



# ECOLOGICAL AND ECONOMIC BENEFITS ASSESSMENT FOR ENVIRONMENTAL DECISION-MAKING

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LTG 3 Poster 09

### Science Questions

**MYP Science Question #3**  
 How can classification schemes, modeling scenario analyses, landscape classification, and economic projections be applied to provide alternatives for meeting water quality goals efficiently at multiple scales? What are the economic benefits of watershed management?  
**Research Questions**  
 • What assessment tools and information will enable decision-makers to better understand the gains and losses realized by society in attaining high water quality?  
 • Do ecological and economic assessment methods prioritize restoration projects differently?

### How Research Addresses the Water Quality MYP Goals

The Office of Research and Development (ORD) is leading two efforts to provide methodologies for assessing the ecological and economic benefits of environmental decisions. The first research area will develop a framework to enable water quality managers to better understand the gains and losses of attaining high water quality. The second effort will develop a methodology to prioritize restoration projects. In addition to other decision-support research (see Integrated Watershed Management, LTG3, poster #8), both efforts provide tools needed for water quality management. As we progress, ORD will communicate to our customers how these tools and methods can be utilized to meet water quality goals cost-effectively.

These two ORD research efforts are not exclusive activities. Other Agency-wide activities help address approaches for benefits assessment for environmental decision-making. In addition, the Agency has developed a research plan and strategy:

- Ecological Benefits Assessment Strategic Plan (EBASP; Draft 2004)
- Environmental Economics Research Strategy

Suzannahanna River  
 Photo Courtesy of D. Williams

### Weighing Ecological Risks, Costs, and Benefits in Use-Attainment Decisions

#### Background

Under the Clean Water Act (CWA), states and tribes adopt water quality standards (WQS); this includes setting *designated uses* or goals for their water bodies. States and tribes may consider removing or modifying the designated use when natural, man-made, or socioeconomic factors preclude attainment. Before changing a use, analyses (e.g., use attainability analyses) are required. In certain cases, the evaluation focuses on the costs and impact (i.e., losses) of achieving the designated use. Sometimes these decisions involve both gains and losses among health, ecological, institutional, and socioeconomic considerations. To the extent economic analysis is done, most attention is given to costs. Evaluating the gains may introduce a more balanced analysis.

#### Research Objectives

Complying with the CWA, provide a framework to better understand the trade-offs (i.e., gains and losses) of use attainment, and to incorporate community preferences in decision-making.

#### Research Methods & Collaboration

Collaborating with the OW/Office of Science and Technology (OST) and building on the EPA Report (EPA/R-03/140R), *Integrating Ecological Risk Assessment and Economic Analysis in Watersheds*, the National Center for Environmental Assessment (NCEA) is developing a decision support tool that evaluates the ecological benefits of attaining high water quality.

The step-by-step process analyzes the trade-offs of water quality management options:

Management alternatives can be developed to alter the effects of land uses or sources. *Expanded conceptual models* depict the impact of management options on stressors (e.g., chemicals or habitat alteration), track changes through ecosystem processes/components and assess ecosystem services and regulatory compliance (Figure A). The models can then illustrate the anticipated effects of each of the management alternatives on ecosystem services. Ecological risk assessment, economic analysis, and health and sociocultural analyses characterize and compare the management options to support use-attainment decisions.

#### Research Results

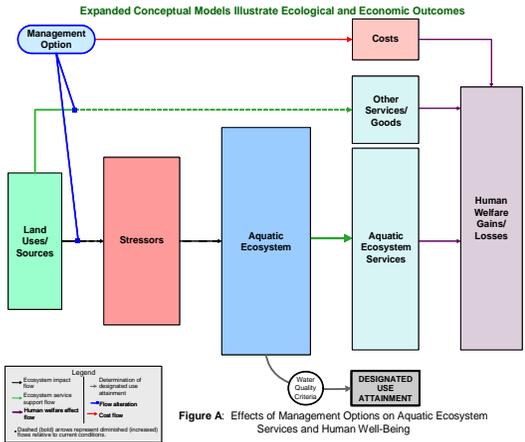
A draft of the report is available to the public. It consists of three chapters that serve as (1) an introduction to the CWA and WQS Regulations; (2) a basis for understanding the relationship between water quality decisions and their subsequent effects on ecosystems, ecosystem services, and ecological benefits; and (3) a reference for methods that elicit or infer preferences for trade-offs related to attaining designated uses.

An invitational workshop is planned for early 2006 to critique the current draft and test an implementation process. Participants will work through case studies to build a process that involves the community, evaluates their preferences, and remains consistent with policy requirements. Final report anticipated in 2008.

#### Research Conclusions & Future Directions

While useful for regulatory determinations, cost analyses may not fully inform affected communities because little attention is given to benefits that would be obtained in the process. This report will introduce approaches to incorporate more analysis of the benefits that result from management actions that are taken to achieve WQS. Approaches will include qualitative and quantitative analyses of both ecological and economic changes.

A potential next step includes field testing the approach. In addition, customers who do not have the resources or expertise may want specific tools. Tasks may include developing a website that would help estimate benefits or examining connections between multimetric indices and economic metrics for benefits assessment.



### Using Economic and Energy Analyses to Prioritize Water Remediation: An Application to the Cheat River Watershed (CRW) in West Virginia

#### Background

Several thousand kilometers of West Virginia streams are degraded by acid mine drainage (AMD), and estimates for the cost of cleanup range in the billions of dollars. Little money is available for restoration; a method to prioritize those streams is needed.



Pringle Run, WV  
 Photo Courtesy of H. Thurston



#### Research Methods & Collaboration

ORD is collaborating with West Virginia University, The Canaan Valley Institute (CVI), and EPA's Region 3. This work relates to Ecological Research LTG 3: *understand the importance of ecosystem services and make informed, proactive management decisions that consider a range of choices and alternative outcomes.*

Economic analysis, led by the National Risk Management Research Laboratory, prioritizes projects based on benefit-cost analysis (BCA). Benefits estimated with:

- Benefit transfer utilizes point estimates or functions derived from similar studies to make statements about the effects of restoration options.
- Hedonic prices modeling derives benefits for water quality improvement using the housing market along the Cheat River. Restoration has facilitated the return of aquatic life, while downstream, severe impairment exists. Differences create treatment and control sections of the river, and allow a comparison of housing prices, pre- and post-restoration.

#### Research Objectives

- Provide options for ranking restoration sites so that the public realizes the largest gains from environmental investments, using economic and energy approaches
- Contrast and compare the approaches to determine the advantages and limitations to support restoration decisions
- Focus on AMD impaired streams of the CRW

#### Research Results

##### Economic Analysis

Using benefit transfer, an annual value between \$1.4 and \$2 million (2004\$) was estimated for restoring the Cheat River. Hedonic price modeling results expected in 2006.

##### Energy Analysis

Restoration sites were ranked by Emergy Benefit-Cost Analysis (EmBCA) on four small Cheat River watersheds affected by AMD (assuming in-stream limestone and treatment). The EPA Report, *Environmental Accounting Using Emergy: Evaluation of the State of West Virginia* (EPA/600/R-05/008) provided an overview of the environmental and economic resource base for WV and the emergy-to-money ratio (used in the EmBCA). The EmBCA showed most of the emergy cost of restoration derives from the geological work of limestone formation (the Emergy Yield Ratio for limestone treatment is around 10:1). Thus, Emergy Benefit:Cost ratios for the four watersheds ranged from 1.55 to 1.88 when cost included the geological work and from 54 to 175 when only the economic emergy of fuels and human service was considered. The total annual benefit expected from restoring the four watersheds was 1.3 million emdollars (1997 WV basis). In contrast to these positive ratios for restoration, the above report found that, for its economic activity as a whole, WV exports nearly twice as much emergy as it receives.



Blackwater River, WV  
 Photo Courtesy of M. Heberling

#### Research Conclusions & Future Directions

We have defined two types of analyses for prioritization. A comparison of the two approaches will illuminate the similarities and differences in the information supplied and the type of support provided to decision-makers.

Next steps include working with CVI to disseminate the results and provide ranking tools to watershed groups.

### Interactions with Customers

- Main customers:**
- CW/Office of Science and Technology
  - EPA Regions
  - States, tribes, and watershed groups
  - The Canaan Valley Institute

### Use-Attainment Decisions

NCEA has collaborated with OST, a major customer, throughout the planning and execution stages. Results have been presented to customers at the 2005 WQS Coordinators National Meeting, Workshop participants (see Results) and potential users of the report include individuals from academia, private industry, government, and watershed groups.

### Economic and Energy Analyses

In September 2001, a joint project between the CVI, a private nonprofit corporation, and ORD was begun. CVI provides assistance to watershed groups and helps communities solve problems that threaten their environmental resources. Results will be distributed to interested EPA, local, state, and regional organizations through journal articles and book chapters.

### How Research Contributes to Outcomes

The goal of this research is to enhance environmental decision-making. Activities resulting from the EBASP will improve the Agency's ability to assess the national-level ecological benefits of its actions and the ORD Research Program will help local, state, and federal decision-makers better integrate ecosystem benefits into decisions about watershed management and associated outcomes, and to evaluate restoration options. This research is expected to enable users to preserve a healthy aquatic ecosystems and restore damaged ones in a cost-effective way in order to take advantage of our investments in environmental protection.

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