

Environmental Benefits Analysis Research Program

*Improving benefit assessments using
scientifically-based metrics and peer-reviewed
methods in support of the Federal investment in
ecosystem restoration.*

Craig Fischenich, PhD, PE
ERDC Environmental Lab



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The Need for the Program

Deficiencies in Corps ER feasibility reports and in the demonstrated success of the agency's ER program have been identified by decision-makers at HQ, at the Office of ASA(CW), and in OMB.

- Analyses of environmental benefits must be based on **best available methods** that will withstand external peer review
- **National and regional strategies** for environmental restoration must be formulated and articulated
- **Clear communication and accounting** is required of the benefits of proposed and in-place restoration projects, as well as the Corps' ER Program



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The Challenge



Wetlands



River Basins



SAV



Sea Grass



Coastal



Stream Corridors



Urban



Terrestrial



Reservoirs

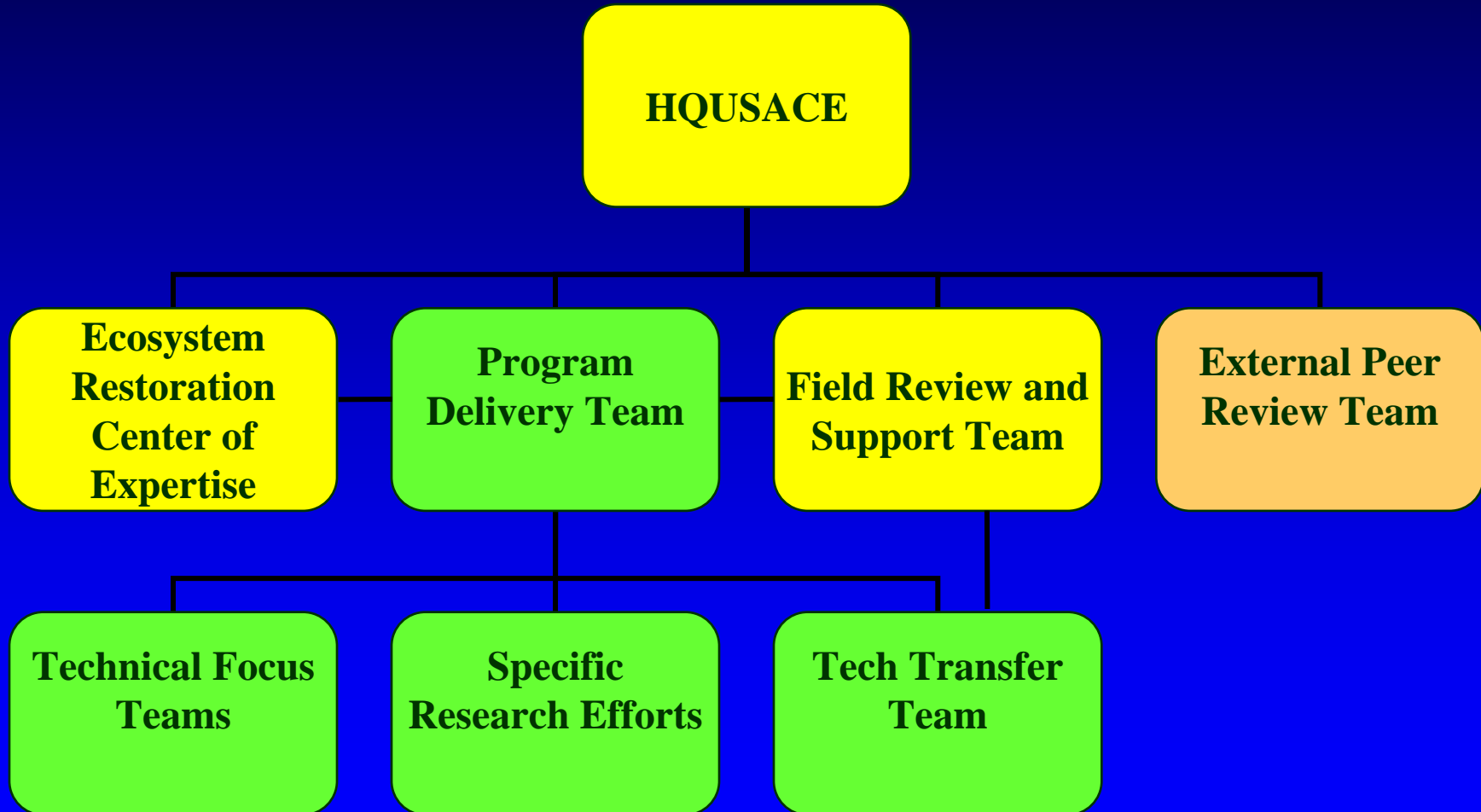
Keystones of the EBA Research Program Structure

- Full participation by **external experts**
- Active and continual exposure to critical **peer review**
- Real **partnering** of ERDC with Corps HQ, Districts, and Divisions
- Proactive methods for **tech-transfer** of new research results



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Organizational Structure



Themes of EBA Research Program

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 national and regional levels



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EBA Workshop Goals

- Assess and summarize the **state of the science** and the **state of the practice**
- Produce **interim guidelines** for use during the continued research effort
- 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



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Ecological Models

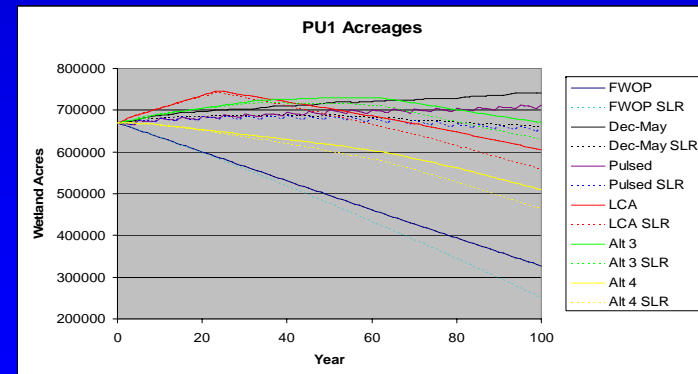
Restoration ecology is a young science with considerable uncertainty

Models support both communication and prediction of benefits

Conceptual models specify the *presumed relations* of hydrologic, hydraulic, and geomorphic change to ecosystem response

Empirical, stochastic and mechanistic models make *quantitative predictions* of ecosystem response to hydrogeomorphic change

| A1 | Number of Monte Carlo Iterations | | |
|----|---|--------------|-----------------------------|
| A | B | C | D |
| 1 | Number of Monte Carlo Iterations | 50 | |
| 2 | Diversion Hydrograph | | |
| 3 | | | Clear Monte Carlo Data |
| 4 | | | |
| 5 | River Hydrograph | | |
| 6 | Only used if sediment rating is used. | | |
| 7 | | | Run Monte Carlo Analysis |
| 8 | Annual Discharge Volume, V_{ann} (L) | 3.3452E+12 | Note: St Dev = (Max-Mean)/3 |
| 9 | Nutrients | | |
| 10 | | Mean | Std Dev |
| 11 | Plant Productivity Rate, P_r ($g/m^2 \cdot y$) | 2842.046404 | 3000 |
| 12 | % Retention | 0.604570126 | 0.5 |
| 13 | Percent of N and P in Plant Biomass, % TNP | 0.005766244 | 0.0068 |
| 14 | TNP_{veg} (kg/ac) | 66.313 | 0.001133333 |
| 15 | Background Conc of N and P, $TNP_{background}$ (mg/L) | 0.301177888 | 0.35 |
| 16 | Source Conc of N and P, TNP_{source} (mg/L) | 2.060549827 | 2 |
| 17 | TNP_{av} (kg) | 5885455.1 | 0.22 |
| 18 | Nutrient Potential Acres, A_{npot} (ac) | 53657 | |
| 19 | Land Loss Rate | -0.002546402 | -0.0044 |
| 20 | Nutrient Acres | 136.6 | 0.000733333 |
| 21 | Wetland Flow Geometry | | |
| 22 | | | |
| 23 | Initial Land Area, A_i (ac) | 126155 | 126155 |
| 24 | Initial Water Area, A_w (ac) | 134723 | 134723 |



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Multi-Scale Metrics

Metrics establish the terms of assessment, and serve to **integrate** objectives, decision criteria, benefits quantification, and monitoring

Relevant spatial and temporal **scales vary** widely, and clear **differences exist** among ecosystems, and between project and program perspectives

Need to address...

- **Requirements** or characteristics for good metrics
- Concept and potential of **universal** metrics



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Decision Analysis

Most restoration projects have multiple objectives, and information and knowledge uncertainty is common

Formal decision analysis tools can help...

Promote a **common understanding** of complexity

Promote decisions despite **uncertainty**

Integrate stakeholders' **values** with predicted **performance** of alternatives

Help identify critical information **needs** and support adaptive mgt.

Tools must ensure national significance while acknowledging local priorities

Uncertainty must be explicitly addressed and incorporated into decisions



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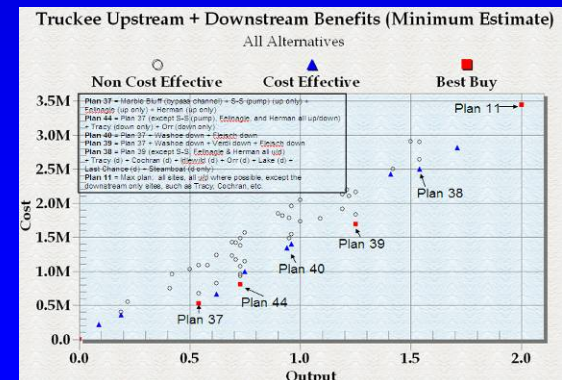
Environmental Benefits Quantification

We do not fully account for ecosystem restoration benefits

Restoration generates significant economic benefits associated with tourism, recreation, increased property values, job creation, etc.

EB Quantification must support alternatives evaluation during project planning, but should also describe the return on investment

Guidance is needed for EB analyses and presentation. Merger of multi-criteria decision and incremental cost analysis tools is likely

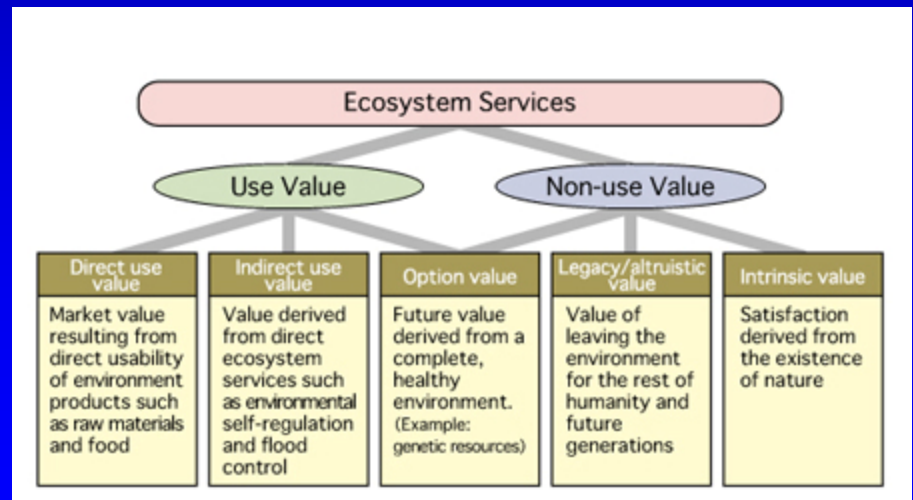


Ecosystem Services

Restoration projects have diverse benefits: social, economic, and ecological

Economic costs of restoration projects must be considered

Economic principals can be applied to place environmental benefits into a social context



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Programmatic Assessment

National and regional priorities must inform selection among competing restoration projects

Criteria and metrics for national and regional prioritization should relate to project-level criteria and metrics

Support for national and regional restoration programs is critical and the program must be capable of presenting summaries of project-or region-level progress toward realization of benefits

Benefits must be readily apparent and convincing to non-technical audiences

Tools and guidance are needed to define significance



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Budgetary Criteria

- Scarcity
- Connectivity
- Special Status Species
 - Provides significant contribution to key life requisite of special status species
- Hydrologic Character
 - Restores the natural hydrologic “signature” of a system (timing, magnitude, duration, frequency of flows)
- Geomorphic Condition
 - Establishes suitable structure and physical processes (erosion, sediment transport, deposition) for successful restoration
- Plan Recognition
 - Contributes to watershed or basin plans as emphasized in “CW Strategic Plan”
- Self-sustaining
 - Ideal goal is self-sustaining ecosystem consisting of natural processes



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Technology Transfer

Innovative web-based design that encourages shared efforts of ERDC, HQ, Districts, Divisions, and others

Single portal to national, regional, and site-specific information and products with opportunity to affect those under development

Field-oriented publications to compile experience and keep focus on efficient improvement of restoration planning and documentation

Peer-reviewed publications; necessary but insufficient

Increased use of **web-based training,** video presentations, and toolboxes

Environmental Benefits Analysis Toolbox - Microsoft Internet Explorer

Address: <http://www.environment.usace.army.mil/ebah/toolbox.cfm>

Developing State-of-the-Art Tools and Techniques for the Assessment of Environmental Benefits in Support of the Federal Investment in Ecosystem Restoration

Toolbox

This toolbox contains the models, tools, presentations, and training materials developed under the EBA Program. Documents, including technical notes, reports, etc., can be found on the [Toolbox!](#) New tools will be posted as they become available.

| Model/Tool | Work Unit | Product | PI |
|-------------------------|--|--|----------------|
| Benefits Quantification | Assessing Benefits | On-Line Tool Assesses for Ecosystem Outputs | Leigh Skaggs |
| Decision Analysis | GIS Tools for Support, Integration, Display of EBA Model Results | "Patch Calculator" - An ArcGIS v9 Tool for the Analysis of Landscape Patches | Jeff Lan |
| Forecasting | Coupling Physical Process Models with Environmental Analysis | "MarshBuilder" - An EXCEL model to compute wetland acreages from freshwater diversions | Craig Furchick |

| Presentations | Work Unit | Product | PI |
|-------------------------|--|--|----------------|
| Benefits Quantification | New Environmental Benefits Metric for Ecosystem Mgmt | A New Non-monetary Metric For Environmental Benefits | Dick Cole |
| Benefits Quantification | New Environmental Benefits Metric for Ecosystem Mgmt | A Nonmonetary Metric for Benefits Analysis | Dick Cole |
| Benefits Quantification | New Environmental Benefits Metric for Ecosystem Mgmt | Measuring Environmental Value in Nonmonetary Terms: A Review | Dick Cole |
| Conceptual Models | Coupling Physical Process Models with Environmental Analysis | Application of Conceptual Models to Ecosystem Restoration | Craig Furchick |

Privacy and Security Notice
Updated May 2008

Collaborators

- Environmental Protection Agency
 - Gulf Ecology Division Laboratory
 - Ecosystems Research Division
- US Department of Agriculture
 - Forest Service Rocky Mountain Research Station
 - Natural Resource Conservation Service
 - Agriculture Research Service
- NOAA National Marine Fisheries Service
- US Fish and Wildlife Service
- US Geological Survey
- National Academies
 - Patrick Center for Environmental Restoration
 - National Center for Earth Science Dynamics
- Montana Dept. of Justice
- NGOs
 - American Rivers
 - The Nature Conservancy
 - Canaan Valley Institute
- Several Universities and Affiliated Centers
 - Notre Dame, U. of Maryland, U of New Orleans, Johns Hopkins, U of Florida
 - River Basin Center, U. Georgia
 - Intermountain Center for River Rehabilitation and Restoration, Utah State U.
 - Center for Riverine Science and Stream Re-Naturalization, U. Montana



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Products

FY07

- TR: Measuring Environmental Value In Non-monetary Terms: A Review of Common Practices and Elements
- TR: A New Non-monetary Metric for Benefits from Army Corps of Engineers Ecosystem Restoration Projects
- TN: Restoration of Delta Streams: A Case History and Conceptual Model
- TN: Library of Habitat Models to Evaluate Benefits of Aquatic Restoration Projects on Fishes
- TN: Availability of Patch Calculator - An ArcGIS v.9 Tool for the Analysis of Landscape Patches
- TN: Habitat Equivalency Analysis - a Potential Tool for Estimation of Environmental Benefits
- Workshop to assess Corps state-of-the-art knowledge and R&D needs related to Environmental Benefits Analysis
- TN: The Application of Conceptual Models to Ecosystem Restoration
- TN: Hydraulic Losses in River Meanders
- TN: Vegetation Impacts Upon Stream Width
- TN: Development and Application of Flow Duration Curves for Stream Restoration
- TN: Sediment Sampling and Analysis for Stream Restoration Projects

Products

FY08

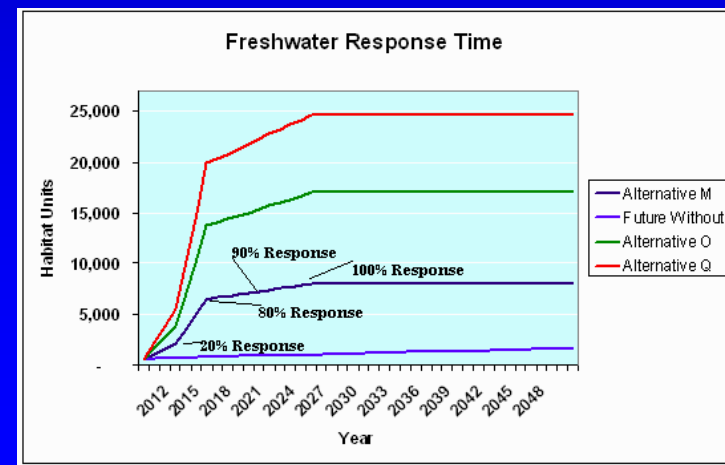
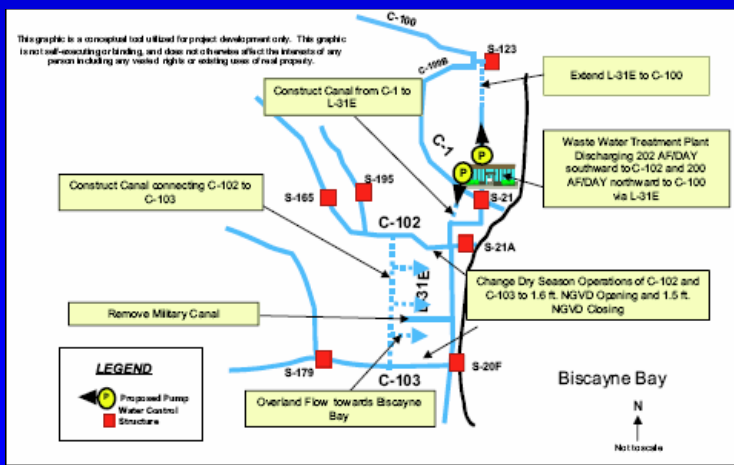
Conduct focus area workshops

15 journal papers, including one special edition

20 technical notes

Web Gateway and at least 4 web-based tools

Program and product reviews



What Next?

FY09 - 11

Establish a framework for the assessment of environmental benefits at the project and programmatic levels, employing metrics and methods that are scientifically founded and that work across ecosystem types.

Develop necessary tools and guidelines



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