US Army Corps of Engineers®

Evaluation of Environmental Investments Research Program

Throughout the Nation, there is an increased awareness and concern for the protection and restoration of environmental resources. Within the U.S. Army Corps of Engineers, new Congressional authorities and policy changes are providing more and more opportunities to pursue environmental initiatives. This increased emphasis on the environment, however, brings with it a need for improved techniques for evaluating and comparing environmental projects and programs.

There is almost always more than one way to address a particular problem, and typically more projects and programs waiting to be undertaken than funds available. Currently, however, there is a lack of accepted methods for assessing the effectiveness (does the project achieve its objective?) and efficiency (is it achieved in the least cost manner?) of investments in the protection or restoration of environmental resources.

To address these issues, the Corps initiated the Evaluation of Environmental Investments Research Program (EEIRP) in 1993. The EEIRP, completed in 1996, aimed to provide Corps planners with methodologies and techniques to aid in developing supportable environmental restoration and mitigation projects and plans. Additionally, the EEIRP aimed to develop a framework for providing decision makers with information to facilitate the allocation of limited funds among a range of proposed projects and programs and to identify future research needs.

Traditional Program

Historically, the U.S. Army Corps of Engineers Water Resources Development Program has been charged with improving and maintaining navigable waterways and reducing flood damages. Along with these primary missions have arisen complementary programs for generating hydroelectric power, providing water supplies, protecting coastal shorelines, managing natural resources, and providing recreation opportunities. Individual projects typically began with an authorization by Congress to develop a plan to address a particular water resources problem. These studies were most often initiated by local interests. They included a partnership, with non-Federal interests, and public participation in the planning and implementation process. And they were justified by an economic analysis, comparing both project benefits (for example a reduction in flood damage) and construction and operation costs in monetary terms. The traditional engineering projects that resulted (for example dams, levees, and modifications of river channels) were built with the expectation of improving the nation's material welfare, but often resulted in substantial alterations to existing watershed features and processes.

Changing Public Values

The Corps water resources program has changed significantly over the past two decades. These changes reflect changing national preferences and desires. Alteration of watersheds for such purposes as flood control and navigation is no longer considered a sure path to economic development. There is more concern today for the protection and restoration of the natural services of heavily altered watersheds, many of which were related to previous Corps water resource development projects.

Since the early 1970's, the emphasis of the Corps water resources program has shifted from the construction of new projects to the improved operation of existing projects with increased concern for the environment. Today, Corps funds budgeted for the operation and maintenance of existing projects exceed those budgeted for new construction. Environmental restoration is now a "high priority" mission in the Corps budgetary process, along with the more traditional missions of navigation and flood control. In addition the Corps can participate in the modification of existing projects for the purposes of fish and wildlife habitat restoration.

Evaluating Environmental Investments

Although there is a change in emphasis, there is every reason to believe the planning approaches of the past can be adapted for evaluating environmental projects. Authorization by Congress for individual projects or programs will still be required, as will partnerships with non-Federal interests and public involvement. Limited funds will be available to allocate among these projects and programs, and there will still be the need to answer the analytical question of how much should the fish and wildlife habitat or the watershed be altered in relation to some existing condition. However, unlike more traditional projects, many outputs of environmental restoration and mitigation cannot be measured in monetary terms.

The challenge, therefore, becomes how to select the most efficient and effective projects when they cannot all be compared in like, monetary terms. Questions addressed by the EEIRP include how to incorporate "uncertain" measures of output and differing public and institutional values into a rational and supportable evaluation and selection process.

Research Program

The overall objective of the EEIRP was to provide an evaluation framework, techniques, and procedures to assist planners, managers, and regulators in addressing both the site and portfolio issues; i.e., whether the recommended action is the most effective and efficient alternative for a particular location, and how to allocate limited resources among competing recommended actions. A goal of the program was the development of a series of environmental evaluation procedures manuals ("how to" manuals) addressing various steps in the planning, evaluating, and prioritizing processes. This paper provides an annotated bibliography of EEIRP reports, manuals, and other products and includes information for ordering copies.

EVALUATION OF ENVIRONMENTAL INVESTMENTS RESEARCH PROGRAM REPORTS AND MANUALS

Evaluation of Environmental Investments Procedures Manual Interim: Cost Effectiveness and Incremental Cost Analyses, IWR Report 95-R-1, May 1995.[1]

This manual is a guide for conducting cost effectiveness and incremental cost analyses for the evaluation of alternative environmental restoration or mitigation plans. It presents a procedural framework for conducting the cost analyses and discusses how they fit into, and contribute to the water resources planning process. Discussed are the conceptual underpinnings, practical step-by-step procedures, and implications for decision making. The manual also includes user-friendly computer software for conducting the cost effectiveness and incremental cost analyses in environmental planning.

Review of Monetary and Nonmonetary Valuation of Environmental Investments, IWR Report 95-R-2, February 1995.[1]

Placing value on the environment, whether through monetary-based methods or through other evaluation techniques, has been and will continue to be a widely debated topic. The conceptual foundation and institutional setting for pursuing further study are developed in this report. Specific objectives are to: 1) describe services provided by environmental resources and systems and methods for their measurement or valuation; 2) review existing research programs and products; and 3) evaluate the resource constraints on potential Corps' field applications. Independent expert views from an economist, engineer, ecologist, and psychologist as to environmental outputs and valuation techniques are included as appendices. The report concludes with recommendations for further research.

Prototype Information Tree for Environmental Restoration Plan Formulation and Cost Estimation, IWR Report 95-R-3, March 1995.[1]

This report focuses on three specific objectives: 1) developing a prototype information tree to provide and organize information useful for formulating and estimating the costs of environmental restoration and mitigation plans; 2) describing the contents and linkages within the tree; and 3) beginning the process of building the tree database and identifying data deficiencies and data sources. Preliminary implementation of the tree is provided with illustrative linkages of *broad problem area/management approach* to *management measure* to *management technique* to *major environmental engineering features* for lakes and ponds, rivers and streams, non-tidal wetlands, and tidal wetlands.

Compilation and Review of Completed Restoration and Mitigation Studies in Developing an Evaluation Framework for Environmental Resources, Volumes I and II, IWR Reports 95-R-4 and 95-R-5, April 1995.❶

This two-volume set describes important environmental restoration and mitigation planning issues currently facing Corps planners. Findings are based on ten field case studies, including interviews of both Corps and non-Corps study team members, and a focus session conducted with Washington level reviewers. Volume I includes a description of the research approach, and findings and recommendations for future research. Detailed summaries of the focus session and the individual case study interviews are in Volume II.

Trade-off Analysis for Environmental Projects: An Annotated Bibliography, IWR Research Report 95-R-8, August 1995.❶

This study explores the literature for analytical techniques that can support the complex decision-making process associated with Corps environmental projects. The literature review focuses on opportunities for using trade-off methodologies and group processes in environmental plan formulation and evaluation. An annotated bibliography is included.

Resource Significance: A New Perspective for Environmental Project Planning, IWR Report 95-R-10, June 1995.❶

Resource significance is one metric that can be used in the selection and prioritization of environmental projects for implementation. This report provides a brief discussion of the concept of resource significance in terms of scientific or *technical, institutional, and public* criteria. It provides a summary of a review of 95 existing programs that have been developed for purposes of ranking projects, with more detailed summaries of selected programs that assist in determining environmental significance. Included in the review are examples of Federal, regional, state, and nonprofit programs and programs for historical properties.

National Review of Non-Corps Environmental Restoration Projects, IWR Report 95-R-12, December 1995.❶

This report has compiled and compared management measures, engineering features, monitoring techniques, and detailed costs for a representative sample of non-Corps environmental projects or engineering projects (39) with environmental features. This report is part of the series of reports that will help build into the ***Prototype Information Tree for Environmental Restoration Plan Formulation and Cost Estimation*** report. The projects are categorized into 16 types, based on the project's primary features. These types are: 1) bottomland hardwood forest restoration, 2) enhancement of fish and wildlife habitat, 3) estuarine wetland creation, 4) estuarine wetland enhancement, 5) estuarine wetland restoration, 6) estuarine wetland restoration and wildlife enhancement, 7) mitigation bank

establishment, 8) stream enhancement, 9) stream restoration, 10) water quality remediation, 11) wetland creation, 12) wetland creation and enhancement, 13) wetland enhancement, 14) wetland mitigation, 15) wetland restoration, and 16) wetland restoration and enhancement.

Linkages Between Environmental Outputs and Human Services, IWR Report 96-R-4, February 1996.[1]

This report identifies relevant socioeconomic use and nonuse values associated with environmental projects and also improves the linkages between environmental output measures and necessary inputs for socioeconomic evaluation. It answers the question: What are the possible changes in the ecosystem that may result from USACE environmental mitigation and restoration projects, and what outputs and services doe these changes in the ecosystem that may result from USACE environmental mitigation and restoration projects, and what outputs and services do these changes provide society? The report includes a suite of tables which link USACE management options, to ecological inputs, to ecological outputs, and then finally to human services. Also, indirect effects of management options are identified.

Significance in Environmental Project Planning: Resource Document, IWR Report 96-R-7, February 1996.[1]

This report discuses the use of resource significance as a factor for consideration in environmental project planning and identifies information sources to assist in this effort. Institutional, public, and technical recognition are described as the three bases for determining and describing the significance of environmental resources. Guidance on how to identify, evaluate, and communicate the importance (significance) of environmental resources is presented for each of the three. In addition examples of existing programs, agency and organization process, information sources, and criteria or concepts for determining environmental resource significance are presented as appropriate.

An Introduction to Risk and Uncertainty in the Evaluation of Environmental Investments, IWR Report 96-R-8, March 1996.[1]

Incorporating risk and uncertainty into environmental restoration planning studies can be a means of improving the quality of the decision-making process. This report introduces Corps personnel involved in the planning of environmental restoration projects to the basics of risk and uncertainty analysis. The taxonomy of terms described in this report provides the new risk analyst with a way to think about the knowledge, model, and quantity uncertainty that is present in environmental planning. Selected tools and broad concepts are introduced as a means of addressing these uncertainties. In addition to generic, “big picture” sources of uncertainty related to the Corps’ six step planning process, uncertainties specific to environmental planning are identified. Common potential sources of uncertainty include

delineation of the study area, identification of target species, the structure of habitat suitability index models, habitat variable measurements, calculation of existing and future habitat units, and modeling project performance using habitat evaluation procedures. An example introducing risk-based analysis to the estimation of habitat unit changes is offered to demonstrate the feasibility of some of the methods presented in this report.

Incorporating Risk and Uncertainty into Environmental Evaluation: An Annotated Bibliography, IWR Report 96-R-9, September, 1996.

This report summarizes the applicability of existing Corps of Engineers guidance (on risk-based analysis of flood damage reduction projects and major rehabilitations of hydropower and navigation projects) to environmental projects. In brief, while the sources of uncertainty in the evaluations of these kinds of projects obviously differ from environmental projects, addressing such topics as the decomposition of risk among constituent parts and analytical techniques for dealing with uncertainty do provide valuable insight into how risk analysis might be applied to environmental investment planning. The same report also reviews literature dealing with general risk and uncertainty assessment and management techniques and specific examples of risk analysis applications with an environmental emphasis. Over 50 references are annotated. The review targets two audiences. First, it serves as a primer on the literature to help planners find the tools they need to do risk analysis. Second, it should help professionals (e.g., modelers and environmental scientists) consider the risk analysis aspects of environmental resource evaluations. Significant findings of the review include 1) the relatively recent vintage of the writings on environmental and ecological risk (since 1990, for the most part), and 2) the dearth of useful examples of risk analysis applications related to such environmental restoration topics as habitat evaluation models or the evaluation of environmental management measures.

Environmental Valuation: The Role of Stakeholder Communication and Collaborative Planning, IWR Report 96-R-17, June 1996.

This report describes how understanding the perspectives of stakeholders in USACE environmental projects might improve the identification and communication of project benefits. This report is based, in part, on three case studies of current USACE environmental projects as well as interviews with HQUSACE personnel involved in policy making for or review of environmental projects. The goal of the interviews and meetings was to better understand project priorities from individual stakeholders and to observe interchange on selected issues among the stakeholders.

Evaluation of Environmental Investments Procedures Interim Overview Manual, IWR Report 96-R-18, June 1996.

This interim report supports planners by identifying EEIRP products that can be used to

apply the P&G planning process to environmental projects. Underlying the incorporation of the EEIRP products in the planning process is the need to 1) integrate the tools and techniques identified and developed by the EEIRP and 2) ensure that they collectively address the site and portfolio questions. This report is intended to serve as a reference guide for Corps environmental planning. It is a procedures manual that synthesizes the many products of the EEIRP and shows how they can support environmental planning, which is conducted in accordance with the six-step planning process. It provides an overview of Corps environmental planning and identifies EEIRP products that support specific planning activities. Planners are encouraged to obtain the EEIRP products that pertain to their specific planning challenges.

Planning Aquatic Ecosystem Restoration Monitoring Programs, IWR Report 96-R-23, December 1996.[1]

The purpose of this report is to provide a unified approach to planning, implementing, and interpreting the monitoring of restoration projects. The report is directed at Corps planners to help them determine what factors to consider in a monitoring program, and how to design and implement an efficient, cost-effective program. The report guides the planner on how a monitoring program proceeds from the identification of goals through selecting monitoring methods, and finally to interpretation and dissemination of results. The report reviews how to use monitoring results to implement corrective actions to assure that performance goals are met. This report brings together a number of previously published but somewhat unrelated reports that have attempted to develop monitoring approaches. This report is not a “how-to” manual of the specifics of sampling, sample processing, statistical analysis of data, etc., but rather a guide to fundamental elements of a monitoring program for aquatic restoration.

Monetary Measurement of Environmental Goods and Services: Framework and Summary of Techniques for Corps Planners, IWR Report 96-R-24, November 1996.[1]

This report provides information on the potential applicability and use of monetary measurement techniques (also referred to herein as economic benefits estimation or valuation techniques) for environmental project planning studies within the Corps of Engineers’ Civil Works Program. In some cases it may be possible and desirable to estimate the monetary benefits associated with certain environmental outputs provided by ecosystem restoration projects. The purpose of this report is to help project planners better understand what tools are available for estimating the monetary benefits of environmental outputs, when they may be technically appropriate to use, and their potential resource requirements in the ecosystem restoration context.

A variety of economic techniques are available for estimating the monetary benefits provided by nonmarketed environmental goods and services. Most of these tools are described in very broad terms in economic textbooks and in very detailed terms in economic journals,

leaving an information gap which often makes it difficult for potential practitioners to evaluate their potential applicability and use in different contexts. Additionally, very little summary information has been compiled concerning the data requirements of these techniques, the time it takes to perform such analyses, and the technical expertise required to use these techniques effectively. This report attempts to address these information gaps by providing Corps planners with a summary of selected economic evaluation techniques and their resources requirements, as well as a framework for evaluating their potential applicability and use in ecosystem restoration planning.

National Review of Corps Environmental Restoration Projects, IWR Report 96-R-27, December 1996.[1]

This report provides descriptive information from 52 Corps environmental restoration studies. For each project, information is provided concerning: its geographical location, the resource problems being addressed, objective(s), management measures, outputs, and estimated total costs. Also included in the report are unit price tables for various engineering features from many of the Corps projects described in the report. The projects selected represent a cross-section in terms of geographic location, legislative authority, and types of engineering features recommended. This report is not a critique or an analysis of these 52 Corps environmental restoration studies; rather, its primary purpose is to provide descriptions of environmental management measures and/or engineering features and their costs. For example, the resource problems, objectives and outputs/benefits are provided only to assist the reader in better understanding the setting under which the management measures were being considered. This information was directly extracted or summarized from the study reports without critique or evaluation.

Identifying Small Group Techniques for Planning Environmental Projects: A General Protocol, IWR Report 96-R-29.[1]

This report provides planners with a protocol for small group techniques to support the planning of ecosystem restoration projects. It examines techniques that are structured to improve the efficiency and effectiveness of generating ideas, making decisions, and discussing information. The protocol will help planners consider alternative small group techniques for use with stakeholders to: 1) gather and share information, 2) generate alternatives, and 3) evaluate alternatives. These techniques are designed to address the needs of small groups. Task forces, planning teams, advisory boards, and steering committees are some examples of typical small group meetings. They do not readily lend themselves to large public meeting formats. Although the organization of these techniques has been developed for ecosystem restoration planning, there are broad applications to other planning, operations, and regulatory settings where small groups of people are brought together. A case study is included in the report.

Evaluation of Environmental Investments Procedures Overview Manual, IWR Report 96-R-30.❶

This report is a revision of the *Interim Overview Manual* described on page six of this bibliography. This revision includes additional EEIRP products and reports that were not completed when the *Interim Overview Manual* was published. Additionally, this revised *Overview Manual* incorporates clarification of ideas and information that has come through the application of EEIRP products in ecosystem restoration studies.

Valuing Urban Wetlands: A Property Pricing Approach, IWR Report 97-R-1, March 1997.❶

The report estimates the value of wetland amenities in the Portland, Oregon, metropolitan area using the hedonic property pricing approach. Detailed residential housing and wetland data are used to relate the sales price of a residential property to the structural characteristics of the property, neighborhood attributes in which the property is located, and amenity values of wetlands and other environmental characteristics. The measures of primary interest are distance to four different wetland types (open water, emergent vegetation, scrub-shrub, and forested). Other environmental variables evaluated include size of nearest wetland and proximity to parks, lakes, streams, and rivers. In addition to estimating the hedonic price functions, second-stage regression analysis is used to estimate the willingness-to-pay function for wetland size.

Resource Significance Protocol for Environmental Project Planning, IWR Report 97-R-4, July 1997.❶

The report provides a protocol or guidance for determining and documenting environmental resource significance, which can be an indicator of a resource's importance or value. Resources may be described, for example, in terms of habitat, species, or ecosystems, and significance can be measured from Institutional, Technical and Public perspectives. In addition to one or more of the perspectives, resources may be recognized as significant at differing levels, including national or international, regional, state and local. The protocol includes a series of worksheets to help organize and summarize information and to assist the user in determining perspectives and levels of significance for resource(s) in a study area. Information from these summaries can be used to prepare Significance Statements to help communicate the importance of the environmental resources to other stakeholders, reviewers, and decision makers. Numerous examples of Significance Statements for various resources are also provided. Provided as an addendum is a previous report, "Significance in Environmental Project Planning: Resource Document" (IWR Report 96-R-7) . This latter report identifies numerous agencies and organizations which provide information on resource significance and provides instructions for obtaining information from them. The information sources in the addendum complement the protocol and worksheets.

Risk and Uncertainty Analysis Procedures for the Evaluation of Environmental Outputs, IWR Report 97-R-7, August 1997.❶

Ecosystem restoration projects are replete with uncertainties, large and small. A major source of uncertainty in many such projects is the environmental output of the project. To estimate existing and future environmental outputs, many Corps' projects rely on habitat evaluation models, like the Habitat Evaluation Procedures (HEP) developed by the U.S. Fish and Wildlife Service. HEP analysis, as this process is called, relies on the estimation of the number of habitat units that exist at a site under certain environmental conditions. Habitat units are the simple product of a number of acres of habitat and a habitat suitability index that indicates the relative suitability of those acres for a particular wildlife species. The habitat suitability index is based on the mathematical manipulation of a set of habitat variables. A case study is used to illustrate the role that habitat variable measurements play in the uncertainty that attends the estimation of project outputs. As a result of the lessons learned during the course of the case study investigation and prior experience with risk analysis, a flexible eight-step set of procedures was developed. Although HEP analysis was used in the case study, the procedures presented are general enough to use with other kinds of models used to measure ecosystem resources. The value of using interval rather than point estimates is that they can be used to support sensitivity analysis and Monte Carlo simulations, two of the most commonly used techniques in this kind of risk analysis.

Trends and Patterns in Cultural Resource Significance: An Historical Perspective and Annotated Bibliography, IWR Report 96-EL-1, January 1996.❷

This report offers a broad, analytical review of the literature concerned with the challenging subject of evaluating cultural resource significance. The review of significance includes two main sections: (a) an Annotated Bibliography (consisting mostly of peer-reviewed literature) and (b) an Analysis Section (devoted to tracing historical trends in archaeological method and theory). The literature summarized is extensive and is not accessible widely to the archeological and cultural resource management (CRM) communities. After analyzing a wide range of publications, 21 major themes or concepts were established to characterize the breadth of archaeological views and ideas about significance. A review of each theme was undertaken, including both a discussion and a graphical presentation of trends through time. Systematic indexing and cross-referencing of publications, authors, and significance themes have also been carried out to assist user in locating references of special interest. The concluding section offers some suggestions and insights into the future direction of significance evaluation with respect to this work unit and within CRM generally. Particular emphasis is placed on the opportunities to develop more holistic management strategies, to make greater use of new approaches and technologies, and to use more explicit evaluation methods.

Development of an Integrated Bio-Economic Planning System for Corps of Engineers Planning Projects: Conceptual Design, IWR Report 96-EL-2, February 1996.❷

This report describes the conceptual design of an Environmental Decision Support System (EDSS) that would give planners the ability to design multiple management scenarios and assess the biological outputs associated with each scenario in a "user-friendly" environment. The EDSS would allow comparisons of multiple scenarios and combinations of scenarios using a cost effectiveness and incremental cost strategy. Four major components would be combined to produce the EDSS: 1) spatial information and analysis; 2) environmental benefit and cost evaluations; 3) cost effectiveness and incremental cost analyses; and 4) multiple management design analyses.

Evaluating Cultural Resources Significance: New Directions in Theory and Practice, Proceedings of a Corps of Engineers Workshop, IWR Report-96-EL-3, August 1996.❷

This report is composed of six papers presented at an EEIRP workshop that focused on evaluation of the significance of cultural resources. The papers are authored by Corps and Forest Service cultural resource managers. The papers discuss various aspects of evaluating cultural resources significance in light of field experience in Corps and Forest Service planning and regulatory contexts. The subjects covered in the papers include existing challenges; current, state-of-the-art, and holistic approaches; and future directions in significance evaluation.

Planning and Evaluating Restoration of Aquatic Habitats from an Ecological Perspective, IWR Report 96-EL-4, September 1996.❷

Planning for ecosystem restoration requires an understanding of the structure and function of aquatic ecosystems. This report provides profiles of aquatic ecosystems to be used in developing an understanding of ecological processes. The information can be used to identify those ecological processes that are important to ecosystem structure and function and that should be part of restoration of the affected ecosystem. Profiles are included for open coastline and near coastal waters, subtidal estuarine habitats, coastal wetlands, freshwater wetlands, streams and rivers, and lakes and reservoirs. For each ecosystem the habitat profiles include information on physical condition, conceptual models, geographic distribution, zonation with habitats, biological community, and key ecological processes.

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