomed, used to postulate alternative hypotheses and design management experiments. Wide publishing of scientific findings.
(A) Agency scientists do work that is largely independent from public and other institutions.	1	2	3	4	5	(B) Agency scientists interact in 'learning teams' and/or 'issue networks' with scientists from NGOs, academia and stakeholder groups (incorporating traditional knowledge). Involvement in data collection encouraged to build confidence and trust.
(A) Goals of Adaptive Management experiments are not well defined or linked to decisions; alternative hypotheses not defined for key uncertainties; experimental design at wrong spatial/temporal scale or inadequate to provide required insights; and/or poor documentation.	1	2	3	4	5	(B) Clearly defined, measurable goals of Adaptive Management experiments, linked to decisions; alternative hypotheses defined for key uncertainties; experiments designed at appropriate spatial/temporal scale; thorough documentation; results fed back into revised decisions.
(A) Avoid/ignore cumulative effects due to difficulties of drawing scientifically defensible conclusions.	1	2	3	4	5	(B) Consider cumulative outcomes even if scientifically defensible conclusions not possible.
Notes:						

Handout 5: Adaptive Management Examples

AM Program	Location	Context	Stage of AM	References
Trinity River Restoration Program	Trinity River, USA	Water management recovery of species of conservation concern (fish).	Implementation of AM plan ongoing, learning occurring.	US Fish and Wildlife Service and Hoopa Valley Tribe. 1999. Trinity River Flow Evaluation: Final report. USFWS and Hoopa Valley Tribe. http://www.trrp.net/ http://odp.trrp.net/FileDatabase/Documents/TRRP_2014_AnnRept1.pdf
Glen Canyon Dam Adaptive Management Program	Colorado River, USA	Large river water management for recovery of endangered species (fish).	Implementation of AM plan ongoing, learning occurring.	Melis T.S., Korman J. and C.J. Walters. Active adaptive management of the Colorado River ecosystem below Glen Canyon Dam, USA: using modeling and experimental design to resolve uncertainty in large-river management. In Proceedings of the International Conference on Reservoir Operation and River Management, Guangzhou, China 2005 Sep 18. http://www.usbr.gov/uc/rm/amp/
Platte River Recovery Implementation Program	Platte River, USA	Large river water management for recovery of endangered species (birds).	Implementation of AM plan ongoing, learning occurring.	Smith, C. B. 2011. Adaptive management on the central Platte River—Science, engineering, and decision analysis to assist in recovery of four species. Journal of Environmental Management 92: 1414–1419. https://www.platteriverprogram.org/Pages/Default.aspx

AM Program	Location	Context	Stage of AM	References
Missouri River Recovery Program	Missouri River, USA	Large river water management for recovery of endangered species (birds and fish).	AM being considered, under development, not implemented.	http://moriverrecovery.usace.army.mil/mrrp/f?p=136:1:0::NO
NA	North West Coast, AUS	Multi-species commercial trawl and trap fisheries management.	Implementation of AM plan complete, learning occurred and management adjusted.	Sainsbury, K. J. 1991. Application of an experimental management approach to management of a tropical multispecies fishery with highly uncertain dynamics. ICES Marine Science Symposia, 193: 301–320 Sainsbury, K. J., Campbell, R. A., Lindholm, R., and W. Whitelaw. 1997. Experimental management of an Australian multispecies fishery: examining the possibility of trawl-induced habitat modification. In Global Trends: Fisheries Management, pp. 107–112. Ed. by E. L. Pikitch, D. D. Huppert, and M. P. Sissenwine. American Fisheries Society Symposium 20. Bethesda, Maryland, USA.
Effects of Line Fishing (ELF) Program	Great Barrier Reef, AUS	Commercial and recreational fisheries management.	Implementation of AM plan complete, learning occurred and management adjusted.	Mapstone, B.D., R.A. Campbell and A.D.M. Smith. 1996. Design of experimental investigations of the effects of line and spear fishing on the Great Barrier Reef. CRC Reef Research Centre Technical Report No.7. Townsville: CRC Reef Research Centre. Davies C.R., Little L.R., Punt A.E., Smith A.D., Pantus F., Lou D.C., Williams A.J., Jones A., Ayling A.M., Russ G.R. The effects of line fishing on the Great Barrier Reef and evaluations of alternative potential management strategies. Townsville, Queensland, Australia: CRC Reef Research Centre; 2004.

AM Program	Location	Context	Stage of AM	References
				McCook LJ, Ayling T, Cappo M, Choat JH, Evans RD, De Freitas DM, Heupel M, Hughes TP, Jones GP, Mapstone B, Marsh H. 2010. Adaptive management of the Great Barrier Reef: A globally significant demonstration of the benefits of networks of marine reserves. Proceedings of the National Academy of Sciences 107:18278-85.
Comprehensive Everglades Restoration Plan	Florida, USA	Water management and restoration to repair hydrological processes.	Implementation of AM plan ongoing, learning occurring.	LoSchiavo, A. J., R. G. Best, R. E. Burns, S. Gray, M. C. Harwell, E. B. Hines, A. R. McLean, T. St. Clair, S. Traxler, and J. W. Vearil. 2013. Lessons learned from the first decade of adaptive management in comprehensive Everglades restoration. Ecology and Society 18: 70. http://141.232.10.32/pm/program_docs/adaptive_mgmt.aspx
Middle Rio Grande Endangered Species Collaborative Program	Middle Rio Grande River, USA	Large river water management for recovery of endangered species (fish).	Plan developed but not yet implemented.	Murray, C., Smith, C., and D. Marmorek. 2011. Middle Rio Grande endangered species Collaborative Program Adaptive Management plan Version 1. Prepared by ESSA Technologies Ltd. and Headwaters Corporation for the Middle Rio Grande Endangered Species Collaborative Program, Albuquerque. 108 p.
NA	Murray-Darling River, AUS	Water management to enhance the environmental benefits of altered flow regimes.	Implementation of AM plan complete, learning occurred and management adjusted.	Allan C, Watts RJ, Commens S, Ryder DS. 2009. Using adaptive management to meet multiple goals for flows along the Mitta Mitta River in southeastern Australia. In Adaptive Environmental Management 2009 (pp. 59-71). Springer Netherlands.

Exercise 5: Applying Adaptive Management

The instructions below summarize an activity to complete in your group – a template is provided for documenting your responses for report out. Although you will have ~45 minutes to complete this activity before reporting out and general discussion, the intent is to support learning by asking you to consider how each of these elements applies to a specific problem (described by workshop facilitators) in a holistic/integrated way. Try not to let perfection slow you down or time-pressure rush you through this activity!

(1) (***~2 min***) Assign four roles within your group:

- a *facilitator* to ensure the discussion covers all of the topics;
- a *recorder* of main outcomes and key discussion points (use template on next page);
- a *timekeeper* to help apportion time available for sub-tasks helping to make sure that the group does not spend too long on any one element; and
- a *reporter* to present highlights of the group's design to the plenary.

(2) (***~10 min***) Identify some pressing management problems/questions that you would face for the project described by the facilitators.

Use what you learned in the morning to review your list of candidate questions against the list of AM suitability factors, weed out those questions that may not be suitable, and then ***pick one*** of the remaining questions to be the focus of the rest of the exercise. Be sure to state it explicitly as a **management uncertainty** in the template on the next page.

(3) (***~30 min***) Identify the following for your chosen management problem/question, and record your results in the template on the following page:

- **Management goals/objectives** – what is the desired management outcome that you are ultimately trying to achieve? (*~10 min*)
- **Alternative Management Actions** – what are the different ways in which the management goals/objectives might be obtained (i.e., what would the treatments be in the management experiment)? *(~10 min*)
- **Adjustments** – how will what's learned actually be used? What would change? *(~5 min*)
- **Individuals and Organizations** — what expertise and organizations might be involved across steps in the process? (~5 min)

(4) (***~10 min***) Discuss and be prepared to report back to plenary on:

- What challenges you encountered and how you addressed them (what elements were hardest)?
- What you learned during this exercise and how it relates to material covered in Sessions 1 and 2
- Were there any surprises as you worked through this? What and why?

Exercise 5: Template for Group Assignment

Management Problem / Question – stated as a management uncertainty	
Management Goals/ Objectives – what is the ultimately desired management outcome?	
Alternative Management Actions – which treatments will you be testing?	
Adjustments – how would what's learned actually be used?	
Individuals and Organizations – what expertise and organizations might be involved in the process?	

Exercise 5: Template for Reporting Back to Plenary

What was the **management problem/question** that you considered (from row 1 on previous page)?	
What **challenges** did your group encounter, and how did you addressed them? What elements were hardest?	
What did your group **learn** during this exercise?	
Were there any **surprises** as you worked through this? What were they?	

Handout 6: Adaptive Management Reading List

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Handout 7: Facilitation Basics

Three levels:
- Meeting Organization
- Facilitation
- Facilitation with Science

Meeting Organization
- Inviting attendees
- Preparing materials
- Securing meeting room
- A/V needs
- Coordinating with presenters
- Misc. logistics (food, room set up, etc.)
- Meeting minutes

Facilitation
- Conducting convening assessments and laying groundwork for discussion prior to meetings
- Making sure all the right people are in the room
- Ensuring participation in good faith
- Working with difficult personalities
- Ensuring equal opportunity to participate
- Mediating issues
- Negotiating amongst stakeholders
- Keeping conversations on track
- Maintaining impartiality and confidentiality
- Keeping the trust of all parties
- Maintaining administrative records of conversations, key decisions, agreements, and next steps

Facilitation Involving Science
- Ensuring all parties have a common understanding of the science
- Facilitating amongst parties of different scientific backgrounds and disciplines
- Facilitating amongst parties with different levels of scientific knowledge
- Working with competing scientific opinions and viewpoints
- Ensuring parties are working with the best available science
- Ensuring parties have equal access to data and information they require for their discussions

In Sum:
- Meeting Organization
  - Managing Logistics
- Facilitation
  - Managing Logistics and People
- Facilitation with Science
  - Managing Logistics and People and Information

Photo Release Form

US Army Engineer Research and Development Center
3909 Halls Ferry Road
Vicksburg, MS 39180

Permission to Use Photograph

Event: Adaptive Management for USACE

Location: St. Louis, MO

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I have read and understand the above:

Signature ________________________________

Printed name _____________________________

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Date ____________________________________

Workshop Evaluation Form

*Name (optional):*____

Q1: Overall, how successful do you think this workshop was in meeting its objectives?

(1) Learn what adaptive management (AM) is and when AM is most useful	☐	☐	☐
(2) Understand the basic steps and key elements of AM	☐	☐	☐
(3) Convey some examples of AM	☐	☐	☐
(4) Discover enabling and inhibiting factors related to AM governance and decision making	☐	☐	☐
(5) Explore opportunities for participants to apply AM to Civil Works Projects	☐	☐	☐

Q2: Do you have any comments on the overall success of the workshop?

Q3: How much did you like each of the individual sessions?

Session Topics:	Not at all	Somewhat	Very
Session 1: AM Basics			
Session 2: AM Governance and Decision Making			
Session 3: AM in Practice			

` ☐ ☐ ☐

Q4: Do you have any comments on individual sessions (e.g., what ones did you like or not like)?

Q5: How did you like the smaller group activities?

Not at all	Somewhat	Very
☐	☐	☐

Q6: Do you have any comments on the group activities (e.g., what ones did you like or not like)?

Q7: How would you rate the venue for this workshop (e.g., comfort, acoustics, visuals)?

Poor	Fair	Excellent
☐	☐	☐

Q8: Do you have any comments on the venue?

Q9: How would you rate the facilitators?

Poor	Fair	Excellent
☐	☐	☐

Q10: Do you have any comments on the facilitation of the workshop?

Q11: Are you leaving this workshop with a better understanding about Adaptive Management?

Q12: Do you have any other comments, observations or insights to share?

Thank you!

MIDDLE RIO GRANDE ENDANGERED SPECIES COLLABORATIVE PROGRAM

July 2017

"The views, opinions and findings contained in this report are those of the authors(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other official documentation."

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About the Middle Rio Grande

Rio Grande was an aggrading system

Water management operations
Irrigation
Flood control - dams and levees,
Alter the river's natural flow and sediment transport
Decreased overbank flooding.

The Collaborative Program is a partnership involving 16 signatories organized to protect and improve the status of endangered species along the Middle Rio Grande of New Mexico while simultaneously protecting existing and future regional water uses.

Middle Rio Grande
Endangered Species Collaborative Program

- U.S. Bureau of Reclamation
- U.S. Fish and Wildlife Service
- U.S. Army Corps of Engineers

- New Mexico Interstate Stream Commission
- New Mexico Department of Game and Fish
- New Mexico Attorney General's Office

- Santo Domingo Tribe
- Pueblo of Sandia
- Pueblo of Isleta
- Pueblo of Santa Ana

- Middle Rio Grande Conservancy District
- Assessment Payers Association of the Middle Rio Grande Conservancy District
- Albuquerque-Bernalillo County Water Utility Authority
- City of Albuquerque
- New Mexico Department of Agriculture
- University of New Mexico

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Endangered Species on the Middle Rio Grande

Rio Grande silvery minnow (*Hybognathus amarus*)

Requires a spring flood pulse to cue spawning and shallow, slow-moving water in areas
Overbank flooding for nursery habitat.
Reduced spring flood volumes in the river
Channel incision reduced frequency of overbank flooding

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Endangered Species on the Middle Rio Grande

Southwestern Willow Flycatcher
(*Empidonax traillii extimus*)

Requires dense riparian habitats dominated by native willows for nesting and rearing its young.

Historically, floods on the river produced a mosaic of shifting sandbars that favored the establishment of such willow stands; however,

Water management has led to stabilization of sandbars

Willow communities have been replace with non-native shrubs

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Endangered Species on the Middle Rio Grande

Western Yellow-billed Cuckoo
(*Coccyzus americanus occidentalis*)

Riparian habitat mosaic dominated by cottonwoods for nesting and rearing its young.
Opportunistic foraging for insect outbreaks and nesting

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Endangered Species on the Middle Rio Grande

New Mexico Meadow Jumping Mouse
(*Zapus hudsonius luteus*)

Emergent herbaceous wetlands with sedge or reed canarygrass
Riparian Scrub-shrub dominated by willows
Historic range along Rio Grande
Mostly upland streams

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US BUREAU OF RECLAMATION COLLABORATIVE PROGRAM AUTHORITY

Reclamation serves the leadership role

Activities include:

- Water acquisition and management
- Habitat restoration
- Endangered species monitoring
- Rio Grande silvery minnow propagation

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USACE
COLLABORATIVE PROGRAM AUTHORITY

…USACE..may carry out and fund planning studies at 100 percent Federal expense to accomplish the purposes of the 2003 Biological Opinion …or any related subsequent biological opinion, and the Collaborative Program long-term plan. In carrying out a study, survey, or assessment under this subsection…USACE…shall consult with Federal, State, tribal and local governmental entities, as well as …other…entities participating in the Collaborative Program. USACE..may also provide planning and administrative assistance to the …Collaborative Program…

Collaborative Program goals (April, 2013)

Conserve and contribute to recovery of the listed species.

- Support the development of self-sustaining populations through implementation of the RIP Action Plan and Annual Work Plan.
- Continually identify the critical scientific questions and uncertainties that will be addressed through adaptive management.
- Assist in avoiding jeopardy to the species and adverse modification of designated critical habitat within the Program area.

Protect existing and future water uses.

- Provide a mechanism for ESA compliance for non-federal actions that are the subject of Reclamation’s January 16, 2013 Biological Assessment.
- Provide a process for streamlined Section 7 consultation for future water uses needing compliance with the ESA.
- Obtain hydrologically sustainable solutions for the species.

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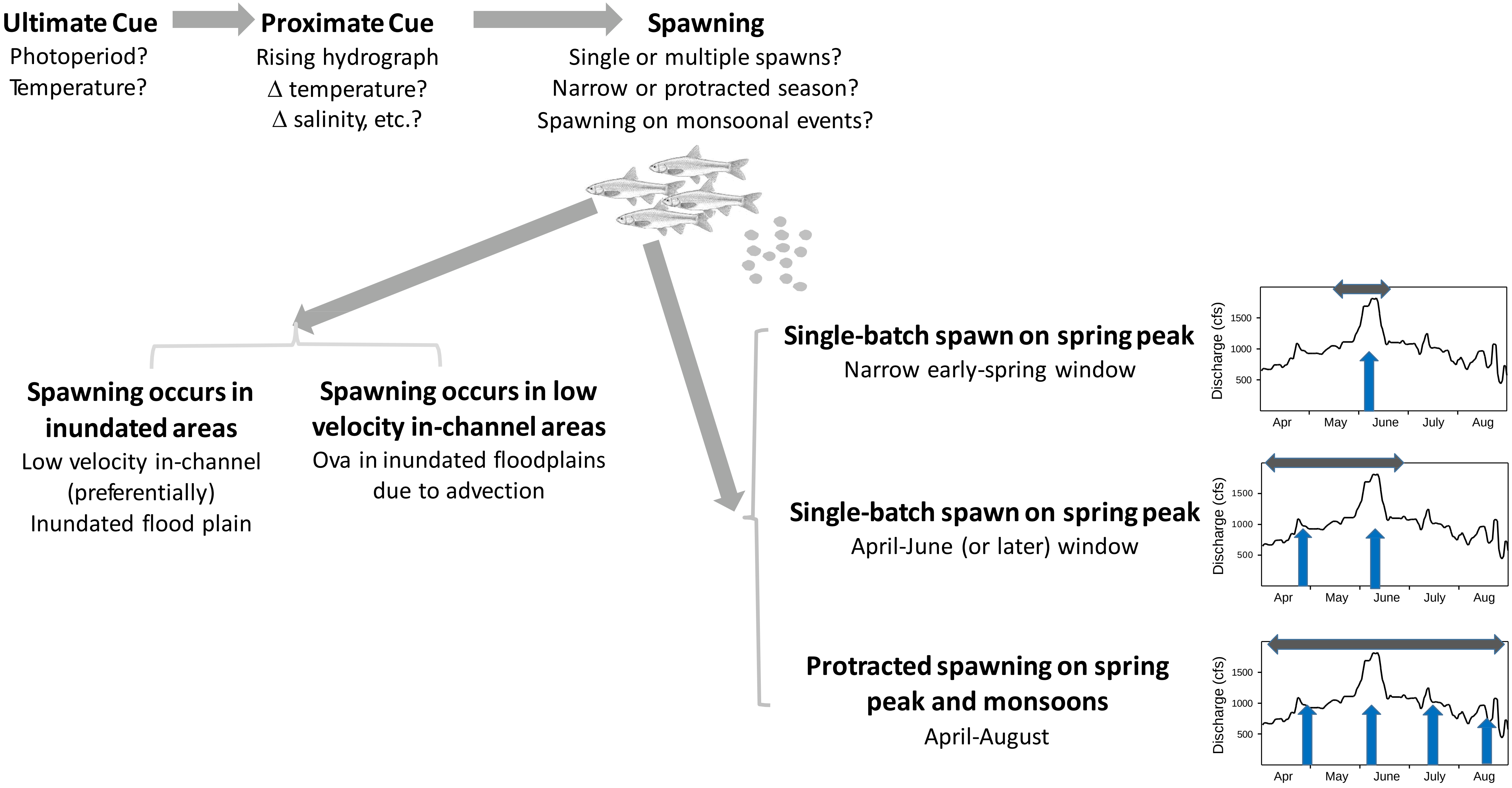
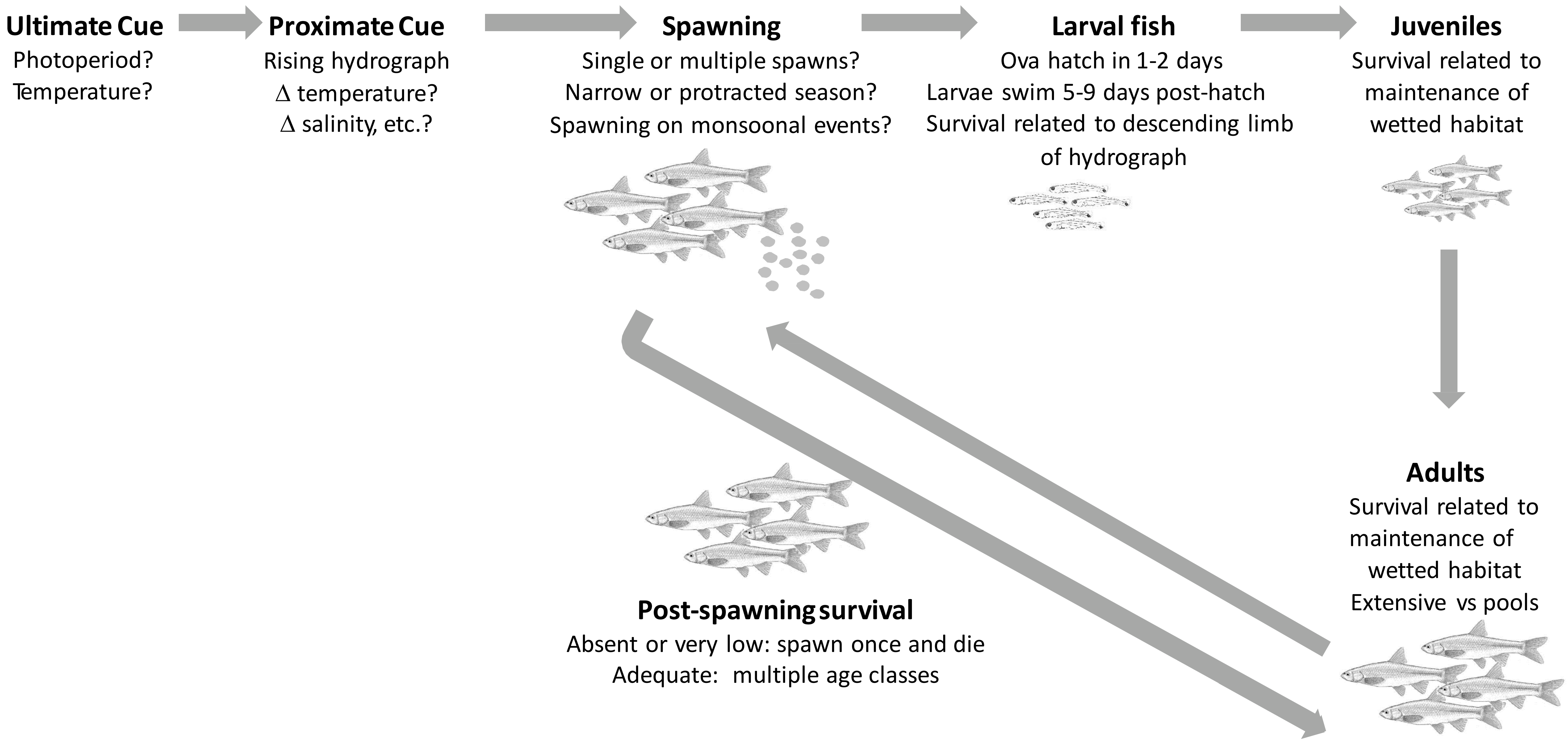

Ultimate Cue
Photoperiod?
Temperature?
Proximate Cue
Rising hydrograph
Δ temperature?
Δ salinity, etc.?
Spawning
Single or multiple spawns?
Narrow or protracted season?
Spawning on monsoonal events?
Spawning occurs in inundated areas
Low velocity in-channel (preferentially)
Inundated flood plain
Spawning occurs in low velocity in-channel areas
Ova in inundated floodplains due to advection
Single-batch spawn on spring peak
Narrow early-spring window
Single-batch spawn on spring peak
April-June (or later) window
Protracted spawning on spring peak and monsoons
April-August
Discharge (cfs)
1500
1000
500
Apr
May
June
July
Aug


Ultimate Cue
Photoperiod?
Temperature?
Proximate Cue
Rising hydrograph
Δ temperature?
Δ salinity, etc.?
Spawning
Single or multiple spawns?
Narrow or protracted season?
Spawning on monsoonal events?
Larval fish
Ova hatch in 1-2 days
Larvae swim 5-9 days post-hatch
Survival related to descending limb of hydrograph
Juveniles
Survival related to maintenance of wetted habitat
Adults
Survival related to maintenance of wetted habitat
Extensive vs pools
Post-spawning survival
Absent or very low: spawn once and die
Adequate: multiple age classes

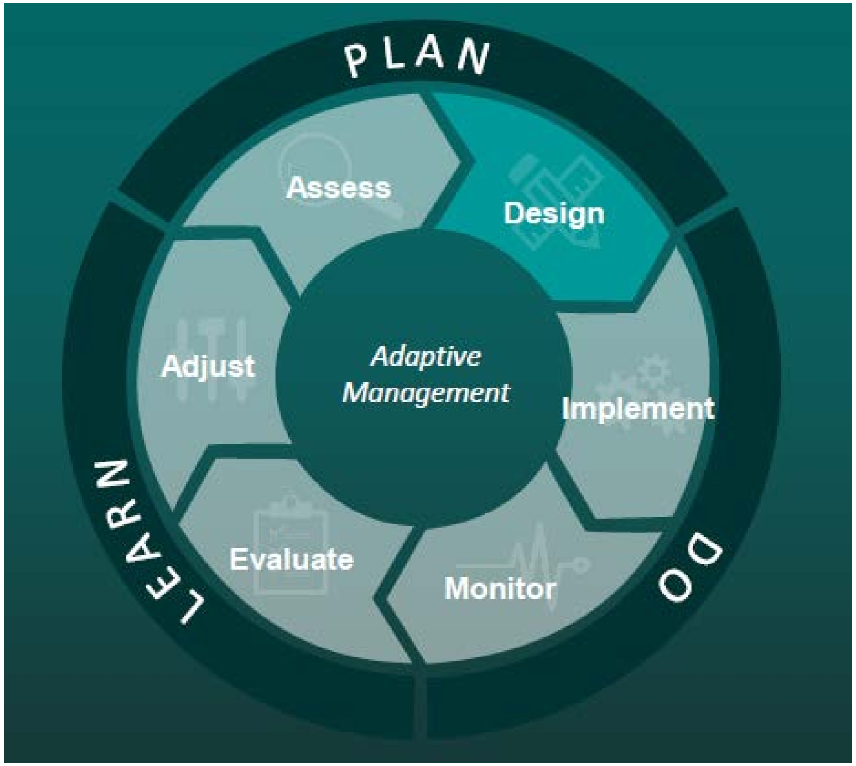
AM Plan Development (Step 2 Plan/Design)

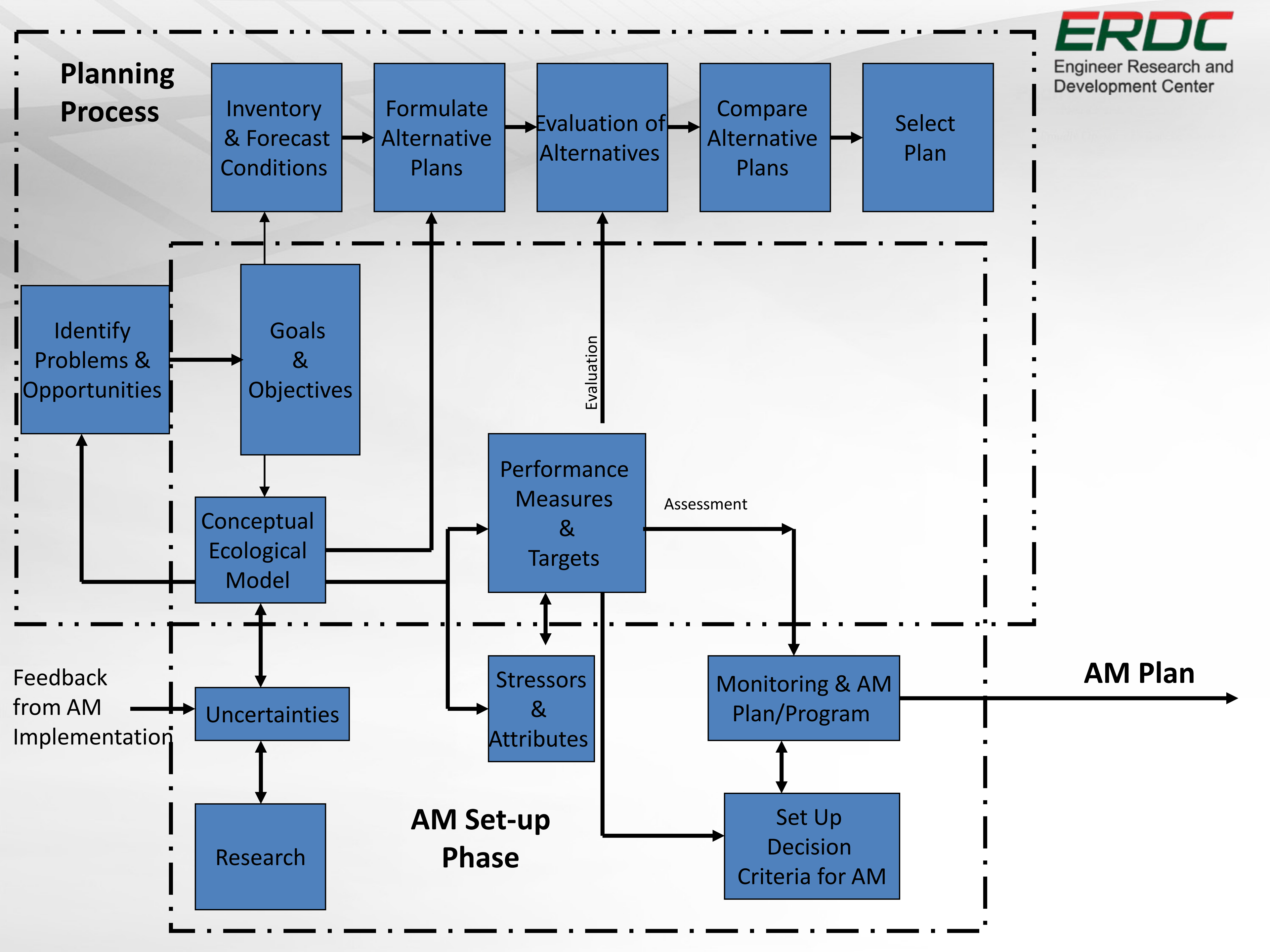
Craig Fischenich
Chuck Theiling

Office of Research and Technology Transfer
Adaptive Management Workshop
Albuquerque, NM2
25-28 July 2017

Plan/Design Step

- **Design management treatments; contrasts, replicates, controls…**
- **Identify metrics/indicators of treatment responses** (*will you be able to detect changes?*)
- **Design plans for next steps (power analysis, statistical monitoring design, field sampling protocols, data analysis plans)**
- **Predict expected outcomes and responses, ID decision criteria & contingencies**




ERDC
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Planning Process
Inventory & Forecast Conditions
Formulate Alternative Plans
Evaluation of Alternatives
Compare Alternative Plans
Select Plan
Identify Problems & Opportunities
Goals & Objectives
Evaluation
Performance Measures & Targets
Assessment
Conceptual Ecological Model
Feedback from AM Implementation
Uncertainties
Stressors & Attributes
Monitoring & AM Plan/Program
AM Plan
Research
AM Set-up Phase
Set Up Decision Criteria for AM

AM Plan Scope & Importance

Key elements of the AM plan:

- Goals and objectives
- Uncertainties
- Hypotheses
- Management actions
- Model predictions
- Decision criteria
- Monitoring program
- Analytical requirements
- Decision-making process and roles
- Contingency actions
- Reporting and communications
- Process and timeline for modification

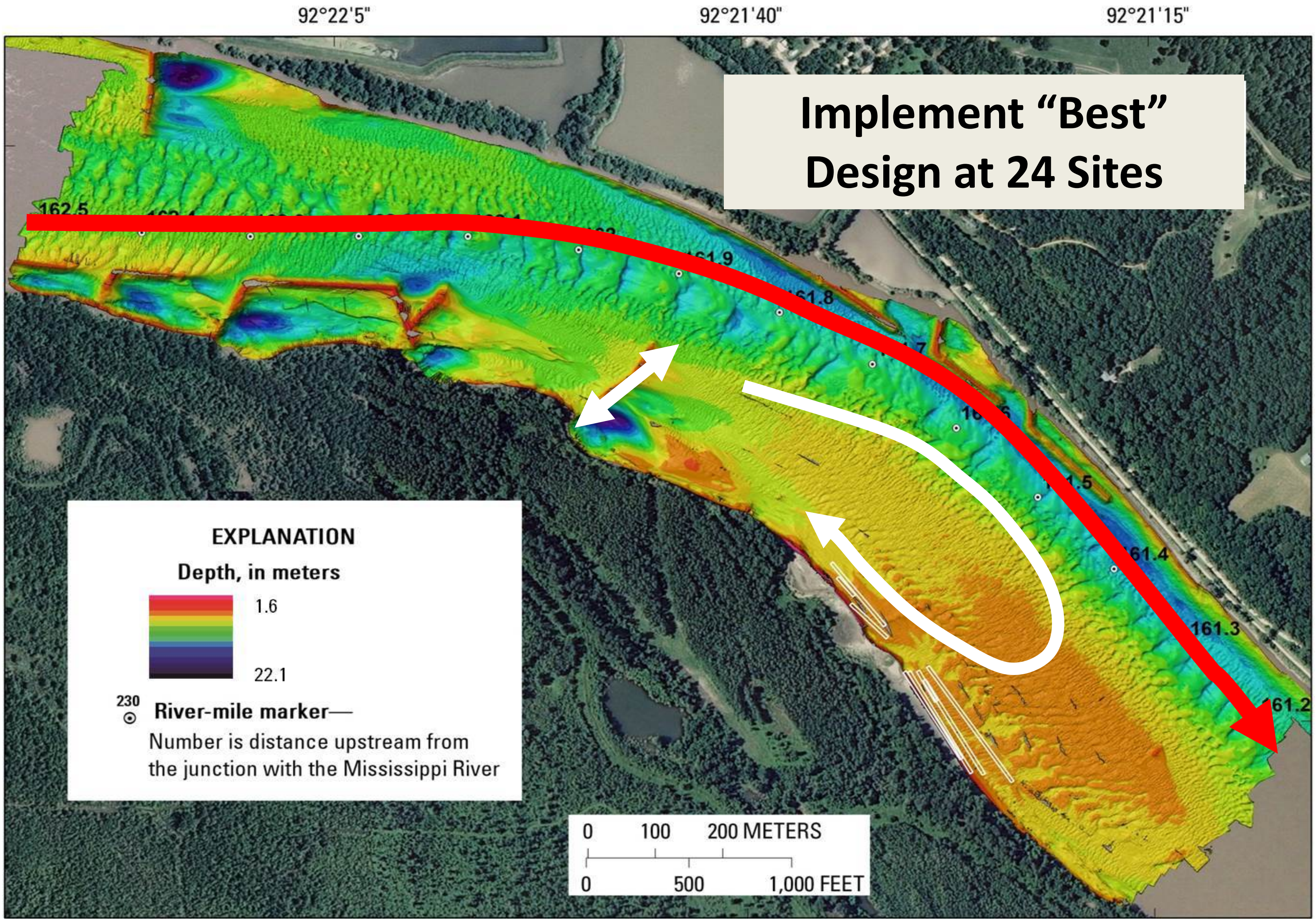
EXAMPLE

ADAPTIVE MANAGEMENT TABLE OF CONTENTS

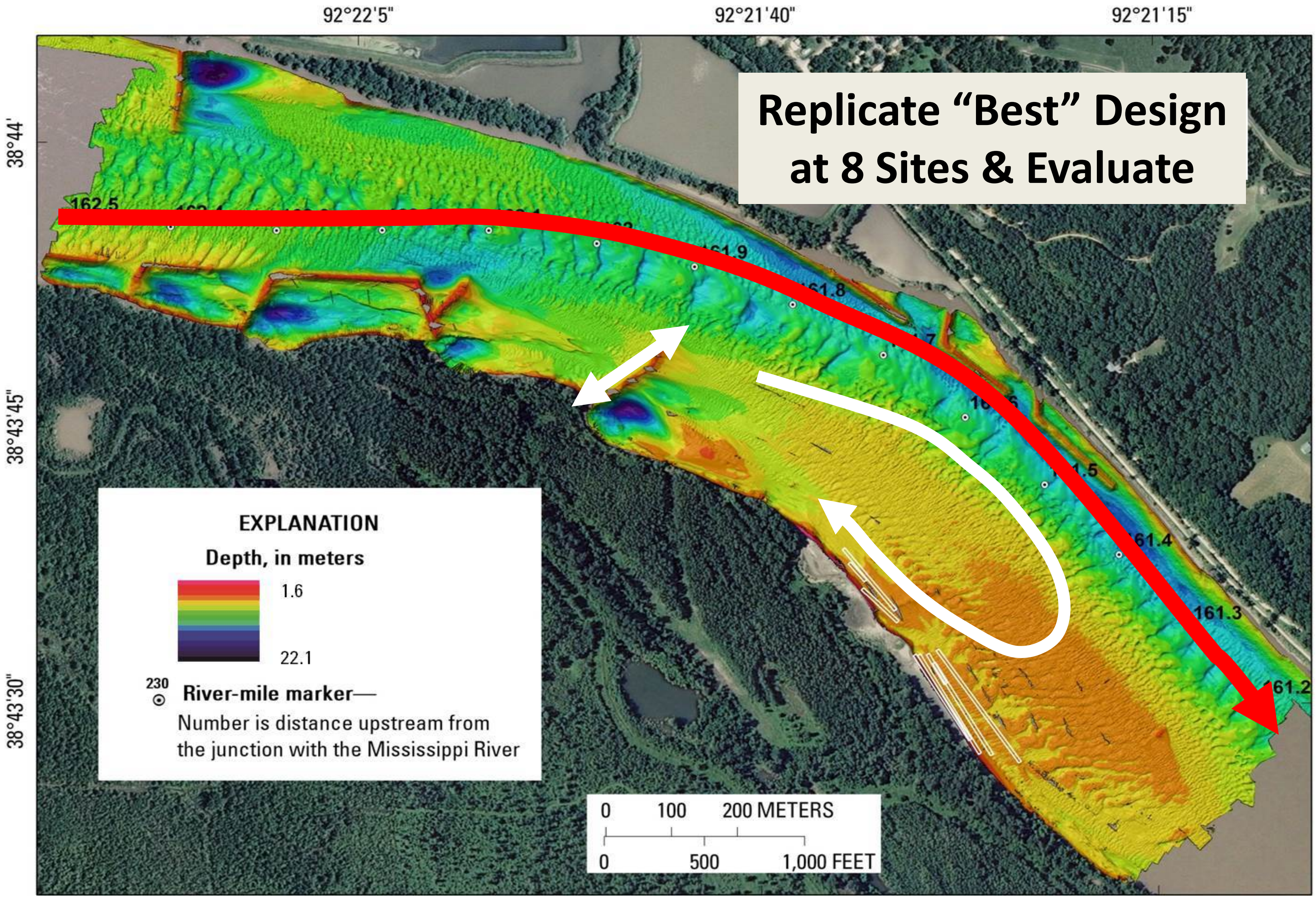
Ecosystem Restoration Decisions

- What is the problem?
- Is there a Federal interest?
- What are the alternative solutions?
- What are the benefits?
- Are the benefits worth the investment?
- Which solution is preferred?
- Is AM warranted?

Example – Passive or No AM



Example – Passive AM



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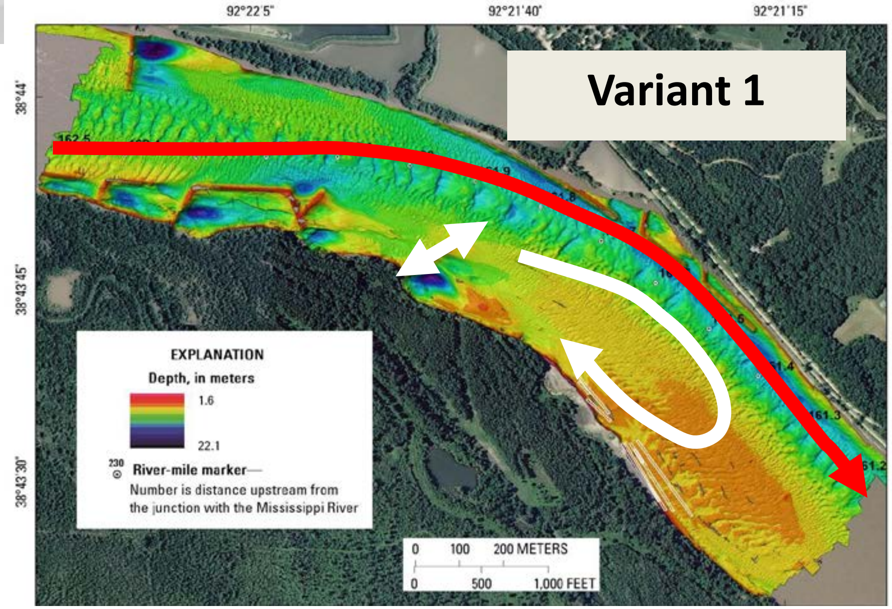
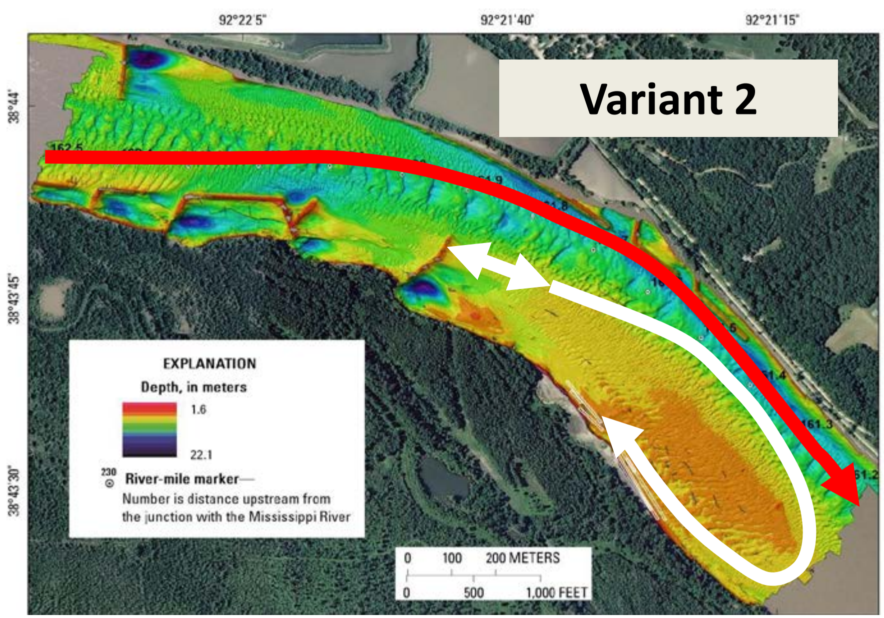
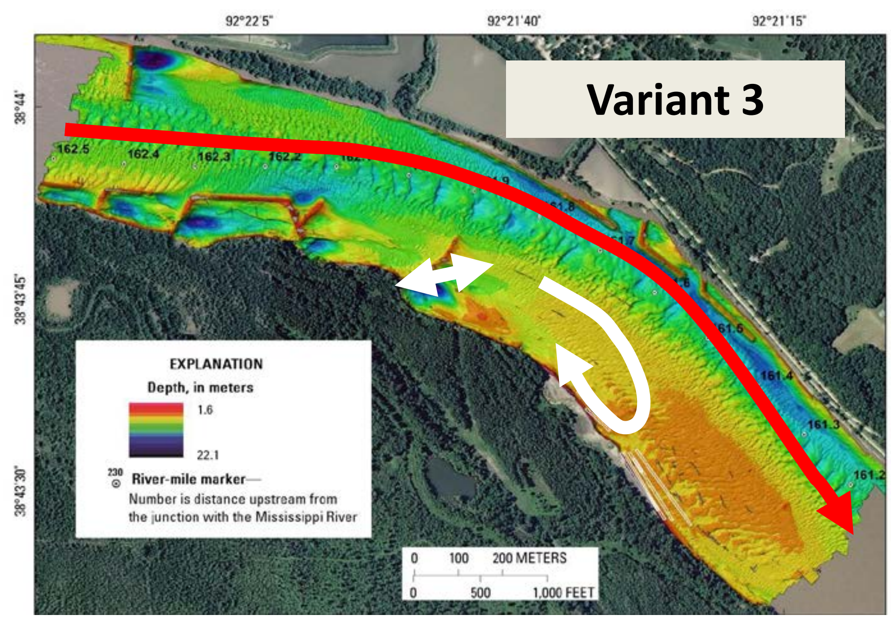
Example – Active AM

Implement 3 variants at 3 sites each in year 1; Use results for subsequent experiments or implement







Developing the Plan

Engineer Research and Development Center

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 (if warranted)
2. For each critical uncertainty/hypothesis
   a. Do the above, plus
   b. Consider the most efficient way to address the concern,
   c. Specify an experimental design (as needed)
3. Identify baseline or comparative (e.g. reference) study needs
4. Determine analytic needs
5. Establish data management, storage, and access protocols
6. Describe governance structure and operation
7. Estimate costs

Adaptive Management Team

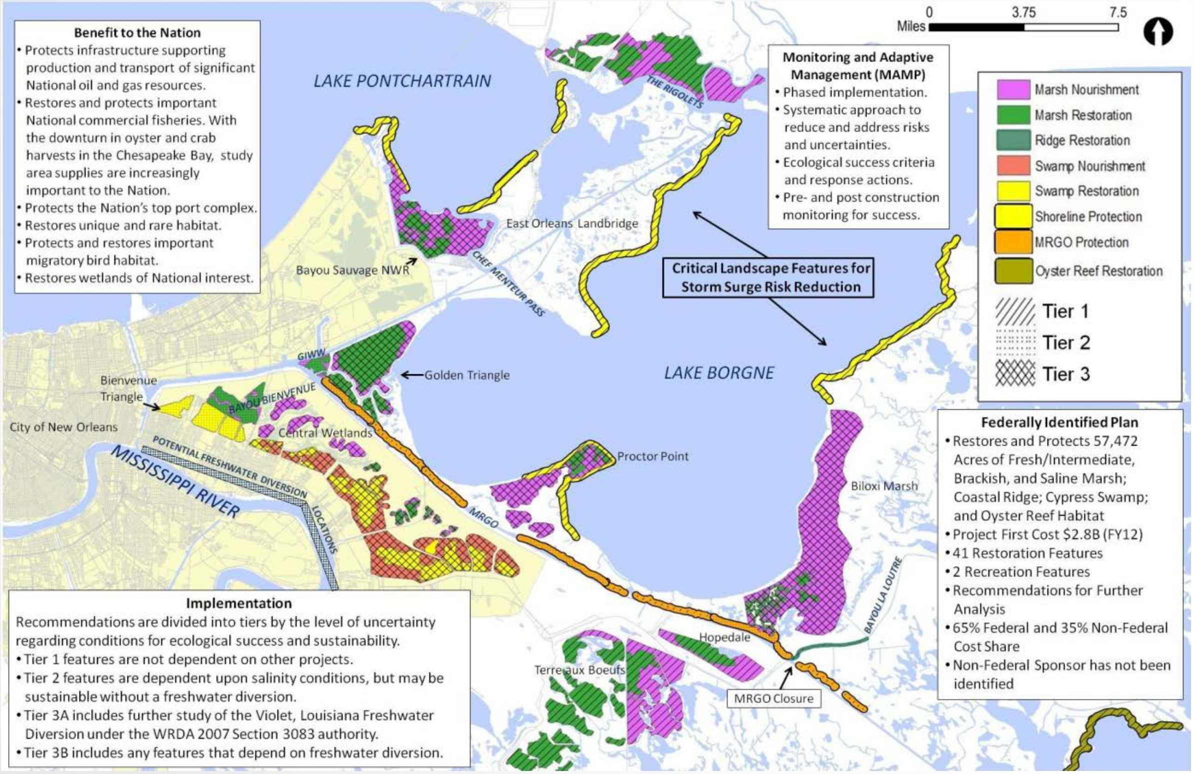
- Responsible for implementation of AM plan
- Consist of planners, scientists, engineers, and decision-makers involved in the planning process
- Team should be formalized
- Possible augmentation during the AM process by individuals with special technical skills or management experience uniquely required by the particular AM program
- Individuals responsible for carrying out an AM program should be clearly identified throughout the course of the program.
- Operating Principles

Example Questions for PDT

- 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)?

Project vs Programmatic AM

- Different Objectives
- Different Uncertainties
- Different Suite of Adaptive Actions



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

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	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

Ecosystem Restoration Benefits

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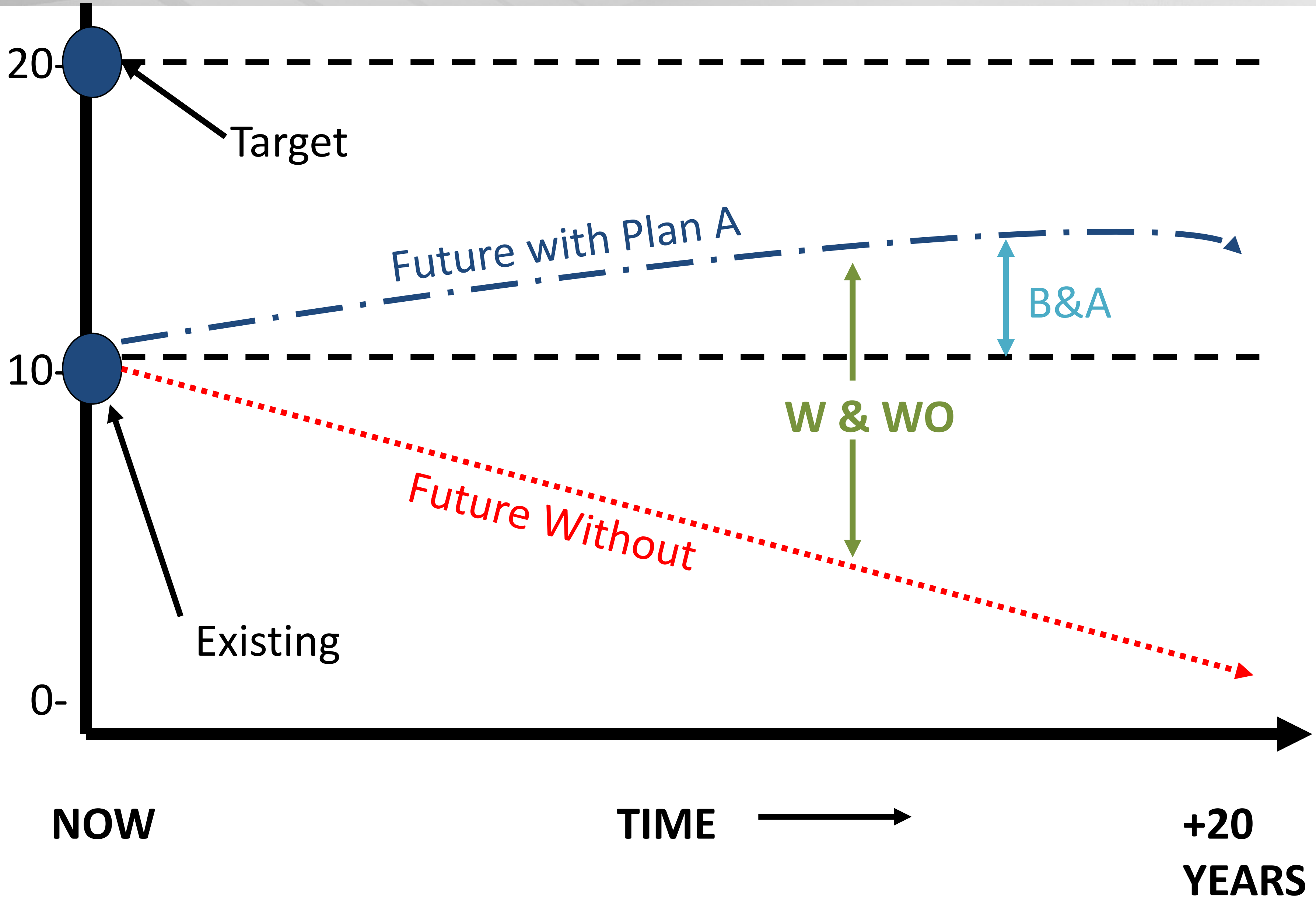
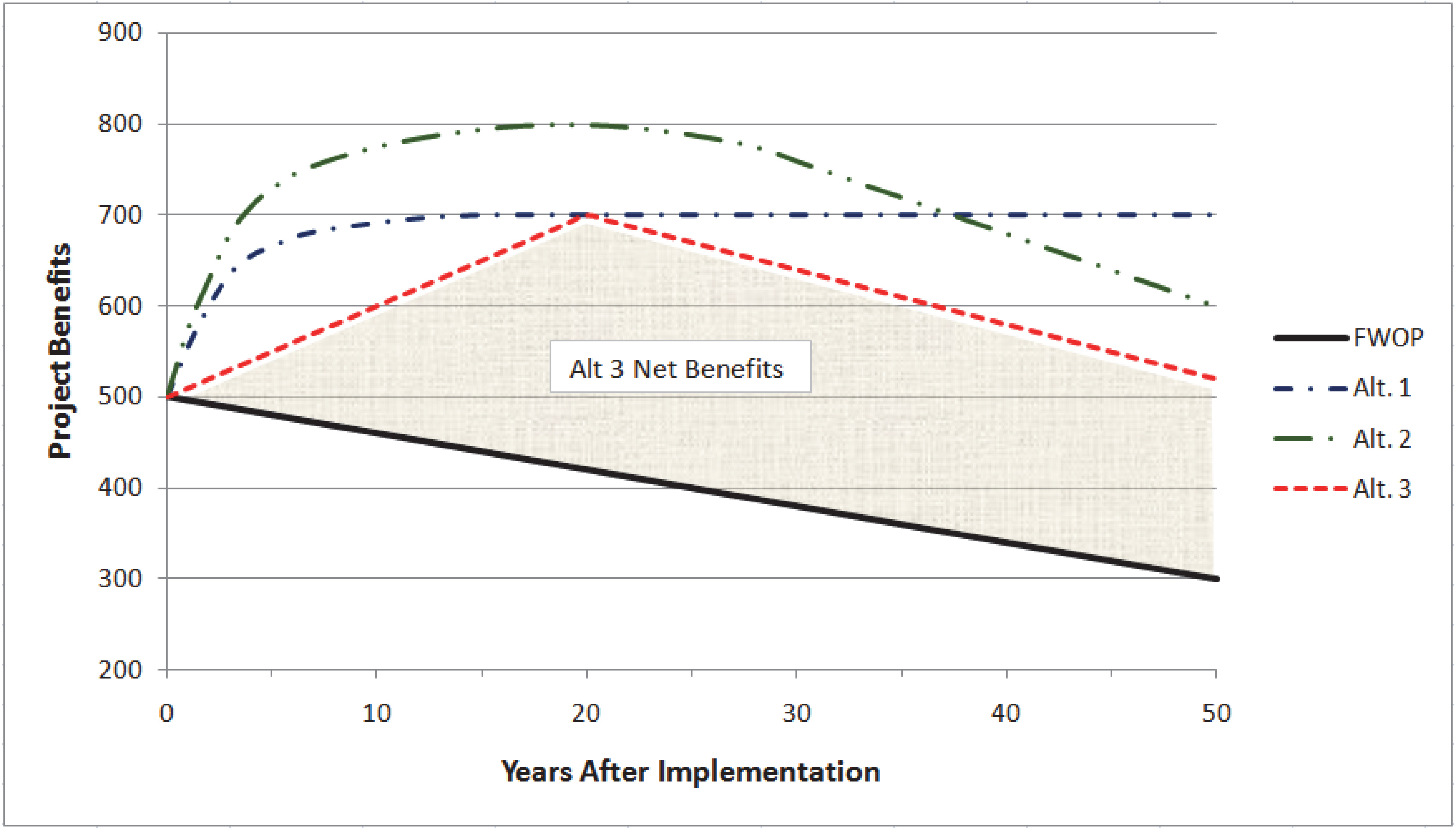
Four elements are required to effectively quantify aquatic ecosystem restoration benefits:

1. A baseline against which ecological changes can be compared (this includes ecological changes in the absence of any project and is the "future without-project" condition).
2. An understanding of ecological changes likely to result from the restoration action (e.g., the "future with" project condition).
3. A timeline (the period of analysis).
4. A mechanism for recognizing and attributing value to changes in ecological conditions (i.e. Is the condition improved or made worse? By how much?).

Basis for Comparison



Basis for Benefit Quantification



Modeling for AM & Plan Formulation

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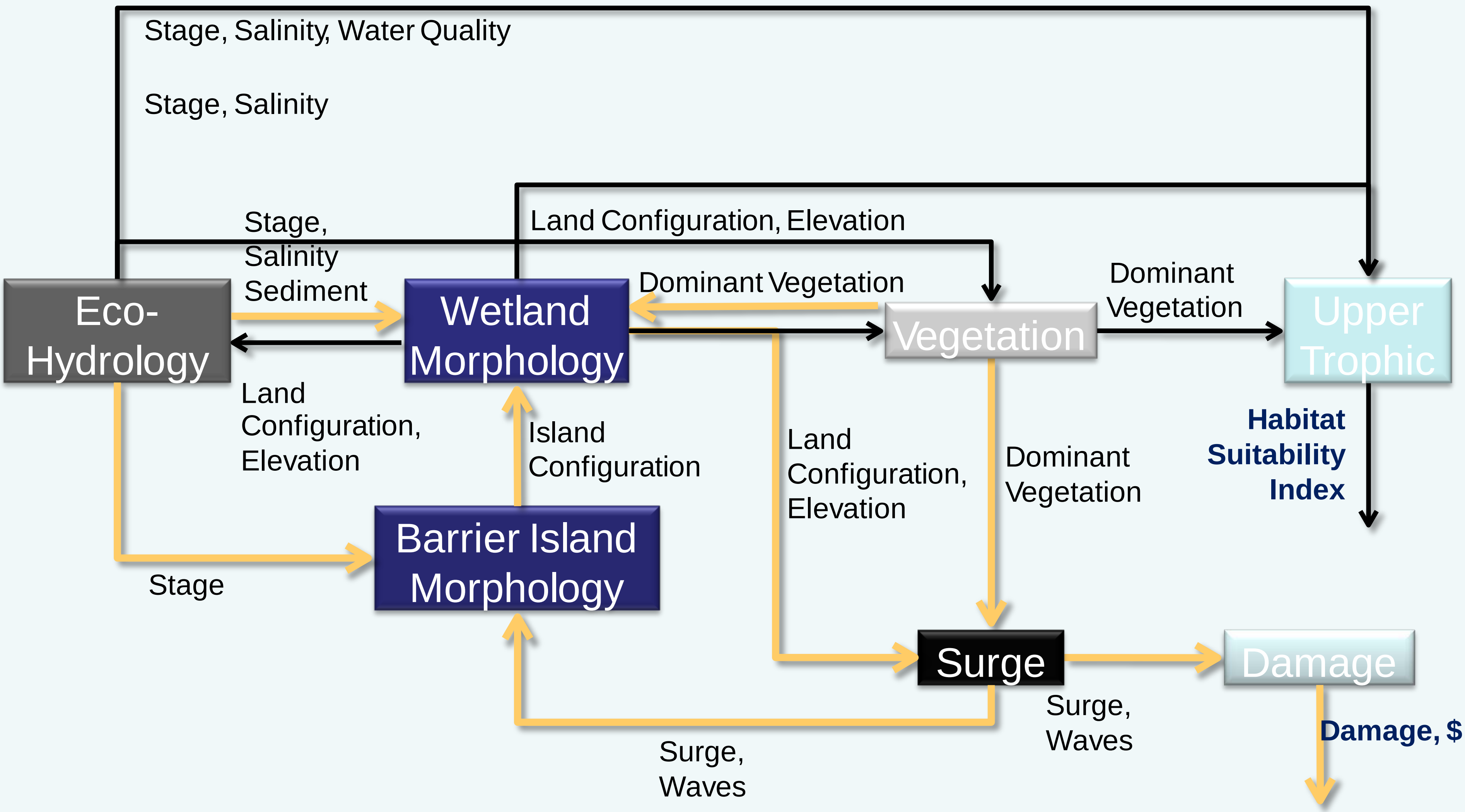
Data Integration



Modeling in Support of AM

Modeling provides:

- Framework for assessing “consequences”
- A mechanism to quantify uncertainty & risk

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, code development, error checking, calibration, verification, validation,…

Adaptive Management Workshop Presentation
07-25-17

The Non-Federal Signatories to the Middle Rio Grande Endangered Species Collaborative Program are committed to a science based adaptive management process. A critical component of this Program must be objective science isolated from political influence that is conducted in a completely open, transparent, and reproducible manner. In the past, entities have selectively distanced themselves from scientific results that they do not like. A structured adaptive management approach should (in a perfect world) create a forum to make decisions that flow from sequential steps. These sequential steps should include:

- Consensus-based framing of problems
- Hypothesis formulation
- Experimentation or testing

One significant benefit of this method is that the Collaborative partners will be in a position to embrace the results and move to the "adjust" phase of management in the adaptive management cycle.

The Middle Rio Grande is unique in a number of aspects, but perhaps the most significant for conducting adaptive management is that the majority of resources subject to management are privately held. One example is that water rights are constitutionally protected property, and the Rio Grande was fully appropriated prior to 1907. This makes genuine stakeholder involvement critical. Additionally, resource managers not only are constrained by ownership issues, but by jurisdictional authorities and funding limitations as well. This makes efficient use of all resources a requirement for all activities. To this end, essential to the adaptive management process is the ultimate utility of projects. That is, while there are many questions that would be interesting to explore regarding endangered species, projects should be prioritized by degree to which results lead to achievable management modifications.

An example of how the organizational process for pursuing adaptive management is:

Conceptual Management Organization for the Middle Rio Grande

- Stakeholder involvement is critical to the Adaptive Management (AM) process.
- AM in the Middle Rio Grande (MRG) should be stakeholder-driven.
- By defining the context and environment of adaptive management, stakeholders directly influence decision making, the opportunity to learn, and the use of learned information in resource management, essential to stakeholder mission.
- Non-Federal stakeholders often have considerable access to, and control of, program resources and infrastructure that are critical to implementation of AM.
- Non-Federal stakeholders can provide funding and services in implementation of AM.

Adaptive Management Cycle for the Middle Rio Grande

- Stakeholders and resource managers should work with scientists to identify a set of resource problems and associated potential linkages and causes.

- Identification of resource problems can lead to a range of possible hypotheses upon which scientists can design and conduct experiments, as part of the learning process.
- Experiments can be conducted in a laboratory setting, or as "condition-dependent" experiments in the field.
- Once resource problems are identified, hypotheses should be evaluated and prioritized by a Science Review Panel (SRP) and a Science Coordinator (SC), in collaboration with stakeholders.
- Identified research and monitoring (R&M) projects should be implemented as part of a Short-Term Plan (updated every 3-5 years) and a Long-Term Plan.
- The body of working scientists in the MRG should conduct the work in the field under the guidance of the SRP and the SC.
- Research and monitoring results are reported in an Annual Science Reporting (ASR) Meeting, with exchange among scientists, stakeholders, and resource managers on results, interpretation, and modification of R&M projects.
- Results of the ASR Meeting are assimilated by the Science Coordinator and presented to the Executive Committee to make decisions on (a) new projects, (b) ongoing projects that move forward, (c) ongoing projects that move forward with modification, and (d) ongoing projects that are discontinued.
- Once experimentation has established causation, the experimental phase can be transitioned into management policy that becomes part of ongoing program management.

Conceptual Modeling

Craig Fischenich

ERDC Environmental Laboratory

PROSPECT Ecosystem Restoration
June 29, 2017
Missoula, MT

Why Discuss Conceptual Models?

Engineer Research and Development Center

Environmental Advisory Board recommended that:

"The Corps should encourage the explicit use of conceptual models to guide ecosystem restoration planning and implementation. Conceptual models should be required as a first step in the planning process, as they provide a key link between early planning (e.g., an effective statement of problem, need, opportunity, and constraint) and later evaluation and implementation." (EAB 2006)

Aug 13, 2008 Memo from CECW-CP Re: Policy Guidance on Certifying Models

"Recommendation regarding the importance, use and review of conceptual models is adopted" (refers to ECO-PCX white paper):

Conceptual models should be developed for all ER projects, but will be reviewed as part of the normal ITR process and do not require certification.

What Are Conceptual Models?

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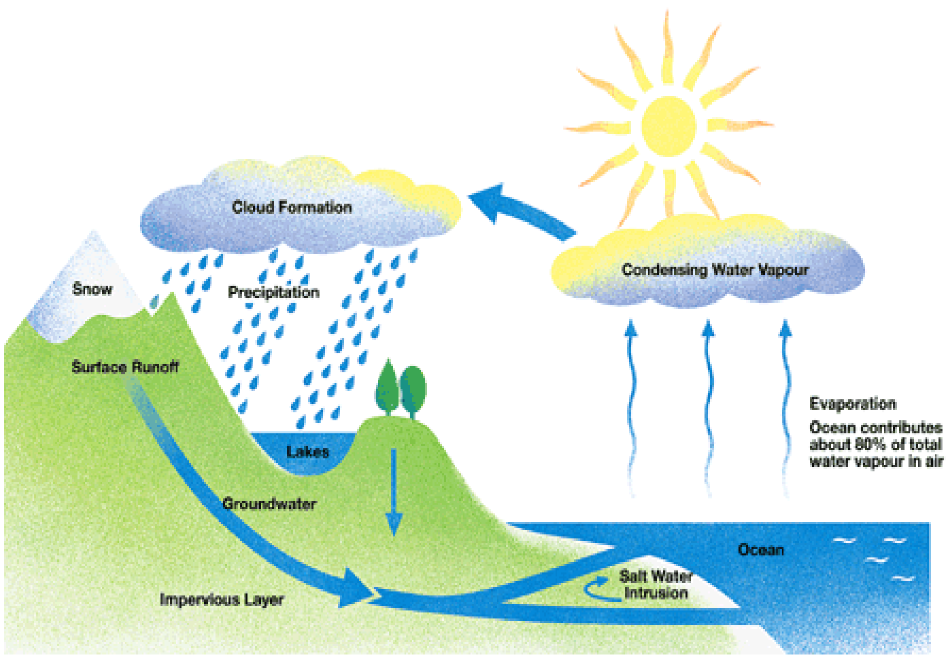
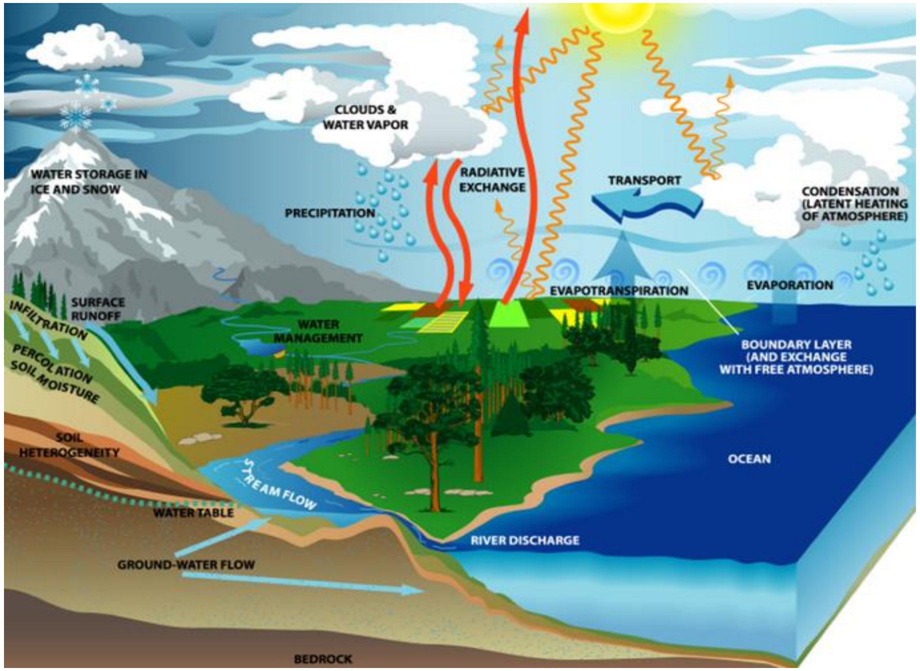
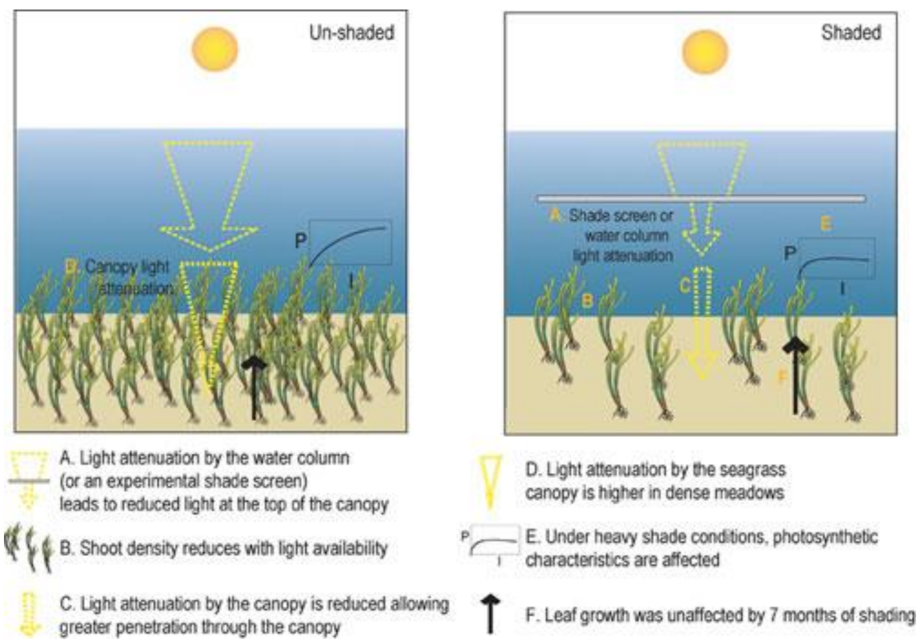
A conceptual model is a tentative description of a system or sub-system that serves as a basis for intellectual organization.

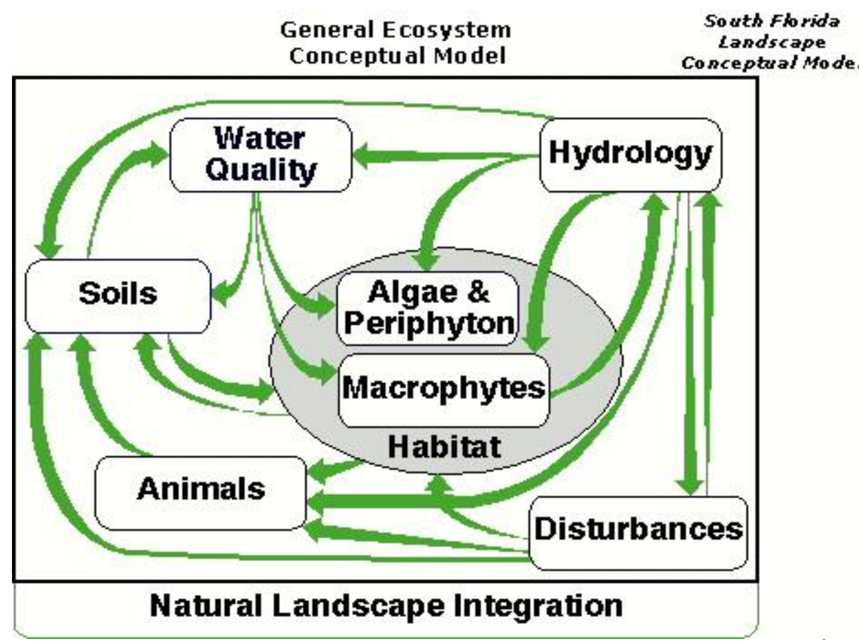




What CM's Do

Conceptual models describe general functional relationships among essential ecosystem components. They tell the story of "how the system works."





Example –
River Continuum Concept

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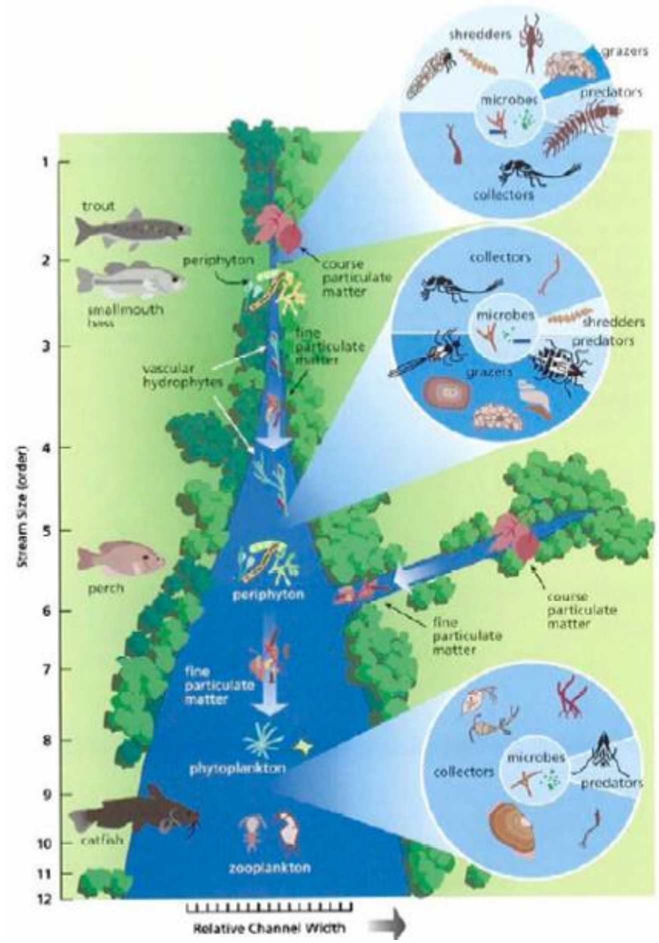
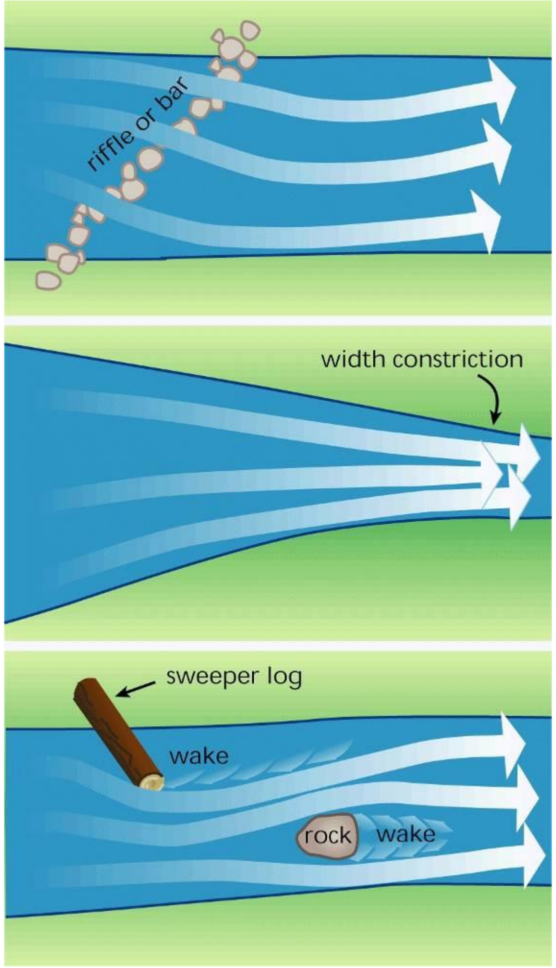
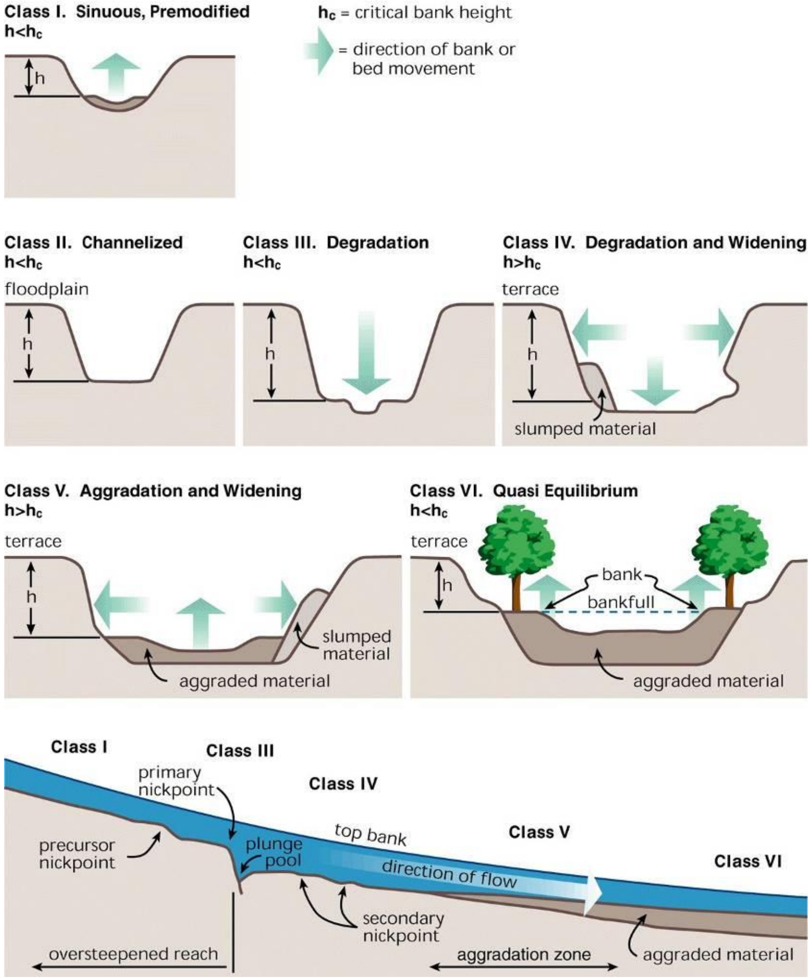
A river's biological and chemical processes correspond to its physical attributes. The nature of biological communities changes in a downstream direction in relation to the changing, but predictable physical structure. This means that the structure of the biological communities is also predictable and that the communities adapt to the particular conditions of a stretch of stream.



(Vannote et. al. 1980)

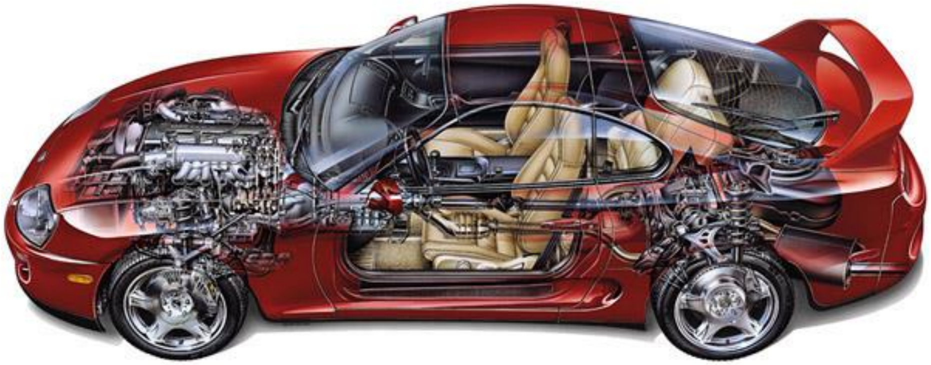
Examples – Hydraulic Structure and Channel Evolution Model





Perspective Matters

- The same system can have many potential conceptual models
- CMs reflects our personal understanding and viewpoint

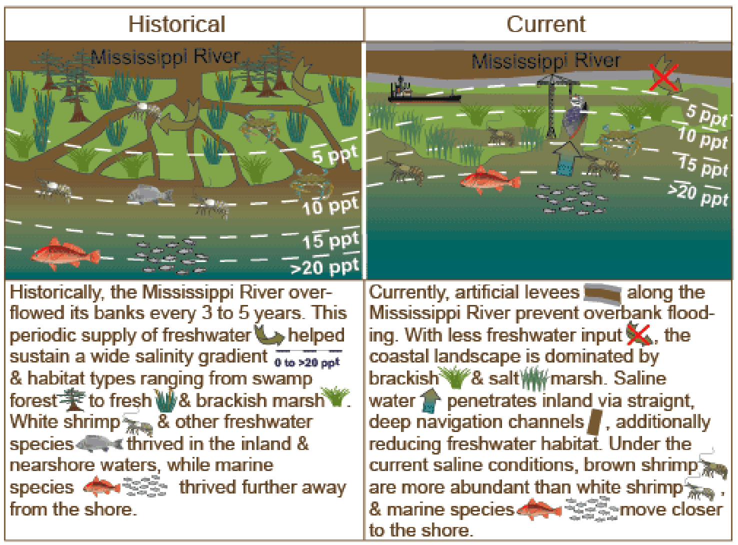


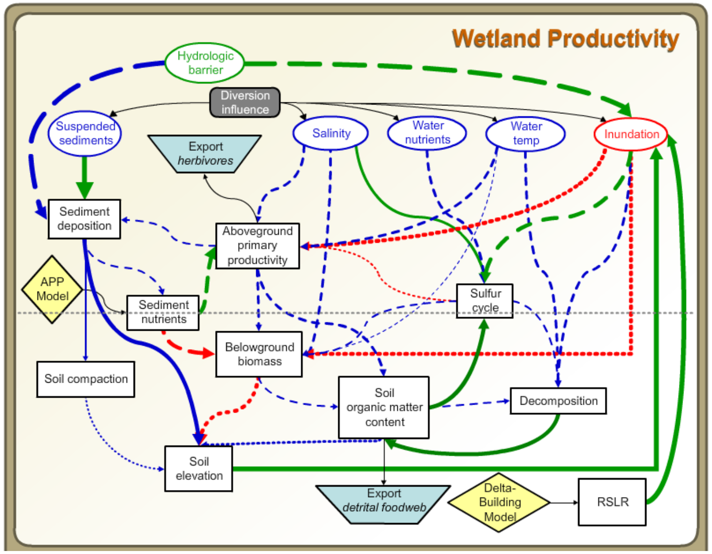
Conceptual Models are NOT:

- ***The truth*** – they are simplified depictions of reality
- ***Comprehensive*** – they focus only upon those parts of an ecosystem deemed relevant while ignoring other important (but not immediately germane) elements
- ***Final*** – they provide a flexible framework that evolves as understanding of the ecosystem increases

How are Conceptual Models Used?

- Means of Organization and Communication
- Facilitate Alternative Formulation & Detailed Analyses
- Basis for Numerical Models (e.g. Benefits Assessment)
- Metrics, Monitoring and Adaptive Management





Example models from Coastal Louisiana Ecosystem Assessment & Restoration website, http://www.clear.lsu.edu/conceptual_ecological_models/

Common Misconceptions

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A model cannot be built with incomplete understanding.

Managers make decisions with incomplete information all the time! This should be an added incentive for model-building as a statement of current best understanding.

A model must be as detailed and realistic as possible.

If models are constructed as 'purposeful representations of reality', then design the leanest model possible. Identify the variables that make the system behave and join them in the most simple of formal structures.

(Starfield et al. 1997)

Approach to Development

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1. State the model objectives and ID audience(s).
2. Bound the system of interest.
3. Identify critical model components within the system of interest.
4. Articulate the relationships among the components of interest.
5. Represent the conceptual model using an appropriate form (sometimes multiple models).
6. Describe the expected pattern of model behavior.
7. Test, review and revise as needed (including removal of non-relevant components).

Classes of Conceptual Models

Three Common Constructs:

1. Control
2. State and Transition
3. Driver-Stressor

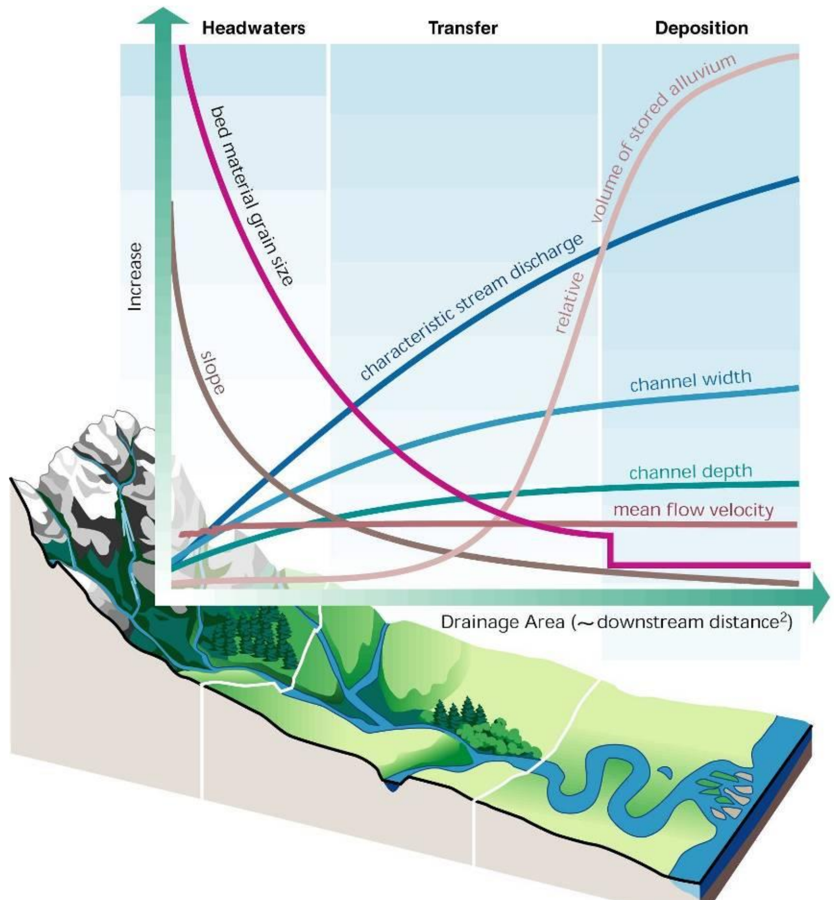
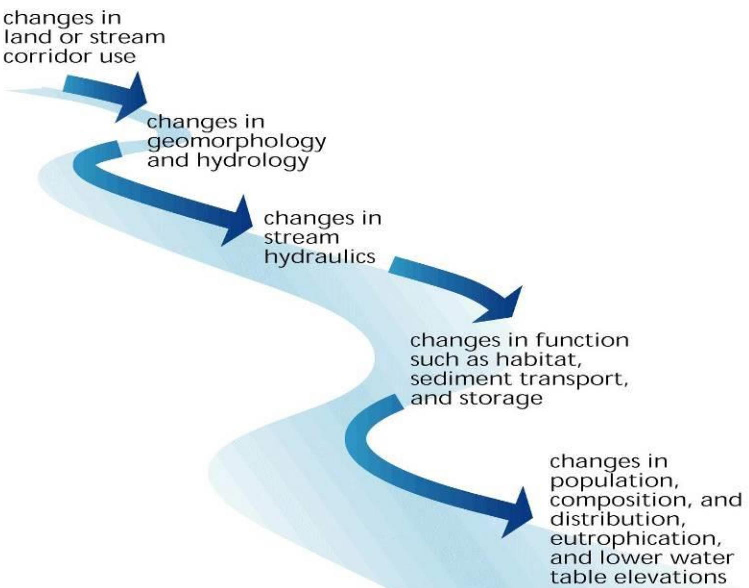
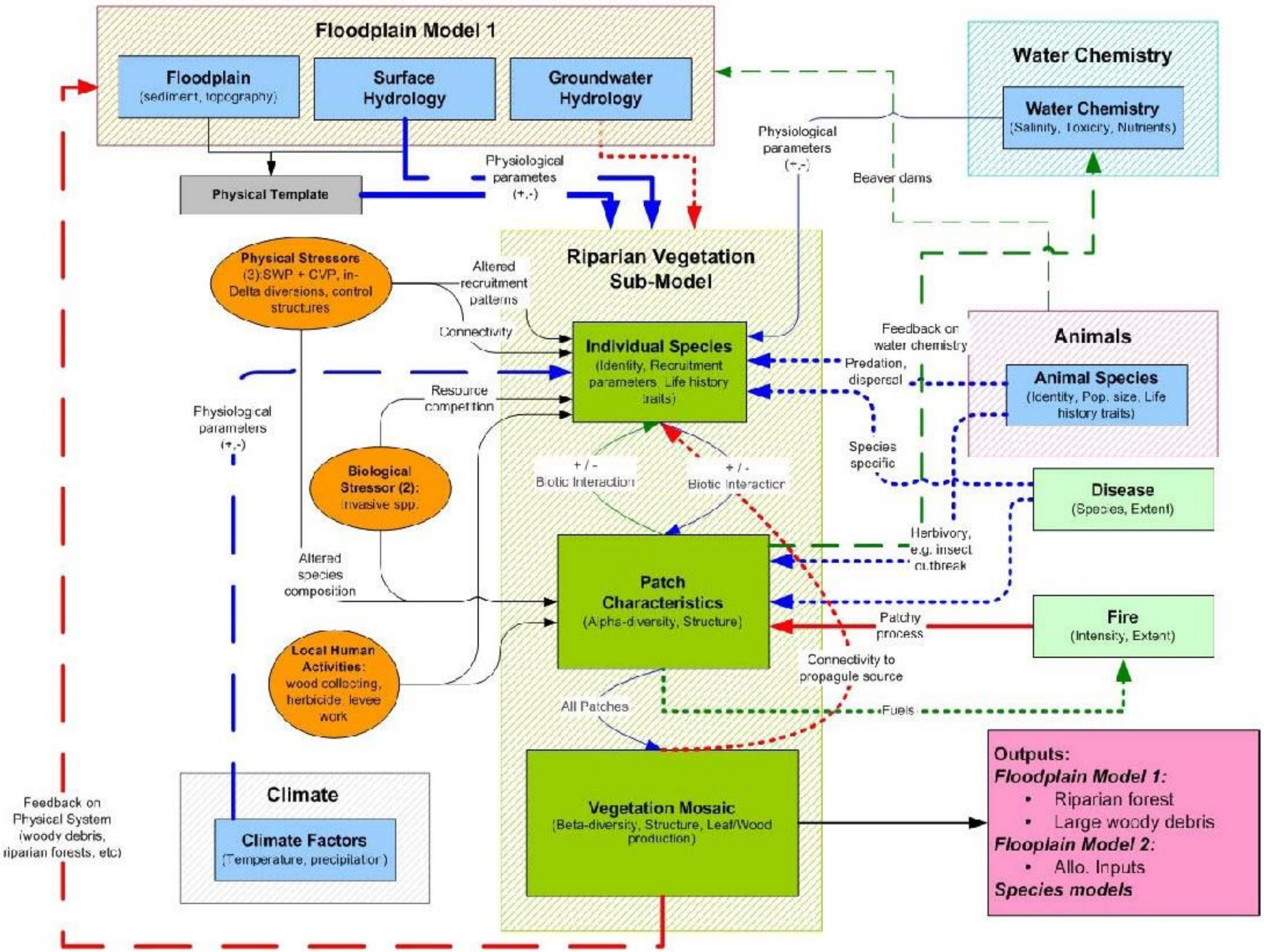


Fig. 1.28r: Changes in the channel in the three zones. Flow, channel size, and sediment characteristics change throughout the longitudinal profile. In Stream Corridor Restoration: Principles, Processes, and Practices, 10/98. by the Federal Interagency Stream Restoration Working Group (FISRWG) (15 federal agencies of the US government).



Control Model



State-Transition

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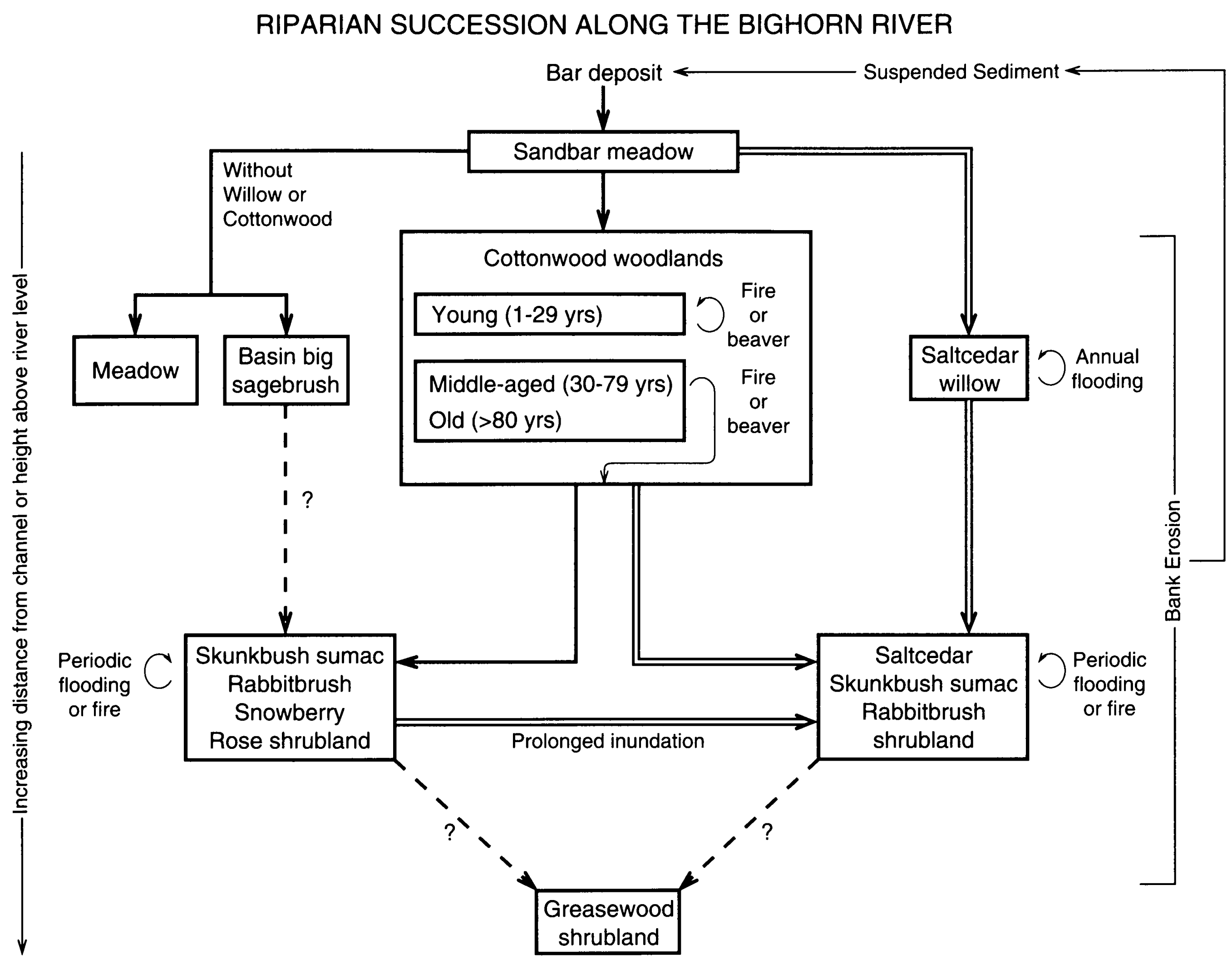

Driver-Stressor

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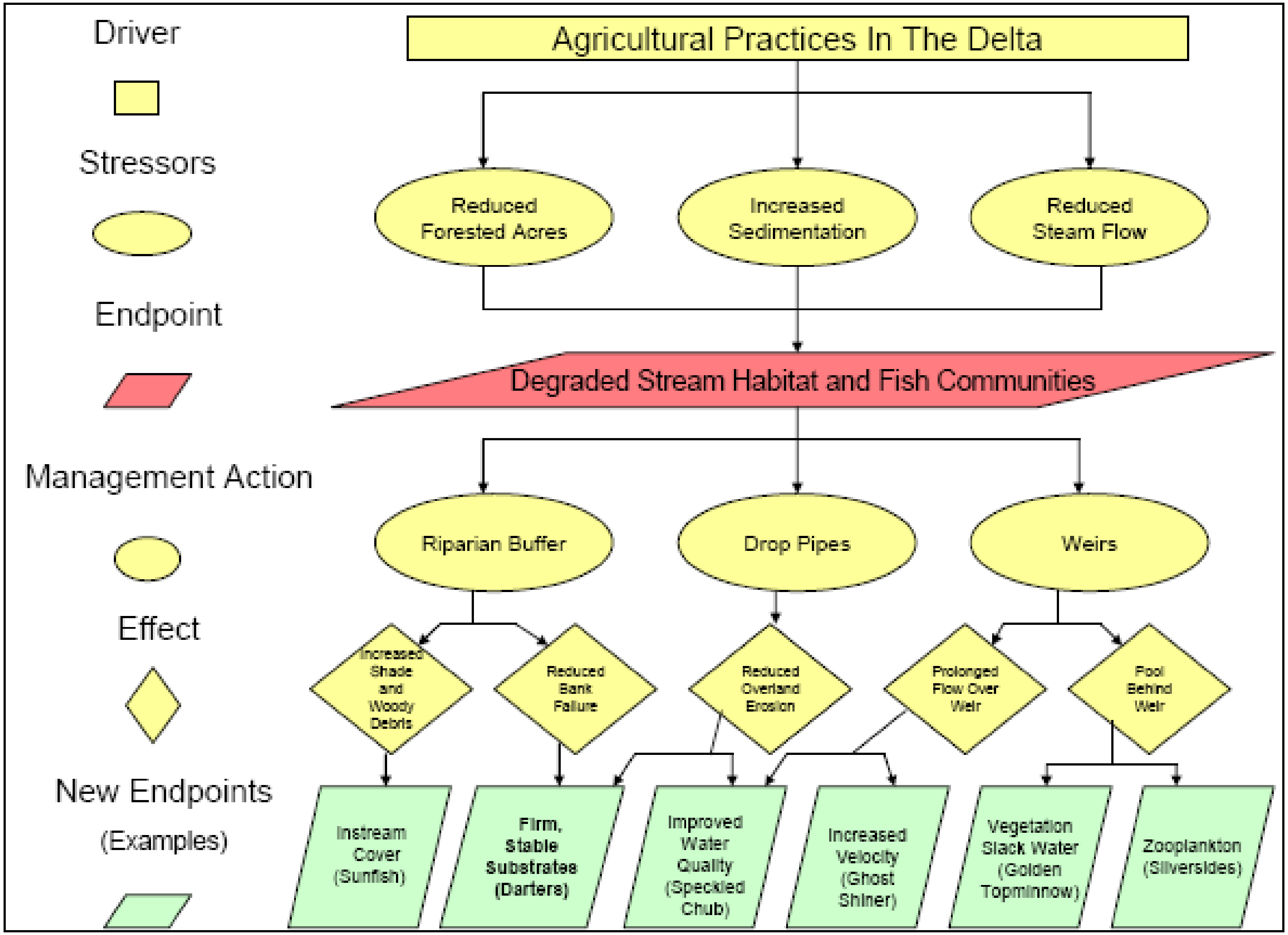

(Killgore 2007)

Model Strengths and Weaknesses

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CONTROL MODELS

- accurately represent feedbacks and interactions
- usually most realistic structure
- numerous insights derived from their construction
- often complicated and hard to communicate
- state dynamics may not be apparent

STATE AND TRANSITION

- permit clear representation of alternative states
- can be simple
- excellent communication with most audiences
- often lack mechanisms of change
- often too general to directly link to triggers

DRIVER-STRESSOR MODELS

- provide clear link between agent of change and state
- simple and easy to communicate
- no feedbacks
- few or no mechanisms
- frequently inaccurate and incomplete

Common Form for USACE

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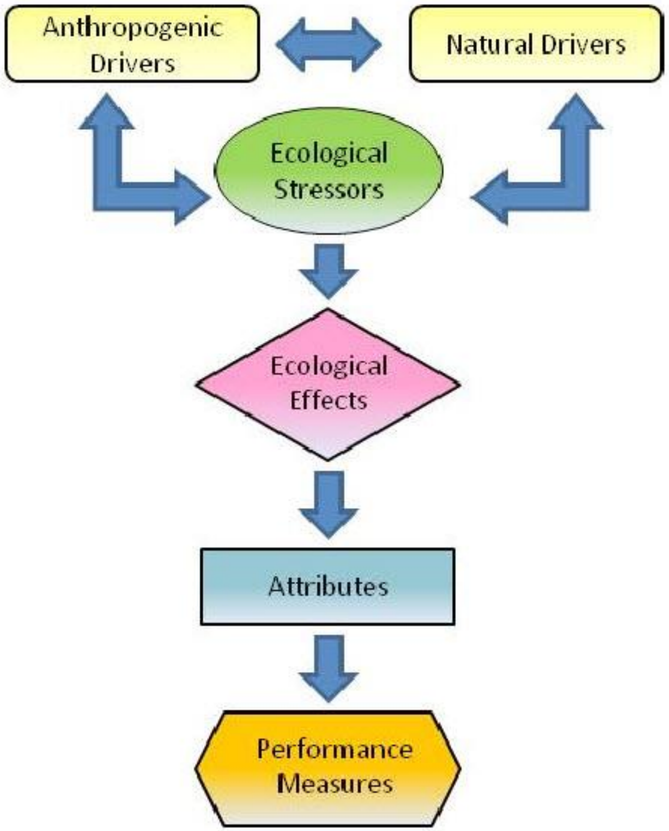
Driver-Stressor-Ecological Response

- Drivers
- Ecological Stressors
- Ecological Effects
- Attributes
- Performance measures
  - Strength of relationship
  - Key uncertainties
  - Importance



White Ditch CEM

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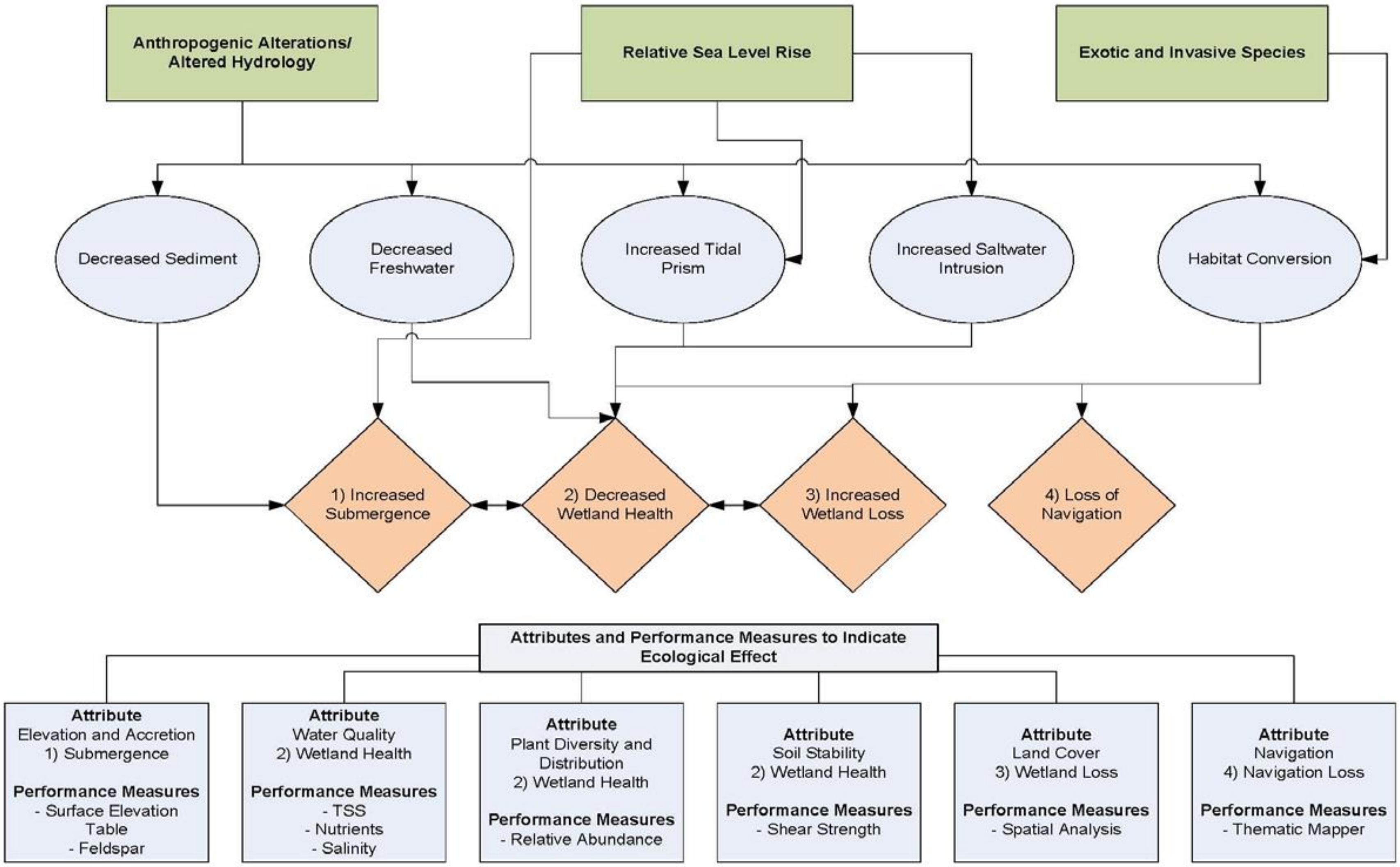

Nesting of Models

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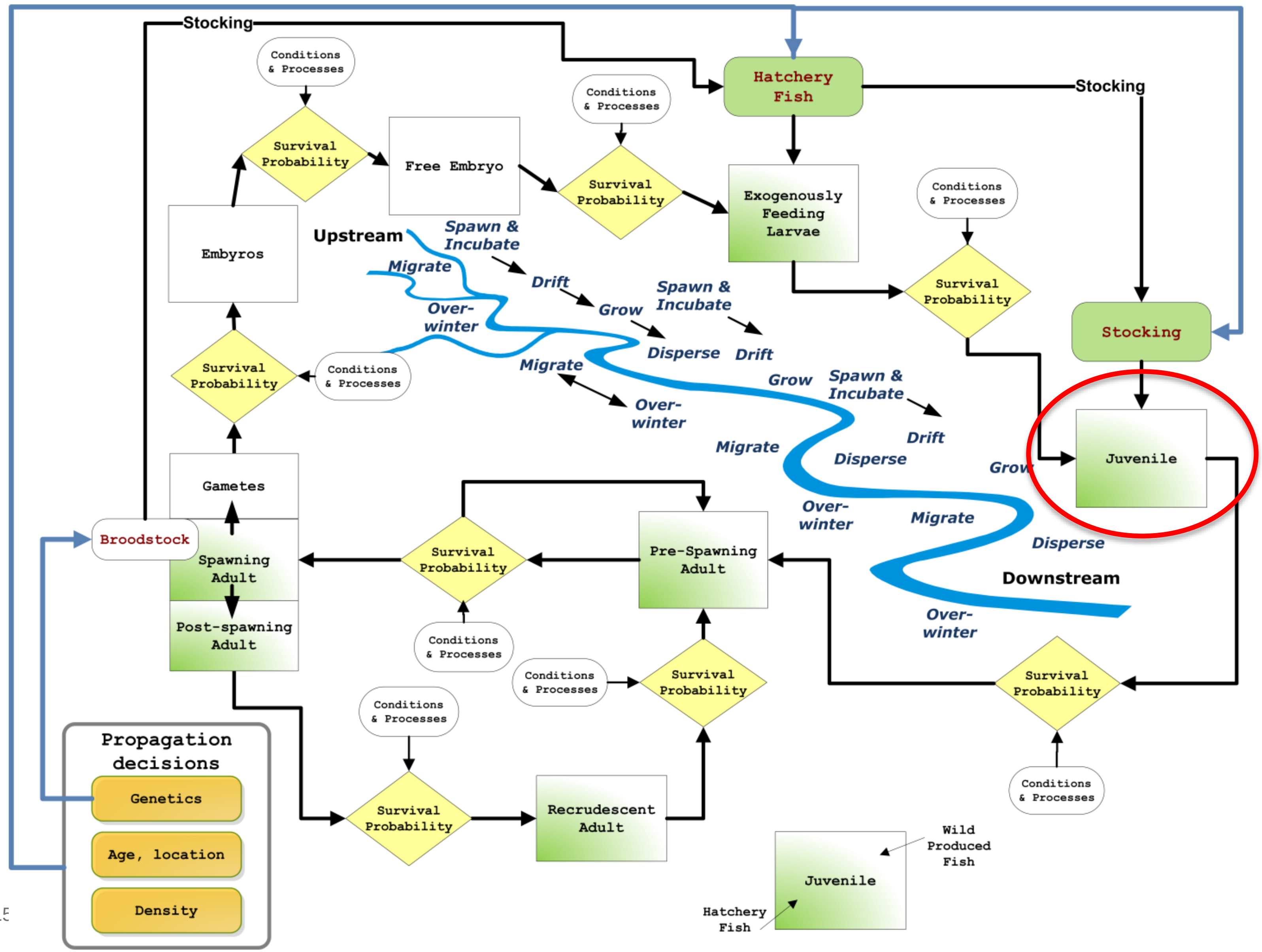
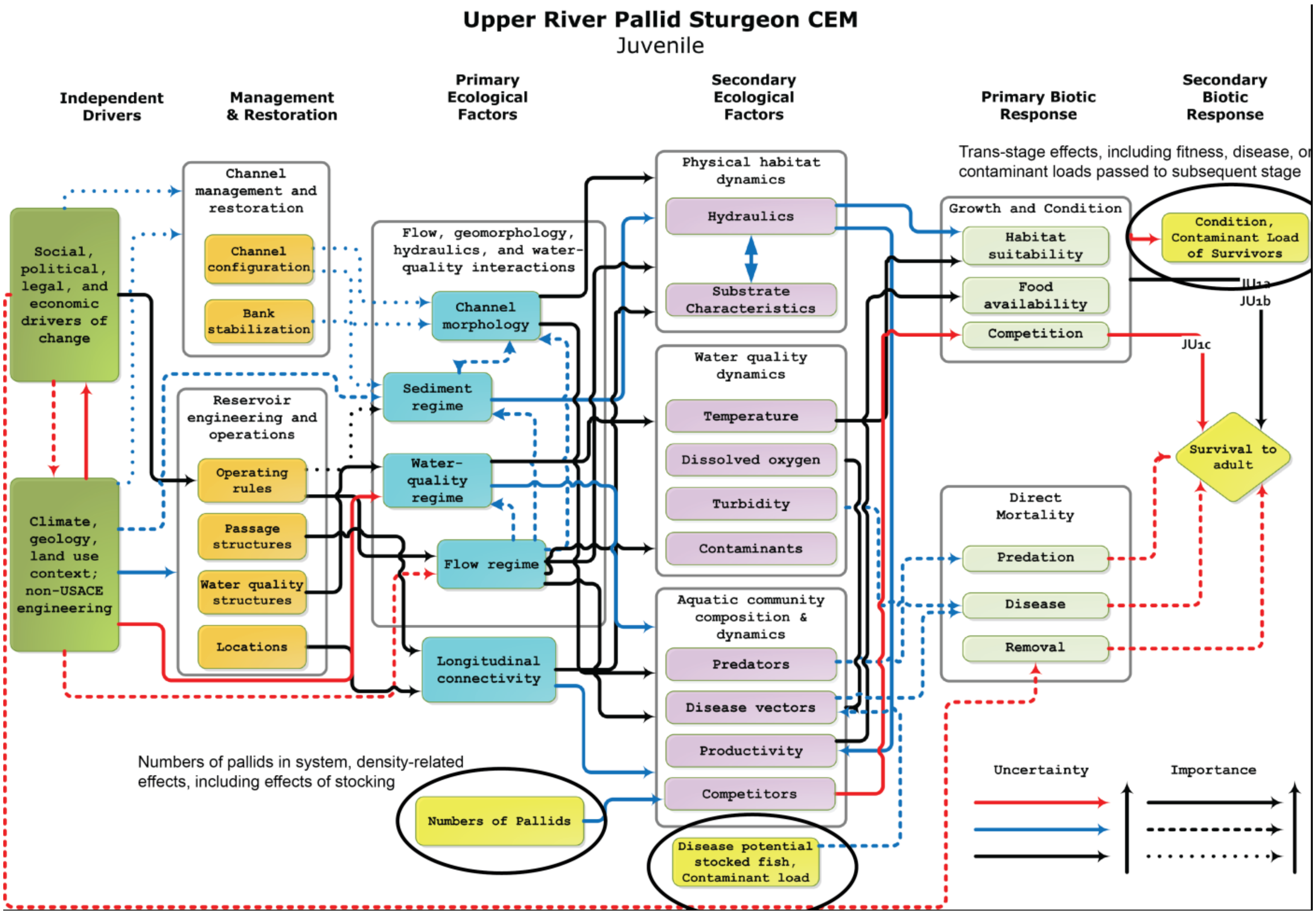


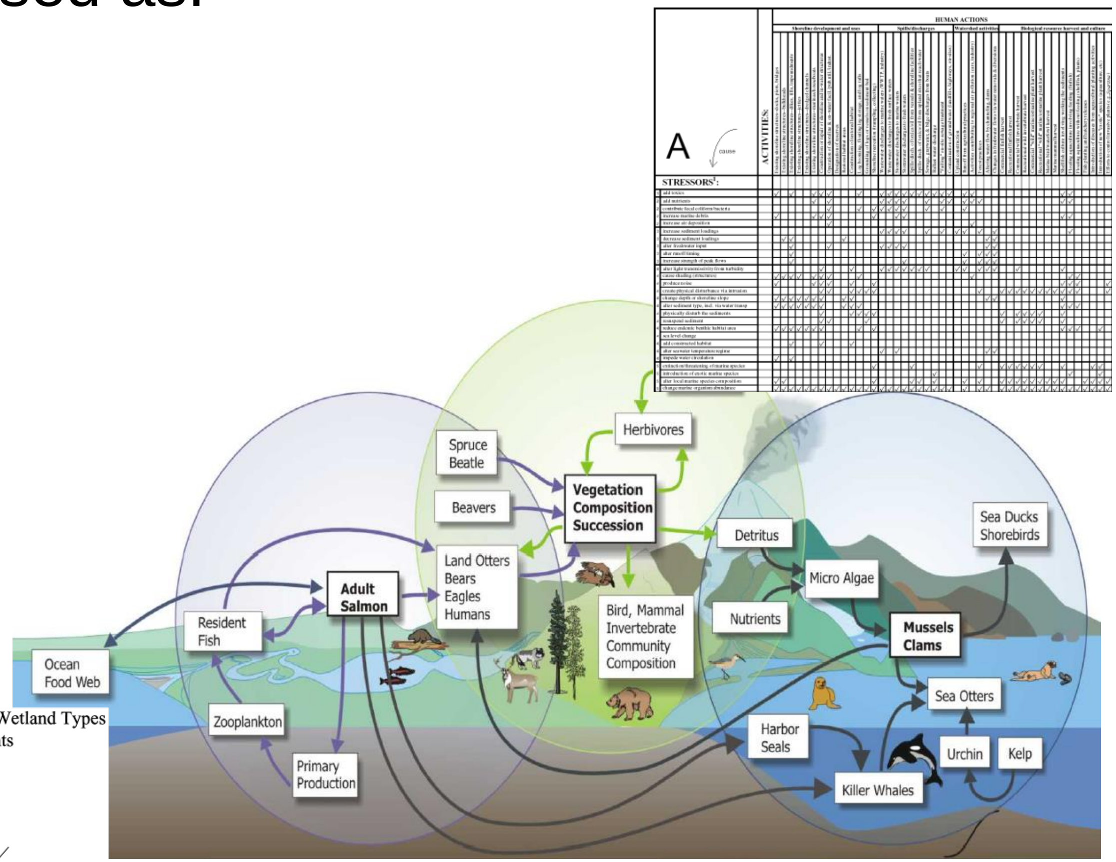
Pallid Sturgeon Juvenile Stage

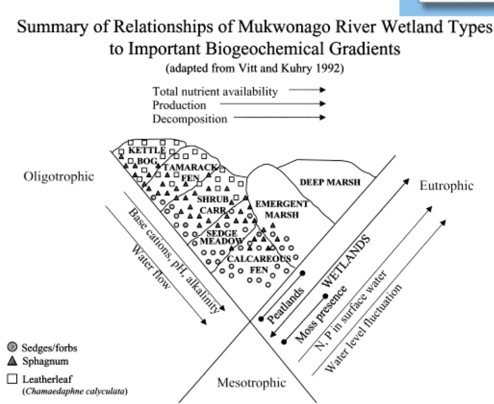


Forms of Conceptual Models

Most commonly expressed as:

- Narrative
- Graphical
- Box Diagram
- Matrix/Tabular





Jorgensen (1988) lists 10 forms

Limited Narrative
Ponderosa Pine State and Transition Model

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Desirable park-like stand
- grassy understory
- ~ 100 trees/ac
- frequent "cool" ground fires
- fires extensive and patchy
- minimal influence by exotics

Overgrazing, fire suppression

Prescribed burning, thinning

Moderately dense even or mixed-aged stand
- many saplings
- infrequent fire due to suppression or non-continuous ground fuel
- fires likely to be intense, extensive, and stand-replacing

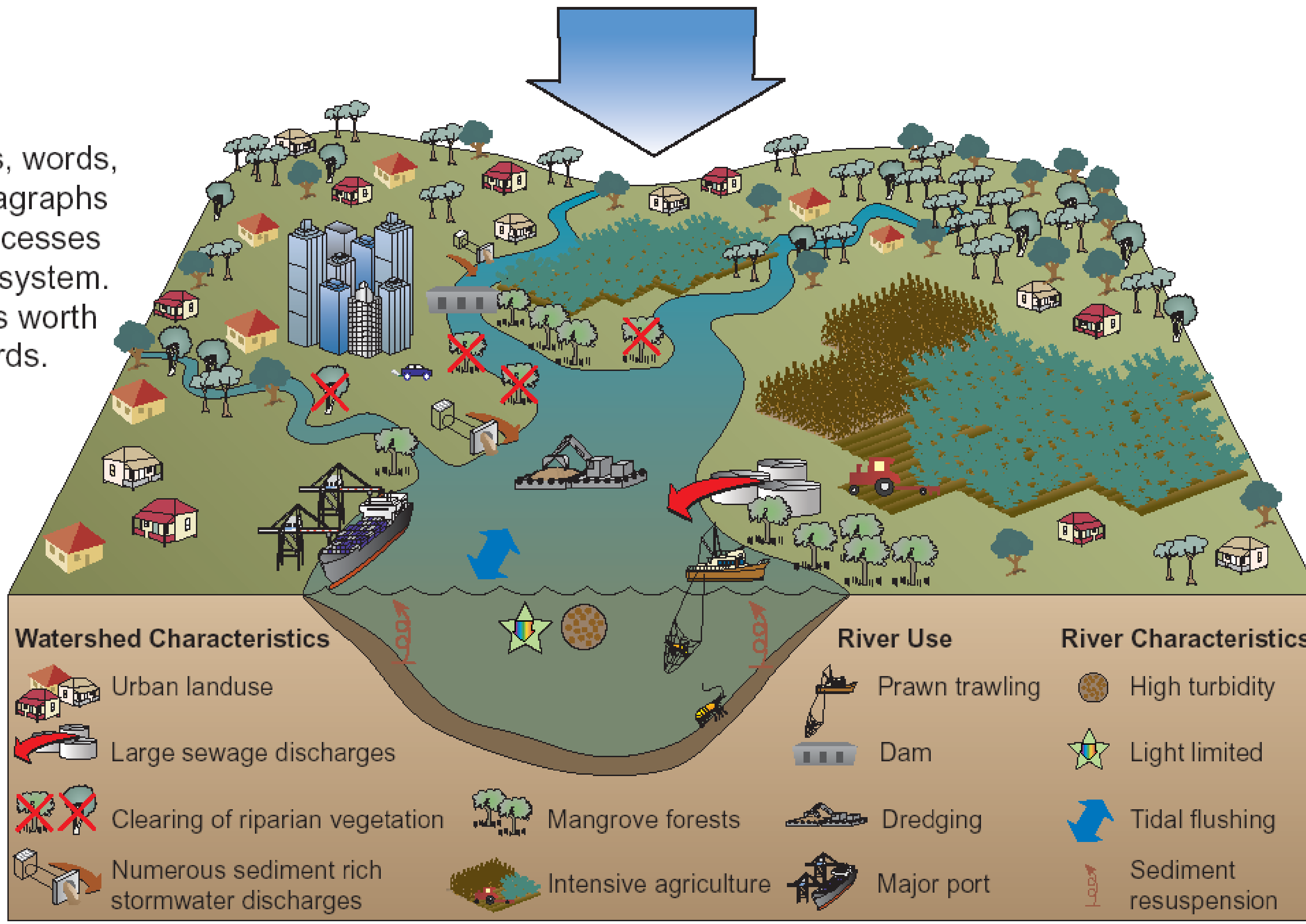
Intense crown fires

Thin and burn?

Dense even-aged stand
- stand-replacing fires frequent or infrequent
- understory vegetation sparse
- fuel load large and continuous
- fires intense and spatially extensive

Graphical

It takes many letters, words, sentences and paragraphs to describe the processes that make up an ecosystem. In short, a picture is worth a thousand words.



Box Diagram Aquatic Model

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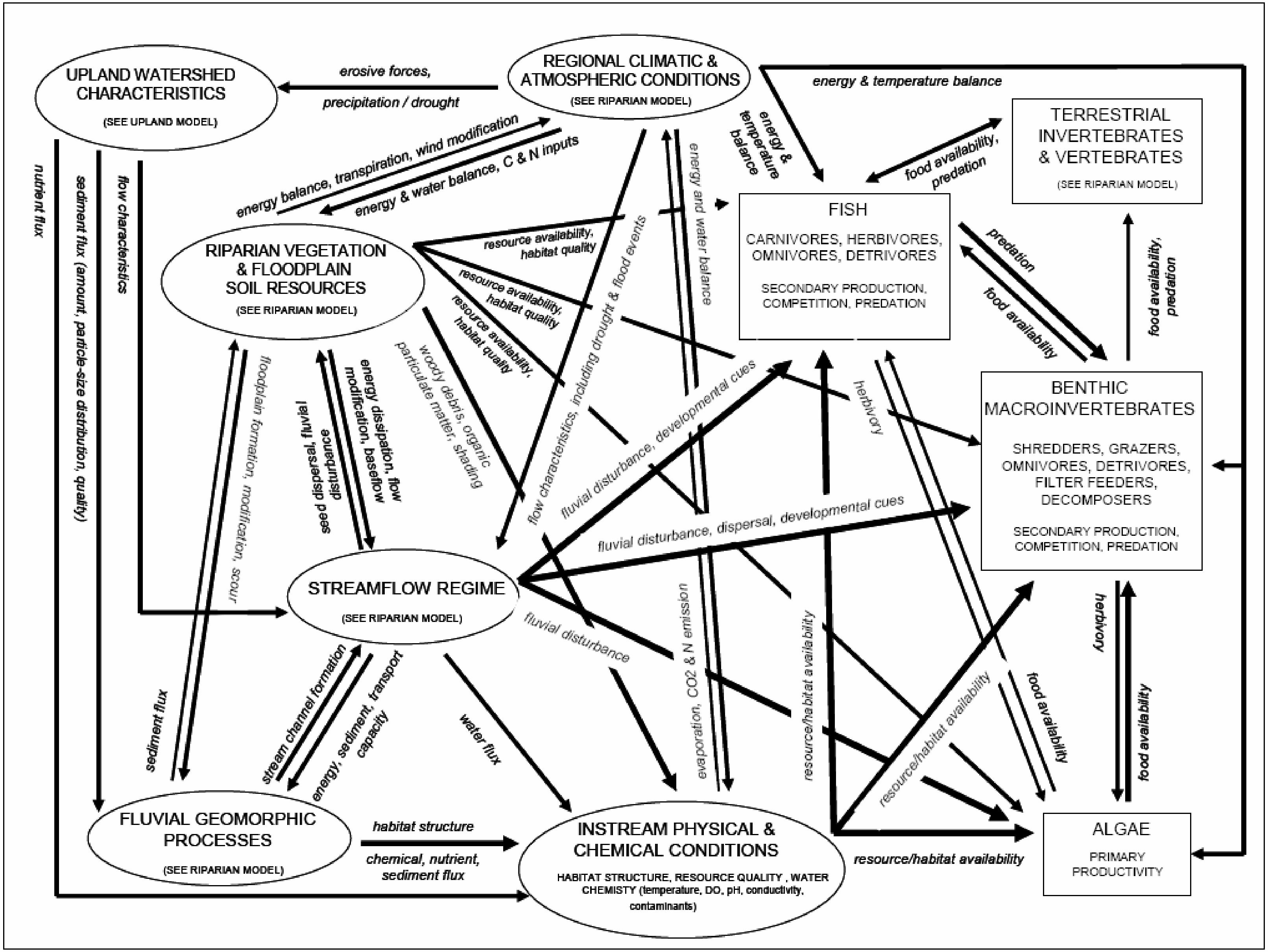

Tabular

Habitat	Salinity (yearly average)	Source for Salinity Restrictions	Inundation (% of year)	Source for Inundation Restrictions
Bottomland Hardwood	< 2 ppt	Conner et al. (1997)	< 30%	Conner et al. (1997)
Swamp Forest	< 4 ppt	Höppner (2002)	Up to whole year if not stagnant	Höppner (2002)
Fresh Floating Marsh	< 2 ppt	Chabreck (1970), Hester et al. (2002)	Not Applicable	
Fresh Attached Marsh	< 2 ppt	Chabreck (1970)	Up to whole year if not stagnant and below 30 cm of water on marsh	Evers et al. (1998)
Intermediate Marsh	2-6 ppt	Chabreck (1970)	Up to whole year if not stagnant and below 30 cm of water on marsh	Evers et al. (1998)
Brackish Marsh	6-15 ppt	Chabreck (1970)	< 64%A	Sasser (1977)
Saline Wetlands	> 15 ppt	Chabreck (1970)	< 80%A	Sasser (1977)

Comparison of Model Types

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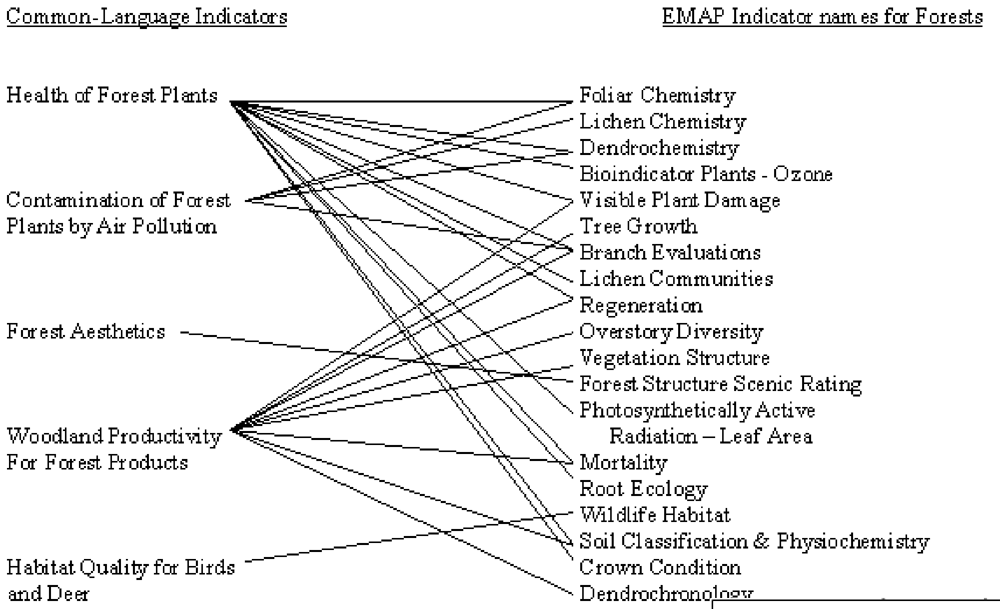
Type of model	Description	Strengths	Drawbacks
Narrative	Use word descriptions, mathematical or symbolic formula	Summarizes literature, information rich	No visual presentation of important linkages
Tabular	Table or two-dimensional array	Conveys the most information	May be difficult to comprehend amount of information
Picture models	Depict ecosystem function with plots, diagrams, or drawings	Good for portraying broad-scale patterns	Difficult to model complex ecosystems or interactions
Box and arrow (Stressor model)	Reduce ecosystems to key components and relationships	Intuitively simple, one-way flow, clear link between stressor and vital signs	No feedbacks, few or no mechanisms, not quantitative
Input/output matrix (Control model)	Box and arrow with flow (mass, energy, nutrients, etc.) between components	Quantitative, most realistic, feedback and interactions	Complicated, hard to communicate, state dynamics may not be apparent

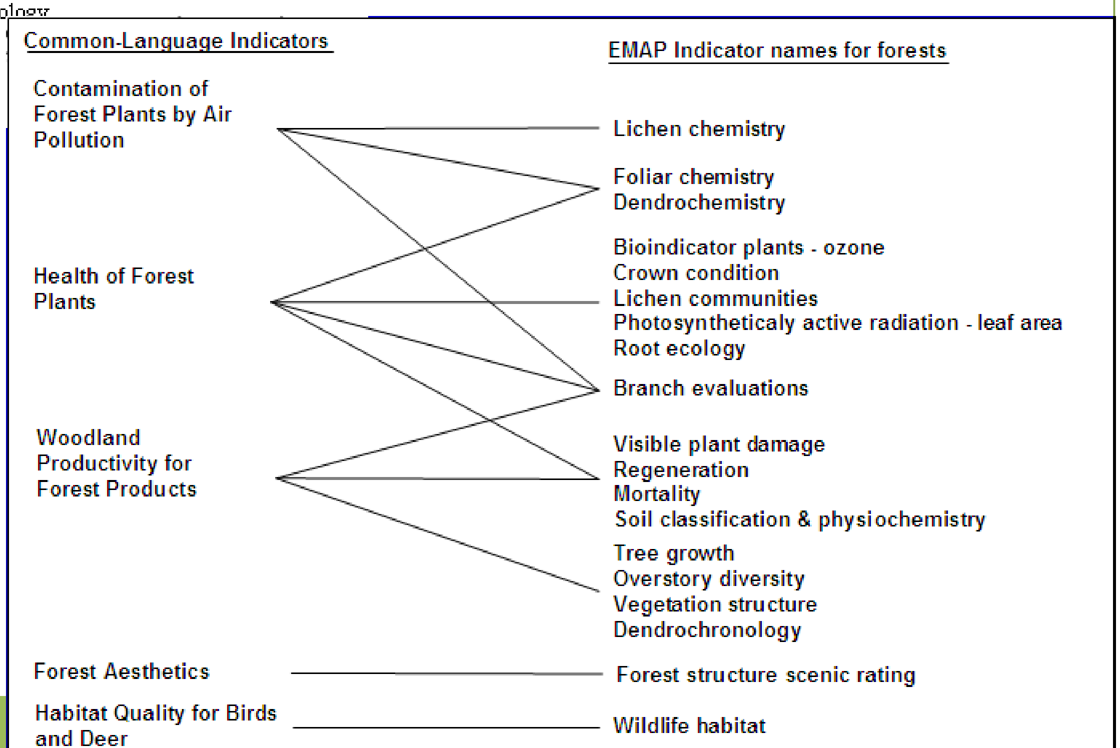
(Gucciardo 2004)

Craft Matters

Help readers by grouping related elements, aligning elements, and minimizing crossed lines.



These are the same!



Presentation Tips

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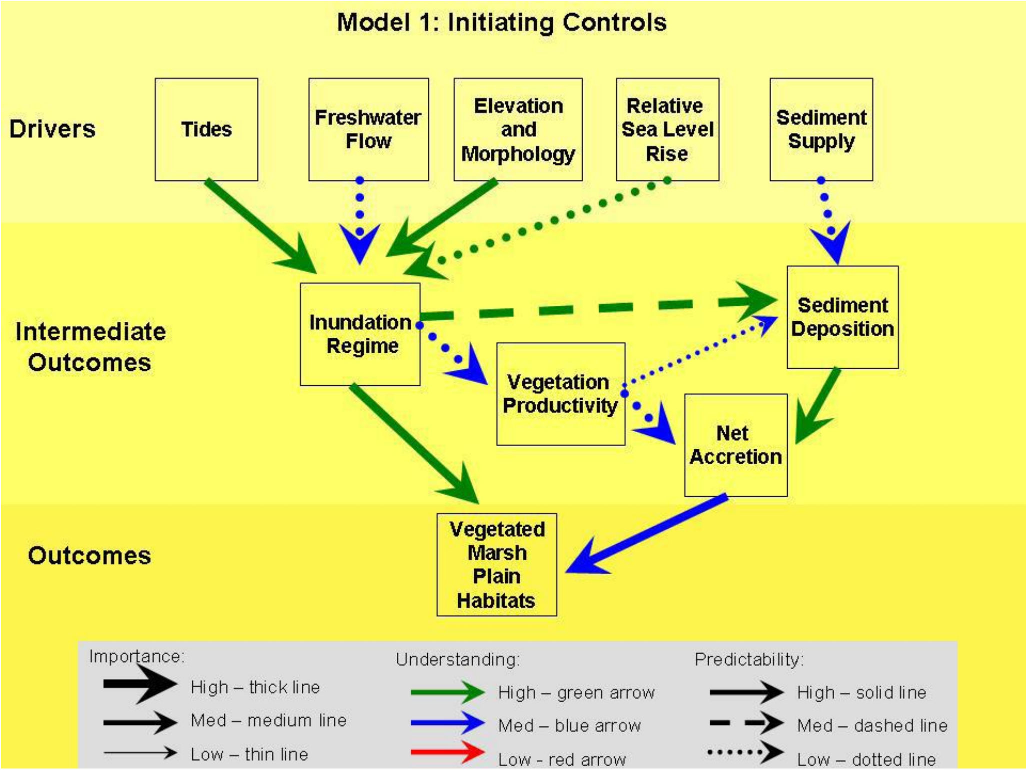
- Combine graphical and narrative descriptions
- Organize categorically: align components, both horizontally and vertically
- Use line weights, colors and types to provide info
- Aggregate lines when possible
- Avoid shaded boxes, colors or other elements that photocopy poorly
- Use colors and shapes, but limit complexity
- Maximize 'content' but remove non-relevant components & links



Good conceptual models should include the following:

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- Those physical, chemical and biological attributes of the system that determine its dynamics.
- The mechanisms by which ecosystem drivers, both internal (e.g., flow rates) and external (e.g., climate), cause change with particular emphasis on those aspects of the system where the Corps can effect change.
- Critical thresholds of ecological processes and environmental conditions
- Discussion of assumptions and gaps in the state of knowledge, especially those that limit the predictability of restoration outcomes.
- Identification of current characteristics of the system that may limit the achievement of management outcomes.
- Adequate references to substantiate the model.

Summary

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- Conceptual ecological models (CEMs) are an underutilized tool
- CEMs are required for ecosystem restoration projects - should be developed early in the process and revised/updated as needed
- Uses for CEMs include:
  1. Means of organization and communication
  2. Facilitate alternative formulation & detailed analyses
  3. Basis for numerical models (e.g. benefits assessment)
  4. Metrics, monitoring and adaptive management
- Process for development:
  1. State the model objectives, including audience(s).
  2. Bound the system of interest.
  3. Identify critical model components within the system of interest.
  4. Articulate the relationships among the components of interest.
  5. Represent the conceptual model using an appropriate form.
  6. Describe the expected pattern of model behavior.
  7. Test, review and revise as needed (including removal of non-relevant components).
- Encourage use through guidance, training, and software that facilitates design, construction, and presentation

References

Fischenich, C. 2008. *The Application of Conceptual Models to Ecosystem restoration*. EBA Technical Notes Collection. ERDC TN-EBA-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center. *www.wes.army.mil/el/emrrp*.

Henderson, J. E., and L. J. O'Neil. 2007a. Template for conceptual model construction: Model review and Corps applications. ERDC TN-SWWRP-07-4. Vicksburg, MS: U.S. Army Engineer Research and Development Center. https://swwrp.usace.army.mil/

Henderson, J. E., and L. J. O'Neil. 2007b. Template for conceptual model construction: model components and application of the template. SWWRP Technical Notes Collection, ERDC TN-SWWRP-07-x. Vicksburg, MS: U.S. Army Engineer Research and Development Center. https://swwrp.usace.army.mil/

CEMCAT Software Download at:

http://cw-environment.usace.army.mil/eba/cemcat.cfm

Questions?

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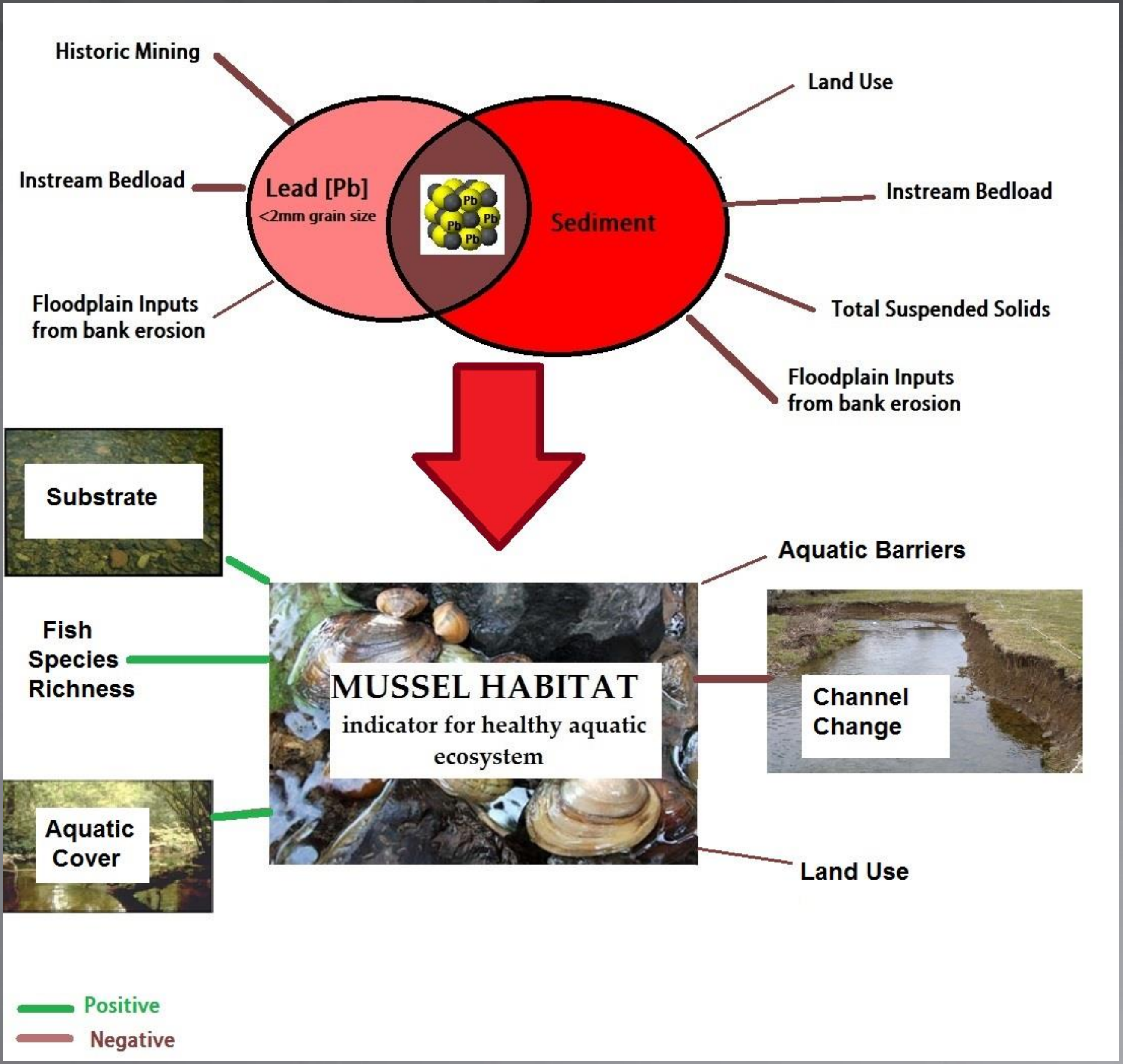

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AM Governance, Data Management, Reporting and Communications

Craig Fleming
Craig Fischenich

Office of Research and Technology Transfer
Adaptive Management Workshop
Albuquerque, NM
25-28 July, 2017

AM Governance

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- Governance is a term used to describe the approach for converting knowledge into improved management through decision making. It includes:
  - **what** decisions need to be made,
  - **who** is involved in the decision process,
  - **how** decisions are made, and
  - **when** decisions are required.
- Other functional purposes of governance include:
  - Program administration
  - Trust-building
  - Knowledge generation
  - Collaborative learning
  - Preference formation (including trade-off analysis)
  - Conflict resolution

AM Tech Guide Implementation Schematic

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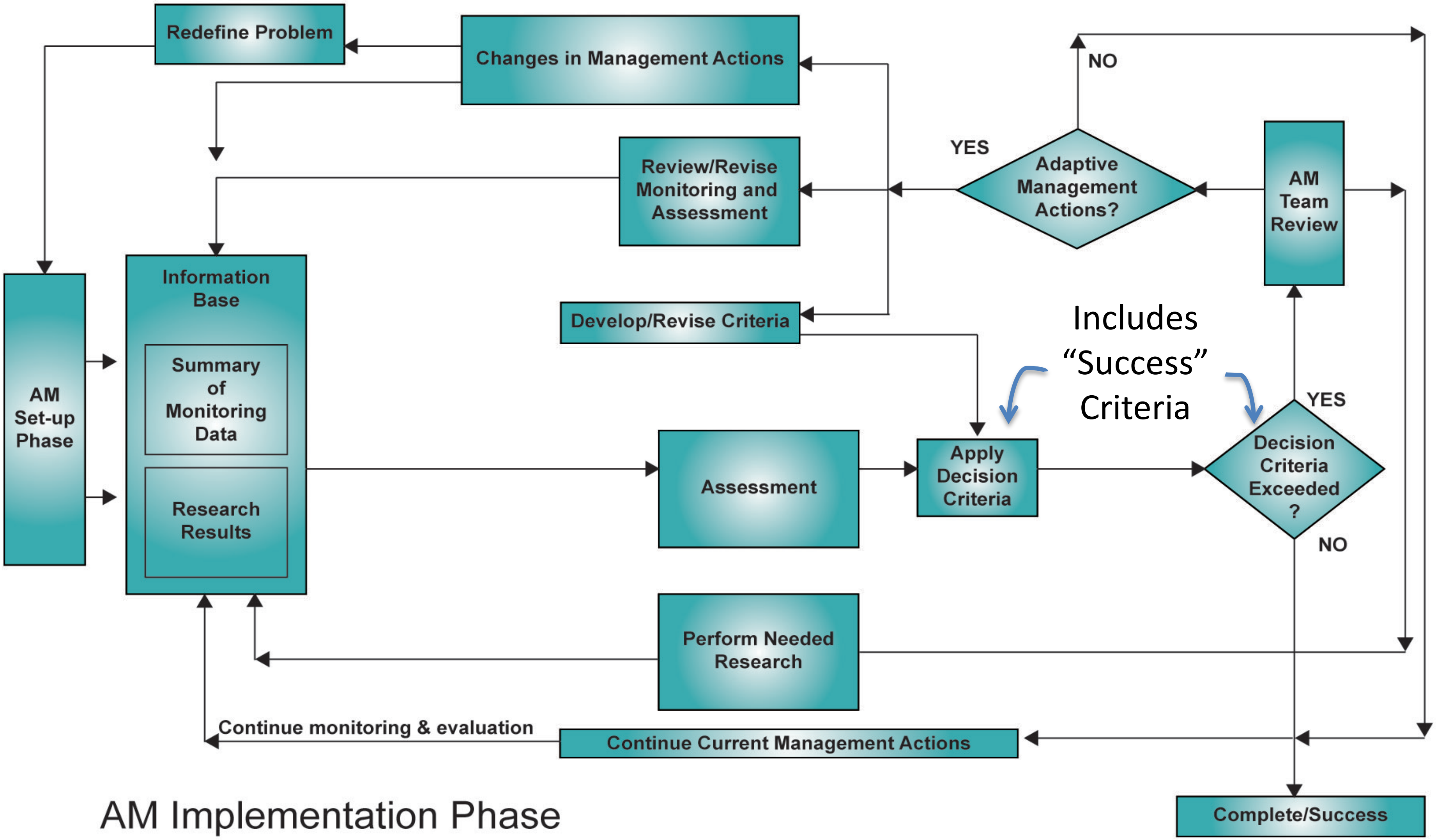
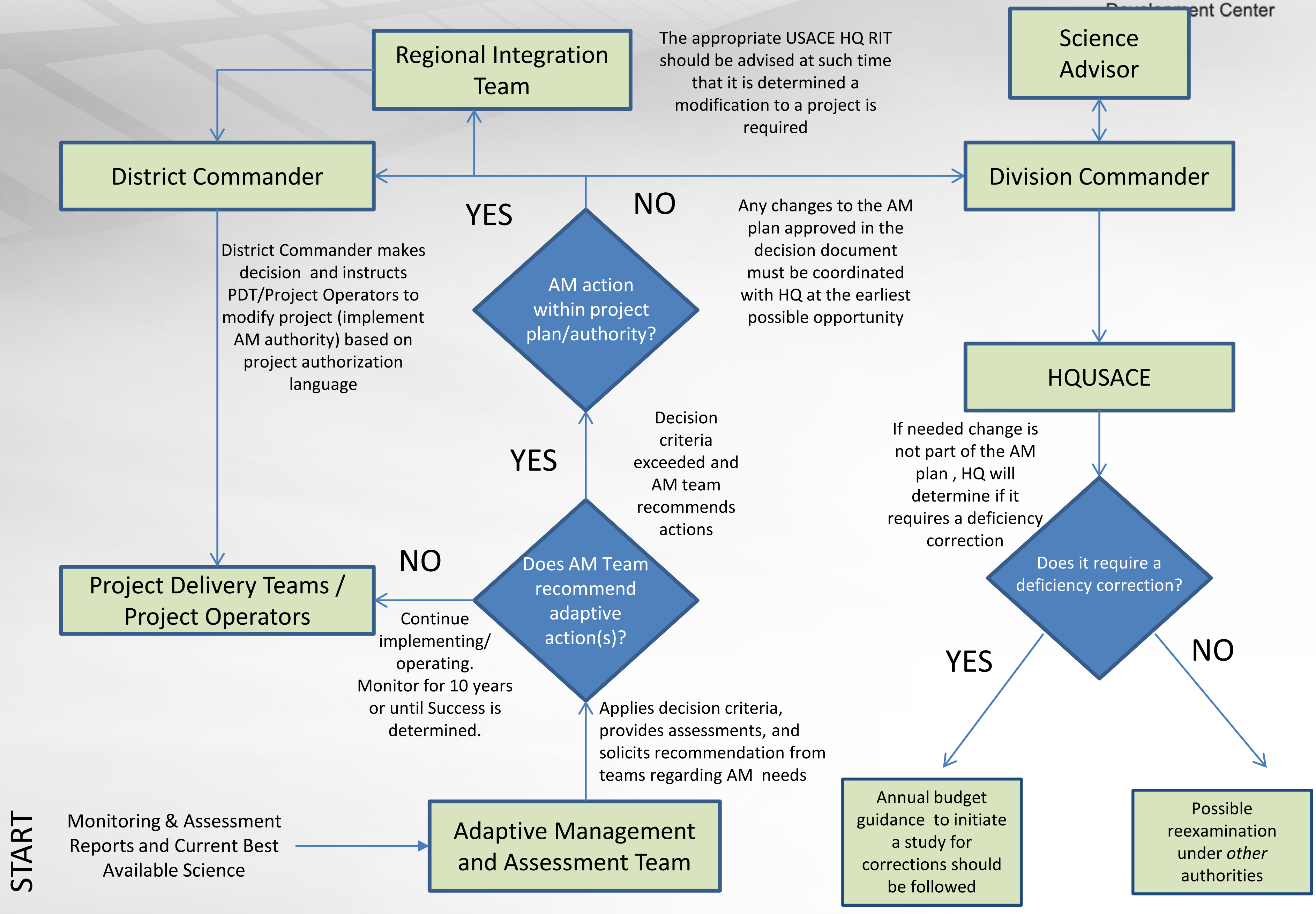


AM Implementation Phase

General Processes for AM Decision Making



CERP Governance Process

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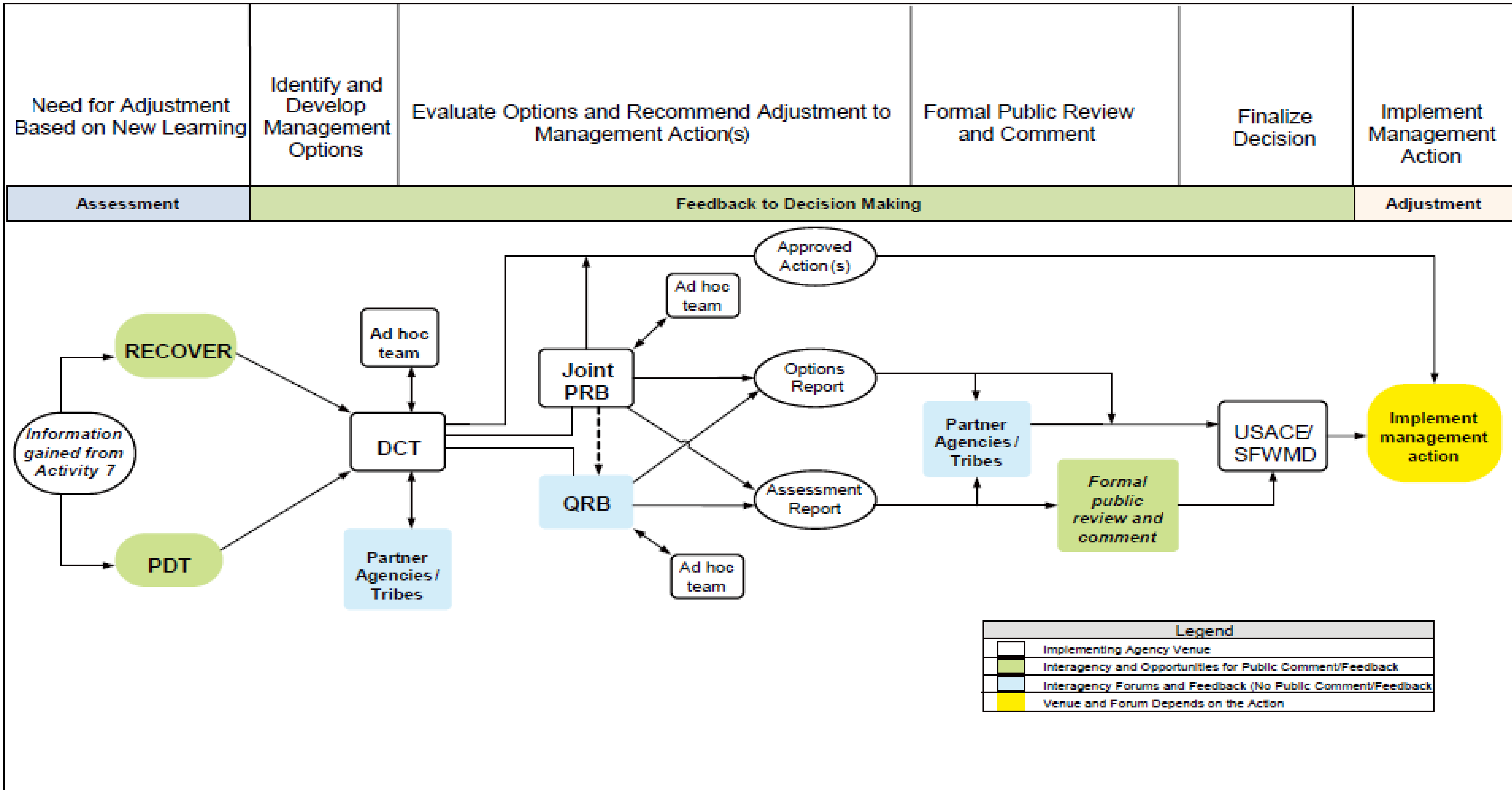
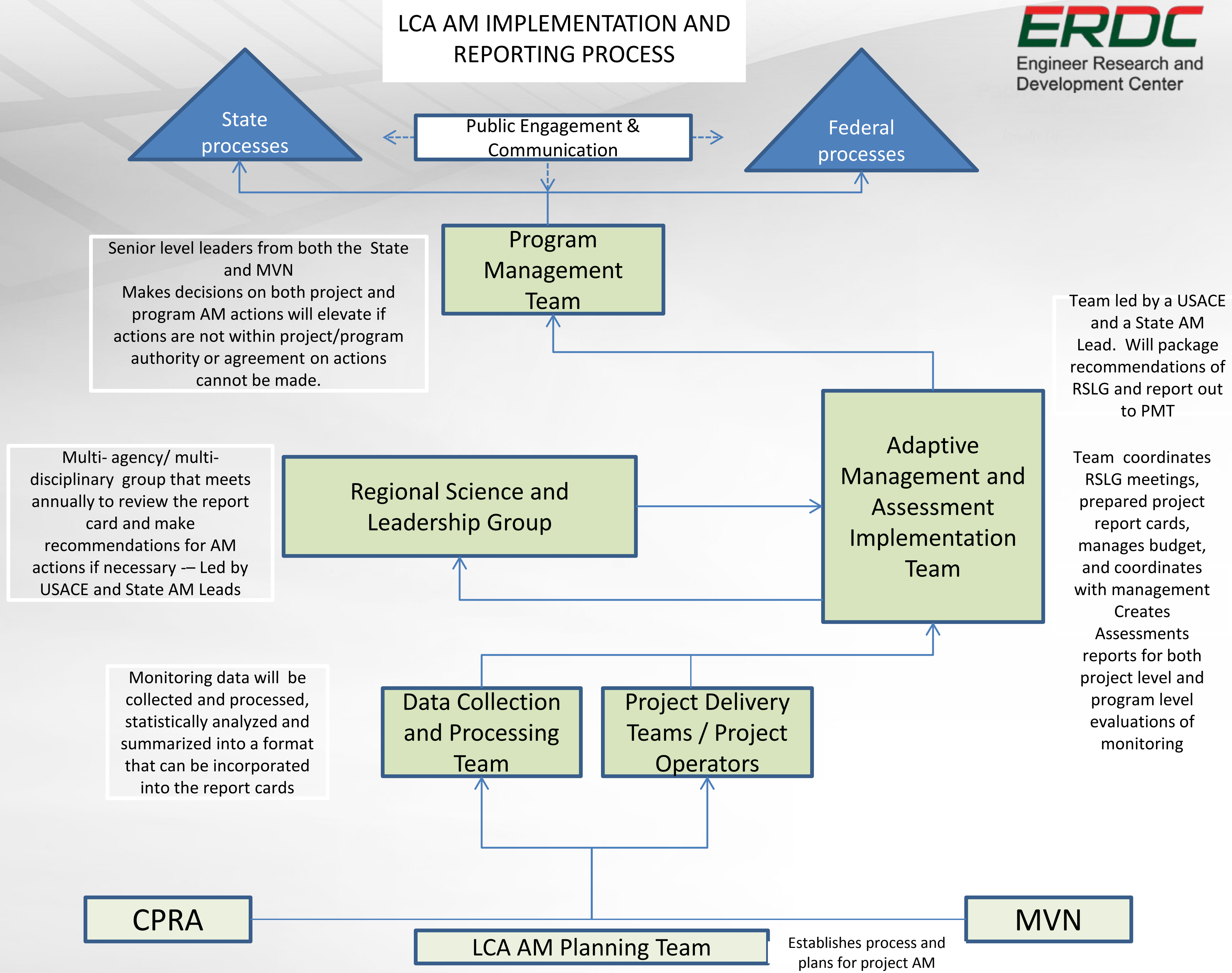
Figure 3-9: Decision-Making Process for Adaptive Management Activities 7, 8, and 9



Note: DCT = Design Coordination Team, QRB = Quality Review Board, and Joint PRB = Joint Project Review Board

LCA AM IMPLEMENTATION AND REPORTING PROCESS



Governance & Decision-Making Advice

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- Failed governance is cited as the most common source of AM failure; learn from others' mistakes
- Process and responsibilities for decision making should be documented as part of AM plan
- Develop the governance process that meets your needs – don't try to force fit an existing structure
- Minimize complexity to extent practical
- Engage stakeholders and seek transparency
- Build trust in the process – detailed understanding of all factors by everyone is seldom possible
- Build in flexibility and periodic review of the governance; adapt the adaptive management as needed

Critical Inputs to Governance and Decision Making

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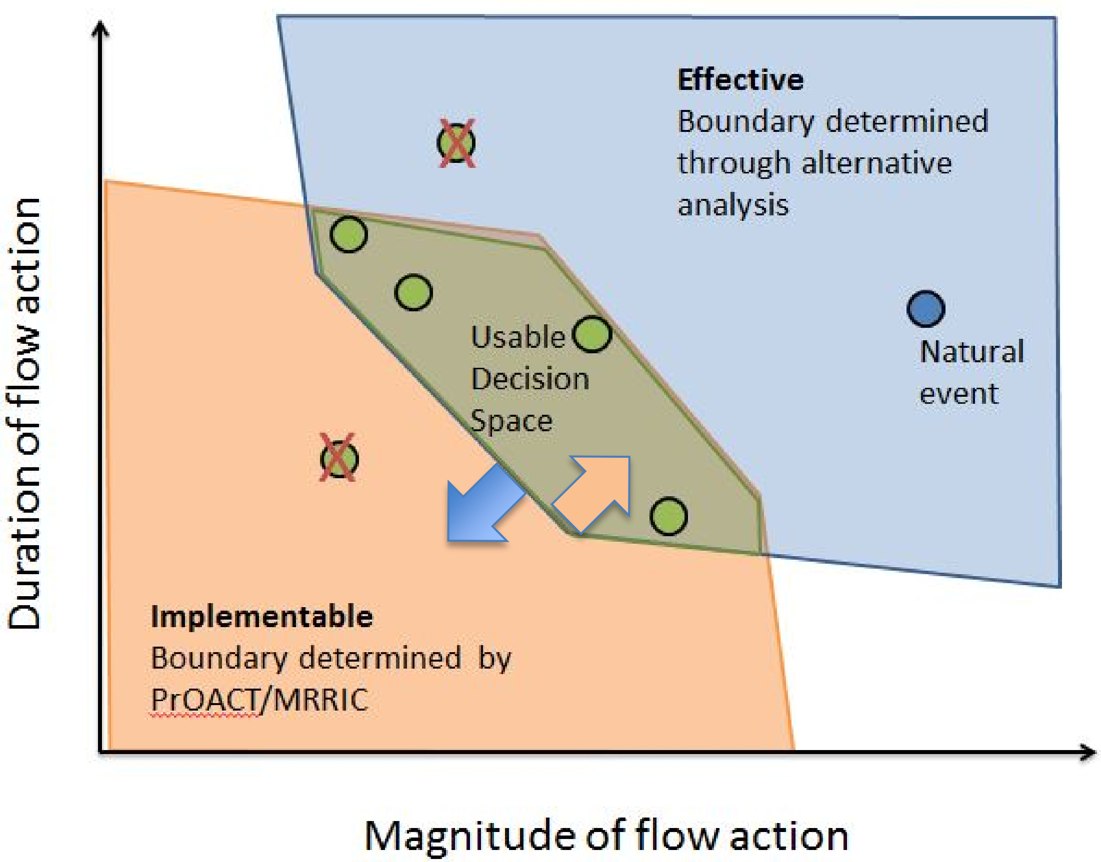
- Important differences in **forms of knowledge**:
  - *"**hard**"* knowledge based on scientific methods of observation and analysis; note that even "hard" knowledge may be uncertain and multiple lines of evidence may be required
  - *"**soft**"* knowledge based on inherent judgments, priorities, and values of individuals

- Types of "soft" knowledge vary by **roles and technical understanding**:
  - **Stakeholder values**: scope of the policy space and desired outcomes (diversity of values and opinions)
  - **Expert judgments**: technical understanding about cause-effect (value neutral)
  - **Manager priorities**: risk tolerance and tradeoffs (bridging science and values with authority for decision making)

Management Flexibility and Stakeholder Considerations

- The “decision space” for management actions is determined by the combination of science findings and agency/stakeholder input
- Adaptive management provides a mechanism to adjust the bounds of potential management in response to learning



Engaging Stakeholders

- Understand requirements of Federal Advisory Committee Act.
- Employ a facilitator when dealing with large or difficult groups.
- Promote transparency. Build trust in the process – not necessarily detailed understanding.
- Listen closely. Anecdotes are experience in the form of "soft" data and "Stories" can contribute to conceptual models.
- Employ Decision Analysis and Trade-off techniques to build understanding and buy-in around choices.
- Disagreements can take the form of hypotheses (expect frustration).
- Quiet stakeholders may indicate a lack of understanding. Try different language, different examples or different messenger.

Engaging Managers

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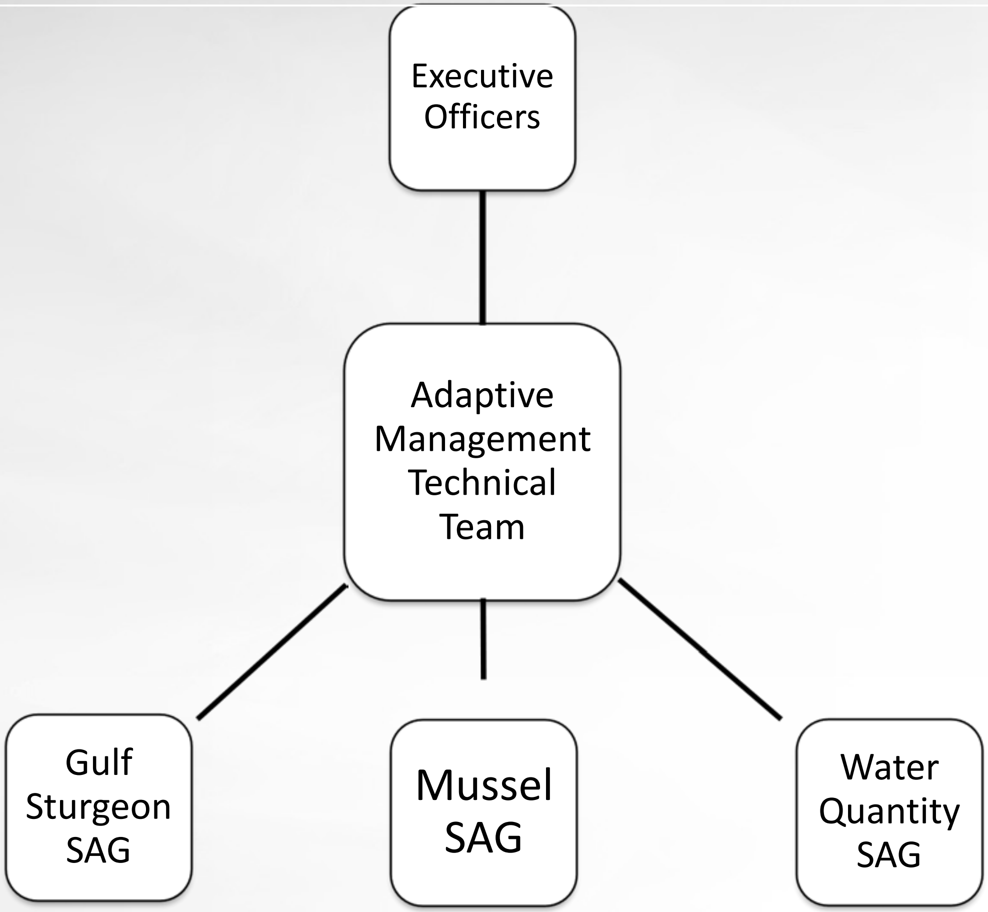
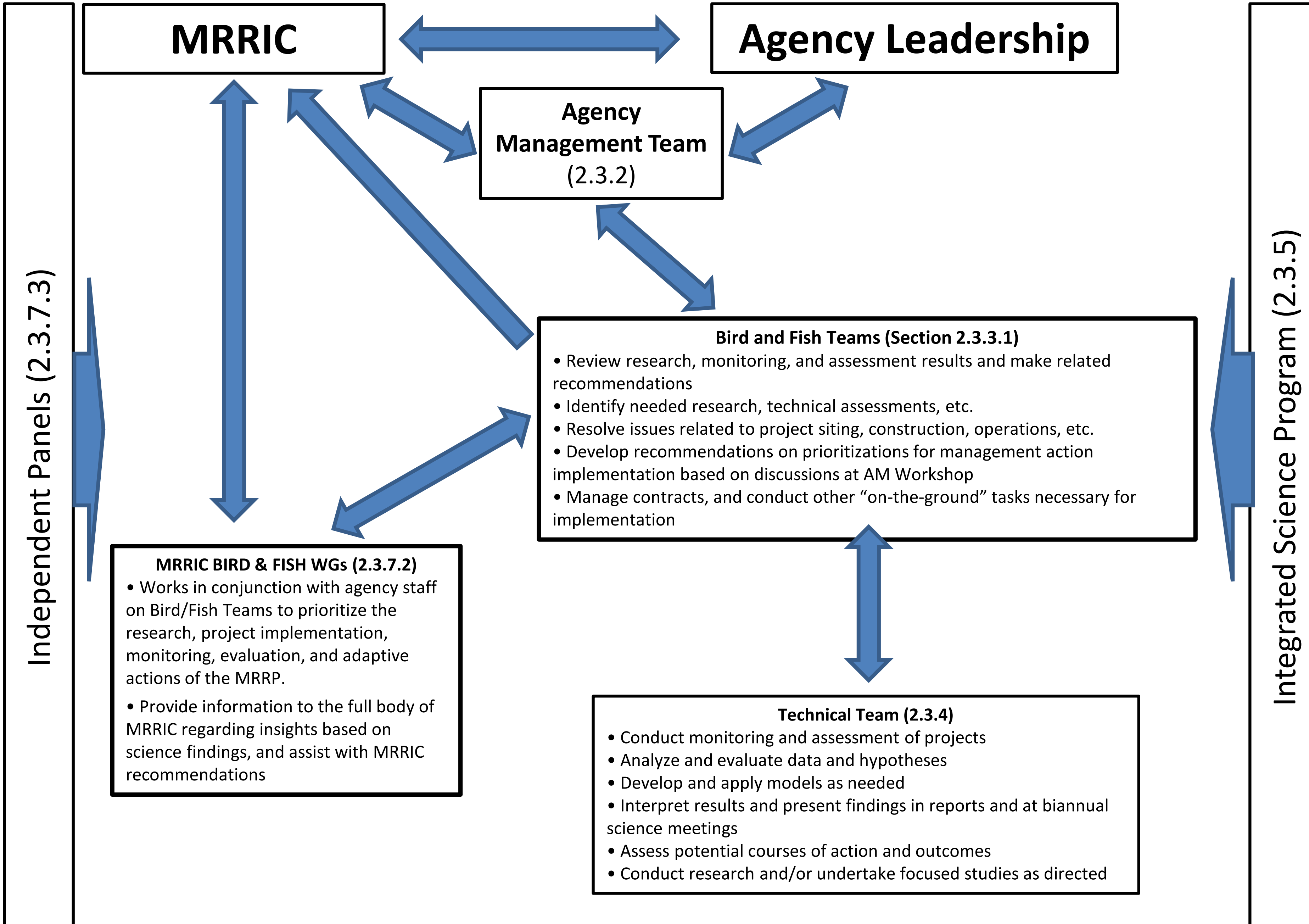
- Seek input regarding:
  - Management objectives/targets
  - Governance/decision making process
  - Resources (people, time, money), including contracting expert help
  - Work planning/workflow
  - Thresholds around risk tolerance
  - Policy positions
- Identify preferred mechanisms for information exchange and internal decision-making
- If possible, specify categories of decisions that can be made at different levels of authority; exercise decisions at lowest level acceptable to promote efficiency

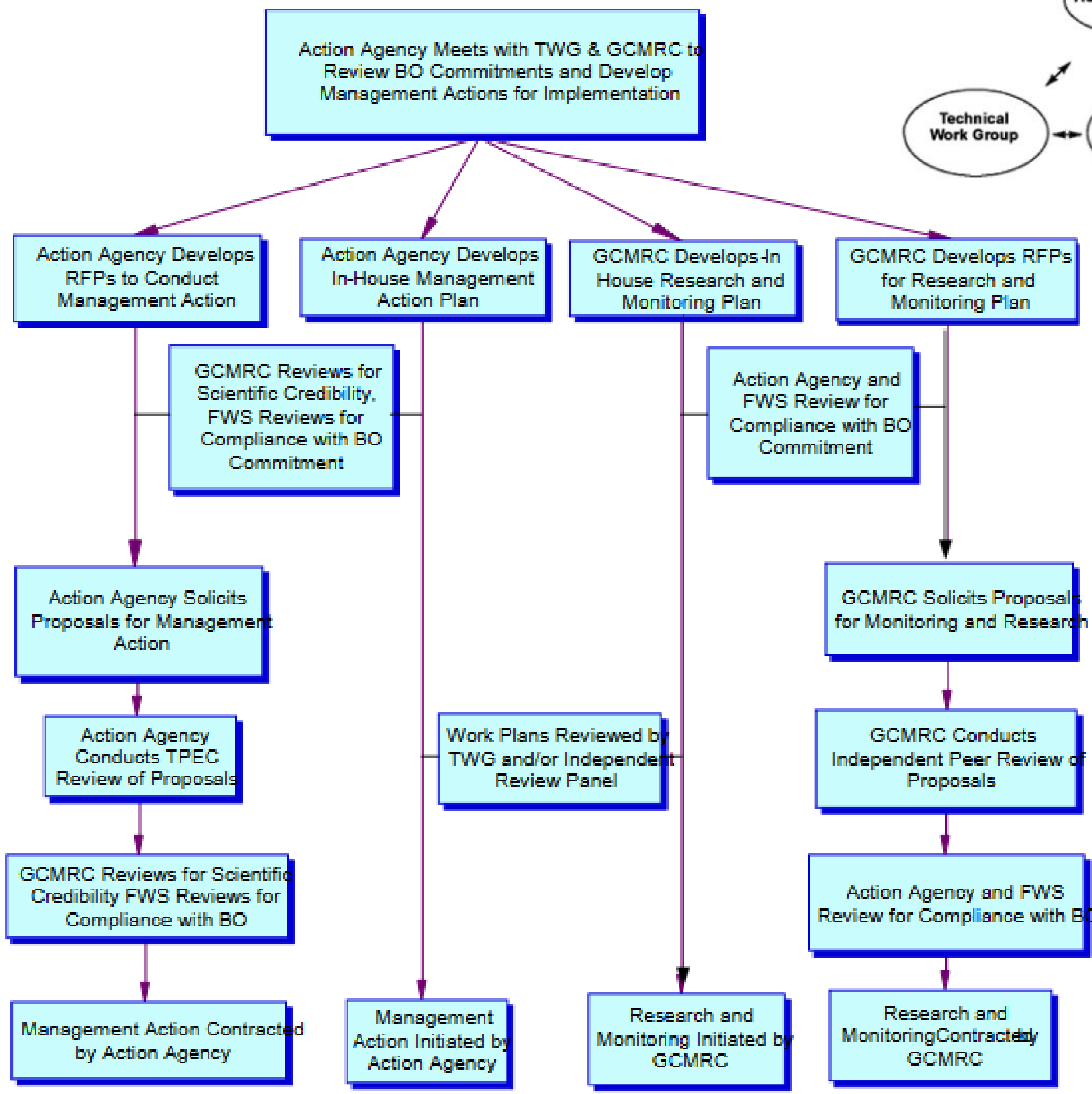
Apalachicola-Chattahoochee-Flint AM Program for ESA Compliance

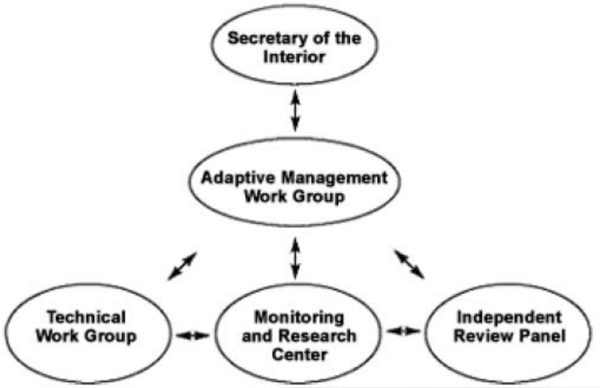




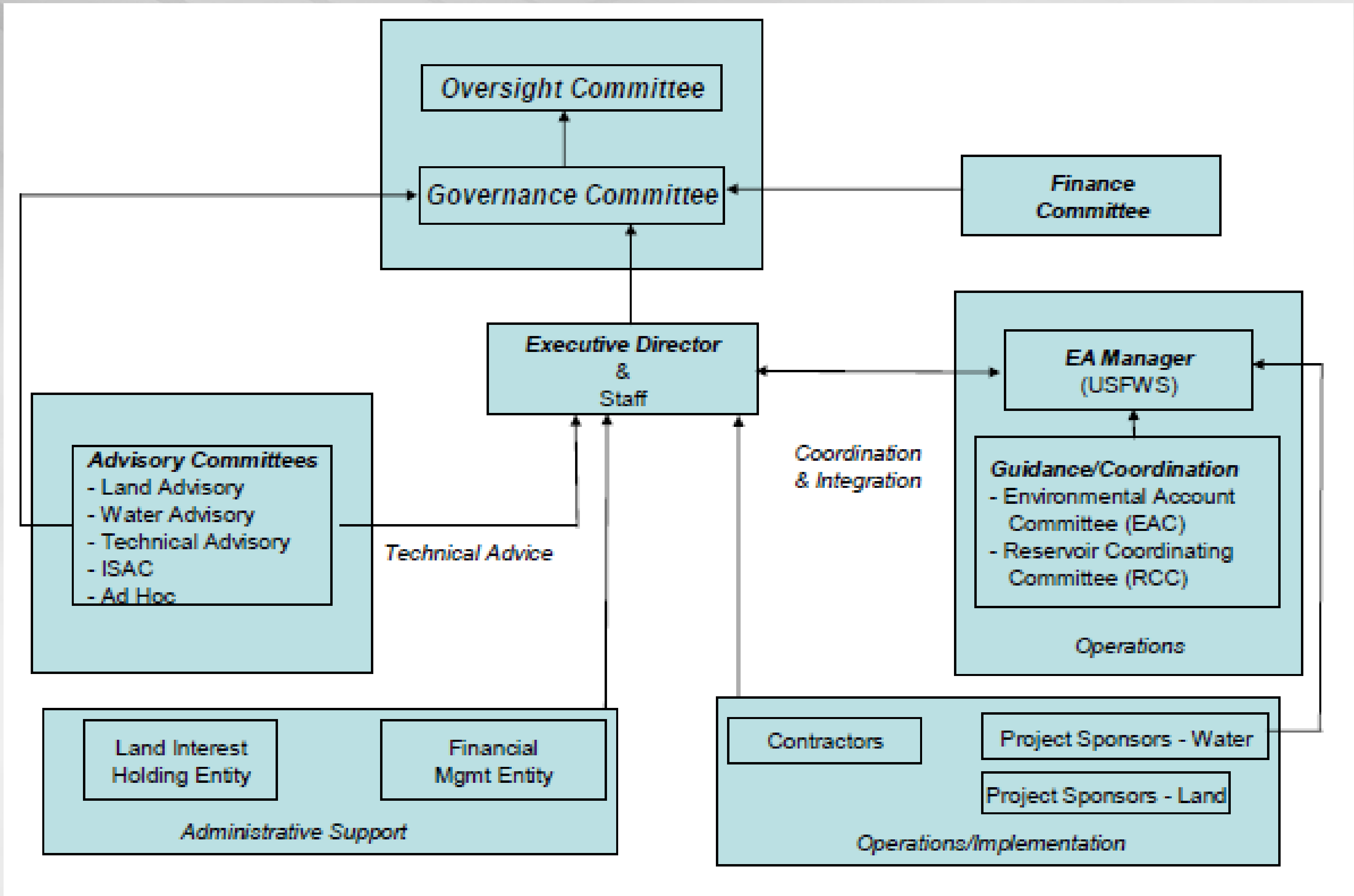
Summary of roles and responsibilities of entities involved with implementing the MRRP –(parenthetical reference is to section of SAMP)

Glen Canyon Implementation Process





Platte River Organizational Structure



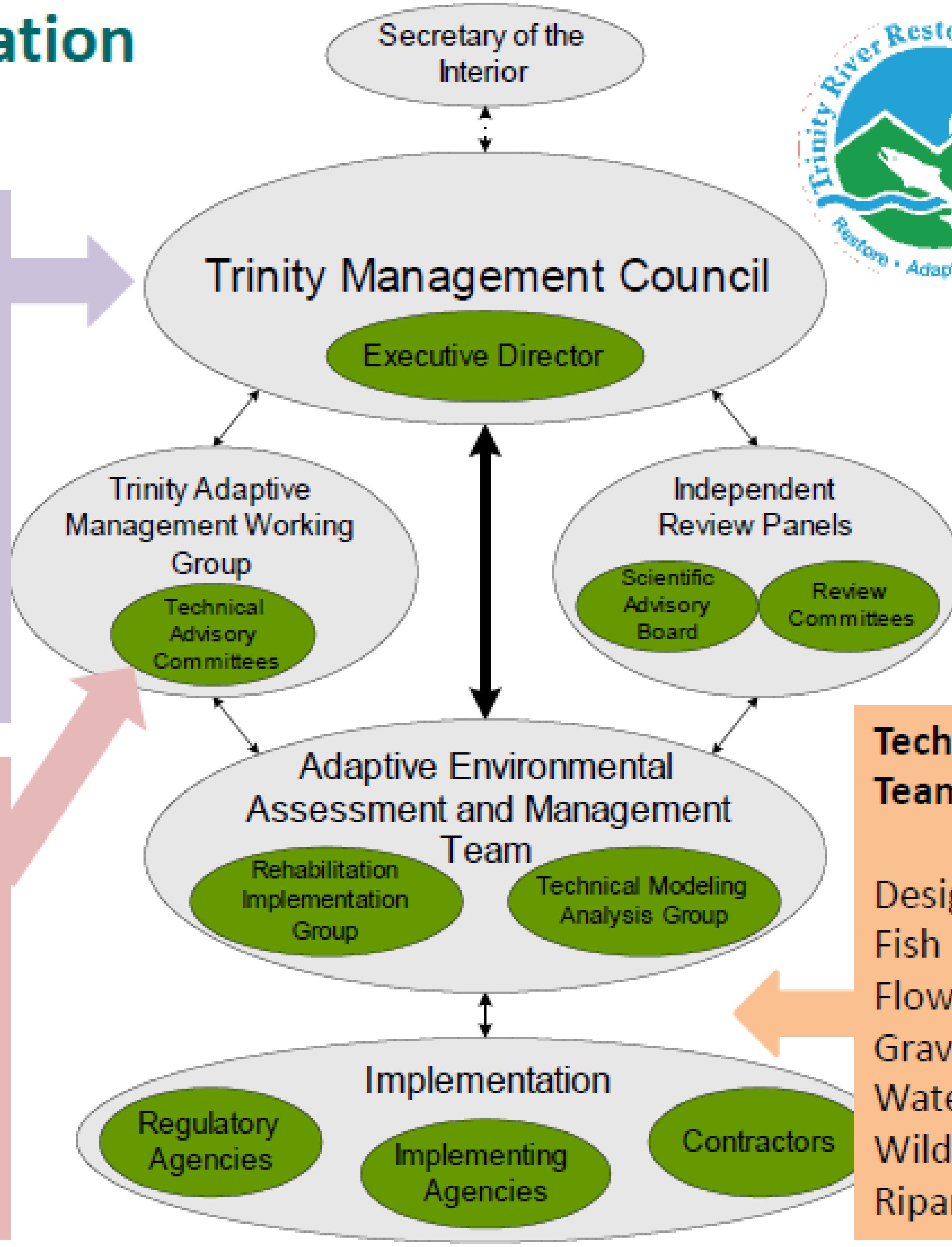
Trinity River Restoration Program (TRRP)

Trinity Management Council (8)

U.S. Bureau of Reclamation
U.S. Fish and Wildlife Service
Hoopa Valley Tribe
Yurok Tribe
California Resources Agency
National Marine Fisheries Service
U.S. Forest Service
Trinity County

Trinity AM Working Group (14)

Environmental Organizations (3)
Local Land/Business Owners (3)
Agricultural Water Users (1)
Trinity County Residents (2)
Fishing / Rafting Guides (2)
Utilities (2)
Commercial Fishing (1)



Technical Teams

Design
Fish
Flow
Gravel
Watershed
Wildlife
Riparian

Edwards Aquifer Habitat Conservation

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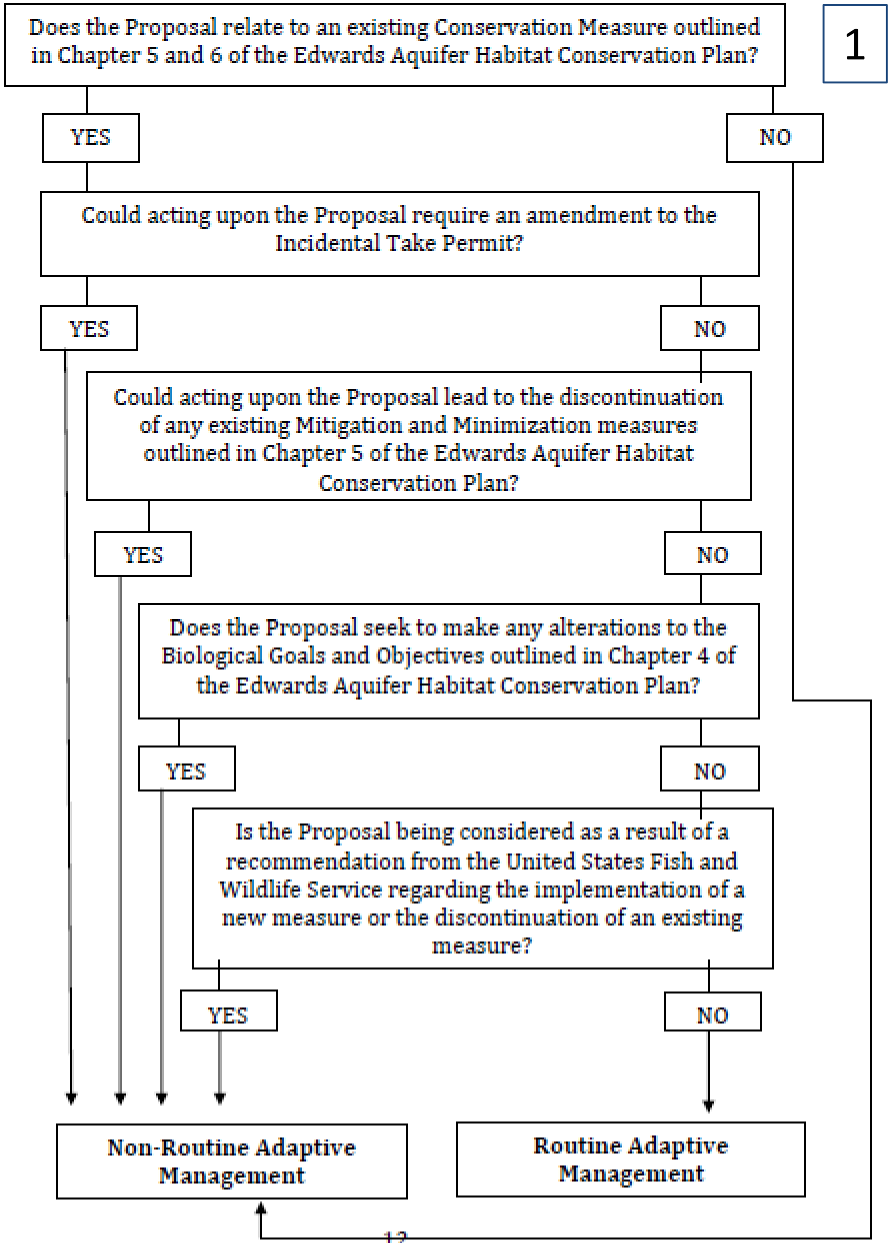
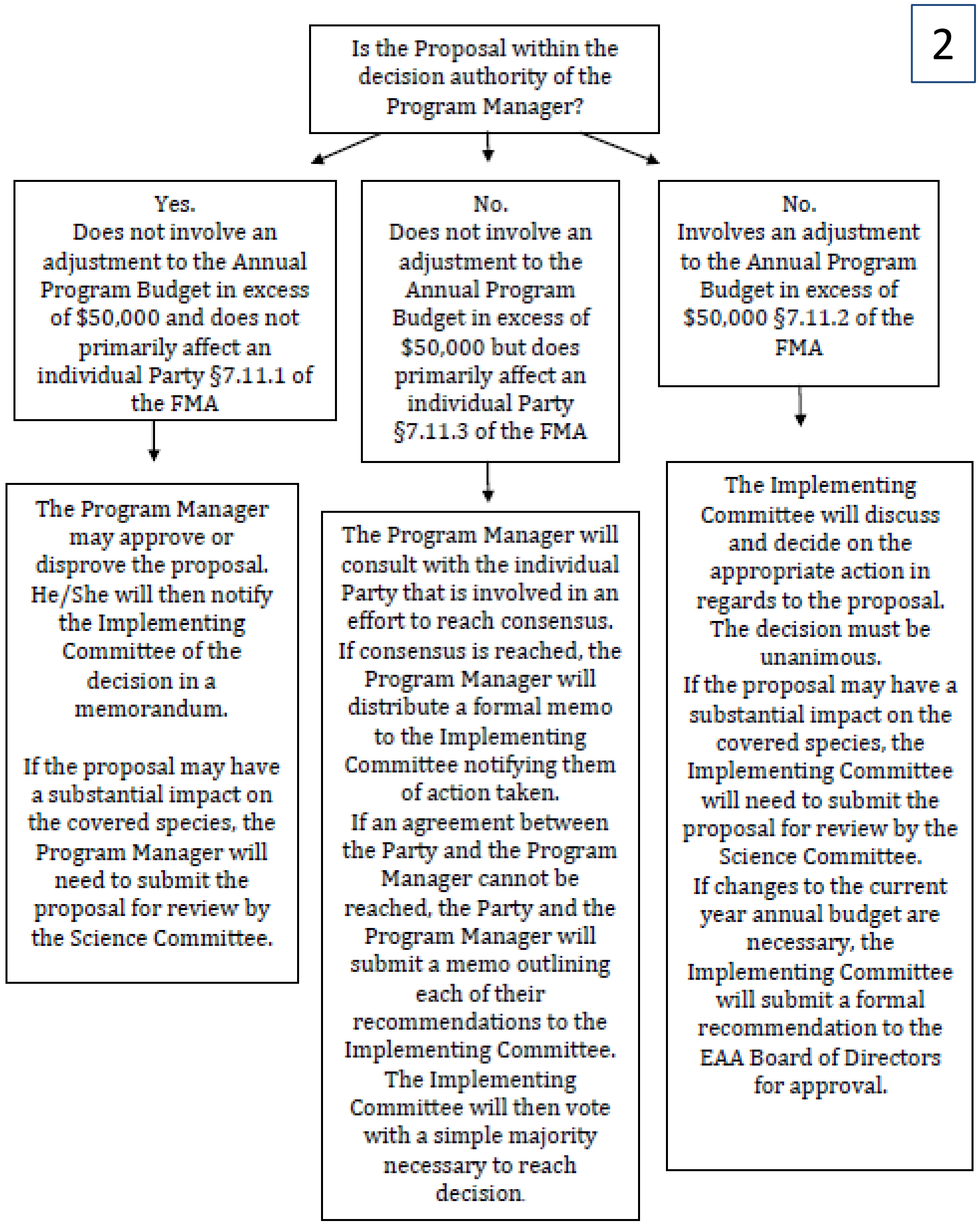
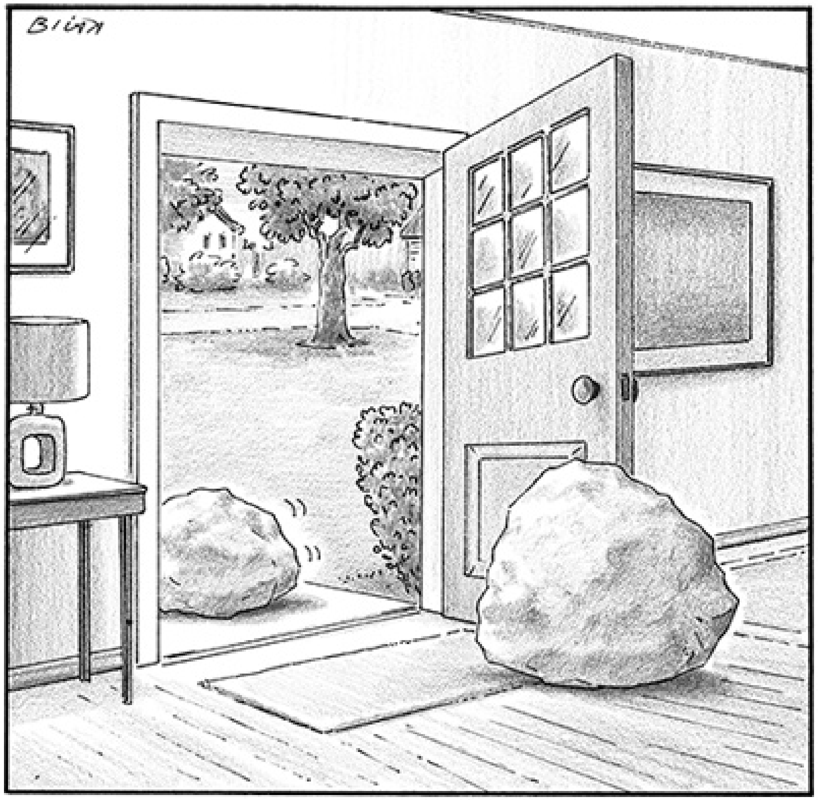
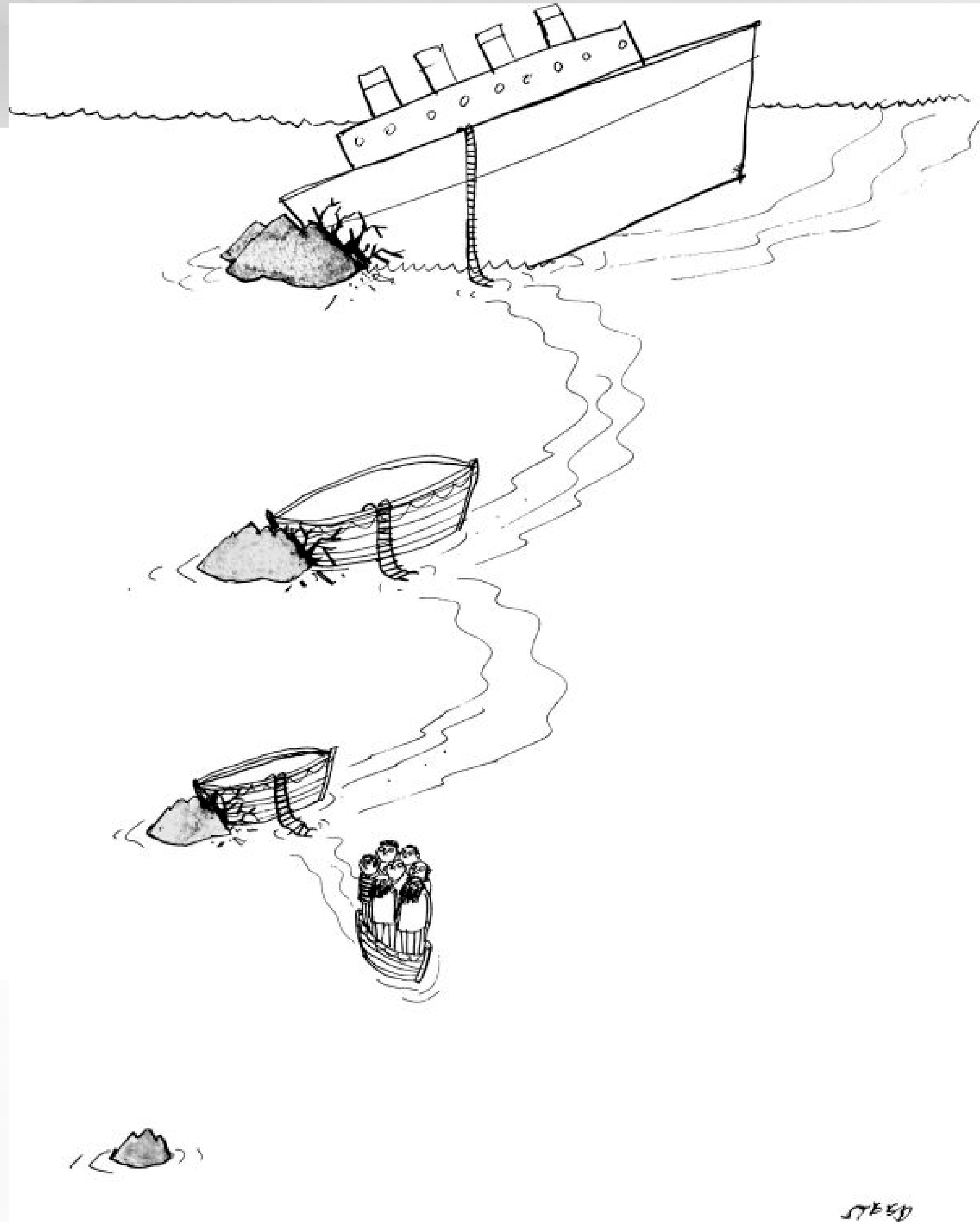




Summary



"Come back—I can change!"



WEST Inc.

Environmental & Statistical Consultants

Facilitation and Communication & Adaptive Management

Debbie Lee

Adaptive Management Implementation Workshop

July 25, 2017

USACE Albuquerque District

Science-Management Nexus

- Facilitation is most useful when the issues involve:
  - High level of controversy
  - Disputes
  - Log jam
  - Soured relationships
  - A need for a really clear record of decision-making
  - A need to engage stakeholders and/or the public
- Adaptive Management is a collaborative process which can be improved by facilitation
- Facilitation as governance/process structure

The Levels of Facilitation


Facilitation Involving Science
Facilitation
Meeting Organization

Meeting Organization

- Inviting attendees
- Preparing materials
- Securing meeting room
- A/V needs
- Coordinating with presenters
- Misc. logistics (food, room set up, etc.)
- Meeting minutes

Facilitation

- Conducting convening assessments and laying groundwork for discussion prior to meetings
- Making sure all the right people are in the room
- Ensuring participation in good faith
- Working with difficult personalities
- Ensuring equal opportunity to participate
- Mediating issues
- Negotiating amongst stakeholders
- Keeping conversations on track
- Maintaining impartiality and confidentiality
- Keeping the trust of all parties
- Maintaining administrative records of conversations, key decisions, agreements, and next steps

Facilitation Involving Science

- Ensuring all parties have a common understanding of the science
- Facilitating amongst parties of different scientific backgrounds and disciplines
- Facilitating amongst parties with different levels of scientific knowledge
- Working with competing scientific opinions and viewpoints
- Ensuring parties are working with the best available science
- Ensuring parties have equal access to data and information they require for their discussions

Science Facilitation

- Neutrality, impartiality, and a clear administrative record are vitally important to the integrity of the process.
- Important in creating trust in science and policy.
- If done wrong, harms public trust in both science and policy.
- If done right, can build public trust and protect the outcomes of the process from challenges.

Facilitation: Different Hats

- Broker of Trust
- Steward of Governance
- Native Speaker in Different Disciplines
- Translator
- Organizer
- Manager
- Convener
- Facilitator
- Mediator
- Negotiator
- Traffic Cop
- Time Keeper
- Record-Keeper

PROCESS MANAGER

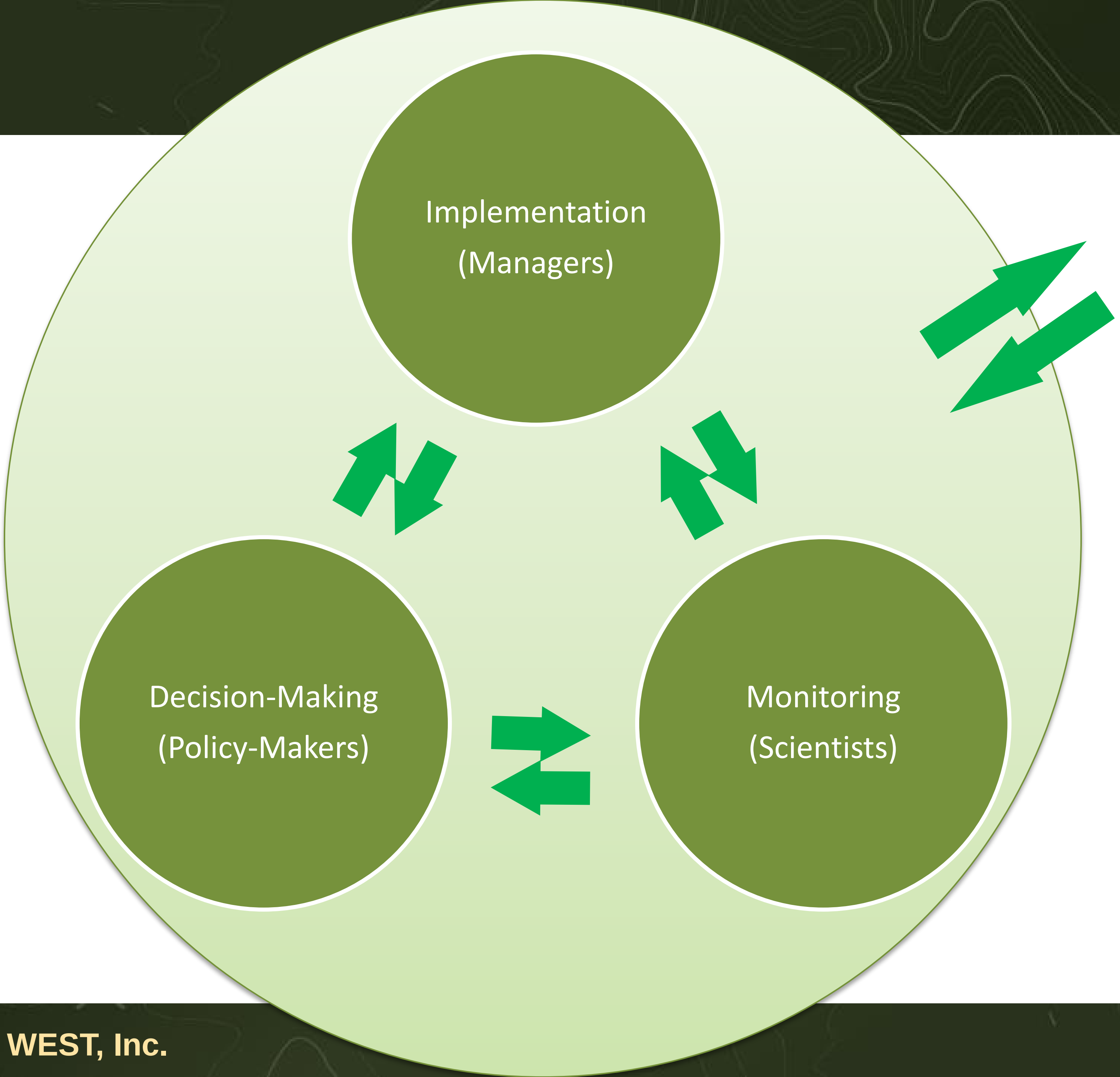
Communication Principles

Adaptive Management

- Adaptive Management is a *collaborative process* among scientists, managers, and decision-makers
- AM processes require clear agreed-upon ground rules about roles and responsibilities and communication principles.
- Facilitator's role is to ensure that agreed-upon processes are adhered to by participants
- Participants agree to participate *in good faith* in the process

Adaptive Management

- Structured decision-making for:
  - Management actions and monitoring/research
  - Determining the best available science
  - Evaluating new scientific findings and determining how to implement new information
  - Communicating information about science and management activities (both internally and externally)



- Public
- External Stakeholders
- Congress
- Etc.

MRGESCP Communication Principles from April Retreat

- Clearly defined roles and responsibilities, for clarity on who has authority to make decisions or represent a signatory at a Program meeting
- Schedules and deadlines should be communicated as far in advance as practical to the appropriate individuals. Those in turn should communicate information within their own organizations.
- Signatory representatives are responsible for keeping the others in their respective organizations informed and up-to-date on relevant information, requests, and action items.

MRGESCP Communication Principles from April Retreat

- An organization should, as much as possible, present a unified message on an issue. If there is disagreement, it should be made clear which viewpoints are individual opinions.
- Agreements that are made in meetings should be communicated within Program signatory organizations and to appropriate members of the public.
- Information and data that is used to inform decisions should be accessible to all parties in a transparent manner.

MRGESCP Communication Principles from April Retreat

- Raise any issues with the Program Manager and/or Science Coordinator as soon as possible.
- The Program Manager and/or Science Coordinator should be copied on relevant communication.
- Provide opportunities for public comment and outreach.

Avoid Miscommunication

- *Clear* communication:
  - Among individual participants
  - Within an agency/organization
  - Between agencies/organizations
  - To entities outside the Program
- *Consistent* communication:
  - From an agency/organization
  - From the Program

Build Trust in the Adaptive Management Process

- Transparency
- Open-access (to meetings, data)
- Clear administrative record
- External evaluation (independent expert panels)
- Clear, concise, and *complete* public communication

- Technology tools to provide public transparency

Resources

- Adler, Peter S. et al. "Managing Scientific and Technical Information in Environmental Cases: Principles and Practices for Mediators and Facilitators." http://www.mediate.com/articles/pdf/envir_wjc1.pdf.
- Adler, Peter S. & Juliana E. Birkhoff. 2002. "Building Trust: When Knowledge from 'Here' Meetings Knowledge from 'Away.'" http://www.resolv.org/wp-content/uploads/2011/02/building-trust.pdf.
- Bingham, Gail. "When Sparks Fly: Building Consensus when the Science is Contested." http://www.resolv.org/wp-content/uploads/2011/02/When_the_Sparks_Fly.pdf.
- Ozawa, Connie P. (2006) "Science and Intractable Conflict," Conflict Resolution Quarterly, Vol 24(2):197-205. http://web.pdx.edu/~ozawac/CRQ.pdf.

WEST Inc.

Environmental
& Statistical
Consultants

Debbie Lee

MRGESCP Program Manager

dlee@west-inc.com

(505) 219-5309 (cell)

US Army Corps
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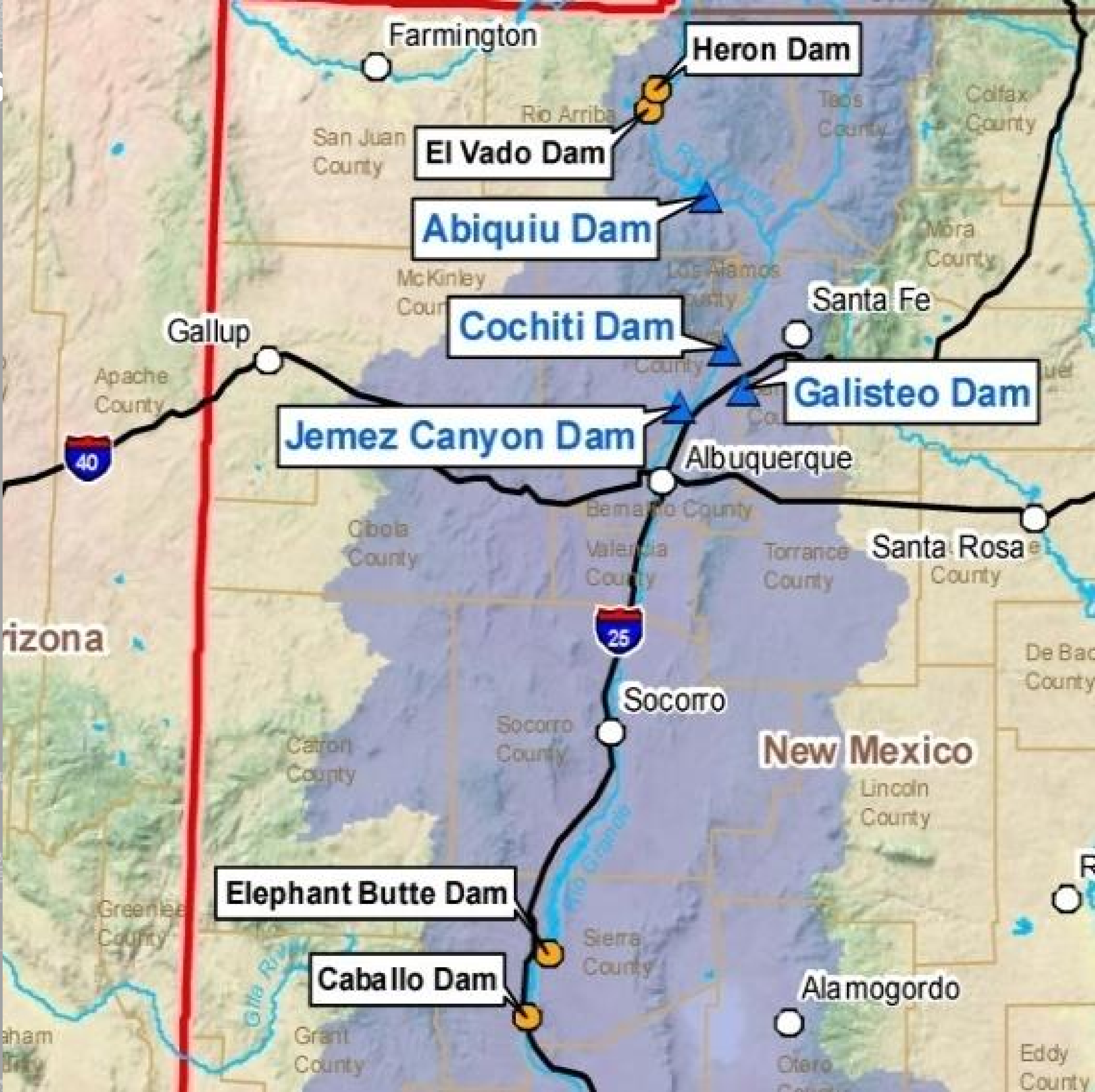
CORPS DAMS AUTHORIZED FOR FLOOD AND SEDIMENT CONTROL



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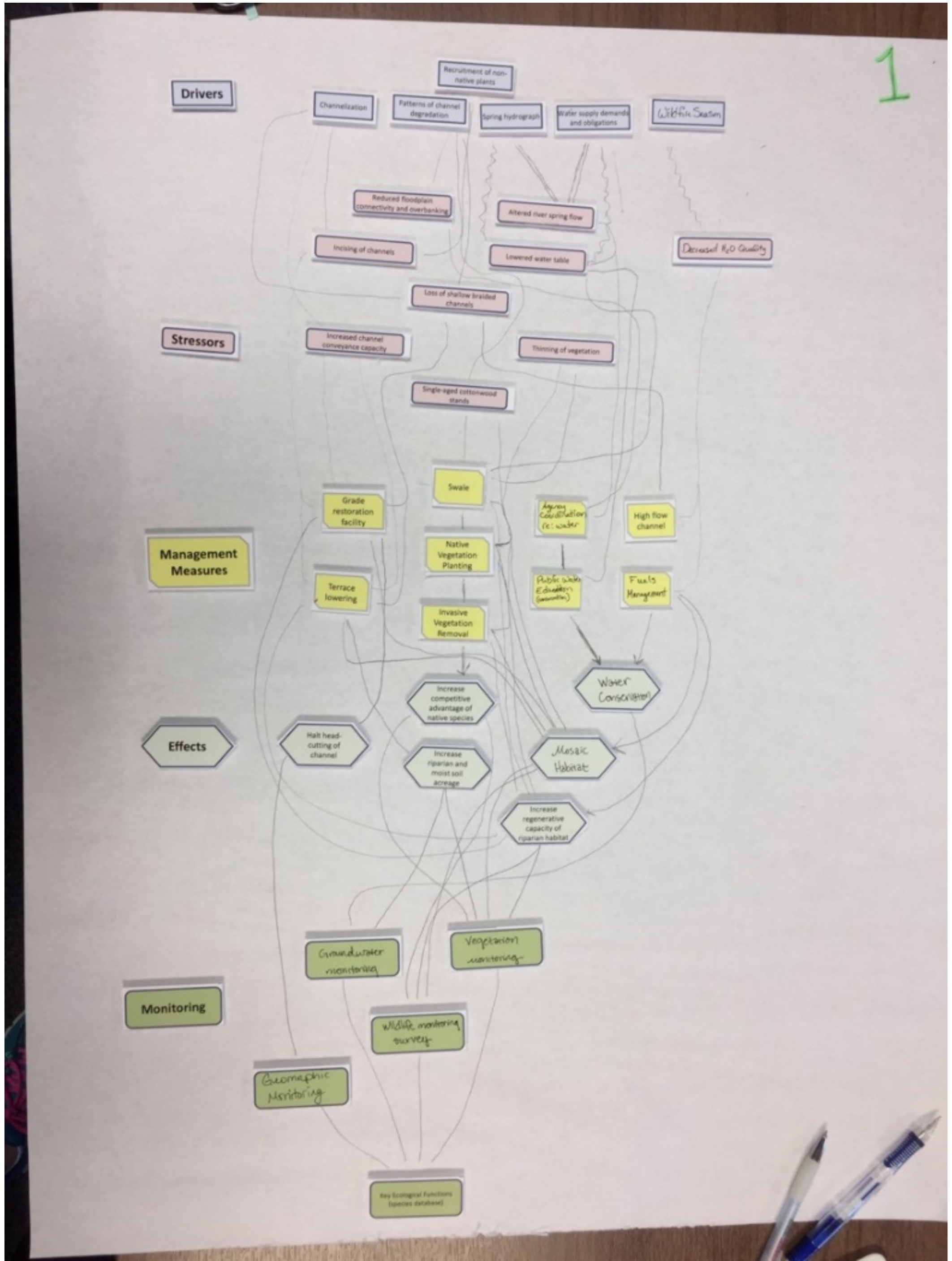
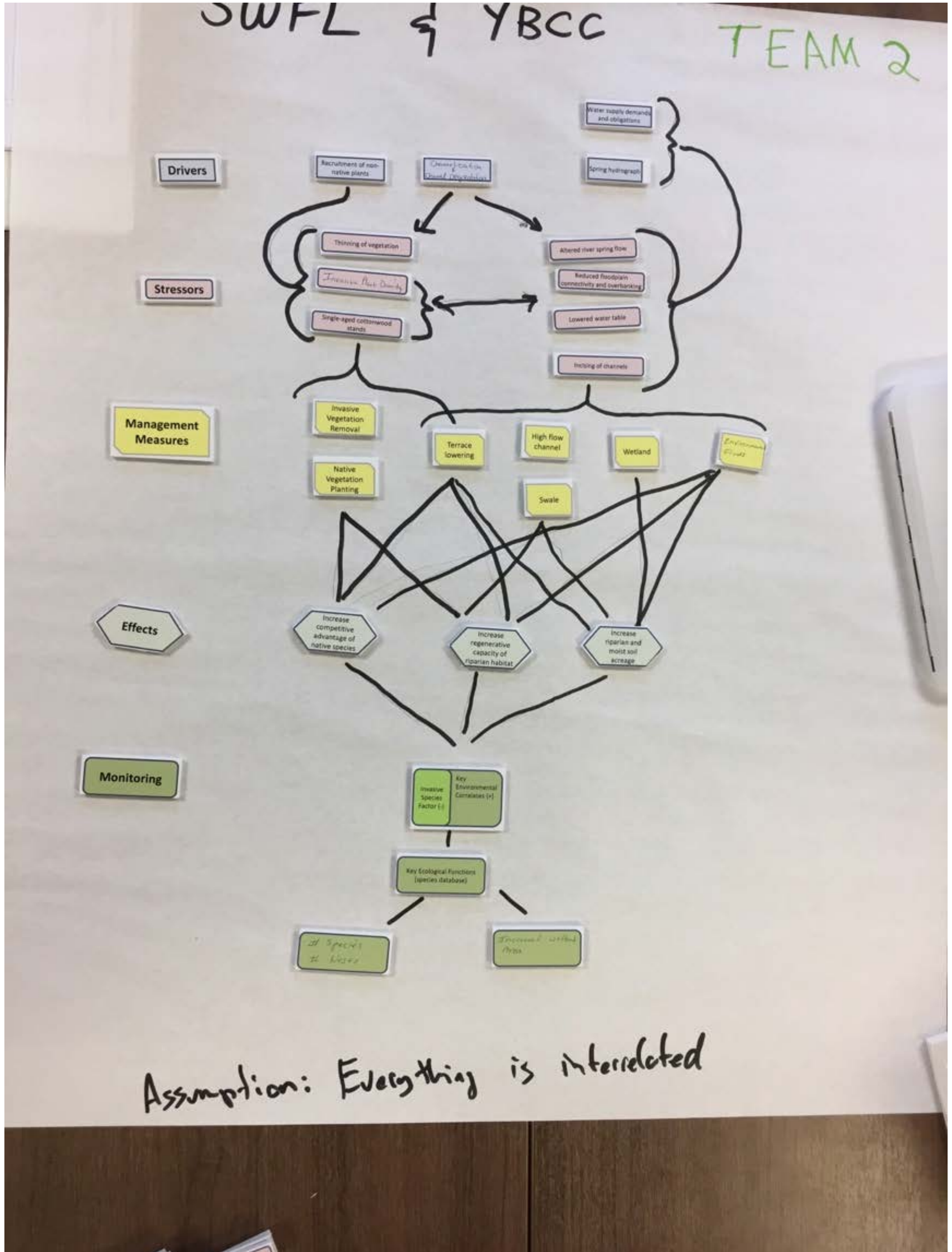
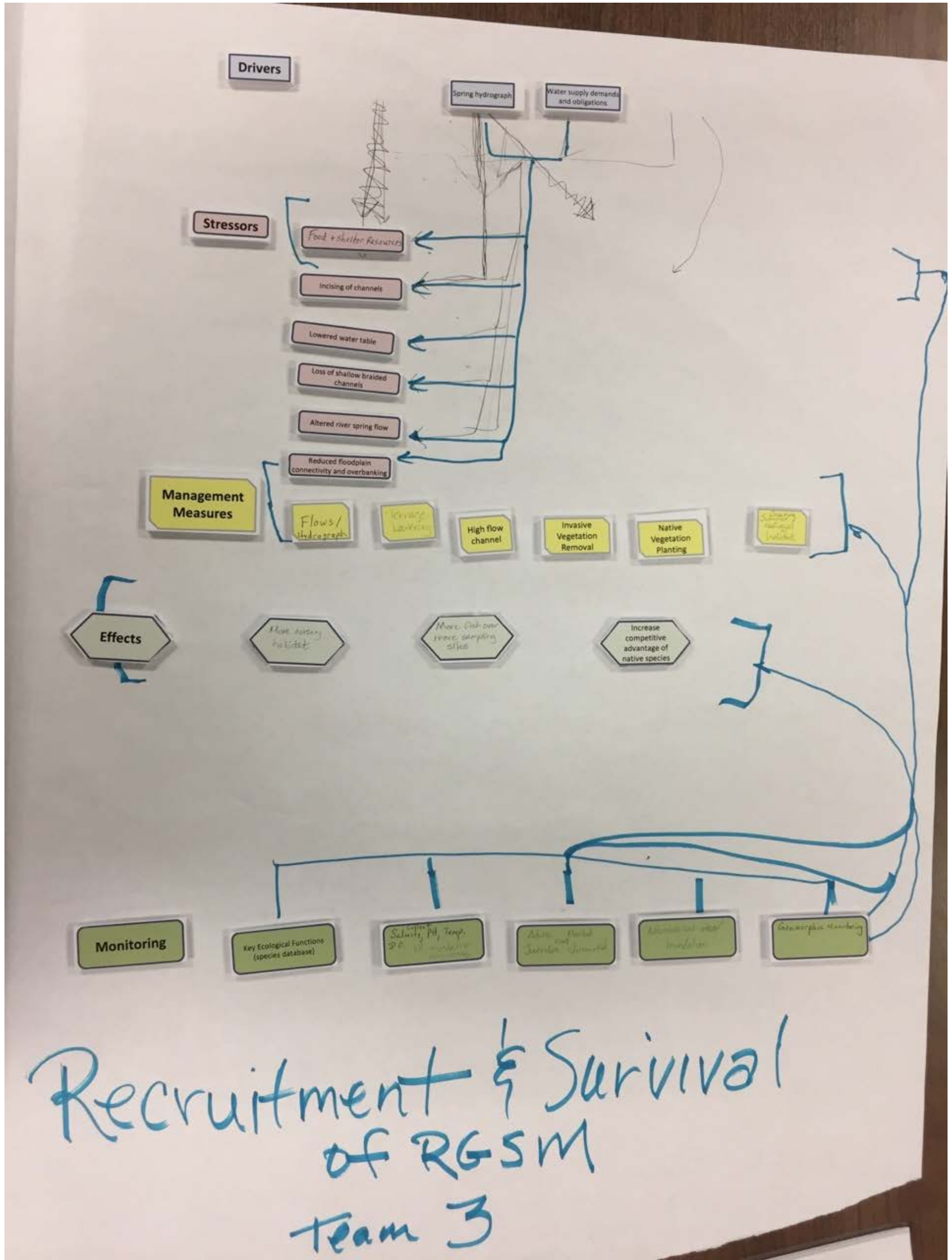
U.S.ARMY

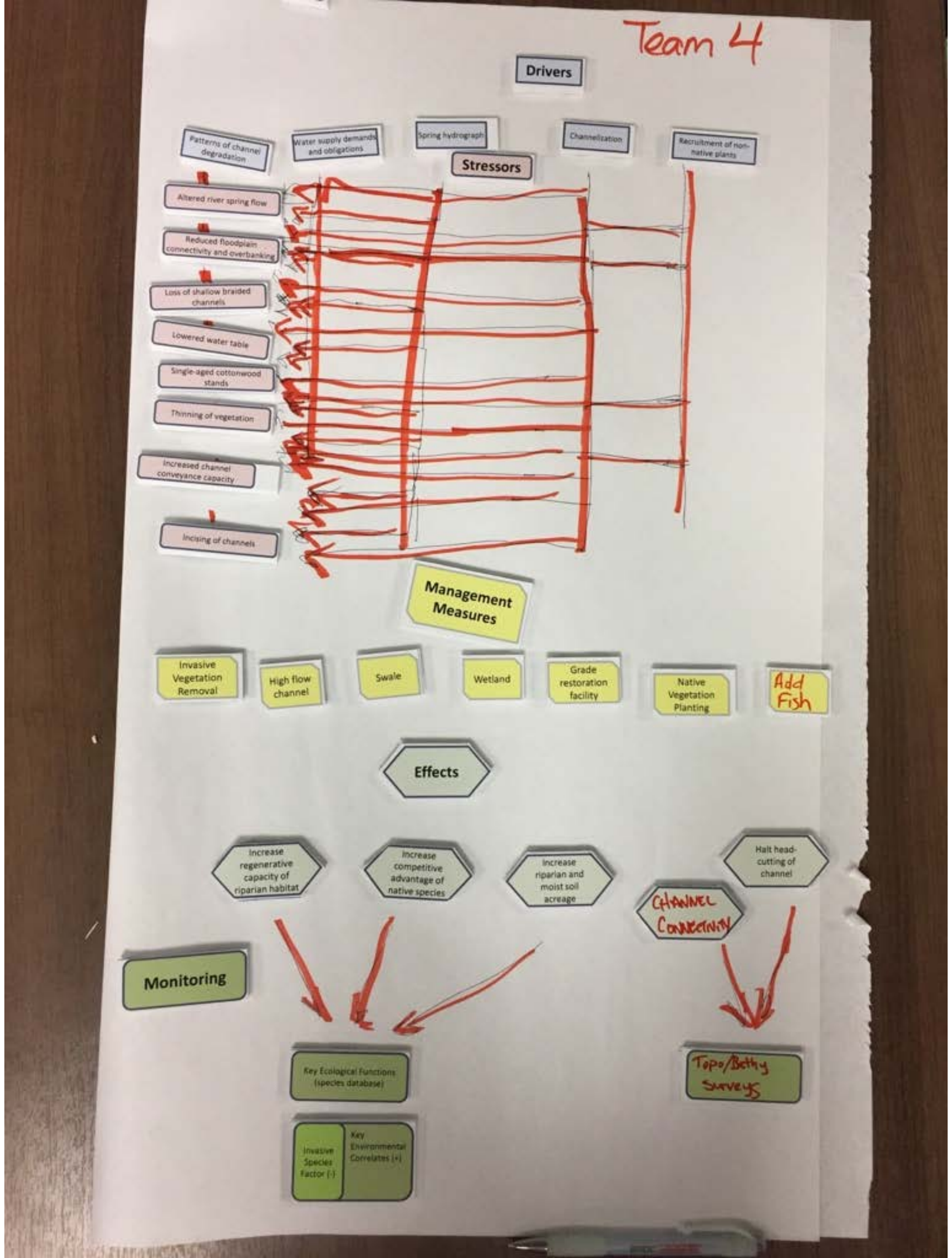
US Army Corps of Engineers ®

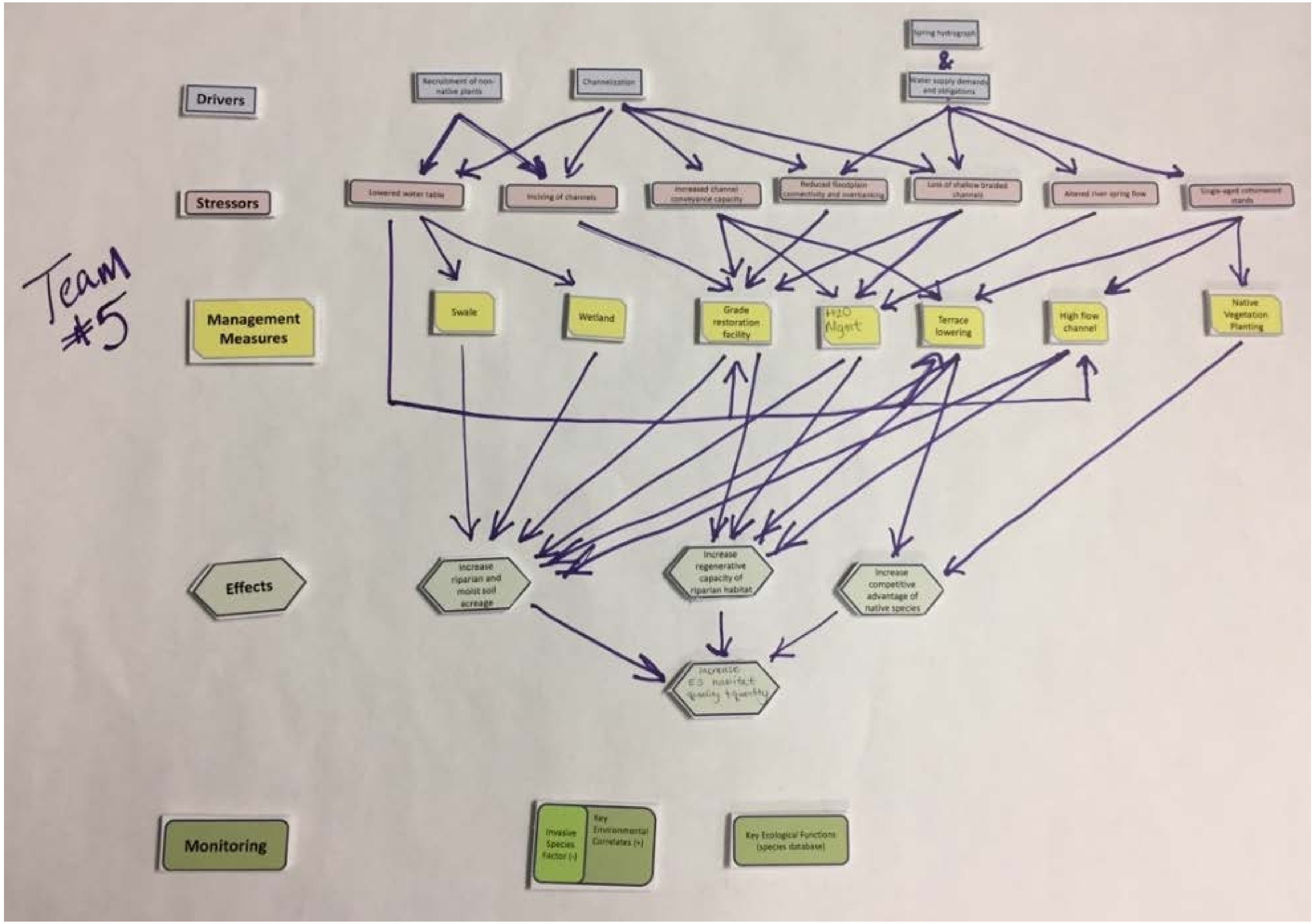
U.S.ARMY


1
Drivers
Recruitment of non-native plants
Channelization
Patterns of channel degradation
Spring hydrograph
Water supply demands and obligations
Wildfire Season
Reduced floodplain connectivity and overbanking
Altered river spring flow
Incising of channels
Lowered water table
Decreased H_2O Quality
Loss of shallow braided channels
Stressors
Increased channel conveyance capacity
Thinning of vegetation
Single-aged cottonwood stands
Swale
Grade restoration facility
Agency Coordination re: water
High flow channel
Management Measures
Native Vegetation Planting
Terrace lowering
Public Water Education
Fuels Management
Invasive Vegetation Removal
Water Conservation
Increase competitive advantage of native species
Effects
Halt head-cutting of channel
Increase riparian and moist soil acreage
Mosaic Habitat
Increase regenerative capacity of riparian habitat
Groundwater monitoring
Vegetation monitoring
Monitoring
Wildlife monitoring survey
Geomorphic Monitoring
Key Ecological Functions (species database)


SWFL & YBCC
TEAM 2
Drivers
Recruitment of non-native plants
Water supply demands and obligations
Spring hydrograph
Stressors
Thinning of vegetation
Single-aged cottonwood stands
Altered river spring flow
Reduced floodplain connectivity and overbanking
Lowered water table
Incising of channels
Management Measures
Invasive Vegetation Removal
Native Vegetation Planting
Terrace lowering
High flow channel
Swale
Wetland
Effects
Increase competitive advantage of native species
Increase regenerative capacity of riparian habitat
Increase riparian and moist soil acreage
Monitoring
Invasive Species Factor (-)
Key Environmental Correlates (+)
Key Ecological Functions (species database)
Assumption: Everything is interrelated


Drivers
Spring hydrograph
Water supply demands and obligations
Stressors
Food + shelter Resources
Incising of channels
Lowered water table
Loss of shallow braided channels
Altered river spring flow
Reduced floodplain connectivity and overbanking
Management Measures
Flows/ Hydrograph
High flow channel
Invasive Vegetation Removal
Native Vegetation Planting
Effects
Increase competitive advantage of native species
Monitoring
Key Ecological Functions (species database)
Geomorphic Monitoring
Recruitment & Survival of RGSM
team 3


Team 4
Drivers
Patterns of channel degradation
Water supply demands and obligations
Spring hydrograph
Channelization
Recruitment of non-native plants
Stressors
Altered river spring flow
Reduced floodplain connectivity and overbanking
Loss of shallow braided channels
Lowered water table
Single-aged cottonwood stands
Thinning of vegetation
Increased channel conveyance capacity
Incising of channels
Management Measures
Invasive Vegetation Removal
High flow channel
Swale
Wetland
Grade restoration facility
Native Vegetation Planting
Add Fish
Effects
Increase regenerative capacity of riparian habitat
Increase competitive advantage of native species
Increase riparian and moist soil acreage
Halt head-cutting of channel
Channel Connectivity
Monitoring
Key Ecological Functions (species database)
Topo/Bathy Surveys
Invasive Species Factor (-)
Key Environmental Correlates (+)


Team #5
Drivers
Recruitment of non-native plants
Channelization
Spring hydrograph
&
Water supply demands and obligations
Stressors
Lowered water table
Incising of channels
Increased channel conveyance capacity
Reduced floodplain connectivity and overbanking
Loss of shallow braided channels
Altered river spring flow
Single-aged cottonwood stands
Management Measures
Swale
Wetland
Grade restoration facility
H2O Mgmt
Terrace lowering
High flow channel
Native Vegetation Planting
Effects
Increase riparian and moist soil acreage
Increase regenerative capacity of riparian habitat
Increase competitive advantage of native species
Increase ES habitat quality + quantity
Monitoring
Invasive Species Factor (-)
Key Environmental Correlates (+)
Key Ecological Functions (species database)

Missouri River Recovery Program Adaptive Management

Adaptive Management Workshop

June 6, 2017

Craig Fischenich
Craig Fleming,

Background

- Biological Opinion (2003)Bank Stabilization and Navigation Project Mitigation Program
  - Prescriptive
  - RPA- flows and mechanical habitat creation, pallid augmentation and stocking, Monitoring and research, Adaptive Management
- Missouri River Recovery Program established in 2006

> - *“The Corps should embrace an adaptive management process that allows efficient modification/implementation of management actions in response to new information and to changing environmental conditions to benefit the species . . .” (USFWS 2000)*

- From 2003-2006 we set up monitoring plans and modified every structure in the river to create Shallow Water Habitat
- 2005 we had a collaborative process to run a prescribed spring pulse for the pallid sturgeon.
- 2006 Spring pulse happen (insignificant amounts of water…) AND AM made the scene

Early Attempts

- First attempts at AM
  - 2008 SDM Rapid Prototype workshop for Emergent Sandbar habitat
  - 2009 SDM Rapid Prototype Workshop for Shallow Water Habitat

Structured Decision Making (SDM)

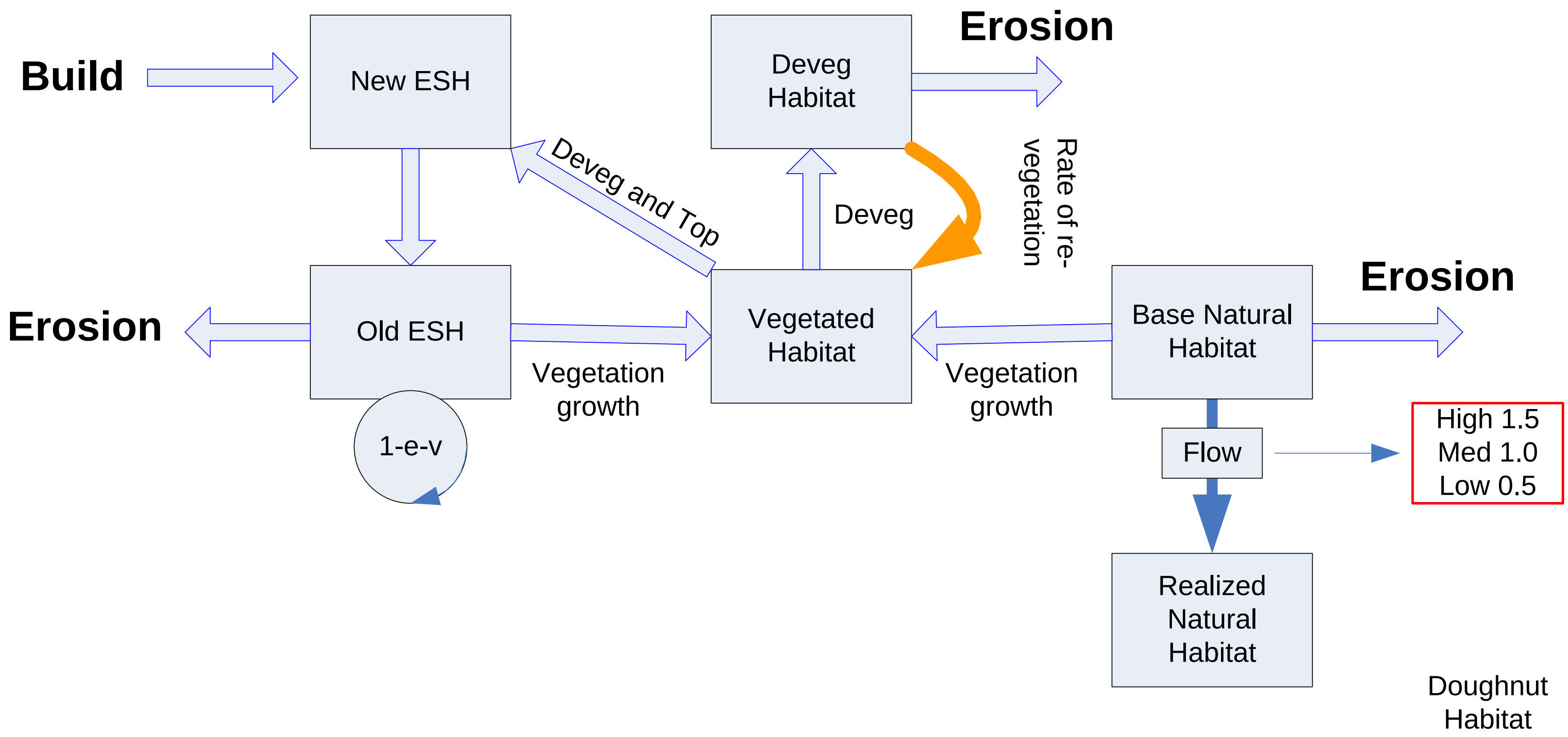
as a tool to develop AM

"SDM is the formal application of common sense to situations too complicated for the informal application of common sense"

Ralph Keeney, Harvard Business School

- SDM brings focus, purpose and organization to management actions, monitoring and assessment to improve our decision making ability

•Second Prototype Habitat Model



Things Happen as you work…

- WRDA 2007 established
  - Missouri River Recovery Implementation Committee
  - Missouri River Ecosystem Restoration Plan
- MRRIC- ~ 70 members representing local, state, tribal, and federal interest throughout the basin; 28 stakeholders represent 16 non-governmental categories

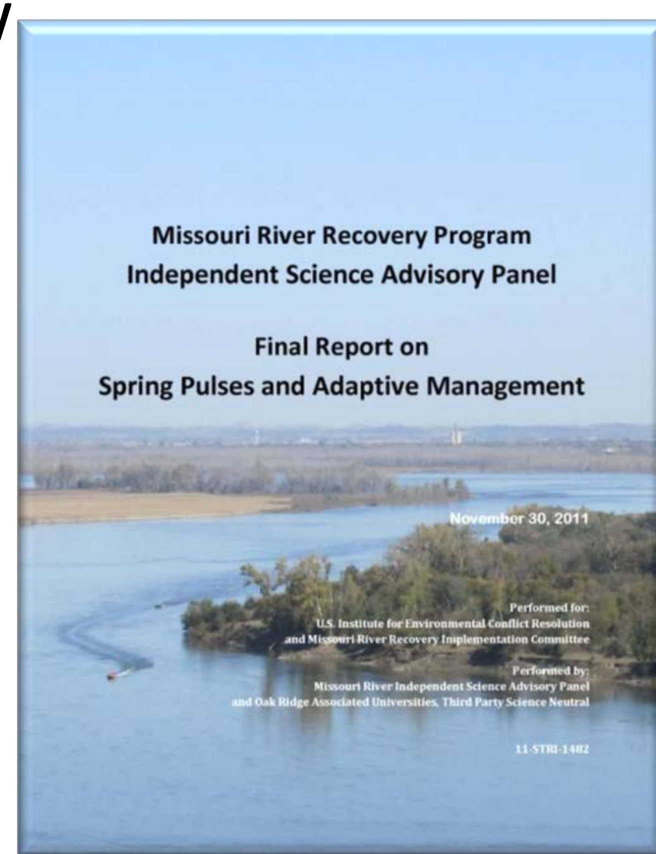
As things evolved

- AM Framework Document
- ESH EIS
  - Furthered models
  - Developed decision tools
  - Produced AM Reports annually
  - Started learning

MRRIC established Independent Science Advisory Panel!

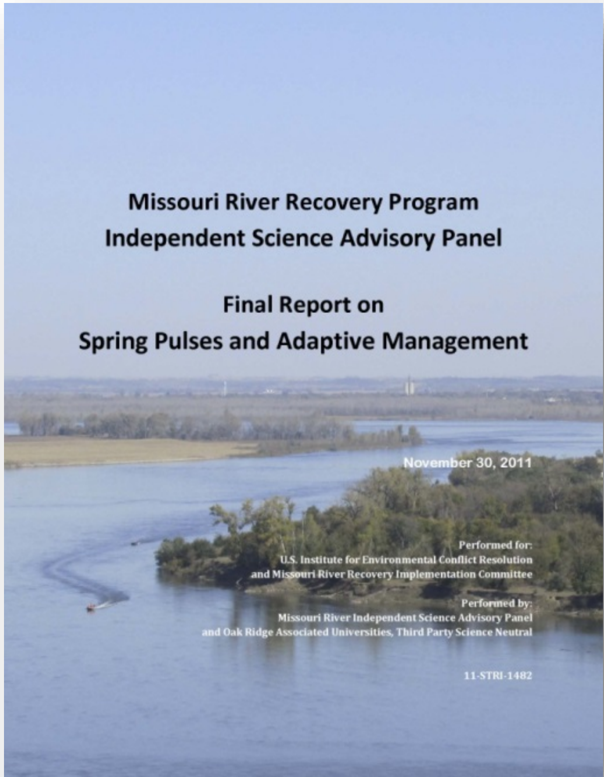
Then, we started a new path…

- First assignment to review flow component of the BO
- MRRIC Independent Science Panel 2011 Review
- 2012 Begin Management Plan EIS

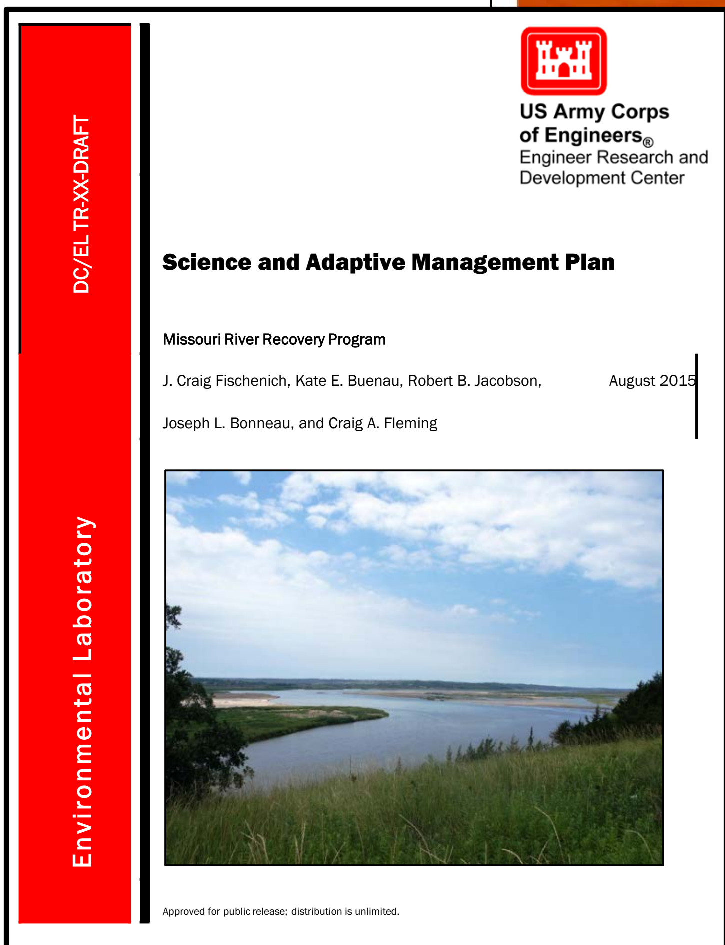


ISAP evaluation & MRRIC recommendation

1. Develop Effects Analysis √
2. Develop CEMs √
3. Evaluate other programs √
4. Overarching adaptive management •√
5. Design monitoring programs√
6. Identify decision criteria√
7. Evaluate entire hydrograph •√



Effects Analysis Begun in 2013



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Science and Adaptive Management Plan

Missouri River Recovery Program

J. Craig Fischenich, Kate E. Buenau, Robert B. Jacobson, Joseph L. Bonneau, and Craig A. Fleming

August 2015

Approved for public release; distribution is unlimited.

Environmental Laboratory

Pacific Northw
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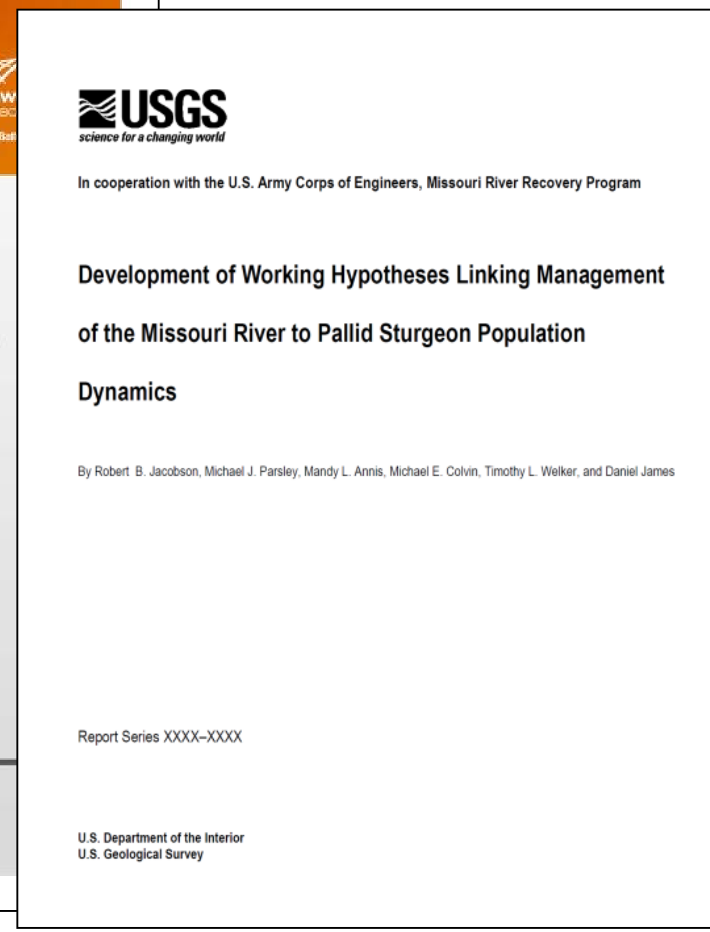
CJ Huber
CR Vernon

epared for the U.S. Department of Energy
der Contract DE-AC05-76RL01830



USGS
science for a changing world

In cooperation with the U.S. Army Corps of Engineers, Missouri River Recovery Program

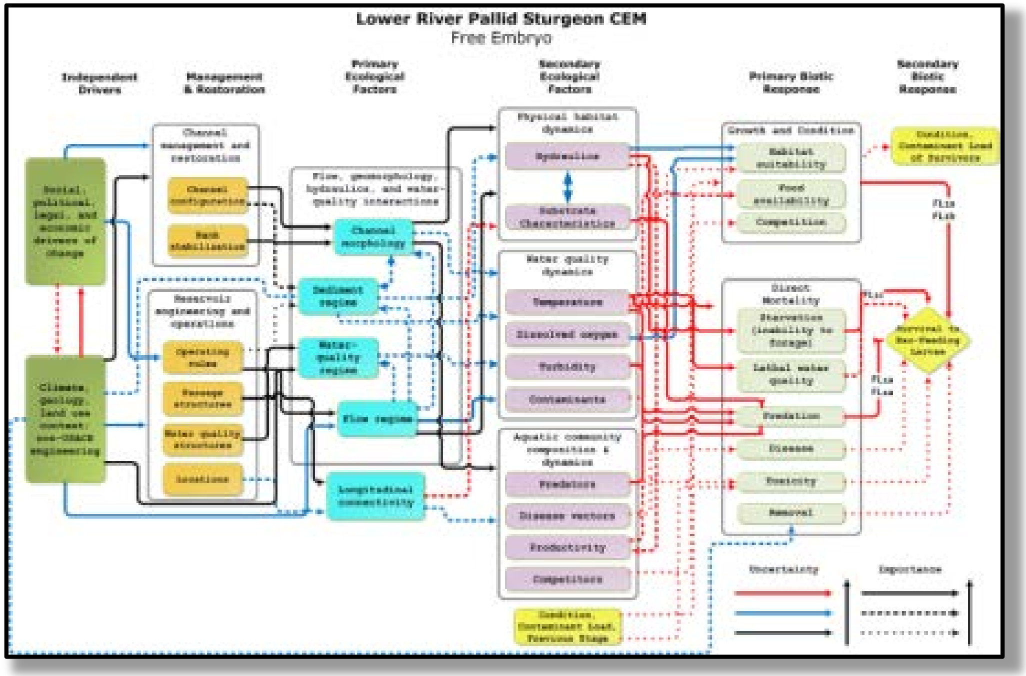
Development of Working Hypotheses Linking Management of the Missouri River to Pallid Sturgeon Population Dynamics

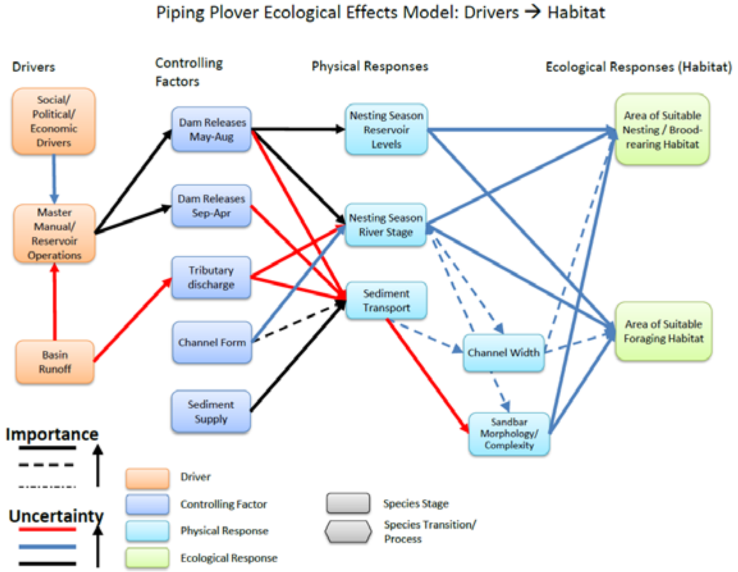
By Robert B. Jacobson, Michael J. Parsley, Mandy L. Annis, Michael E. Colvin, Timothy L. Welker, and Daniel James

Report Series XXXX–XXXX

U.S. Department of the Interior
U.S. Geological Survey

Effects Analysis improved our CEMS

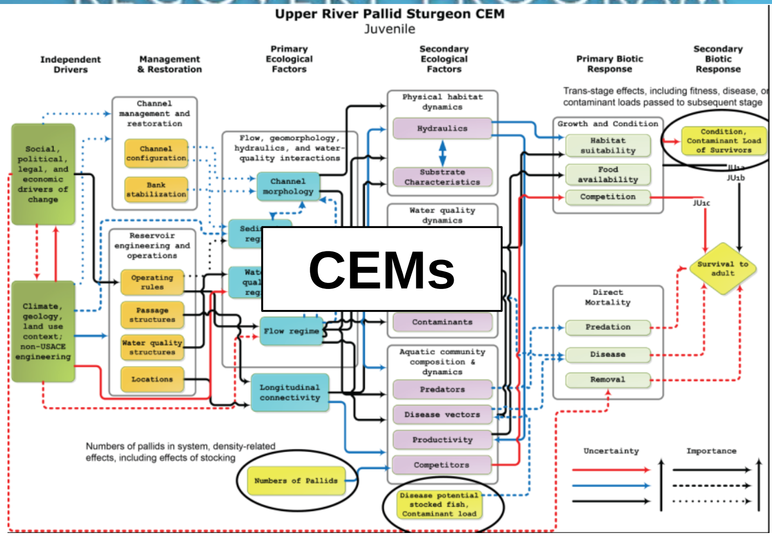


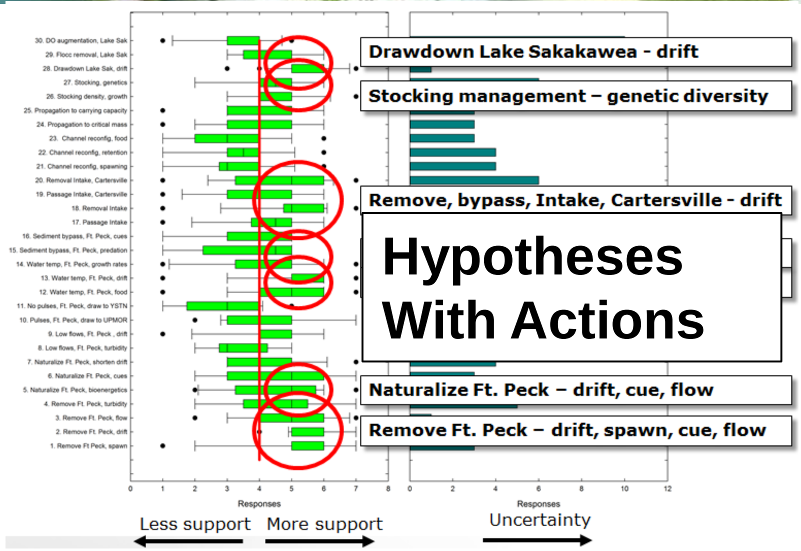


Equally important

- Convinced senior leadership from both agencies to attend SDM Rapid Prototyping exercise
  - Solidified Problem we are working to solve which provides focus to all our efforts
  - Provided assignments for developing fundamental objectives
  - Solidified our use of SDM throughout our process and into implementation

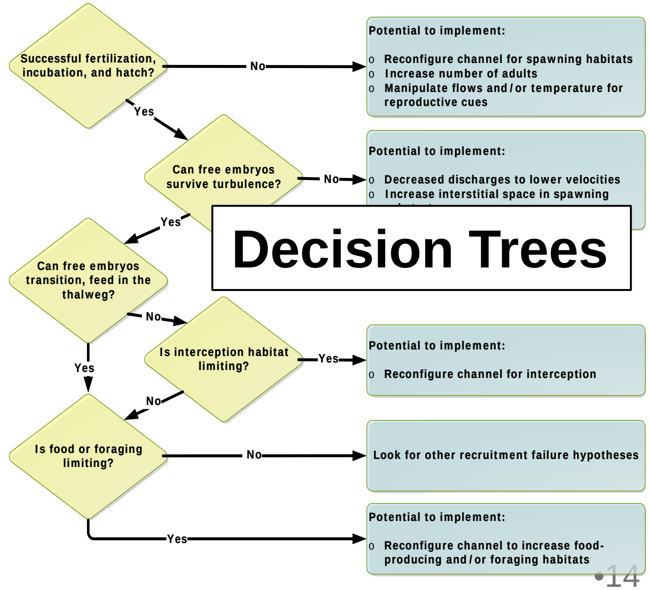
Hypothesis Assessment



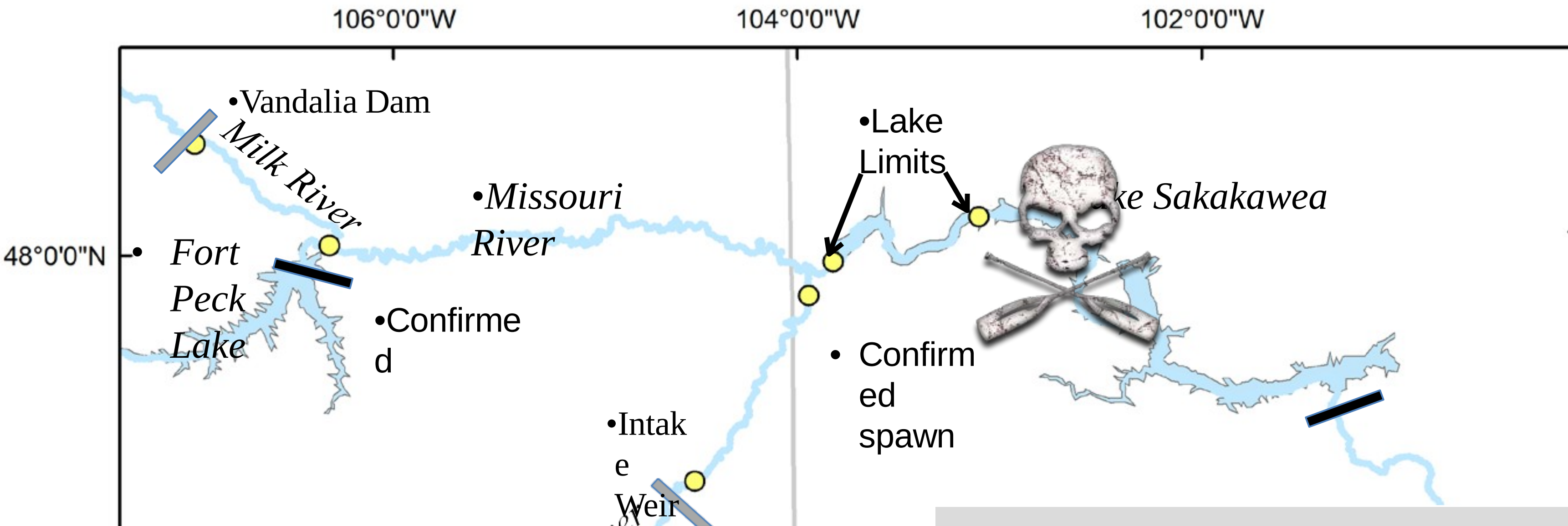


Decision Criteria

	Question	Y	U	N
1	Is this factor limiting pallid sturgeon reproductive and/or recruitment success?			
2	Are pallid sturgeon needs sufficiently understood with respect to this limiting factor?			
3	Do one or more management action(s) exist that could, in theory, address these needs?			
4	Has it been demonstra[…] has a sufficient probability of […]			
5	Have other biological, legal, and socioeconomic considerations been sufficiently addressed to determine whether or how to implement management actions to Level 3?			
	Criteria for level 3 implementation			
	1 - A "Yes" to all five questions triggers level 3 implementation			
	2 - A "Yes" to four of five, with an "Uncertain" for either #1 or #2 triggers a two-year clock to either reject the hypothesis or implement at level 3			



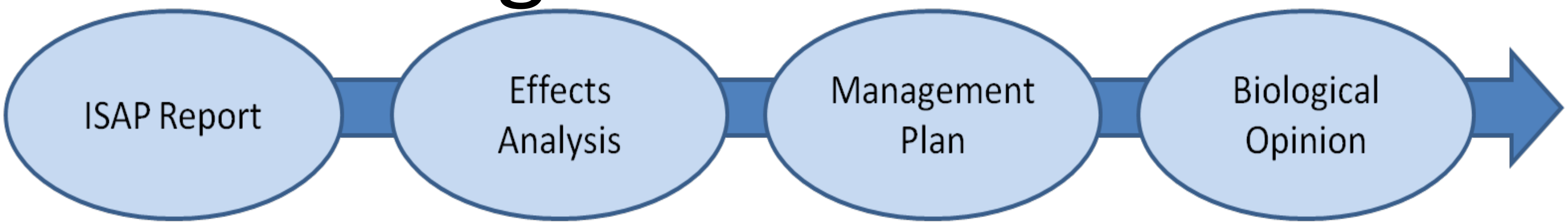
Free Embryo Drift and Survival Upper Missouri and Yellowstone Rivers



Management Working Hypotheses:

- **Upper Missouri**
  - **Low flows from Fort Peck**
  - **Increased temperatures from Fort Peck**
  - **Drawdown of Lake Sak**
- **Yellowstone**
  - **Provide passage at Intake**
  - **Drawdown of Lake Sak**

Management Plan Process



ISAP Report
- ISAP Recommendations
- MRRIC Proposed Actions

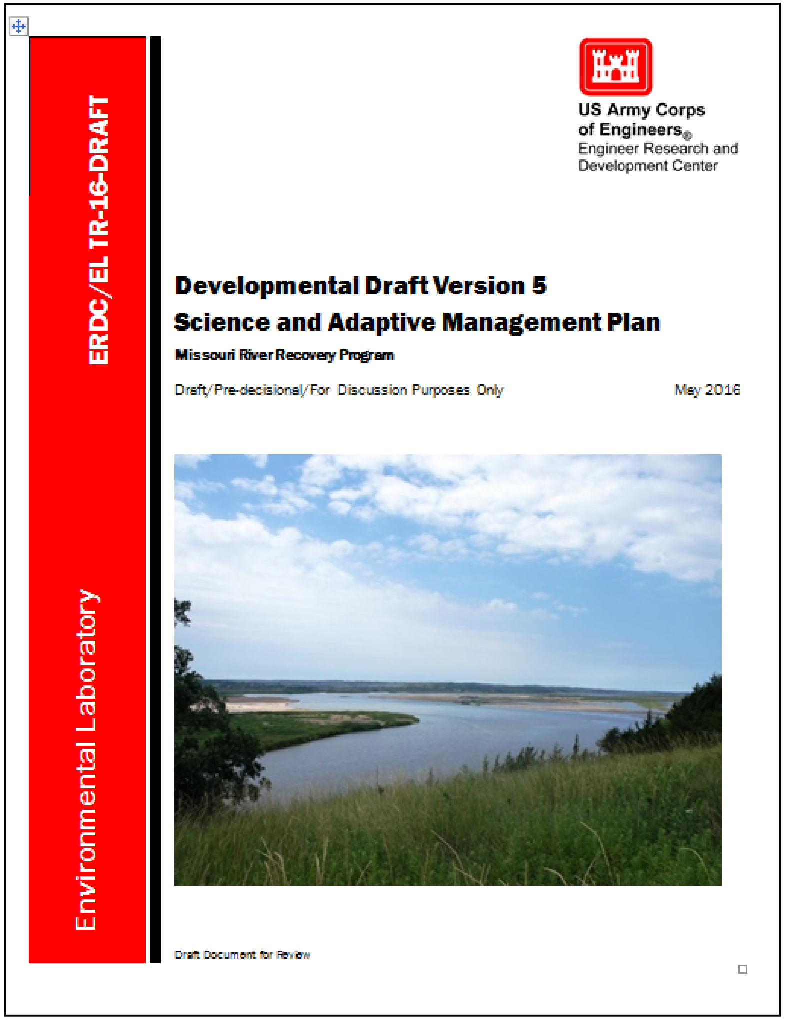
Effects Analysis
- CEMs
- Compile existing data and resources
- Hypotheses
- Evidence based assessment of hypotheses
- Potential Management Actions

Management Plan
- Alternatives
- Human considerations
- Record of Decision
- Biological Assessment
- AM Plan

Biological Opinion
- Revised
- New
- No Change

Primary Actions	Alternative 1- No Action	– USFWS 2003 BiOp Projected Actions	Alternative 3- Pallid Habitat Construction and ESH Mechanical	Alternative 4- Pallid Habitat Construction and ESH Spring Release (42 MAF)	Alternative 5– Pallid Habitat Construction and ESH Fall Release (35 SL)	Alternative 6- Pallid Habitat Construction and ESH Mechanical w/ Spawning Cue
Mechanical ESH Creation- *extent varies by alternative due to other ESH creation actions*	X	X	X	X	X	X
Spring Release ESH Creation *NOT in MM*				X		
Fall Release ESH Creation *NOT in MM*					X	
Low Nesting Season Release *NOT in MM*		X				
Pallid Early Life History Habitat Construct (Level 3)	X (SWH)	X (SWH)	X (IRC)	X (IRC)	X (IRC)	X (IRC)
Pallid Spawning Habitat Construction (Level 3)			X	X	X	X
Pallid Propagation and Stocking (Level 3)	X	X	X	X	X	X
Pallid Spawning Cue Release (Level 3) *v1 IS in MM; v2 & v3 are NOT in MM*	X *v1*	X *v2*				X *v3*
Active AM (includes Level 1-2 components for all hyp)			X	X	X	X
Riparian habitat development on any acquired land	X	X	X	X	X	X

July 2015 we put together the pieces into an Adaptive Management Plan V1



ERDC/EL TR-16-DRAFT

US Army Corps of Engineers®
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Developmental Draft Version 5

Science and Adaptive Management Plan

Missouri River Recovery Program

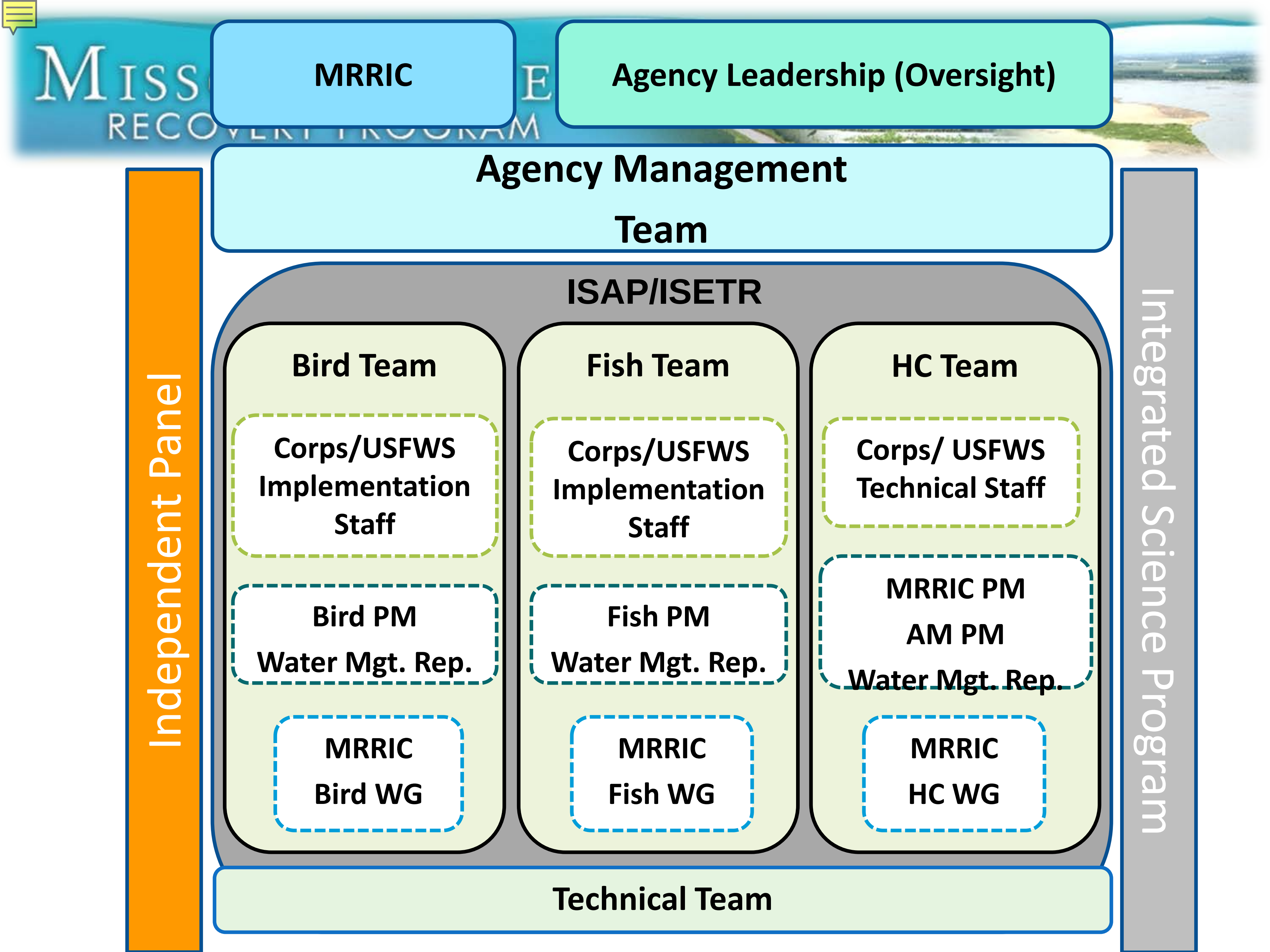
Draft/Pre-decisional/For Discussion Purposes Only May 2016

Environmental Laboratory

Draft Document for Review

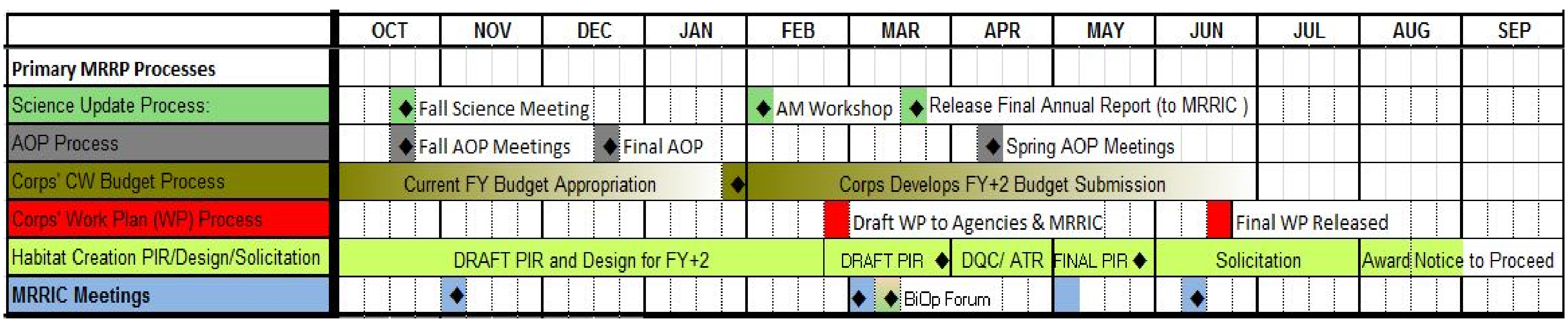
Adaptive Management Plan

- Chapter 1 – Summary of Plan
- Chapter 2 – Governance
- Chapter 3 – AM for Plover and Tern
- Chapter 4 - AM for Pallid Sturgeon
- Chapter 5 - Human Considerations
- Chapter 6 - Data Acquisition, Management, Reporting and Communications

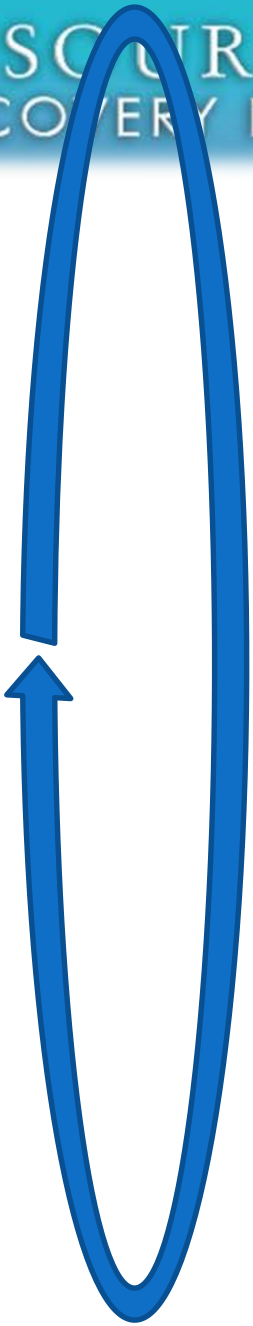

MISSOURI RIVER
RECOVERY PROGRAM
MRRIC
Agency Leadership (Oversight)
Agency Management Team
Independent Panel
Integrated Science Program
ISAP/ISETR
Bird Team
Corps/USFWS Implementation Staff
Bird PM
Water Mgt. Rep.
MRRIC
Bird WG
Fish Team
Corps/USFWS Implementation Staff
Fish PM
Water Mgt. Rep.
MRRIC
Fish WG
HC Team
Corps/ USFWS Technical Staff
MRRIC PM
AM PM
Water Mgt. Rep.
MRRIC
HC WG
Technical Team

Key Processes

- Science Update Process
- Annual Operating Plan
- Work Plan Development
- Corps CW Budget Development
- MRRIC Engagement

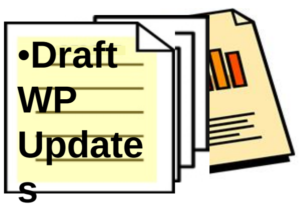


- •Existing Strategic WP; Budget; Guidance & Direction
- •Ongoing R&D; Monitoring & Assessment; Projections



- **Technical Team** develops:
  - •AM Performance Assessment,
  - •Model Projections
  - •Science Findings
  - •Alternative Designs/Assessments

•**Bird & Fish Teams** prepare:
- •Prioritized List of Actions
- •List of Other Needs
- •Other Recommendations

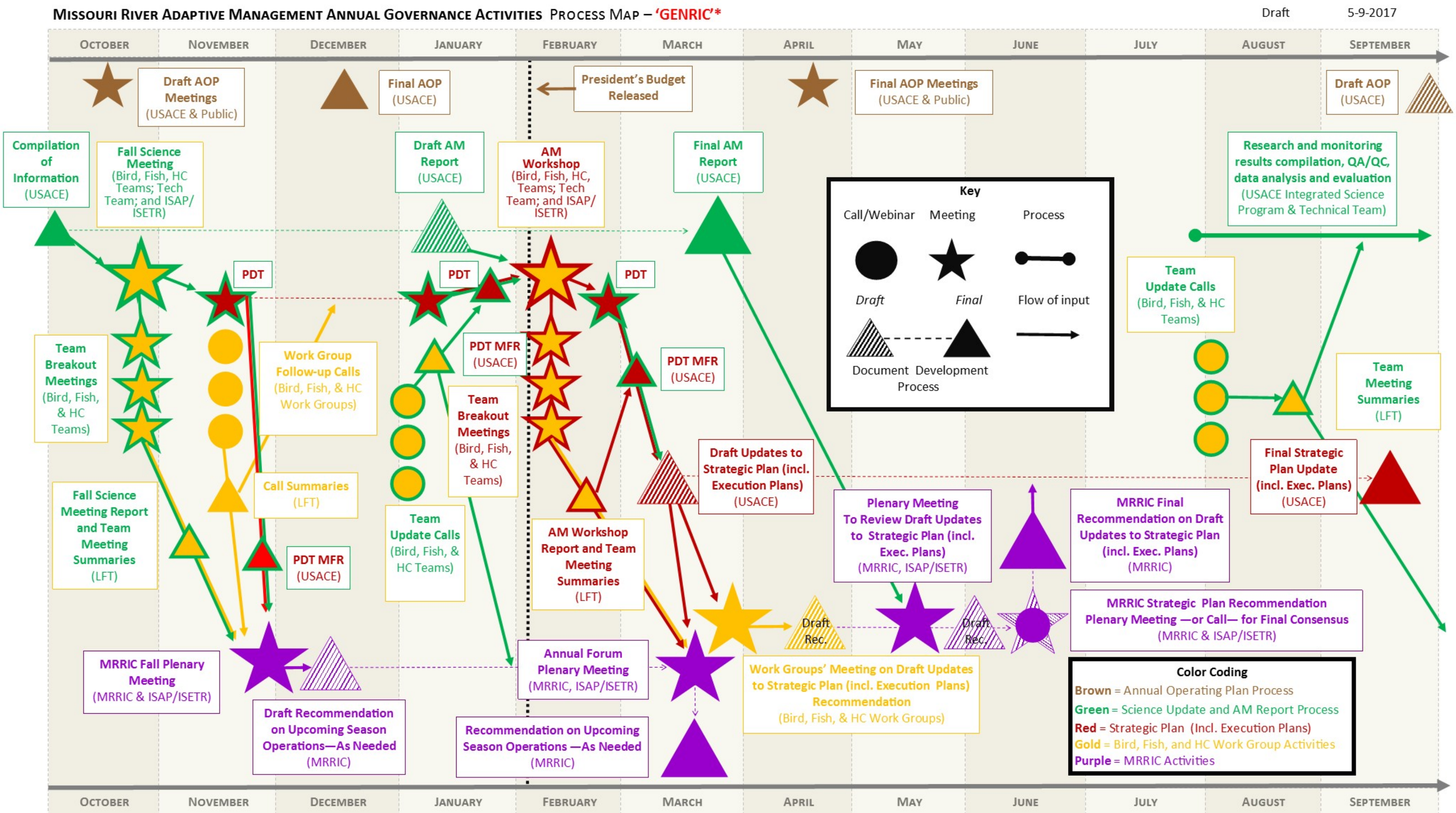


•**Management Team** develops:
- •Draft Updates to Strategic Plan
- •Other Recommendations

•(Review/Meetings)

•**MRRIC** provides:
- •Consensus Recommendation

Science Update Process



This process map depicts the proposed governance activities to be undertaken annually by the U.S. Army Corps of Engineers (USACE), the U.S. Fish and Wildlife Service (USFWS), and the Missouri River Recovery Implementation Committee (MRRIC) in the implementation of Adaptive Management (AM) related to the endangered piping plover and pallid sturgeon in the Missouri River. ***This process map reflects the MRRIC AM Governance Planning Ad Hoc Group's 'generic' approach to governance to be presented to MRRIC at the May 2017 meeting.**

Strategic Plan

Significant Changes:

- Shift to a more strategic planning perspective (FY+2 focus)
- Roles and engagement processes for MRRIC WGs

CFY
- Minor or no adjustments

FY+1
- Minor adjustments based on new information and FY+1 P-bud

FY+2
- Management actions, research and other studies or activities needed to meet objectives;
- Developed at level of detail for budgeting purposes

FY+3
- Adjustments to former FY+4 strategic plan based on current projections

FY+4
- New strategic plan based on current projections & risk management

Critical uncertainties

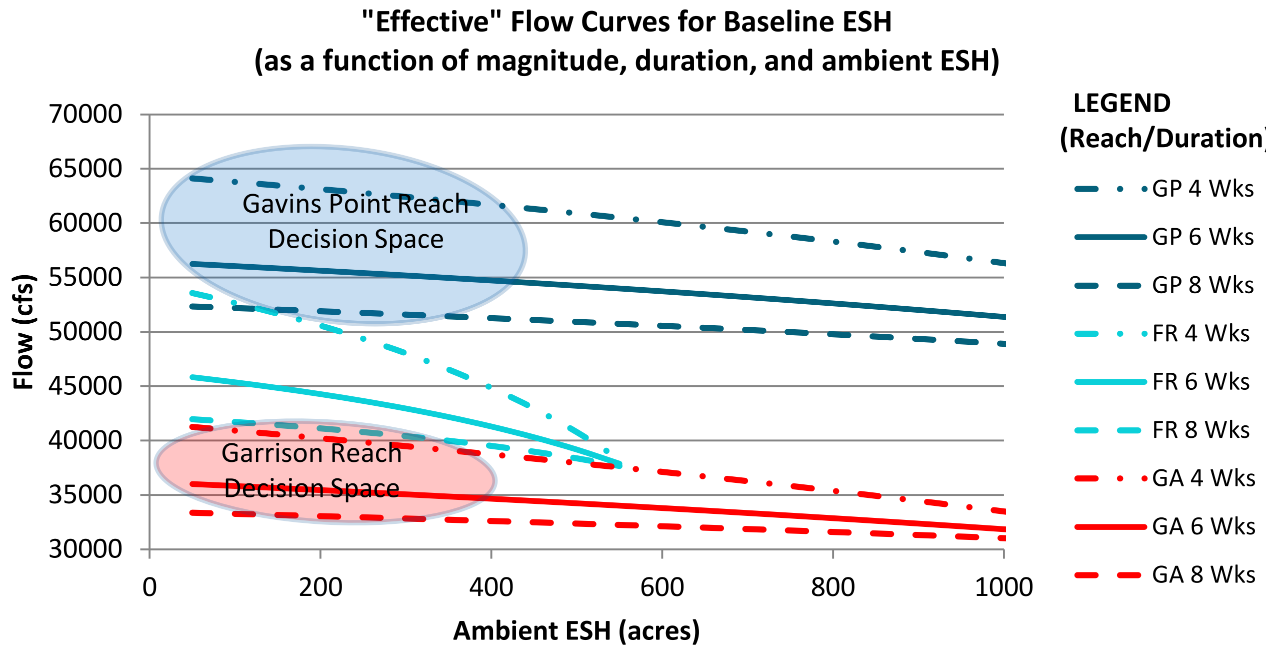
management hypotheses.

Management Critical Uncertainties	Actions	Management hypotheses
Creating New Habitat What is the most effective and efficient way of **creating habitat** within the larger context of management and uses of the Missouri River? a. Are there effective and implementable ways of using flow modification to provide and enhance habitat availability and quality? b. Can habitat be mechanically created in an effective and sustainable manner? c. What are the effects of habitat creation actions on Human Considerations?	Habitat-creating flows	Habitat-creating flows of sufficient magnitude and duration increase the area of nesting/brood rearing habitat and foraging habitat on the river by increasing deposition, assuming sediment is available, thereby increasing fledgling productivity.
	Mechanical habitat creation on river (ESH)	Mechanical habitat creation of ESH in river segments increases nesting/brood-rearing and foraging area, which increases survival of eggs to chicks and chicks to fledglings by reducing predation and increasing food availability. Mechanical habitat creation of sandbars in river segments increases nesting/brood-rearing and foraging area relative to the condition and availability of habitat at other breeding areas, thus increasing the number of adults through net immigration from other areas.
	Mechanical habitat creation on reservoirs shorelines or islands	Mechanical habitat creation of habitat on reservoir shorelines/islands increases nesting/brood-rearing and foraging area, which increases survival of eggs to chicks and chicks to fledglings by reducing predation and increasing food availability. Mechanical habitat creation of habitat on reservoir shorelines/islands increases nesting/brood-rearing and foraging area relative to the condition and availability of habitat at other breeding areas, thus increasing the

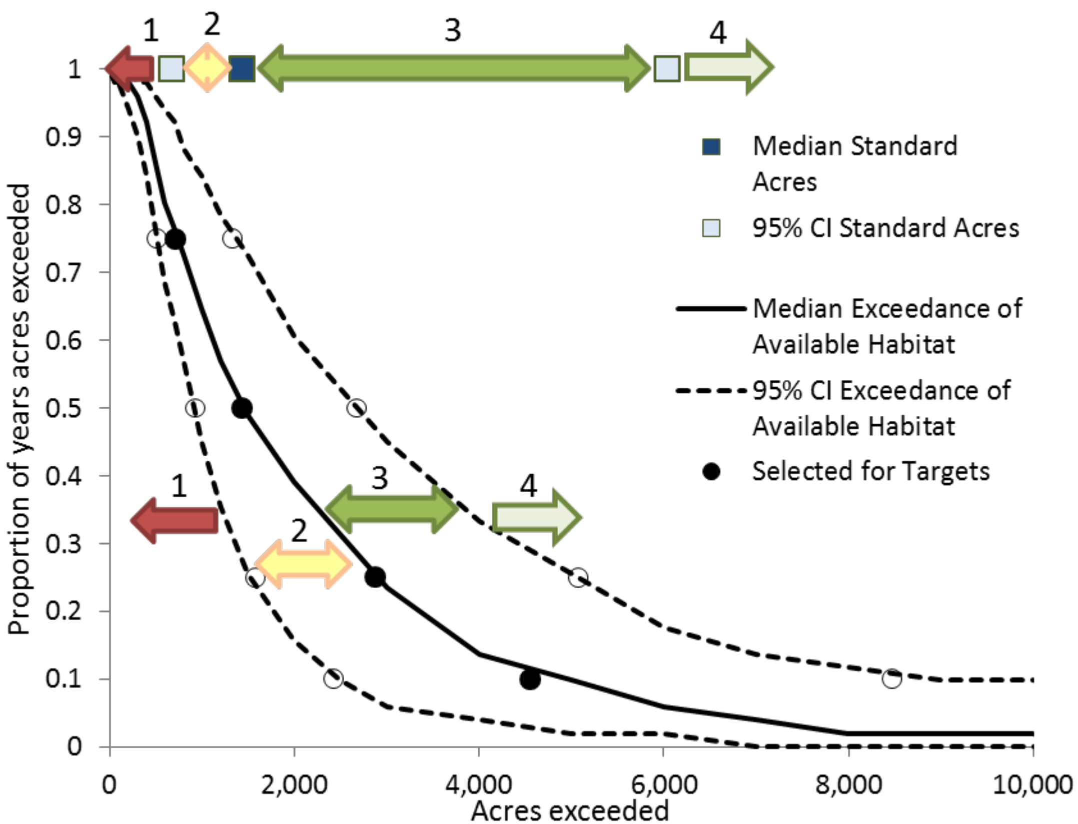
Missouri River Recovery Program

Decision Criteria

- Criteria for implementation
- Criteria for Adjustment
- Decision and collaboration level



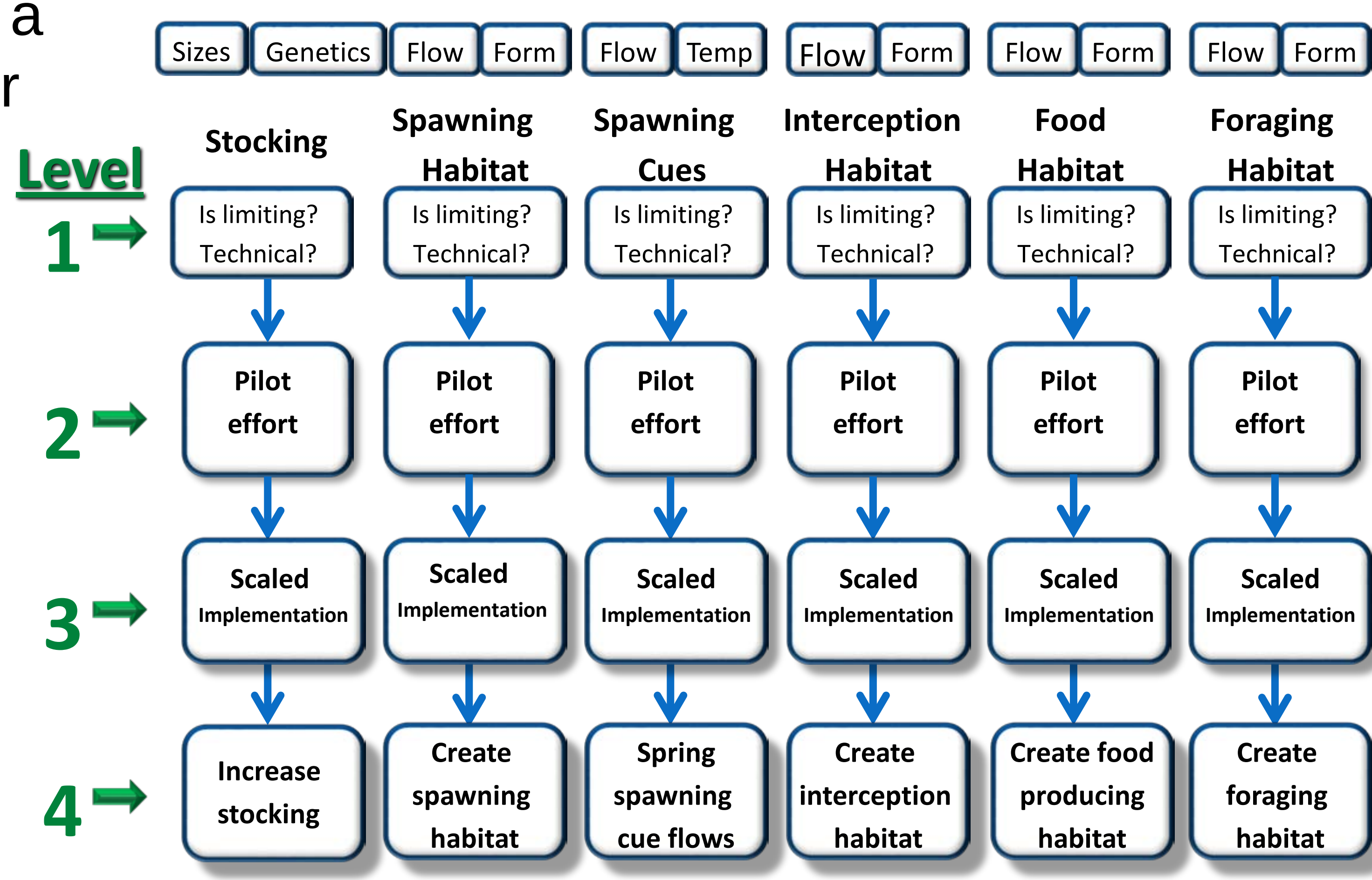
Evaluation Criteria



Framework Organization

Organized in a linear manner

Comprehensive descriptions of science, pilot projects, Level 3 actions,



Level 1-4

<table>
<tr><td>Level 1: Research</td><td rowspan="2">Population Level Biological Response IS NOT Expected</td></tr>
<tr><td>Level 2: In-river Testing</td></tr>
<tr><td>Level 3: Scaled Implementation</td><td rowspan="2">Population Level Biological Response IS Expected</td></tr>
<tr><td>Level 4: Ultimate Required Scale of Implementation</td></tr>
</table>

Prioritization criteria used in AM Plan for Level 1 and Level 2 activities (App. F)

- **Relevance to *current* decisions/actions:**
  - Higher weight for Level 2 and Level 3 actions that are included in EIS
  - Action effectiveness and cause-effect work related to action effectiveness
- **Value of information for *future* decisions:**
  - Critical information on either biological benefit or feasibility of actions
  - High information value relative to cost
  - Reduces critical uncertainties on which future actions to pursue
- **Foregone risk to species:**
  - Provides information which helps to avoid taking actions that may pose a high risk to species
- **Progress towards compliance:**
  - Helps to evaluate status and trend of populations at risk, progress towards USFWS objectives
- **Timeliness of learning:**
  - If all else equal, fast answers favored over slow answers
- **Cost feasibility:**
  - Benefits of information vs. costs

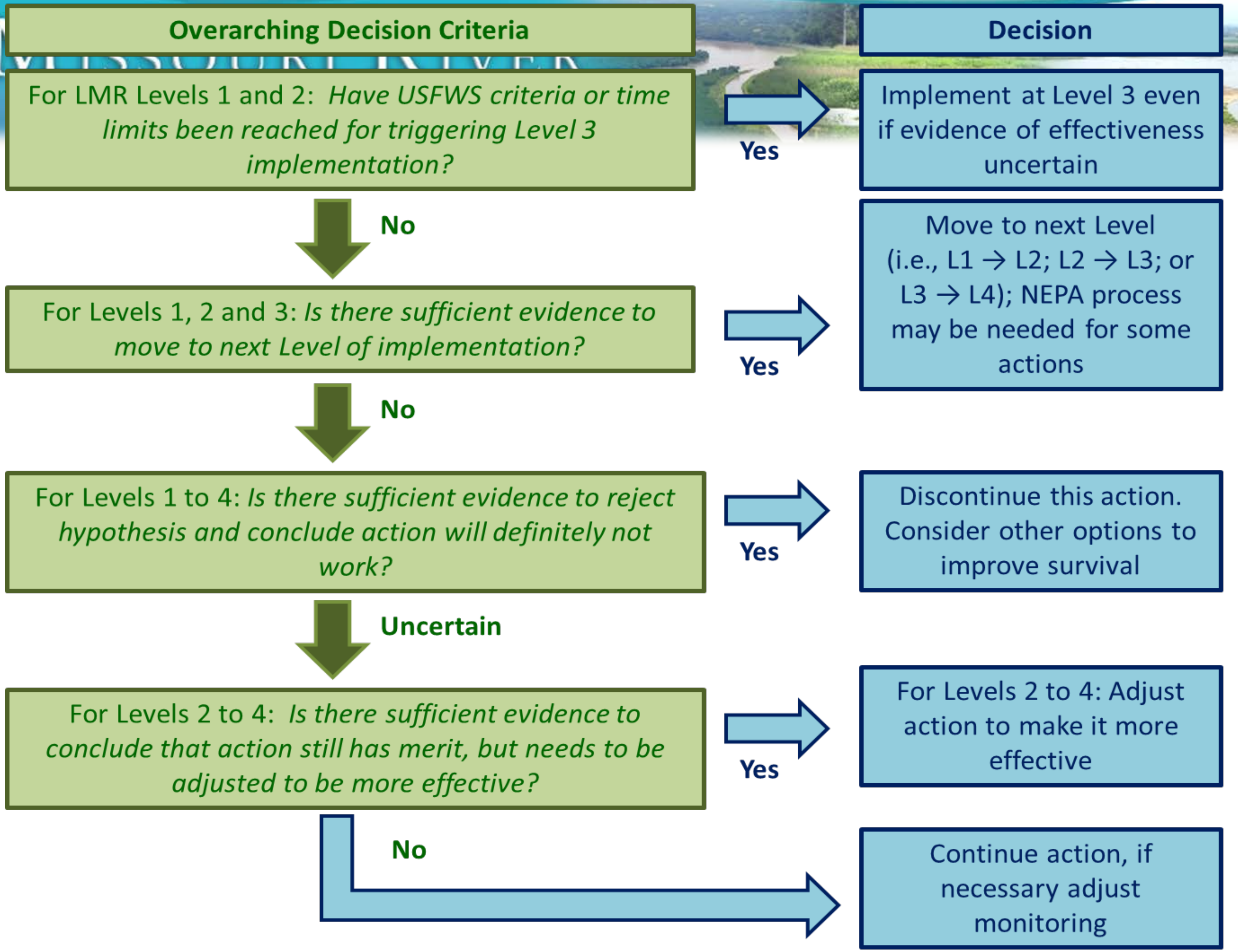
IRC Habitat Sampling Design

- Sampling design based on logistical feasibility and statistical power (C = control; T = treatment;   T = treatment + construction);
- 6 treatment sites and 6 control sites monitored over 12 years

Site/Year	1	2	3	4	5	6	7	8	9	10	11	12
01	C	T	T	T	T	T	T	T	T	T	T	T
01 Control	C	C	C	C	C	C	C	C	C	C	C	C
02		C	T	T	T	T	T	T	T	T	T	T
02 Control		C	C	C	C	C	C	C	C	C	C	C
03			C	T	T	T	T	T	T	T	T	T
03 Control			C	C	C	C	C	C	C	C	C	C
04				C	T	T	T	T	T	T	T	T
04 Control				C	C	C	C	C	C	C	C	C
05					C	T	T	T	T	T	T	T
05 Control					C	C	C	C	C	C	C	C
06						C	T	T	T	T	T	T
06 Control						C	C	C	C	C	C	C

Upper Missouri River – Big Picture

Task Name																	
Big Question 1: Spawning Cues	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Level 1																	
C1 Design complementary passive/active telemetry network		■	■														
C2 Opportunistic tracking of reproductive behaviors	■	■	■	■	■	■	■	■	■	■	- - -	- - -	- - -	- - -	- - -	- - -	- ->
C3 Mesocosm experiments, reproductive behaviors							■	■	■	■	■	■					
Big Question 2: Flow Naturalization and Productivity	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Level 1																	
C1 Engineering models, interactions with authorized purposes							■	■	■								
C2 Screening: limitations of food or forage habitats										■	■	■	■				
C3 Field studies along gradients, food and forage habitats										■	■	■	■	■			
C4 Mesocosm studies: quantitative habitat – survival relations										■	■	■	■	■			
Big Question 3: Temperature manipulations at Fort Peck	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Level 1																	
C1 Screening: Feasibility, modeling of effects							■	■	■	■							
C2a Screening: is food limiting to age-0 survival?										■	■	■	■				
C2b Are Lake Sakakawea conditions limiting to age-0 survival?	■	■	■	■	■												
C3a Field gradient, temperature and food production										■	■	■	■	■			
C3b Field experiment dift/dispersal advection/dispersion validation	■	■	■	■	■	■											
C4a Mesocosm studies: temperature, food, survival relations										■	■	■	■	■			
C4b Development rates of embryos, free embryos, larvae	■	■	■														
Big Question 4: Sediment bypass	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Level 1																	
C2 Mesocosm study of turbidity-limited survival										■	■	■	■				
C3 Mesocosm study of turbidity-limited survival rates										■	■	■					
Big Question 5: Passage, drift, and recruitment	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Level 1		■	■	■	■	■											
C1a Model integration, drift and development		■	■														
C1b Modeling location and rate of change of headwaters		■	■														
C2a Patchiness of anoxic zone		■	■	■													
C2b Spawning habitat distribution on the Yellowstone River		■	■	■													
C3 Field experiment drift/dispersal, advection/dispersion validation	■	■	■	■	■	■											
C4 Mesocosm studies to quantify transport	■	■	■	■	■												
Level 2																	
C5 Engineering studies for effects of low flows							■	■									
C6a Drift experiments, Fort Peck flows and drawdowns							■	■	■	■	■	■					
C6b Adult translocation experiment, Yellowstone							■	■	■	■	■	■					
Big Question 6: Population Augmentation	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Level 1																	
C1 Engineering feasibility hatchery needs, facilities, operations	■	■	■														
C2 Retrospective study survival linked to hatchery operations		■	■	■													
C3 Simulation models, population sensitivity to size, health, genetics		■	■	■	■												
Level 2																	
C4 Field experimentation with varying size, location of stocking					■	■	■	■	■	■							
Level 3					`												
Stocking	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■


Overarching Decision Criteria
Decision
For LMR Levels 1 and 2: *Have USFWS criteria or time limits been reached for triggering Level 3 implementation?*
Yes
Implement at Level 3 even if evidence of effectiveness uncertain
No
For Levels 1, 2 and 3: *Is there sufficient evidence to move to next Level of implementation?*
Yes
Move to next Level (i.e., L1 → L2; L2 → L3; or L3 → L4); NEPA process may be needed for some actions
No
For Levels 1 to 4: *Is there sufficient evidence to reject hypothesis and conclude action will definitely not work?*
Yes
Discontinue this action. Consider other options to improve survival
Uncertain
For Levels 2 to 4: *Is there sufficient evidence to conclude that action still has merit, but needs to be adjusted to be more effective?*
Yes
For Levels 2 to 4: Adjust action to make it more effective
No
Continue action, if necessary adjust monitoring

Human considerations

- Have developed hypotheses for Human Consideration and have tried to maintain HC’s as a priority
- HC Teams have yet to engage due to ongoing critical path activities

HC Continued…

- Working to:
  – More explicitly integrate HCs into proposed decision making processes
    - Consider potential need for and use of HC decision thresholds
  – Screen and ID worthwhile HC monitoring priorities
  – Identify key uncertainties and potential monitoring initiatives
    - Begin to detail HC monitoring requirements and protocols

Chapter 6

- Data Management Principles and practices
  - Description of how teams and advisory committees will define needs for data management and develop the system
- Monitoring and data acquisition
  - Examples of how information management needs would be identified and addressed
- Data Info Management
- Reporting and Communication

Appendices

- **Appendix A. Attachments**
- Appendix B. Conceptual Ecological Models, Hypotheses, and Key Findings of the Effects Analysis
- Appendix C. Detailed Description of Level 1 and 2 Science Components for Pallid Sturgeon
- Appendix D. Population Monitoring and Modeling for Pallid Sturgeon
- **Appendix E. Listing and Description of Protocols for Sturgeon-Based Process Monitoring and Assessment**
- Appendix F. Cost Estimates, Level 1 and Level 2 Science Components
- **Appendix G. Listing and Description of Monitoring and Assessment Protocols for the Birds**
- **Appendix H**. Monitoring and Assessment Protocols for Human Considerations
- Appendix I. Quality Assurance Project Plan (QAPP)
- **Appendix J. Integrated Science Program**
- **Appendix M**. Distributed Systems Data Management Requirements

Questions

Step 1 – Evaluation (related topics)

Craig Fischenich
ERDC Environmental Laboratory

Office of Research and Technology Transfer
Adaptive Management Workshop
St. Louis, MO
6-9 June, 2017

AM Cycle

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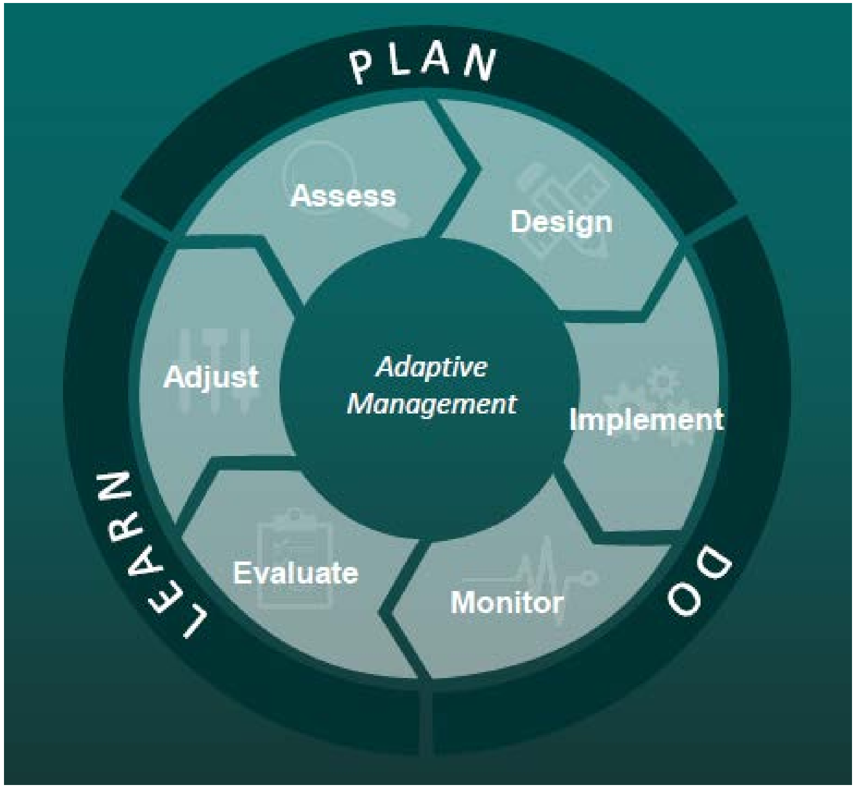
- **PLAN**: Frame problem and analyze actions from the view of management uncertainties
- **DO**: Implement and monitor actions using principles of experimental design
- **LEARN**: Evaluate data to learn about effectiveness of actions and reduce uncertainties

See Handout #4 for details



*This and the next set of figures taken from ESSA (2012).

Assess Step

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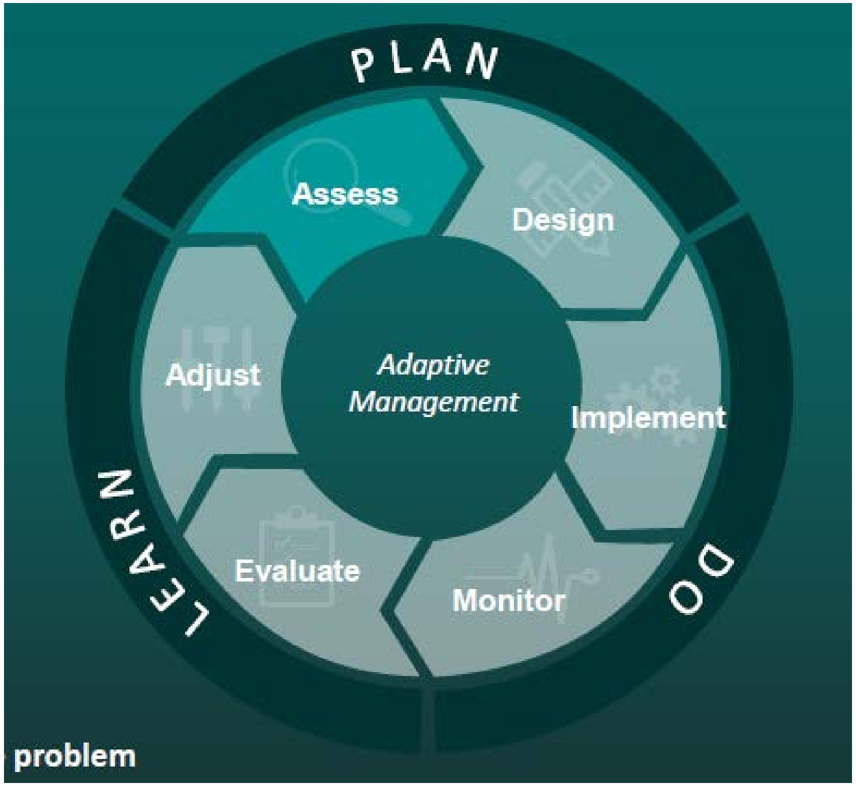
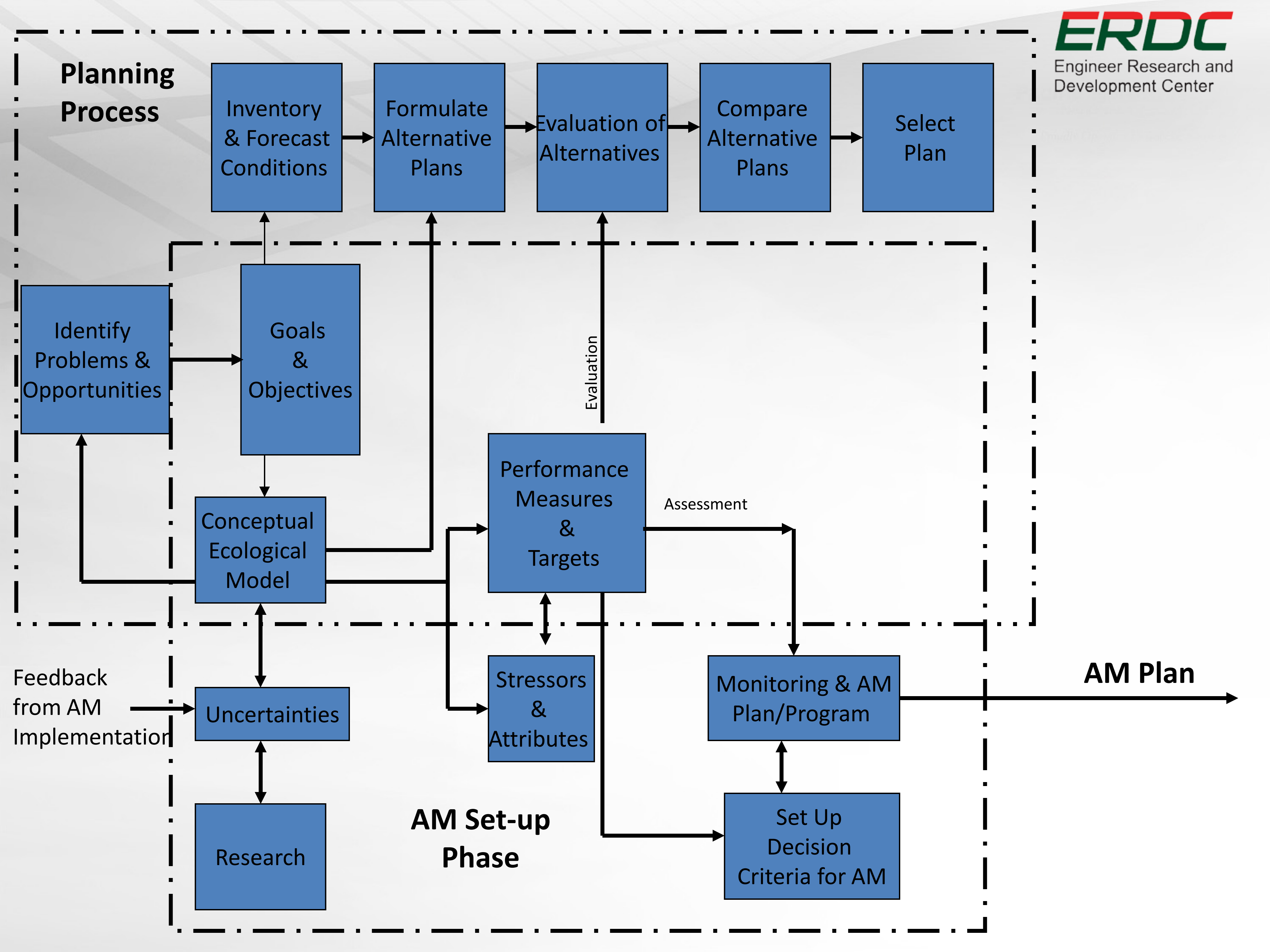
- **Define the problem**
- **Identify measurable objectives** (*what are you trying to achieve and how will you know when you get there?*)
- **Identify mgm't (i.e. decision-relevant) uncertainties** (*what do you want to learn about achieving objectives?*)
- **Build conceptual and/or quantitative models; explore hypotheses, alternative actions**
- **Incorporate insights** (*what would you change based on what you learn?*)





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Planning Process
Inventory & Forecast Conditions
Formulate Alternative Plans
Evaluation of Alternatives
Compare Alternative Plans
Select Plan
Identify Problems & Opportunities
Goals & Objectives
Evaluation
Performance Measures & Targets
Assessment
Conceptual Ecological Model
Feedback from AM Implementation
Uncertainties
Stressors & Attributes
Monitoring & AM Plan/Program
AM Plan
Research
AM Set-up Phase
Set Up Decision Criteria for AM

Overview

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Parallel Planning Steps

1. Information gathering or scoping
2. Develop problem and opportunity statements
3. Develop goals and objectives
4. Identify constraints
5. CEMs
6. Inventory & Forecast

Problem and Opportunities Statements

- Avoid mentioning solutions in these statements
- Reflect the concerns and priorities of all the stakeholders
- If done correctly, can satisfy NEPA scoping
- Foundation for the planning process

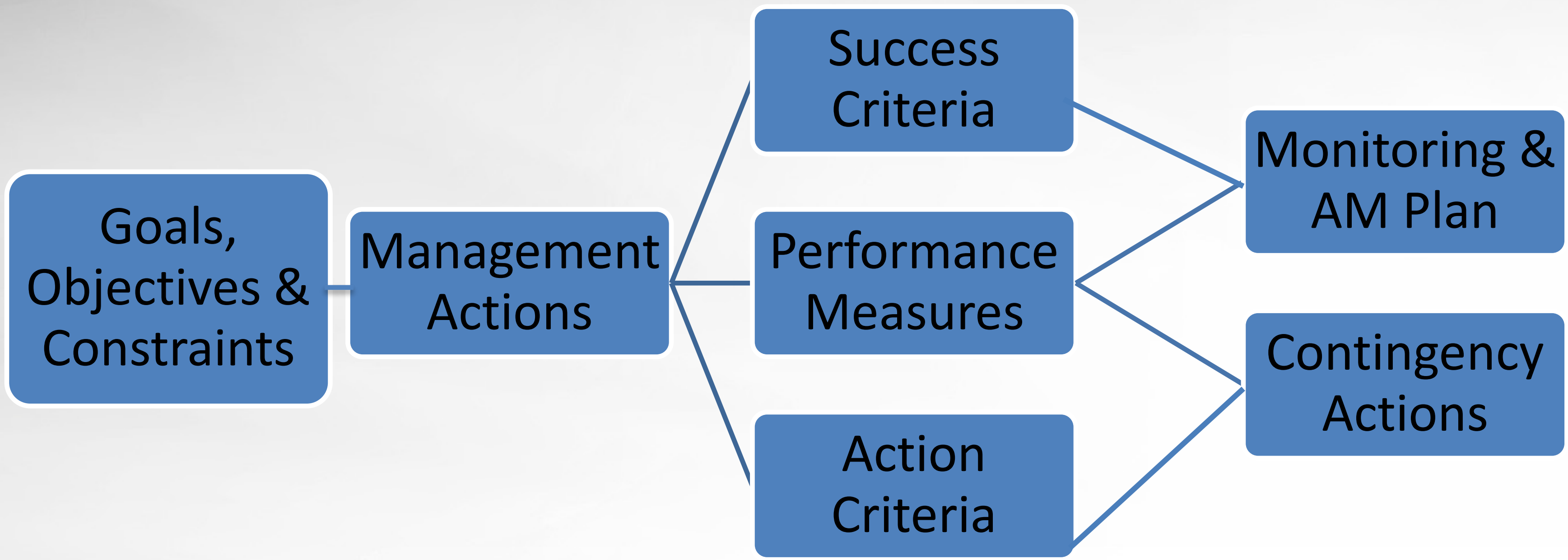
Goals and Objectives

- Must be useful for Decision Making and Evaluation
  - Specific/Clearly Focused
  - Measurable
  - Achievable
  - Results-oriented
  - Time-fixed
  - Relevant, Unambiguous, Direct, Operational, Understandable, etc.,
- Identified at beginning of the planning process
- Address stakeholder values
- Linked problems to opportunities
- Linked to management actions
- Linked to adaptive management strategy

Goals and Objectives

Goal	Objectives	Measures
Overarching topics that the study wants to achieve; where the focus will be	Statements that describe the desired results of the study by solving the problem and taking advantage of the opportunities; measurable	Features or activities that can be implemented at a specific site to address one or more objective; not limited Corps implementation

Linkages



Goals, Objectives & Constraints
Management Actions
Success Criteria
Performance Measures
Action Criteria
Monitoring & AM Plan
Contingency Actions

Objective-Based Example

Objective 3: 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.

Adapted from LCA Convent/Blind River diversion project.

Hypothesis-Based Example

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Action	Question	Method for Evaluating
Interception and Rearing Complexes (IRCs) [H17, H18, H19] Experimental design: sections 4.2.6.3.4 4.2.6.4.4	Do free embryos and exogenously feeding larvae leave the thalweg and enter IRCs? [L3, Lower] Is there sufficient food in IRCs for exogenously feeding larvae to grow better and maintain a healthier condition than reference areas and times? [L3, Lower] Do age-0 fish that occupy IRCs survive better than age-0 fish in reference areas and times? [L3, Lower] What's the population-level effect of improved survival of age-0 fish in IRCs? [L3, Lower] Is food limiting outside of IRC habitats[L3, Lower]	Predicted fate of free embryos from advection/ dispersion models. Testing of these predictions with field monitoring (see below). Staircase design comparisons of IRC habitat sites with reference areas and times, using the metrics listed in Table 9, section 4.4 (e.g., CPUE, probability of apparent presence, food production/area, condition, growth and survival of age-0 fish), and applying covariates to help explain year to year variation (e.g., index of upstream spawning success). Population model projections of the consequences of improved age-0 survival rates.

Example Metrics

Objectives/Constraints	Units Measured	Action Criteria/Trigger
Performance Measures		
Wetland hydrology	Days inundated	>30 days during Jul-Sep
Population size for 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

Role of Conceptual Models

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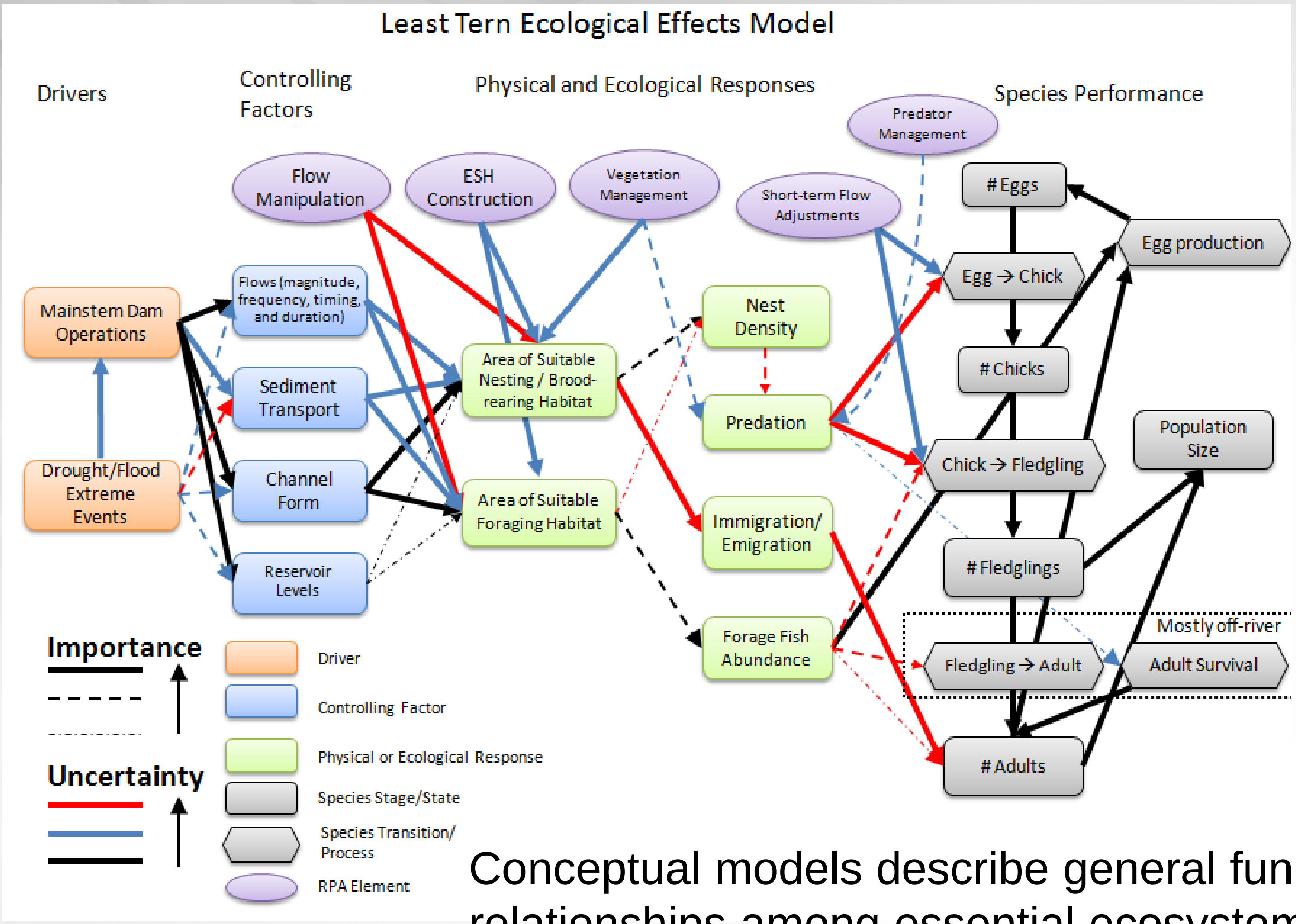

Conceptual models describe general functional relationships among essential ecosystem components. They tell the story of “how the system works.”

Comparison of Model Types

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Type of model	Description	Strengths	Drawbacks
Narrative	Use word descriptions, mathematical or symbolic formula	Summarizes literature, information rich	No visual presentation of important linkages
Tabular	Table or two-dimensional array	Conveys the most information	May be difficult to comprehend amount of information
Picture models	Depict ecosystem function with plots, diagrams, or drawings	Good for portraying broad-scale patterns	Difficult to model complex ecosystems or interactions
Box and arrow (Stressor model)	Reduce ecosystems to key components and relationships	Intuitively simple, one-way flow, clear link between stressor and vital signs	No feedbacks, few or no mechanisms, not quantitative
Input/output matrix (Control model)	Box and arrow with flow (mass, energy, nutrients, etc.) between components	Quantitative, most realistic, feedback and interactions	Complicated, hard to communicate, state dynamics may not be apparent

(Gucciardo 2004)

Good conceptual models should include the following:

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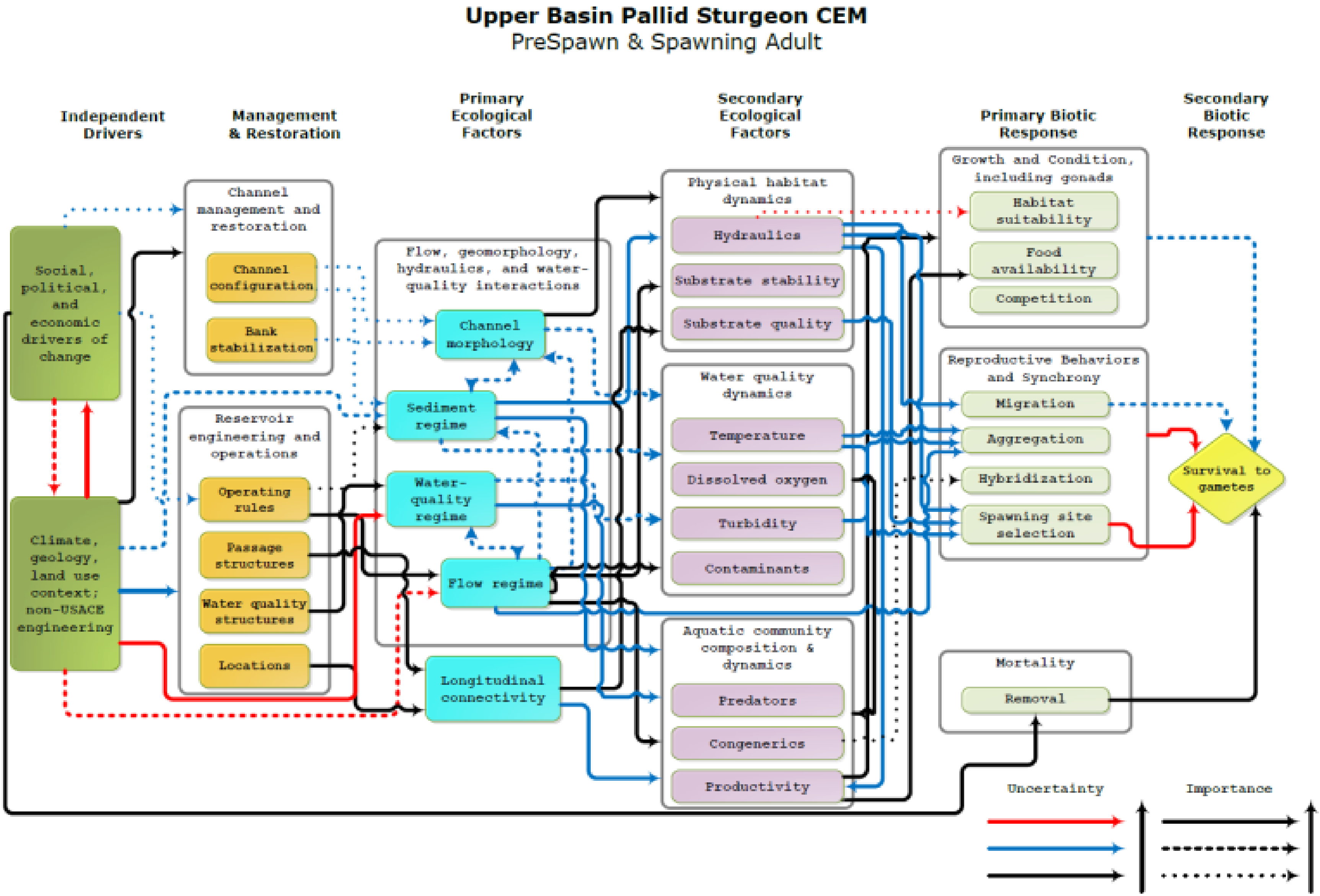
- Those physical, chemical and biological attributes of the system that determine its dynamics.
- The mechanisms by which ecosystem drivers, both internal (e.g., flow rates) and external (e.g., climate), cause change with particular emphasis on those aspects of the system where the Corps can effect change.
- Critical thresholds of ecological processes and environmental conditions
- Discussion of assumptions and gaps in the state of knowledge, especially those that limit the predictability of restoration outcomes.
- Identification of current characteristics of the system that may limit the achievement of management outcomes.
- Adequate references to substantiate the model.

Uncertainty in Conceptual Models



Common Sources of Uncertainty Addressed using AM

- Scientific understanding
- System state (incl. climate)
- Performance
  - Management action
  - Programmatic level
- Program administration (funding, policies, etc.)

Uncertainty

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➢**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?

Formulate Hypotheses

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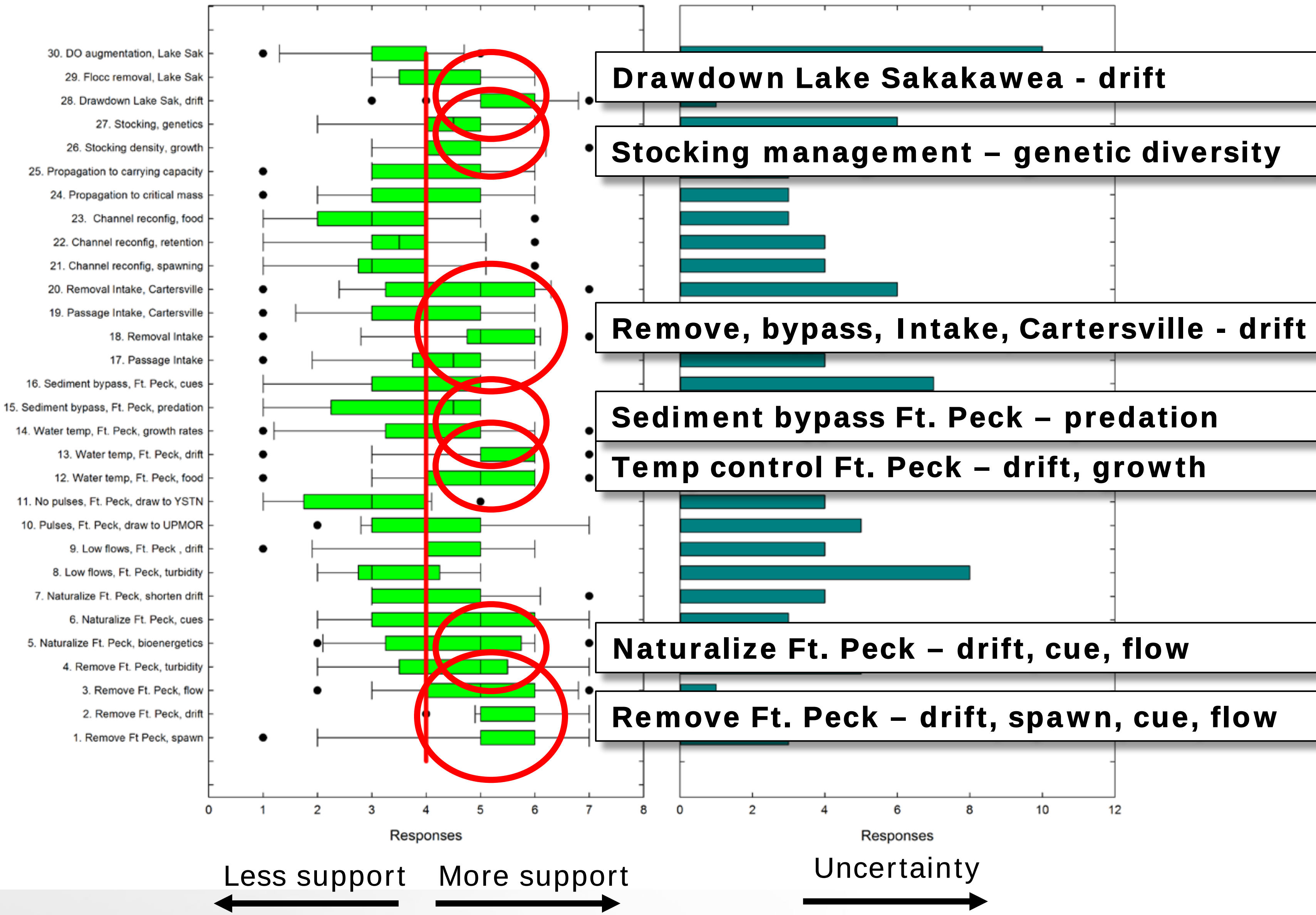
What	Management Hypothesis	Findings	Routing
Alter Flow Regime at Gavins Point	Naturalized flows, aggregation & spawning cues	Theoretical support, no specific data, models to forecast for pallids	Research, monitor responses to events
	Naturalized flows, increased productivity	Theoretical support, hydrodynamic models, no specific data, models to forecast for pallids	Research, monitor responses to events
	Naturalized flows, decreased energetic demands	Theoretical support, hydrodynamic models, no specific data, models to forecast for pallids	Research, monitor responses to events
	Decreased spring flows & velocities, reduced drift	Theoretical support, hydrodynamic models, but equivocal as limiting factor	Research
Temperature management, Gavins Point	Naturalized temperatures, increased aggregation and spawning cues	Theoretical support, no specific data, models to forecast for pallids	Research, monitor responses to events
Channel Reconfiguration	Reconfigure channel for spawning habitats	Theoretical support, hydrodynamic models, but equivocal as limiting factor	Research, field experiment
	Reconfigure channel for food production habitats	Theoretical support, hydrodynamic models, but equivocal as limiting factor	Implemented, validate with monitoring, assessment
	Reconfigure channel for foraging habitats	Theoretical support, hydrodynamic models, but equivocal as limiting factor	Implemented, validate with monitoring, assessment
	Reconfigure channel for interception habitats	Theoretical support, hydrodynamic models, but equivocal as limiting factor	Implemented (?), validate with monitoring, assessment
Propagation Lower Basin	Improved stocking strategy, size classes	Potential effective action, subject to hatchey capacities	Implemented, validate with monitoring, assessment
	Improved stocking strategy, parentage & fitness	Theoretical support, no specific data, models to forecast for pallids	Research

Management Hypotheses Expert Survey



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Adaptive Management Basics

Sarah J. Miller
Craig Fischenich
ERDC Environmental Laboratory

Office of Research and Technology Transfer
Adaptive Management Workshop
Albuquerque, NM
25-28 July 2017

Purpose

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- Introduce the workshop and define adaptive management
- Describe the history, role and benefits of adaptive management
- Introduce the AM cycle
- Present a few key AM principles
- Point participants toward useful resources
- Establish a foundation for the remaining presentations in this workshop

What is Adaptive Management?

“Adaptive management [is a decision process that] promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process.” (NRC 2004)

- OR -

Adaptive Management (AM) is a formal, science-based approach to risk management that permits implementation of actions despite uncertainties. Knowledge gained from monitoring and evaluating results is used to adjust and direct future actions.

- OR -

Adaptive management is doing while learning in the face of uncertain outcomes.

Origins of AM

Walters, C. 1986
Adaptive management of renewable resources.
New York: MacMilla
Publishing Comp

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

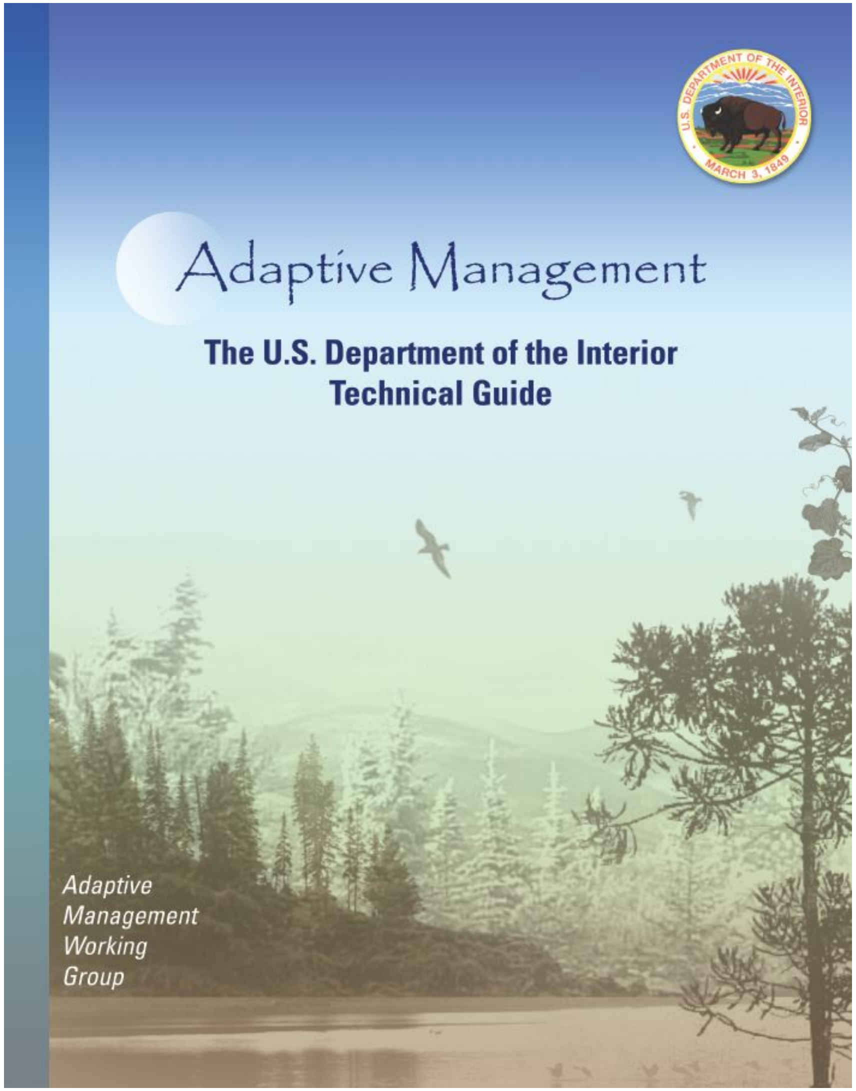
NRC. 2004
Adaptive Management for Water Resource Planners
The National Academies Press, Washington, D.C.

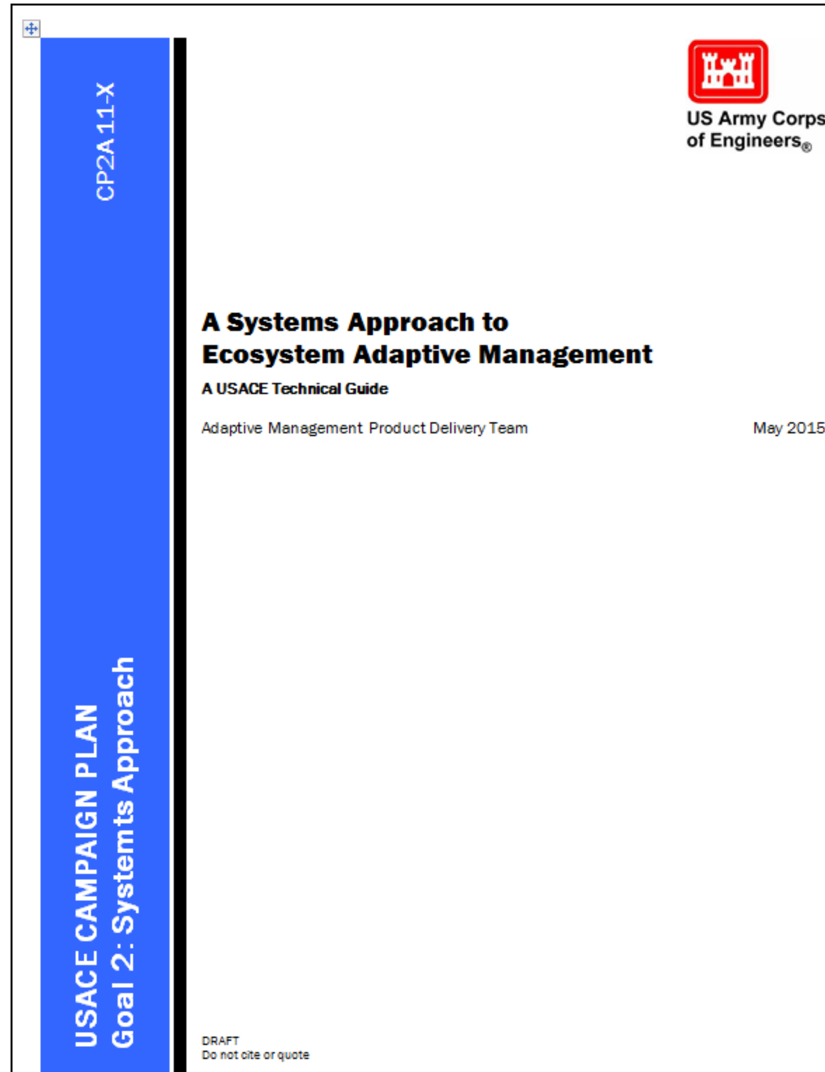
Lee, K. 1993
Compass and gyroscope: Integrating science and politics for the environment.
Washington D.C.
Island Press.

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.

Recent Information Sources





A Practitioner's Definition

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A **systematic, rigorous** approach for

designing and implementing **management actions**

in order to

maximize **learning** about **critical uncertainties**

that affect management **decisions or policies**

while simultaneously

striving to meet **management objectives**.

Corps History With AM

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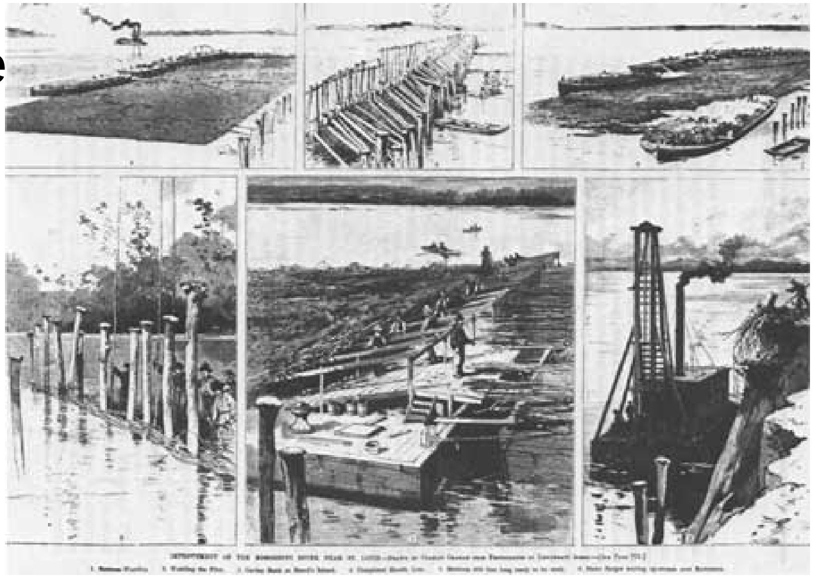
- Extensive practical experience with the general concept.
- Relatively little discussion of AM prior to ecosystem restoration authorities.
- Numerous institutional barriers and challenging factors.
- WRDA 2007
  - Sec. 2036
  - Sec. 2039
- AM Implementation Guidance
- Major ER Programs
  - CERP
  - UMRR
  - MRRP
  - LCA



Role and Limitations of AM

- AM should be considered for all ER Projects
- Not all projects lend themselves to AM. Three elements must be present for AM to proceed:
  1. One or more critical uncertainty
  2. Ability to learn through monitoring
  3. Ability to make adjustments based on new knowledge
- Additionally, AM should afford a more cost-effective strategy than other alternatives (difficult to know *a priori*)
- Finally, institutional commitment is needed (see #3 above); this can be elusive for various reasons

Is Adaptive Management Needed?

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QUESTIONS

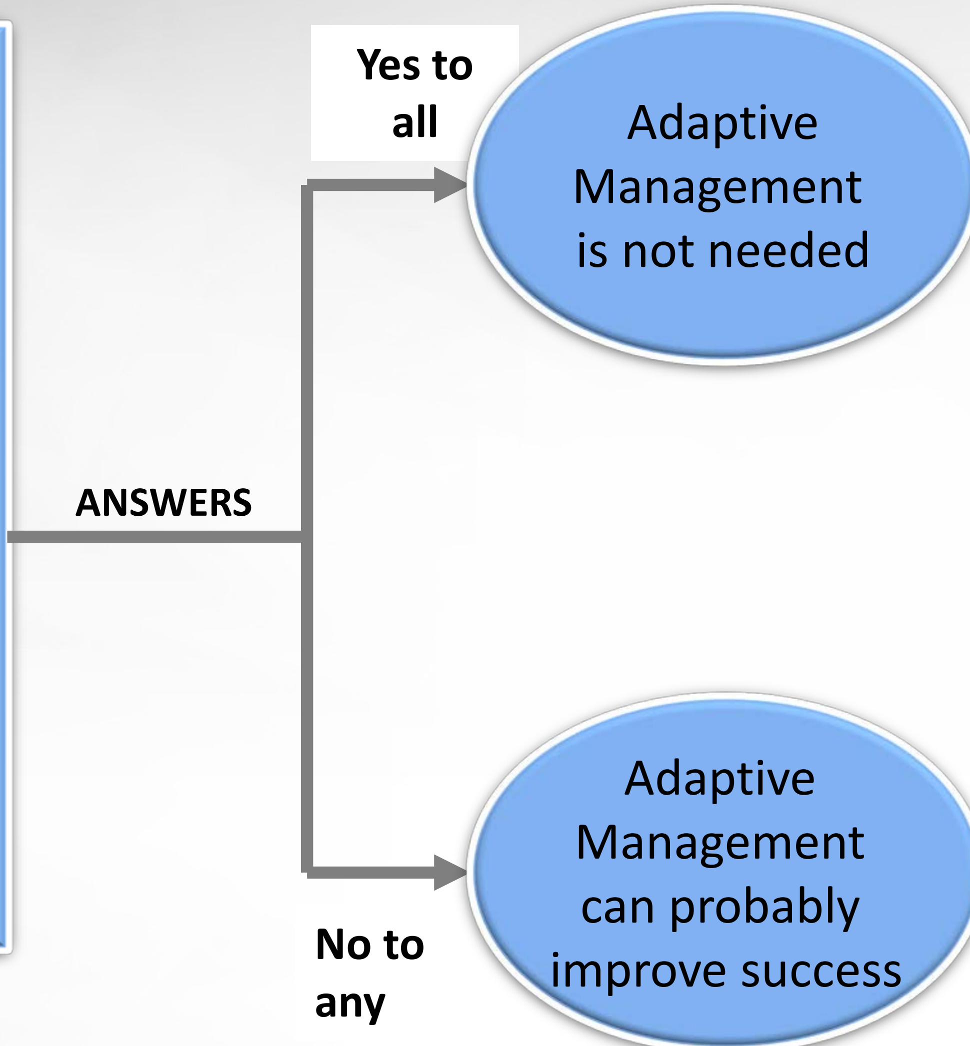
Is there sufficient flexibility within the project design and operations that permits adjustment of management alternatives?

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?



What are the benefits of AM?

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- Provides a precautionary approach to act in the face of uncertainty
- Improved probability of project/program success
- Incorporates flexibility and robustness into project/program design, implementation, and operations
- Process of developing an AM plan inevitably improves the plan formulation process & products
- Promotes collaboration and conflict resolution among agencies and stakeholders, scientists and managers while empowering all the above groups
- Moves the state of science and understanding of ecosystem restoration forward in a deliberate way
- Can improve cost effectiveness

AM Strategies

Passive Adaptive Management :

-Most widely used approach but often criticized

-Useful when action adjustments related to system state anticipated or when applying project learning to programs

-Focus on mgt objectives; learning is opportunistic but not an imperative

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)

Contingency Planning :

-Not AM, but can be an important part of an AM plan/program

-Requires careful consideration of alternative outcomes

-Identification of criteria and triggers for objectionable outcomes

-Employs pre-defined “Contingencies” in the event they are needed

Adapted from Walters, C.J. (1986) *Adaptive Management of Renewable Resources*

Characteristics of Active AM

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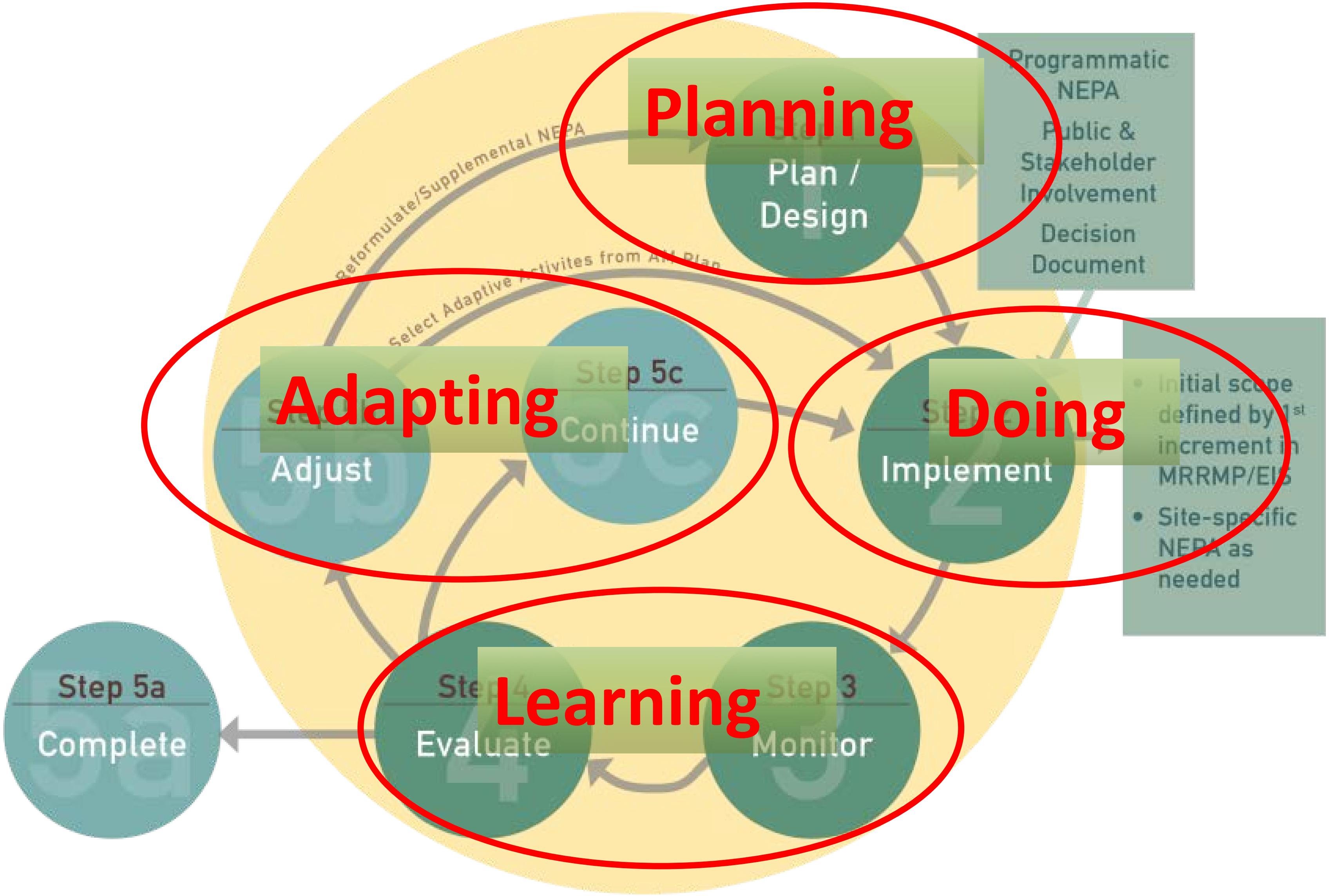
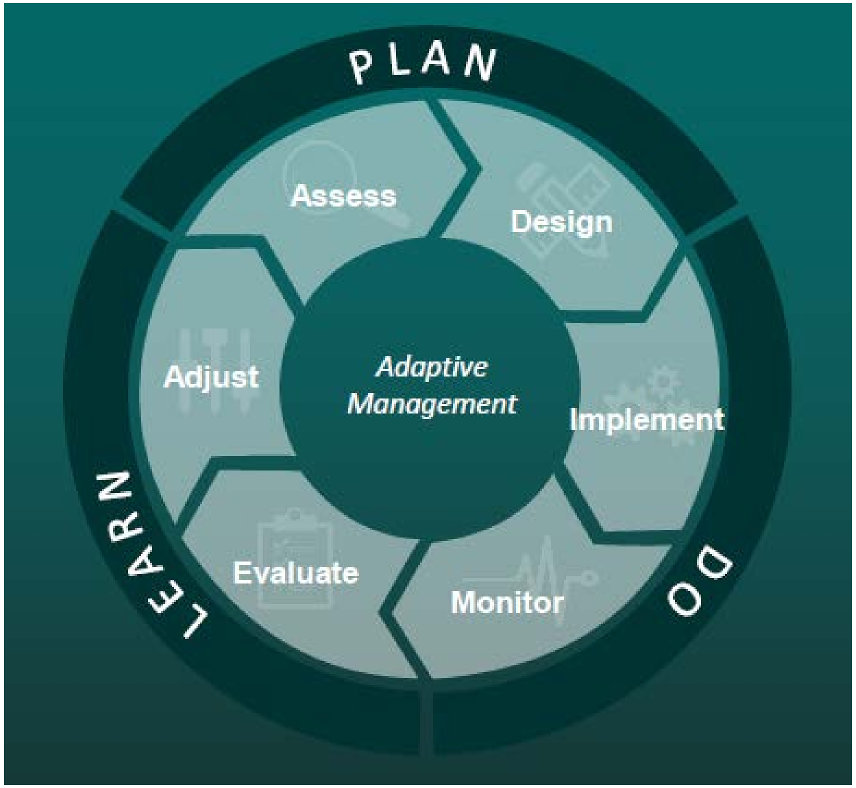
- Treats management as an ‘experiment’
  - seeks to learn from contrasting management actions
  - takes a ‘systems approach’ – requires planning rigor
- Addresses critical uncertainty
  - explicitly recognizes decision-relevant uncertainties
  - learning is (at least initially) a prime objective
- ‘Closes the loop’
  - requires predictions of outcomes
  - confronts decision-makers with information
  - makes adjustments based on actual outcomes

The AM Process



AM Cycle

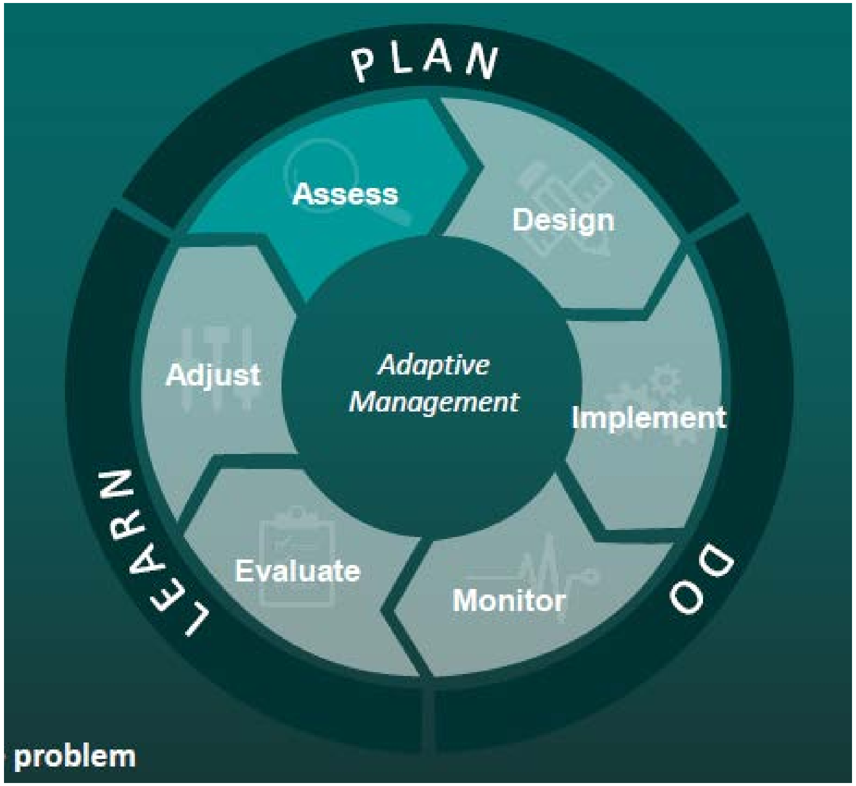
- **PLAN**: Frame problem and analyze actions from the view of management uncertainties
- **DO**: Implement and monitor actions using principles of experimental design
- **LEARN**: Evaluate data to learn about effectiveness of actions and reduce uncertainties



*This and the next set of figures taken from ESSA (2012).

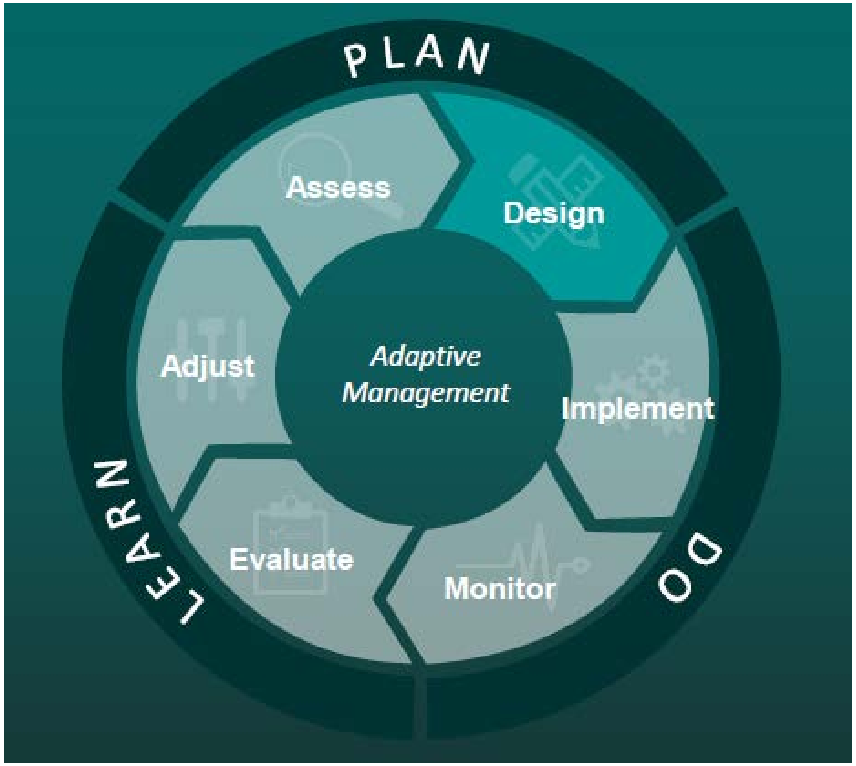
Assess Step

- **Define the problem**
- **Identify measurable objectives** (*what are you trying to achieve and how will you know when you get there?*)
- **Identify mgm't (i.e. decision-relevant) uncertainties** (*what do you want to learn about achieving objectives?*)
- **Build conceptual and/or quantitative models; explore hypotheses, alternative actions**
- **Incorporate insights** (*what would you change based on what you learn?*)



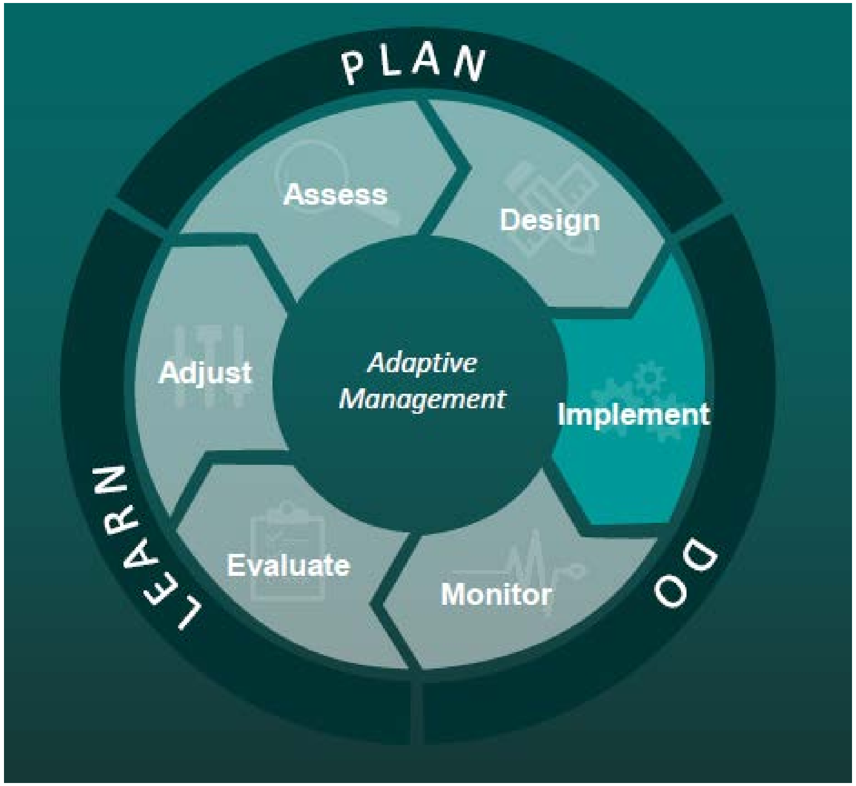
Plan/Design Step

- **Design management treatments; contrasts, replicates, controls…**
- **Identify metrics/indicators of treatment responses** (*will you be able to detect changes?*)
- **Design plans for next steps (power analysis, statistical monitoring design, field sampling protocols, data analysis plans)**
- **Predict expected outcomes and responses, ID decision criteria & contingencies**



Implementation Step

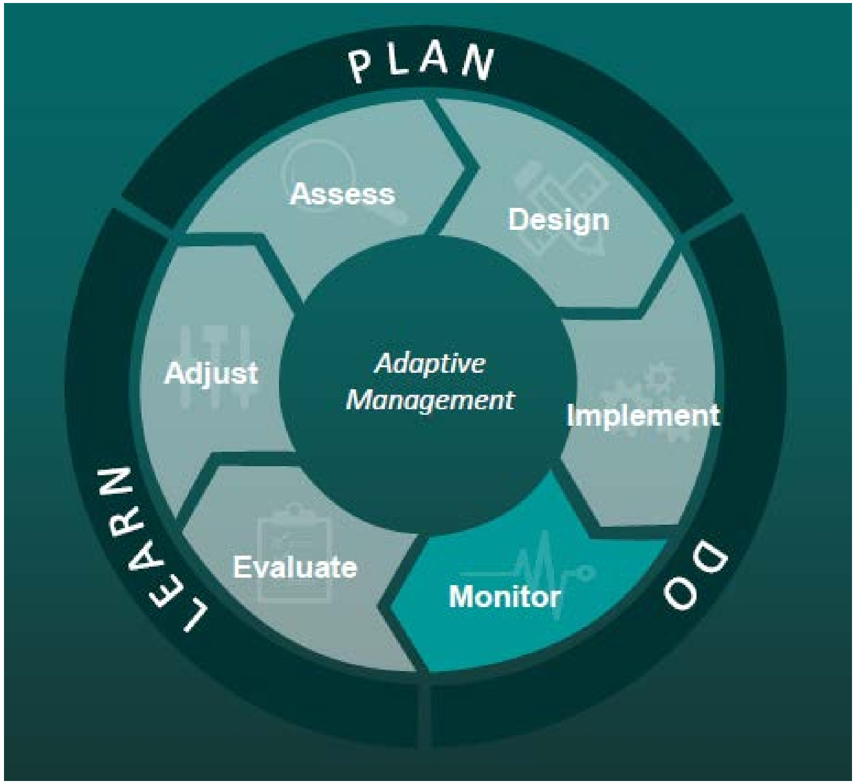
- Implement the actions/treatments as designed
- Document the implementation and any deviations



Monitoring Step

ERDC
Engineer Research and Development Center

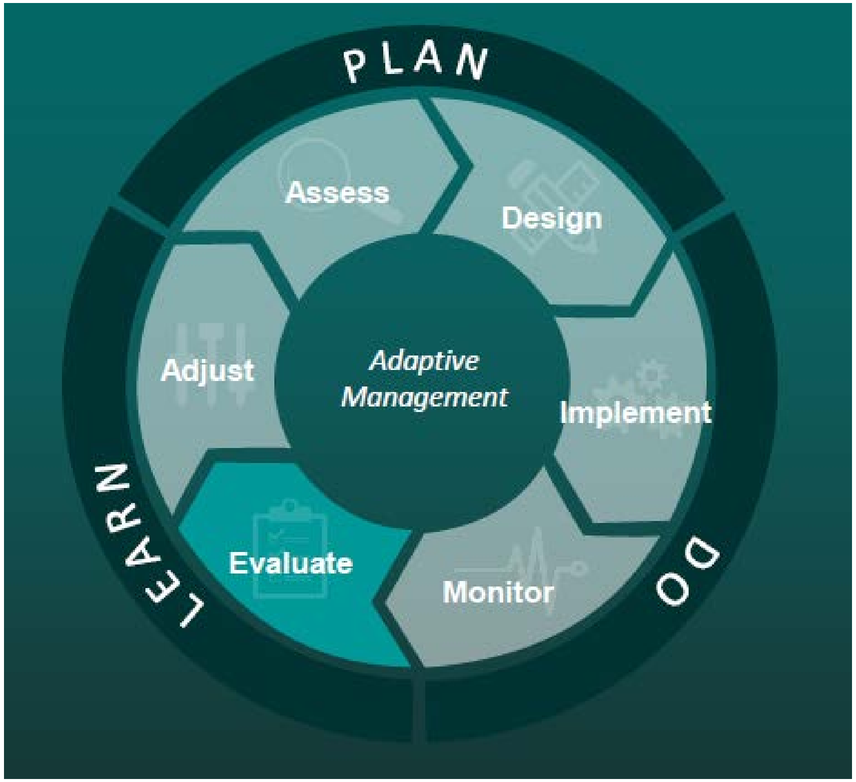
- **Gather data on performance of treatments/actions following pre-defined protocols**
- **Implementation monitoring** (*was the treatment/action implemented correctly?*)
- **Effectiveness monitoring** (*what were the results/responses?*)
- **Validation monitoring** (*did the system respond as expected to the treatment/action?*)



Evaluation Step

Engineer Research and Development Center

- **Analyze data as related to management uncertainties/questions/hypotheses**
- **Compare actual results with earlier predictions**
- **Consider best available science (whatever the source)**
- **Draw conclusions** (*what was learned?*)



Decision (continue/adjust/complete) Step

ERDC
Engineer Research and Development Center

- Adapt actions/treatments based on what was learned

OR

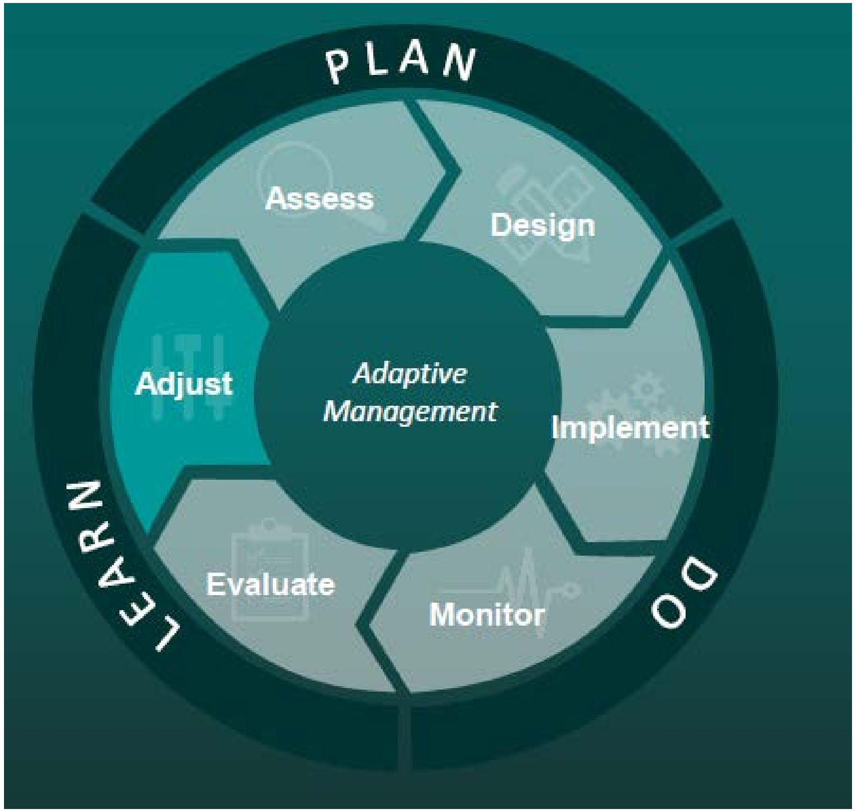
- Implement contingency plans following criteria

OR

- Modify the experiment (design, monitoring), or modify policy and practices

OR

- Determine success
- Share new knowledge with others



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

Required Mindset for AM

- Be honest about uncertainties and tackle them head-on
- View choices/management actions** as 'treatments' to be tested
- Make a commitment to learning
- Mistakes are not all bad – they enhance learning
- Expect surprises and learn from them
- Encourage creativity and innovation
- Start small; build on successes

*** ….where actions can include various* ***management actions*** *related to allocation, restoration, levels and patterns of disturbance, as well as* ***policy-oriented measures*** *related to permitting, incentives, and financing, among others.*

Lessons from a Practitioner

- 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 or programs lend themselves to AM
- Governance is crucial and may be difficult to assure for some projects and programs
- Cost estimates are complicated by uncertainties
- Refinement during PED is likely, and flexibility in implementation is probably needed
- Successful efforts typically have an AM "champion"

Lane Lefort

References (see Handout #10)

Engineer Research and Development Center

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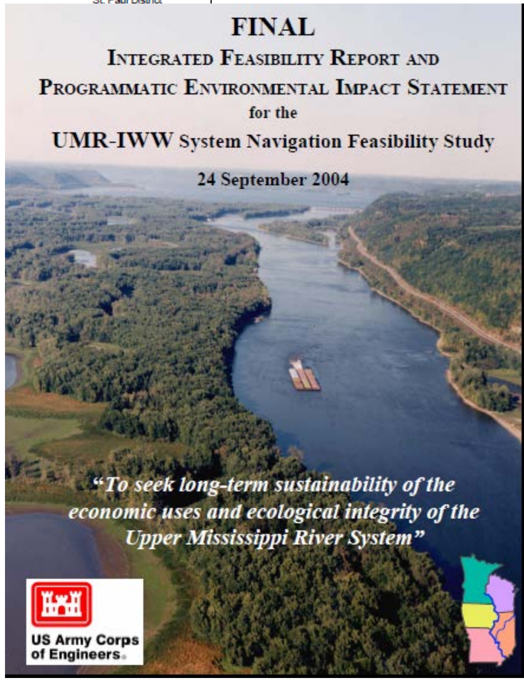
Williams, B. K., R. C. Szaro, and C. D. Shapiro. 2009. Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC. *http://www.doi.gov/ppa/upload/TechGuide.pdf*

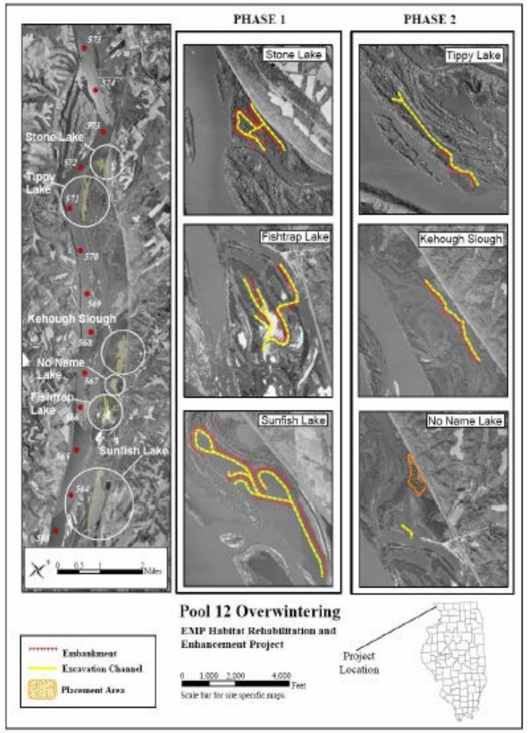
Upper Mississippi River Adaptive Management

UMR-IWW Navigation Feasibility Study/NESP

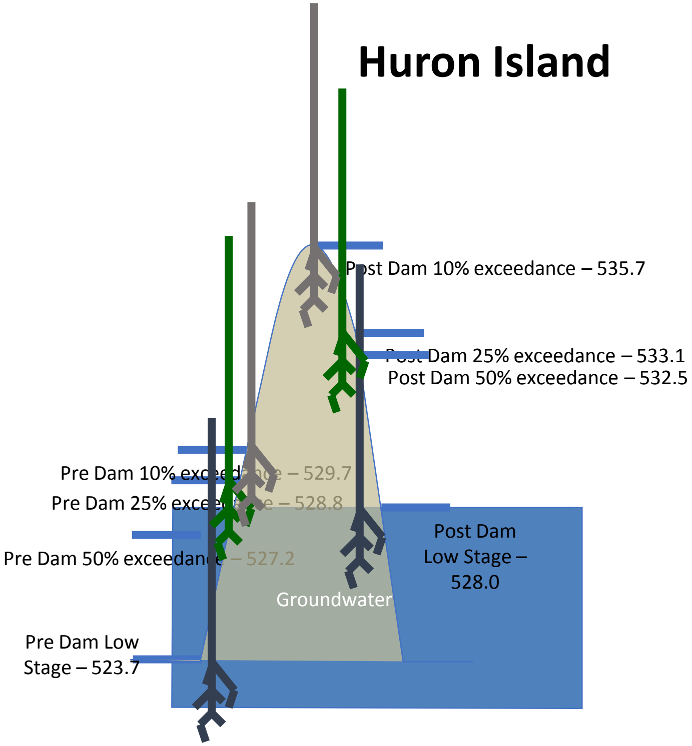
&

Upper Mississippi River Restoration





Huron Island



Mud Lake

Upper Mississippi River – Illinois Waterway System Navigation Feasibility Study: Environmental Science Panel Report


ENV Report 52

Interim Report For The
Upper Mississippi River – Illinois
Waterway System Navigation Study

Upper Mississippi River – Illinois Waterway
System Navigation Feasibility Study:
Environmental Science Panel Report

December 2003

Rock Island District
St. Louis District
St. Paul District

US Army Corps
of Engineers

Members of the Science Panel:

Dr. John W. Barko – Co-Chair, U.S. Army Corps of Engineers, Engineer Research and Development Center – Environmental Laboratory, Vicksburg, MS

Dr. Kenneth S. Lubinski – Co-Chair, U.S. Geological Survey, Upper Midwest Environmental Science Center, La Crosse, WI

Dr. Mark B. Bain, Cornell University, Center for the Environment, Ithica, NY

Dr. Steven M. Bartell, Cadmus Group, Inc., Maryville, TN

Mr. Gordon Farabee, Missouri Department of Conservation (retired), Palmyra, MO

Dr. Robert B. Jacobson, U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO

Dr. Carl E. Korschgen, U.S. Geological Survey, Columbia Environmental Research Center, Columbia, MO

Dr. Tatsuaki Nakato, Lucille A. Carver Mississippi Riverside Environmental Research Station, Muscatine, IA (University of Iowa)

Dr. John M. Nestler, U.S. Army Corps of Engineers, Engineer Research and Development Center – Environmental Laboratory, Vicksburg, MS

Dr. L. Jean O'Neil, U.S. Army Corps of Engineers, Engineer Research and Development Center – Environmental Laboratory, Vicksburg, MS

Dr. David M. Soballe, U.S. Geological Survey –Upper Midwest Environmental Sciences Center (Current Affiliation: U.S. Army Corps of Engineers, Engineer Research and Development Center – Environmental Laboratory, Vicksburg, MS)

Regional Support Team:

Mr. Kenneth A. Barr – Co-Chair, U.S. Army Corps of Engineers, Rock Island District, Rock Island, IL

Dr. Clinton A. Beckert, U.S. Army Corps of Engineers, Rock Island District, Rock Island, IL

Mr. Robert C. Clevenstine, U.S. Fish and Wildlife Service, Rock Island Field Office, Rock Island, IL

Mr. Robert D. Davinroy, U.S. Army Corps of Engineers, St. Louis District, St. Louis, MO

Mr. Jon R. Duyvejonck, U.S. Fish and Wildlife Service, Rock Island Field Office and Upper Mississippi River Conservation Committee, Rock Island, IL

Mr. Jon S. Hendrickson, U.S. Army Corps of Engineers, St. Paul District, St. Paul, MN

Mr. Kevin J. Landwehr, U.S. Army Corps of Engineers, Rock Island District, Rock Island, IL

Mr. Charles H. Theiling, U.S. Army Corps of Engineers, Rock Island District, Rock Island, IL

Mr. Daniel B. Wilcox, U.S. Army Corps of Engineers, St. Paul District, St. Paul, MN

Definition

As implied in its name, adaptive management prescribes a management process wherein management activities can be changed in relation to their efficacy in restoring and/or maintaining an ecological system in a specified desired state or ecological potential (Gunderson and Holling 2002). The desired

Walters (1986) – AM Types

1. Evolutionary (trial and error)
2. Passive Adaptive
3. Active Adaptive

Adaptive Management Concepts

- Sustainability
- Ecological Integrity
- Baseline Conditions
- Reference Conditions

Adaptive Management Elements

- Establishing Goals and Objectives
- Increasing Understanding Through Models
- Implementing Management Actions
- Monitoring and Evaluation

Adaptive Management Challenges

- Modeling – Never-ending loops
- Cost to doing business
- Bureaucratic Obstacles
- Value conflicts

Surmounting Challenges to AM

- Strong institutional arrangements
- Conceptual models
- Peer review
- Simulation models

Defining UMRS Adaptive Management Goals and Objectives

Vision Statement

To execute this new mandate, the Corps first requested the help of stakeholders in preparing a common vision for the future of the UMR-IWW. In November 2001, the Economic Coordinating Committee (ECC) and the NECC drafted the following vision statement:

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

Goal

The following definition of sustainability was collaboratively developed and agreed to by the group as well:

> "The balance of economic, ecological, and social conditions so as to meet the current, projected, and future needs of the Upper Mississippi River System without compromising the ability of future generations to meet their needs."

Implementing UMRS Adaptive Management

Designing and Maintaining Institutional Arrangements

- Institutional arrangements must promote a consensus-based, collective understanding of current UMR-IWW ecosystem conditions, and use that understanding as the primary basis for action.
- Institutional arrangements must provide for regular review and updating of the collective understanding.
- Institutional arrangements must facilitate effective dialog about system conditions and stressors among technical, management, and stakeholder groups.
- Institutional arrangements must encourage rigorous scientific verification of "conventional wisdom."
- Institutional arrangements must support actions that are designed to improve the information base while achieving specific ecological objectives.
- Institutional arrangements must facilitate shared learning from actions taken outside the system.
- Institutional arrangements must assure stakeholder groups that their goals and objectives are sufficiently considered within the management process.
- Institutional arrangement must assure technical and scientific groups that their understanding is sufficiently considered within the management process.

Goals and Objectives

Table 3 UMR-IWW Higher Order Goals
First Tier Goal: • The balance of economic, environmental, and social conditions so as to meet the current and future needs of the Upper Mississippi River System without compromising the ability of future generations to meet their needs. **Second Tier Goals:** • Maintain viable populations of native species in situ. • Represent all native ecosystem types across their natural range of variation. • Restore and maintain evolutionary and ecological processes (e.g., disturbance regimes, hydrologic regime, nutrient cycles, etc.). • Integrate human uses and occupancy within these constraints.

Objectives

Table 4
Ecological Objectives and Need Statements (81 total)

Biogeochemistry

- Achieve state water quality standards for all uses
- Reduce contaminant loadings to the river
- Reduce mobilization of sediment contaminants
- Achieve state total maximum daily load (TMDL) standards
- Reduce fine sediment loadings to the river
- Reduce coarse sediment loadings to the river
- Reduce nutrient (N and P) loading from tributaries to river
- Reduce nutrient (N and P) export from UMR-IWW to Gulf of Mexico
- Maintain adequate DO concentrations during ice-free periods for fish
- Maintain adequate DO concentrations during winter for fish
- Create thermal and velocity refugia (e.g. holes >3 m) in backwaters and channels
- Maintain water clarity sufficient to support submersed aquatic vegetation and aquatic invertebrates and sight feeding fishes

Geomorphology

- Increase the number and area of secondary channels
- Increase depth diversity in secondary channels
- Restore the channel geometry and floodplains of tributary rivers
- Restore the channel geometry of tertiary channels
- Increase the depth diversity in main channel border areas
- Increase the extent and number of sandbars
- Increase the extent and number of mud flats
- Increase the extent and number of gravel bars
- Increase the area and number of islands
- Increase the area and number of rock and gravel riffles
- Increase the extent and number of rock and gravel substrate areas
- Increase the area and relief of ridge and swale topography in the floodplain
- Increase topographic diversity and elevation of floodplain areas
- Restore channelized tributaries in the mainstem river floodplains
- Restore fluvial dynamics (e.g. channel avulsion - secondary channel - distributary channels - etc.)
- Reduce rate of delta formation
- Increase the rate of delta formation
- Increase connectivity between channels and contiguous backwater areas
- Reduce connectivity between channels and contiguous backwater areas
- Increase connectivity of floodplain areas
- Reduce connectivity of floodplain areas
- Increase extent of contiguous backwater areas
- Increase the number and extent of isolated floodplain lakes
- Increase the extent of unleveed floodplain at tributary confluences
- Increase the extent of unleveed floodplain

(Sheet 1 of 3)

Table 3-1 (Continued)

Hydrology/River Hydraulics

- Naturalize hydrologic regime
- Reduce stage and discharge fluctuations caused by dam operation
- Restore desirable stage: discharge relationship
- Restore or naturalize hydraulic interactions between the river and tributaries
- Naturalize tributary discharge hydrographs - reduce effects of hydro operation
- Increase storage and conveyance of flood water on the floodplain
- Provide desirable pattern of hydraulic conditions in tailwaters (e.g. increase area of <0.3 m/sec current velocity - attract fish to fishways)
- Provide pathways for animal movements through and across dams
- Reduce wind fetch in open-water areas (e.g. backwaters and impounded areas)
- Provide desirable current velocity and residence time in aquatic areas

Habitat

- Restore and maintain a diverse mosaic of plant communities
- Increase extent, abundance, and diversity of submersed aquatic plants
- Increase extent, abundance, and diversity of emergent aquatic plants
- Increase extent, abundance, and diversity of floodplain grassland
- Increase extent, abundance, and diversity of floodplain shrub cover
- Restore and maintain large contiguous grassland patches (>1000 acres)
- Restore and maintain large contiguous forest patches (>1000 acres) with connected corridors
- Restore and maintain large contiguous wetland patches (>1000 acres) every 30-40 miles
- Increase the extent, diversity, and successional variety of the floodplain forest
- Increase the number and area of backwaters with suitable habitat for fish
- Increase the number and extent of managed marsh areas in leveed floodplain
- Maintain the existing extent of floodplain agricultural areas
- Increase the number and extent of continuous habitat corridors (floodplain forest - prairie - marsh)
- Increase the number, width, and length of vegetated riparian buffer strips along tributaries and ditches
- Increase woody debris in secondary channels
- Increase the area of suitable winter habitat for lentic fishes
- Increase the area of suitable winter habitat for lotic fishes

Biota

- Maintain viable populations of native plant species throughout their range in the UMR-IWW at levels of abundance in keeping with their biotic potential
- Maintain the diversity and extent of native plant communities throughout their range in the UMR-IWW
- Maintain viable populations of native macroinvertebrate species throughout their range in the UMR-IWW at levels of abundance in keeping with their biotic potential
- Maintain the diversity and extent of native macroinvertebrate communities throughout their range in the UMR-IWW
- Maintain viable populations of native mussel species throughout their range in the UMR-IWW at levels of abundance in keeping with their biotic potential
- Maintain the diversity and extent of native mussel communities throughout their range in the UMR-IWW

(Sheet 2 of 3)

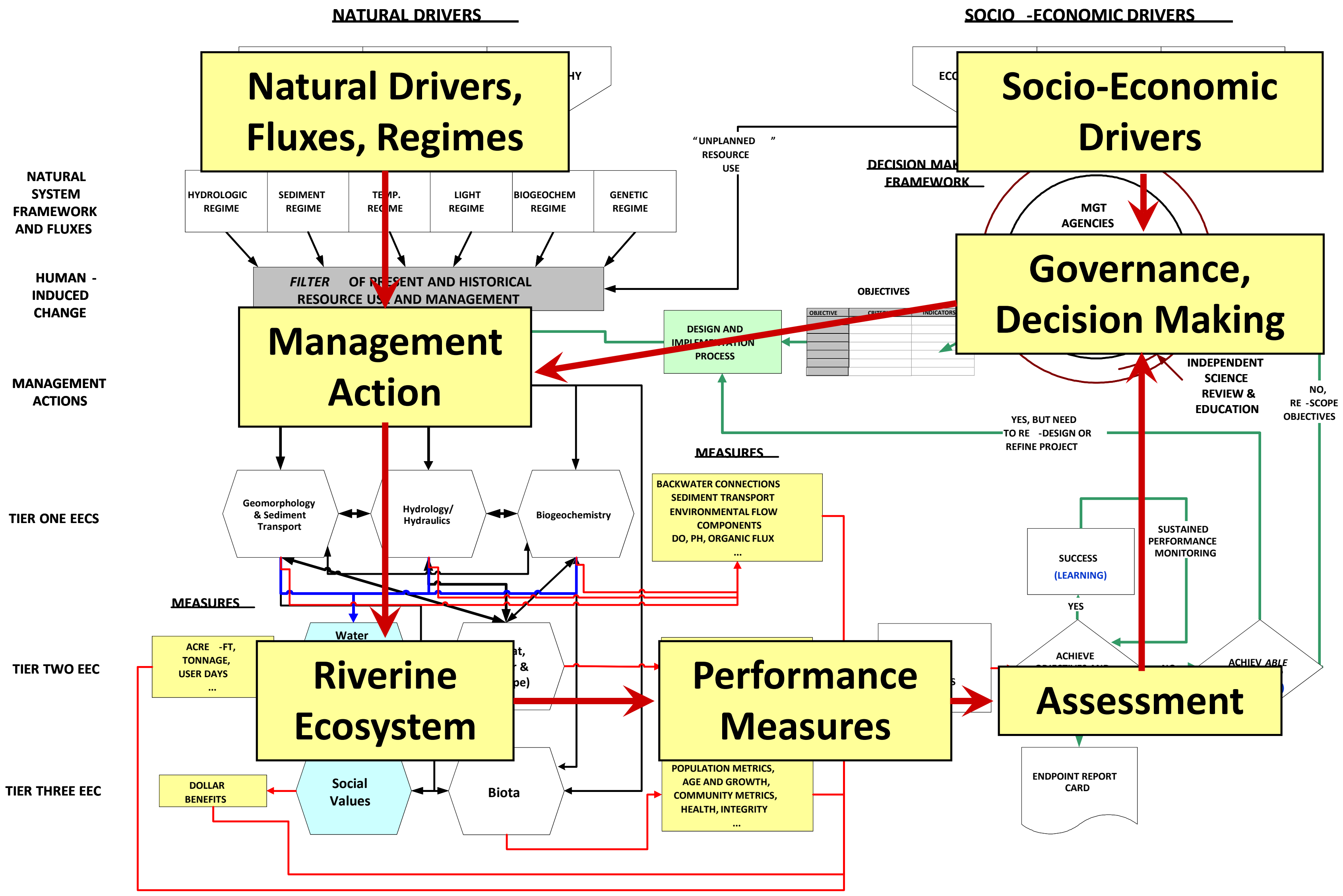
Table 3-1 (Concluded)

Biota (cont.)

- Maintain viable populations of native fish species throughout their range in the UMR-IWW at levels of abundance in keeping with their biotic potential
- Maintain the diversity and extent of native fish communities throughout their range in the UMR-IWW
- Maintain viable populations of native amphibians and reptiles throughout their range in the UMR-IWW at levels of abundance in keeping with their biotic potential
- Maintain the diversity and extent of native amphibian and reptile communities throughout their range in the UMR-IWW
- Maintain viable populations of native birds throughout their range in the UMR-IWW at levels of abundance in keeping with their biotic potential
- Maintain the diversity and extent of native bird communities throughout their range in the UMR-IWW
- Maintain viable populations of native mammals throughout their range in the UMR-IWW at levels of abundance in keeping with their biotic potential
- Maintain the diversity and extent of native mammal communities throughout their range in the UMR-IWW
- Prevent the introduction and dispersion of exotic invasive species
- Reduce the extent and abundance of exotic invasive species
- Reduce the adverse effects of invasive species on native biota

(Sheet 3 of 3)

General Conceptual Model of the UMRS



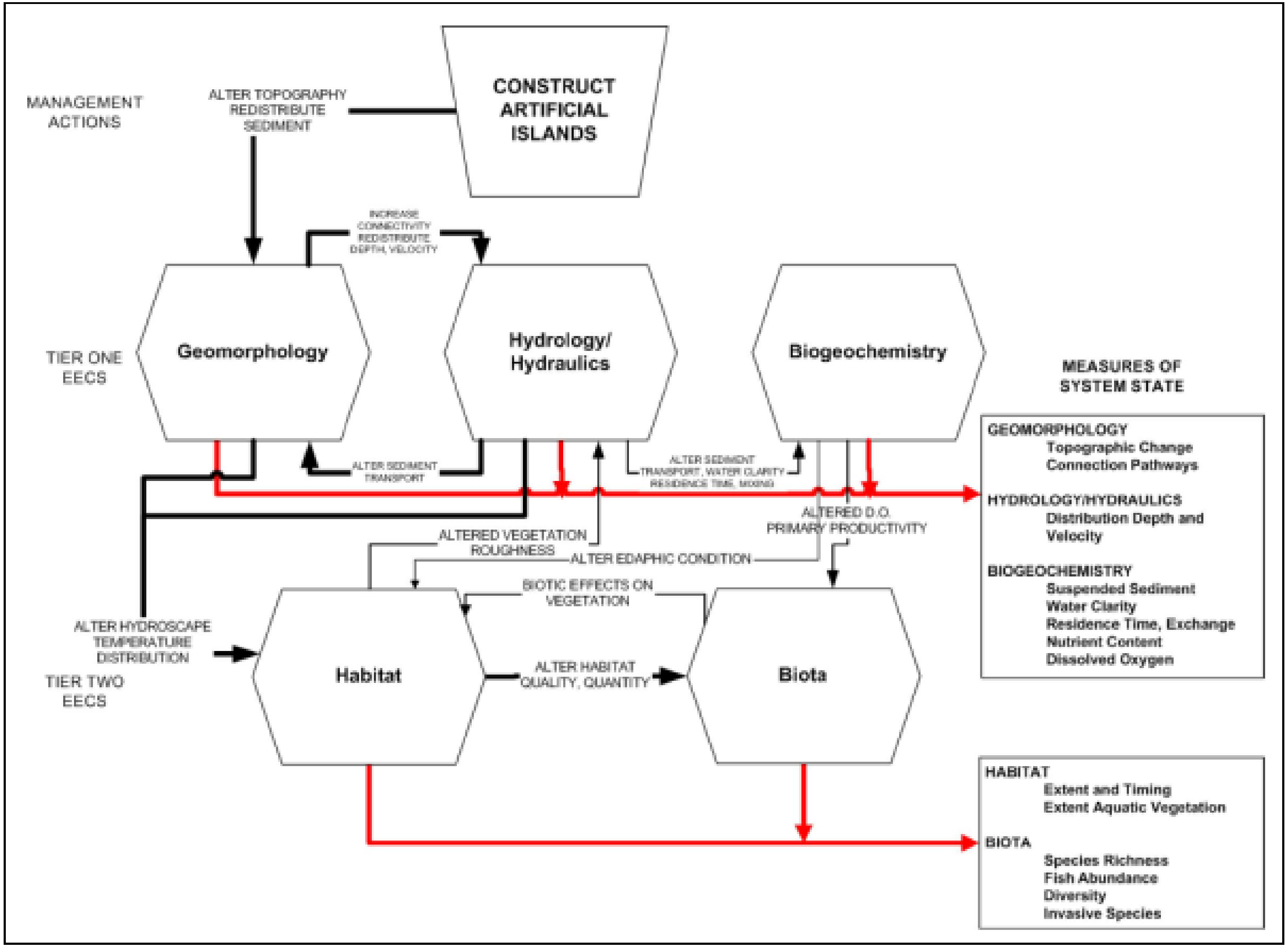


Figure 4. Conceptual model for island creation for the UMR-IWW system

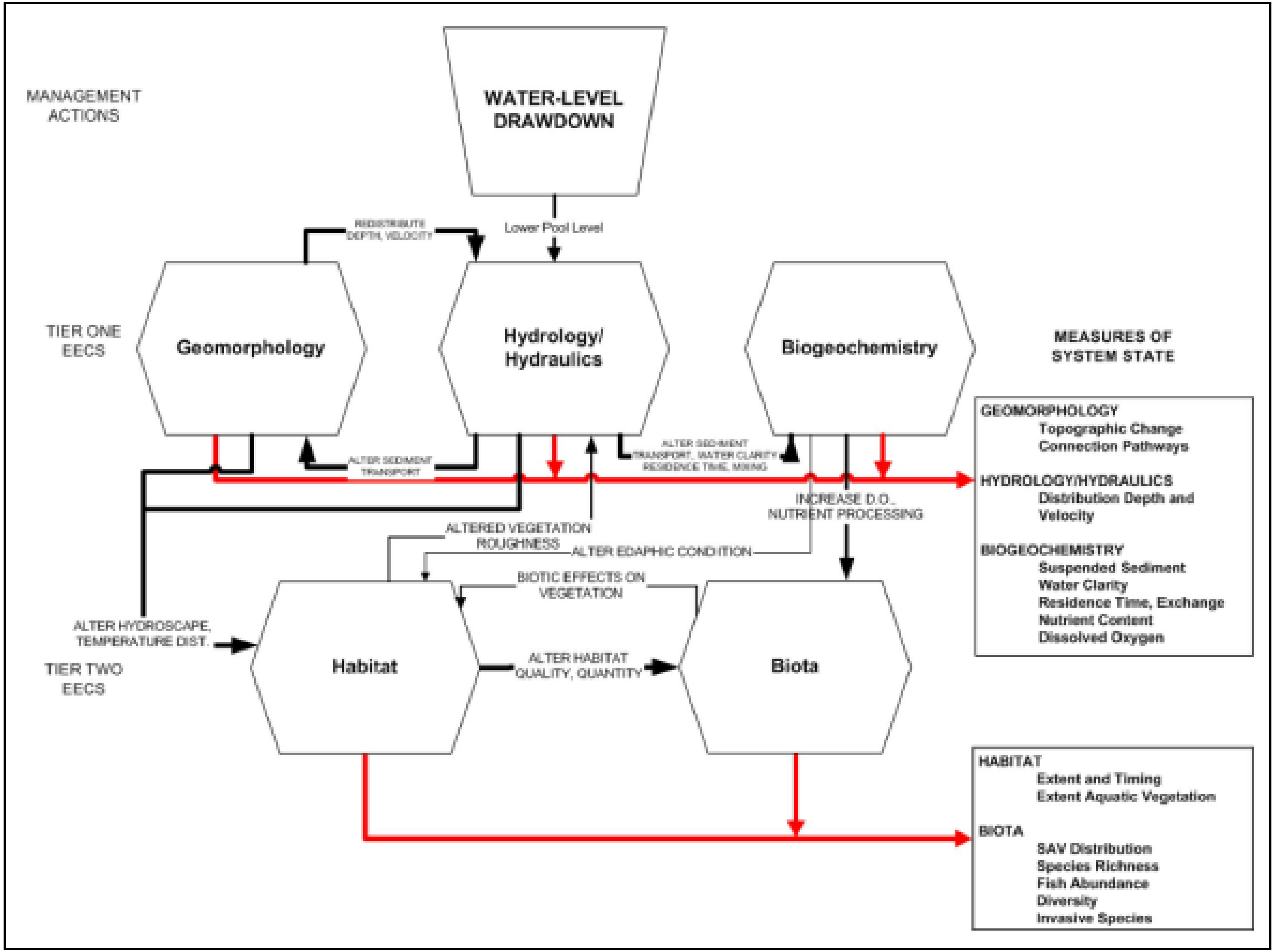


Figure 6. Conceptual model of water level management (drawdown) for the UMR-IWW system

Evaluation and Monitoring

- Determining Endpoints
  - Policy and Management Relevance
  - Technical Merit
  - Practically
- Selecting Indicators
- Report Card

Table 6 Selected Ecological Endpoints to Evaluate UMR-IWW Management Actions and Objectives
Biota
Abundance of Asian carps
Population of lake sturgeon
Abundance of waterfowl
Neotropical migrant birds
Freshwater mussel populations
Mast tree populations
Biogeochemistry
Water quality criteria
Nutrient concentrations in water
Fine sediment entering the system
Contaminated sediments
Geomorphology
Topographic connections
Topographic variability
Rates of bank erosion
Hydrology and Hydraulics
Water levels below dams
Water levels during growing season
Pool stage in winter
Dam operations
Habitat
Aquatic vegetation in shallow lentic waters
Natural terrestrial habitat on floodplain
Special aquatic sites
Islands with natural habitats

LTRM Status and Trends 2008

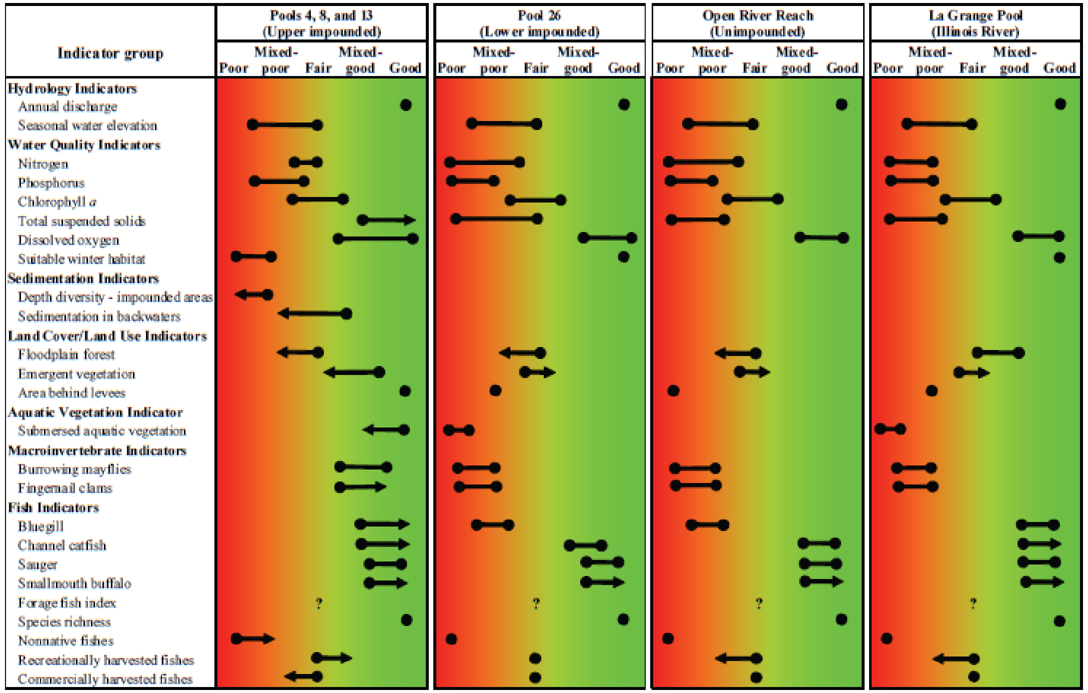


Figure 3.1. Comparison of ratings of the status and trends for resource indicators derived from data collected at the six study areas of the Long Term Resource Monitoring Program (LTRMP) on the Upper Mississippi River System. The black bars indicate the range of status within that LTRMP sampling areas. An arrow at the end of a bar indicates a trend in that direction for that sampling area (or at least one sampling areas in the left panel). A question mark means that rating of that indicator was not possible. See the text for details on the locations of the study areas (Chapter 1) and reasons for specific ratings (Chapter 2).

OUTCOME
Navigation Study Recommendations (2004)

Adaptive Management

Implementation of any alternative needs to be done in the context of a comprehensive and integrated plan for river management because many system components are intrinsically linked. Making decisions to address and resolve the complex assortment of ecological needs and objectives within the UMRS **should be conducted in the context of a long-term commitment to a policy of adaptive management.** Adaptive management is a process that seeks to aggressively use management intervention as a tool to strategically probe the functioning of an ecosystem. Management measures are designed to test key hypotheses about the structure and functioning of the ecosystem. Adaptive management identifies uncertainties, and then establishes methodologies to test hypotheses concerning those uncertainties. It uses management actions as tools to not only change the system, but as tools to learn about the system.

There are several elements both scientific and social that are vital components of adaptive management:

1. Management is linked to appropriate temporal and spatial scales
2. Management retains a focus on statistical power and controls
3. Use of computer models to achieve ecological consensus
4. Use embodied ecological consensus to evaluate strategic alternatives
5. Communicate alternatives to stakeholders for negotiation of a selection

Specific elements incorporated into the UMRS adaptive management program would include:

1. Organization
    - River Management Council
    - Science Panel
    - River Management Teams
2. Systemic Studies
    - Ecosystem Modeling (numerical and conceptual)
    - Information Needs Assessment
    - Biological data collection (example Fish Stock Assessment)
    - Physical data collection (bathymetry)
    - Etc.
3. Restoration Measure Evaluation
    - Island Building
    - Fish Passage
    - Side Channel Restoration
    - Etc.

Table 6-20. Ecosystem alternative cost estimates (over 50 years in 2003 dollars).

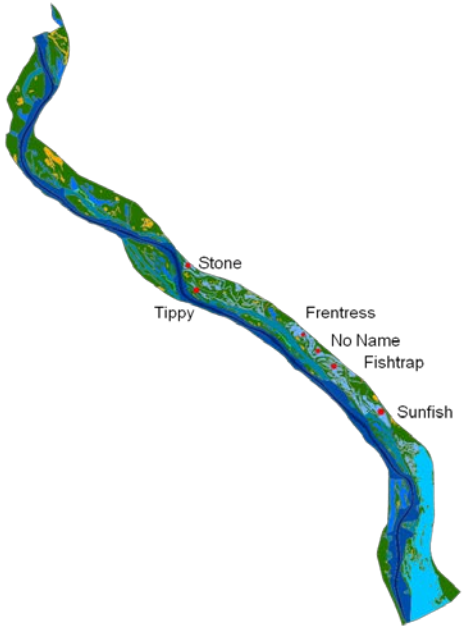
UMR-IWW Ecosystem Measure Construction Costs	Cost ($1,000,000's)				
Ecosystem Measure	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E
Island Building	$0.0	$107.2	$235.2	$314.8	$401.2
Fish Passage	$0.0	$0.0	$0.0	$329.0	$775.5
Floodplain Restoration	$0.0	$2.0	$77.0	$496.0	$1,208.0
Water Level Management - Pool	$0.0	$54.0	$54.0	$54.0	$117.1
Water Level Management - Backwater	$0.0	$0.0	$3.4	$23.8	$30.6
Backwater Restoration (Dredging)	$0.0	$167.5	$321.0	$483.8	$628.0
Side Channel Restoration	$0.0	$84.1	$155.2	$213.2	$250.9
Wing Dam/Dike Alteration	$0.0	$14.1	$40.0	$50.2	$53.4
Island Protection	$0.0	$83.0	$83.0	$83.0	$83.0
Shoreline Protection	$0.0	$124.2	$124.2	$124.2	$124.2
Topographic Diversity	$0.0	$24.6	$24.6	$24.6	$24.6
Dam Point Control	$0.0	$0.0	$23.2	$23.2	$32.2
Total Construction Costs (with real estate)	$0.0	$660.8	$1,140.8	$2,219.8	$3,728.7
Contingency					
Contingency (35% construction costs)	$0.0	$231.3	$383.5	$677.2	$1,058.3
Adaptive Management Costs					
Adaptive Management	$0.0	$223.0	$369.8	$653.0	$1,020.5
Additional Costs					
Forestry Management	$0.0	$75.0	$87.5	$100.0	$125.0
Systemic Fleeting Plan	$0.0	$0.3	$0.3	$0.3	$0.3
Cultural Res. Management/Mitigation	$0.0	$26.8	$44.4	$78.4	$122.5
Planning, Engineering, Design, and Management Costs					
Planning, Eng., Design, and Admin (30%)	$0.0	$365.1	$607.9	$1,118.6	$1,816.6
Supervision and Administration (9%)	$0.0	$109.5	$182.4	$335.6	$545.0
UMR-IWW Ecosystem Alternative Costs	**$0.0**	**$1,691.7**	**$2,816.6**	**$5,182.8**	**$8,416.7**

NESP Adaptive Management Implementation (2007-2011)

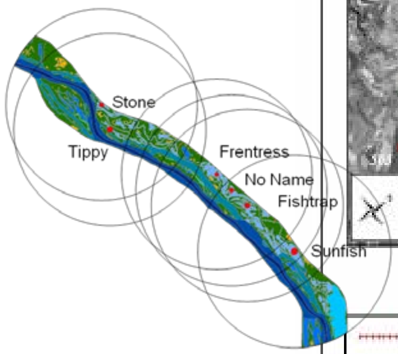
- Reach Planning – Identify first round of ER projects
- IWW water levels
- Water level management – mussel impacts
- Wing dam alterations
- Fish Passage
- Forest Management Plan
- Navigation adaptive mitigation
- UMRS Teacher's guide
- Our Mississippi newsletter

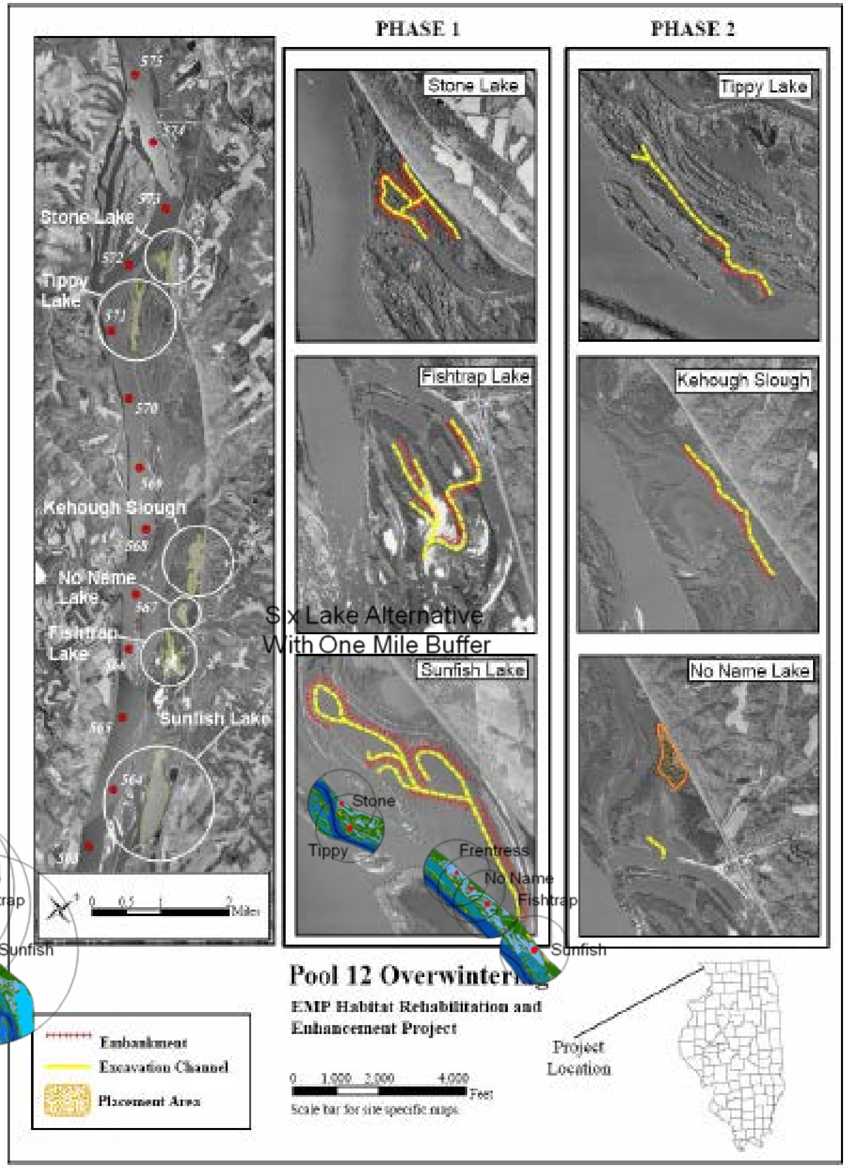
Upper Mississippi River Restoration Pool 12 Overwintering HREP

- Upper Pool 12 backwater lakes
- Benefit analysis for six lakes and combinations



Six Lake Alternative With Three Mile Buffer



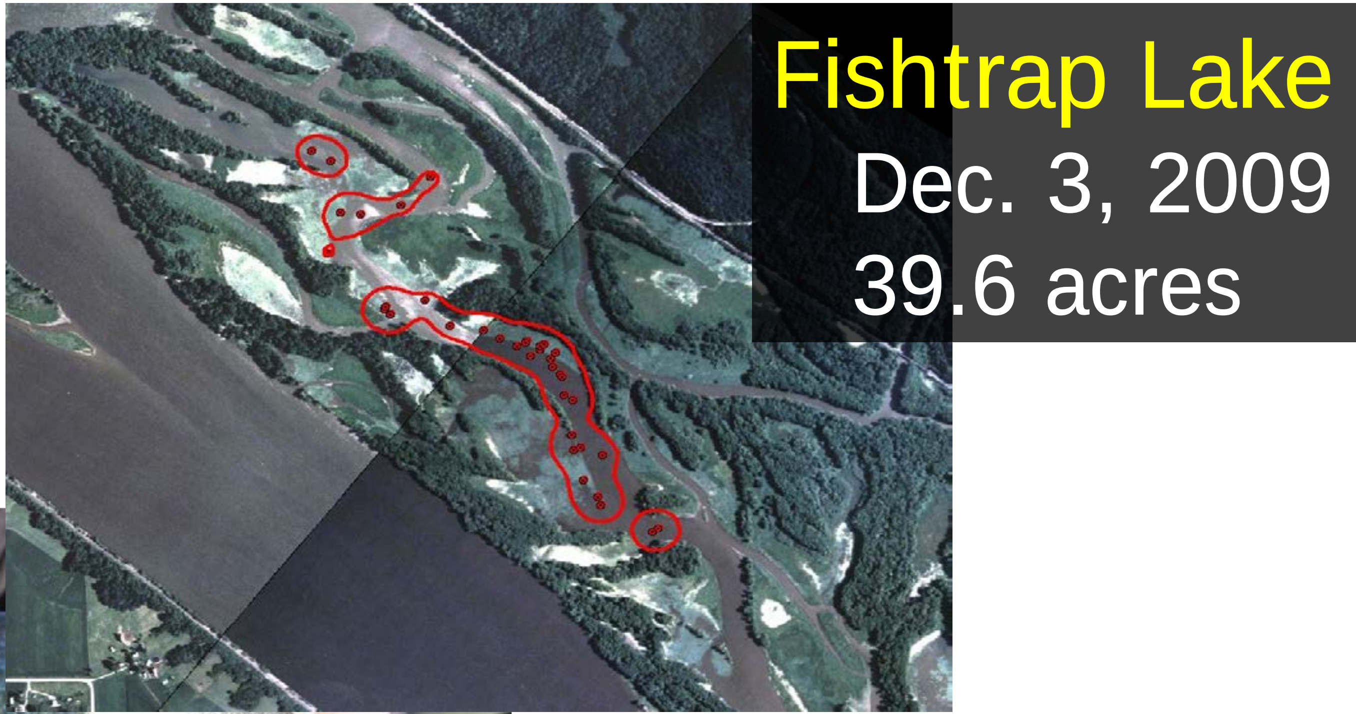


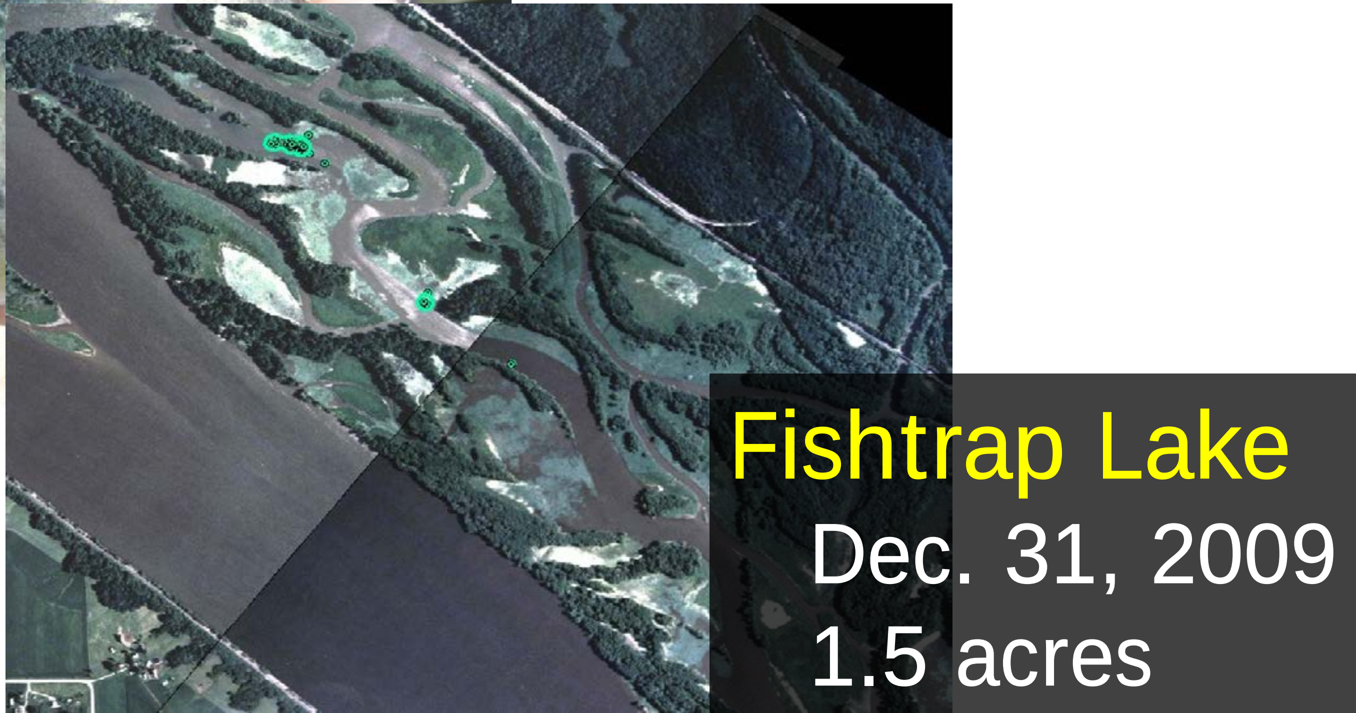
Poor Winter Water Quality

- Generally falls into two categories:
  - Low DO
  - Too much flow (causes low temperatures)
- These two conditions do not affect all sizes of fish equally
- Anoxic conditions are harder on larger fish

Adaptive Management Radiotelemetry Monitoring

- Pre-project
- Post project



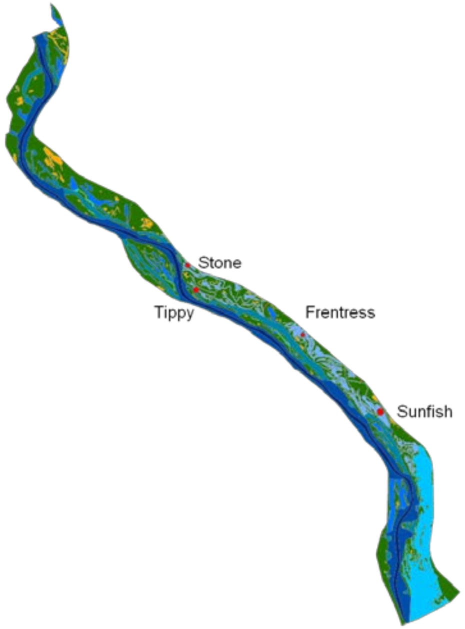


Pool 12 Systemic Benefits

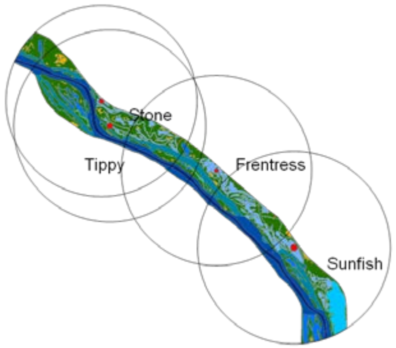
- MVD was disappointed by cost per AAHU
- Wanted to see more benefits
- Used NESP Area of Influence
- Used GIS 1 and 3 mile buffer analysis

Recommended Plan

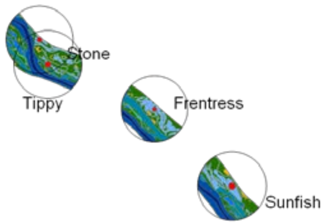
- Dredging in four backwater lakes
- Increase island topographic/forestry diversity
- Manage backwater connectivity



Four Lake Alternative
With Three Mile Buffer



Four Lake Alternative
With One Mile Buffer



Pool 12 Adaptive Management

Monitoring Subject Mortality

HTRW Issues

Tracking Backwater Crappies

Kirk Hansen, research biologist with the Iowa Department of Natural Resources, uses external tags—little "crappie backpacks" that weigh about 4 grams—to track movements in the backwaters of the Mississippi River. He found that movements tend to be slight, closely tied to environmental changes like rising or falling water levels and oxygen content. "We tracked all year, but are trying to find out about winter habitat use in these lakes," Hansen says. "Often the deepest holes are only 3 to 6 feet deep. Crappies and bluegills concentrate near or in those shallow depressions.

"We can map out the areas they use in winter," he says. "Ice fishermen need to understand—just because they caught crappies or bluegills in one spot doesn't mean they'll be there next week. Thick ice and heavy snow can reduce light to the point that most vegetation and plankton die. Oxygen becomes scarce. But floods are worse. In December 2015, the whole area became inundated and all the crappies we were tracking perished. When water is 32°F and flowing, they don't do well. Panfish avoid current at all costs in winter."

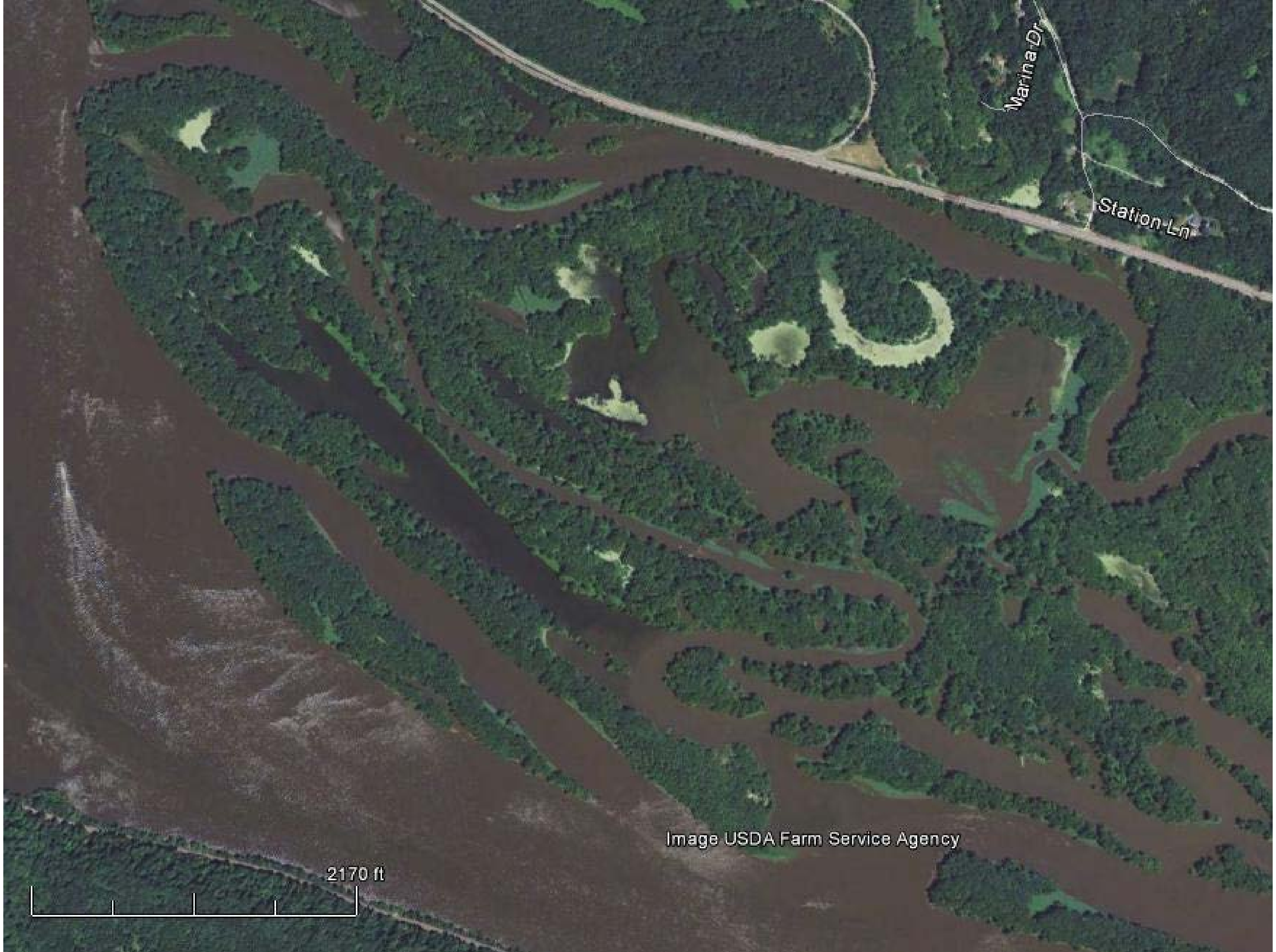
Late fall: Panfish sought the warmest water with sufficient oxygen, while avoiding flow.

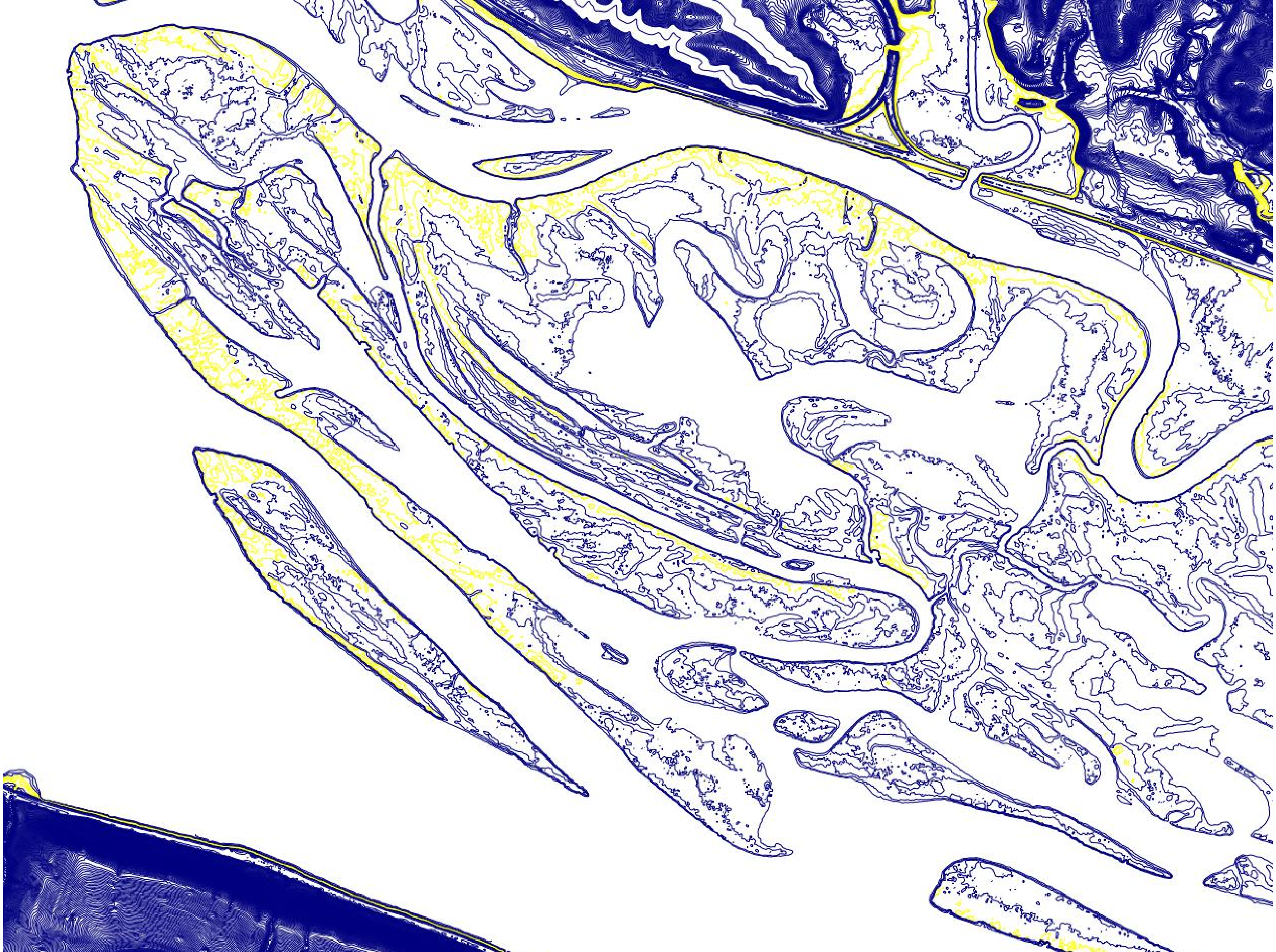
A rise in water level increased oxygen levels in the lake and fish dispersed over a larger area.

Water level decreased, oxygen levels decreased again, and crappies moved back toward the flow area.

Natural Levees

- Existing quality overwintering lakes are surrounded or capped by diverse forests
  - Higher elevation
  - Less frequent overland flooding
  - Better sediment filtration
  - Lower sedimentation


Marina Dr
Station Ln
Image USDA Farm Service Agency
2170 ft



Natural Levees

- Strong tie between high quality terrestrial and aquatic habitat
- Enhance forestry resources while reconstructing natural filter for backwaters
- **Building like nature** will result in more resilient and healthy projects

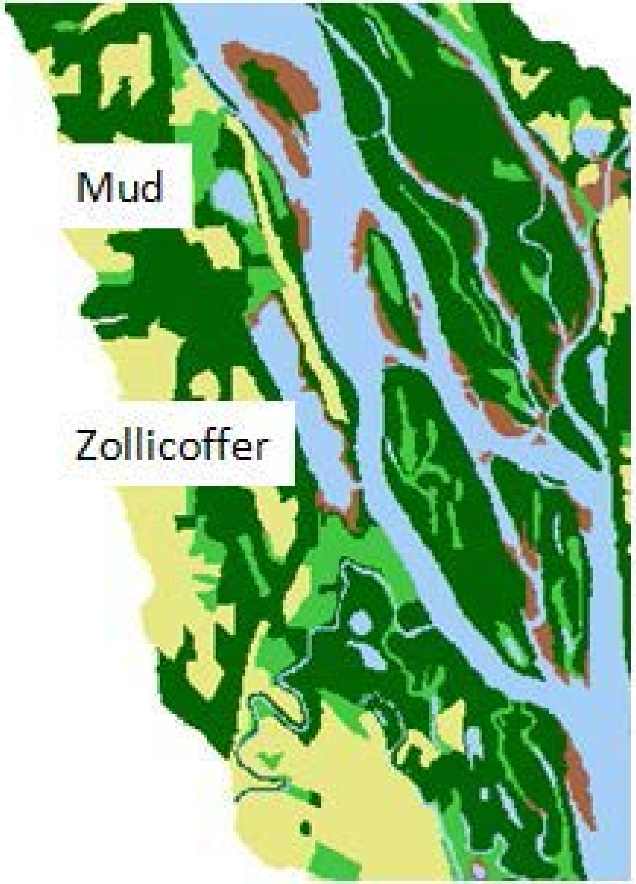
Future Adaptive Management

Dave Bierman (Iowa DNR; April 2017)
Chuck - We've got 21 confirmed dead, with another 6 "probable" mortalities. Hopefully when we re-do Kehough after the HREP is completed, more will stay alive and we can pat ourselves on the back and say the HREP increased overwinter survival! There's just flat-out too much flow through that complex to be a stellar overwintering area as it now sits (in my humble opinion).

- Climate Adaptation for high winter river stages
- Use climate EC for final design
- Contingency planning for final construction phases

Mud Lake HREP

Pre-Dam

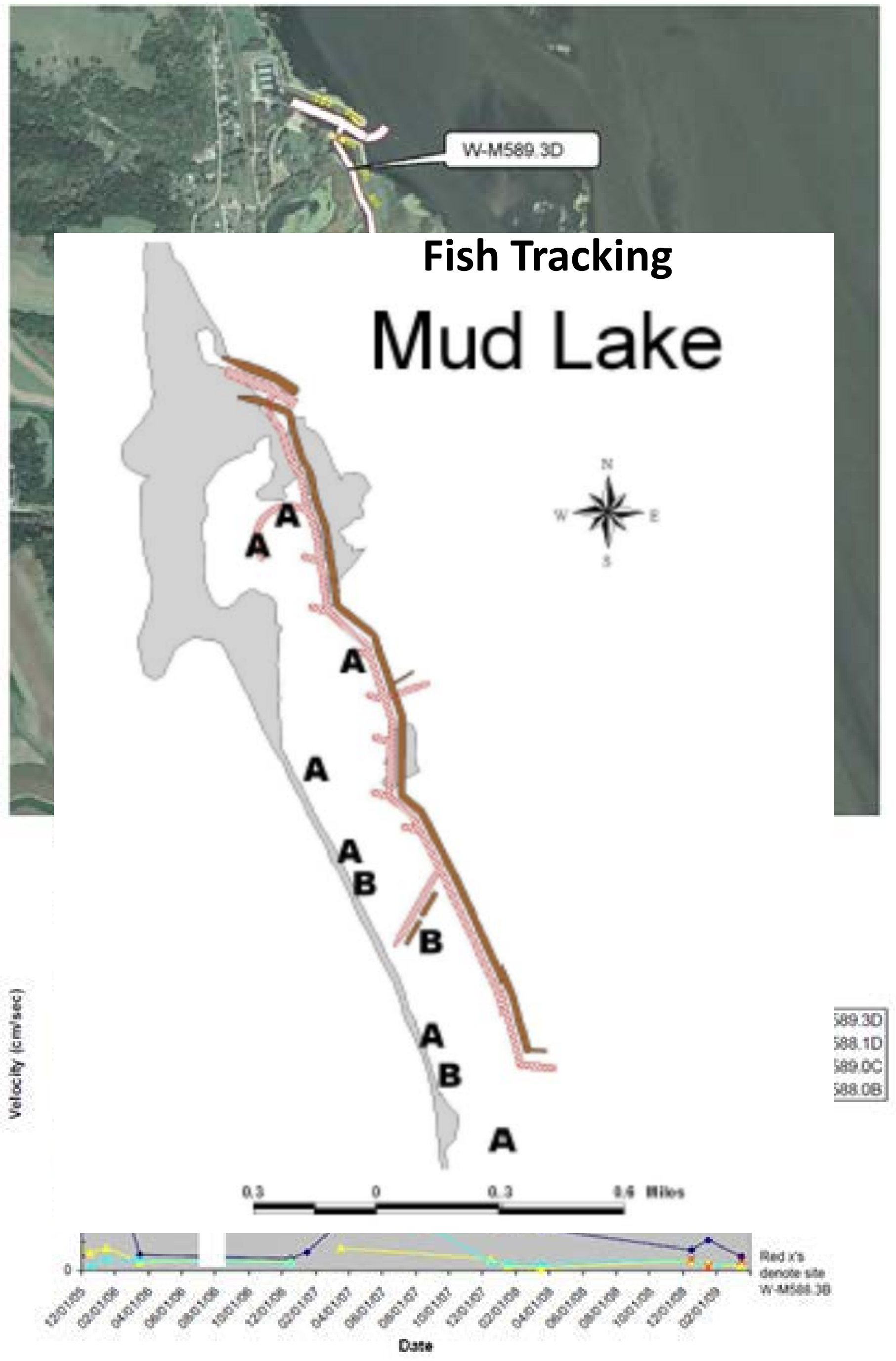


Pre-HREP

Post HREP

Pre- Project Uncertainty Regarding Inlet Flow

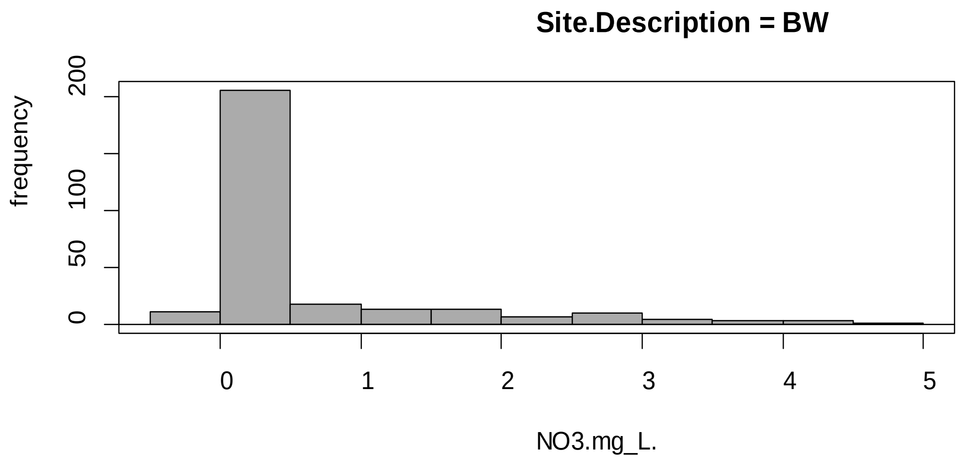
- First design open to bottom = way too much flow
- RMA-2 hydraulic model used to model 20 cfs
- Poor calibration
- Estimated opening too large, but stockpiled rock

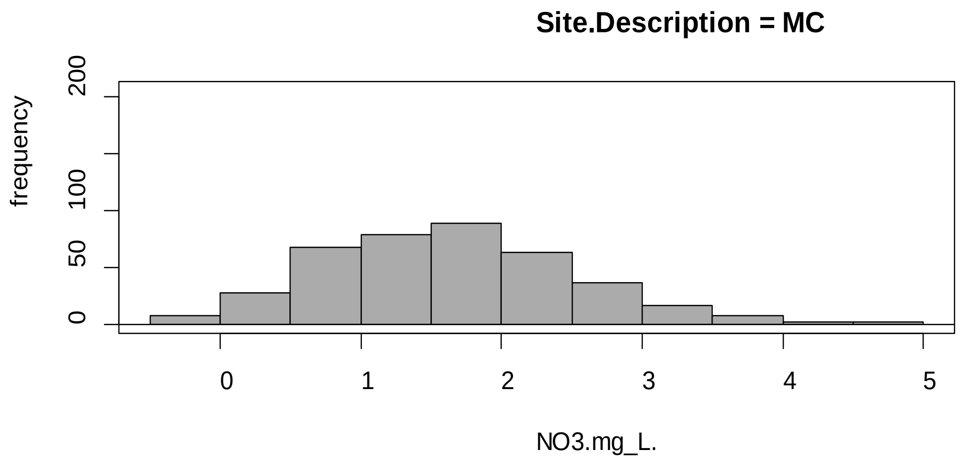


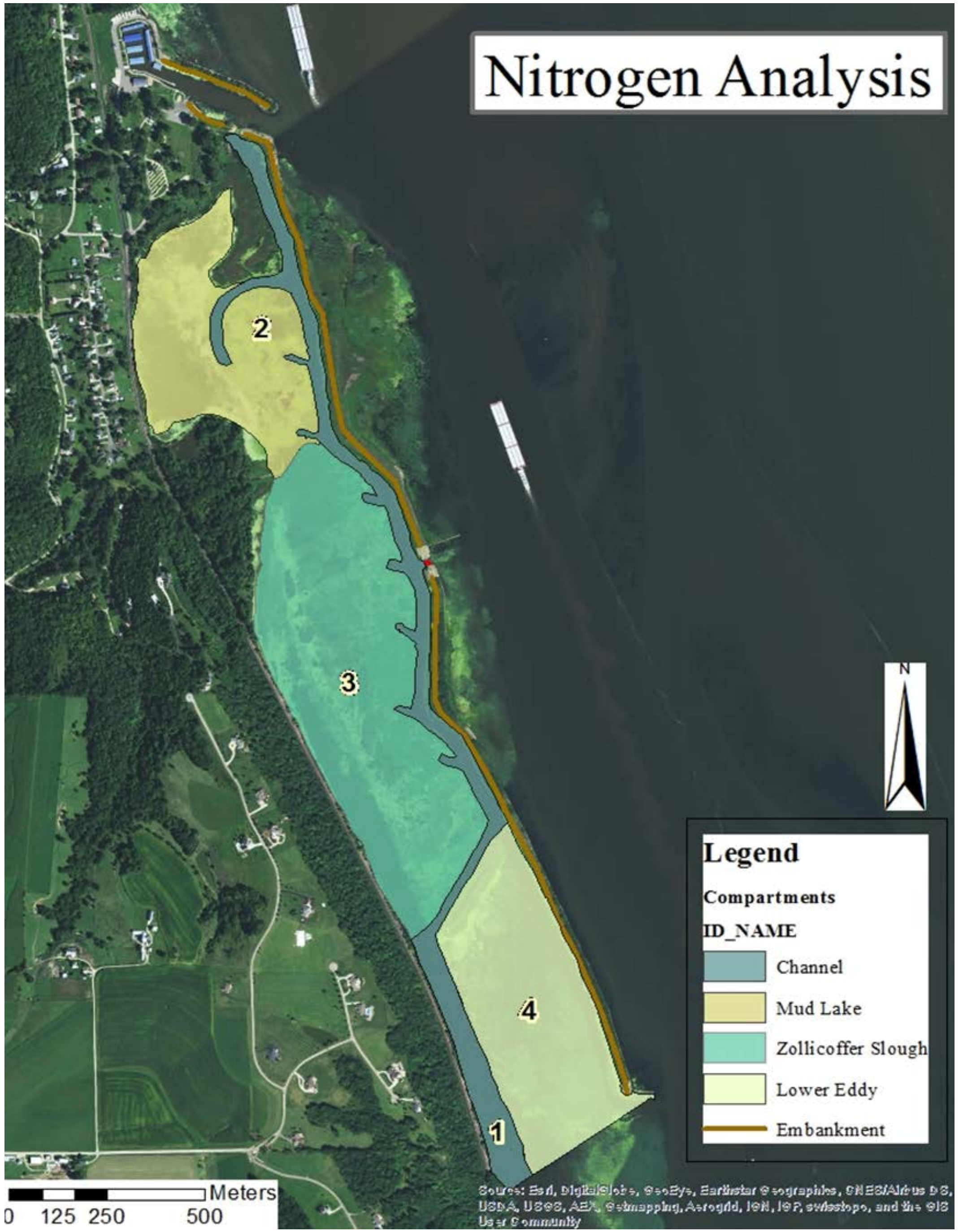
Stakeholders Wanted More Flow Reduction

1. Dye study to understand existing flows
2. Sponsor added rock to closing structure
3. Dye study documentation to confirm outcomes

Next Adaptations: Nutrient Sequestration







Next Adaptations: Nutrient Sequestration

Table 2. Mud Lake Hydrological-Nutrient Simulation Model Results

Alternative	Compartment	Name	Area	Flow	τ	Denitrification rate	Time	Total N Denitrified	Alternative N Denitrified
			m²	H/M/L	H/M/L	mg/m²/d	days	mg/m²/gs	mg/m²/g
	1	Channel	154,228	H	L	300	150	6.94E+09	
	2	Mud Lake	198,454	L	H	200	150	5.95E+09	
	3	Zollicoffer Upper	393,808	L	H	200	150	1.18E+10	
	4	Lower Eddy	234,243	H	L	300	150	1.05E+10	
Notch Weir									**3.52E+10**
	1	Channel	154,228	L	H	200	150	4.63E+09	
	2	Mud Lake	198,454	L	H	200	150	5.95E+09	
	3	Zollicoffer Upper	393,808	L	H	200	150	1.18E+10	
	4	Lower Eddy	234,243	L	H	200	150	7.03E+09	
Rock Closure									**2.94E+10**
	1	Channel	154,228	M	M	500	150	1.16E+10	
	2	Mud Lake	198,454	M	M	500	150	1.49E+10	
	3	Zollicoffer Upper	393,808	M	M	500	150	2.95E+10	
	4	Lower Eddy	234,243	M	M	500	150	1.76E+10	
Gated Culvert									**7.36E+10**

Huron Island HREP

The goals of the Project are to:

(1) Manage for a diverse and dynamic pattern of habitats to support native biota ;

(2) Manage for viable populations of native species within diverse plant and animal communities; and

(3) Manage for processes that shape a physically diverse and dynamic river-floodplain system

The objectives of the Project are to:

(4) increase the areal coverage as measured in acres of **emergent and submersed aquatic vegetation** in backwater areas during the growing season;

(5) increase diversification of year round **floodplain forest and scrub-shrub habitat** on Huron Island, as measured in acres;

(6) increase the structure and function of year-round **aquatic habitat** diversity, as measured by acres and native fish use of spawning, rearing, and overwintering habitat in the Project area;

and

(4) maintain side channel riverine **hydrodynamic, sediment transport and geomorphic processes** in Huron Chute.

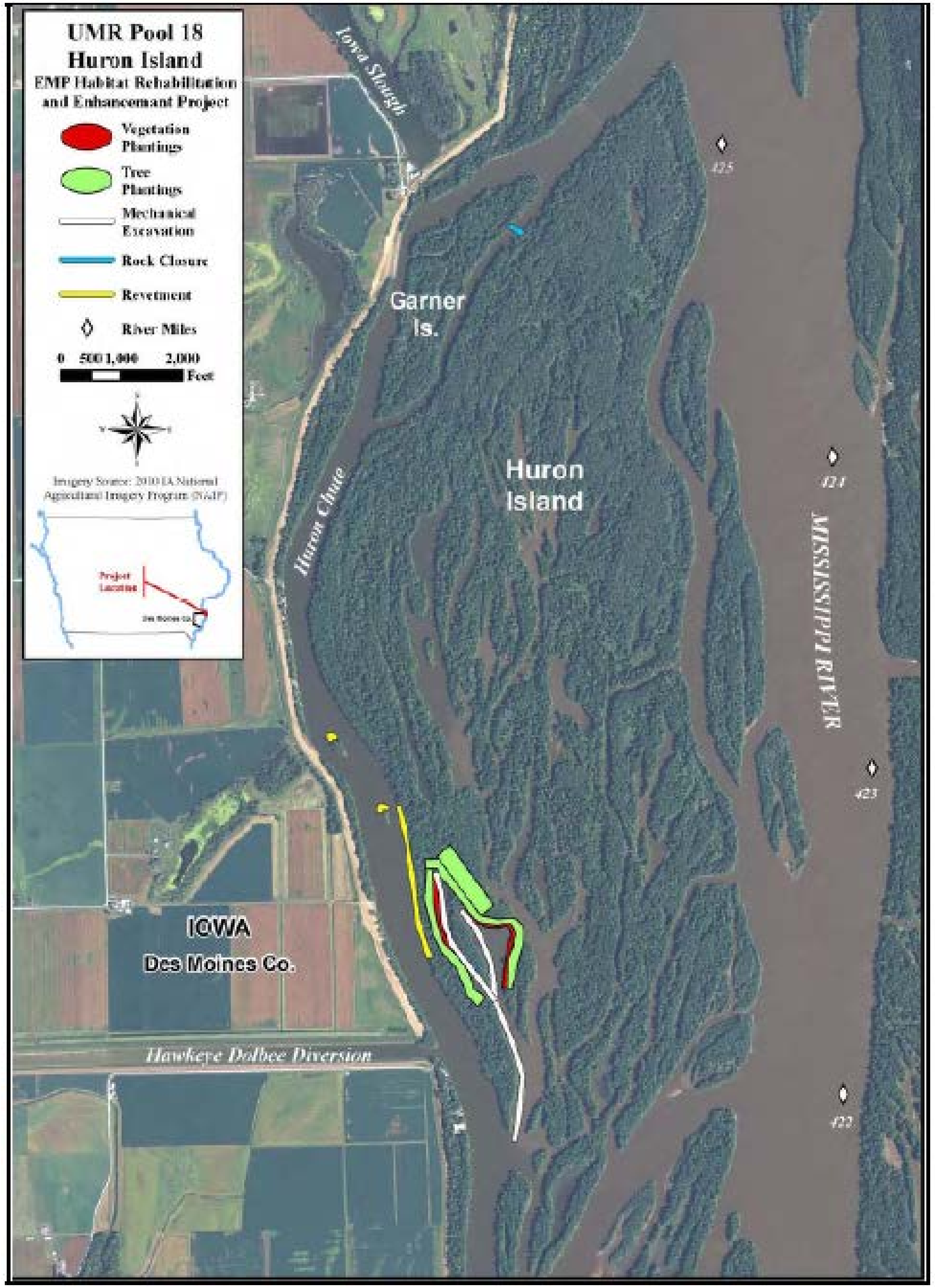
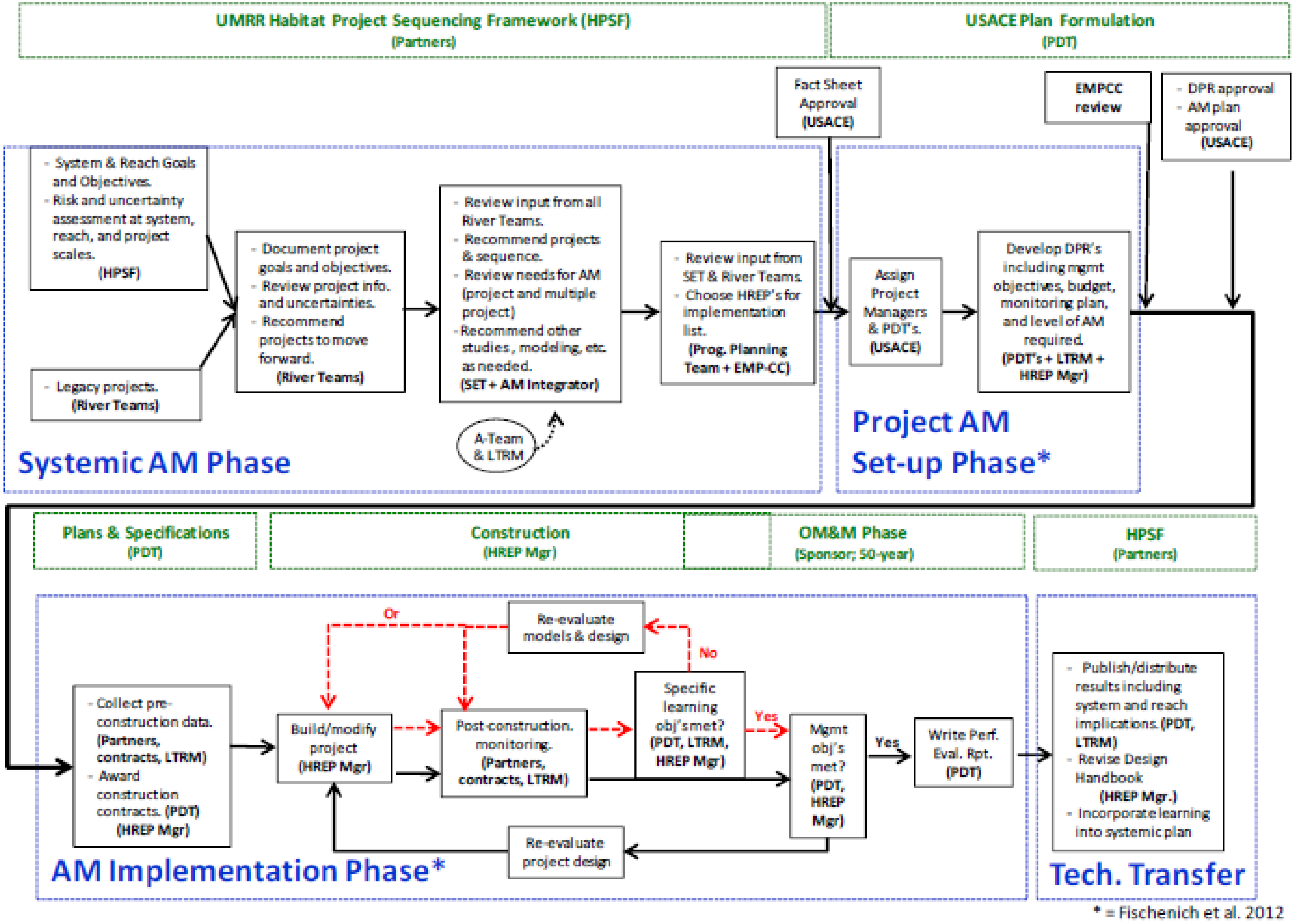
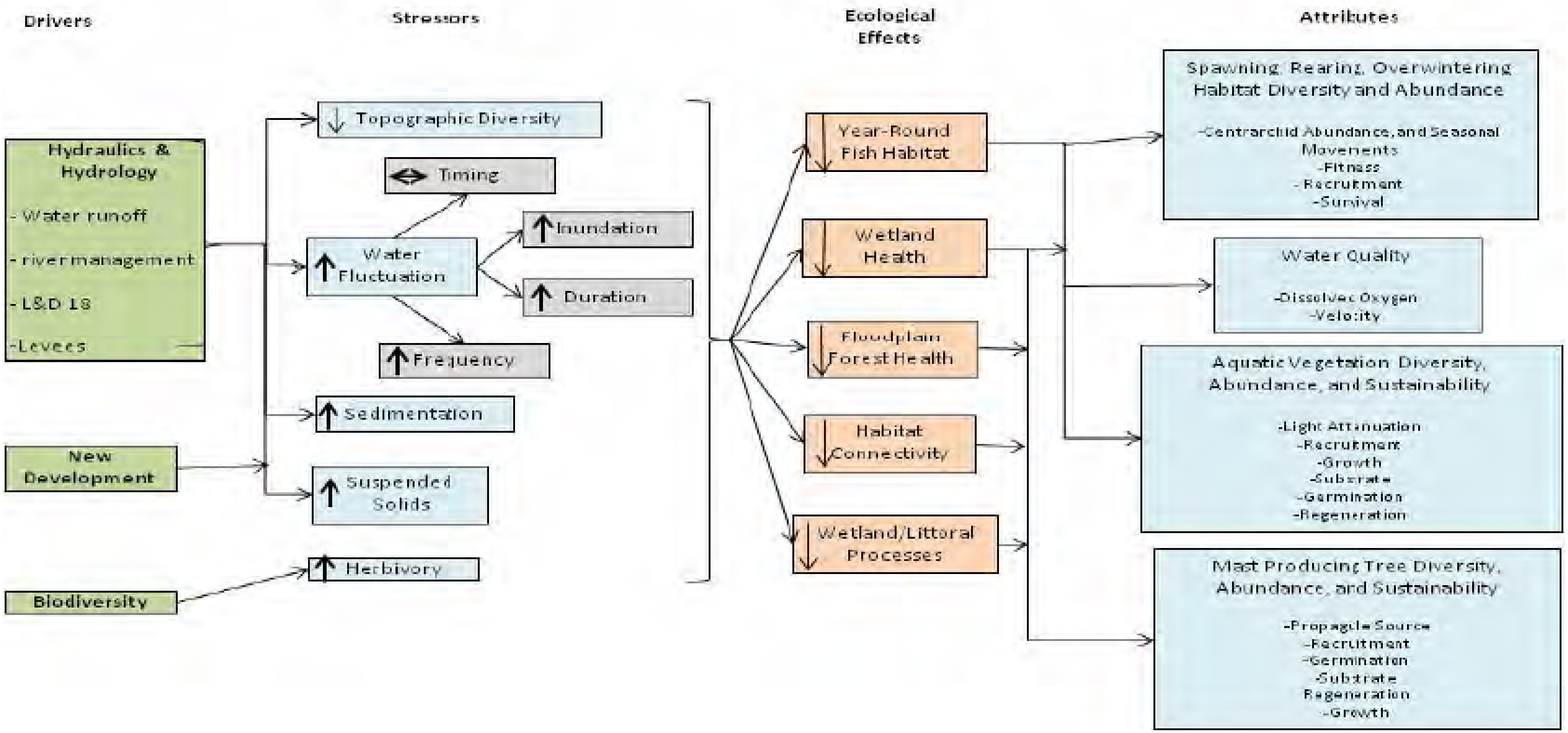


Figure K-1. UMRR EMP HREP Adaptive Management Planning Flowchart





Drivers
Stressors
Ecological Effects
Attributes
Hydraulics & Hydrology
- Water runoff
- river management
- L&D 18
-Levees
New Development
Biodiversity
Topographic Diversity
Timing
Water Fluctuation
Inundation
Duration
Frequency
Sedimentation
Suspended Solids
Herbivory
Year-Round Fish Habitat
Wetland Health
Floodplain Forest Health
Habitat Connectivity
Wetland/Littoral Processes
Spawning, Rearing, Overwintering Habitat Diversity and Abundance
-Centrarchid Abundance, and Seasonal Movements
-Fitness
- Recruitment
-Survival
Water Quality
-Dissolved Oxygen
-Velocity
Aquatic Vegetation Diversity, Abundance, and Sustainability
-Light Attenuation
-Recruitment
-Growth
-Substrate
-Germination
-Regeneration
Mast Producing Tree Diversity, Abundance, and Sustainability
-Propagule Source
-Recruitment
-Germination
-Substrate
Regeneration
-Growth

2.2. Sources of Uncertainty. Adaptive management provides a coherent process for making decisions in the face of uncertainty. Scientific uncertainties and technological challenges are inherent with any ecosystem restoration project. Below is a list of uncertainties associated with restoration of aquatic vegetation, aquatic fish habitat, and floodplain habitat in the Huron Island HREP.

2.2.1. Aquatic Vegetation

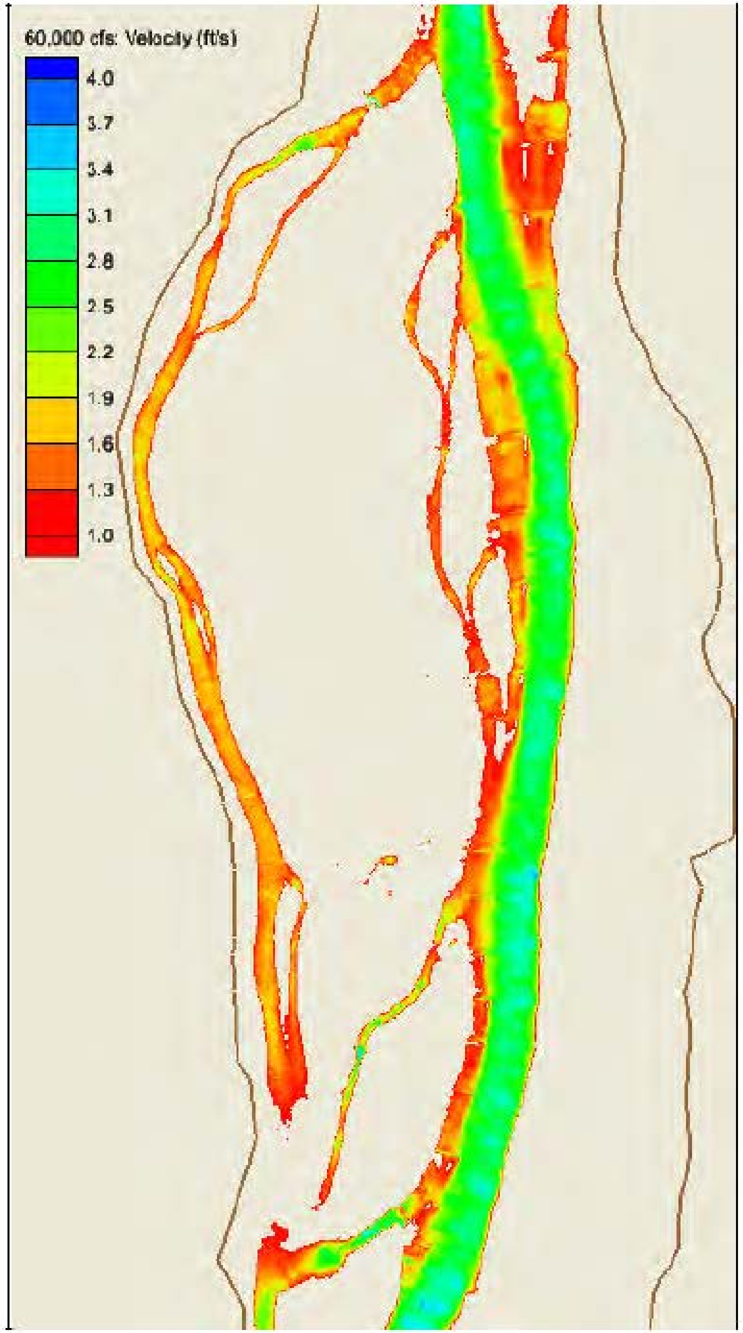
- selection of appropriate species for the waterbody
- selection and acquisition of suitable propagules
- species specific effects of turbidity on growth
- species specific water level fluctuation tolerances
- species specific herbivory tolerance
- planting density

2.2.2. Floodplain Forest

- species specific water inundation and duration tolerances, which leads to optimal planting elevation
- species specific herbivory tolerance
- interaction of optimal tree size and optimal planting elevation

2.2.3. Aquatic Habitat

- winter dissolved oxygen (DO) concentrations
- species specific seasonal movements and site-loyalty of restored Huron Island
- year-round backwater habitat during the spawning, rearing, and wintering seasons



ure H-20. Existing Condition Velocity Results for Huron Chute, Garner C and the Main Channel Under Discharge Conditions Of 60,000 cfs.

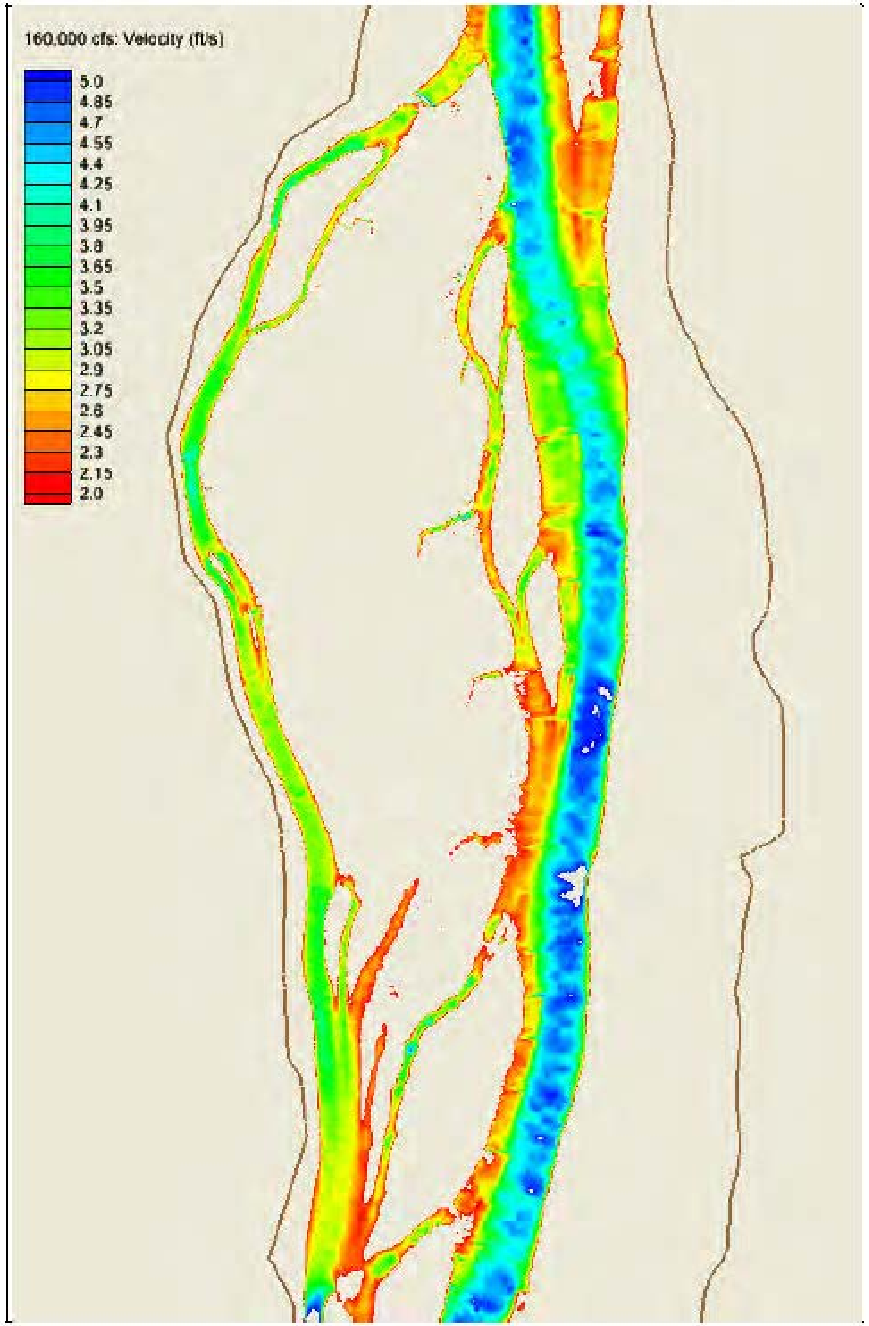


Figure H-18. Existing Condition Velocity Results for Huron Chute, Garner Chute and the Main Channel Under Discharge Conditions of 160,000 cfs

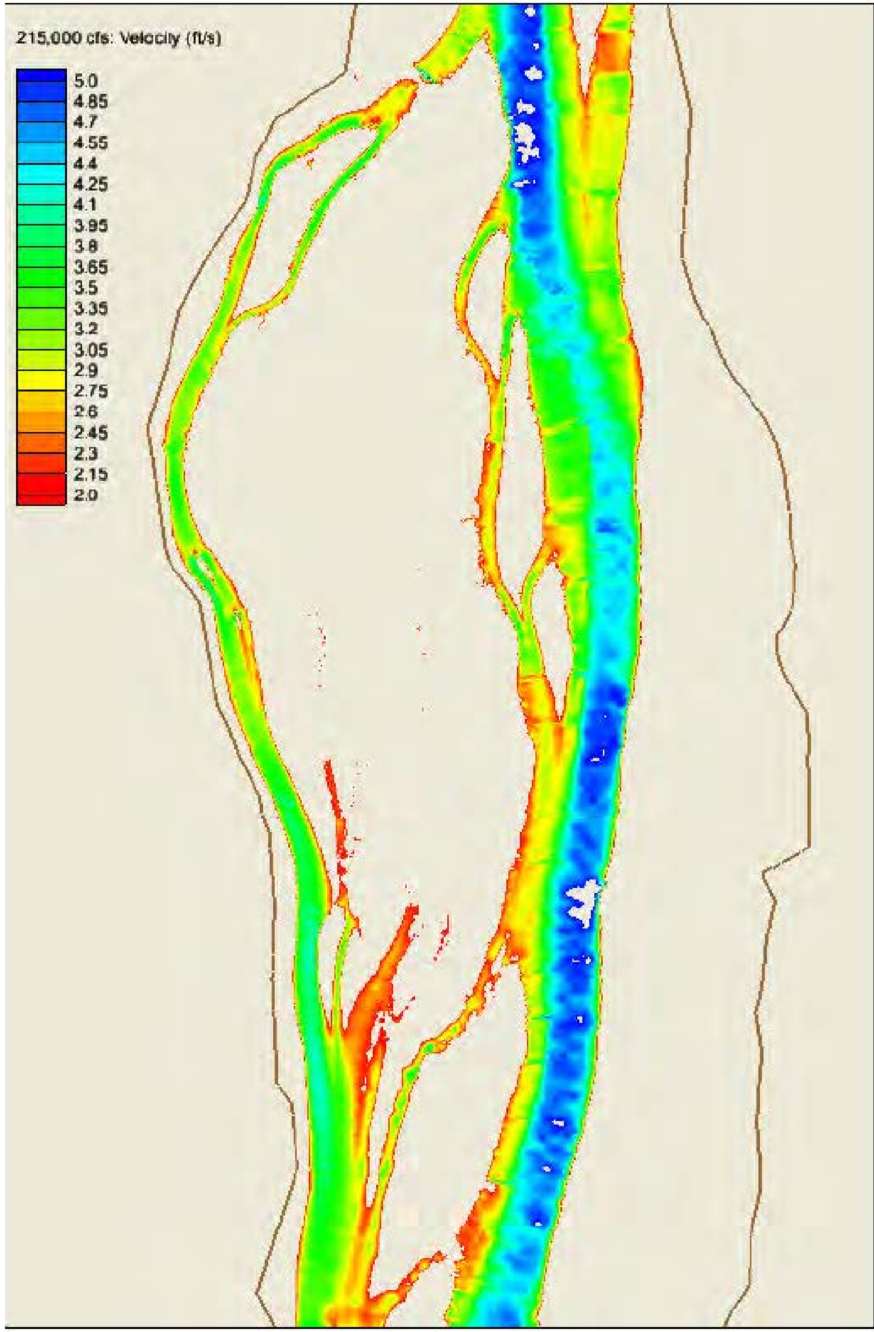


Figure H-19. Existing Condition Velocity Results for Huron Chute, Garner Chute and the Main Channel Under Discharge Conditions of 215,000 cfs

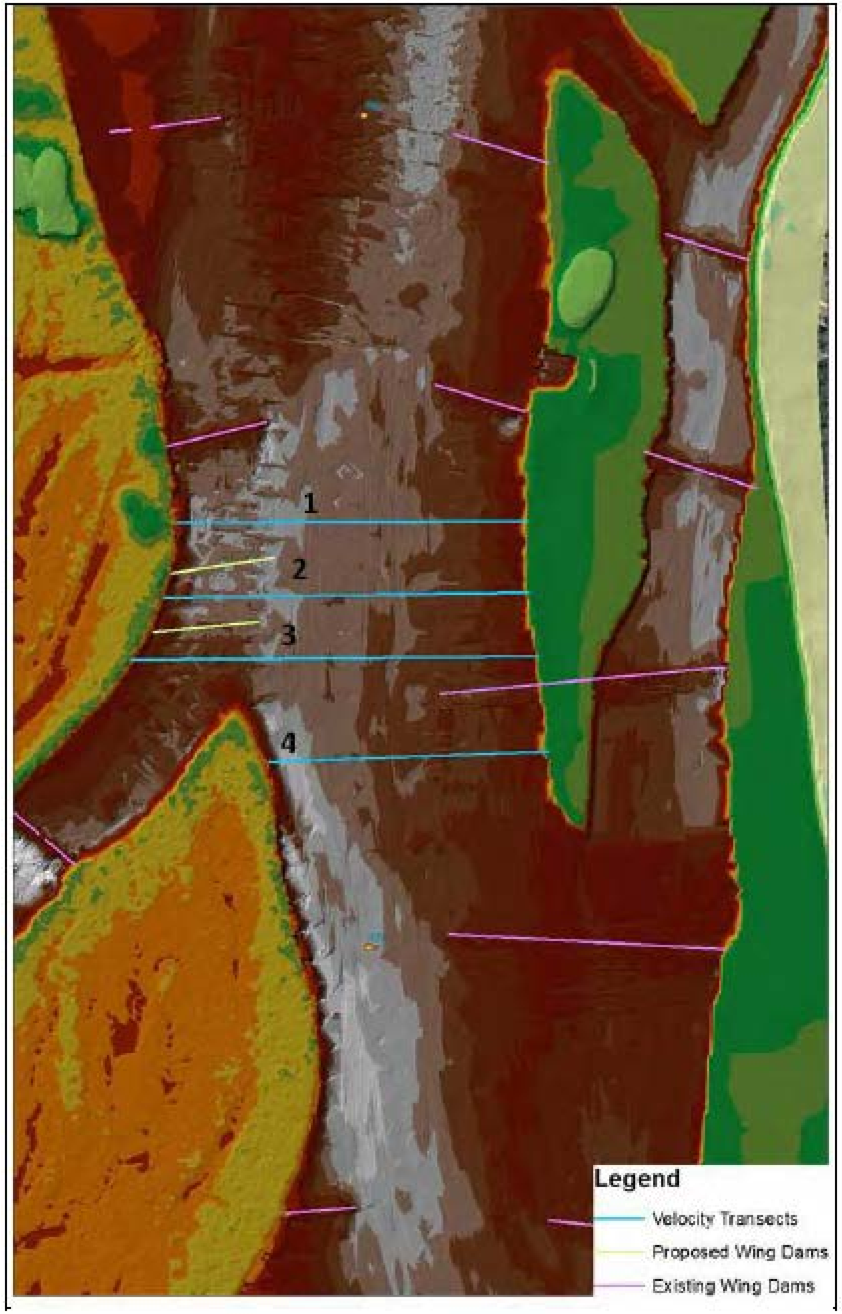


Figure H-26. Location of Velocity Transects With Respect to Proposed and Existing Wing Dams

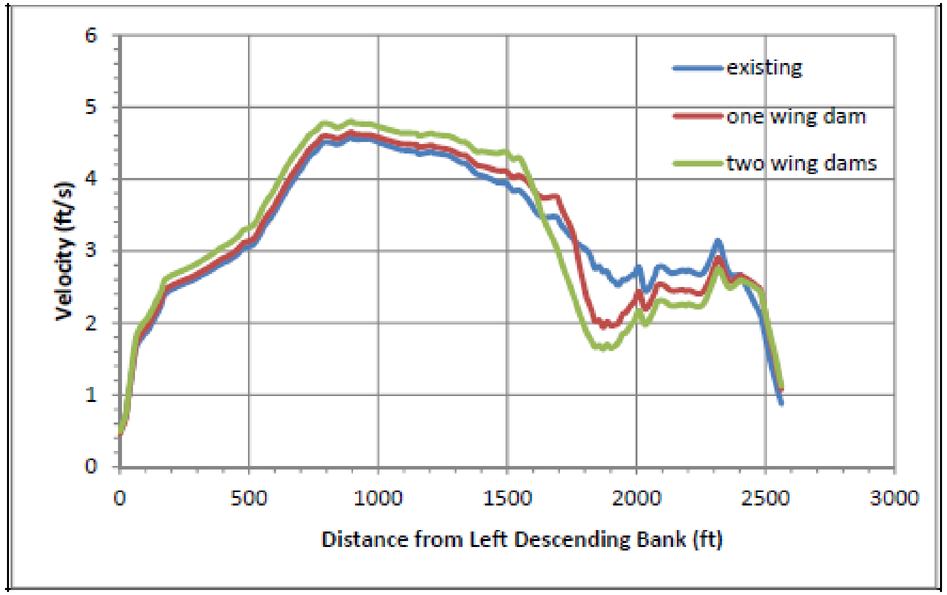


Figure H-29. Comparison of Computed Velocities During 160,000 cfs Discharge at Transect 3 (figure H-26)

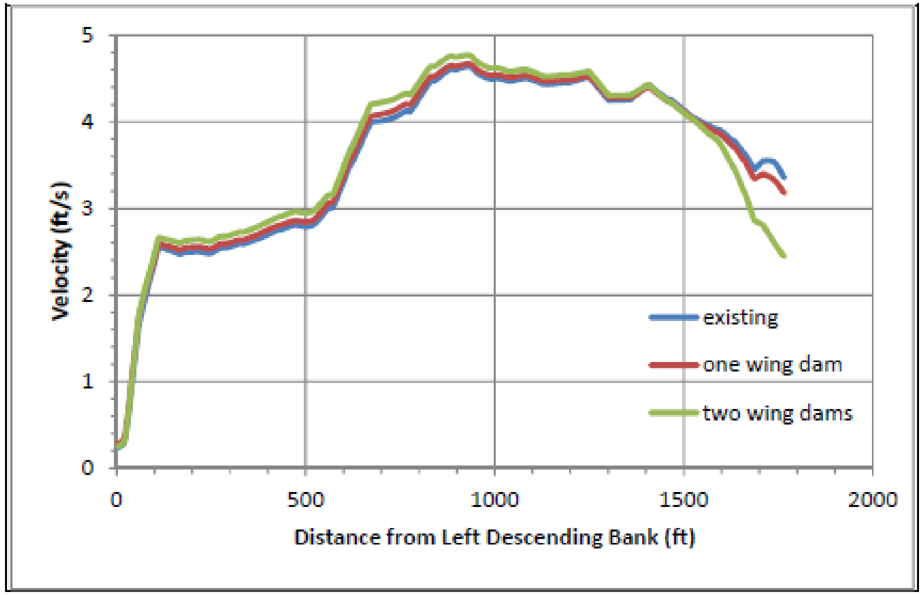


Figure H-30. Comparison of Computed Velocities During 160,000 cfs Discharge at Transect 4 (figure H-26)

Project Performance Objectives

3.1. Aquatic Vegetation

Performance Measure. Increase diversity, abundance, and areal coverage of native submerged, floating-leaved, and emergent aquatic vegetation compared to pre-project conditions and control sites within Huron Island.

Criteria. Species richness of 5 and areal coverage of 1 acre of native submerged, floating-leaved, and emergent aquatic vegetation within 5 years. The monitoring design and associated adjustments to the planting design described below will be used to meet the decision criteria.

Monitoring Design. Ongoing e
are critical in the decision-making process
operations required for sustained establish
vegetation component protocols and GIS r
growth, and areal coverage. The analysis
vegetation establishment, compared to the

3.2. Floodplain Forest

Performance Measure. Increase species diversity, abundance, and areal coverage of native diverse mast producing tree species

Criteria. Species richness >11 species and > 7 acres of native diverse forest

Performance Measure. Determine optimal elevation, size of RPM tree, and protection from herbivory to maximize growth, survival, and seed production

Criteria. Attain an average growth rate of 0.5 in/year dbh, an average survival rate of >80 percent, and seed production within 10 years

Performance Measure. Determine optimal elevation, size of RPM tree, and protection from herbivory to initiate regeneration of mast producing trees

Criteria. Attain mast producing tree regeneration within 10 years

3.3. Aquatic Habitat

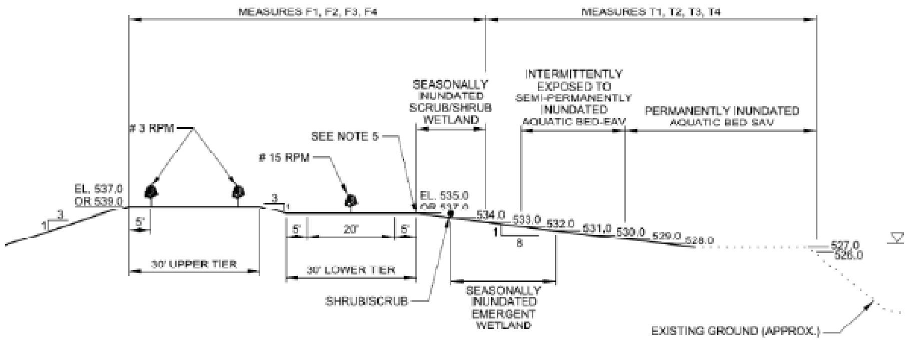
Performance Measure. Increase abundance and site-loyalty of centrarchids during spawning, rearing, and overwintering in restored backwaters compared to pre-project conditions

Performance Measure. Decrease seasonal movements between overwintering, spawning, and foraging habitat

Criteria. Reoccurring winter DO levels below 2 mg/L

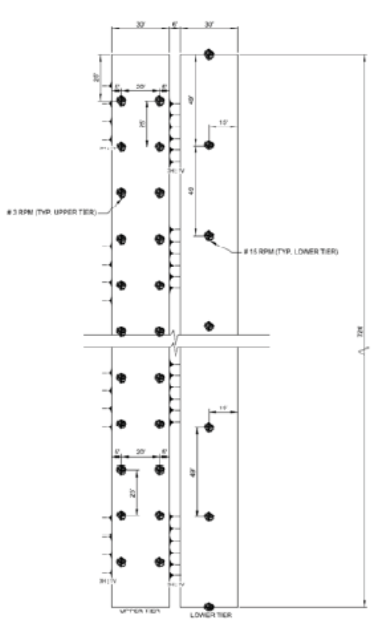
Adaptive Management Plantings

Seasonally Inundated Scrub/Shrub Wetland (SISSW) - EAV
EL. 533-535

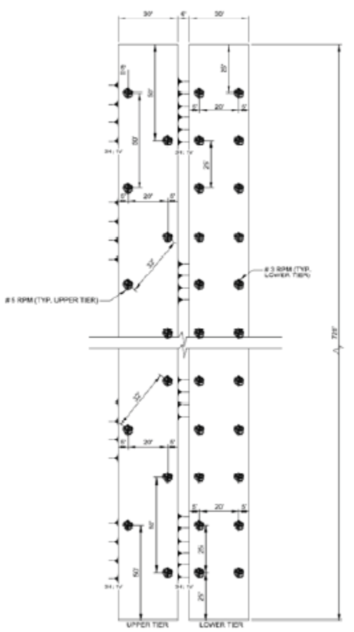


SISSW TOP Elevation	535.0	
SISSW Bottom Elevation	533.0	
Elevation Change	2.0	FT
Slope	8.0	H:1V
	16.0	FT
Slope Distance	16.1	FT
AREA	34,909.6	SF
	0.8	AC
Continency	20%	
	1.0	AC
Acres to Plant	**1.0**	AC

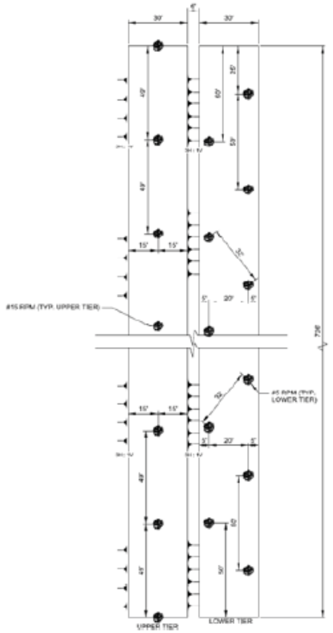
Trees



TREE PLANTING PLANS - PLOT 1 (MEASURES F1, F2, F3, AND F4



TREE PLANTING PLANS - PLOT 2 (MEASURES F1, F2, F3, AND F4)



F1, F2, F3 AND F4) - PLOT 3

Number of Trees per plot is shown on sheet called "Tree Layout"

Table K-1. Experimental Design and Monitoring for Aquatic Plant Establishment

Year 1 Learning Phase	**Year 2 Learning/Implementation**	**Year 3 Implementation/Meet Project Objectives**	**Year 4 Implementation/Project Success**	**Year 5 Project Success**
Plant acquisition	Additional plant acquisition if needed			
Initiate plant production	Continue plant production	Continue plant production		
Materials acquisition (nursery)	Materials acquisition (exclosures)	Materials acquisition (exclosures)		
	Planting	Planting		
	Evaluations	Evaluations	Evaluations	Evaluations
Status report	Status report	Status report	Status report	Final report

UMRS Adaptive Management

- Significant history using AM principles
- Many opportunities for passive and active AM
- Need contingency plans

AM Plan Development-Basics

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AM Plan Development

- Most agencies have some form of guidance on AM
- Follow your agency guidance or find a good example
- Most AM efforts involve data (monitoring), teamwork contingency planning and decision making
- Section 2039 of WRDA 2007 is USACE rules or framework
- IG provides a roadmap for policy requirements, not details
- Draft 2011 USACE handbook is a good source for details and issues
- Some basics, with MRG Collaborative Program spin….

AM Plan Development

- Data
- Structured monitoring program (sounds like you have)
- Some form of timeline for comparison or trends analysis (20yrs)
- Regular Technical Team meetings (Eng and Sci in agencies-Technical)
- Regular Management meetings (program mgrs. in agencies-$$)
- Regular (annual) Executive Team meetings (DE, USFWS, BoR, NF-decisions, direction)
- Large and complex or controversial? (external input and eyes)
- How many of these are in place in MRGCP?

AM Plan Development-Data

- What is overall Program purpose?
- What is project purpose?
- Projects should align with overall program goals and purpose
- Are we collecting the right data to answer our purpose and uncertainties?-Constantly check
- How flexible is program to data collection changes*?
- Is data collection integrated among agencies in a unified plan?
- Is data publically posted once “QC’d”?

AM Plan Development-Data

- Monitoring Plan-annual “work plan” as well as longer term
- Budget is stable and healthy…you are lucky
- Is cost going up or down over time?
- Multi species makes it complex and can be costly
- Nursery rearing of minnows
- SW willow flycatcher
- YB Cuckoo-too new?
- Mouse
- Other “boring” organisms/habitats?

AM Plan Development-data

- Do we track these costs annually? Seasonally?
- Are there contingencies in the case if high water, drought etc?
- Contingency actions for monitoring can have odd effects
- Public and stakeholders and agencies should be able to access data on some public portal or website
- How much is currently spent annually?
- How much has been spent since Collaborative program started?
- If you don’t have a good monitoring plan it is difficult to get $$

AM Plan Development-Contingency actions

- Itemize things you would do (program and project)
- Inlet sizing, planting versus volunteer plants, etc.
- Each has a cost and a potential benefit
- For MRG CP perhaps these are tied (or can be to BoR RPMs in new BO?
- Need a Tech Team to collect and pour over annual data and flag issues for mgmt. and ET action
- Need a management team to assess funding and success/problems
- Need an Exec Team or office directors/DE/etc who can guide overall program (now do the science and engineering or program mgmt.

AM Plan Implementation-general

- Stakeholders and public must be intergrated into this, they pay for it.
- Create your own “fan base”=$$
- NEPA documents should leave room for AM adjustments but should be specific enough that folks know what the change might be and why (triggers, thresholds, performance measures).
- Think of MRG CP actions and needs (past, present and future) as we discuss case studies.

Adaptive Management Costs

July 2017 Albuquerque workshop

AM Costs

- Contingency plans for your restoration efforts
- Action> what could go wrong and how>what would you do?
- A contingency plan effort is basically a “Plan B”
- Can be very detailed or less so-scaleable, driven by program needs
- Some actions can be relatively minor tweaks; some wholesale changes

AM Plan cost estimates

- Get a cost engineer involved. Critical!
- May need some form of contract capability to implement
- Tie your plans to your objectives
- For MRG CP is that four main listed species?
- Most contingency plans will be redo of original feature or project OR
- Can be ongoing tweaks to how a program is deployed.
- Examples online or via agency reps.
- Don’t re-invent the wheel unless needed.

AM Costs

- Example Terrace scraping
- Original feature cost-$150,000 with maybe 20% contingency
- Monitor that for restoration effectiveness…so what do you monitor, and why, and for how long? What is target for declaring success?
- We expect this…..
- But this could go wrong….and if so….
- We will take this action at this cost….
- “Worst case” could be another $150K (total rebuild) or less.

AM cost

- Sediment transport action
- So you might build a feature for $1m to ensure sediment transport down the river is appropriate…state the purpose…
- In river work is risky so contingency % may be set a bit higher…
- We expect this…
- Usually plan for tweaks or changes…explain what these would be…
- What could go wrong…what would be the plan or plans to respond if needed….maybe a level 1, 2 or 3 contingency plan (response)…
- These scales of responses would have different costs but at least are thought out and discussed.

AM costs

- What do we spend on monitoring and what are we monitoring and why?
- Say bird monitoring…annual or seasonal..so line item out X biologists for X days to collect X data and report it.
- This may be pretty stable as long as the scope of the effort doesn’t change annually. Usually you deploy these folks each year in a specific timeframe.
- Data can support (or not) projects impeltmtned to support bird habitat features.
- If you build it and they don’t come then what?

AM costs

- Silvery minnow monitoring…how much do “we spend”?
- Field work, lab work (genetics), fish hatchery costs, etc.
- Field work is team of X “biologists” for X days in the field for X weeks…could need to be an “emergency response” if triggered by flows etc…
- O&M costs for hatchery “program efforts”….How much are “we” spending…
- genetics lab work…how much $, how frequent, how are results used?

AM Costs

- River flow and temperature data
- Central gage…
- Other gages and features (diversions etc)
- Water rights issues…
- Remote operations, data collection and reporting?
- X gages over X years…ongoing costs but may be critical!

AM Costs-contractors

- Use of contractors can save a lot of time and money
- Ongoing data collection and storage
- “emergency” quick deployment
- Public and stakeholder outreach (newsletters, meeting etc)
- Allows govt employees to focus on the technical work
- Allows for more flexibility to scale up and down relative to funding changes.
- May already be using effectively?

Monitoring and AM “Base costs”

- Cost Engineers!
- What is non negotiable (as a group)
- “we” need this as a minimum or don’t give us anything
- Then have incrementally larger plans to use more funding in strategic manner.
- Drop data collection which doesn’t yield info tied to the overall goals and objectives of management and recovery.
- Add data which might or does
- I’d suggest a “technical” plan as well as a “digestable” plan for different communities
- Bilingual?

Step 3 – Planning for Implementation of Adaptive Management

Craig Fischenich &
AM Technical Guide

Office of Research and Technology Transfer
Adaptive Management Workshop
Albuquerque, NM
25 – 28 July, 2017

Engineer Research and Development Center

- Procedures for Implementation
  - Implementation requires the formulation of standard procedures that document how the adaptive management plan will operate.
  - The documented procedures for carrying out the adaptive management plan should include, but should not be limited to:
    - Specifying the mechanism for responsible personnel to execute the adaptive management plan and process. This mechanism might reasonably include meetings, teleconferences, web meetings, and electronic or written correspondence.
    - Delineating the location and frequency of such interactions, as well as logistic responsibilities necessary for implementing the adaptive management plan.
    - Formulating rules or policies that stipulate how the members will interact to conduct business (e.g., evaluation of monitoring results in relation to decision criteria). These interactions might reasonably include provisions for the participation of technical support personnel or stakeholders.
    - Communicating the deliberations of the adaptive management team to decision makers.
    - Making or participating in adaptive management decisions.

PLANNING AM IMPLEMENTATION

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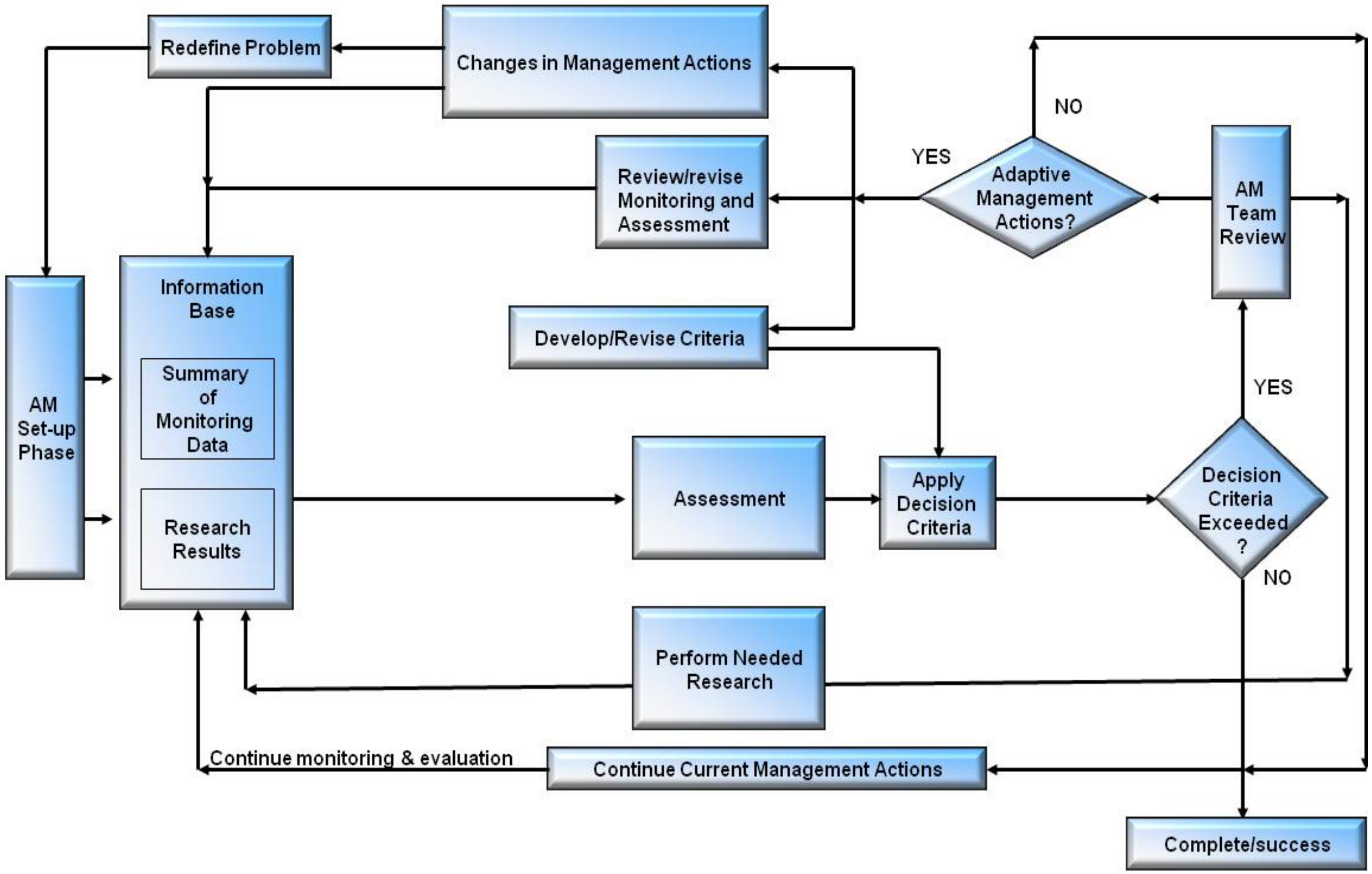
Implementation describes how the adaptive management plan developed for a specific application will be put into action.



Information Base

- Data management system to support the adaptive management process
  - Existing data and information that were used in the development of the set-up phase
  - accumulated results of monitoring
  - scientific and technical support that accumulate during the course of the adaptive management process
- Decision making during the adaptive management process can be documented and preserved as part of the information base

Assessment

ERDC
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- The assessment process compares the results of the monitoring efforts to the decision criteria defined as the desired values of project performance measures and/or acceptable risk endpoints

PLANNING FOR ASSESSMENTS IN ADAPTIVE MANAGEMENT

- Identify persons responsible for performing assessments
- Identify methods for comparing monitoring results with decision criteria
- Define frequency of assessments
- Develop documentation for results of assessments
- Communicate assessment results to managers and decision-makers

Frequency of Assessment

ERDC
Engineer Research and Development Center

- The implementation plan should specify the frequency and scheduling of assessments. This specification should address:
  - Relevant temporal scales of the performance measures and risk endpoints,
  - The time required to obtain sufficient monitoring results and analysis for meaningful comparisons with the decision criteria,
  - The consequences (ecological, socioeconomic, political, stakeholder) of variances with decision criteria,
  - The logistical requirements to perform the assessment,
  - The availability of the adaptive management personnel, and
  - Funding.

Assessment Documentation

ERDC
Engineer Research and Development Center

- Procedures for documenting the assessments:
  - Summaries of meetings in which assessments were performed
  - Results of monitoring and their comparisons with decision criteria
    - Tables
    - Figures
    - Text
  - Variances determined for any of the performance measures
  - Risk endpoints along with suggested actions to address variances (i.e., to adaptively manage or continue the status quo).

Decision-Making Process

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- The process whereby the results from monitoring and assessment will be used to make decisions concerning project management
  - An initial list of adaptive management decisions should be defined.
    - simply continuing the project as originally planned,
    - altering the implementation or operation of the project,
    - embarking on some other project alternative aimed at the same goals and objectives, or
    - terminating the management or restoration project
- The decision-making process should be developed and documented as part of the overall adaptive management plan
  - identifying who is responsible for making the decisions,
  - how the decision-making group operates, and
  - how they report their decisions.

Decision Making

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- ***Decision Makers:*** individuals and organizations entrusted with making decisions regarding adaptive management for a specific USACE application

- The decision-making step importantly lists the kinds of decisions that might reasonably be made by the decision makers during adaptive management.

- The complexity of the decision-making process can be influenced by the number of performance measures and risk endpoints included in the assessment

- Methods for decision making:
  - Structured decision making with MCDA
  - Meta-analysis
  - Other multivariate techniques

Decision Making

- The decision-making process should specifically address relationships between monitoring results and decision criteria that would trigger a decision, relationships between decision criteria and decision making and decision alternatives

- Can be based on consensus, majority voting, or other means
- Should include methods for resolving conflicts that might arise during implementation
- It is important that the process be defined before conflicts arise to ensure the efficient and continued operation of the adaptive management process.

Documenting Adaptive Management

- Implementing adaptive management emphasizes an open and transparent management practice
  - Monitoring
  - Assessment
  - Decision making
- specify the provisions for regularly documenting adaptive management
- data management system should play an instrumental role in archiving the results of monitoring and assessment
- described and justified in corresponding documentation.

Implementing Adaptive Management

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- “Simply” putting the plan into action.
- Fundamental tenet of adaptive management is that the entire process is adaptable
- Can be revised and the process of implementation continued

EXAMPLE
ADAPTIVE MANAGEMENT TABLE OF CONTENTS

1.0 Introduction
- 1.1 Authorization for Adaptive Management
- 1.2 Procedure for Drafting Adaptive Management Plan
- 1.3 Communication Structure for Implementation of Adaptive Management

2.0 Project Adaptive Management Planning
- 2.1 Project Goals and Objectives
- 2.2 Conceptual Ecological Model for Monitoring and Adaptive Management
- 2.3 Sources of Uncertainty

3.0 Rationale for Adaptive Management
- 3.1 Adaptive Management Program for Project

4.0 Monitoring
- 4.1 Rationale for Monitoring
- 4.2 Project Monitoring Plan
- 4.3 Analysis and Use of Monitoring Results

5.0 Database Management
- 5.1 Description and Location
- 5.2 Data Storage and Retrieval
- 5.3 Analysis, Summarization, and Reporting

6.0 Assessment
- 6.1 Assessment Process
- 6.2 Frequency of Assessments
- 6.3 Variances and Success
- 6.4 Documentation and Reporting

7.0 Decision-Making
- 7.1 Decision Process
- 7.2 Decision Criteria
- 7.3 Potential Adaptive Management Decisions
- 7.4 Project Close Out

8.0 Costs for Adaptive Management
- 8.1 Adaptive Management Planning Costs
- 8.2 Monitoring Costs
- 8.3 Adaptive Management Implementation Costs

9.0 Literature Cited

Supporting Appendices

Adaptive Management in Civil Works

July 25-28 2017, Albuquerque, NM

Jeff Trulick
HQ Planning Office of Water project Review

Purpose of this module

- Brief overview of history of AM
- How monitoring and AM has evolved in Civil Works
- Common problems, challenges, misconceptions
- Current policy from WRDA 07 2036 and 2039
- Short discussion of how we can develop these examples

History of Adaptive Management

- Robust decision making in the face of uncertainty
- Models/data only get you so far
- AM has been around a very long time (Yap, Micronesia)
- Frederick Taylor in early 1900s
- Dr. Holling (1973 paper), Walters (1986) and Lee
- Term first used in Hollings’ 1978 book on resilience
- Three main modes (active, passive and reactive)

Monitoring and AM in Civil Works

- In CW, monitoring and informal AM has been done forever.
- Gates, etc on inland locks and dams
- Water management decisions at our lakes and flood projects
- When to dredge and how much on our deep draft NAV projects
- WRDA ’86 gave us official AER mission
- To ensure benefits we need information, data…so monitoring
- To ensure success or changes needed and how, we need AM
- Allows changes over time (could be small or large)

Monitoring and AM in Civil Works

- Originally very limited.
- Perception by OMB that we wanted R&D funds
- Monitoring limited to 1% of project cost
- AM limited to not more than 3 percent of project cost
- Monitoring limited to up to five years
- THIS IS STILL IN THE CURRENT PGN! (don't use it)
- WRDA '07 2036 & 2039 did away with percentages
- Now need an actual plan and budget
- Allows up to 10 years of cost shared monitoring

Common problems, challenges, etc

- Still perceived as making up for something we didn't study
- Still seen as R&D to an extent
- Some program have very large $$
- Some projects need it and don't include
- About ½ projects don't follow the old or new guidance on AM
- Getting better!
- People in the Hill are watching….always watching…
- Need a handbook (others have)

Current AER Mon and AM policy

- WRDA 2007, Section 2039
  - Google the WRDA IG
  - https://planning.erdc.dren.mil/toolbox/index.cfm
  - Requires a monitoring plan
  - Requires an Am or "contingency plan or actions"
  - Requires a cost estimate
  - Can be UP TO 10 years cost shares with NF sponsors
  - Some O&M plans may include same actions (but are NF funded 100%)

Current habitat mitigation policy

- WRDA 2007, Section 2036 (several parts)
- Requirements are comparable and similar
- Monitoring can be longer (to ensure mitigation)
- Shouldn’t be any longer then needed
- Needs a plan and a budget
- Very similar technical work to AER mon and AM plans.

Case studies this week

- Many examples out there
- Ask ECO-PCX
- Ask subCoP mail lists
- Wheel is mostly round
- Many standing programs have their own larger examples
- CERP, Missouri River, Poplar Island, LACPR, etc

Monitoring in Adaptive Management for USACE Ecosystem Restoration & Natural Resource Management

Sarah J. Miller
Environmental Laboratory, ERDC

Office of Research and Technology Transfer
Adaptive Management Workshop
Albuquerque, NM
25-28 July 2017

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Ecosystem Restoration in the Corps

- Purpose: "…to restore significant structure, function and dynamic processes that have been degraded." (ER 1165-2-501)
- Intent: "…to partially or fully reestablish the attributes of a naturalistic, functioning, and self-regulating system." (EP 1165-2-502)
- Scope: "Nationally and regionally significant wetlands, riparian and other floodplain and aquatic systems" (ER 1105-2-100)

Implementation Guidance – §2039, WRDA 2007

ER Feasibility Studies:

- Monitoring Plan (determine success)
- Contingency Plans (~AM)

Appropriately scoped to project scale, addressing:

- **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
441 G STREET NW
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.

Common Elements of AM Plans

- 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

Monitoring – one Definition…

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Monitoring is the process of measuring attributes of the ecological, social or economic system. Monitoring has multiple purposes, including:

- to provide a better understanding of spatial and temporal variability,
- to confirm the status of a system component,
- to assess trends in a system component,
- to improve models,
- to confirm that an action was implemented as planned,
- to provide data used to test a hypothesis or evaluate effects of a management action, and
- to provide an understanding of a system attribute which could potentially confound the evaluation of action effectiveness.

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Optimal Monitoring Plan

- **Clear monitoring program goals and objectives – tied directly to project objectives**
- Appropriate scaling (temporal and spatial) and resource allocation for data collection, management, interpretations, and analyses
- Standardized QA/QC procedures
- Programmatic and procedural flexibility
- Reasonable costs
- High implementation efficiency
- Reportability to diverse audiences

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MRGESCP Adaptive Management Framework PWS 2015

- Background: “AM is intended to maximize learning about critical uncertainties (what we ‘need’ to know) that affect decisions while simultaneously striving to meet multiple management objectives.
- “It involves synthesizing existing knowledge, identifying critical uncertainties, developing scientific hypotheses related to those critical uncertainties, and exploring alternative management actions to test those hypotheses.”
- “These management actions will include explicit predictions of their outcomes including the level of risk involved with implementation.”
- “Finally, science-based monitoring and research would be conducted to see if actual outcomes match those predicted, and then these results will be used to learn and adjust future management and policy.”

MRGESCP Adaptive Management Framework PWS 2015

- AM definition: "…synthesizing existing knowledge and identifying critical uncertainties, developing scientific hypotheses related to those critical uncertainties and exploring alternative management actions to test those hypotheses."

- USACE role as member agency: "...assistance is for projects designed to alleviate jeopardy for specific federally-listed endangered species and track recovery of those listed species in a manner consistent with existing and future water uses and in accordance with Federal and State laws."

- Task 3: "The Contractor shall prepare, as the deliverable for Task 3, a Draft and Final *Report of Prioritized Critical Uncertainties, Testable Hypotheses, and Specific Management Actions…"*

MRGESCP Tracking Tool and Effectiveness Monitoring Plan (Optional Task 5)

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- Scope: "…develop a plan for implementing, monitoring and evaluating those AM actions."
- "Develop an AM Tracking Tool that documents evaluation criteria in order to document success and develop management decisions."
- "The objective of Optional Task 5 is to develop, in coordination with the Adaptive Management Team, a plan for monitoring and evaluation of the agency actions undergoing immediate implementation."
- "The purpose of Optional Task 5 is to guide the Team toward the development of an Effectiveness Monitoring Plan (Monitoring Plan) for habitat restoration measures and other agency actions to benefit the minnow and the flycatcher. "

MRGESCP Tracking Tool and Effectiveness Monitoring Plan (Optional Task 5)

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- “Monitoring will focus on documentation and detection of changes resulting from management actions…”
- “Develop an AM Tracking Tool that documents evaluation criteria in order to document success and develop management decisions.”
- “The objective of Optional Task 5 is to develop, in coordination with the Adaptive Management Team, a plan for monitoring and evaluation of the agency actions undergoing immediate implementation.”
- “The purpose of Optional Task 5 is to guide the Team toward the development of an Effectiveness Monitoring Plan (Monitoring Plan) for habitat restoration measures and other agency actions to benefit the minnow and the flycatcher. “

Use Your Conceptual Model…

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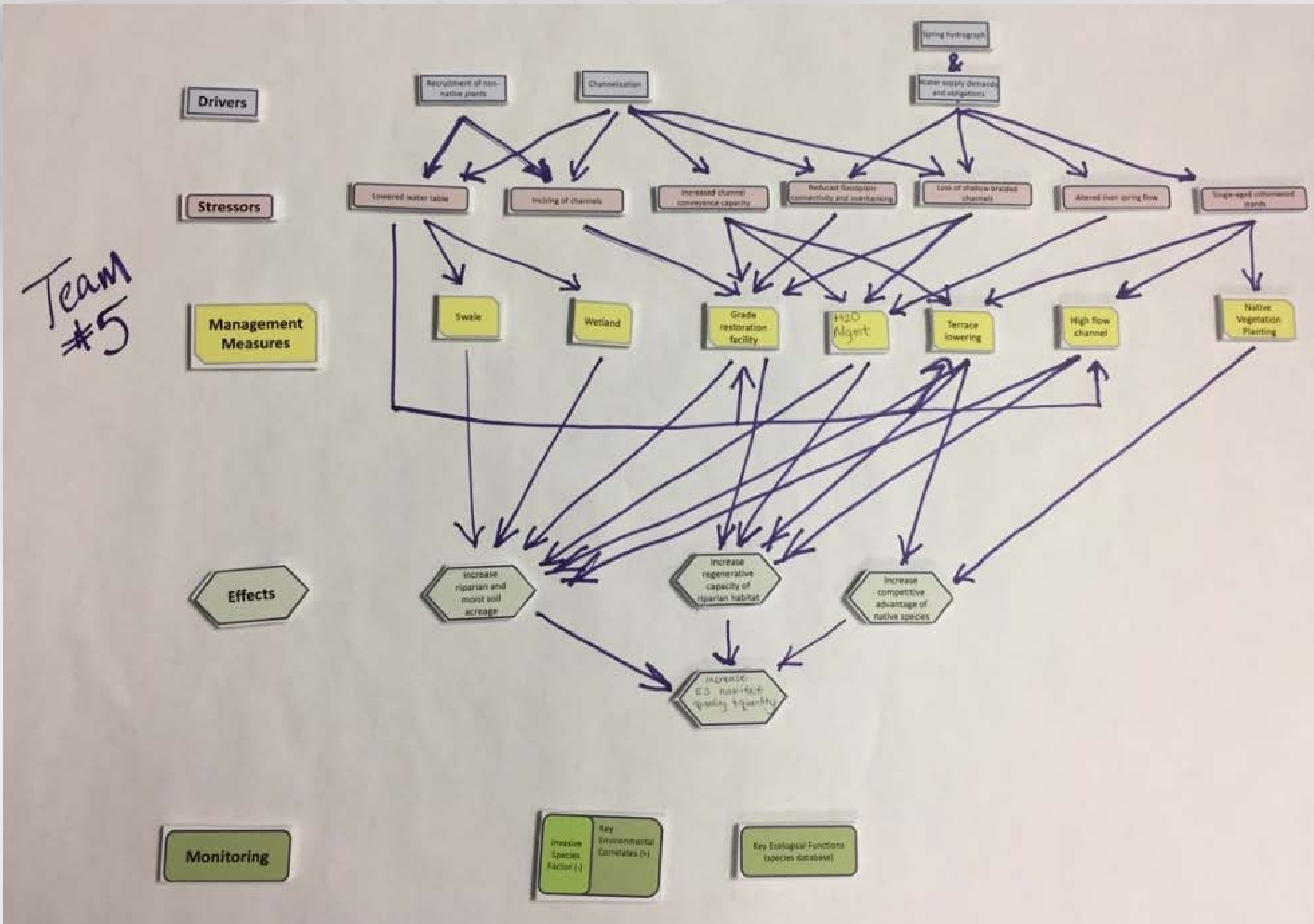
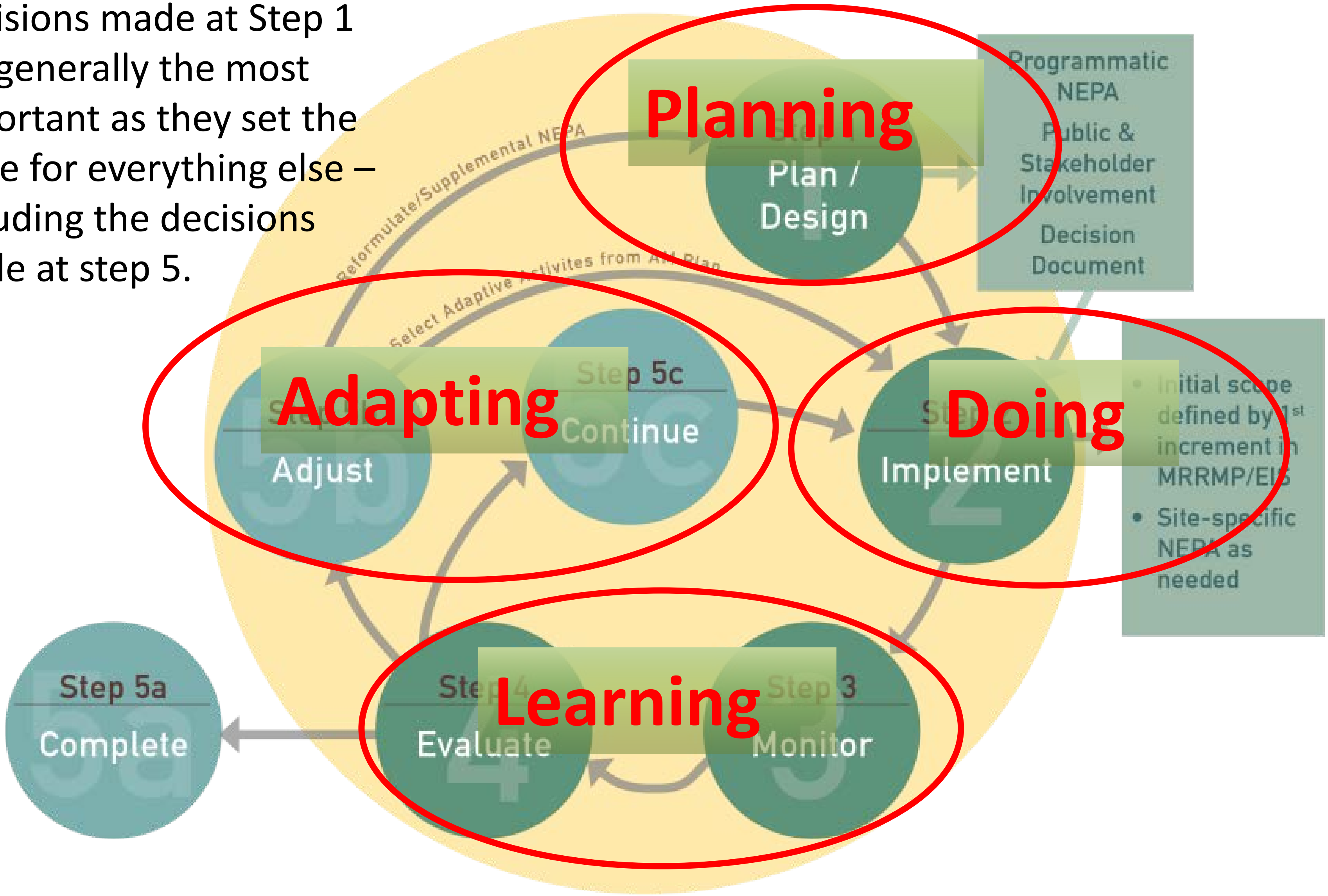


The Adaptive Management Process

Decisions made at Step 1 are generally the most important as they set the stage for everything else – including the decisions made at step 5.



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Key elements of the AM plan:

- Goals and objectives
- Uncertainties
- Hypotheses
- Management actions
- Model predictions
- Decision criteria
- *Monitoring program*
- *Analytical requirements*
- *Decision-making process and roles*
- *Contingency actions*
- *Reporting and communications*
- *Process and timeline for modification*

*NOTE: Italicized elements occur during implementation

Adaptive Management Steps Leading to Monitoring Plan Development

- Identify measureable objectives – what are you trying to achieve and how will you know when you get there?
- Identify metrics (measureable properties) or indicators of management treatment (restoration measures) responses – will you be able to detect changes?
- Predict responses and identify decision criteria
- Design monitoring program, sampling protocols, data analysis and assessment

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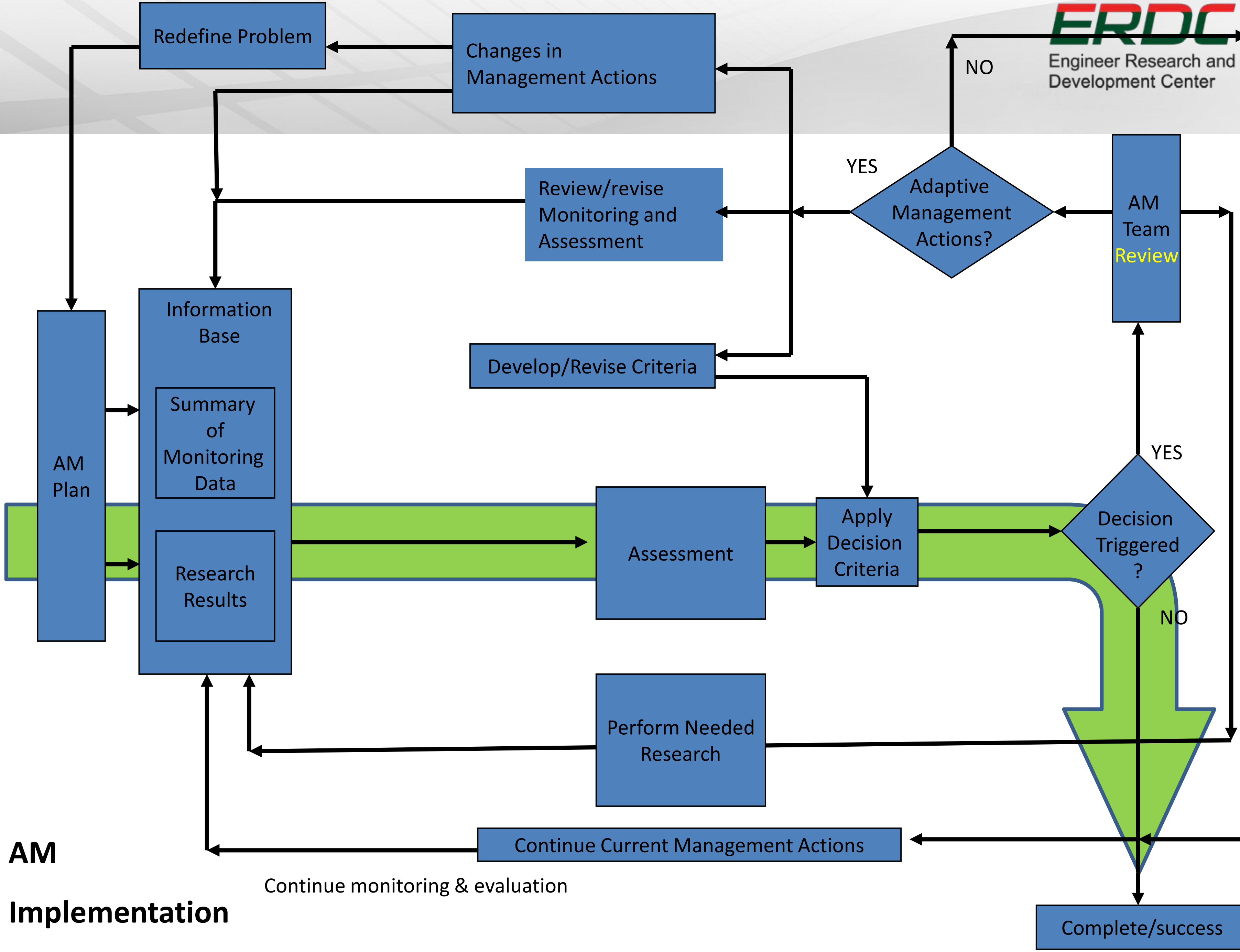
AM Implementation



Clear and Explicit Monitoring Data

- Foster trust in information as the foundation for decision-making
- Derive metrics from objective statements
- Relevant measures that relate to specific elements or processes
- Methods that capture variability and range as needed
- Specify sampling design and protocols – spatial limits, periodicity, frequency, duration, sample number
- Data custody, storage, entry, processing, QA/QC roles




Methodological Categories

- Direct field measurement – in person or by in-situ sensors or other instruments
- “Indirect” field measurement – accessing field databases maintained by others
- “Assumptive” measurement – surrogates, proxies, indexes, representative sampling and extrapolation; modeling of a huge range of complexity
- Remote sensing – also a huge range of complexity and source types

Direct Data Collection Considerations

- Plan Ahead – SOP, QAPP (Quality Assurance Project Plan) including your experimental/sampling design, documented protocols/procedures, complete equipment specifications, data documentation and custody, etc.
- Well-trained, consistent staff, with the right gear
- Plan B – you *will* end up with dead batteries for your GPS unit, laser level sensor or datalogger, no satellites due to bad scheduling, deep valley or heavy cloud cover, broken ______, or missing ______

Direct Data Considerations

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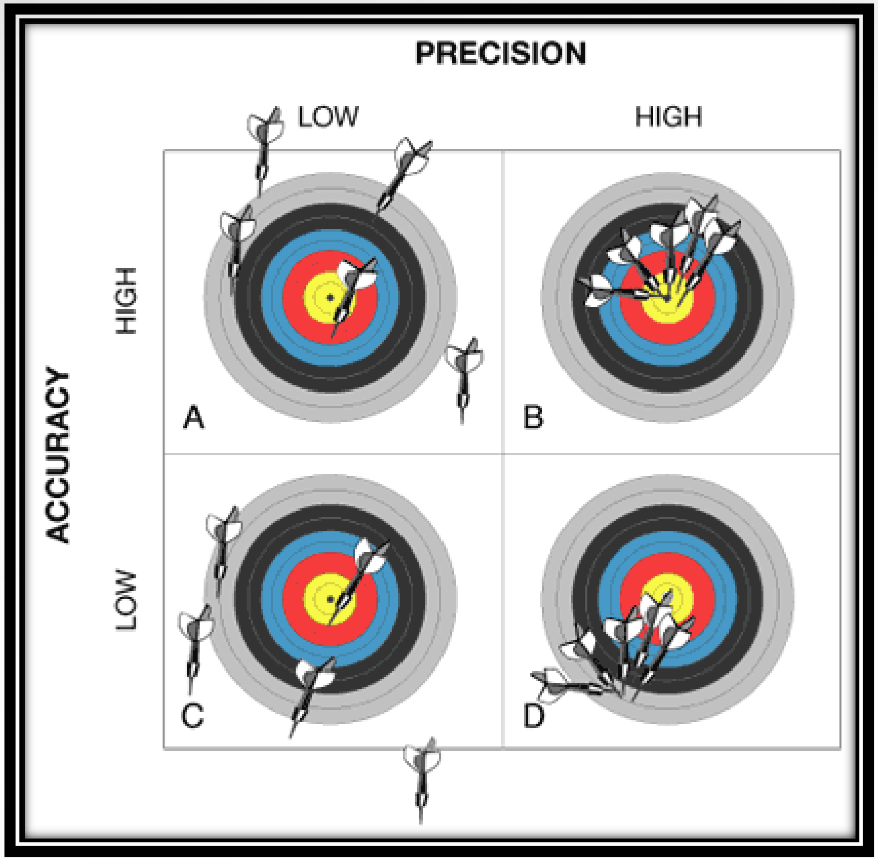
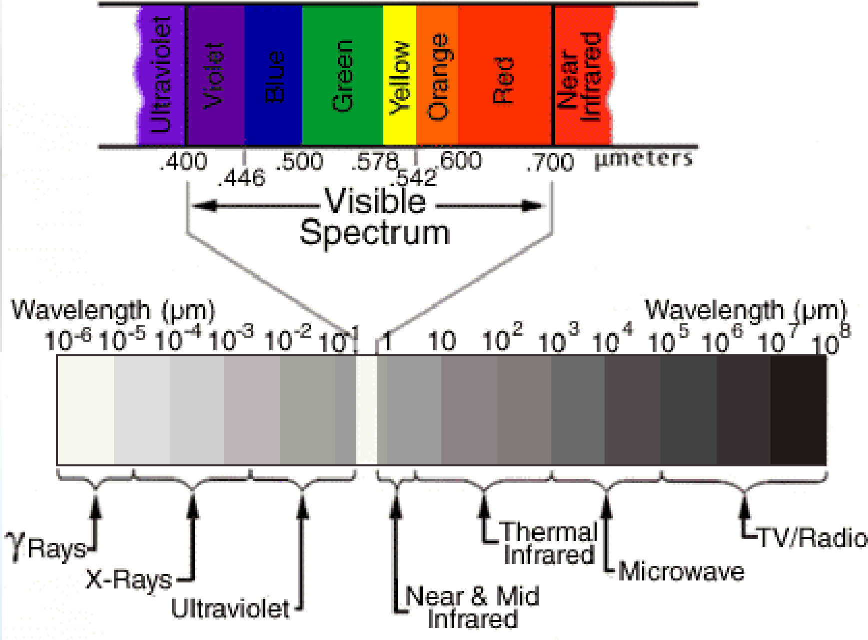
Know the difference between accuracy and precision, which one you really need to get the job done, which one is superfluous, and *when you need both*



Indirect and Representative Database Considerations

- All the things you plan for in your own field data collection should be readily determinable for others' data sources, models or indices
  - SOPs, QAPP, other QA/QC
  - Locations, conditions, other considerations for data – e.g., USGS Q wading measurements are not necessarily always taken at the same station depending on stage
  - Changes in methodology, precision, frequency
  - Hidden things – e.g., USGS stream gage stations that have recorded many rating curve shifts, know the % that triggers a rating shift

Remotely Sensed Data Considerations

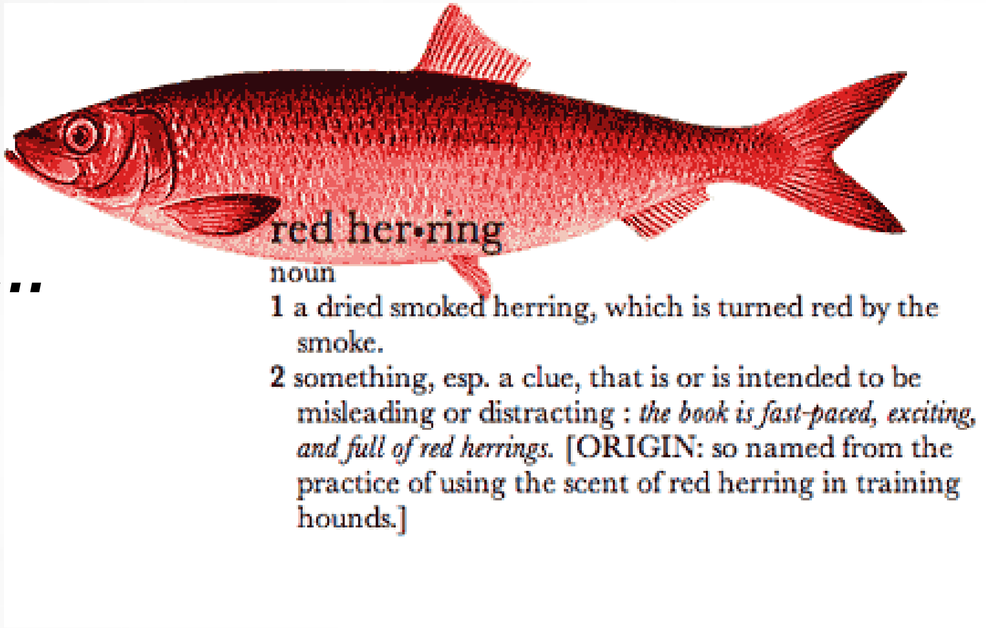


Similarly, various elements should be readily determinable for remotely sensed data

- Know your source and the type of imagery: Aerial Photography, Multispectral, Active and Passive Microwave and LiDAR
- Under what conditions were data acquired – time of day, season, atmospheric conditions
- Resolution – Spatial, Spectral, Temporal, Radiometric
- Just like other data – SOPs, QAPP, QA/QC, metadata
- Interpretation – shape, shadow, tone and color, texture, pattern, relative height and depth,

Data Compartmentilization

- For each data category that applies to our project, we need *only the type and amount of data required to make decisions or determinations*
- The point is not that we know all the terms, roles and formative processes of each feature in any landscape we manage, but that we understand *there are parameters we can monitor that directly pertain to our goals and objectives,* ***and others that may not…***



Change Over Time – DeBary Bayou, DeBary, FL Case Study

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DeBary Bayou 1940 to 2006

Change over time – georeferenced aerial photo series, satellite images

DeBary Bayou Timeline

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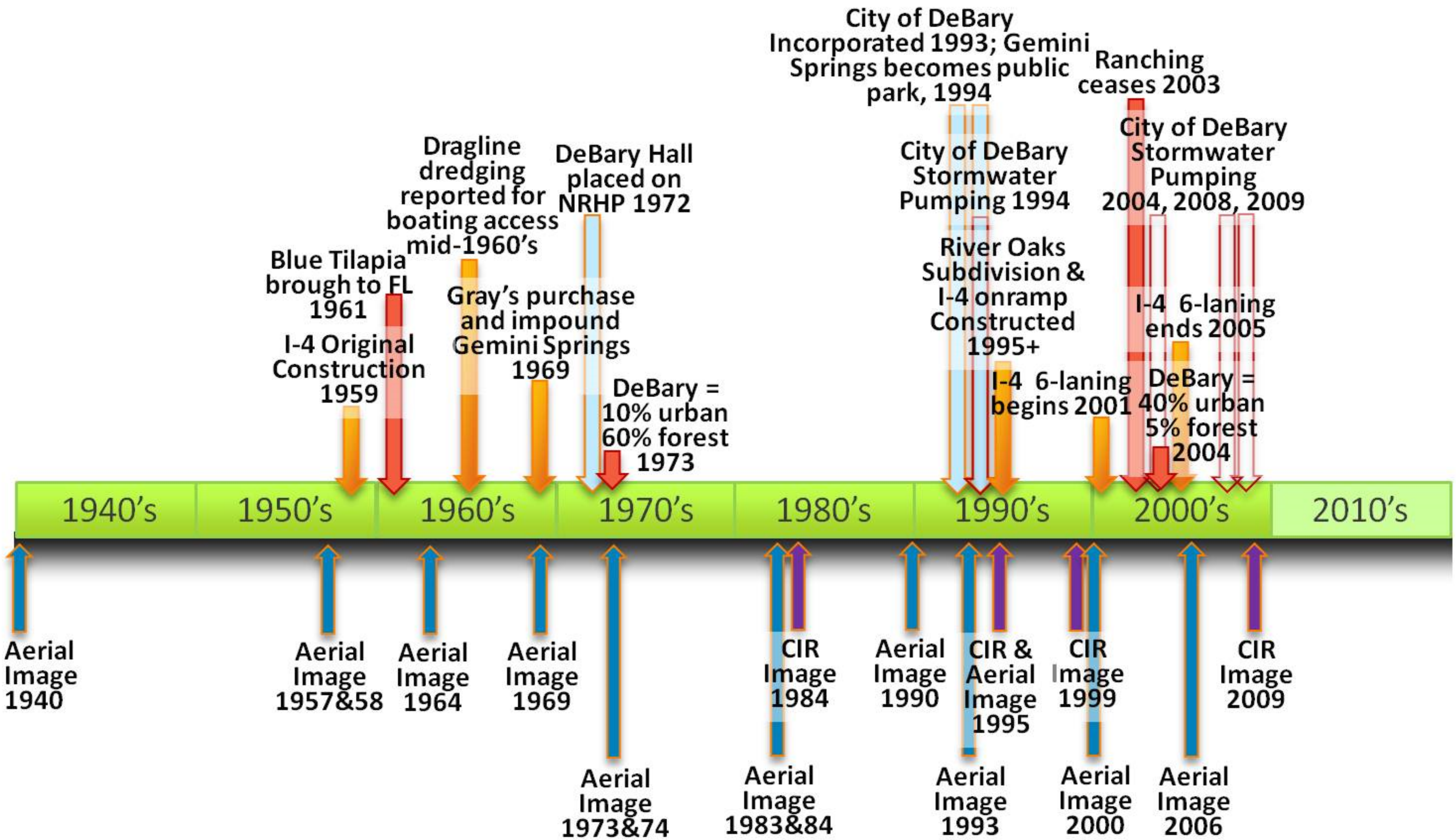
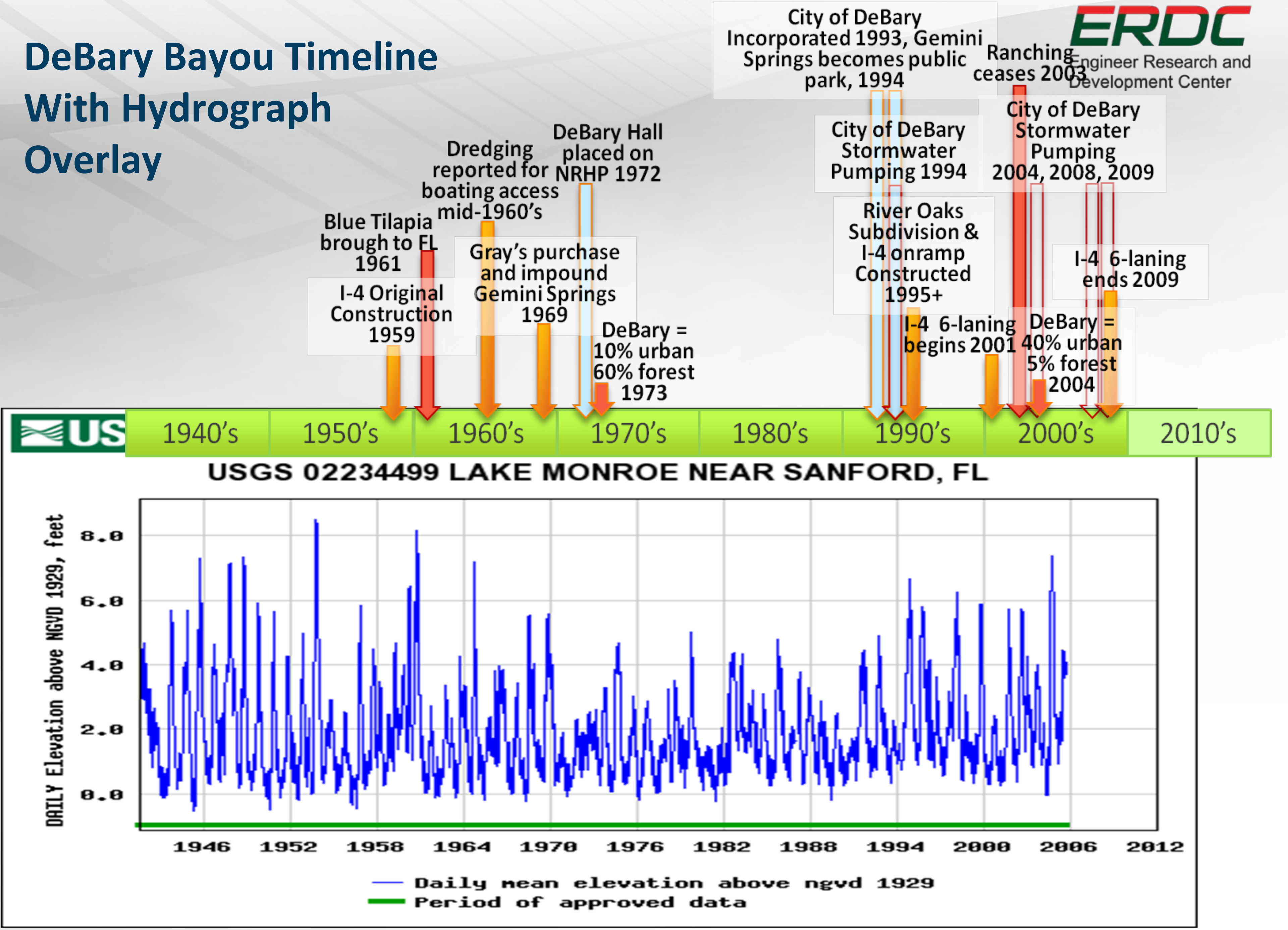


DeBary Bayou timeline of selected construction or development events in light orange, historic dates in light blue, landuse- or resource-related dates in dark orange, stormwater pumping dates outlined in red, and remotely sensed data available in dark blue and purple depending on type of imagery.

DeBary Bayou Timeline With Hydrograph Overlay



Fluvial Geomorphology

- Elevation, topography, bathymetry surveys can be done on foot or vehicle, by land or water, directly or indirectly
- Longitudinal profiles, cross sections, transects or Rangelines (BoR has been surveying these since the early 90's to help ID aggrading/degrading reaches to prioritize or adjust project implementation)
- Specific features thalweg, water surface (current, bankfull, flood) floodplain, bank, terrace, edge of water, dune crest, bar front – geomorphic features reflect a change in process (wetted areas, vegetation shifts, constituent materials shifts, etc.).
- Specific feature topo or site topo – design, layout, as-built, adjustment, other goal-specific monitoring
- hand level and cable, range-finder, survey level and tapes, transit, total station, handheld LiDAR, low-altitude LiDAR…

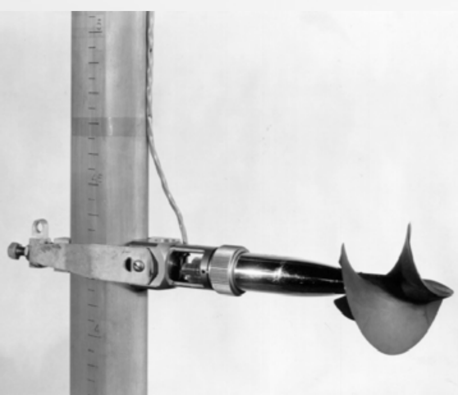
Surface Water

Water surface elevation/level, stage, slope (energy surface)

- Continuous stage recording gages (USGS other agencies, commissioned installation)
- crest or maximum stage recording gages (high tech, low tech)
- field survey at the time or by flood marks
- wetland: similar methods, though may require greater precision since slopes tend to be lower

Velocity – highly situation dependent – many methods from very low tech to high tech.

- Use existing databases or hydrodynamic models
- Make direct measurements (if wadable) – current meter (e.g., Price Pygmy up to 3 fps or AA up to 8 fps), Acoustic Doppler, electromagnetic, other…



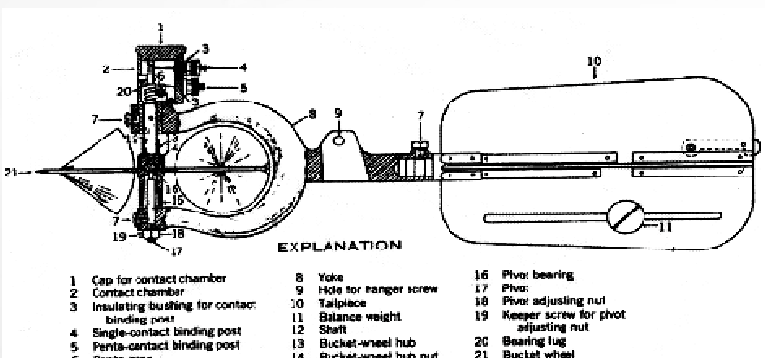


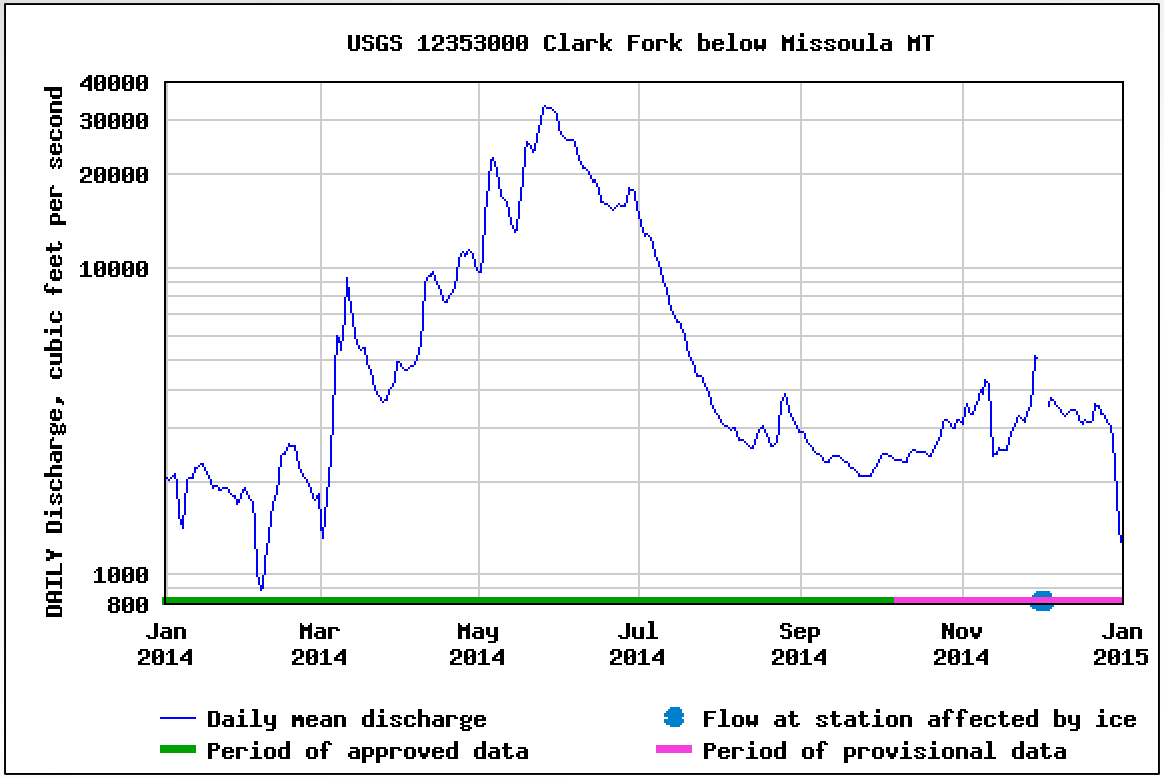
Figure 1.--Assembly drawing of Price type AA current meter.

Flow Magnitude, Duration, Frequency

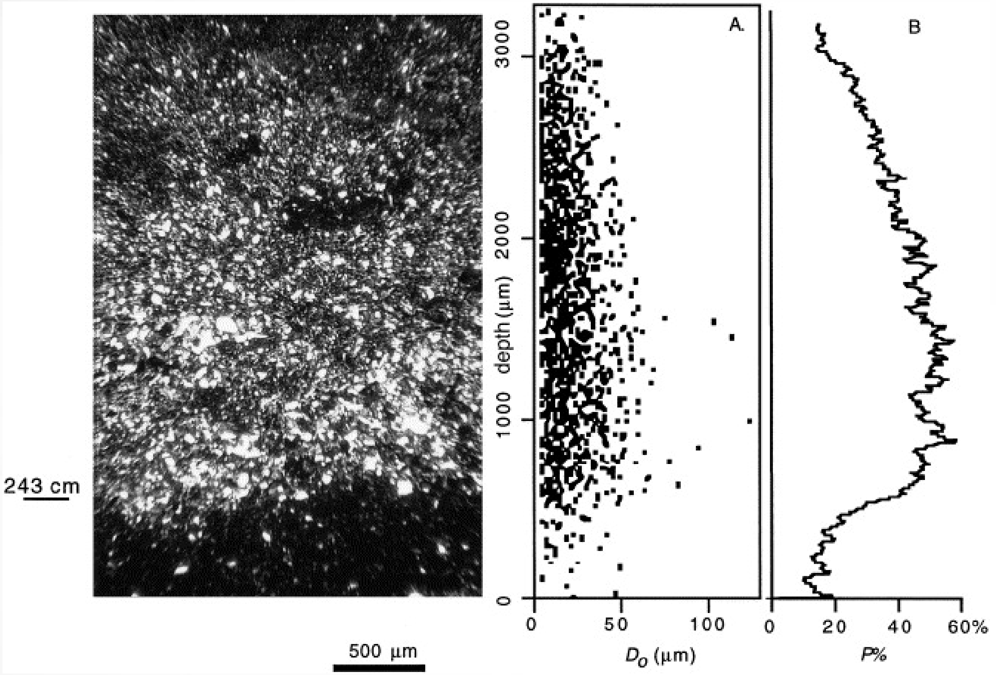
- Discharge magnitude – for MRG – USGS gages are probably the best!
  - for very small settings, construct a weir and create a stage/discharge rating curve
  - for larger settings, can also create a rating curve by measuring velocity, multiply by XS area (Q=AV) – USGS
  - Take advantage of culverts, bridge openings, etc.
- Duration – hydrograph plotting, sampling density to get enough but not too much info – 15 min, hourly, daily, monthly, annual… >> flow duration, inundation duration
- Frequency – influential occurrences such as floods, baseflow, some threshold of inundation or recession – this is primarily a sampling design and statistical or analytical exercise to manipulate field or other data you already have

Characterizing a Hydrologic Flow Regime

- **Magnitude**: How big (or small) is an event?
- **Frequency**: How often does an event occur?
- **Timing**: Does the time of the flow event matter?
- **Duration**: How long is the event?
- **Rate-of-change**: How quickly does the event change?



- Constituent materials characteristics and transport dynamics
- Soil properties and sampling
- geotechnical properties – levees, dams etc – seepage, piping, burrowing
- ground penetrating radar
- Surface or bulk substrate sampling, in-situ sampling methods – many of these… pebble counts, sieve analysis, image analysis, freeze cores
- scour chain analysis
- Cobble to boulder tracers, painted / drilled and bolted
- Sand and silt – dyed, surveyed, scour cores, layers analysis

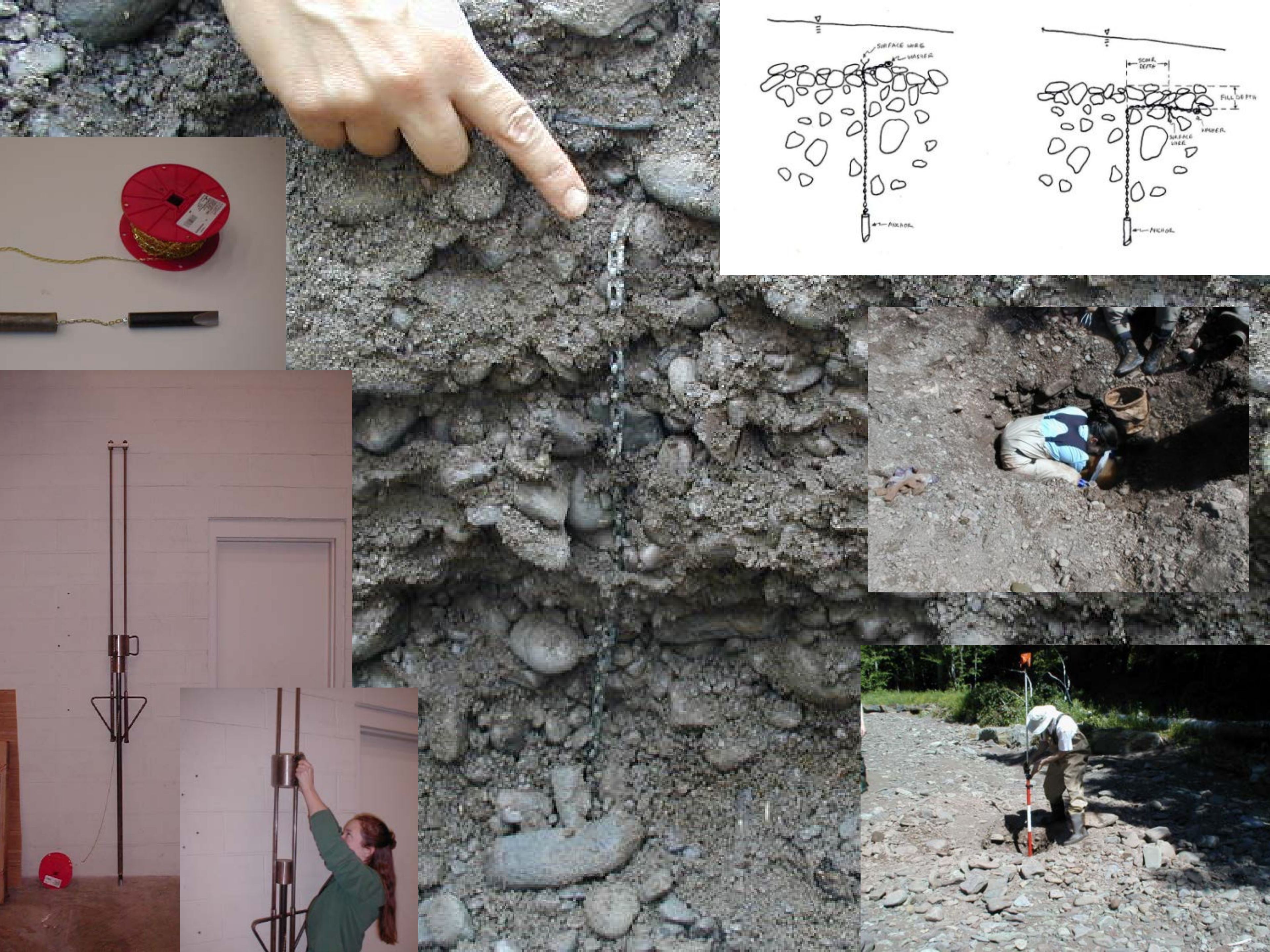


Sediment Monitoring

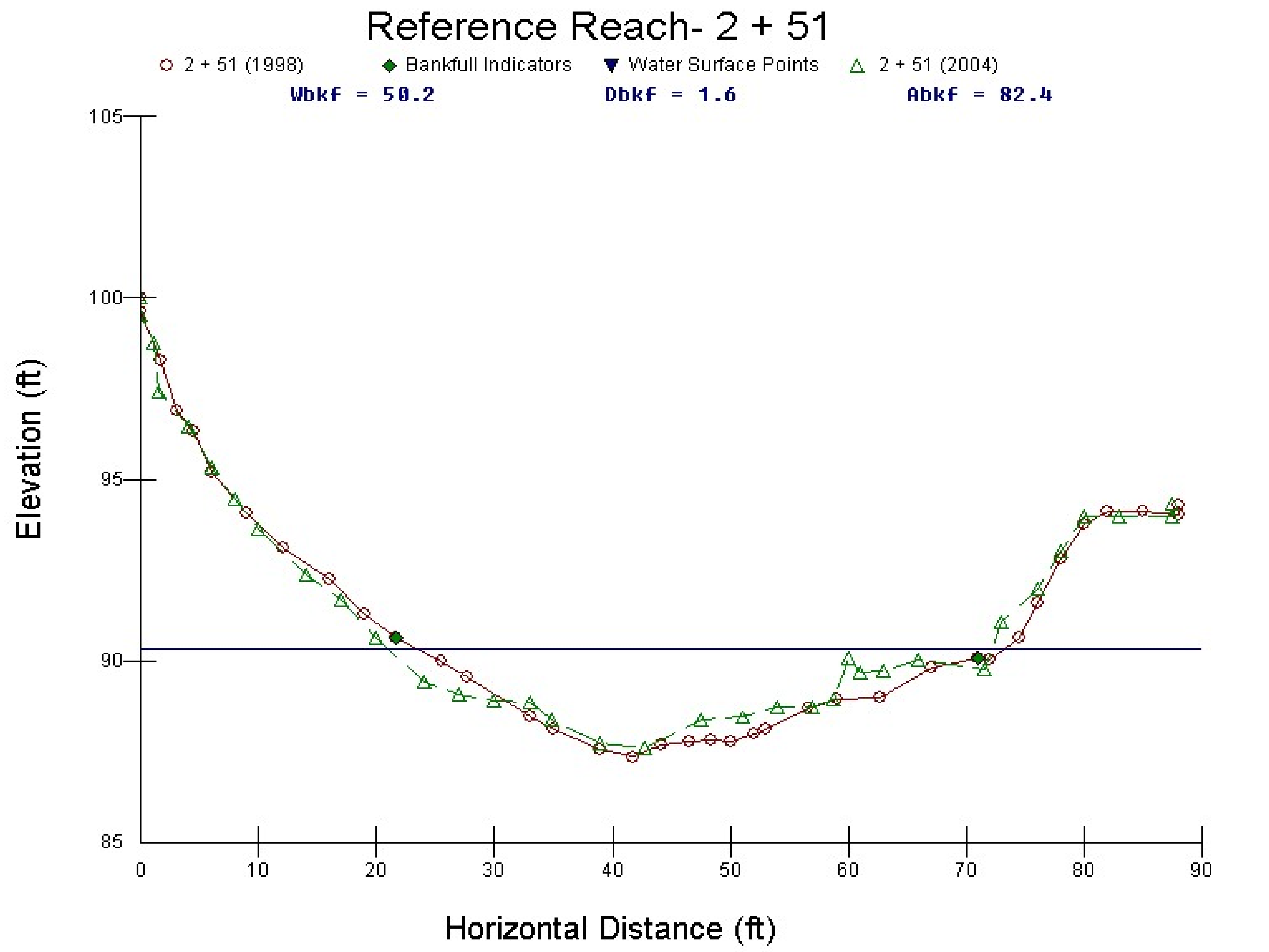
- Constituent materials can be their own tracers
- Aerial imagery – especially low altitude flyovers (drones!)

Sediment Monitoring

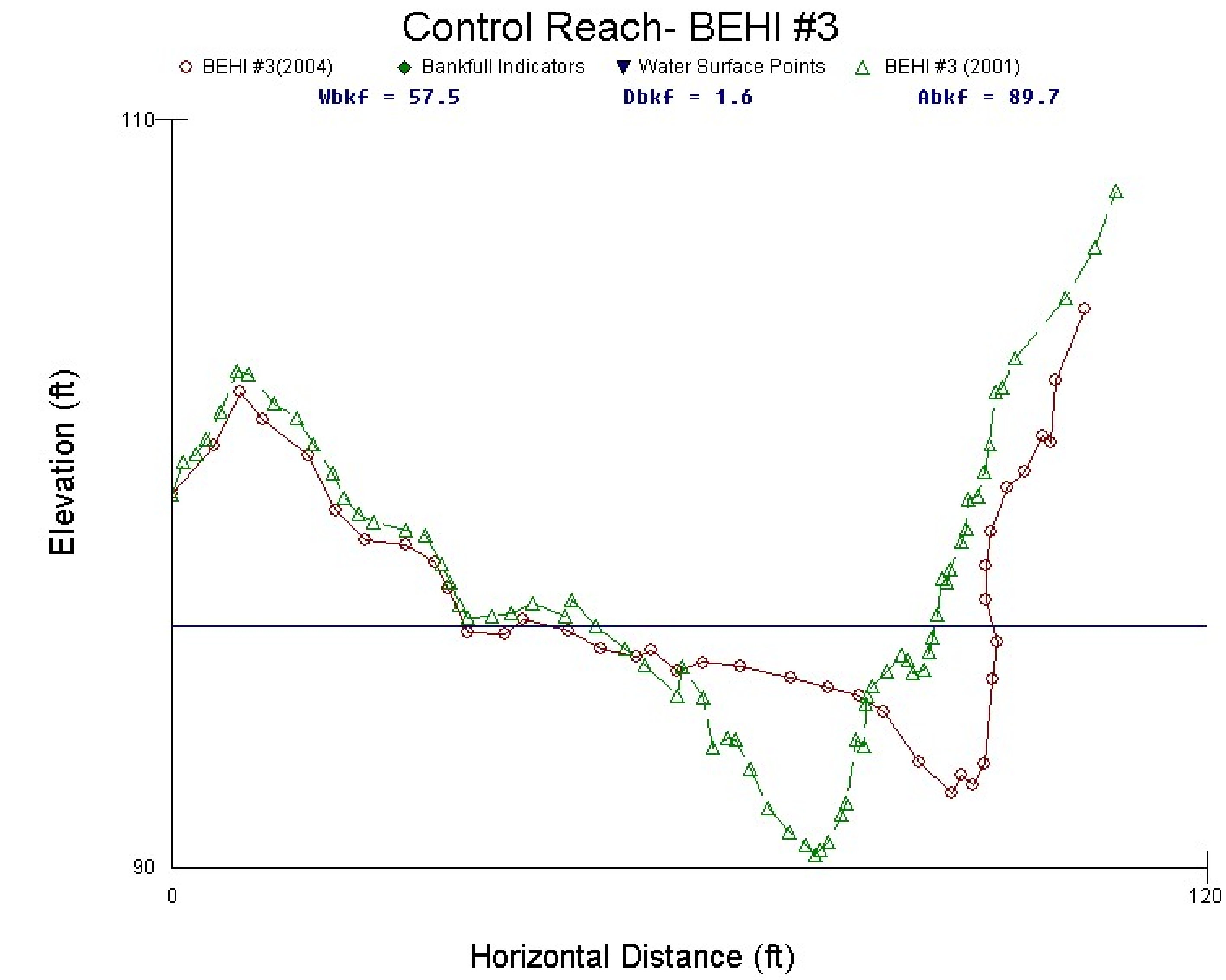
- Constituent materials can be their own tracers
- Specific events can leave layers or material types


SURFACE WIRE
WASHER
ANCHOR
SCOUR DEPTH
FILL DEPTH
WASHER
SURFACE WIRE
ANCHOR


Broadstreet Hollow Reference Reach, XS 2 + 51



Reference Reach- 2 + 51
2 + 51 (1998)
Bankfull Indicators
Water Surface Points
2 + 51 (2004)
Wbkf = 50.2
Dbkf = 1.6
Abkf = 82.4
105
100
95
90
85
0
10
20
30
40
50
60
70
80
90
Elevation (ft)
Horizontal Distance (ft)



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ent Center

Hydrologic Connectivity

"Hydrologic connectivity is used here in an ecological sense to refer to water-mediated transfer of matter, energy, and/or organisms within or between elements of the hydrologic cycle." Pringle (2001)

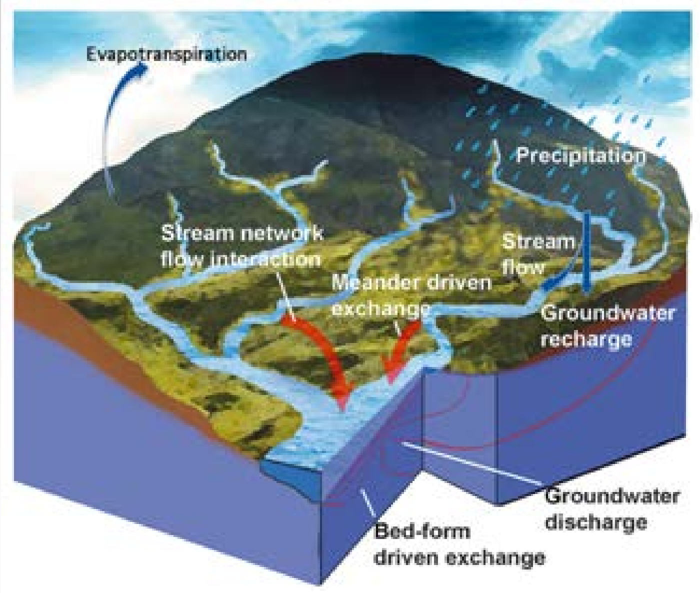


Figure right, Boano et al. (2014)

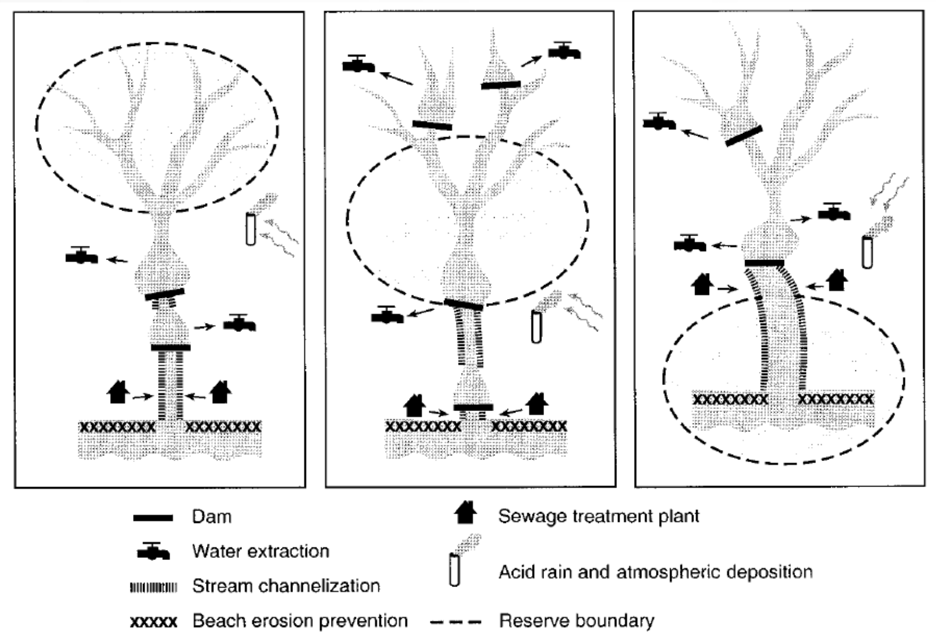
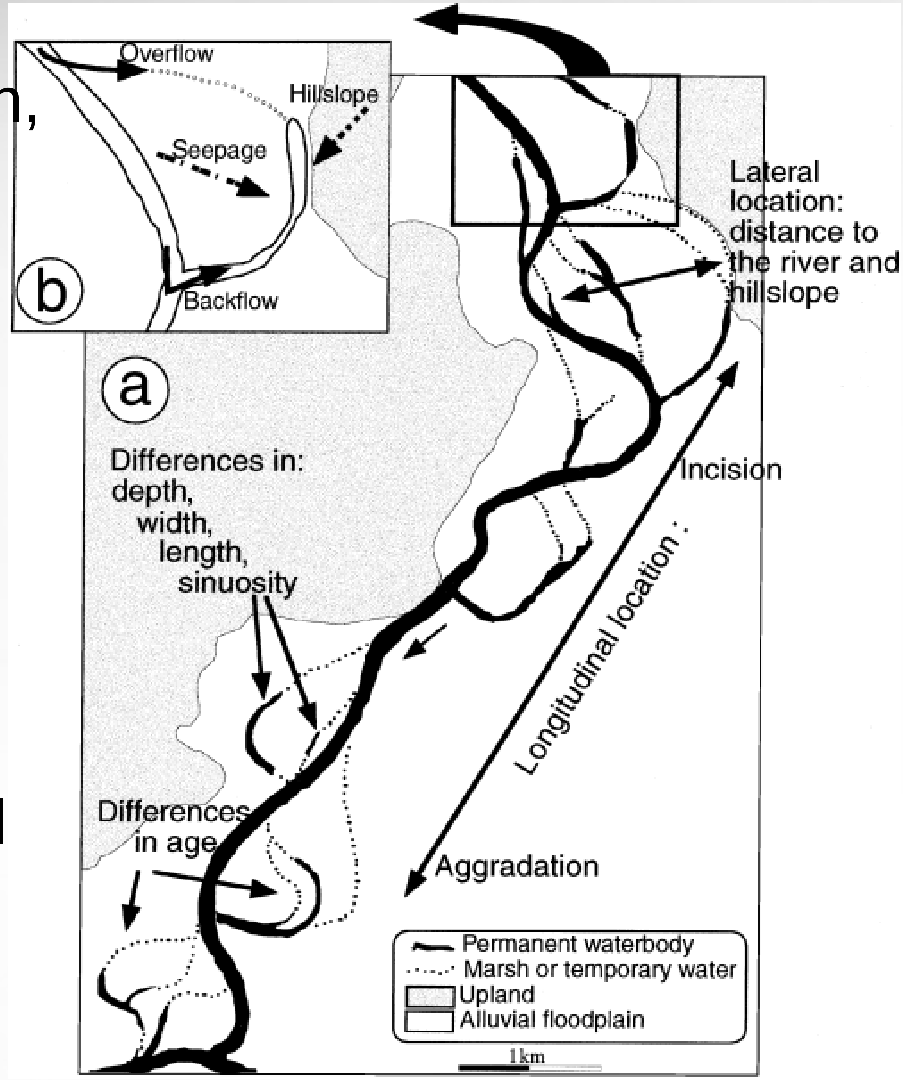


Figure right, Pringle (2001)

Broad conceptual definitions of connectivity in riverine ecosystems

Figure below, Amoros & Bornette (2002)

- surface water connectivity for riparian/terrestrial, water column, benthic aquatic species
- lateral (floodplain access), longitudinal (classic upstream/downstream river corridor migration), vertical (nutrients, oxygen, sediments, organisms or genetic material), temporal
- Site, reach, watershed, regional scales



Riverine Connectivity Examples

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- Connected physical ecosystem components within the river corridor are critical for primary productivity and biodiversity
- Partitioning/allocation of surface water impacts interconnected or proximal patch habitats for critical life stage development
- Networks of riparian corridors critical for migratory birds or other terrestrial species
- Dams, weirs or grade control structures fragment flow-based corridors for animals, nutrients, substrate, genetic materials
- Levees disconnect floodplains or fragment backwater or side channels affecting rearing, spawning or other habitat for aquatic or amphibious animals, or vegetation

Population Monitoring Considerations

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- Reproduction, Movement, Survival
- Species life cycle interactions
  - Presence/absence
  - Abundance
  - Mark-Recapture
- Do they answer Project questions (objectives, measures)?

Batavia Kill, Catskill Mountains, NY. Photo by Sarah J. Miller

Thank you!

Batavia Kill, Catskill Mountains, NY. Photo by Sarah J. Miller

AM Evaluation

Craig Fischenich
Chuck Theiling

Office of Research and Technology Transfer
Adaptive Management Workshop
Albuquerque, NM
25-28 July 2017

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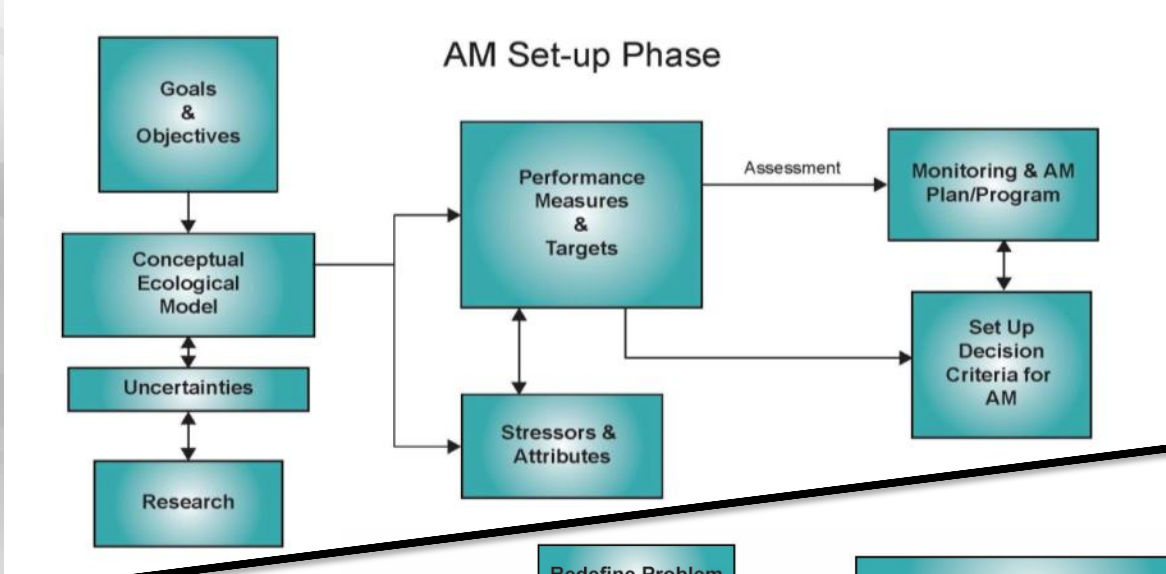
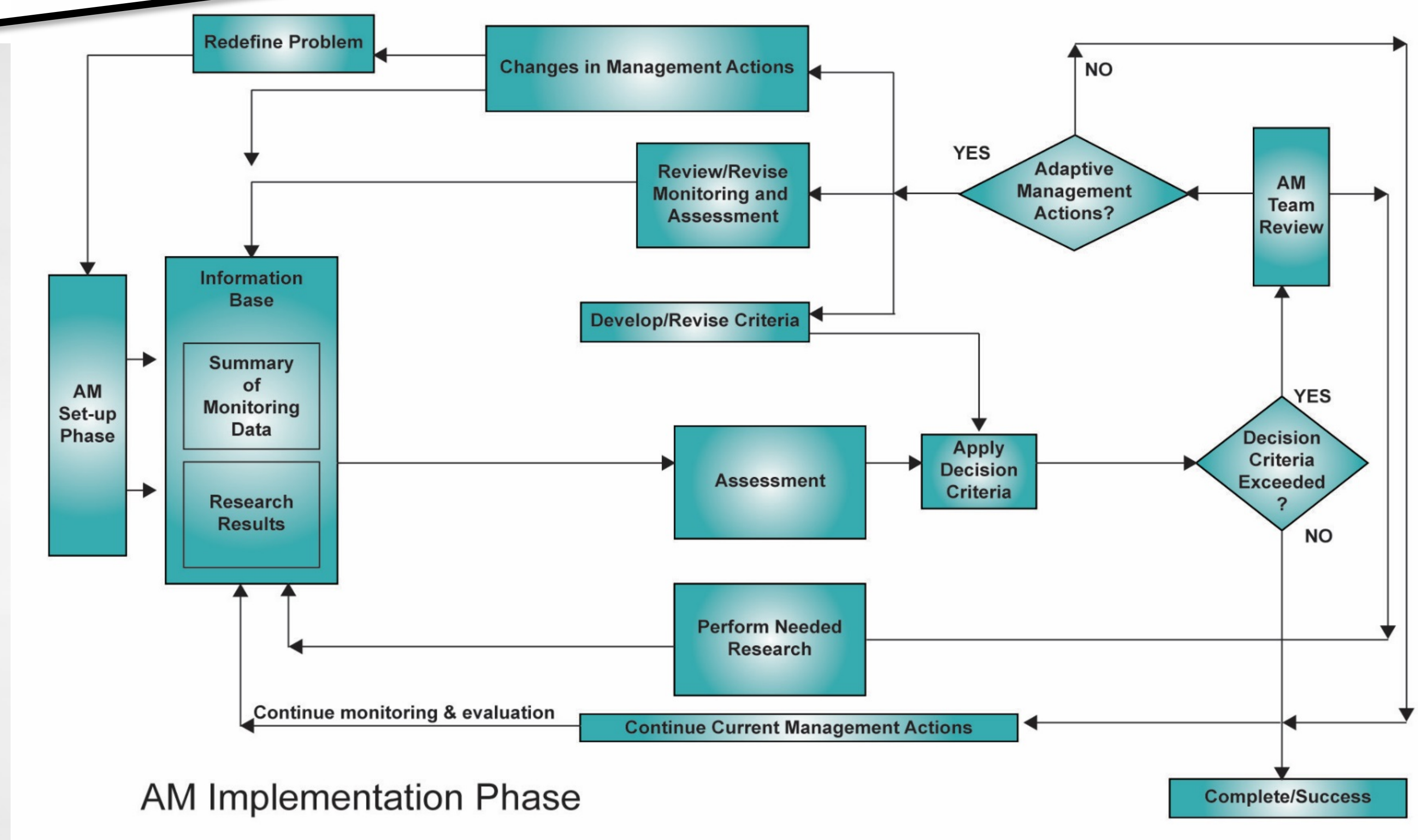
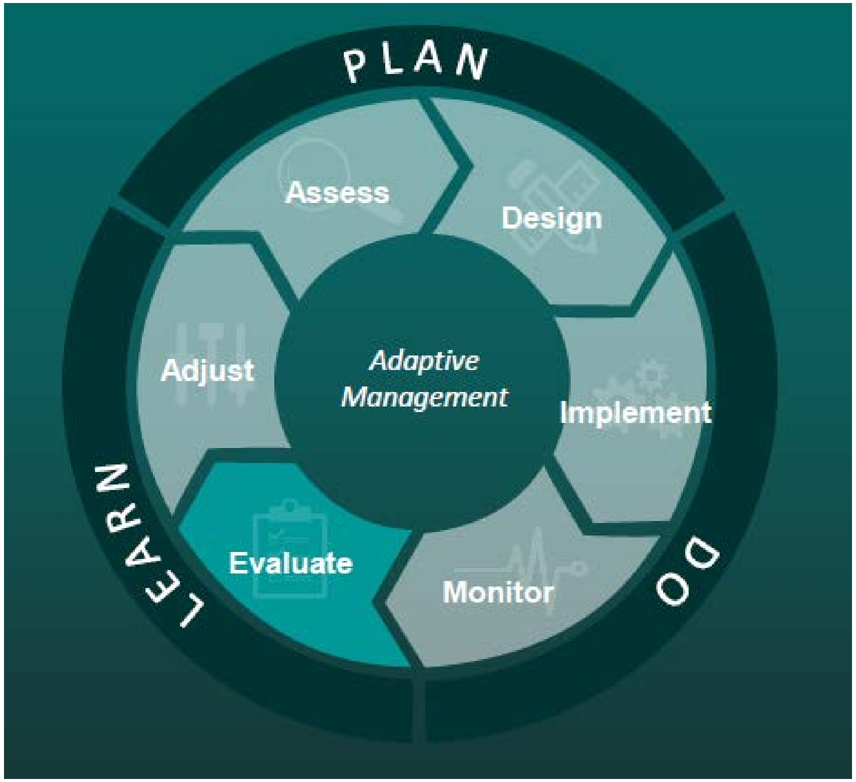
Adaptive Management: A Two Phased Approach





Evaluation Step

- **Analyze data as related to management uncertainties/questions/hypotheses**
- **Compare actual results with earlier predictions**
- **Consider best available science (whatever the source)**
- **Draw conclusions** (what was learned?)



A Few Considerations

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S2039 required evaluation for success (objectives) →	Success criteria, metrics, and benefits models apply
Evaluation needs will be project specific (uncertainties) →	There is no generic evaluation methodology
Evaluation results will often be equivocal →	Experimental design? Adequate time? Decision strategies based on lines of evidence?
Evaluation results may be misleading →	Be sure to consider variability and observation/evaluation frequency
Stakeholders may question reliability of evaluation →	Use objective methods, outside support and independent review
Be sure evaluations support decision needs →	Complicated technical factors require distillation for managers

Ecosystem Restoration Benefits

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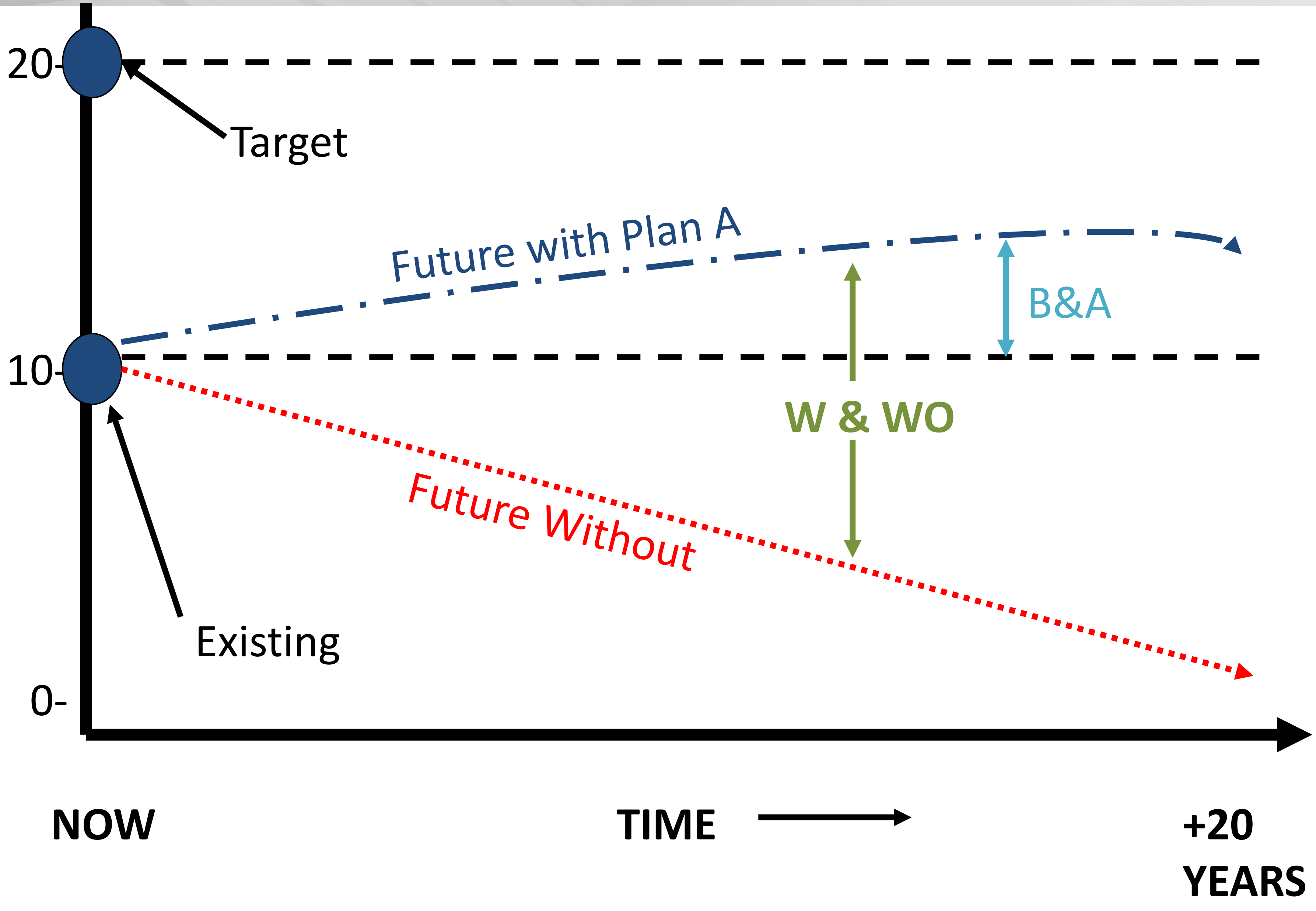
Four elements are required to effectively quantify aquatic ecosystem restoration benefits:

1. A baseline against which ecological changes can be compared (this includes ecological changes in the absence of any project and is the "future without-project" condition).
2. An understanding of ecological changes likely to result from the restoration action (e.g., the "future with" project condition).
3. A timeline (the period of analysis).
4. A mechanism for recognizing and attributing value to changes in ecological conditions (i.e. Is the condition improved or made worse? By how much?).

Basis for Comparison



Basis for Benefit Quantification

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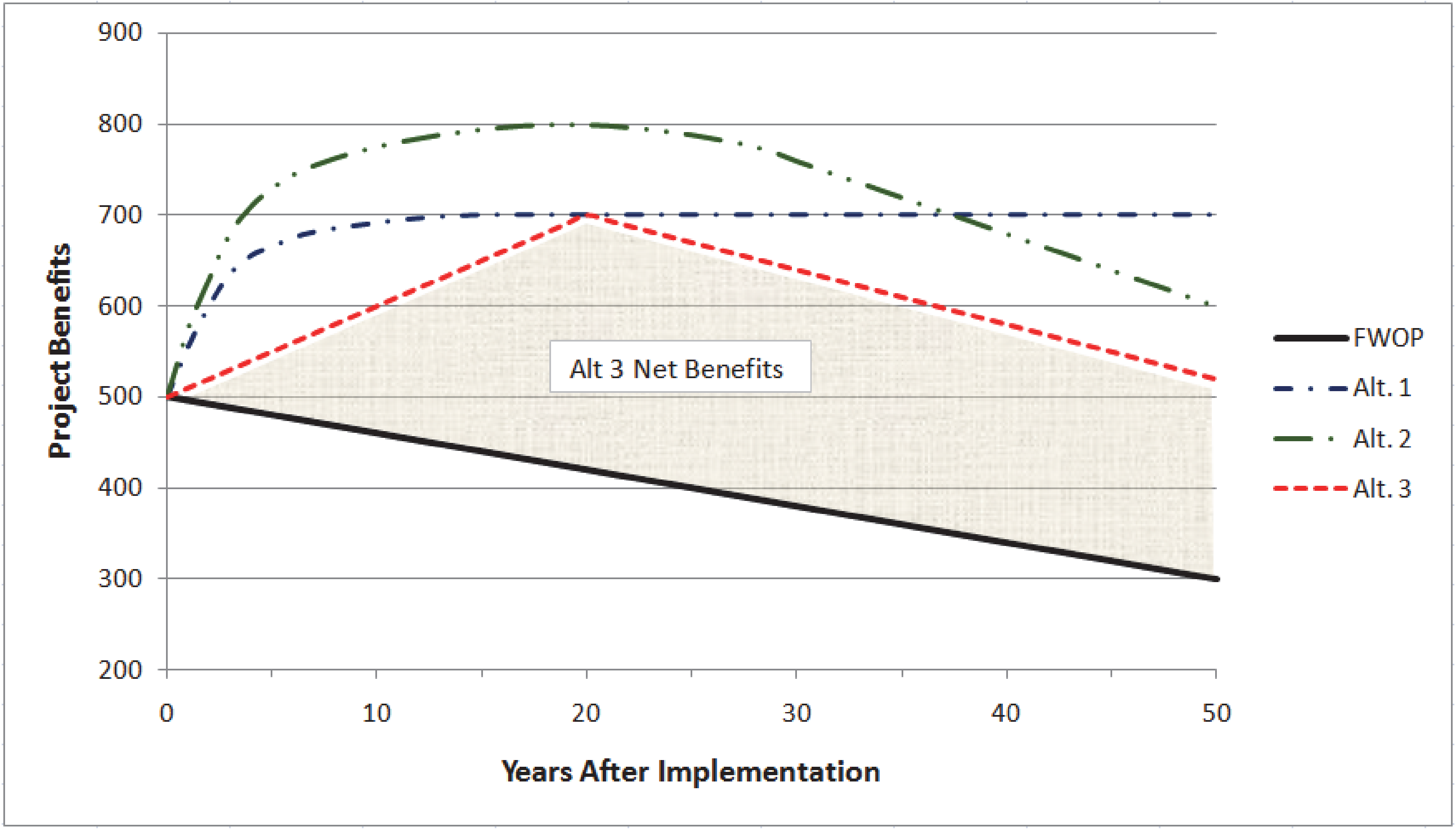

Basis for Comparison

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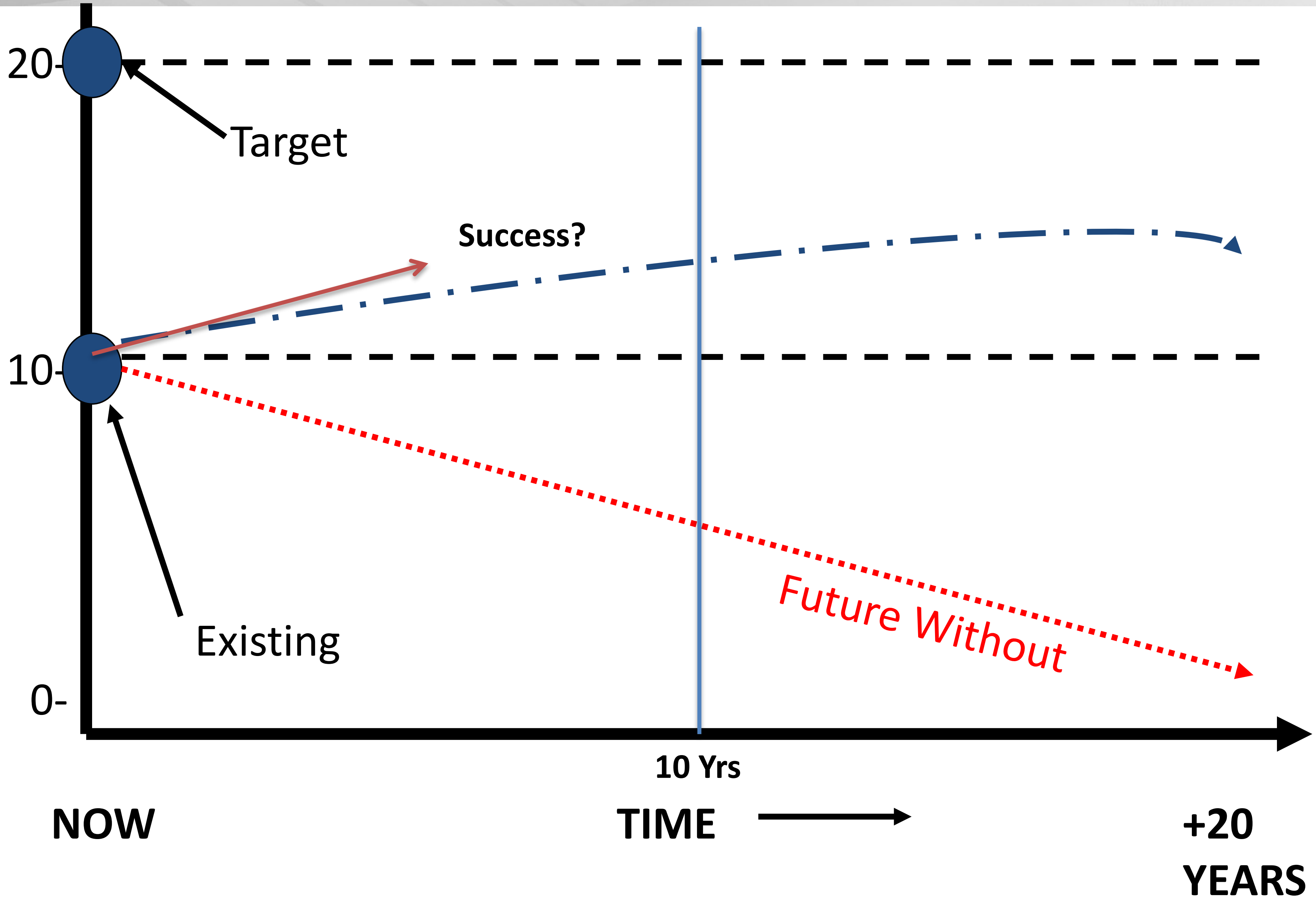

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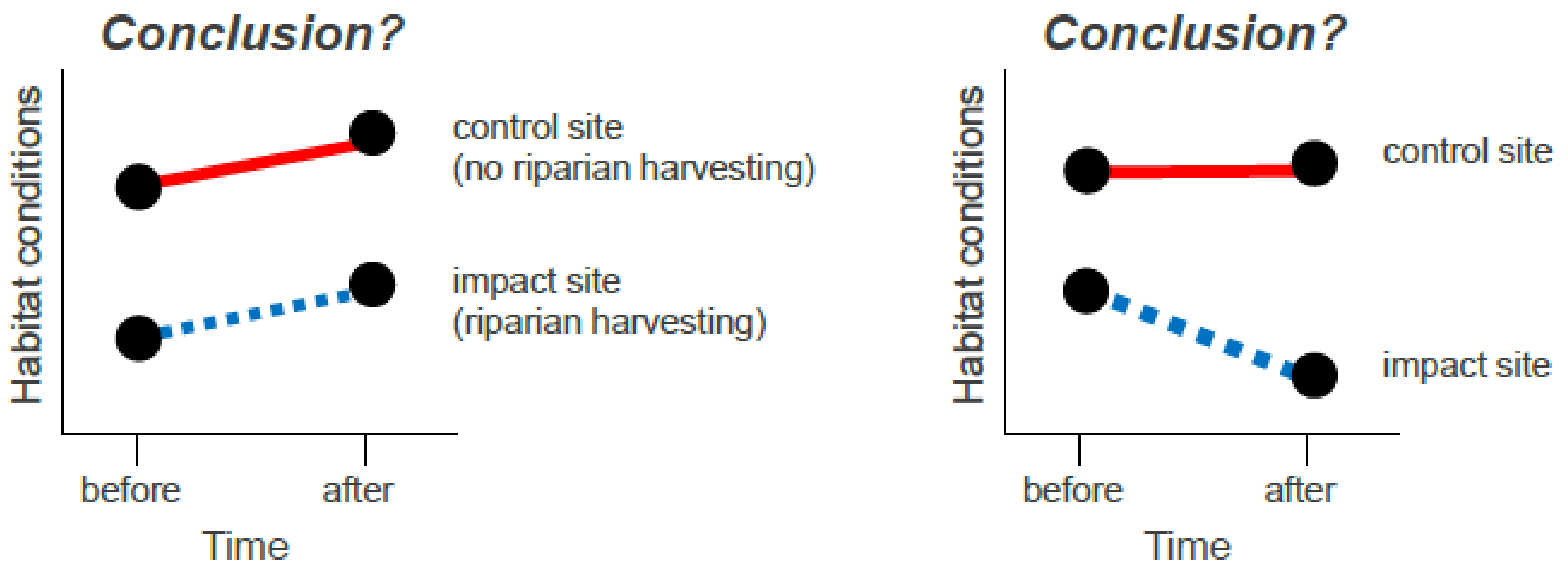
Observations and conclusions from a hypothetical riparian vegetation study



- No evidence of impact
- Control vs. impact reflects site differences
- Both sites experience same temporal trend

- Change over time differs between sites
- Action appears to have had an effect

Variability

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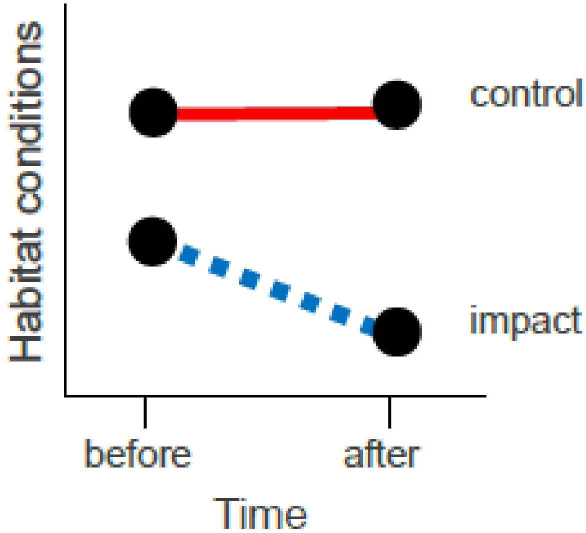
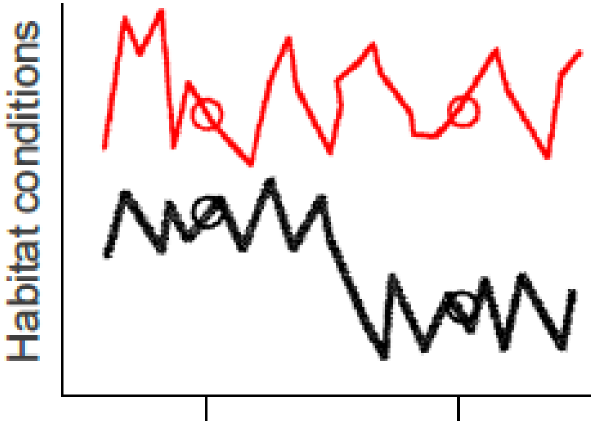
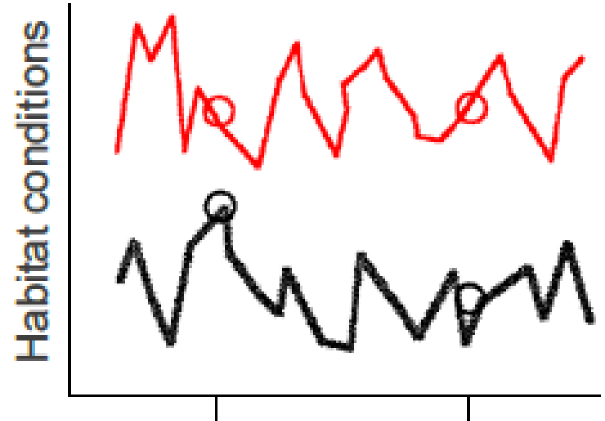
But was this conclusion correct?



…yes, if:

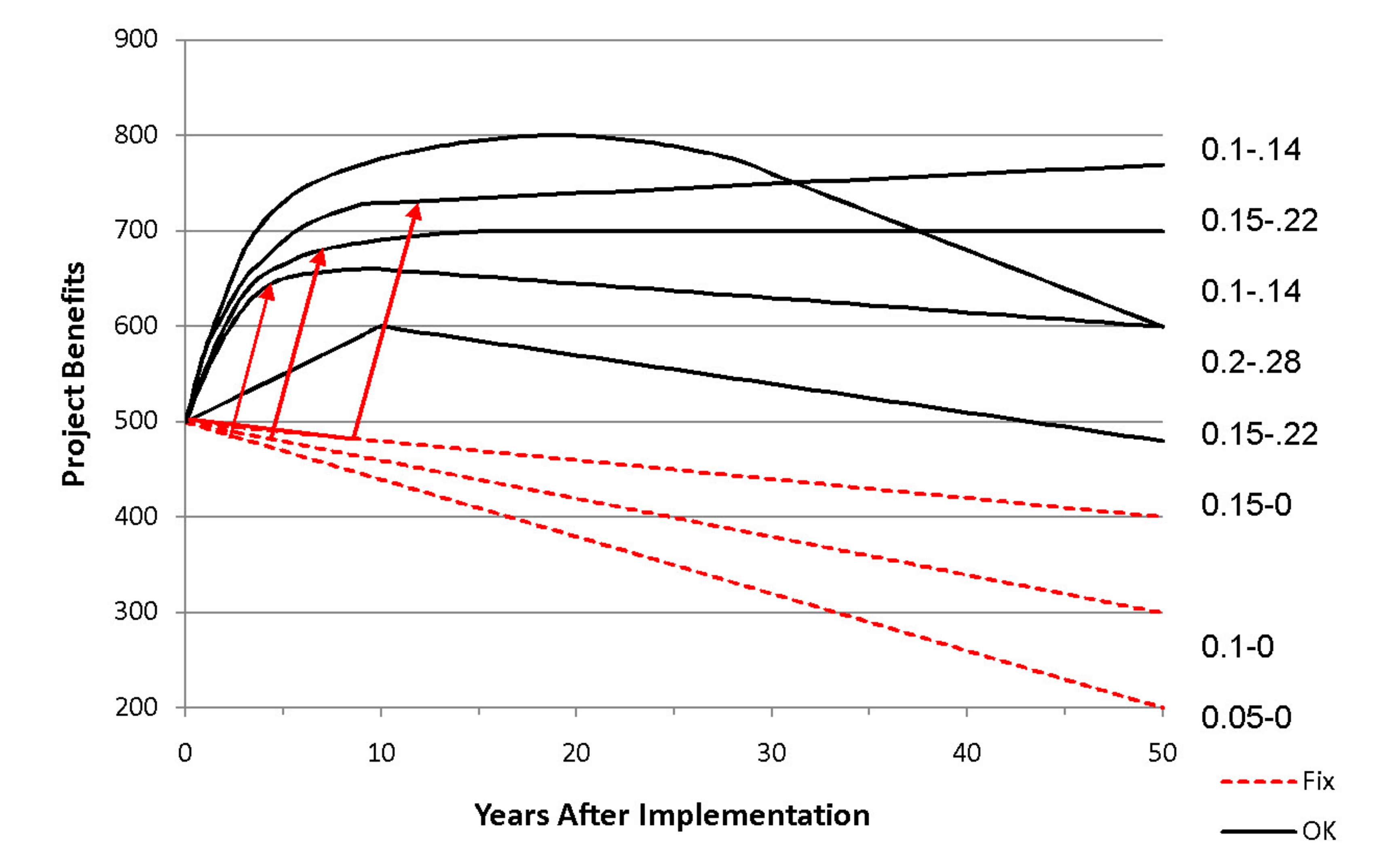


…but no, if:



Strong experimental design needed to disentangle effect of human activities from natural variability

Alternative Outcomes



Modeling for AM & Plan Formulation

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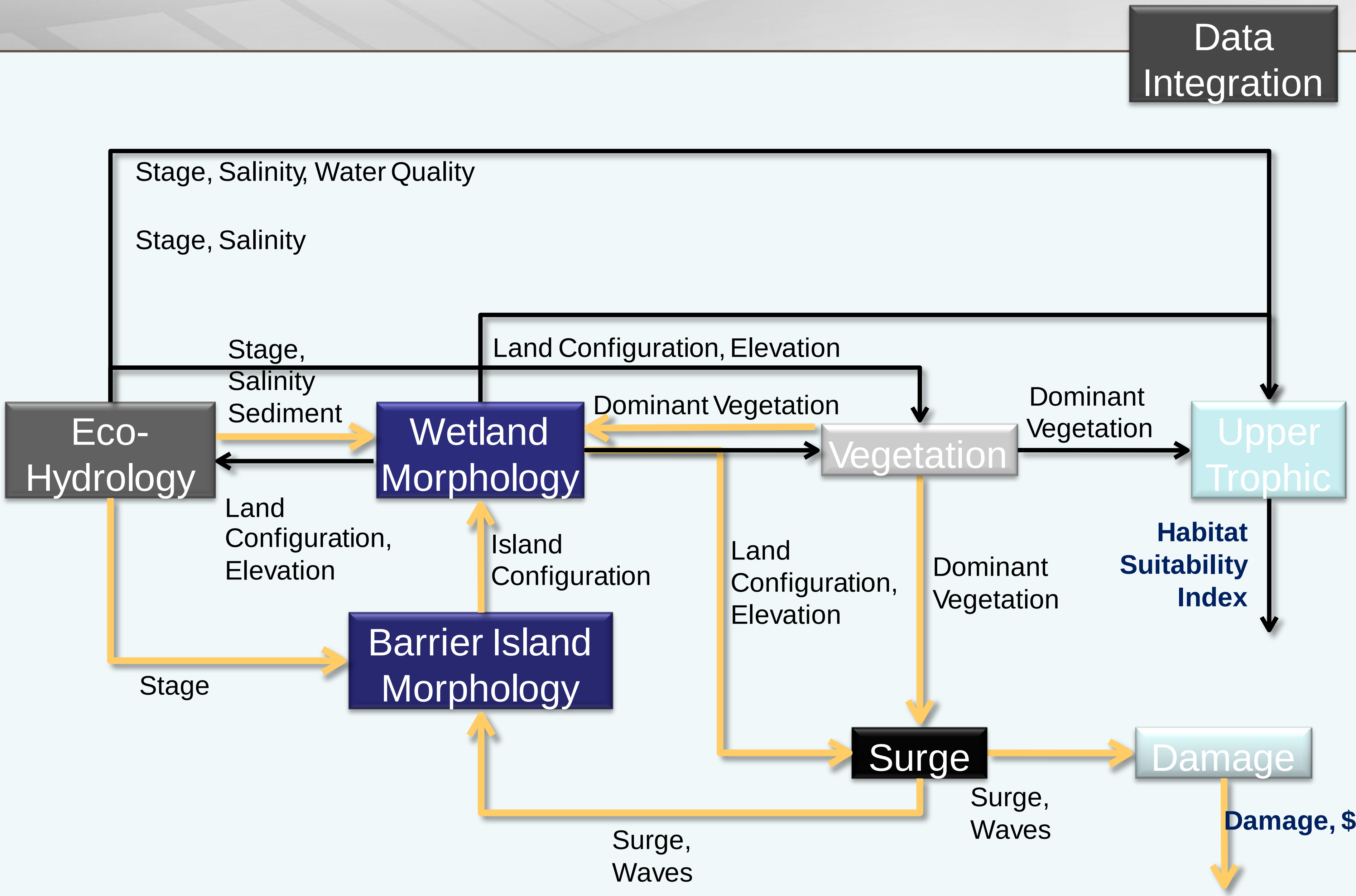

Modeling in Support of AM

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Modeling provides:

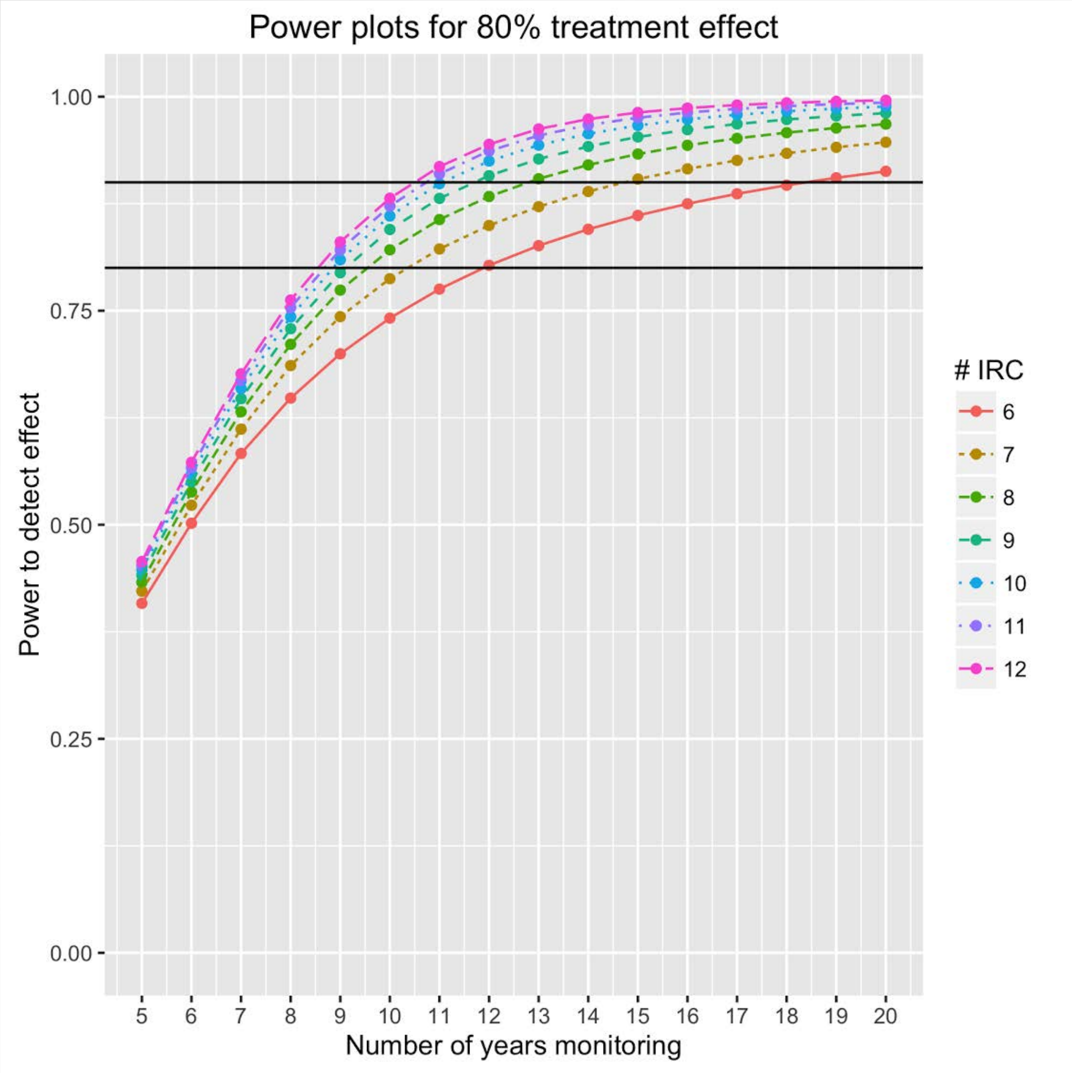
- Framework for assessing “consequences”
- A mechanism to quantify uncertainty & risk

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, code development, error checking, calibration, verification, validation,…

Time for Evaluation of Effects

- 2 habitats sites constructed per year
- Different number of total years of sampling
- Increased number of sites
- 80% power achieved with:
  - 6 sites & 6 controls monitored for 12 years
  - 7 pairs for 10 years
  - 9 pairs for 9 years
  - 12 pairs for 8 years



Decision Rubrics for Equivocal Situations

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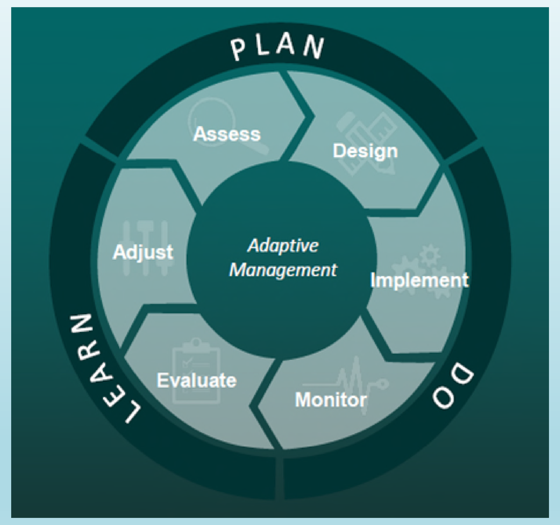
	Question	Y	U	N
1	Is this factor limiting pallid sturgeon reproductive and/or recruitment success?			
2	Are pallid sturgeon needs sufficiently understood with respect to this limiting factor?			
3	Do one or more management action(s) exist that could, in theory, address these needs?			
4	Has it been demonstrated that at least one kind of management action has a sufficient probability of satisfying the biological need?			
5	Have other biological, legal, and socioeconomic considerations been sufficiently addressed to determine whether or how to implement management actions to Level 3?			

Decision Criteria for Level 3 implementation
1 - A "Yes" to all five questions triggers Level 3 implementation
2 - A "Yes" to four of five, with an "Uncertain" for either #1 or #2 triggers a two-year clock to either reject the hypothesis or implement at Level 3



Adaptive Management for Ecosystem Restoration & Natural Resource Management: USACE Projects, Programs & Installations

FY17 Technology Transfer Demo Program: Office of Research and Technology Transfer, Technology Advancement Division

By Sarah J. Miller[1], J. Craig Fischenich[1], Courtney Chambers[1], Chuck Theiling[1], Jeff Trulick[2] and Craig Fleming[3]

[1]US Army Engineer Research and Development Center (ERDC) Environmental Laboratory (EL),
[2]US Army Corps of Engineers (USACE), Headquarters Planning Office of Water project Review,
[3]Omaha District US Army Corps of Engineers (NWO)

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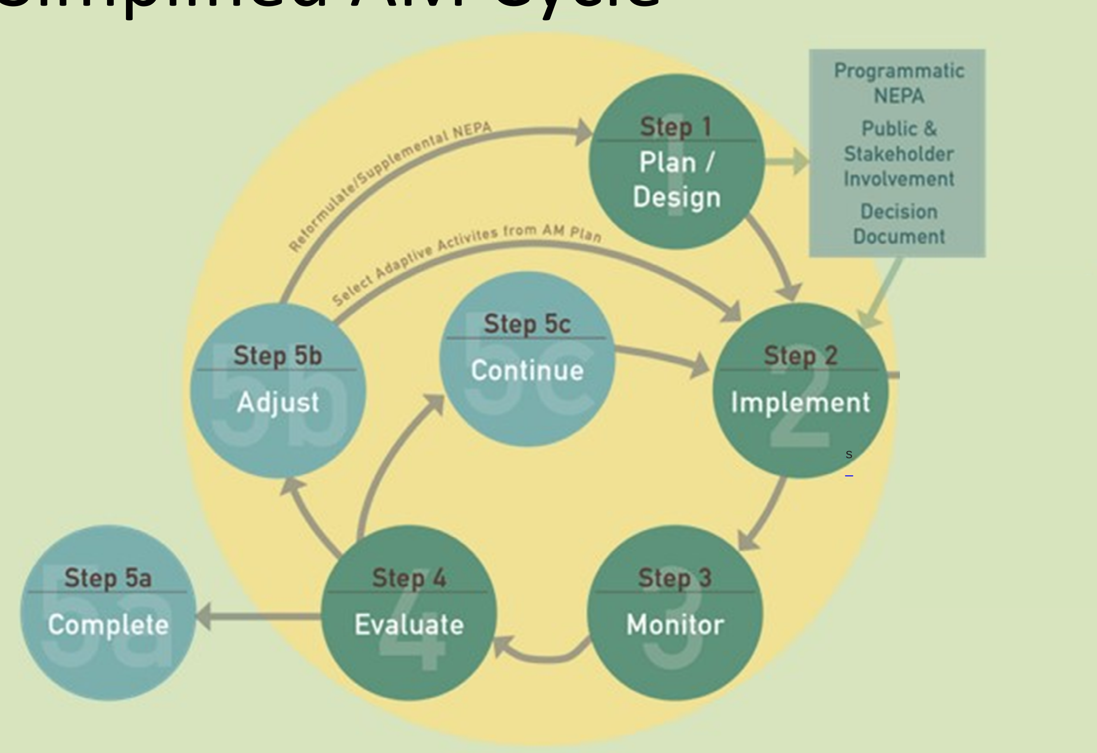
ABSTRACT

Adaptive Management (AM) provides a structured, science-based process for matching management actions to project objectives, reducing critical uncertainties, enabling risk management, and using an experimental approach to test hypotheses about important ecological responses. AM is doing while learning through a cycle of iterative steps. Step 1: assess current knowledge, identify uncertainties, plan actions to meet objectives; Step 2: implement actions; Step 3: monitor; Step 4: evaluate results; and Step 5: adjust based on what is learned. Section 2039 of WRDA (2007) requires Monitoring and Adaptive Management (M&AM) Plans for ecosystem restoration projects, though development and implementation continues to pose challenges. In response to the need for readily available and adjustable training and tools to provide detailed guidelines for each Step, ERDC Environmental Laboratory (EL) developed a training workshop series for Corps Districts, funded by the ERDC Office of Research and Technology Transfer (ORTT) and taught by an interdisciplinary team: Craig Fischenich, Sarah Miller and Courtney Chambers (ERDC EL), Craig Fleming (NWO), Chuck Theiling (formerly MVR, now EL) and Jeff Trulick (HQ Office of Water Project Review). We created a format covering AM issues specific to Ecosystem Restoration, but with potential for Mitigation, Operations and Installation Natural Resource Programs. Modular workshop components and materials can be modified to suit scale, stakeholders, phase or type of project or program (https://wiki.erdc.dren.mil/Adaptive_Management_Workshops_2017). This series opened an opportunity for our Team to engage with the Chief's Environmental Advisory Board (EAB) on a task in their 2017-2019 work plan to evaluate USACE policies and practices related to M&AM, with the aim of providing recommendations to the Chief regarding M&AM opportunities throughout the USACE. Our final workshop in 2017 advanced our working relationship with the EAB to review available AM materials and tools, discuss the state of the practice, characterize technical needs, and set a path forward for practical M&AM assistance Corps-wide.

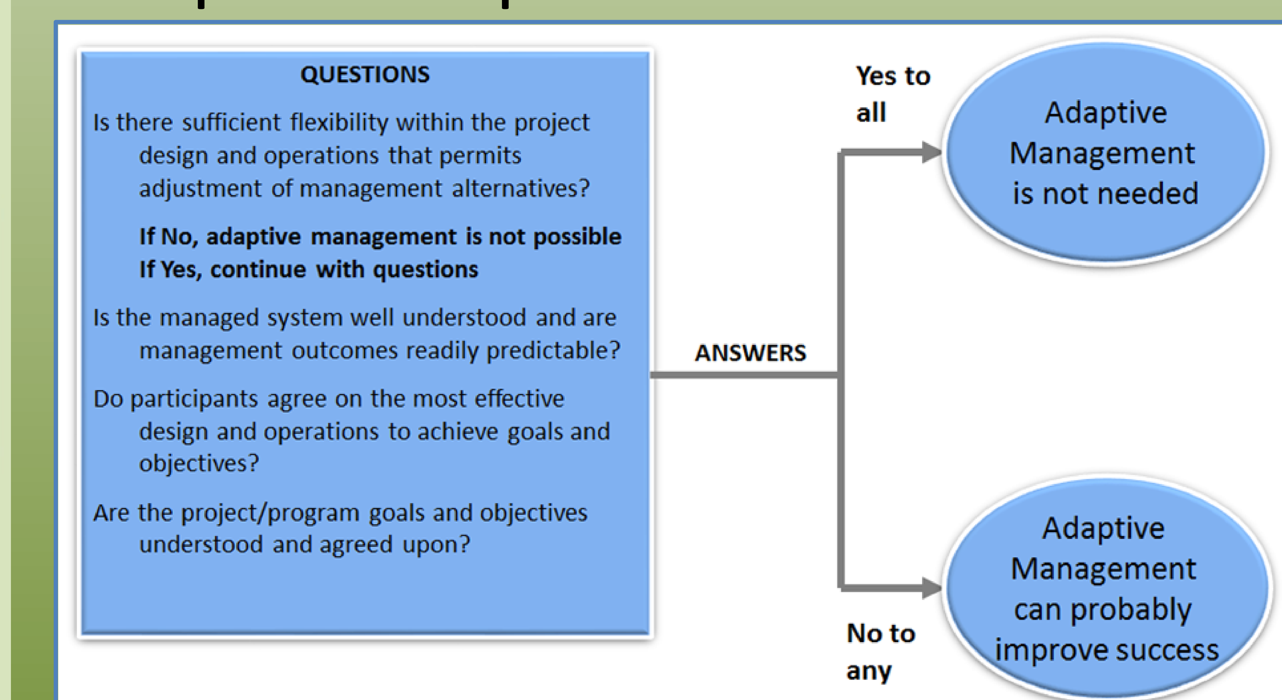
ADAPTIVE MANAGEMENT BASICS

A practitioner's definition: AM is a **systematic**, **rigorous** approach for designing and implementing **management actions** in order to maximize **learning** about and **minimizing critical uncertainties** that affect **decisions** or policies, while striving to meet **management objectives**

Simplified AM Cycle



Simple Example: AM Decision Tree

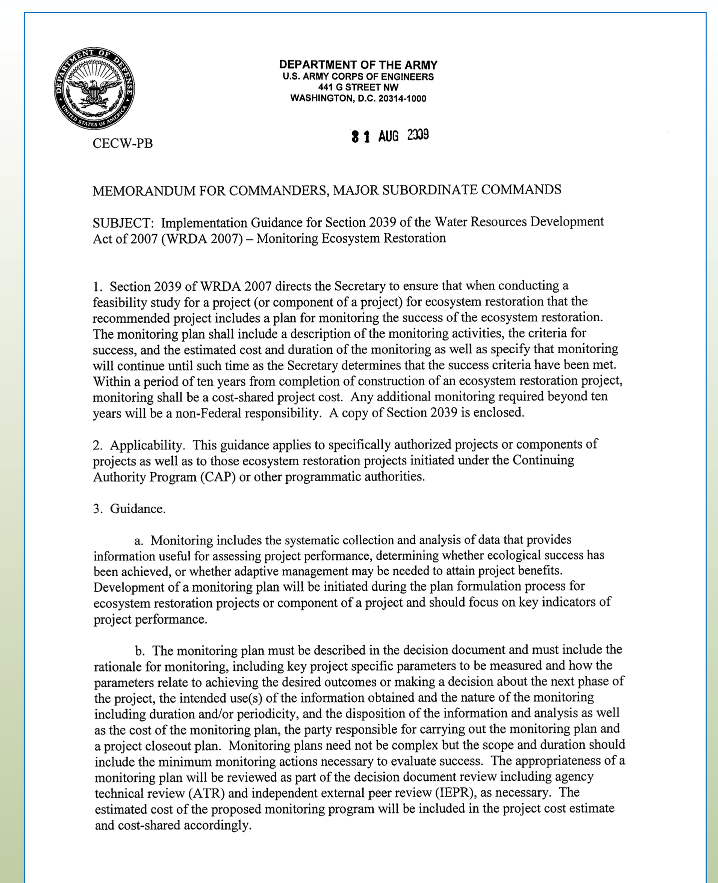


THE CHALLENGE

HQ OWPR, ERDC EL Teams and our District Partners have identified needed solutions to support effective AM:

- Address gaps in experience and training
- Interpret of official policy and guidance
- Improve knowledge and/or access to existing technologies and tools
- Compile applicable case studies and modular examples

A TRAINING SOLUTION



DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET NW
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.

WORKSHOP OBJECTIVES

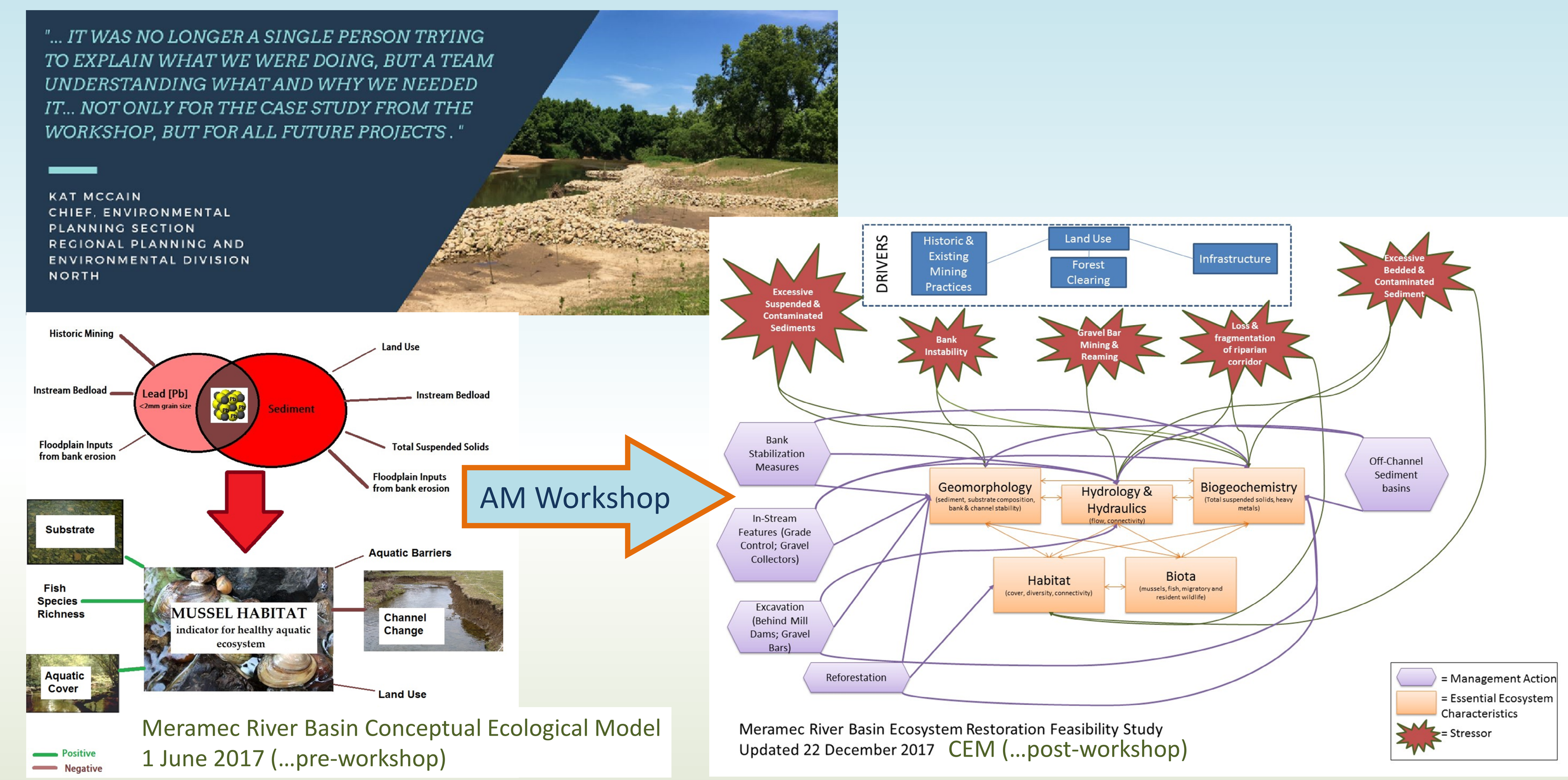
- Provide knowledge for effective participation
- Learn what AM is *and what it isn't*
- Determine when AM is most useful *and when it may not be useful or appropriate*
- Understand policies, guidance, basic processes and key elements
- Convey examples *who, where, why and how*
- Discover enabling and inhibiting factors for governance and decision-making
- Learn relevant techniques and standards of practice, focusing on developing AM Plans
- Explore new AM implementation tools

Workshops have been held at **St. Louis District (MVS)** and **Albuquerque District (SPA)**. Each host District gave us opportunities to tailor teaching objectives and materials, provided insight to the state of AM practice in the Corps and contributed to our understanding of the need for training and tools. Our third workshop was hosted at IWR to coordinate with the Chief's Environmental Advisory Board (EAB) to help them evaluate AM in the Corps and set a path for ongoing collaboration with the EAB to improve M&AM development and implementation for the USACE as a whole.

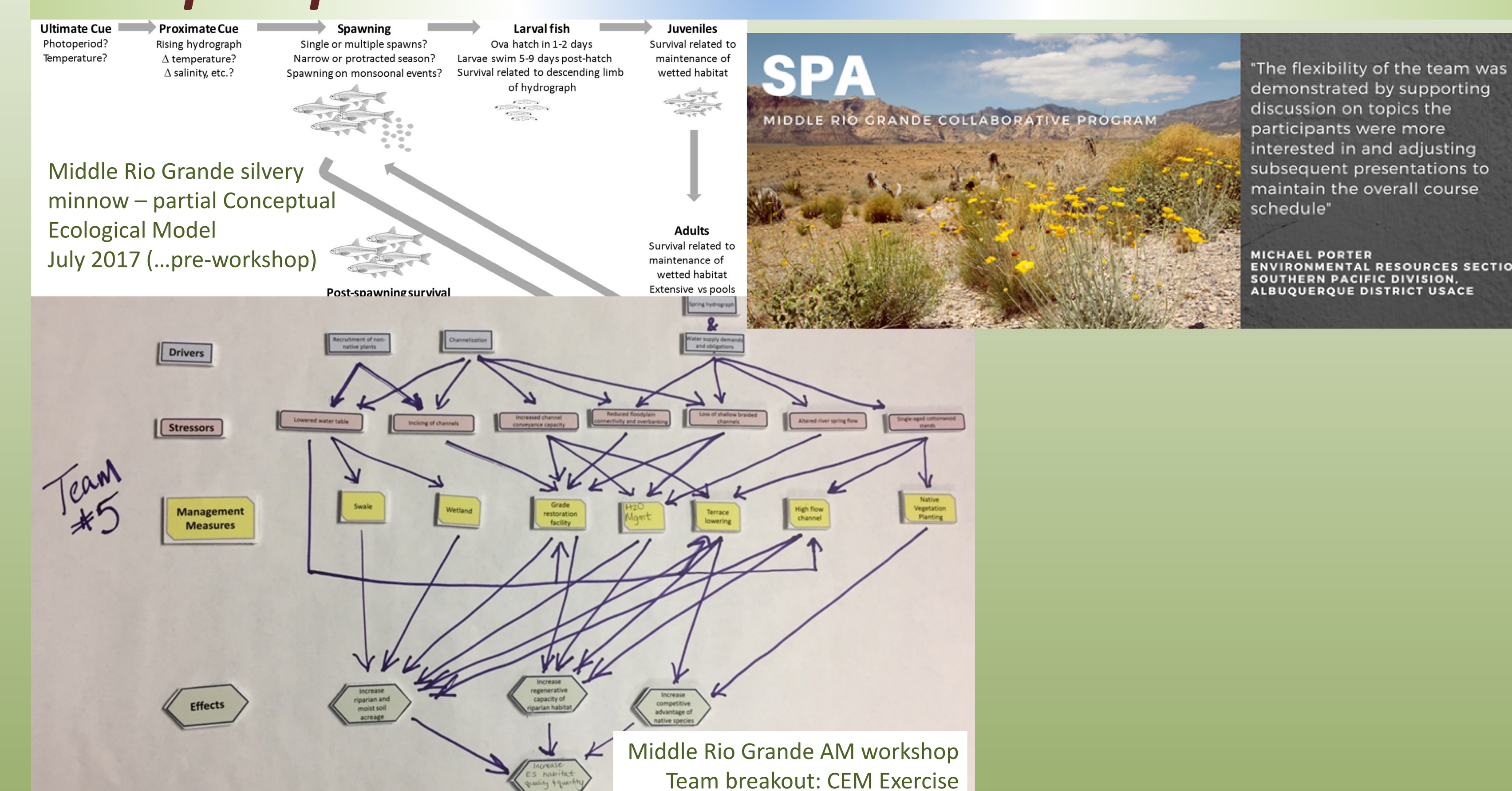
THE WORKSHOPS

FY17 workshops worked with over 50 participants representing five USACE Districts, two Federal Agencies, two State Agencies, a Municipal Water Authority and three cooperating Environmental Consultants.

St. Louis District…



Albuquerque District…



USACE Institute for Water Resources…