Section 2. Civil Works Ecosystem Restoration: What, How, and Why?

This section describes the planning framework established for Civil Works ecosystem restoration. Drawing on Corps planning regulations and supporting policy information presented in Box 2.1, it outlines the basic guidance established for Civil Works ecosystem restoration planning, and examines the implications for characterizing and evaluating restoration outputs.

2.1 Ecosystem Restoration Defined

Natural ecosystems are self-regulating complexes of habitat and biotic communities, which vary in form and function, while consistently maintaining attributes that differentiate them from other ecosystems. They typically are recognized by the composition of species and population life stages of the communities, and by habitat attributes shaped by the biotic community. For example, a "cypress-dominated forest wetland" is an ecosystem recognized not only by the dominant species, but also by an assemblage of associated species, water-stained brown by dissolved organic matter, sediments rich in particulate organic matter, standing and downed dead woody debris, and other physical-chemical characteristics. The attributes of many ecosystems are disproportionately influenced by one or a few "keystone" species, such as alligators in cypress swamps. Numerous identifiable complexes of community and habitat are associated with the rivers, floodplains, coastal systems, and shore areas influenced by Civil Works activities.

"Ecosystem restoration" is defined by Corps policy documentation as management actions that "attempt to accomplish a return of natural areas or ecosystems to a close approximation of their conditions prior to human disturbance, or to less degraded, more natural conditions." The first part of this definition suggests that restoration is a concept that relies on some historical record of previous ecosystem condition as a target for management actions. The second part, on the other hand, recognizes that many ecosystems have been altered to such an extent that even partial return to some previous condition may not be possible. Further, there often may not even be any reliable historical record of previous ecosystem conditions that could serve as a target for restoration actions. These factors imply that, whether or not a return to some specific historical ecosystem condition is possible or practical, Corps efforts to restore ecosystems should seek to establish more natural, functioning and self-regulating systems.

2.2 Focus of Ecosystem Restoration

Corps environmental management expertise generally centers on the hydrology and geomorphology of aquatic systems. Corps restoration projects typically focus on significant water and related land resources of river and coastal ecosystems, including their associated floodplains, shores, and wetlands. The boundaries of these natural systems typically define the appropriate focus of all Civil Works activities, including traditional flood damage reduction and commercial navigation projects as well as ecosystem restoration projects. But whereas traditional Civil Works projects generally rely on management measures to eliminate hydrologic extremes, ecosystem restoration generally requires measures to reintroduce natural variability. The key to restoring the attributes of functioning and self-regulating aquatic, wetland and other floodplain ecosystems is the reestablishment of more natural spatial and temporal variability of flow regimes.

Box 2.1. Basics of Civil Works Ecosystem Restoration: Excerpts from Planning Regulations & Supporting Policy Information

Ecosystem restoration defined

"Civil Works ecosystem restoration initiatives attempt to accomplish a return of natural areas or ecosystems to a close approximation of their condition prior to disturbance, or to less degraded, more natural conditions. In some instances a return to pre-disturbance conditions may not be feasible. However, partial restoration may be possible, with significant and valuable improvement made to degraded ecological resources. The needs for improving or re-establishing both the structural components and the functions of the natural area should be examined. The goal is to partially or fully reestablish the attributes of a naturalistic, functioning and self-regulating systems." [EP 1165-2-502, Section 7b]

Focus of ecosystem restoration

"Corps activities in ecosystem restoration should concentrate on engineering and other technical solutions to water and related land resource problems, with emphasis on improving degraded ecosystem function and structure. Those restoration opportunities associated with wetlands, riparian and other floodplain and aquatic systems are likely to be most appropriate for Corps involvement. The Corps will focus its restoration efforts on those initiatives most closely tied to Corps missions and areas of expertise. There may be instances where components of ecosystem restoration problems or opportunities are better addressed by other agencies through their missions and programs. Generally, it will not be appropriate for the Corps to implement ecosystem restoration activities on upland, terrestrial sites which are not closely linked to water and related land resources or on Corps project lands." [EP 1165-2-502, Section 7l]

Objective of ecosystem restoration

"The Corps objective in ecosystem restoration planning is to contribute to national ecosystem restoration (NER). Contributions to national ecosystem restoration (NER outputs) are increases in the net quantity and/or quality of desired ecosystem resources." [ER 1105-2-100; Section 2.2b] "The purpose of Civil Works ecosystem restoration activities is to restore significant ecosystem function, structure and dynamic processes that have been degraded." [EP 1165-2-502, Section 7l]

Evaluation of ecosystem restoration

"Measurement of NER is based on changes in ecological resource quality as a function of improvement in habitat quality and/or quantity and expressed quantitatively in physical units or indexes (but not monetary units)." [ER 1105-2-100; Section 2.2b.] "Ecosystem restoration outputs must be clearly identified and quantified in appropriate units. Although it is possible to evaluate various physical, chemical, and/or biological parameters than can be modified by management measures which would result in an increase in ecosystem quantity and quality in the project area, the use of units that measure an increase in ecosystem value and productivity are preferred. Some examples of possible metrics which may be used include habitat units, acres of increased spawning habitat for anadromous fish, stream miles restored to provide fish habitat, increases in number of breeding birds, increases in target species and diversity indices. Alternative measures of ecosystem value and productivity may be used upon approval by CECW-P. Monetary gains (e.g., incidental recreation or flood damage reduction) and losses (e.g., flood damage reduction or hydropower) associated with the project shall be identified." [ER 1105-2-100, Section 3.5c(1)]

In addition, the success of restoration efforts depends largely on how well management decisions incorporate ecological processes outside the immediate scope of projects. For most Corps projects, the physical environmental forces and source materials needed to establish and sustain project success derive from a larger watershed, estuarine, or coastal context. This means that restoration projects should be designed and evaluated within a regional context and with consideration for all factors determining the desired ecosystem form and function.

2.3 Objectives of Ecosystem Restoration

Civil Works activities alter the structure and processes of ecosystems. The evaluation of such alterations for decision-making purposes requires a standard of value for indicating whether a change is better or worse. That valuation standard value should follow logically from the stated objective in Civil Works planning.

In traditional Civil Works planning, the Federal objective is defined as utilitarian; that is, to contribute to the satisfaction of human preferences. Economic value provides an empirical "account" of the contribution of Civil Works activities to preference satisfaction, and represents the standard of value specified by Corps guidance for the evaluation of traditional projects. Further, Corps guidance specifies the specific purposes -- or desired economic outputs -- to be served by traditional projects. These economic outputs can be viewed in terms of closely related "ecosystem services".

As depicted in Figure 2, the structural features and ecological processes of an ecosystem--as affected by environmental forces and constraints, management actions, and social and economic activity in the area--yield a mix of functions that in turn provide various "services" valued by society. Ecosystem services have been defined as "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life" (Dailey, 1997). As this definition implies, ecosystem services can be viewed as the link between the natural environment and human benefits. That is, the service concept connects an ecological focus on "what ecosystems do" with an economic focus on how ecosystems contribute to the satisfaction of human preferences. As such, the concept embodies both an ecological dimension and a human dimension. Table 2.1 provides a list of example ecosystem services and the various ways in which they can contribute to economic value.

Traditional Civil Works purposes include many of the production and consumption activities listed in the right hand side of Table 2.1, and these in turn are closely linked to

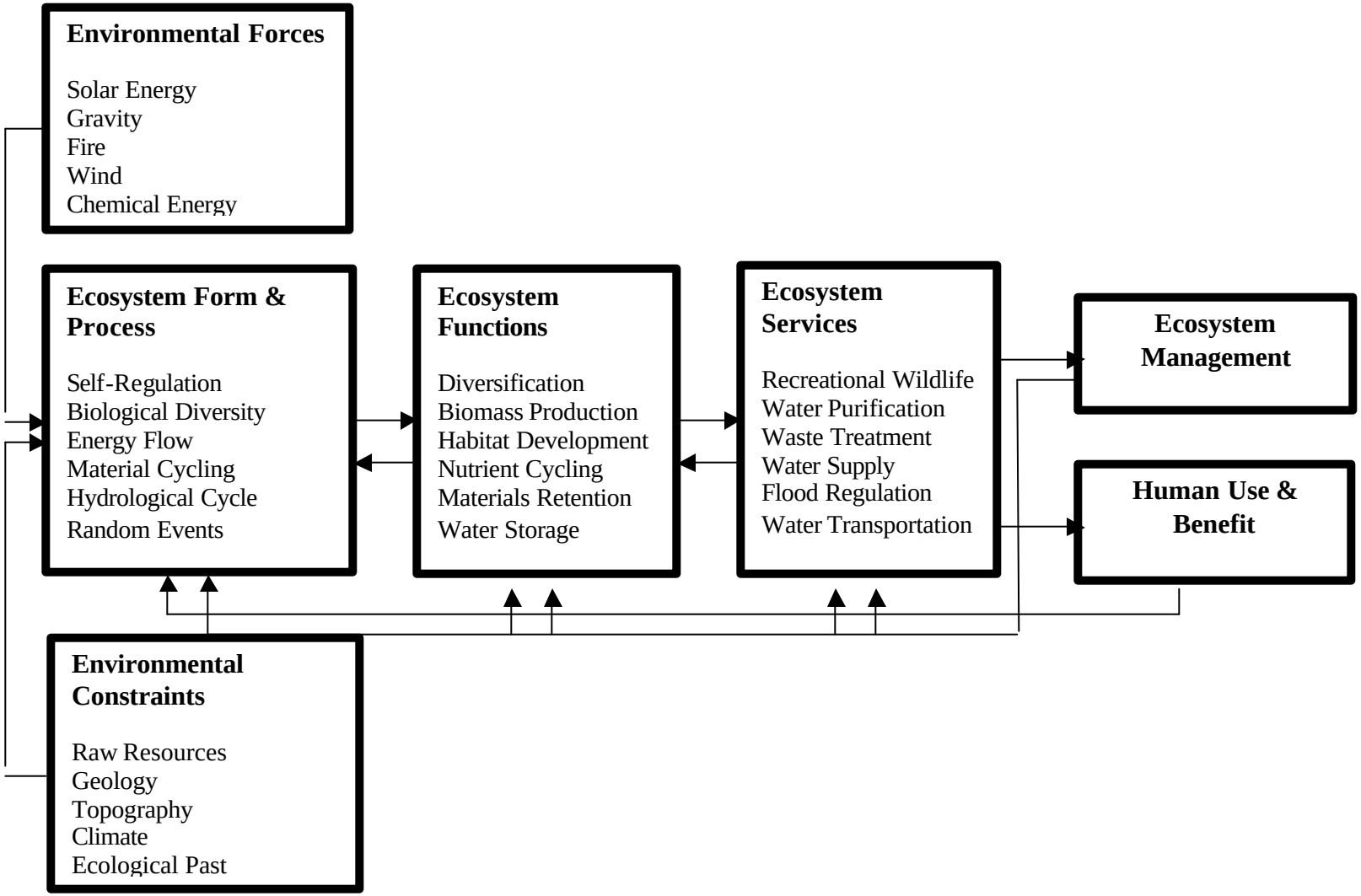

Figure 2.1 General relationships among ecosystem form and process, functions, services, and human uses and benefits in river and floodplain ecosystems.

Table 2.1 Examples of Ecosystem Services and Associated Human Uses & Benefits

Ecosystem Services	**Channels Through Which Ecosystem Services Contribute to Economic Value**	
• Disturbance Regulation (flood, wind & wave) • Waterway Transportation Links • Water Storage • Water Purification • Sediment Trapping • Waste Treatment • Biological Pest Control • Climate Regulation • Rare and Unique Species/Genetic Store • Wildlife Support (e.g., food chain, nursery)	Direct Passive Use	• Personal satisfaction derived from the knowledge that rare ecosystems & associated functions & services are intact, independent of any actual or anticipated active use
	Direct Consumption	• Community Flood & Storm Protection • Municipal & Residential Water Supply • Consumptive & Non-consumptive Recreation • Aesthetics, Observation & Study
	Production Inputs	• Land Productivity for Agriculture • Commercial Navigation • Hydroelectric Power Generation • Water Input for Agriculture & Industry • Commercial Fishing, Hunting/Trapping, etc.

one or more underlying ecosystem services listed on the left side of the table. Indeed, it is these associated ecosystem services that are the focus of plan formulation for traditional Civil Works projects. So, for example, commercial navigation projects focus on intensive enhancement of natural waterway transportation links, and flood damage reduction projects focus on enhancement of the natural flood regulation service

While the relationship between ecosystem services and the traditional Civil Works objective and specific purposes is straightforward, the relevance of services to the ecosystem restoration mission is not as apparent. Corps planning regulations and supporting policy documentation specify that the Federal objective in ecosystem restoration is to increase the net quantity and/or quality of desired resources through the restoration of significant ecosystem function, structure and dynamic processes that have been degraded. The relevance of ecosystem services for the restoration mission depends on how this objective statement is interpreted in terms of desired ends. At least two possible motives for movement along a restoration gradient can be identified.

First, restoration might be sought purely for utilitarian reasons, implying a concern for services that people value. That is, management actions might seek to restore the hydrologic conditions thought necessary to secure a mix of ecosystem services and associated human benefits only because that is the best plan for reestablishing deficient services. But, when services ordinarily associated with a more natural condition are better gained by artificial means, a simulation of natural measures—a naturalistic approach—or even a highly artificial plan, might be chosen. The approach to restoration might be called “the manager knows best” approach and is based on careful analysis of resource and service flow from a variety of natural and artificial management measures. As indicated in Table 2.1, natural ecosystem services can produce economic value in a variety of ways. In the extreme, people may derive satisfaction from the mere knowledge

that rare ecosystems and associated services are maintained in good condition. Such assurance is said to produce "passive use value" that is independent of actual or planned visitation or active use. By contrast, "use value" is generated when people actively use ecosystems services by consuming them directly or indirectly as inputs into commercial production. For example, restoration can augment water purification and wildlife support services that generate use value directly by improving recreation opportunities, and indirectly by supporting commercial fisheries. Restoration of nature's services can also generate use value in more subtle and indirect ways by supporting general economic and social activity—for example, services such as climate regulation, sediment trapping, and waste treatment support and prevent damage to a wide range of consumption and production activity. Of course, restoration in any context would not be expected to augment all potentially affected services—the flows of some natural services would likely decrease as others increase. And inasmuch as restoration involves movement towards greater hydrologic variability, certain natural services might be served at the expense of other services that previously had been enhanced to serve to traditional Civil Works purposes.

A second possible motive for pursuing restoration is the "naturalness" of ecosystem hydrology and geomorphology, as an end in itself (Shabman, 2002). This approach is not independent of the resulting mix of service flows, but assumes that whatever results ecologically is more acceptable than the results from any other alternative. This might be called a "nature knows best" approach. It ignores the service flows from proposed management measures based on the *a priori* judgment that no better plan alternative exists. On the surface at least, this seems to be the position of some environmental interest groups that advocate a return to free-flowing rivers in certain contexts. The notion that naturalness is an independent value to be advanced by civil works planning is at odds with the traditional civil works objective rooted in utilitarianism, but represents one plausible motivation for Corps restoration activities.

Acceptance of that interpretation does not imply that Civil Works restoration is unconcerned with the interests of people, however. There exist theories of value that recognize human-based values as distinct from utilitarian value. Perhaps most notably, "Kantian Ethics" asserts that human society can establish moral rights and obligations that recognize the value of certain things and outcomes as ends in themselves (National Research Council, 1999b). In the restoration context, a Kantian perspective might assert that in some cases ecosystem naturalization is the "right thing to do" for humanity (not for plants and animals, which are given no moral standing), and should be promoted as a matter of collective responsibility rather than individual preference satisfaction.

Corps planning guidance does not specifically establish the desired ends of restoration as naturalness for its own sake, or for supporting natural ecosystem service outcomes. Instead, guidance emphasizes the "significance" of resources and effects for judging the desirability of restoration. The significance concept is defined in terms of institutional, public or technical recognition of importance, and as such seems broad enough to include both naturalness and associated services as desired restoration ends. As one example where both types of value may be relevant, consider the plan now being pursued to

restore a portion of the historic Florida Everglades system. In this case, restoration of a more natural pattern and timing of flows (and whatever ecologic response that results) might be viewed as a valued end in itself, and also as a necessary condition for improving ecosystem services that give rise to utilitarian value.

2.4 Evaluation of Ecosystem Restoration

Corps regulations specify that restoration outputs must be evaluated in non-monetary metrics, with preference given to "units that measure an increase in ecosystem value or productivity" (see Box 2.1). Ideally, these value metrics should follow from the desired ends of restoration in any particular context. For example, if restoration of naturalness represents one valued end to project stakeholders, then the non-monetary metrics chosen for evaluation might be derived from the pre-disturbance ecosystem condition or some related reference condition. On the other hand, if the restoration of ecosystem services that give rise to utilitarian value is a prime concern, then stakeholder may demand project evaluation metrics that indicate the desired direction of change in one or more services. When services and associated utilitarian values are one project goal, the best indicator of the output significance is monetary benefits. However, natural ecosystem services largely represent "public goods" that provide benefits that are collectively supplied to all potential users, and thus are not traded and priced in the marketplace like private goods. As discussed in more detail in Section 6, the lack of market prices for natural ecosystem services is a significant barrier to economic valuation of changes in service outcomes resulting from restoration. This may at least partly explain why Corps regulations require restoration outcomes to be evaluated in non-monetary terms. At any rate, to the extent that one goal of restoration is to augment valued services, then project evaluation requires planners to move beyond metrics indicating a more natural state to non-monetary metrics that indicate the desired direction of change in desired service outcomes.