Environmental Benefits and Performance Measures: Defining National Ecosystem Restoration and how to measure its achievement.

A Discussion Paper

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The Recommendations and Findings contained in this document represent the opinions and views of the Chief of Engineers Environmental Advisory Board based on technical information provided by the Corps of Engineers

The Issue

The Corps created an ecosystem restoration mission out of congressional authorities in response to public belief that water resources development for economic benefit had eroded natural ecosystem services enough to reduce national welfare. Implementing projects under that mission requires the planning process to predict outcomes, and monitoring to assess project performance. In addition, performance based budgeting requires the Corps to routinely identify progress towards ecosystem restoration at a programmatic level. This paper presents the EAB views on an appropriate Corps role relative to ecosystem restoration, and how benefits metrics and performance measures can contribute to furthering that role in an adaptive management framework.

The Corps Context

Civil Works ecosystem restoration policy and environmental benefits analysis has roots in the Fish and Wildlife Coordination Act (FWCA) of 1958 and the National Environmental Policy Act (NEPA) of 1969, which required consideration of fish and wildlife and other environmental values, and possible avoidance of or compensation for losses at water resources projects. The requirements of these Acts were well integrated into Civil Works planning process (the so called "NEPA" process) by the time the Corps received its first environmental improvement authority in 1986 (Section 1135 of the 1986 WRDA). The 1135 program was the pilot for the Corps ecosystem restoration program and where most of the ecosystem restoration policy issues were first addressed. Corps environmental improvement authority was initially defined by Civil Works policy to mean fish and wildlife habitat improvement, similar to habitat development in compensation for project damage under the FWCA. However, the policy evolved relatively rapidly in the 9 years from 1991 to 2000.

By 1990, Corps ecosystem restoration policy emphasized restructuring of the physical habitat to a condition more like the natural one. The ecosystem restoration concept evolved through numerous iterations of guidance for the various ecosystem restoration continuing authorities and publication of an Engineering Circular titled "Ecosystem Restoration in the Civil Works Program" in 1995. By 1997 the guidance for sections 1135 and 206 (ecosystem restoration authorities) stated, "The objective of section 1135 and 206 projects should be restoring degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition, which will involve consideration of the ecosystem's natural integrity, productivity, stability, and biological diversity." ER 1165-2-501, "Civil Works Ecosystem Restoration Policy" was published in September of 1999 but was essentially developed concurrently with the major revision of the Planning regulations (the Planning Guidance Notebook or PGN) published in April 2000.

The 2000 PGN established a concept of national ecosystem restoration (NER), through which outputs from ecosystem restoration projects contribute to the Federal objective of Corps civil works. It also established that the importance of NER in the Federal objective

is on par with National Economic Development (NED) and it *implied*, through its statement about joint formulation of NER and NED in multipurpose projects, that the Federal objective of Civil Works planning is maximization of national welfare through optimum combination of NER and NED.

Two years later the Environmental Operating Principles (EOP)were published, committing the entire USACE to "strive to achieve environmental sustainability" and to do it by balancing human development against the need to maintain viable ecosystems.

EAB Findings and Recommendations

1. The National Ecosystem Restoration Objective

The NER concept and qualifying contributions are much less precisely stated than the concept of and contributions to NED in the Federal planning objective. Some of this subjectivity can be avoided with a more precise Civil Works program statement of the ecosystem restoration objective. Planning policy makes it clear that contributions to NER in the Federal objective are to result in increased quantity and/or quality of "desired ecosystem resources" as a function of habitat "improvement", and that "the objective of ecosystem restoration is to restore degraded ecosystem structure, function, and dynamic processes to a less degraded, more natural condition. Civil Works restoration policy is consistent with the EOP in its emphasis on ecosystem naturalness. While it does not refer to "natural services", it does refer to "ecological services" in a statement buried deep in the PGN:

> "The planning for ecosystem restoration objectives is essentially the same as for other water resources development purposes. However, there are some special considerations because of limitations in understanding the complex inter-relationships of the components of ***ecological resources and services, which are the focus of these studies,*** and because the environmental outputs considered in the evaluation process are typically not monetized." (emphasis added)

The EAB recognizes that the skills and experience of the Corps require them to focus their actions on the hydrologic and geomorphic aspects of the ecosystem. The nature of the ecosystem outcomes associated with hydrogeomorphic actions will be affected by many factors outside the influence of the Corps, e.g., availability of habitat at other stages of a species life cycle, natural variability in ecosystem dynamics.

Recommendation: *To focus the attention of the Corps NER mission on those aspects of ecosystem restoration most appropriate for Corps attention and to be consistent with the CW Strategic Plan, the NER objective in the PGN and other planning guidance should be rephrased to state:*

> *The objective of NER planning is to restore sustainable natural hydrologic and geomorphic processes, in so far as they affect native communities and associated functions, that have been disrupted and/or degraded and that*

have resulted in significant environmental, economic or social problems and conflicts.

2. The Need for Conceptual Models

The Corps role in ecosystem restoration must embrace the full life cycle of the project – from problem identification and planning, through implementation and ongoing adaptive management. Implicit in all of these steps is a conceptualization of how the system works and how Corps activities that restore hydrologic and geomorphic processes can result in ecosystem change. Explicit conceptualization is crucial to facilitate understanding and to consistently guide any restoration through its life cycle. Simple guidelines on how to develop conceptual models are already available through ERDC, however their utility for planning, assessment and communication has not been sufficiently emphasized. Project objectives, benefits, monitoring and performance measures should be driven by a well thought out conceptual model of how the system works.

Conceptual models are the fundamental framework for ecosystem restoration planning in Comprehensive Everglades Restoration Plan (CERP) and CALFED Bay-Delta Program, and should be specifically used in all Corps restoration work. While the Florida Everglades and the Sacramento-San Joaquin delta are large complex systems, the elements of conceptual models are common allowing the same approach to be used at a variety of restoration scales. Essentially, conceptual models should include:

- Those physical, chemical and biological attributes of the system that determine its dynamics.
- The ways in which ecosystem drivers, both internal (e.g., flow rates) and external (e.g., climate) cause change with particular emphasis on those aspects of the system where the Corps can effect change.
- Critical thresholds of ecological processes and environmental conditions
- Assumptions and gaps in the state of knowledge, especially those that limit the predictability of restoration outcomes.
- Current characteristics of the system that may limit the achievement of management outcomes.

Models should include narrative and references at a minimum and may be summarized in simple graphics to facilitate communications of key cause-effect relationships.

Conceptual models do not, in and of themselves, allow prediction of restoration outcomes. However, as they summarize current understanding of how the ecosystem works, they can provide a key foundation for the development of benefits metrics, monitoring plans, and performance measures. Due to the long life cycle of many Corps projects, it will be necessary to routinely revisit and revise CMs as new information is developed. This is crucial to the success of ecosystem restoration in the long-term and a key element of effective adaptive management.

Recommendation: *The Corps should encourage the explicit use of conceptual models to guide ecosystem restoration planning and implementation. Conceptual models should be required as a first step in the planning process, as they provide a key link between early*

planning (e.g., an effective statement of problem, need, opportunity, and constraint) and later evaluation and implementation.

3. Predicting Ecosystem Outcomes During Planning

In place of benefit-cost analysis, Corps ecosystem restoration policy requires the less rigorous cost effectiveness and incremental cost analyses. This approach assumes that some reliable non-monetary indicator of benefit exists across plans and scales of effort, and that less worthy projects can be discriminated from those that justify investment. Current policy allows any defensible physical or indexed measure of project output. Development of an NER account requires specification of the "things" to be evaluated as well as a basis for evaluation. In other words, it requires definition of the outputs to be served by formulated project plans, and the evaluation standard to be used for judging when a change in outputs is "better or worse".

Stakhiv et al. (2003) addressed the issues facing environmental benefits analysis for ecosystem restoration and recommended a 3-phase strategy for improvement. The study reviewed existing concepts of ecological resource and service flows, including numerous interrelationships regarding ecosystem structure, function, integrity, sustainability, health, resilience, functional stability, and biodiversity. The study concluded that no fully inclusive monetary measure of ecosystem restoration effects now exists, and that significant technical obstacles currently preclude the economic valuation of all restoration outcomes. Non-monetary NER outcomes as a category of effects separate from monetary effects will continue to be appropriate for the foreseeable future.

Early in the history of environmental improvement planning, a single-species Habitat Suitability Index (HSI) was the recommended way to approach project formulation and evaluation. The habitat-unit (HU), which, on the face of it, appears to be a commensurate measure across scales and projects, continues to be commonly used as a metric in planning although HSI models have been developed which reflect change in communities rather than just single species (e.g., Wetland Value Assessment, Environmental Work Group, 1998). Environmental benefits metrics must reflect the objectives that the project seeks to achieve (e.g., the NER objective), discriminate amongst alternative plans, and be predictable over 50 year planning horizons. In a recent examination of the use of benefits metrics for planning restoration in coastal Louisiana, Reed et al. (2006) identified several outstanding issues pertaining to the use of environmental benefits metrics:

- How to Reflect Societal Value. Few of the available models address this issue at all. It is crucial for both the transparency of the planning process and confidence in the outcome that the public see their interests reflected in the 'effectiveness' of the project.
- Transparency. The output of the models must be accessible to stakeholders. This requires both the development of specific metrics to reflect societal goals and presentation of the model output in terminologies and formats that are commonly understood.
- Quality & Quantity of Input Data. Output generated using existing models are only as good as the data used for input. Predictive tools must be improved and/or developed

to provide data at appropriate temporal and spatial scales to meet the assessment needs.

- How to be Comprehensive in such a Complex System. Not all aspects of ecosystem function or system value can be encompassed by even a suite of improved benefit assessment models. Clear articulation of restoration goals, both ecological and societal, can guide the selection of model components and assure the utility of the tools in meeting program needs.

Recommendation: *Benefits metrics used in Corps planning should explicitly identify the linkages between hydrogeomorphic change and native communities and ecosystem functions (as identified in the Conceptual Model), and should rely only on inputs which can be confidently predicted at the spatial and temporal scales appropriate to the project. Efforts should be made to ensure that metrics are meaningful to local sponsors and other stakeholders, subject the criteria of the Planning Models Certification process.*

4. Performance Measures – Project Scale

Performance measures are defined as standards or indicators used to evaluate the outcome of management actions. It is an *indicator* of progress toward a *goal*, *objective*, or *target*. All performance measures need to be measurable in the landscape with a high degree of certainty (high signal-to-noise ratio). Selection of performance measures for any project should be based on the goals and objectives and the understanding of system dynamics articulated in the Conceptual Model. Even when a goal is clearly defined, it is necessary to define whether a performance measure *assesses goal attainment* or *tracks change*. They must also reflect the different spatial and temporal scales at which Corps actions affect ecosystem response. Within the context of Corps ecosystem restoration, performance measures are usually addressing the question 'Was the action successful?' Note that this is not the question 'Did the action make a difference?' Performance measures are specifically related to the expectation of the action (as defined during the planning process in the Conceptual Model).

Defining and measuring performance measures are a crucial component of adaptive management. In most AM frameworks the performance measures are the mechanism by which the outcomes are compared to the expectations of a project, and modifications are made to seek an improved measure of performance. However, whether the action made a difference may be dependent upon other aspects of system dynamics beyond the control of the Corps. The Conceptual Model allows the identification of such potential externalities, provides a context for monitoring or tracking them as funds permit, and is thus crucial to the identification of effective performance measures.

For the Corps, recognizing that most projects manipulate or manage only the hydrogeomorphic aspects of the ecosystem, performance measures should be defined in hydrogeomorphic terms. Whether species or habitat outcomes are achieved as a result of the hydrogeomorphic changes effected by the project may depend on a number of external factors. For example, the CERP may have a primary interest in securing desired wading bird numbers and species composition at a certain location. However, the ability to predict changes in species numbers and composition is complicated by multiple relevant stressors, natural variability, and model limitations. It is more appropriate to

predict during planning the hydrologic and landscape conditions that would result from an action and that would tend to favor these species, rather than a metric about the state of the species themselves. Thus performance measures should not be restricted to wading birds numbers and species composition, but rather should focus on the hydrologic and landscape conditions achieved by CERP actions.

Importantly, performance measures must be measurable in the field at a temporal and spatial scale relevant to project objectives. When NER projects include funds for monitoring or adaptive management, the identification of effective, measurable performance measures is essential to justify the expenditure. Such performance measures must acknowledge the facets of ecosystem dynamics that the project can and cannot influence and be structured to elicit both whether hydrogeomorphic outcomes were achieved and whether the expected ecological consequences were realized.

Recommendation. *The Corps should develop guidance to the field regarding the development and application of performance measures. This guidance should explicitly identify the difference between performance that the Corps actions can directly impact and those expected outcomes which may be influenced by external factors.*

5. Programmatic Performance Measures

In addition to the assessment of individual project performance, the Corps needs ways to assess its overall performance in ecosystem restoration. For example the Performance Assessment Rating Tool used by the Office of Management and Budget requires program performance measures. This presents problems for the Corps ecosystem restoration program as it is essentially a summation of individual projects with their own goals and objectives, each with their own timelines and budgets. The diversity of ecosystem restoration issues that these restoration projects address, e.g., floodplain habitat, flow regimes, barrier island restoration, coastal wetland creation and protection, also means that it is challenging to develop individual metrics that adequately reflect the array of annual outcomes. The nature of Corps restoration authorities means there are no meaningful national targets or goals for Corps ecosystem restoration against which the program can be measured.

One approach to the identification of programmatic ecosystem restoration goals is to take a regional approach. The National Strategy for Estuary and Coastal Habitat Restoration (Restore America's Estuaries, 2002) proposes regional identification of restoration priorities based on:

1. Severity of need (scarcity of habitat and threat to species or habitat)
2. Ecological benefits provided by the habitat or species
3. Chances of successfully restoring the habitat or species
4. Public support for restoration of the habitat or species
5. Social and economic benefits provided by the habitat or species

NOAA is also developing approaches for regional assessment of restoration priorities. However, such efforts can only be successful if sufficient data is available to allow the identification of problem areas, and if appropriate metrics can be developed to reflect these factors. For the Corps, the project approach to restoration limits their ability to strategically address regional goals even if such goals were articulated, but a regional

framework of need might allow a broader context for the assessment of Corps restoration outcomes.

Recommendation. *The Corps should continue to work with other Federal agencies with interests in ecosystem restoration to identify regional goals for restoration and develop common metrics to assess outcomes of ecosystem restoration investments. To demonstrate its potential as a leader in ecosystem restoration the Corps should take initiative in this arena and convene a working group of agency and other experts to develop an appropriate performance assessment approach that can then be applied at the regional level by all involved.*

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