ENVIRONMENTAL RESTORATION IN THE ARMY CORPS OF ENGINEERS: PLANNING AND VALUATION CHALLENGES

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INTRODUCTION

The traditional U.S. Army Corps of Engineers (USACE) project was expected to promote the nation's "economic" prosperity through construction of dams, channels, locks and ports. Such engineering works altered watershed hydrology, wetlands, and riparian areas for achieving flood hazard reduction, enhanced transportation opportunities, and water supply storage. Today, a restoration alternative might reverse the effects of these past development projects in order to replicate some prior hydrologic regime, to re-create some historic riparian zone or re-flood some drained wetland (Shabman 1994). *In general, the term "restoration" describes a class of water and land management alternatives intended to return to some historic watershed condition* (National Research Council 1993).

Sometimes a restoration alternative is just a modest change in the operation of an existing USACE project. In this case, project benefits are not compromised and financial costs for the project are insignificant. At other times, a restoration alternative may involve major alteration to the existing watershed condition. This alternative may have opportunity costs such as increased flood risk, reduced navigation capacity or less generous irrigation water supply. In addition, significant financial outlays by governments and by individuals may be required for implementing that restoration alternative. In these cases, the "value" of the restoration project will need to be compared with the expected costs. This review focuses on how the USACE can adapt its long standing planning approaches to restoration alternatives having significant costs.

Recently the USACE developed draft restoration project planning guidelines (USACE 1994) that will be modified over time based on experience and on the findings from the Evaluation of Environmental Investments Research Program (EEIRP). One work unit of EEIRP is to review monetary and other valuation techniques for environmental investments, presumably to facilitate estimation of restoration benefits. This report is a contribution to that EEIRP work unit. However, only by a review of all the planning elements can the meaning of, and approaches to, valuation be clarified. Therefore, the scope of this discussion extends beyond formal valuation methods.

This paper is tailored to USACE's particular organizational circumstances. Therefore, conceptual discussions of planning theory and resource valuation only are introduced when they apply to the particular circumstances of the agency. In addition, the report draws upon recent experiences of the USACE in restoration planning to illustrate several themes.[1]

The New Context for USACE Planning and Valuation

The final selection of a restoration alternative registers decision makers' judgment on whether the costs for a restoration project are warranted by the values received. Valuation is accomplished when a decision to implement a plan is made. Decision makers are those individuals and organizations that can block or advance implementation of an alternative. By this definition, individuals who allocate budgets in the USACE are decision makers. So, too, is the USACE planner whose professional analytical decisions create a particular perception of the watershed effects of an alternative. Decision makers also are those outside the USACE, indeed outside of government, who are able to take *effective* political or legal action to advance or thwart the USACE ability to implement an alternative. Such decision makers might be the USACE cost sharing partner, the national office of the Sierra Club or a local port authority. Decision making to select a restoration alternative requires agreement among decision makers.

Planning should be conducted to secure agreement among decision makers. Agreement must be grounded in a common perception of the "facts." For example, decision makers may have different perceptions of the effect of increased water deliveries on marsh survival. The ability to reach factual agreement might be served by a technical study using controlled experimental methods. In the past, the USACE might have conducted such a study and then asserted that its planners had established the relationship between water deliveries and marsh survival. However, the power of the USACE to assert analytical dominance has waned in recent years. Today, negotiation among the natural resource agencies of the Federal government and the states, as well as the traditional water development interests and environmental groups, takes place over "technical" decisions such as model selection, estimation of costs, and scope and quality of data bases.

Disagreements will always arise over the desirable outcomes of any action. Decision makers may agree upon the physical and biological effect of reduced water deliveries on a marsh, but disagree about the acceptability of the effect. Conflicts of this nature may need to be resolved so that one view is imposed over the others. In the past, USACE had sufficient power over contending interests to impose a viewpoint without concern that those in opposition might find an alternative decision forum to secure their preferences. Today, this ability has been dispersed to a number of agencies and nongovernment interests who have a variety of legal and political means for advancing their own values.

If the conflict is rooted in strongly held ideological positions, agreement may require selecting an alternative that avoids the conflict of values. In the example used here, the only way to reach agreement may be to find an alternative water source so the deliveries to the marsh will not be affected. However, the disagreement may be over positive or negative wealth effects on different groups, and not over ideological positions. In this case, agreement may be reached by offers of compensation from those benefiting to those harmed. Compensation may be in the form of small changes in the decision. For example, adding a fish ladder to a dam might compensate fish and wildlife advocates who would otherwise oppose the dam's construction because of lost recreation opportunities. In the case of restoration, compensation may need to flow to those who have benefited from dams, water diversions and drained wetlands, if benefits will be given up for restoration. For example, the purchase of farmers' water rights, the provision of alternative water sources or subsidies for the cost of water saving technology may be part of a restoration alternative.

The USACE's ability to assert the validity of its technical studies and to impose alternatives on resistant interests has diminished in the past three decades. The powerful past of the USACE was a time when there was a national consensus behind water development, a time when the perception of expertise being housed in executive agencies was rarely questioned, and a time when access to the courts and to the legislature was limited to a few. In the exercise of that historical power, the USACE developed a hierarchical organization that stressed central planning and budget control through the imposition and enforcement of planning procedures. *In this new era of diffused power, the USACE restoration planning and decision protocols will need to be conceived as supporting consensus building within a fragmented decision making process.*

Elements in USACE Planning

Today, the expectation is that USACE planning will inform decision making (ers) by analyzing data using particular conceptual frameworks. Decision making is supported when the clarifying results of the analysis from each element allow a particular alternative to be selected in consideration of the tradeoff between alternative outcomes of a restoration project and its costs.

Element 1: Establish Planning Objectives

USACE planning is focused on a specific area specified by the law authorizing the study. That area may be defined as narrowly as a specific harbor or area of a city, or as broadly as a watershed the size of the Florida Everglades. Within that area, the agency is expected to address water and related land resource problems and opportunities such as urban flooding, sedimentation of channels or a decline of waterfowl numbers.

The definition of general problem areas must be followed by a statement of planning objectives. Planning objectives are *specific* statements that establish the desired directions of change in the watershed and must be stated in measurable terms. However, these are not end points that are to be achieved at minimum cost. Examples of planning objectives are to reduce flood damages in the downtown business district of city X, to increase the channel depth in the harbor at city Y or to increase the breeding pairs of mallards at site Z. Planning objectives must have enough specificity in their statement to permit the development of particular alternatives in Element 2.

Planning objectives might be stated as a surrogate for a broader conception of the general water resource problem. An example of a surrogate may be the use of an indicator species (a particular species of bird) to represent the general concept of ecological carrying capacity. Thus, a specific planning objective to "increase the population of mallard ducks in lake L," may be a surrogate for measuring improvements in the lake's "ecosystem health."

Element 2: Formulate Alternatives

Plan formulation is expected to consider all the measures available for addressing the planning objectives. Combinations of measures, defined as alternatives, will achieve different levels of satisfaction for each objective. For example, alternatives for flood damage reduction might include the two measures of a reservoir and mandatory purchase of flood insurance in different combinations. Alternatives for increasing mallard duck populations may include different combinations of the measures of water level control, vegetation planting and creation of nesting sites.

The terms used in production economics describe this planning element. Alternatives (inputs) are created by combining measures. The inputs produce different levels of satisfaction of the planning objectives (outputs). Thus, the relationship between alternatives and the planning objectives are analogous to a production function. Determining the relationship of inputs to outputs, or the production function, is Element 3.

Element 3: Measure the Effects of Alternatives on Planning Objectives

This element requires the application of all the engineering, biological and behavioral sciences, as well as extant literature, to estimate the change in the watershed condition with, versus without, the alternative. For example, methods in hydrology must be employed to establish the effect of a channel on flood heights and flow velocity at some location along the river. The effect of insurance purchase requirements on peoples' decisions to develop in flood prone areas might need to be established. The influence of a rise in energy costs on industrial plant location may need to be assessed. The influence of vegetation planting on reproduction and survival of mallard ducks might need to be estimated.

Knowing the effects of the alternatives is a requirement for the formal evaluation required by Element 4. Specifically, in order to evaluate an alternative, an estimate of its output is required. However many of these production relationships will be difficult to establish. The state of hydrology as a discipline, as well as the USACE experience, supports confidence in estimates of the effect of alternatives on river heights and velocities. Conversely, the emerging state of restoration ecology and the USACE's limited experience in environmental planning may mitigate against unquestioned acceptance of models that predict the effects of water levels on mallard duck populations.

Element 4: Formal Valuation of the Alternatives.

Valuation is expected to determine the "worth" of achieving different levels of the planning objective (Element 2) for comparison with the costs of the alternative. Calculations that are part of formal valuation often employ abstract aggregation standards such as economic efficiency or environmental biodiversity. For example, the effects (Element 3) of alternatives on the planning objectives (reduced flood heights and velocity, increased navigation capacity and improved recreational duck hunting) might all be evaluated in monetary terms and added together. Such abstraction permits the combination of incommensurable effects into a few indicators of project worth. More than one aggregation protocol might be used to represent different dimensions of project worth. The presumption is that information reported in the evaluation accounts informs decision makers who then may determine the "public interest" merits of alternative plans.

The USACE has adopted the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) as a multiobjective evaluation system. The evaluation of project effects can be represented in four accounts, although only a national economic development (NED) analysis is required by the P&G.

The *NED account* reports measured changes in the economic value of goods and services. The NED account is the home for monetary valuation of restoration outcomes using the standards given by neo-classical economic efficiency theory. However, the NED analysis is limited to those outputs that can be measured in monetary terms in a manner acceptable to decision makers (see below). If an outcome is not amenable to monetary measure, the outcome is measured in another account. NED measurement is typically applied to outputs such as flood control and navigation. However, even for these outputs the NED evaluation is recognized as only a partial representation of project worth. For example, avoided damages to real property is the NED measure of flood control benefits, but that measure is recognized as being an incomplete measure of the full benefits from a project (Shabman and Stephenson 1993; Shabman and Thunberg 1992).

The *RED account* (regional economic development) also may include effects measured in monetary terms. However, the RED account uses value measurement concepts as employed in national income accounting, such as employment changes, changes in cash income and wealth by economic sector, and fiscal effects.

The *EQ account* (environmental quality) allows the planner to aggregate and report changes in general ecological indicators (e.g., biodiversity), as well as cultural and aesthetic attributes. This account and the OSE (other social effects) account are the home for nonmonetized effects of an alternative. The *OSE account* reports changes from perspectives that are relevant to decision makers, but are not reflected in the other three accounts. Thus, the effects on income distribution, environmental justice and the like might be recorded.

The New Planning Environment, Planning Elements and Environmental Restoration

Planning Objectives for Environmental Restoration

The statement of planning objectives demands that there be some definition of desired changes in the state of the watershed to be achieved by restoration. Specifically, restoration planning requires a definition, in measurable terms, of the outputs of a restoration action. A watershed perspective should be adopted for defining restoration outputs (National Research Council 1993). First, the structural features and processes of a watershed would be described and measured. Physical features (acres and cover types of uplands, wetlands, and riparian zones), chemical features (ambient measures of sediments, temperature, dissolved oxygen, nutrient concentrations and the like in surface and ground water), and biological features (plants and animals within the aquatic environment and related lands) give rise to watershed processes. These processes include soil building, nutrient cycling, carbon storage and patterns and timing of surface and ground water flows. The interactions among features and process are complex and numerous. A wetlands position in the landscape may determine the timing and volume of surface water flows. Building of soil organic matter may increase water retention capacity, slowing run-off. The area between uplands and wetlands may determine waterfowl reproduction capability. Nutrient cycling may determine oxygen levels and in turn fish species composition in a river. At any time, a watershed's features and processes in relationship to one another yield a vector of watershed services which may be valued by people.

Table 1 includes illustrations of four classes of watershed services, all of which may be achieved through environmental restoration. Use of the environment as a production input and for direct use most closely aligns with the types of services that were the focus of the traditional water development programs. In those programs, these services were expected to be captured or enhanced by the construction of water control works. Restoration alternatives may reverse the effects of control works, but may still provide some of the traditional services. For example, wetlands re-creation may reduce downstream flood peaks and permit more intensive land use downstream. The waste assimilation services may be used by intention, but often use is simply the inevitable result of human activity.

Several points about the life support service should be noted. First, this service may be diminished by use of the environment for waste assimilation (e.g., by stressing the nutrient cycling capacity). This service also may be diminished by alteration of the watershed to secure production inputs and for direct uses. Second, the life support services are often intermediate inputs to the other services; nutrient cycling capacity yields the waste assimilation service, the habitat service supports commercial and recreational fishing, the hydrologic regulation service supports the ability to occupy lands that might otherwise be flooded. In general, many of the services at the bottom of Table 1 support services nearer the top.

Many restoration advocates feel that life support services have been diminished by past alterations to watersheds and by the use of the waste assimilation service. Further, they assert that restoration alternatives to enhance the life support services will also improve many of the other services in Table 1. Mimicking a historical pattern and timing of river flows or re-flooding an area that used to be a wetland are examples of restoration alternatives. Restoration alternatives usually are formulated with reference to a historical template, or to a similar watershed which has had less alteration, but for which there is some evidence that, at a prior time, the reference watershed and the target watershed were similar. In all cases the restoration alternatives are expected to yield some vector of the services listed in Table 1, the services being the restoration outcome. *The desire to enhance life support services motivates the current emphasis on environmental restoration alternatives, however, such alternatives can produce the full array of services listed in Table 1.*

TABLE 1
WATERSHED SERVICES

PRODUCTION INPUT FOR MARKET VALUED GOODS AND SERVICES
- Transportation
- Power generation
- Land productivity for food and fiber production
- Water input in commercial and industrial production
- Land productivity for commercial and industrial purposes
- Harvest of commercially marketed fish and wildlife

DIRECT CONSUMPTIVE AND NONCONSUMPTIVE USE
- Recreation
  - Bird watching
  - Fishing
  - Etc.
- Municipal and home water supply
- Aesthetics

WASTE ASSIMILATION
- Processor or sink for human waste products
- Trap for eroded soil

LIFE SUPPORT
- Hydrologic regulation and attenuation
- Global carbon budget
- Water quality
  - Aerobic and anaerobic processes
  - Nutrient cycling
  - Sediment trap and export
- Habitat (food chain, nursery, etc.)

By some definitions, restoration alternatives appear equivalent to restoration outcomes. A National Research Council Report defines restoration as "... the return of an ecosystem to a close approximation of its condition prior to disturbance" (National Research Council, p. 18). Such definitions suggest restoration planning objectives can be an outcome where the landscape features structurally resemble a past condition. To accept this view means that the production function between the alternatives and services need not be precisely specified; if the past is re-created, then the life support services will follow.

At the large watershed scale, the Everglades restoration effort illustrates these different ways to state restoration planning objectives. One approach is to state the restoration planning objective using the services listed in Table 1. For example, the planning objective might be to increase the wading bird population. In this case, analysis of the determinants of wading bird populations may be necessary in order to develop the full range of alternatives that will serve that planning objective at the Everglades scale.[2]

Alternatively, the statement of planning objective may be to re-establish the features of the historical Everglades, in whole or in part. If the structural features were re-established, many desired restoration services might follow. Following this logic, the problem situation might be that water diversions have altered the historical amount and timing of sheet flow. The planning objective then becomes to return the diverted flows in ways that reconstruct the historical hydrologic regime at each remaining space in the original Everglades. If one half of the original Everglades area remains, then the planning objective is to mimic the past hydrologic regime on that half. As a planning objective, the closer the restored hydrology is to the historical, the better.

Another possible statement of the planning objective begins from an analysis that describes the Everglades problem in multiple dimensions of reduced spatial extent, reduced sheet flow, and reduced diversity of wetlands types. This problem assessment may lead to a planning objective to re-create, but in reduced size, the multiple features of the historical Everglades. The planning objective to recreate a microcosm of the historical Everglades presumes that scaling down of each element of the historic Everglades to fit into the remaining space will best assure the return of the life support and other services.[3]

If the planning was for watershed areas smaller than the whole Everglades, the identification of the planning objective is not made any clearer. Again, with reference to the Everglades, the planning objective may be to recreate bird nesting opportunities by the removal of fill material in a waterway. This objective is tied to the services listed in Table 1. Alternatively, the planning objective might be to re-create some limited number of acres of sawgrass marsh. This planning objective is an effort to re-create the structure of the ecosystem.

Restoration planning objectives may be measured either by the level of certain watershed services valued by people or by descriptions of structural watershed features. Ultimately, *the decision to bear a cost for a restoration alternative will be expedited when the decision makers understand the different states of the watershed that will exist with, versus without, restoration. The planning objectives must therefore be credible to, and understood by, decision makers.* Acceptance and understanding by decision makers is a valid reason for selecting any particular definition of the planning objective.[4]

Formulating Restoration Alternatives and Measuring Restoration Effects

Alternatives are engineering, regulatory and other public policy measures expected to address a planning objective. The purpose of plan formulation is to define those alternatives that will serve the restoration planning objective. This must be followed by an estimate of the contribution of the alternative to the objective. Consider an alternative of re-creating sawgrass marsh in the interest of wading bird numbers. The creation of the marsh would be one of several alternatives ways that this service of wading bird numbers could be obtained. Perhaps another alternative would be placement of artificial nests.

If a vector of services is the planning objective (e.g., wading bird population numbers), then the definition of alternatives and their effectiveness becomes complicated. This can be understood by recalling the production function analogy made earlier. The features of a watershed system may be thought of as a physical input which, in combination with human management inputs (the direction of energy, materials and know-how to the watershed), gives rise to a vector of outputs (services). To measure the effects of alternatives requires the technical ability to trace back from the level of the services to the contribution of the alternatives. The absence of a well defined "production function" relating all the services to management alternatives is a formidable barrier to effects measurement. Restoration ecology has yet to make much progress on models to estimate such effects (National Research Council 1993).

A different planning approach is to accept an assertion that "putting it back the way it was" will return some level of lost life support services. In this case the creation of sawgrass marsh itself is the stated planning objective and the alternatives become the different techniques by which such marsh can be created. The effectiveness of saw grass marsh for bird population support is relegated to a lesser concern with attention placed on the effectiveness of techniques for marsh creation and restoration. This approach leads to an overlap between restoration planning objectives and restoration alternatives; indeed, the planning objective and the alternative become indistinguishable.

However, what does it mean for a restoration alternative to re-create a past condition? Consider the Everglades planning effort once more. One viewpoint is that the appropriate alternatives are those which preserve the remaining landscape and just return diverted water back to these preserved areas. The remaining system is expected to evolve into a self-sustaining watershed. A different perspective is that the Everglades has lost much more than water. There has been a reduction in spatial area and in the diversity of wetland and upland types. There is no prospect of regaining the spatial area of south Florida that was once the Everglades, so the only alternatives for restoration are those where management finely controls water flows and levels and assures a historical balance between wetland and upland types, all within reduced in areal extent.

The point here is not to recommend the appropriate Everglades restoration alternatives, but the lesson is clear. *It will frequently be difficult to obtain a consensus among decision makers on defining restoration alternatives. Agreement on how to measure the effectiveness of alternatives in serving the planning objectives is also elusive. This suggests that the USACE must conduct the plan formulation element with an openness to the interests and concerns of decision makers.*

The P&G includes among the criteria for plan selection, "acceptability." A key determinant of acceptability is the ability to compensate losers from plan implementation. In the past, management of a reservoir for a striped bass fishery, or for cold water releases to create a trout fishery, might have been offered as compensation (mitigation) for fish and wildlife losses imposed by the project. In this same manner attention to loss compensation will now be needed in the formulation of restoration alternatives. Thus, a wetlands restoration alternative might include purchase of farming or development rights from landowners. *The complete formulation of the restoration alternative might include compensation to those who must forgo the benefits of existing water and land uses.*

A third requirement is to expand the scope of alternatives beyond those related to water resources engineering at the site. USACE planning has often paid too little attention to alternatives that it had no authority to implement. For example, freeing up water rights markets and power marketing arrangements to synchronize the flows of water and the passage of anadromous fish might be an alternative to modifying the structure of dams in a river system. As another example, changes in the sugar import quota system might be an alternative to influence agriculture's effects in the Everglades. *For restoration planning, the range of alternatives must be quite broad. Therefore, the USACE planning process must explore partnerships with other agency programs and polices in order to formulate a comprehensive array of restoration alternatives.*

Formal Evaluation of Restoration Alternatives

The USACE draft planning guidance requires that evaluation of restoration alternatives be based on incremental opportunity cost analysis. Incremental analysis displays and justifies costs (financial outlays and forgone NED benefits) which are incurred to satisfy increased levels of the restoration planning objective. Conceptually, the formal analysis develops a marginal cost function with the level of achievement of the restoration planning objective on the horizontal axis and costs of the restoration alternatives measured on the vertical.

At present, the incremental cost evaluation requires three types of information: (1) indicators of change in meeting the restoration planning objective for development of the horizontal axis, (2) measures of the net NED opportunity cost of different levels of achievement of the planning objective for the cost axis, and (3) evidence that the proposed alternative is incrementally justified. In these guidelines, justification for a restoration alternative need not include monetary valuation of all outputs. For restoration projects, the USACE planner is asked to establish the incremental costs of achieving different levels of outputs from a restoration alternative.

Monetary valuation of restoration outcomes (satisfaction of the planning objective) using nonmarket valuation methods is admissible as information in justifying a restoration alternative, but is not to be the determining factor. Using the marginal cost information "nonmonetary," as well as monetary, arguments are to be employed in arguing for incurring the increasing costs associated with the arrayed restoration alternatives.

The incremental opportunity cost framework is especially well suited to support restoration decisions made by negotiation. One example illustrates the role of opportunity cost logic outside the USACE. The Federal Energy Regulatory Commission (FERC) reviewed the choice between foregone hydroelectric power and fish restoration potential from removal of two dams in the state of Washington. A United States General Accounting Office (GAO) report on the FERC effort noted that, "Because of the absence of generally accepted methodologies, FERC staff did not attempt to assign dollar estimates to nondevelopmental values such as fish production, recreation use, terrestrial resources, or aesthetics." The FERC analysis did include an estimate of the cost of dam modification and abandonment, as well as the power benefits foregone (measured as the cost of replacing lost power currently generated at the dams). The GAO observed that, "Given that the costs and benefits of various alternatives could not be fully quantified, we believe that the selection of one alternative over another is essentially a public policy decision in which value judgments must be made about the costs, benefits, and any tradeoffs."

Indicators of Change in the Planning Objective. Restoration planning objectives may be multidimensional, but ideally the degree to which these multiple objectives are achieved by a given alternative is measured by a single indicator. This single "state variable" (measure of the watershed condition) would then vary with each alternative. The appropriate set of indicators for restoration outputs in any situation is established by the way the planning objectives are established in planning Element 1.

Reference to historic conditions and to comparable, but less altered, watersheds is the basis for selecting restoration indicators. However, beyond this simple guide, little more can be said. As the NRC notes about restoration planning, "... selecting an appropriate subset of indicators from the universe of possible indicators is a skill and an art - in essence, a separate decision problem that is of great importance to the feasibility, cost, and validity of the evaluation" (National Research Council, p.66). The tool of the oral history may aid immeasurably in executing this planning element (Willard, this publication). *In USACE planning, the decision about indicators is made when planning objectives are written and accepted.*

If the planning objective can be narrowly proscribed to a target species, either as an objective or as an indicator of multiple restoration objectives, then the Habitat Evaluation Procedure (HEP), or any of its derivatives, might be used. HEP relies on describing features in a watershed, as they are necessary for the support of a particular indicator species. HEP scores called HSIs, or habitat suitability indices, may be computed for different species, but there is no acceptable way to unambiguously aggregate different scores into a single index. Increases in HEP scores with a given alternative indicates unambiguous improvement in meeting the planning objective. The HEP indicator has wide acceptance in the USACE and has recently been used to illustrate the incremental cost analysis process.

However, a single species habitat index may not be an acceptable indicator for the restoration planning objectives. One alternative is to use a measure of a watershed features (for example, acres of wetland of type X in location type Y). There are a few generalities that suggest how a change in watershed features would be positive. First, the ecological value of any alternative increases with the area of restoration. Increasing area supporting additional species and diversity and heterogeneity is the key to ecosystem resilience and persistence. Second, given that restoration will occur only in limited areas with human development at the boundaries, a project area that is insulated from deleterious effects at that boundary is preferred. Third, related to the area criterion, is the corollary to minimize fragmentation through corridors that connect patches of landscape which are restored or have not been substantially altered. This allows species migration and the opportunity of plants and animals to move about the landscape in order to survive external perturbations to the system by man or natural forces.[5]

Net Incremental Cost. The USACE draft evaluation guidelines require estimates of the change in net costs to the national economy (forgone NED) of meeting increasingly greater levels of the restoration planning objective. Foregone NED costs include financial outlays made by all governments and by individuals in implementing the restoration alternative. Also, the NED opportunity costs (forgone benefits) from the restoration alternative are to be included in NED cost. Estimating such costs requires running the NED analyses "in reverse" as services are lost rather than gained.

Recall that the P&G states that the NED account values the changes in watershed services (positive and negative) in monetary terms. In Table 1, four classes of watershed services were listed: a production input for market valued goods and services, the provision of direct services to users, waste assimilation, and life support. Moving down this list the services become more closely associated with the life support services associated with restoration alternatives. Economists have developed tools that may be used to place a money (NED) value on each of these services. Therefore, should all the effects of an alternative on the services in Table 1 be measured in NED monetary terms?

Services such as transportation, power, flood control, drainage, commercial and industrial water, municipal and home water supply, irrigation and site-based recreation are traditional outputs of USACE projects. These services are directly used by humans, are closely tied to market processes either because they are traded in markets, are a substitute for a service that is traded or are a production input to a good or service having a market price. By reference to market data the evaluation in NED terms appears to command some acceptance. The NED measurement tools include cost of the next best alternative, the change in net income approach, the land price comparison approach, and the travel cost approach.

For many years the application of the tools by USACE planners has been the subject of criticism, usually by those who oppose a particular project and claim that the calculations were done improperly. The USACE has developed extensive guidelines on the proper approach to benefit and cost estimation. However, there is another dimension to the criticisms of an NED estimate. NED calculations which are rooted in a pure economic efficiency logic may be rejected by some decision makers for being an incomplete value measure or for being an inappropriate measure of the values gained and lost. For example, flood control benefits are measured by the USACE, following NED logic, by the technique of property damages avoided. The NED results might be rejected by some decision makers because nonproperty effects such as reduced anxiety over flood threats are ignored, because the poor are ignored (low income people have little property) or because the calculation ignores the possibility that the flood risk inhibits the development of a community's economic base. If the NED calculation is not accepted by the decision makers for the project, then its contribution to decision making will be neutralized.

Perhaps the most dispute over money measurement arises when the service is valued using what are termed direct, or survey, methods. This form of valuation, called contingent valuation (CVM), seeks values from individuals by asking them directly what they would be willing to pay for a change in the state of the watershed. The answers are hypothetical in the sense that the response does not result in an actual payment being made. Of course, in this sense the CVM is analogous to the property damages avoided approach used in flood control benefit estimates. The avoided damages estimate is a hypothetical amount people ought to be willing to pay for flood damage reduction. What differs with the CVM is that there is no market reference of any kind while avoided damage calculations are grounded in some market and hydrologic information.

However, if an NED price is to be put on nonuse recreation and aesthetics or on people's values for the life support services of the watershed—the services most identified with restoration alternatives—CVM is the tool that is available. While there is some academic support for the application of CVM in the P&G framework (Zilberman 1994), professional and decision maker skepticism continues to greet CVM estimates. (See Appendix A. Also see Schkade, this report, and Russell, this report). Therefore, the USACE does not require that a monetary measure of "life support" services of a restoration plan be a part of the NED calculations in the incremental cost framework. *If use of CVM generates controversy rather than agreement, it should be used only when decision makers are willing to accept the validity of its results within the negotiation process (See Appendix B). In general, the USACE planner should follow a simple, but admittedly ambiguous, guideline when deciding whether to measure any service in NED terms: measure services in NED terms whenever such measurement will be accepted by, and used by, decision makers.*

Justification. The USACE budget process requires a justification statement organized around the incremental cost analysis for allocating federal funds among competing project proposals. The justification statement should demonstrate to decision makers why the costs for the recommended plan are "reasonable." In the past, one piece of evidence that costs were reasonable was the reporting of positive net benefits (NED). Indeed, if decision makers will accept full NED valuation of all services, then the incremental cost framework collapses into a requirement to do an NED based benefit-cost analysis. On the other hand, if a restoration project is not expected to measure its outputs in an NED metric, then the planner must document her/his judgment that the "benefits" from the improvements in the restoration planning objective are in excess of the costs. *This justification must be made to convince those who can block or advance a restoration alternative about the merits of the project. This means that the analysis required for justification can only be determined after determining what will be acceptable to the relevant decision makers.*

Evaluation for Justifying "Small" Projects: A small restoration project is defined here as one which does not "substantially" reduce existing benefits now realized from the watershed. In the case of a USACE project, the benefit stream from the project would be unaffected[6] and only modest financial outlays would be required to implement the restoration alternative. The opportunities for this type of decision making may be numerous, but the restoration outputs will be limited for any case.

For small projects, the USACE may employ any internal planning and budget decision rules it feels are useful for setting priorities (establishing the reasonableness of cost) among this group of small projects. The need is to provide adequate and acceptable decision making information for the budget authorities in the USACE hierarchy. An NED based justification might be required, even one using CVM estimates of life support services. If all restoration services are valued in standardized NED terms comparisons across projects may be made more easily. However, the costs to complete such valuation studies may not be warranted by the project costs. Emerging concepts of "benefits transfer" might be adapted to develop "look-up" tables of monetary values (as with the unit day recreation values) for the smaller projects. Guidelines on how to use such tables would also need to be developed.

Evaluation for Justification of "Large" Projects: A large project is one where opportunity costs are imposed on decision makers outside the USACE. Agreement can be supported by careful assessment of the opportunity costs borne by decision makers adversely affected by a restoration alternative so that compensation strategies can be incorporated into plan formulation. When calculation of opportunity cost is to serve a negotiation process, the calculations necessary will be determined by who is represented in the negotiation and by who might have power to block a decision even if they are not a party to the bargaining. These groups must be identified, their concerns understood, and then the costs imposed on them from each alternative should be clearly identified.

Frequently, analysis which describes such effects as changed revenues to affected businesses, changed prices for consumers, and changed job and income consequences for a region may be important for decision making. Therefore, there will need to be a new priority given to evaluation within the RED and OSE accounts if multiple decision makers' concerns are to be considered adequately in the analytical phases of planning.

Beyond Calculation and Toward Agreement

The USACE planning process is conducted to support reaching of agreement among decision makers, an agreement that leads to project implementation unless the agreement is to take no action. Implementation means that necessary funds are allocated and that no legal or political action blocks the decision. The USACE planning elements facilitate restoration agreements. A facilitator helps groups make tradeoffs between restoration objectives and costs. In the future, for most restoration projects, planning will be focused as much on building external agreements on the "value" of the preferred alternative as on documenting value through computations called for by the agency budget authorities. *The USACE planner will need an understanding of challenges for building agreements as much as an understanding of the tools for analyzing data.*

One challenge will be to determine who should be part of the negotiation process. If some groups are not represented at the negotiation, then negotiated restoration decisions may be neither "equitable" (despite the making of compensation payments) or effective in reaching agreements that will lead to implementation. For example, a negotiated decision for an alternative to increase the salmon runs on the Columbia River that does not include native American interests might not yield an equitable decision or be implementable. However, what interests should be part of a negotiation and what role might they play? Public choice theory from economics describes the increasing decision making costs (decision making delays and financial costs) as group numbers increase. Also there is a decreased likelihood of reaching agreement as group size increases. However, if excluded groups have ways to influence the decision outcome outside of the negotiation, then their exclusion may serve achieving a group consensus on a preferred alternative, but will not assure that the preferred alternative can be implemented. The public choice literature, as well as the literature on environmental negotiation and alternative dispute resolution, includes numerous studies and recommendations about how this dilemma might be addressed through different forms of group decision rules, through the different roles that might be played by the convener of the negotiation (facilitation, mediation and arbitration), through the legislative actions to constrain the opportunities for opposition, and through different rules for the distribution of project costs.

A second challenge will be to communicate the essential analytical findings of the planning elements. Given the scientific uncertainty and room for different views for all of the elements in restoration planning, the ability to accomplish rapid "what if" simulations of different technical and data assumptions will help participants to agree on the planning objectives, on the alternatives that might be formulated and on effects of the alternatives on planning objectives and on their particular social and economic interests. In this way, tradeoff analysis can be rapidly accomplished.

Conclusion

Restoration planning for the USACE still poses the traditional planning question—are the costs of an alternative warranted by the values received? In the USACE tradition, this question was answered by relying on calculations made by planners for the budgetary authorities of the agency. The challenge of doing these calculations is now being replaced by the challenge of building agreements on what costs for achieving restoration planning objectives are "acceptable." Such planning for the USACE will demand identifying the "relevant" decision makers, determining what technical analysis is needed to support decision making and then communicating the finding of that analysis in a way that is useful for reaching agreements.

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[1]The examples offered in this paper have been developed from the author's own experiences and from detailed discussions with Lynn Martin and Ken Orth of the Institute for Water Resources.

[2]Of course, the multiple services of the Everglades may not be adequately represented by wading bird numbers. Indeed actions to increase wading bird numbers may at some level reduce other services.

[3]Additional discussion of this example is included in the next section.

[4]As the cost of restoration alternatives increases some decision makers will expect analytical evidence of the link between restoration of watershed features and restoration services. For example, there is now much uncertainty about how river flows affect downstream salmon passage around the Columbia and Snake River's dams. Advocates for expanded fish passage are anxious to pass water over the spillways, rather than through the turbines of the dams,because they assume this more natural flow will improve fish survival. Opponents of the plan argue that without more compelling evidence about the effectiveness of the measure the foregone power benefits from this trial are too high. The issue remains unresolved.

[5]In this case the planning objective is stated in the same terms as the indicator, so the role of the indicator, to synthesize a multi-dimensional output into a single scale, is not achieved.

[6]The prospect for this type of situation motivated the USACE Section 1135 program, where the presumption was that environmental outputs could be increased from re-operation of existing projects without infringing on existing project purposes.

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APPENDIX A
THE LOGIC OF MONETARY VALUATION

One objective of the EEIRP is to review the role of monetary and other valuation techniques for making environmental investment decisions. Attention to valuation is consistent with the USACE "benefit-cost" tradition. In developing the benefit-cost criterion in the last three decades, the USACE has adopted the prescriptive efficiency logic of neo-classical economics. Thus, the NED account establishes willingness to pay as the organizing principle for the estimation of value. The P&G then goes on to offer the USACE planner a variety of approaches to estimating willingness to pay benefits.

The valuation logic is well understood. First, monetary valuation efforts rest on two critical assumptions: (1) that individual's have and know their preferences (values) for goods and services (states of the world) and (2) that the preferences are revealed through market exchange behavior. Flowing from these assumptions is the result that market prices observed in a presumed equilibrium state provide the empirical data for preference (value) measurement. All buyers and sellers react to common equilibrium prices and equate their marginal utility for the traded goods and services to those common prices. Prices thus reflect individual, marginal valuations (marginal willingness and ability to pay). With the appropriate computational procedures marginal valuations can be used to derive economic surpluses for individuals. Total value measures are calculated by summing over the individuals' surpluses.

Indeed, establishing values for environmental services has become an interesting research puzzle for many economists because, for reasons generally subsumed under the term "transaction cost," market exchange prices for environmental restoration services fail to reveal marginal values. The research agenda and asserted policy need for *nonmarket* valuation rests on the market failure assertion. Values, or benefits, individuals hold for environmental outcomes are estimated as they would have been revealed if a market were able to achieve equilibrium under idealized conditions of exchange. Then, through benefit to cost comparisons, efficient allocations can be described and contrasted with inefficient allocations. Thus, many economists would argue that the USACE's restoration decision demands monetary valuation of restoration services to compare with restoration costs.

Nonmarket value estimation relies on either (1) revealed or (2) hypothetical choice techniques. Revealed choice techniques interpret market prices paid or received for goods or services which are related to some measure of the environment. Land prices near polluted and clean bodies of water are compared using hedonic price analysis. The travel costs to a recreation site are probed for evidence about the value of the site. Recent valuation studies have used purchases of insurance, substitute goods (e.g., bottled water), subscriptions to magazines and memberships in environmental organizations to estimate environmental values. Other studies have analyzed voting behavior and wage differentials among occupations to secure value estimates.

Hypothetical value techniques use surveys instead of market prices for related goods. These survey methods, generally termed the contingent valuation method (CVM), are constructed to elicit individual expressions of willingness to pay for alternative states of nature (which might be considered to be changes in the stated planning objective), under the assumption that the survey instrument has been carefully designed to mimic a "real" market choice. Thus, the CVM method might elicit citizens' willingness to pay for more wading birds at a location in the Everglades or the willingness to pay for increased sawgrass marsh in the Everglades, since either of these planning objectives represent a different state of nature.

Economics research has sought to perfect the nonmarket techniques by developing methods to assure that the simulated market was similar to a real market. Hence, the valuation literature has focused on matters such as (1) assuring the information structure in the simulated market is similar to a "real" market, (2) accounting for partial versus general equilibrium adjustments in markets and by individual households, and (3) guarding against biases that will cause individuals to overstate or understate "true" preferences. Without an actual market exchange there is no obviously correct verification protocol. Therefore, one popular theme of the professional literature involves attempts to verify the accuracy of value estimates. Of course, standard debates over sampling and econometric estimation are also part of this valuation literature.

Despite decades of research, the tools, especially CVM, are still viewed as "experimental" and debate over their utility and the validity of the estimates may be more intense now than at any time in the recent past. Neither this appendix, nor this report, is intended to be a comprehensive review of the technical issues in doing nonmarket valuation. Such reviews can be found elsewhere. A useful summary of the debate over CVM can be found in Portney (1994), Hanemann (1994), and Diamond and Husman (1994).

APPENDIX B
VALUATION AS AN AID TO NEGOTIATION

The perspectives on nonmarket valuation offered here are methodological and historical. Both perspectives suggest that the purpose of valuation is to direct a value discovery process and not to establish value as a computational certainty.

Methodological Perspectives

Little in the nonmarket valuation literature questions the core assumptions of the research: that individuals know their preferences and can express them independently of choice opportunities, and that market equilibrium (which makes such estimations computationally tractable) exists as more than a convenient analytical assumption. Also, there is little serious concern within the literature that nonmarket valuation advances efficiency as a single best public decision rule. However, even a cursory review of the Austrian and Institutional economics literature should make economists uneasy about the benefit estimation research program.

An Austrian Critique: In the Austrian view, prices emerging from market exchange can not be used as a measure of value. Instead, prices are a historical record of a trader's circumstances (information, income, alternatives) and preferences at the time the price was established. The Austrian interpretation of the price a person was willing to pay for an environmental outcome in the past can not be used for establishing future values. People's values may change over time as people gain knowledge about, and experiences with, certain goods and services (such as restored natural environments) and, as a result, they may be willing (or unwilling) to pay more of their money income for those services. Also, the circumstances of the original purchase may have changed. Preferences are discovered and revised through market exchange.

An Austrian argument against valuation through interpretation of prices follows from their conception of the role of market exchange as a social organizer. Formaini (1990) states that in the neo-Austrian world, equilibrium never exists at the level of the market and is only a temporary state for individual market traders. Market prices encourage individual entrepreneurial adjustments as people continuously redefine their preferences and search for new technologies. Klamer and McCloskey have put it this way:

> The problem in economic life is not calculating what to do after knowing all that you need to know. The problem is to know... The Austrians see the economy with the metaphor of fog, the fog in which we maximize what the neo-classicals so confidently describe as 'objective functions' ... the main problem is acquiring knowledge, not exploiting it.

Attempts to read preferences (values) from choices made in this "mist," as is required in the nonmarket valuation research program, is a puzzle solving activity where the puzzle solution has no meaning outside the abstract solution rules given by the market equilibrium analytical framework.

An Institutionalist Critique: Still the advocate for nonmarket valuation may ignore this critique and continue to promote the results for use in a net benefits analysis to direct restoration spending and regulation choices. The net benefits criterion is a guide to efficient public policy; that is, the policy that would emerge from a perfectly functioning market if that market were able to function. Here is where an institutional economics critique of nonmarket valuation would apply. The institutional economist argues that nonmarket value measurement inappropriately elevates the preferences of current individuals and the power system (property rights that establish ability to pay) in the economy to the touchstone for environmental decision making. However, the essence of public policy discourse is to redistribute power and to form new values, in this case for environmental restoration services. Within institutional settings of culture and power, preferences are continuously created and are not fixed parameters to be measured by research economists (Hayden 1993).

Institutional economics reminds us that the discovery of *instrumental value* is the primary purpose of our public policy processes. Instrumental value is not a precise concept, but it recognizes that interests of the community in, for example, the life support services of the environment, can be distinguished from the simple addition of the measured preferences of isolated individuals in nonmarket valuation exercises.

Implications of the Methodological Critiques: The primary difference between the Austrian and Institutional critiques is the institutional economists' discomfort with the methodological individualism of the Austrians. The Austrians study and predict the outcomes of individual "free" (purposeful) choice and they are not willing to challenge the existing institutions of power and property which "weight" each individual's influence in a market, or market-like, system. In offering alternatives to nonmarket valuation, the Austrian would advocate design of market-like bargaining systems that mimic the search and discovery power of the market and find "optimal" allocations as the simple summation of the preferences of individuals.

Institutional economists argue that market and market-like choices are not free choices. Also, for the Institutionalist, a market-like organization can not, by its structure, adequately represent the "instrumental value" of natural systems. Instrumental values are best discovered in an open social/political dialogue that recognizes power and information differences when society sorts out the values that should count.

Despite their sharply contrasting views, the two criticisms both lead to some form of negotiation and bargaining system as the basis for environmental restoration choices. Practitioners of environmental policy must somehow learn from both points of view in improving the design of the current approaches to negotiation over environmental restoration.

At present, there is a tendency to accept negotiation-based restoration decisions as equitable, because compensation for losses is made. These same decisions might be deemed economically efficient, much as we presume voluntary exchange relationships in markets yield efficiency. However, skepticism should always be expressed about the efficiency and equity of any negotiated outcome. In fact, this skepticism is also grounded in the Austrian and Institutional economics traditions. The Austrian (Public Choice) economist will remind us that negotiated restoration decisions have the potential for cost shifting. A decision to accept or reject a restoration plan might be optimal for the parties to the negotiation, but impose a large cost on the society. The institutional economist reminds us that negotiated restoration decisions will not be "equitable," despite the distribution of compensation, if some interests are not represented at the negotiation or if there is an imbalance in the power to influence outcomes. Finally, an evaluation of the negotiated decision against some external, "instrumental" criteria (ideological assertions of proper values) may be necessary to judge the bargaining process.

An Historical Look at Benefit Estimation

The tradition of estimating benefits and costs (now NED analysis) in USACE may suggest that the computations of value are the key to the decision process. Such an inference would support efforts to measure environmental services in the NED account. However, an understanding of the contribution of valuation to decision making is not possible without reference to its historical and bureaucratic context (Shabman 1989). The early water resource development plans of the federal government were expected to show that the financial repayment requirements, where required of project beneficiaries, could be met. In these cases, a demonstration that it was financially feasible to use the project services (e.g., irrigation water) and earn income adequate to repay a share of project costs was all that was required. The 1936 Flood Control Act provided the first legislative admonition to federal agencies to conduct a comprehensive assessment of the benefits and costs of their proposed work.

However, to appreciate the context for that act, it is useful to go back to nonfederal efforts to ascribe benefits to projects before 1936. Beginning with the Mississippi River Commission in the late 1800s, and continuing to the planning efforts of the Miami Conservancy District of Ohio in the 1920s, benefits from reduced flood risk were estimated as the expected difference in land prices with, versus without, a flood control project. These benefit estimates were a starting point for negotiations between local flood control and levee districts and benefiting landowners on the tax payments that would be made to pay for project construction.

Benefit estimation practices for flood control deviated from the land price method when flood control project construction and financing responsibility shifted to the federal government with the 1936 Act. However, the 1936 act had a broader intent than economic efficiency as measured by willingness to pay. In fact, the theoretical efficiency logic behind contemporary benefit analysis had not even been professionally developed at that time. The benefits to be established were the relief from human suffering (as dramatized by the sequence of flood events in the 1930s) and the advancement national economic prosperity in an era of economic depression. Also, water control projects would now be expected to serve multiple purposes in support of these legislative objectives.

These broad social objectives and multiple purposes would not be adequately reflected in private land market transactions. New approaches to benefit estimation were sought. However, despite the broadly stated social goals of the 1936 Act, practical benefit estimation approaches were needed. Hence, for example, flood control benefits were computed as the present value of real property damages avoided (PDA). The PDA technique relied on the hydrologic information that was routinely developed for project planning. Also, the PDA approach had a compelling investment logic: if current expenditures for a flood control project were less than the present value of avoided future property repair costs, then the project was justified. However, the limitations were recognized by planners and decision makers alike, so PDA benefit estimates only were an initial screen to determine project worth. These benefit computations were not intended to be the final factor determining project choice. Therefore, in the political arena where project investment priorities were set, the simple calculations of PDA benefits were part of a broader consideration of the "nonproperty" effects that would be mitigated by the project.

Over time, the stringency of benefit computation requirements was increased and reference was now made to the emerging insights offered by theoretical structure of neo-classical welfare economics. Reflections of this literature appear in a sequence of federal water project evaluation guidelines. Many of these guidelines, while not using the term directly, implied that landowners' and society's "willingness to pay" for project outputs was the standard by which benefits should be established. However, the motivation for the development and transfer of economic efficiency logic to the benefit-cost requirements was not an intellectual commitment to economic theory. Instead, the willingness to pay logic was a vehicle for imposing a defensible new stringency on benefit estimation in order to exert hierarchical and budget control on the agencies, to be able to resist local "boosterism" in project support and, later, to advance an early environmental agenda (Carter) for diminishing the budget of the national water project construction programs. If there was a central decision purpose for benefit estimates, it was that the reporting of benefits was the beginning point for negotiations within the agency, and among the agency, local (congressional) project sponsors, and the administration budget authorities. Positive net benefits might get a project plan to the negotiating table, but they did no more than that.

As the national interest shifted from development to the most "intangible" services of the environment, economists developed CVM to measure willingness to pay benefits for environmental improvements. However, few of the numerous environmental laws of the 1970s provided a place for such information in the decision making. Despite the advocacy by some economists, nonmarket valuations have been ignored in decision making, except in one telling instance—natural resource damage assessment. This application fits well within the historical application of benefits assessment, where such assessments have always been as a starting point for negotiations on spending priorities by government. Today, natural resource damage assessment numbers are only a start on decision making negotiations between those liable for harm and government trustees, often with the oversight of the courts.

Implications of the Historical Perspective

The underlying premises and purposes of measurement have changed over time. However, even as the conceptual foundations for benefit assessment have shifted, the uses made of benefit estimates have been remarkably consistent. The role of benefit computations has not been to establish values, but rather to serve as a starting point in negotiations over value. This kind of negotiation went on when the value of drainage works was negotiated in the 1850s, and 150 years later value estimates are serving negotiations over the values lost when natural resources are damaged. To expect value estimation to be any more than another "argument" introduced into public deliberations is to ignore this history.