Environmental Benefits Analysis Research Update

Craig Fischenich
U.S. Army Engineer Research and Development Center (ERDC)
Environmental Laboratory

Environmental Benefits Analysis (EBA) Seminar
October 13, 2009

Need/Objectives

To address deficiencies in Corps ER feasibility reports identified by HQUSACE and the Office of ASA(CW), and to demonstrate programmatic success to OMB and the public, we require:

Analyses of environmental benefits based on **best available methods** that will withstand external peer review

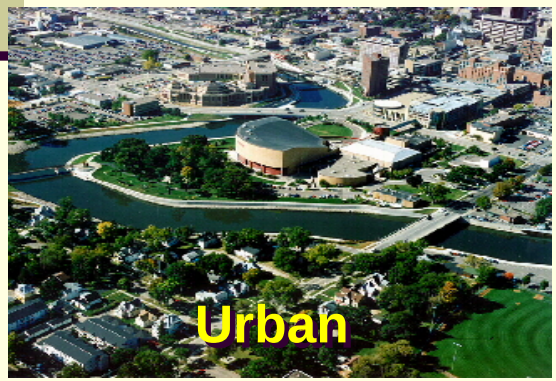
Metrics and methods consistent with **national and regional strategies** for environmental restoration

Clear communication and accounting of the benefits of proposed and in-place restoration projects, as well as the Corps' ER Program

Assessment Questions

- Which alternative is **preferred**?
- Are the benefits **worth** the investment?
- What is the **priority** among projects?
- What are the **cumulative benefits**?

The Challenge



Initial Themes

Conceptual models to link restoration actions to predicted benefits

Empirical, stochastic and mechanistic **forecasts** of ecosystem response to hydro-geomorphic manipulation

Metrics for assessing benefits in different ecosystem types, across regions and applicable at the project and program scale

Multi-criteria **decision** analysis to **support** risk-informed planning, recognizing local needs while ensuring national interest

Environmental **benefits quantification** in alternatives and post-project evaluation to document contribution to NER account

Ecosystem services using economic principals to account for social, economic, and ecological benefits

Tools for **programmatic assessment** at regional and national levels

Research Emphasis

FY08

Identification of needs

Establishment of partnerships

Determination of state-of-science/practice

Develop interim tools and procedures

FY09

Practical technical notes

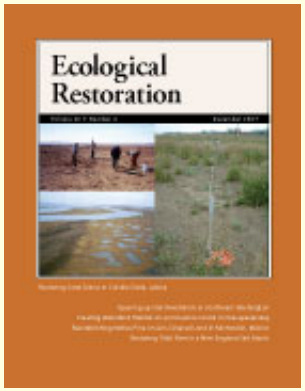
Presentation of case studies and examples

Additional web-based analytical and DSS tools

Program and product reviews leading to decision

EBA Focus Workshops

- Assess and summarize the **state of the science** and the state of the **practice**
- Produce **interim approaches** for use during the ongoing research efforts
- Outline the **research needs** in the field and a path to achieving those needs
- Contribute to a **framework** for EBA at the project and programmatic levels



FY08 Products

Work Unit	Product	Lead PI
Conceptual Models (CM)		
	TN: The Application of Conceptual Models to Ecosystem Restoration	Fischenich
	TN: Restoration of Delta Streams: A Case History and Conceptual Model	Killgore
	JP: The Application of Conceptual Models to Ecosystem Restoration - Setting the Framework	Casper
Decision Analysis (DA)		
	JP: Incorporating Risk, Uncertainty, and Multiple Decision Criteria into Ecosystem Restoration	Suedel
	TN: Risk and Uncertainty Accounting in Environmental Benefits Analysis	Suedel
Ecosystem Services (ES)		
	JP: State of the Science to Support Service-Based Approaches for Quantifying Environmental Benefits	Henderson
	TN: Characterizing Ecosystem Services in Ecosystem Restoration Studies	Henderson
Forecasting (F)		
	TN: Sediment Sampling and Analysis for Stream Restoration Projects	Fischenich
	JP: State of the Science and State of the Practice in Forcasting Ecological Outcomes from ER Projects	Payne
	TN: Forcasting Ecological Outcomes from Ecosystem Restoration Projects	Payne
	TN: Hydrologic Analyses for Stream Restoration Design	Fischenich
	TN: Development and Application of Flow Duration Curves for Stream Restoration	Fischenich
	JA: A Cautionary Note on Area Similitude in Stable Channel Design by Analog Methods	Fischenich
	JA: An Eco-hydraulic Marsh Accretion Model for Quantifying Benefits of Flow Diversion - Theory	Fischenich
	Diversion Benefit Assessment Tool (Marsh Builder)	Fischenich/Mckay

FY08 Products (cont'd)

Work Unit	Product	Lead PI
Benefits Quantification (BQ)		
	TN: Hydraulic Losses in River Meanders	Fischenich
	TN: Vegetation Impacts Upon Stream Width	Fischenich
	TN: Availability of Patch Calculator - An ArcGIS v.9 Tool for the Analysis of Landscape Patches	Lin
	JP: Standards of Practice for Applying Professional Judgement in Ecosystem Restoration	Copes-Burkes
	TN: Application of Best Professional Judgement in Ecosystem Restoration Projects	Webb
	On-Line Tool: Annualizer for Ecosystem Outputs	Skaggs
	TN: Applications of Habitat Equivalency Analysis (HEA) to Corps Projects	Ray
Metrics (M)		
	TR: Measuring Environmental Value In Nonmonetary Terms: A Review of Common Practices	Cole
	TR: A New Nonmonetary Benefits Metric for Ecosystem Restoration Projects	Cole
	JP: Metric Sets For Assessing Benefits From Ecosystem Restoration Projects - State of the Science	McKay
	TR: Selecting Ecosystem Restoration Metrics	McKay
	Patch Connectivity Measurement Tool	Lin
	JP: The Functional Linkage Index: A Metric for Measuring Connectivity among Habitat Patches Using Least-Cost Distances	Lin
	TR: Program and Project Applications of a New Metric for EBA in Civil Works	Cole
	TR: Development and Evaluation of a New Metric for EBA	Cole
Programmatic Assessment (PA)		
	TN: Techniques for Normalizing Ecosystem Benefits	Burkes-Copes
	Guidelines and Examples for HGM Budgeting Criteria Scoring I	Fischenich
Web/Gateway (WEB)		
	Web Gateway Development and Maintenance	Jackson

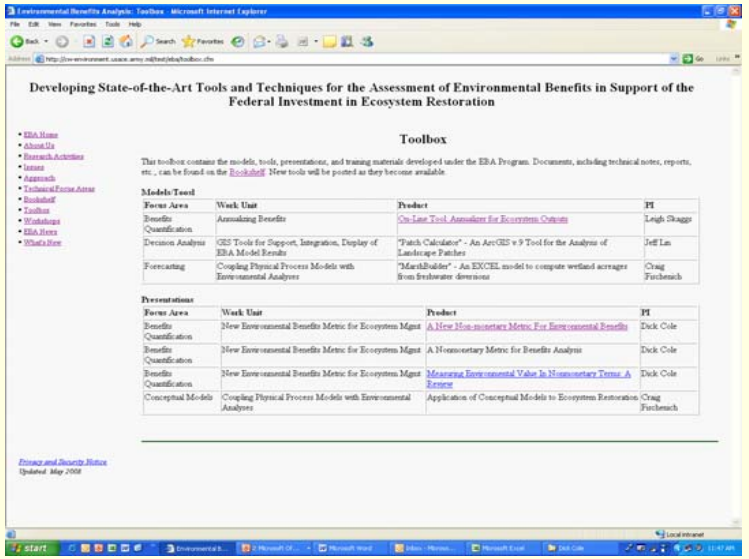
Bookshelf

This bookshelf contains the written products of the EBA Program. Other products can be found in the Toolbox. Documents will be posted as they become available.

Focus Area	Work Unit	Product	PI
Conceptual Model	Validation of Predicted Benefits of Restoration Projects	TN: Restoration of Delta Streams: A Case History and Conceptual Model	Jack Killgore
Conceptual Model	Coupling Physical Process Models with Environmental Analyses	TN: The Application of Conceptual Models to Ecosystem Restoration	Craig Fischenich
Decision Analysis	GIS Tools for Support, Integration, Display of EBA Model Results	JP: The Functional Linkage Index: A Metric for Measuring Connectivity among Habitat Patches Using Least-Cost Distances	Jeff Lin
Decision Analysis	GIS Tools for Support, Integration, Display of EBA Model Results	TN: A Metric and GIS Tool for Measuring Connectivity Among Habitat Patches Using Least-Cost Distances	Jeff Lin
Decision Analysis	GIS Tools for Support, Integration, Display of EBA Model Results	TN: Availability of Patch Calculator - An ArcGIS v.9 Tool for the Analysis of Landscape Patches	Jeff Lin
Ecosystem Services	New Environmental Benefits Metric for Ecosystem Mgmt	TR: Measuring Environmental Value In Nonmonetary Terms: A Review of Common Practices and Elements	Dick Cole
Forecasting	Validation of Predicted Benefits of Restoration Projects	TN: Library of Habitat Models to Evaluate Benefits of Aquatic Restoration Projects on Fishes	Jack Killgore
Forecasting	Coupling Physical Process Models with Environmental Analyses	TN: Sediment Sampling and Analysis for Stream Restoration Projects	Craig Fischenich

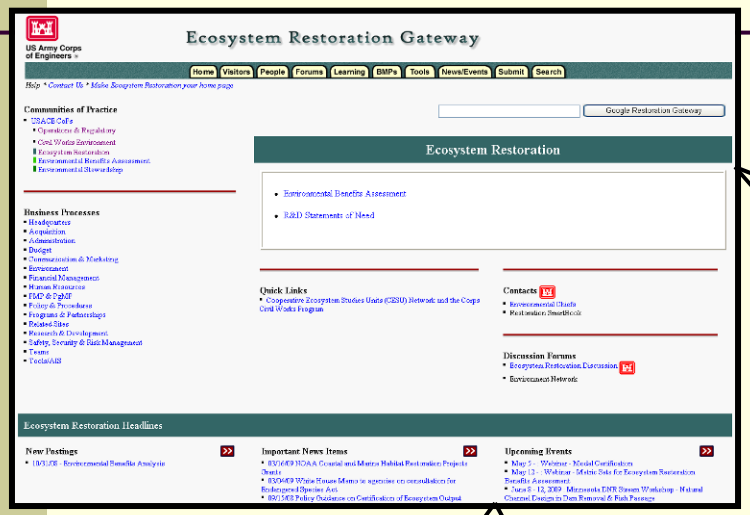
Products/Technology Transfer

- Technical notes
- Technical reports
- Fact sheets
- Position papers
- Models/tools
- Journal papers
- Workshops
- Webinars
- Demonstrations
- Program and product reviews

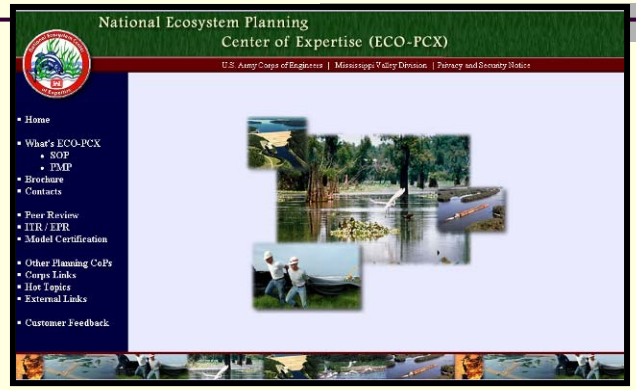


www.CorpsEcoRestoration.us

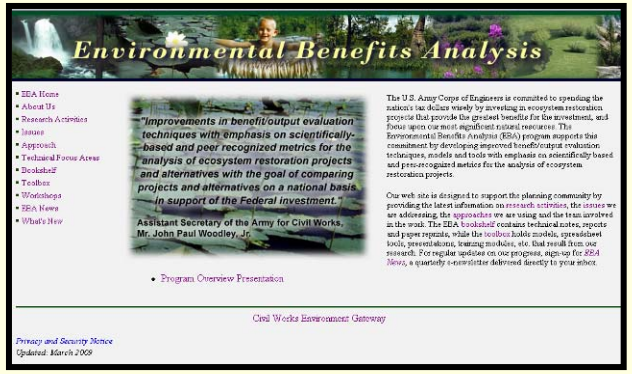
Ecosystem Restoration Gateway



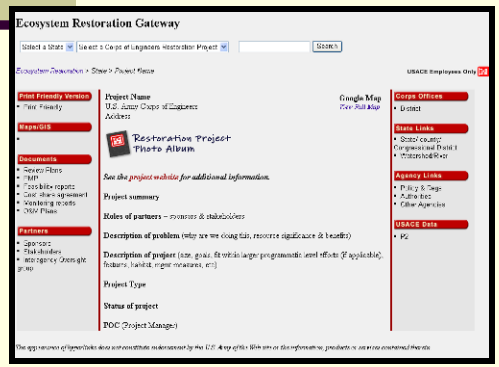
ECO-PCX



EBA & Research



Restoration Fact Sheets



Community of Practice

Webinars

Webinars: Completed Jan – Sep 09

1. Application of Conceptual Models
2. LA Coastal Assessment Office
3. Cooperative Ecosystem Study Units
4. Quantifying Benefits of Flow Diversion to Coastal Marshes
5. Review Plan Checklist
6. Model Certification
7. Metrics Sets for ER Benefits Assessment
8. Reducing Spreadsheet Errors
9. EDYS Lite
10. Use of Professional Judgment
11. Independent External Peer Review -IEPR
12. Adaptive Management

Webinars: Scheduled to Jan 10

1. EBA Program Overview
2. Reference Systems in EBA
3. Ecosystem Restoration Gateway
4. Agency Technical Review
5. Monitoring ER Projects.

Article: *Planning Ahead* -
Completed 28 Jan 09
Status: Appeared - Feb 09

Article: *Planning Ahead* -
Completed 8 Sep 09
Status: Pending

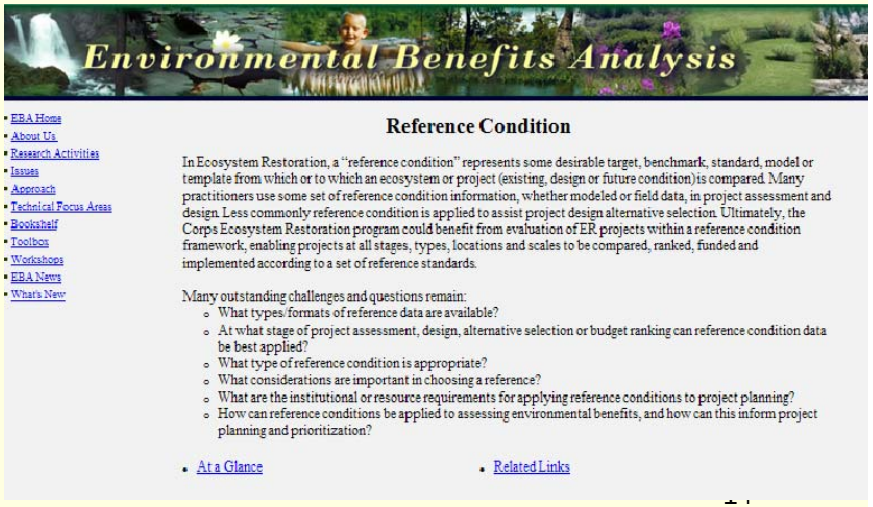
>1000 Participants, 20 Agencies

Content Development Workshops

Home About EBA Applications Research Policy Interact with EBA

Activity: Content Development Workshops for ER, EBA, Coastal & Estuarine Environments

How it Addresses the Problem:
Allows user community to develop the ER website so that it meets their needs.



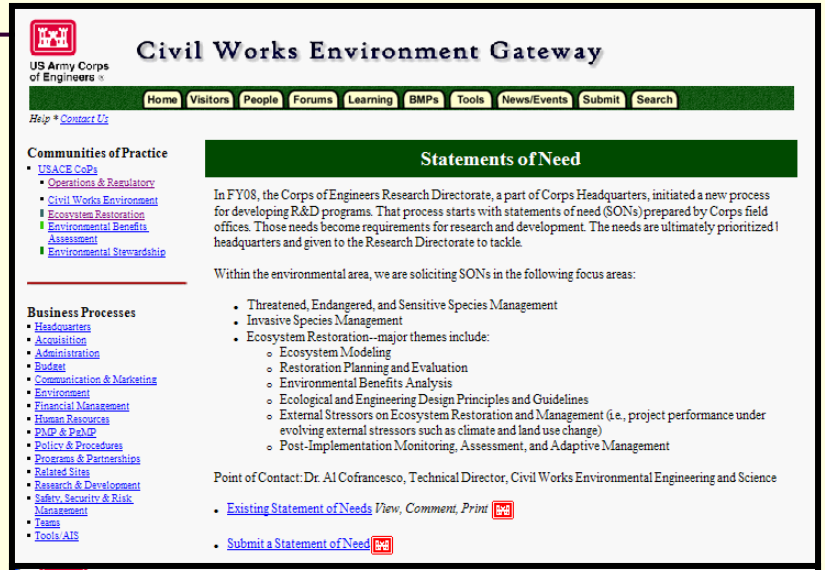
Benefits to Corps Users:
Integration of R&D efforts and basic information required by E.R. CoP to conduct Ecosystem Restoration work. Identification of content needs and website flow for better utilization.

Statements of Need (SON)

Activity: On-line system for SON submissions.

How it Addresses the Problem:
Allows for transparency in R&D statements of need, allows the field to work with principal investigators to describe field problems and research needs.

Benefits to Corps Users:
Allows entire community to view research needs from across the nation, make comments and provides the CoP opportunities to articulate problem statements.



FY09 Focus Areas

- Technical capabilities and case studies
- Conceptual models
- Metrics
- Risk, uncertainty and decision analysis
- Monitoring and adaptive management
- Programmatic capabilities

FY09 Technical Products

- **TN: "Spacio-Temporal Considerations for ER Metrics"** Status: in Development – anticipated 09/09
- **White Paper: "Discounting Environmental Benefits"** Status: in Development —anticipated 10/09
- **TN: "Key Thresholds in Ecosystem Restoration"** Status: in Peer Review—anticipated 10/09
- **TN: "Reducing Spreadsheet Errors"** Status: Complete
- **TN: "Accounting for Dependencies – Truckee Fish Passage Case Study"** Status: Management Review
- **TN: "Characterizing Valued Ecosystem Services – Mollicy Farms Case Study"** Status: Delayed Jan 10
- **TN: "Accounting for Uncertainties – Diversion Benefits Case Study"** Status: Complete
- **TN: "Community Index Models – Middle Rio Grande Bosque Case Study"** Status: Oct 09
- **TN: "MCDA Application – Missouri River Cottonwood Restoration Case Study"** Status: Dec 10

Reducing Spreadsheet Errors

How it Addresses the Problem:

•Provides assistance in reducing errors through four generalized best practices in end-user programming

- •Planning spreadsheet development
- •Avoiding errors in development
- •Finding errors
- •Self-Improvement

	A	B	C	D	E
1	Length (ft)	10		Input	
2	Width (ft)	50		**Calculation /Output**	
3					
4	Area (ft^2)	**500**			

Figure 4. Example of formatting for function.

Benefit to Corps Users:

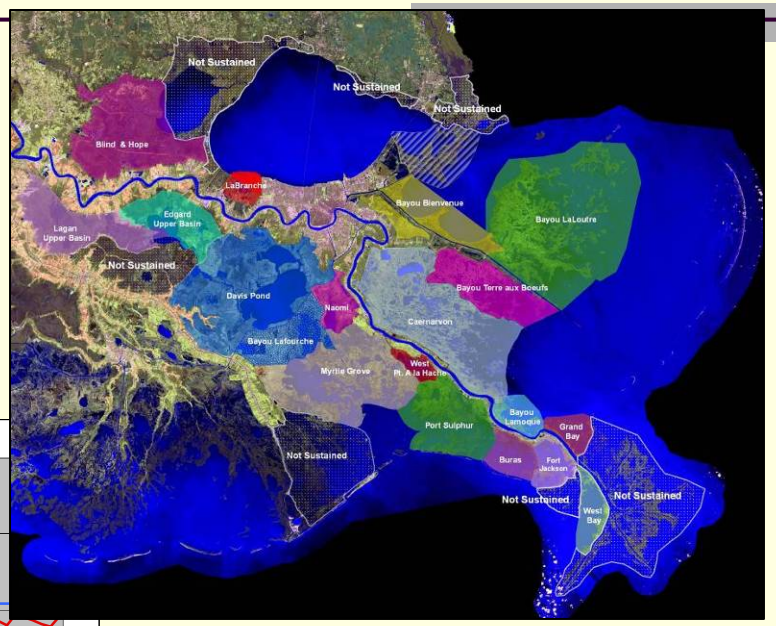
•Synthesizes best practices from countless textbooks, journal articles, and websites on spreadsheet development

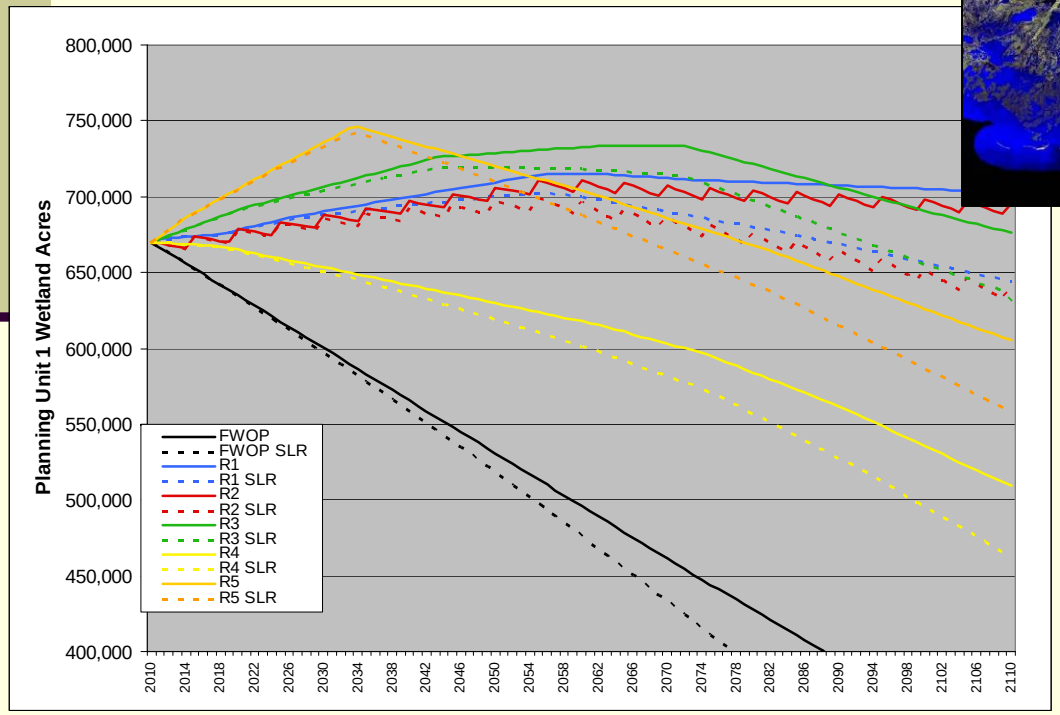
•Provides tractable guidance on implementing these techniques

Case Study: Uncertainty Analysis

Parametric Uncertainty

- Examines predictive confidence
- Monte Carlo simulation – iterates input variables over expected ranges





Scenario Uncertainty

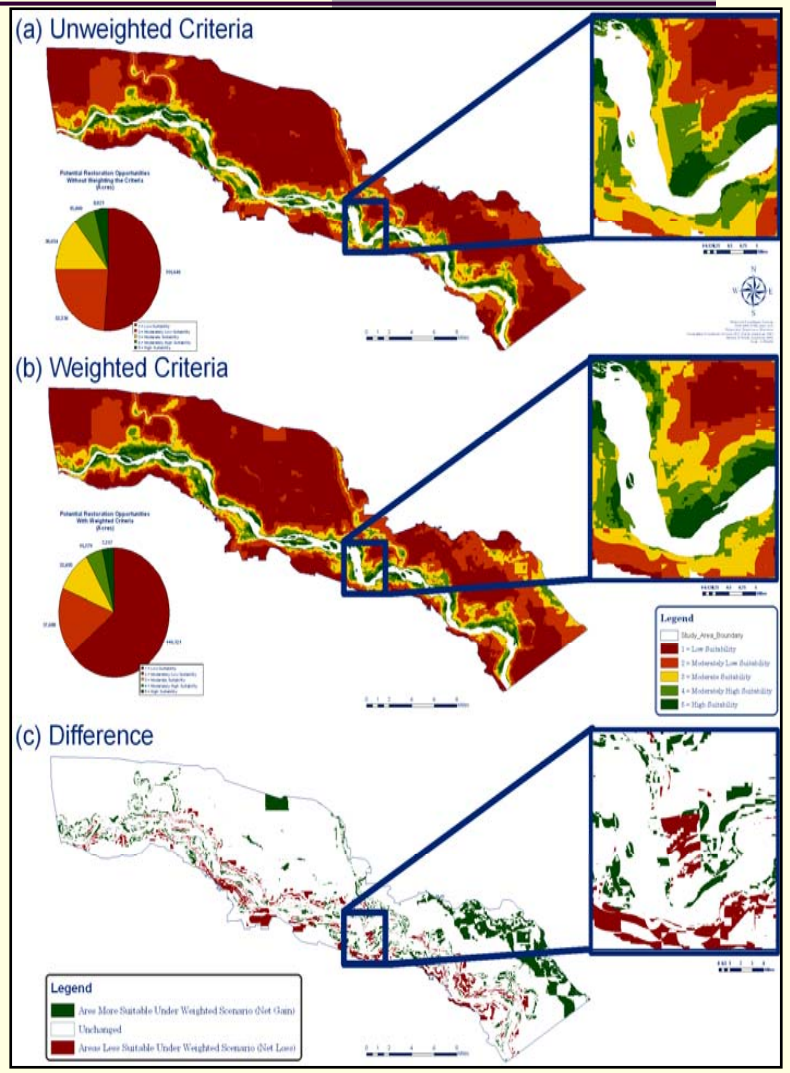
- Addresses fundamental assumptions of baseline
- Sea Level Rise: expected and accelerated

Example Application:
Evaluating ER using MCDA

<u>Product Title</u>: Using MCDA to Support Ecosystem Restoration Planning (Case Study: Missouri River Cottonwood Restoration)

<u>How it Addresses the Problem</u>: Produced a structured and adaptive decision support technique that can be implemented among multiple river segments. The approach **saved time and money**, and the **inherent flexibility** of the approach provided a **transparent decision making process** for stakeholders and experts, **reducing conflict and controversy** throughout the decision making process.

<u>Benefits to Corps Users:</u> Developed a GIS-based sieve-mapping system that uses expert elicitation to identify spatially-explicit "siting" criteria (e.g., proximity to backwater areas) within an MCDA framework that **screened potential restoration and preservation options**.



Case Study: Fish Passage Restoration

Table 1. Summary of fish passage obstructions on the Truckee River considered in this study.

Structure	River mile (mi)	Relative Diversion Discharge (%)*	Structure Height (ft)
Pyramid Lake	0		
Marble Bluff	4	0.0	35
Numana	12.5	3.1	12
S-S	21.75	0.6	na
Fellnagle	27	0.6	4
Herman	31.5	1.9	2.4
Derby	39.5	25.8	?
Tracy PP	44	3.9	?
Cochran	66	0.8	na
Idlewild Ponds	66.5	0.3	na
Chalk Bluff	69.8	10.7	3
Orr	70	3.3	na
Lake	71.5	1.8	na
Last Chance	73	2.6	na
Washoe-Highlands	76	34.9	8 - 10
Verdi	80.5	40.6	13
Steamboat	83.5	7.0	10
Fleisch	86	44.0	14
Lake Tahoe	121.1		

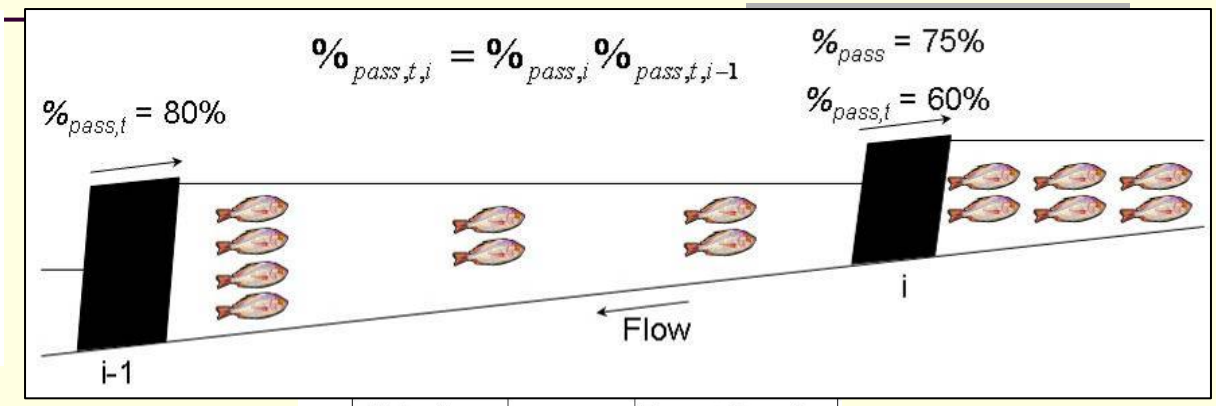
*Ratio of diversion to river discharge.

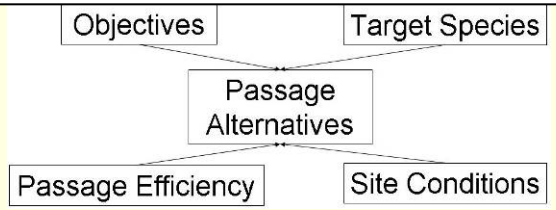
Marble Bluff

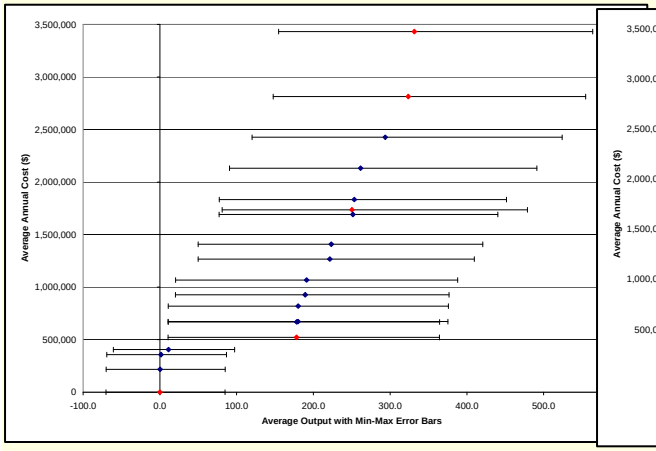
Numana

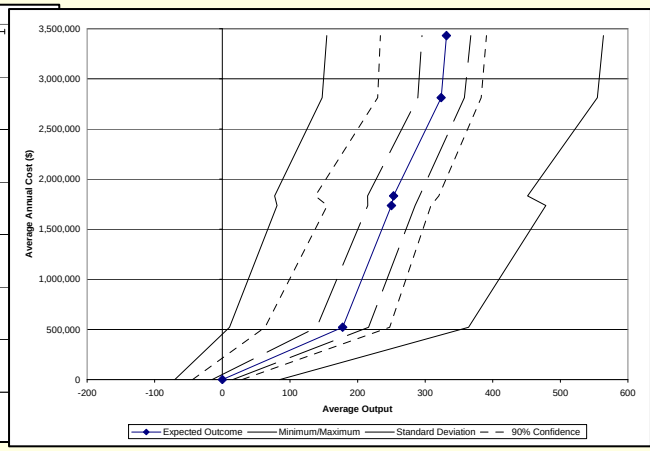
Cochran Ditch

Washoe-Highlands









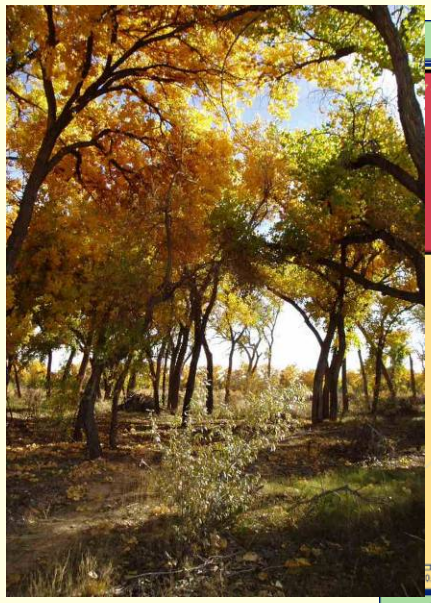
Middle Rio Grande Community Index Models

Focus Areas:

- Ecololgical Engineering
- External Stressors
- Post-implementation monitoring
- Restoration Planning
- Ecosystem Modeling

Challenges:

- Region subject to significant human pressures
- A resulting highly degraded ecosystem
- Loss of ecosystem services to surrounding communities



Solution:

- Community-based index model using HEP
- Model of ecosystem benefits using Ecosystem Benefits Indicators (EBI)
- Multi Criteria Decision Analysis

Impacts:

- Merged econometric valuation methods with ecological alternative assessments
- Successful example of non-monetary quantification of ecosystem outputs

Mollicy Farms Services/Benefits

Recent TNC land acquisition

Ouachita River floodplain in NE La.

Levees and clearing 50 years ago

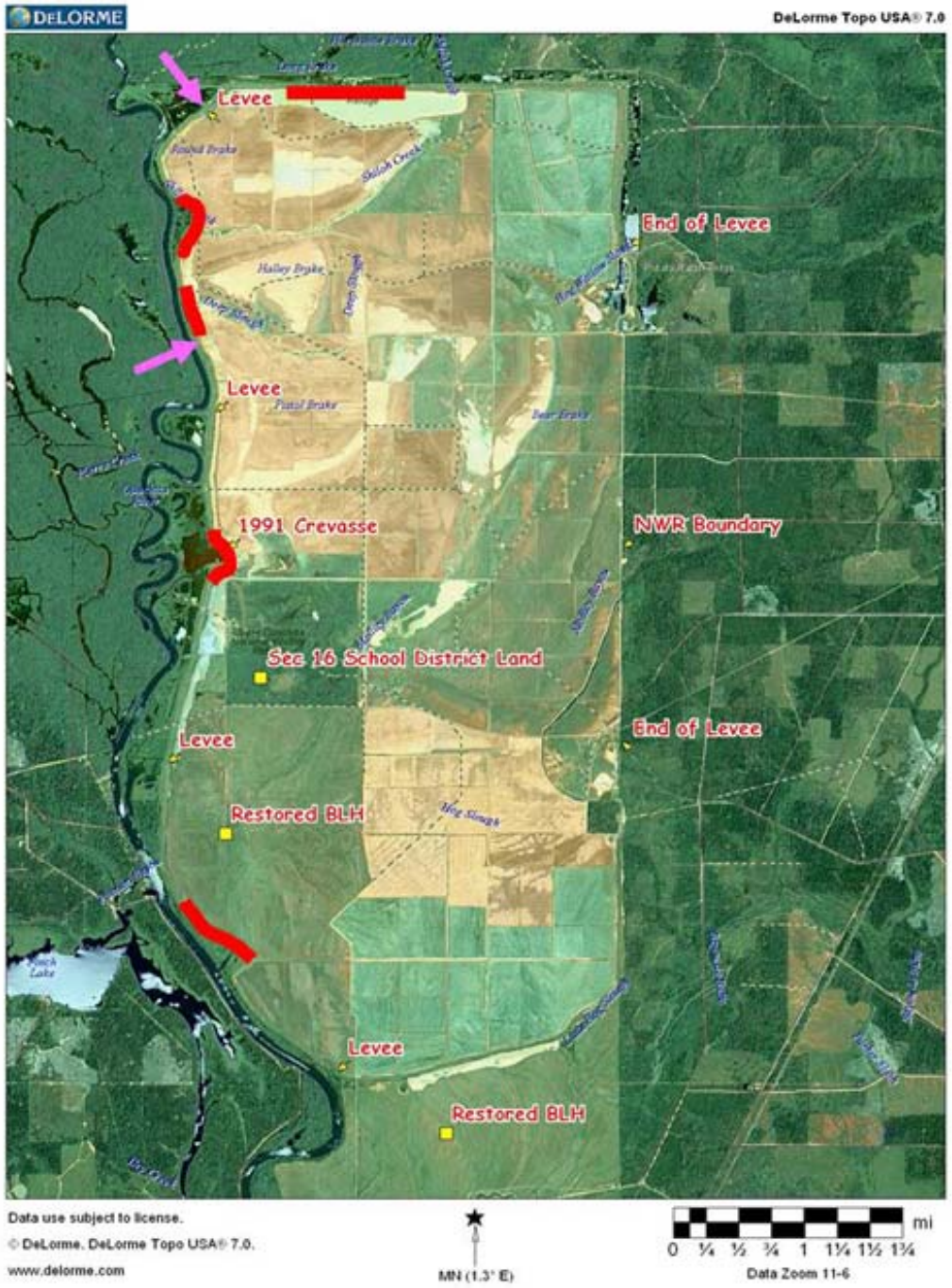
Adjacent of FWS refuge

Baseline decription and monitoring by local universities

ERDC assisted hydrology/hydraulic design

Case study of restoration priorities and EBA/services characterization

Jan ’10 workshop (rescheduled from ’09 due to levee breach)



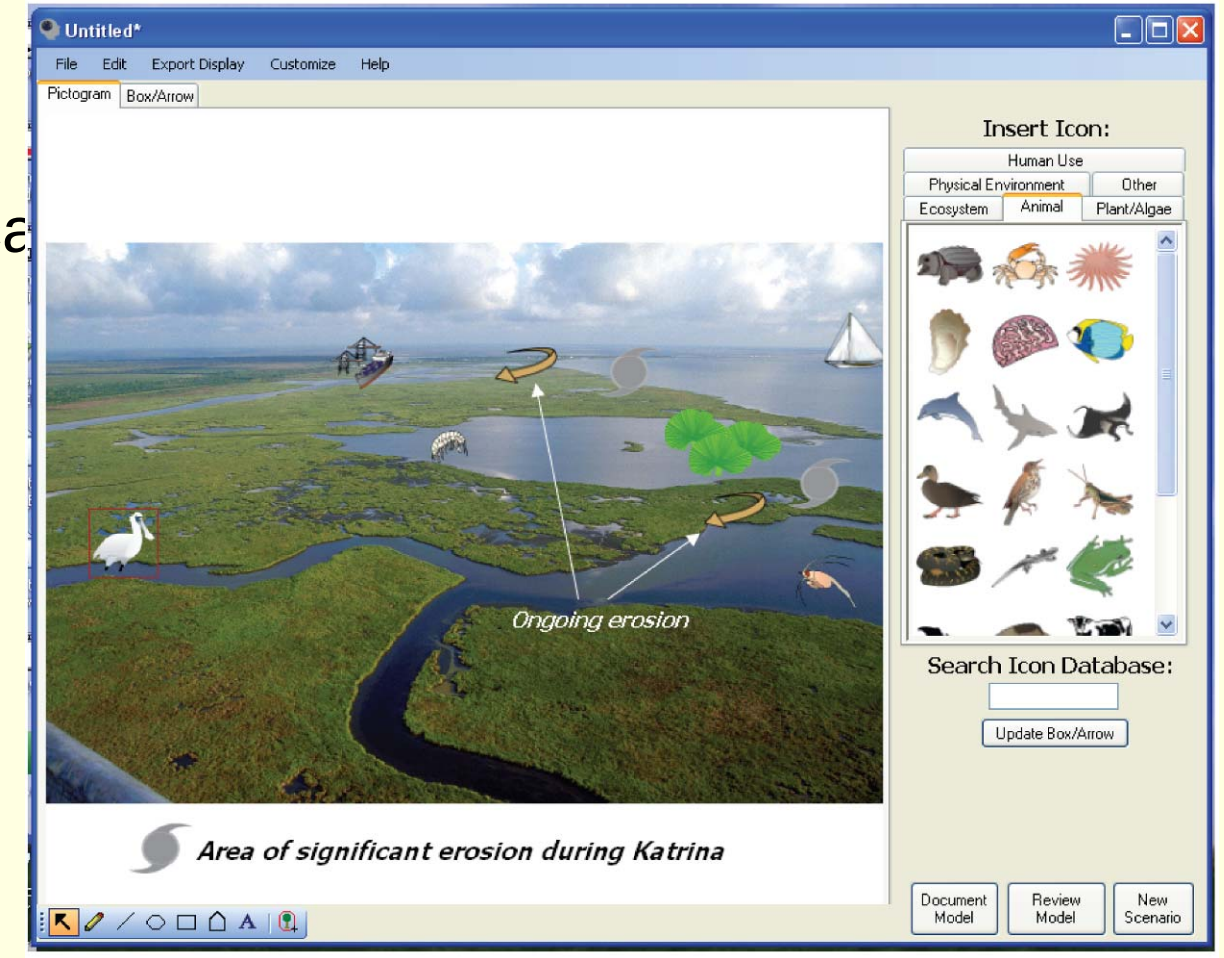
Conceptual Models FY09 Products

- **TN: "Improving Conceptual Model Development: Avoiding Underperformance Due to Project Uncertainties"** Status: (Completed Sep 09)
- **Factsheet - Public focus: "Conceptual Models and Louisiana Coastal Ecosystem Restoration"** Status: (Completed Apr 09)
- **Factsheet – PDT focus: "Conceptual Models in Ecosystem Restoration Project Planning"** Status: (Completed Sep 09)
- **JA: "Conceptual Models in Ecosystem Restoration Planning and Benefits Analysis: State of the Science and State of the Practice"** Status: (75% Completed)
- **Model Building Software V1.0: "Conceptual Ecological Model Construction Assistance Toolbox (CEMCAT)"** Beta Version Complete Sep 09

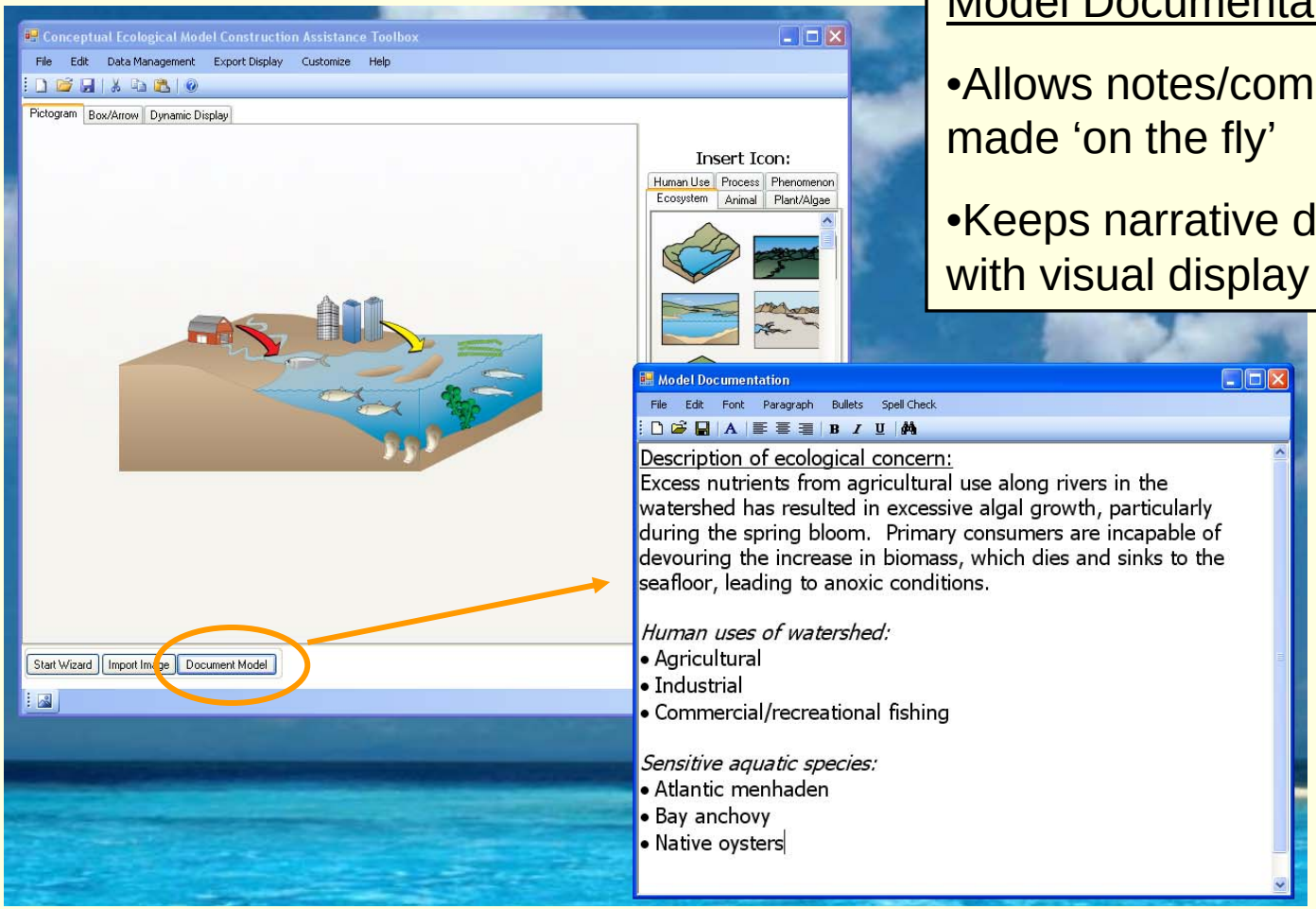
Conceptual Model Software

- Model Building Software V1.0: "*C*onceptual *E*cologica*l* *M*odel *C*onstruction *A*ssistance *T*oolbox (CEMCAT)"
- Status: Completed (September, 2009)

(Show Demo)



Conceptual Ecological Model Documentation/Construction Toolbox



Model Documentation:

- Allows notes/comments to be made 'on the fly'
- Keeps narrative description with visual display

*Conceptual Design

Better Documentation

The Problem Addressed:

Improve the quality, consistency, and completeness of ER project/program documentation

Benefits to Corps Users:

- "Checklist" of common documentation issues/challenges
- Increase consistency in documentation practices among ER practitioners
- Improve quality of document first drafts
- Reduce frequency of repeated errors
- Decrease time/energy associated with review-revision cycle
    - Authors
    - Reviewers
- Identify deficits in existing guidance and techniques

Better Documentation
FY09 Products - Status

- **IEB: "Common Documentation Challenges in Corps Ecosystem Restoration Feasibility Reports and Recommendations: Issues, Examples and Recommendations"** Status: (In Progress - 80% Completed)
- **IEB: "Opportunities for Improving Review Procedures: Ongoing Efforts and Potential Future Activities"** Status: (In Progress - December 2009)
- **TN: "Improving Ecosystem Restoration Feasibility Report Content and Documentation – Part 1: Vertical Team and Headquarters Review"** Status: (In Progress - January 2010)
- **On-line Tool: Glossary of ER/EBA Terminology** (Status: Due Oct. 09)
- **On-line Tool: Citation Index for EBA Sources and References** (Status: Oct. 09)
- **Webinar: "Aquatic Ecosystem Restoration: A Primer "** Status: In Development (December 09)

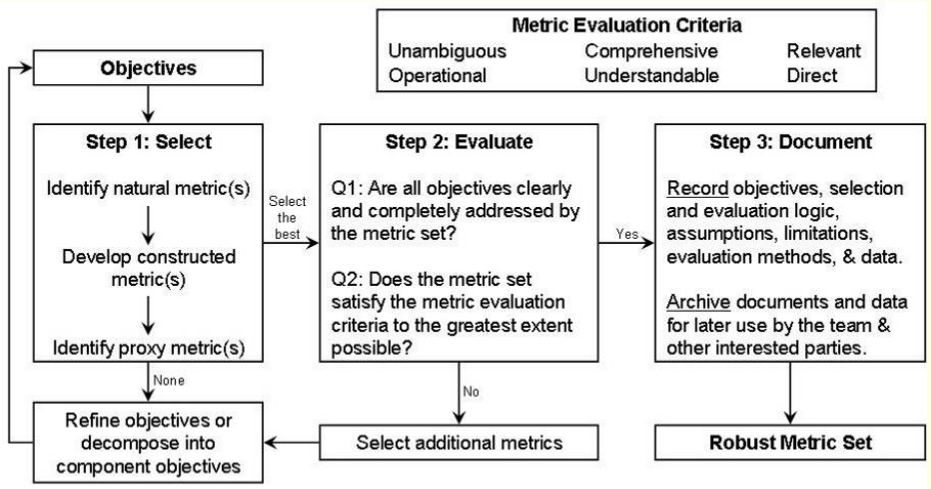
Metric Development for EBA

Problem Addressed:

- Critical considerations in selection and development of metric sets for ecosystem restoration are often overlooked
- Diversity of projects with diverse objectives – a challenge to compare dissimilar metrics within & between projects
- No guidance available to ensure metrics are scientifically valid
- Need for improved/innovative benefits indicators

Benefit to Corps Users:

- Instructional/foundational concepts
- Systematic, structured approach
- Clear objective → metric linkage
- Framework is applicable at project and programmatic scales



FY09 Metrics Products

- **TN/JA: "Metric Development for Environmental Benefits Analysis"** Status: in Management Review
- **TN: "Comparing Project with Dissimilar Metrics"** Status: Submit 9/09
- **TN: "An Approach for Identifying, Applying, Combining, and Comparing Metrics used in Ecosystem Restoration Projects"** Status: Submit 9/09
- **TN: "Methods to Ensure Scientific Validity of Metrics for Ecosystem Restoration** Status: in development
- **TR: "Measuring Environmental Value In Nonmonetary Terms: A Review of Common Practices and Elements"** Status: Final Editing
- **TR: "A New Nonmonetary Metric for Indicating Benefits From Army Corps of Engineers Ecosystem Restoration Projects"** Status: Final Editing
- **TR: "Concept Acceptability of Non-monetary Environmental Benefits Metrics for Ecosystem Restoration Projects Planned by the US Army Corps of Engineers"** Status Peer Review
- **TN/JA: "A New Metric for Indicating Benefits from USACE Ecosystem Restoration Projects"** Status: Peer Review

Comparing Dissimilar Metrics

- Nested normalization
- Ordinal data – To quantity or not to quantify
- Direction of benefit
  - Change the sign of a measurement
  - Take the reciprocal
- Non-continuous scale from worst to best – optimal solutions
  - Use the absolute value of the optimum minus the observed quantity and minimize
- Multiple numerical algorithms for normalization
  - Reduce data to a finite scale (e.g. zero to one) for comparison or combination purposes
  - Different strengths and weaknesses

Numerical Algorithm	**Strengths**	**Weaknesses**
Percent of Maximum	•Respects cardinality •Preserves proportionality •Finite scale (0 to 1)	•Does not cover the interval from 0 to 1 (FWOP > 0) •Values do not sum to one
Percent of Range	•Respects cardinality •Finite scale arrayed from 0 to 1	•Does not preserve proportionality •Values do not sum to one
Percent of Total	•Respects cardinality •Preserves proportionality •Values sum to one •Finite scale (0 to 1)	•Does not cover the interval (FWOP > 0, Max Ben < 1)
Unit Vector	•Respects cardinality •Preserves proportionality •Finite scale (0 to 1)	•Does not cover the interval (FWOP > 0, Max Ben < 1)
Percent of Reference	•Assesses the value of restoration beyond proposed actions	•Identification of reference is challenging •Provides an intangible scale

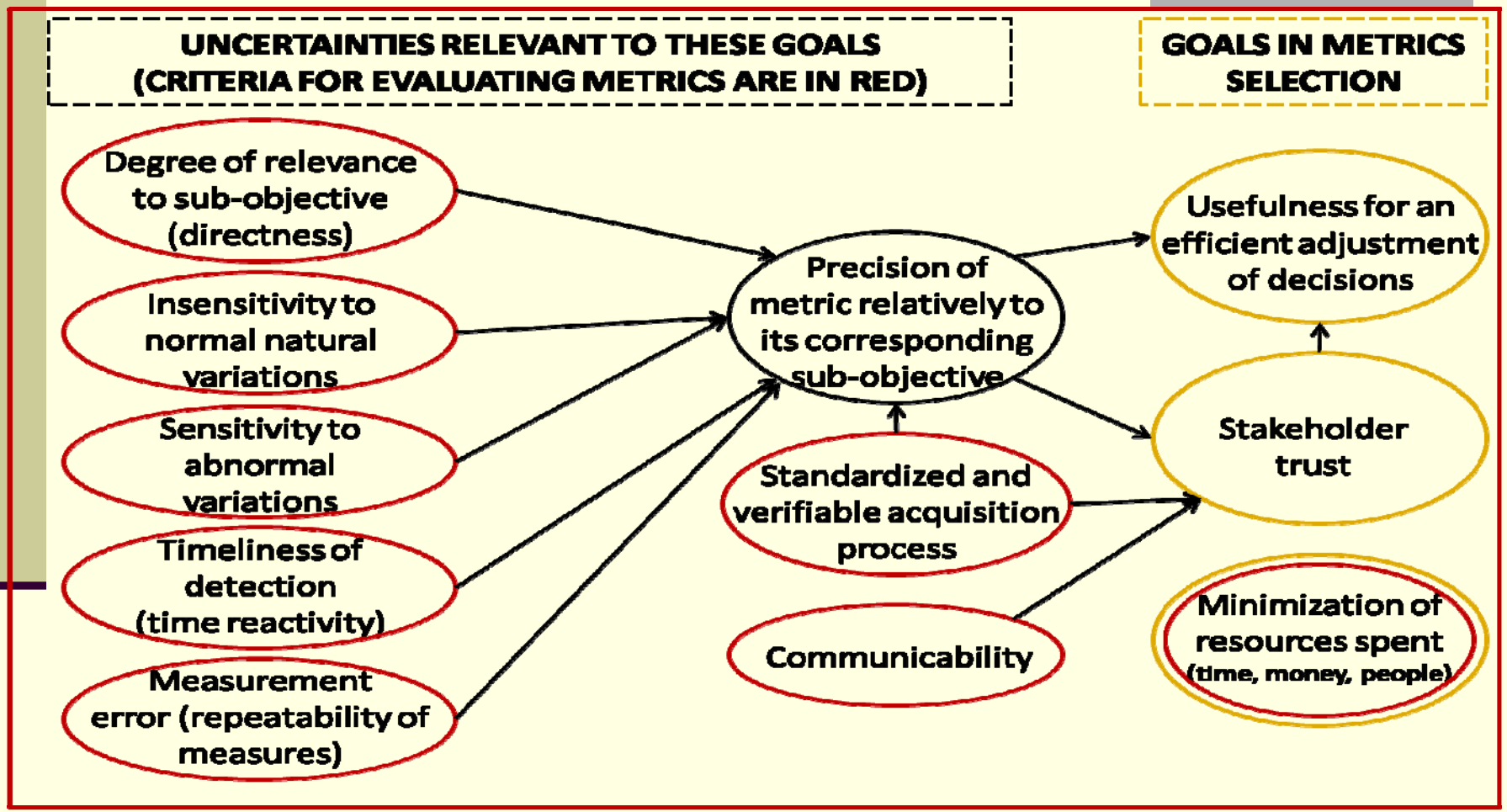
Methods to Ensure the Scientific Validity of Metric Sets

How it Addresses the Problem: Develop scientifically sound principles, standards, and protocols for evaluation of candidate metrics and metric sets that are consistent with Corps planning guidelines.

Benefits to Corps Users:

- Provides a sound basis for calculating environmental benefits and evaluating outcomes
- Helps districts avoid the need for project reformulation as a result of HQ and ASA-CW concerns
- Ensures ability to confidently evaluate project performance and adapt accordingly
- Enhances scientific credibility of the Corps ER program

Comparing and Validating Metrics: *Ensuring scientific validity*



An influence diagram representing criteria for evaluating metrics (starting point for next paper on metric selection)

Risk, Uncertainty and Decision Analysis

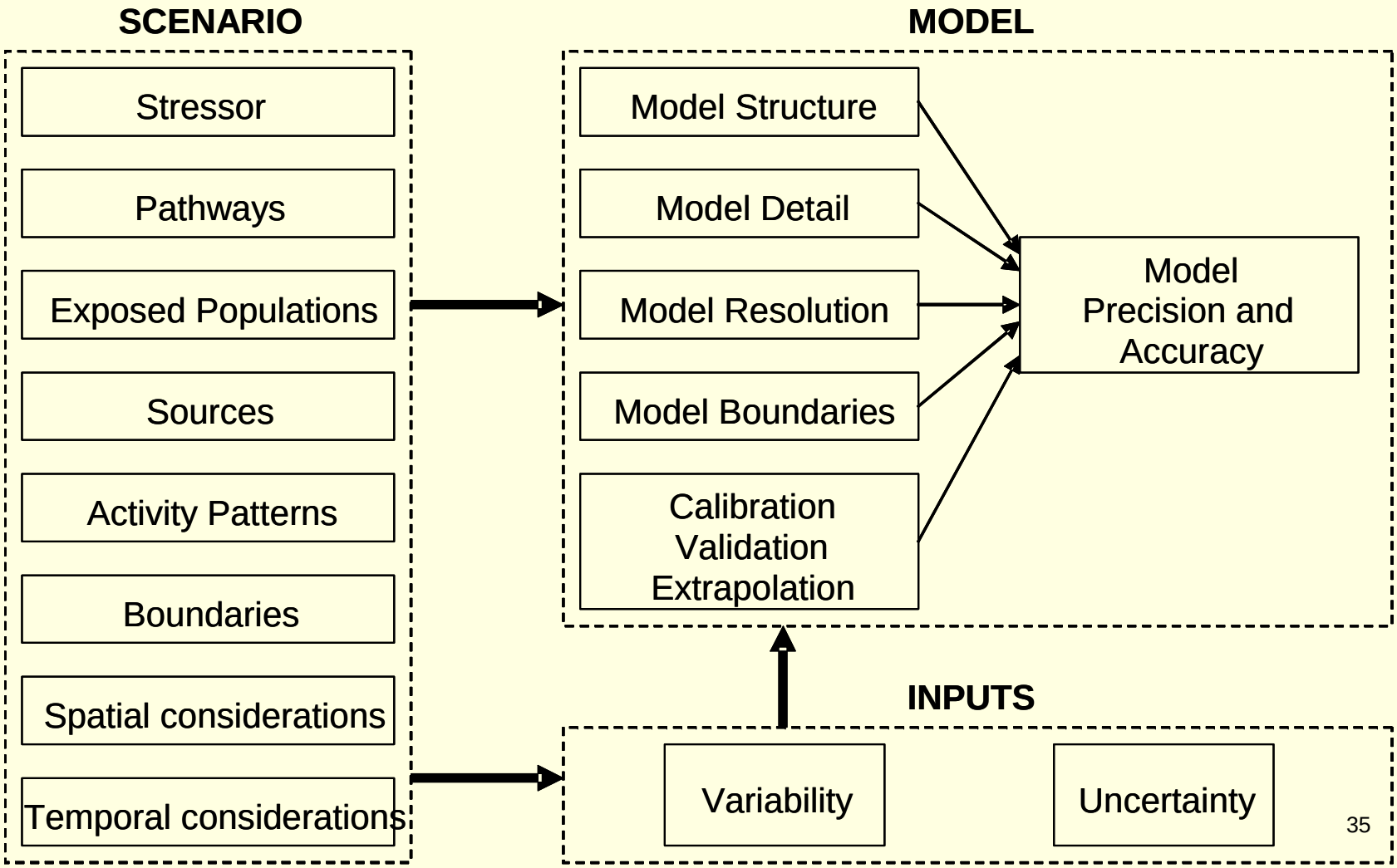
Problems Addressed:

Uncertainty analysis is perceived as overly complex to implement in restoration projects

Methods for decision analysis are not well documented for ecosystem restoration projects

- **TN: Addressing Uncertainty in Ecosystem Restoration** Currently In Internal Peer Review
- **TN: Using Multi-Criteria Decision Analysis to Support Ecosystem Restoration Planning** Submit to Internal Peer Review Sep '09
- **TN: "Monte Carlo Simulations in EXCEL"** Status: Oct 09
- **TN: Forecasting Ecological Response to Urban Growth** Submit to Internal Peer Review Sep '09

Sources of Variability and Uncertainty in Ecosystem Restoration



Monte-Carlo Simulations

Product Title: TN – Monte Carlo Simulations in Microsoft EXCEL

How it Addresses the Problem:

•Microsoft EXCEL has a random number generator feature that can be employed to develop rather simple yet powerful statistical analyses for estimating uncertainty. This brief technical tip explains how it is done.

Benefit to Corps Users:

•A means of addressing uncertainty using existing tools and models

Alternatives Analysis

	Restored Area	Percent Cover of Emergent and Submerged Vegetation				Velocity				Water Depth				Water Regime		Water Temperature		Quality Score	Habitat Units
	ac	%COVER			SIV1	VEL_cm/s			SIV2	DEPTH_m			SIV3	REGIME	SIV4	TEMP	SIV5	HSI	HUs
		Mean	St Dev	Guess		Mean	St Dev	Guess		Min	Max	Guess							
FWOP	1000	20	5	18.64	0.35	50	10	49.01	0.39	1.4	1.6	1.57	1.00	A	1	D	1	0.349	**349**
Alt1 - Plant	1000	40	10	25.65	0.41	40	15	60.48	0.24	1.5	2	1.74	1.00	A	1	D	1	0.244	**244**
Alt2 - Plant, Water	1000	60	5	56.58	0.65	30	10	20.92	0.74	1.75	2.25	2.17	0.87	A	1	D	1	0.653	**653**
Alt3 - Plant, Water, Weir	1000	75	3	73.55	0.79	20	5	16.78	0.79	2.3	2.7	2.69	0.45	A	1	D	1	0.447	**447**
		Normal Dist				Normal Dist				Even Dist									

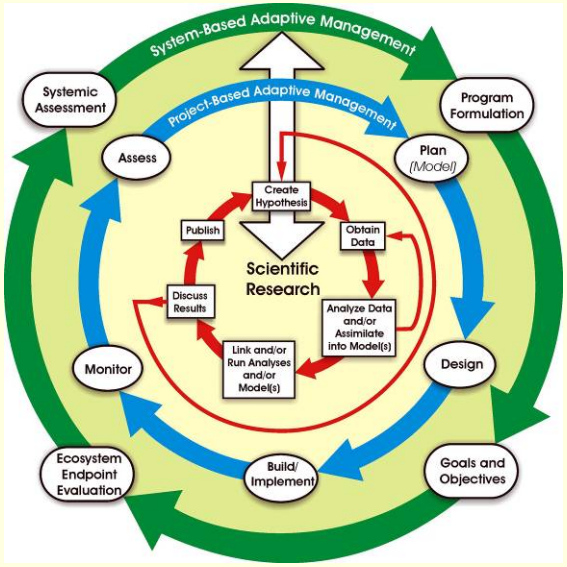
Number of Iterations: 500

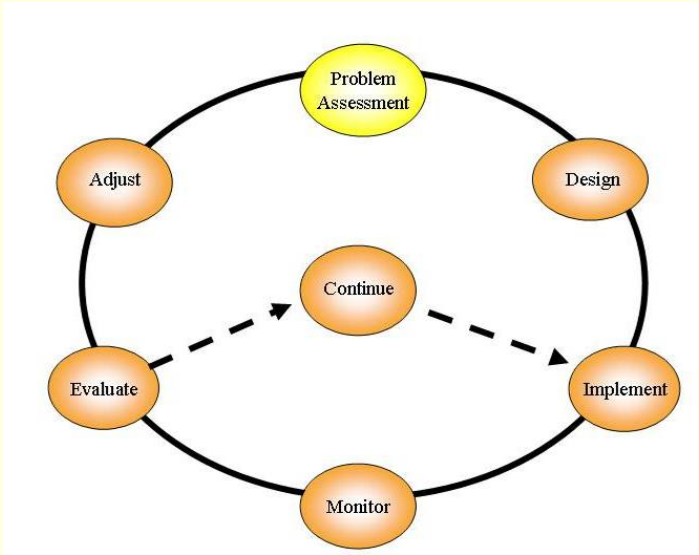
Run Monte Carlo

Clear Results

Monitoring & Adaptive Management

- **TN: "Interim Recommendations on Monitoring Requirements and Practice"** Status: Submit to peer review 9/09
- **JP: "Adaptive Management Strategies for Ecosystem Restoration"** Status: draft complete 9/09, submission 10/09





Monitoring Products

Product Title:

• TN-- “Interim Recommendations on Monitoring Requirements and Practice”

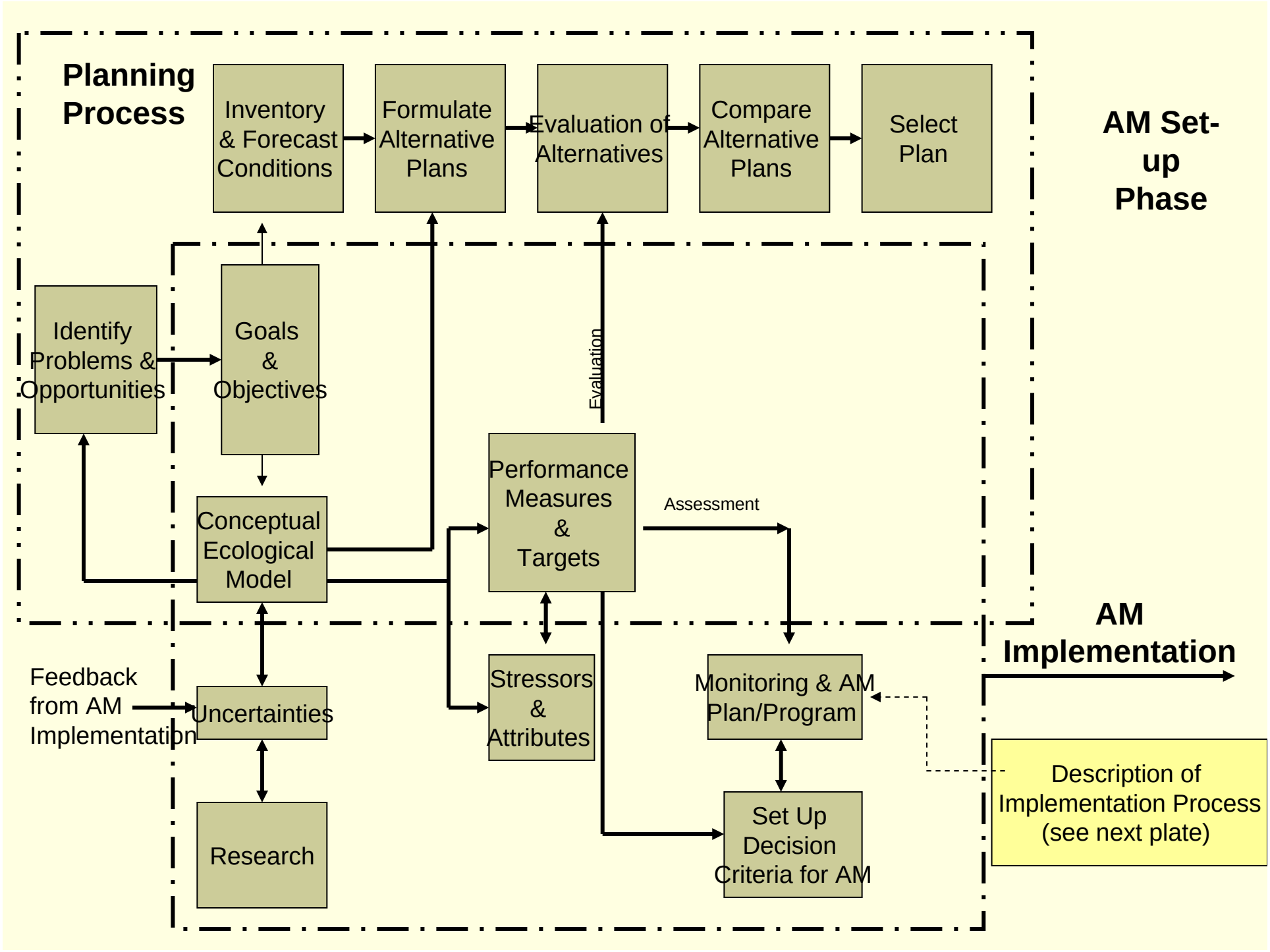
•Webinar-- “Monitoring Requirements”

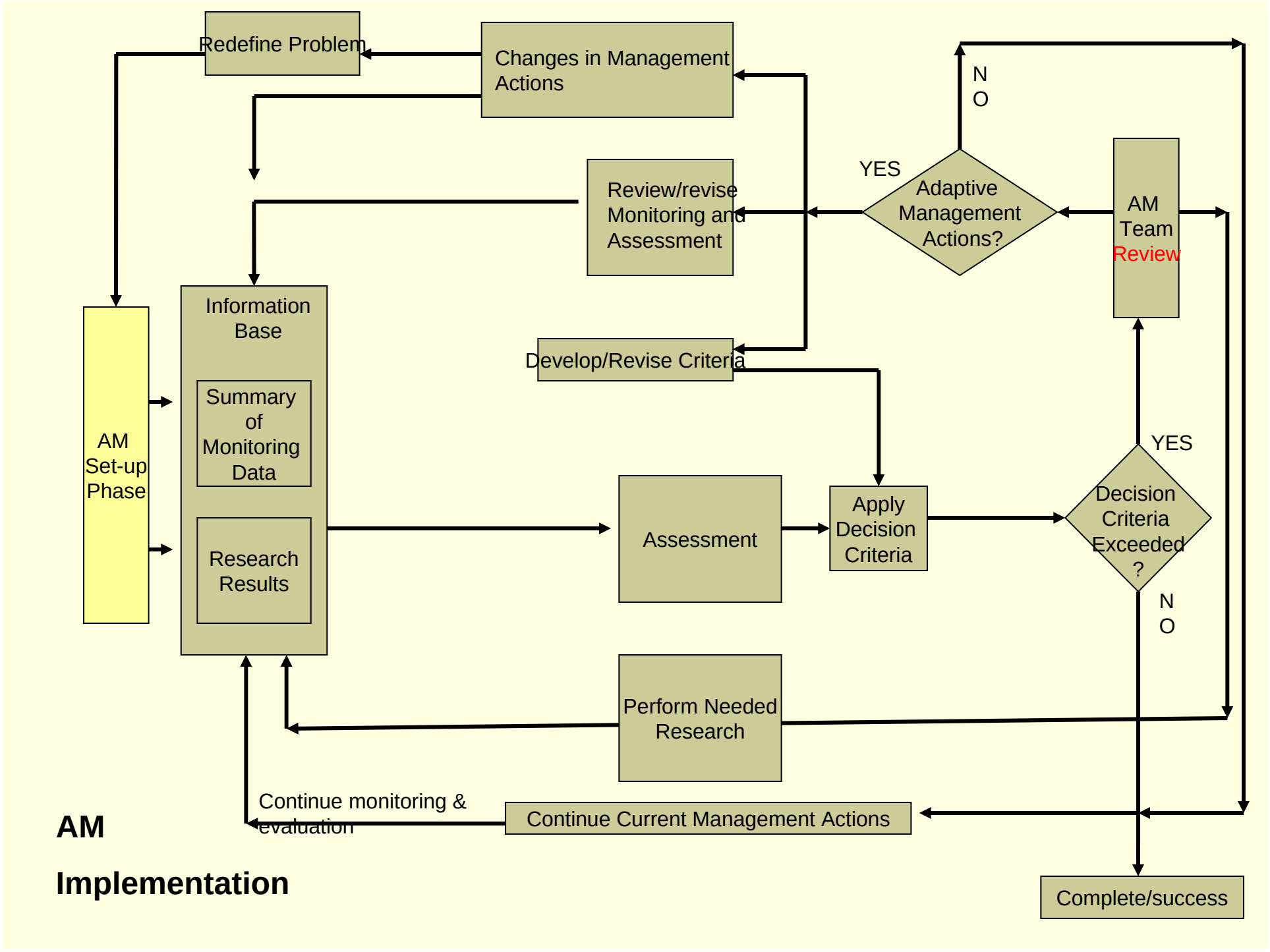
How They Address the Problem: WRDA 2007 and related guidance documents place increased importance on monitoring, both for quantification of project success and to facilitate adaptive management. However, standards and needs are not uniform for all type of projects. These products communicate the changes to the field and offers recommendations on implementation.

Benefits to Corps Users: Effective monitoring using available tools offers planners, practitioners, and leaders a host of benefits in documentation of benefits, learning opportunities, project-level and programmatic efficacy, prioritization, effective and timely adaptive management, and disciplinary progress.

FY09 M&AM Field Tests

- Yellowstone Cumulative Effects - M&AM program under a Special Area Management Program (SAMP) designation for the Upper Yellowstone River
- Truckee River - Monitoring and Adaptive Management for basin-wide fish passage work
- Milltown Dam - Long-term monitoring program for the removals of Stimson and Milltown Dams will support AM activities in channel and riparian restoration.
- Louisiana Coastal Authority – Monitoring and Adaptive Management Plans for first six projects and development of a programmatic framework


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


Redefine Problem
Changes in Management Actions
N
O
YES
Adaptive Management Actions?
AM Team Review
Review/revise Monitoring and Assessment
Information Base
Summary of Monitoring Data
Research Results
AM Set-up Phase
Develop/Revise Criteria
Assessment
Apply Decision Criteria
Decision Criteria Exceeded ?
YES
N
O
Perform Needed Research
Continue monitoring & evaluation
Continue Current Management Actions
Complete/success
AM
Implementation

FY09 Programmatic Products - Status

- **TN: "Establishing and Applying Reference Condition Standards for Ecosystem Restoration"** –Status: Draft in development (September 09)
- **JP: "The Scientific Underpinnings for Reference-Based Approaches to Ecosystem Restoration"** – Status: Draft in development
- **TN: "Guidelines and Examples for HGM Budgeting Criteria Scoring"** –Status: Draft (Nov 09)
- **TN/JA: "A method for quantifying aquatic ecosystem significance at regional and national scales**"; Mar 10
- **TN: "Guidelines for Establishing Regional Ecosystem Restoration Priorities "** Dec 09
- **TN: "Quantifying aquatic ecosystem significance at regional and national scales"** Dec 09
- **TN: "Methods to Characterize End-points in Dynamic Ecosystems"** Dec 09
- **TN/JA "Review: key principles of restoration and recommended strategies for environmental benefits characterization"** (Sep 09)

Reference Approaches

Key Questions:

- Potential for using reference based concepts as fundamental objective in ER projects
- Use as a “metric” – to what extent did we restore the system?
- How do you make comparison to determine what the measure was designed to achieve?
- How do we ID reference systems, real vs. models
- How are reference systems related to idealized or unimpacted condition?

Challenges:

- Which reference target to choose
- Which parameters to measure
- How to address projects of differing scale
- How to reconcile reference condition characterized by different metrics
- How to compare projects of differing scale or type at a regional level
- How to incorporate reference condition comparisons into a national ecosystem restoration program

Significance

Product Title: TN Q*uantifying aquatic ecosystem significance at regional and national scales*

How it Addresses the Problem:

• *Provides a transparent, systematic approach to classifying and ascribing regional and national significance re: aquatic resources*

•*Provides a scientifically valid and professionally accepted approach to augment or replace* ***Scarcity, Connectivity, Special Status Species, and Plan Recognition*** *in the program evaluation process*

Benefits to Corps Users:

• *If implemented, a lookup table reduces district workload by making relevant information readily accessible*

• *Gives HQ program managers objective basis for prioritizing projects*

• *Enhances scientific credibility of the Corps program*

Key Principles

Defining ecosystem restoration

Attributes of restored ecosystems

Reference conditions and succession/restoration trajectories

Assessment criteria (structure, function, services, emergent properties)

Rates of change and temporal scales (ecological time vs. practicality)

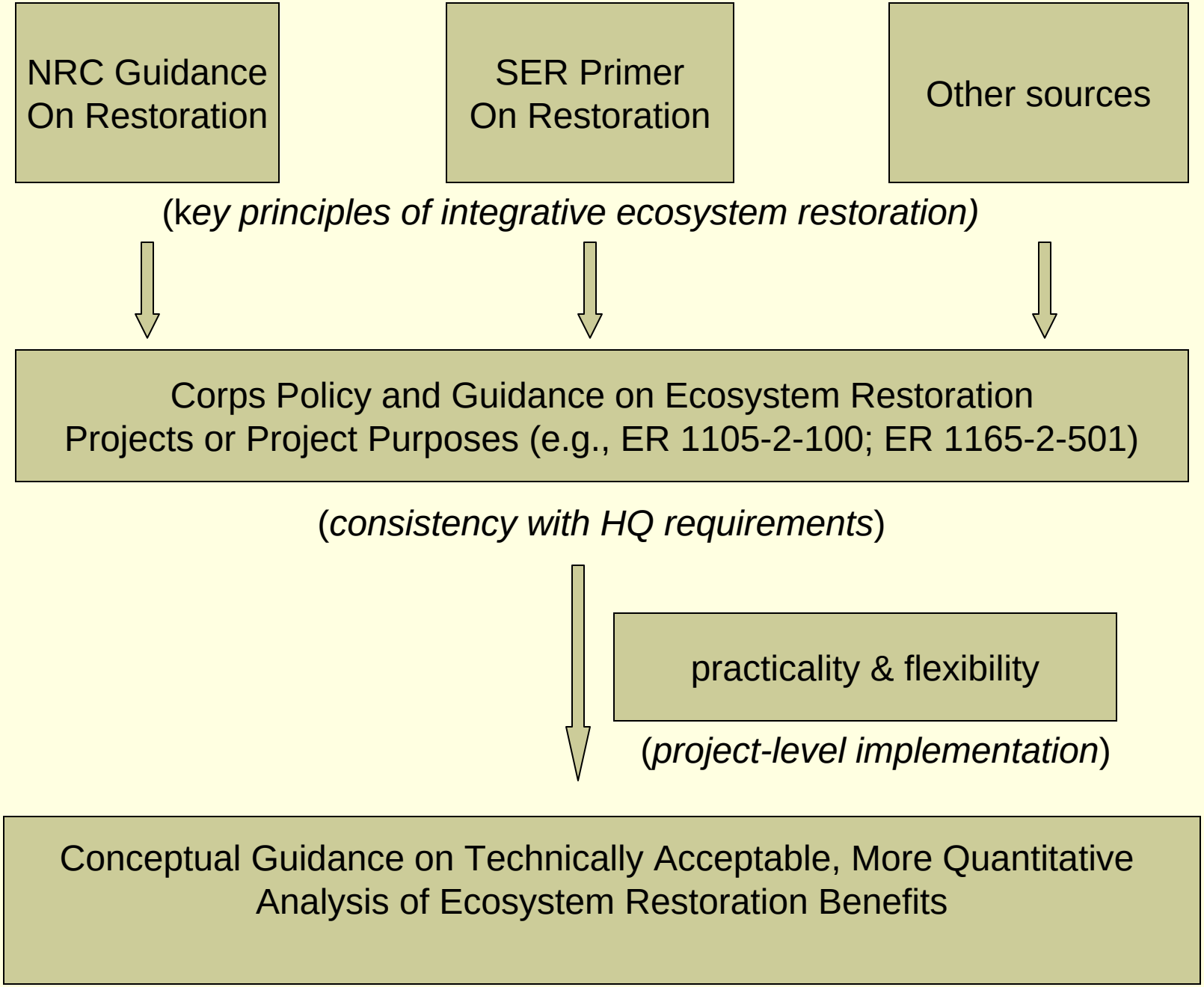
Spatial scales and interactions (large-scale, integrative)

Ecosystem ubiquity and abundance (rarity, scarcity)

Uncertainty (incomplete knowledge, natural variability and dynamics)

Adaptive management

Opportunity-cost analysis


NRC Guidance On Restoration
SER Primer On Restoration
Other sources
(key principles of integrative ecosystem restoration)
Corps Policy and Guidance on Ecosystem Restoration Projects or Project Purposes (e.g., ER 1105-2-100; ER 1165-2-501)
(consistency with HQ requirements)
practicality & flexibility
(project-level implementation)
Conceptual Guidance on Technically Acceptable, More Quantitative Analysis of Ecosystem Restoration Benefits

For Each Key Principle…

(e.g., Reference Condition)

Synoptic technical background

Least disturbed parcels, desired future condition, historical condition, etc

Interaction with surrounding environment

Multiple references, composite representations, stochasticity

Relation to Corps policy and regulations

Naturalistic mimic

Least disturbed condition under constraints

Fast-track to improved practice

Recognizing and describing a reference

Basis of description (empirical or conceptual)

Approach (sources, larger scale, more holistic)

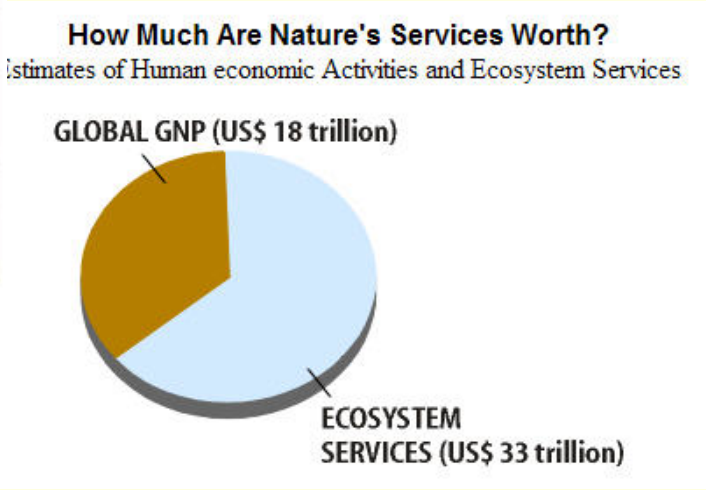
Slow-track to improved capability

forensic analyses

comparative empirical studies

Services / Valuation

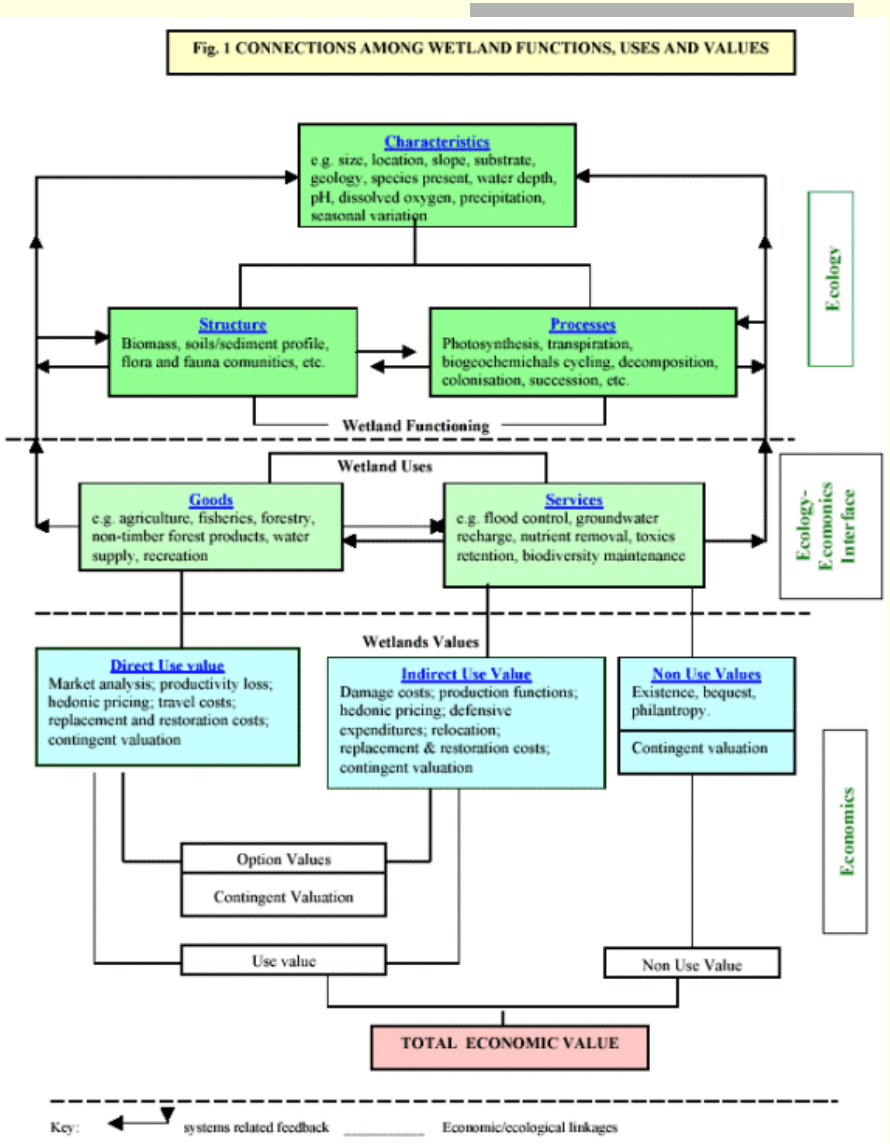
Value of Wetland Services		
	Total value (US$) per hectare per year	Total global flow value (US$ per year)
Estuaries	22,382	4,100,000,000,000
Seagrass/algae beds	19,004	3,801,000,000,000
Coral reefs	6,075	375,000,000,000
Tidal marsh/mangroves	9,990	1,648,000,000,000
Swamp/floodplains	19,580	3,231,000,000,000
Lakes/rivers	8,498	1,700,000,000,000



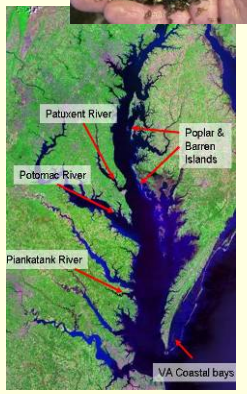
Adapted from R. Costanza et al., "The Value of the World's Ecosystem Services and Natural Capital," Nature, Vol. 387 (1997)

Ecosystem Services Affected by Corps Activities

- Water Supply and Regulation
- Erosion Regulation/ Sediment Management
- Water Purification and Waste Treatment
- Natural Hazard Regulation
- Biodiversity Maintenance
- Recreational Opportunities
- Food
- Fiber, Fuel, and other Raw Materials
- Climate Regulation
- Clean Air
- Science and Education
- Maintain Cultural Diversity
- Spiritual and Inspirational
- Aesthetics



Benefits Quantification



Product Title: Retrospective Evaluation of Corps Ecosystem Restoration Techniques and Practices

How it Addresses the Problem: Data and information on

- Performance of select Corps projects
- Commonly employed techniques and practices
  - *wetland, coastal/estuary, and riverine/stream systems*

Benefits to Corps Users:

- Documents best techniques/practices and lessons learned
- Catalogues innovative and successful projects
- Improves Corps planning and design
- Identifies critical success metrics and monitoring parameters
- Helps formulate programmatic benefits assessment

Workshop Agenda
20-21 October 2009

- General principles & guidelines
- Challenges and opportunities
  - *Potential obstacles*
  - *Opportunities to advance science & practice*
- Metrics & baselines – *what constitutes success?*
- Data availability – *needs, availability, addressing gaps*
- Projects, techniques and practices – *where to focus and how best to assess*
- Innovative case studies
  - *Innovative/effective application of common techniques*
  - *Innovations in techniques and practices*

What Next?

FY10 – FY12

Make “Big Picture” decisions regarding overall strategy (depends upon P&G and other concerns)

Establish an assessment framework.

Develop necessary tools and guidelines.

Maximize technology transfer through demonstrations, partnership opportunities and other means.

Big Picture Considerations

Eco-Centric

- Performance Metrics?
- Significance/System Valuation?
- Degree of Restoration?
- Use of Reference Systems?
- Common Objectives?

Socio-Centric

- Monetization?
- Which Non-Market Valuation Methods?
- Which Services?
- Common National/ Federal Standard?
- Integrative Indexes?

FY10 Example Efforts

- Conceptual Model Builder (Refinements to Beta)
- Avoiding lumpy formulation (separating elements for defining thresholds)
- Defining minimum outputs of significance (how much difference among outputs is significant, and at what point can two alternatives be considered equivalent)
- Services provided by systems and restoration projects
- Optimizing NED/NER benefits using the trade-off and other tools
- Monitoring and Adaptive Management Plan Development Tool
- Future without project scenarios (how to define and characterize)

FY10 Example Efforts (Cont'd)

- Demonstrating the ecological significance of physical changes (especially HGM)
- Defining project limits (what is the extent of the aquatic influence of the project)
- Describing the "natural" range of dynamism for aquatic systems
- Aquatic habitat comparison tool (similarity index)
- Under what circumstances should we rely upon acres and stream length?
- Metric sets for SER's attributes
- Comparing/Combining benefits across programs
- Linking project effects-quantifying cumulative benefits (program versus project)

Key Contacts

Program Manager: Glenn Rhett (ERDC-
Technical Director: Al Cofrancesco
PCX Proponent: Jodi Staebel
HQ Proponent: Rennie Sherman

Website: www.CorpsEcoRestoration.us/EBA