

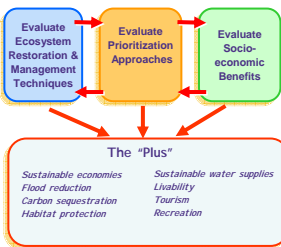


Relevance

Long-Term Goal 3 states that decision-makers will *understand the importance of ecosystem services and make informed, proactive management decisions that consider a range of choices and alternative outcomes*. To reach this goal, EPA is evaluating ecosystem restoration and management techniques to ensure they create sustainable ecological and economic solutions for degraded watersheds. Such sustainable solutions require innovative collaborative research which partners watershed stakeholders and decision makers at all levels in the process to address their concerns and leverage resources to maximize outcomes. For this reason, ORD NRMRL initiated the Restoration Plus (RePlus) program in 2003 as an integrating, cross-MYP program (primarily the Ecological and Water Quality Research Multi-Year Plans) to a) evaluate ecosystem restoration and management options, b) assess the non-monetary and economic benefits of restoration, and c) develop and evaluate strategies for use by watershed managers and others to make appropriate restoration and management choices. These managers make and implement environmental decisions that must incorporate community-based socioeconomic factors and political realities. This poster describes three RePlus research projects which partner Federal, state, local and NGO entities: 1) development and testing of a GIS-based ecosystem restoration prioritization framework for the Mid-Atlantic Highlands; 2) development of techniques for valuation of non-monetary restoration benefits; and 3) assessment of the use of an auction/bidding system as an incentive for implementation of on-lot storm water management BMPs. Anticipated major RePlus products, such as the CVI GIS based restoration prioritization tool and a West Virginia University Press book entitled, "Environmental Economics for Watershed Advocacy Groups: Natural Resource Valuation You Can Use," will provide watershed stakeholders and decision makers with tools and information to select and implement sustainable watershed management and restoration decisions.

RePlus LTG 3 Research Objectives

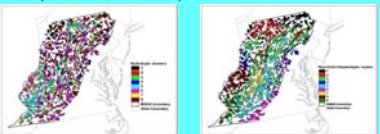
- Collaborative peer reviewed research to develop decision support tools incorporating ecosystem services and other socially important outcomes within decision-making frameworks
- Collaborative peer reviewed research that identifies ecosystem services and benefits accruing from ecosystem restoration activities and tradeoffs



Restoration and Conservation Prioritization

EPA STAR Grant: Classifying and Prioritizing Watersheds for Protection and Restoration

Collaborators: Pennsylvania State University and Canaan Valley Institute (CVI)
Study Period: January 2003- June 2005
 Research was undertaken to develop, validate, and apply a hierarchical, geographically-independent classification of watersheds based on pre-existing environmental data. Using cluster analysis and principal component analysis, 1297 Mid-Atlantic Highlands headwater watersheds have been classified based on their natural features. Cross clustering has demonstrated that hydrologic and physical measures present more resolution at local scale and the addition of soil/ climatic data with strong regional trends mask these features, as shown. This research is now employing linear ordering and echelon analysis, to build a Prioritization Model to classify basins according to disturbance, susceptibility to impairment, and feasibility of restoration, where feasibility includes technical and economic measures.

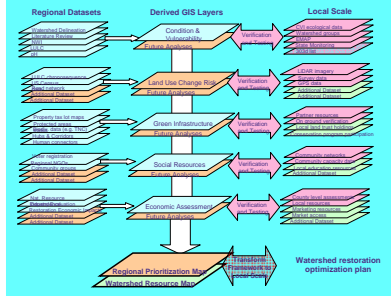


EPA Cooperative Agreement: Mid-Atlantic Highlands Action Program Approach to Ecological Prioritization, Restoration, and Conservation

Collaborators: Canaan Valley Institute
Study Period: August 2004- September 2007
 In this agreement, CVI is preparing a GIS-based ecosystem restoration prioritization framework intended to guide regional restoration efforts and land-use planning (e.g. conservation, development, and land management practices), and to assist local watershed groups in decision making. The framework employs the classification and prioritization scheme developed via the above mentioned STAR grant, and embeds it within user-friendly GIS planning tools. Through workshops and targeted workshops, CVI is in continual dialog with stakeholders to ensure the framework has their buy-in and meets their needs. The GIS system will integrate the ecological, social, and economic data to facilitate the consideration of a range of issues in the search for "win-win" restoration and/or land-use actions for local watersheds.

Anticipated Major Products

- Journal Articles including: "Contextual Clustering for Configuring Collaborative Conservation of Watersheds in the Mid-Atlantic Highlands."
- Tool: GIS Based Restoration Prioritization Framework for the Mid-Atlantic Highlands.



Evaluate Non-Monetary Benefits of Restoration

Using Economic Analysis to Value Water Remediation: An Application to the Cheat Watershed in West Virginia

Collaborators: Canaan Valley Institute and West Virginia University
Study Period: October 2003-September 2004
 Assessment of management options for ecosystems often necessitates prioritizing the implementation of restoration projects based on maximizing the benefits per dollar spent on a project. Study uses two non-market valuation techniques to assign economic value to marginal increases in the quality of water in streams affected by acid mine drainage. The study area is an acid mine drainage (AMD) impaired section of the Cheat Watershed in West Virginia.



The first technique employed is **benefits transfer**: a low cost and increasingly common method for integrating economic values into ecological policy choices. Benefits transfer utilizes the point estimates or an estimating function of previous similar studies to make statements about the effects of a proposed change. In this study, willingness-to-pay (WTP) estimates are derived from four previous water quality studies. Two of the studies examine watersheds where AMD is the cause of the impairment, and two are non-AMD water pollution studies. Using estimates from the four studies, an annual dollar figure of between \$1.2 and \$2 million dollars for remediation in the Cheat Watershed was computed.



In collaboration with researchers from West Virginia University, a more intensive method to measure and quantify environmental benefits known as **hedonic price modeling** was applied. Hedonic price models are used for deriving implicit values from market prices. Estimates of the WTP for water quality through variation in housing values along the Cheat River were made. Recent successful remediation efforts on the Cheat have facilitated the return of aquatic life, while further downstream, severe impairment still exists. These differences are used to create treatment and control sections of the river, and compare housing prices, pre- and post-remediation. Differences in housing values can provide insight into market valuation of implicit goods, such as water quality.

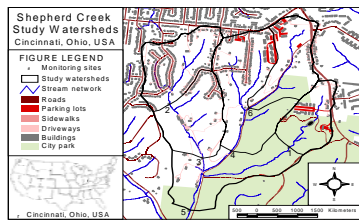
Anticipated Major Products

- Journal Article: "Ecological-Economic Assessment of Acid Mine Drainage and Water Quality Standards: Designing a Conceptual Model and Selecting Assessment Endpoints."
- Journal Article: "Using Benefits Transfer to Value Acid Mine Drainage Remediation Options in West Virginia"
- Journal Article: "Valuing Acid Mine Drainage Remediation using a Hedonic Model" in West Virginia"
- Book: "Environmental Economics for Watershed Advocacy Groups: Natural Resource Valuation You Can Use, West Virginia University Press, Morgantown, WV.

Evaluate Ecological/Economic Impact

Shepherd Creek Watershed Pilot Project

Collaborators: Ohio State and Local Entities
Study Period: October 2003- September 2008
 Stormwater is a multidisciplinary issue, in that legal, socioeconomic, ecological and hydrologic considerations are brought to bear upon the development of acceptable approaches to ecosystem protection and restoration. Impervious surfaces in urban and suburban areas can lead to excess runoff throughout a watershed, overwhelming the existing infrastructure, typically resulting in widespread hydrologic and ecological alteration of receiving streams. Decentralized stormwater management may improve stream ecosystems by reducing erosional stormflows, increasing stream baseflows, and reducing delivery of pollutants to streams. EPA is conducting a pilot study of an economic incentive program, which encourages on-site detention of stormwater runoff by residential landowners. This study will determine whether parcel-level best management practices (BMPs), in the form of rain gardens and rain barrels, can be cost-effectively implemented throughout the headwater areas to reduce hydrologic alteration and improve stream ecosystem health. The study will evaluate legal and institutional barriers to the deployment of BMPs, and for their potential impact on the applicability of these alternative stormwater management programs. The study setting is the Shepherd Creek watershed, a 20 km² basin with a 1960s era residential community occupying its headwaters. A city park, dominated by mature deciduous forest, covers the eastern half of the watershed. The project uses a before-after control-impact site design, where the "before" is the installation of parcel-level BMPs. Six hydrologic and ecological monitoring sites have been established in the watershed. Sites 2-5 are receiving streams for the BMP installation area and sites 1, 6 are control watersheds that will not receive BMPs.



Major Products

- Parkik, F., Taylor, M., Hoagland, T., and Shuster, W., "At the Intersection of Hydrology, Economics, and Law: Application of Market Mechanisms and Incentives to Reduce Stormwater Runoff," (forthcoming) *Environmental Science and Policy*.
- Thurston, H.W., Taylor, M.A., Shuster, W.D., (2004) Trading Allowances for Stormwater Runoff: Potential Hydrology and Opportunity Costs in World Water Congress 2004: Critical Transitions in Water and Environmental Resources Management, World Water and Environmental Resources Congress 2004, Gerald Schlick, Donald F. Hayes, David K. Stevens (eds.), American Society of Civil Engineers.
- Thurston, H.W., "Opportunity Costs of Residential Best Management Practices for Stormwater Runoff: Potential Hydrology and Opportunity Costs in World Water Congress 2004: Critical Transitions in Water and Environmental Resources Management, World Water and Environmental Resources Congress 2004, Gerald Schlick, Donald F. Hayes, David K. Stevens (eds.), American Society of Civil Engineers.
- Thurston, H.W., Goddard, H. K., Szilag, D. and Lemberg, B. (2003) "Controlling Stormwater Runoff with Tradable Allowances for Impervious Surfaces," *Journal of Water Resources Planning and Management*, vol. 129, no. 5, pp. 409-418.
- Thurston, H.W., Goddard, H. C., Szilag, D., and Lemberg, B. (2002) "Trading Stormwater Abatement Credits in Cincinnati's Shepherd Creek," *Stormwater*, vol. 3, no. 5, pp. 50-59.

Future Directions

The **Restoration Plus (RePlus)** research program is specifically designed to develop and evaluate strategies for use by watershed managers and others to make appropriate restoration and management choices, where those choices must not only incorporate ecological endpoints but also community-based socioeconomic decisions and political realities. Building on current restoration effectiveness studies and incorporating efforts such as those described here, RePlus will continue to develop and evaluate the tools needed by decision-makers and managers at local, state and Federal levels to incorporate sound ecological, economic and community priorities.

EPA/CVI Cooperative Agreement: CVI will use the MAH GIS-based framework to prioritize watersheds for restoration action. CVI, with local stakeholders, will apply the Highlands Action Plan (HAP) to the target watershed. HAP is a local process to identify watershed stressors and needs, implement and monitor restoration solutions not only using environmental data on watershed condition, but also socio-economic data to achieve sustainable solutions through local stakeholders involvement and feedback. CVI will provide a test bed for EPA to continue to evaluate the ecologic/economic success of local restoration/conservation actions in the MAH. **Cheat River Project:** Researchers will collect the remaining data needed to finalize results of the non-market valuation methodology. In this case Benefits Transfer Method and Hedonic Estimation. Results will be published in the scientific peer reviewed literature on the valuation of stream restoration, with specific application to West Virginia, and the non-point source AMD. **Shepherd Creek:** Experimental auction will take place in spring/summer 2005 designed to encourage property owners to control runoff via distributed BMPs, without necessitating a legal mandate. Auction bids will reflect landowner's willingness-to-accept BMPs based on: 1) construction and maintenance costs (included), 2) opportunity cost of land taken out of other uses, and 3) non-market water values residents place on positive changes in stream ecosystem health. Researchers will continue to collect sufficient baseline hydrologic and ecological data before installing BMPs. The BMP implementation will happen in spring of 2006 or 2007, with at least 2 years of hydrological and ecological post-installation monitoring.

Anticipated Products and Outcomes

RePlus (Restoration Plus):
 • Active since 2005, RePlus has laid a collaborative foundation with NGOs, Federal, state and county agencies, and academia. The impact of these collaborations and feedback will be to enable decision makers to make informed, proactive management decisions considering a range of choices and alternative outcomes to achieve sustainable ecosystem restoration and protection.

EPA/CVI Cooperative Agreement:
 • Combined use of a user-friendly GIS-based MAH restoration prioritization scheme with the Highlands Action Plan allows effective and sustainable restoration and management solutions to be implemented and evaluated at the local scale. Success at the regional level can only be realized through local-level implementation.

Cheat River Project:
 • "Environmental Economics for Watershed Advocacy Groups: Natural Resource Valuation You Can Use," from West Virginia University Press provides information and techniques to enable watershed groups to incorporate economic values in decision-making regarding the prioritization of restoration projects.

Shepherd Creek Project:
 • Parcel-level approach to BMPs provides a cost-effective and socially acceptable alternative to traditional centralized stormwater management projects.
 • Information on the costs and benefits associated with decentralized stormwater management is used by local communities to realize multiple objectives.

"Conserving ecosystem services through proactive management decisions"