APPENDIX F

SURVEY OF MONITORING PROGRAMS

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The following section is a summary of several publications describing monitoring programs. They are provided to show the variety of parameters available and the recommendations from recognized authorities and agencies. More detailed information regarding the methods and instructions for developing monitoring programs may be found in the Army Corps of Engineers IWR Report 96-R-23, published in 1996.

Example 1: Measurement Selection in Wetlands by Erwin (1990)

Erwin suggested that a quantitative wetland evaluation be implemented "when the construction technique is unproven, where the ability to successfully create or restore habitat is unproven, or when success criteria are related to obtaining specific thresholds of plant cover, diversity, and wildlife utilization." This quantitative wetland evaluation should include hydrological monitoring and vegetation analysis. Qualitative evaluations can be carried out in situations where there is more certainty of success, and where performance is not tied to specific quantitative criteria. As an example of qualitative evaluations used for wetlands, Erwin recommended:

- baseline vegetation surveys
- fixed point panoramic photographs
- rainfall and water level data
- plan view of sampling points
- wildlife use observations
- fish and macroinvertebrate data
- annual reporting for five years

Erwin stated that criteria for performance must be established before the evaluation effort and must be "fundamental to the existence, functions, and contributions of the wetland system and its surrounding landscape."

Example 2: Measurement Selection in Wetlands by the Natural Resource Council (NRC 1992)

The Natural Resource Council described a process that would have structural and functional attributes of a wetland form the basis for evaluating success of the restoration project. The NRC further suggested that two factors influence the success rating: (1) the specific criteria used, and (2) the reference data or sites used for comparison. The NRC recommended the following for a restoration monitoring program:

- assessment criteria should include structural and functional attributes
- criteria should be established before the assessment takes place
- criteria should be linked to objectives for the project
- several criteria should be used for evaluation
- criteria may need to be regionalized
- reasonable reference sites and long-term data set should be available for comparison
- measurements should take into account temporal and spatial heterogeneity
- there should be an a priori indication of similarity expected between the restored sites and the reference sites
- a time frame for monitoring should be established a priori
- criteria and methods should stand up to peer review.

The NRC developed a list of seven wetland functions that should be considered in assessing equivalency between natural and constructed wetland systems. These were based upon experiences in coastal salt marshes, but apply generally to all wetland systems. For each function, the NRC suggested measures that could be used for quantification.

The NRC (1995) reviewed wetland delineation methods and concluded that the use of three wetland indicators, hydrology, soils and wetland plants, were reliable and valid indicators of the presence of a wetland and commended the use of manuals already in place for delineating wetlands. For restoration projects, the 1989 Corps of Engineers method for wetland delineation may be adequate to evaluate wetland development and the area occupied by a wetland (FICWD 1989).

Example 3: Measurement Selection in Wetlands by the U.S. Army Corps of Engineers HGM Method

The U.S. Army Corps of Engineers (Corps) has a history assessing structure and function of wetlands and other habitats. One approach has been developed synthesizes much of the work that is relevant to wetland systems. Brinson (1993) developed an approach for classifying wetlands that is based upon hydrology and geomorphology - the hydrogeomophic method (HGM). This approach relies on water quality, hydrology, and soils as indicators of ecological conditions of a wetland. For example, northern, cold systems with a positive water balance and a low pH may favor *Sphagnum* peat development. So, by characterization of hydrological conditions, along with other aspects of the system, wetland type and ecological function (or significance)can be predicted. Additionally, the HGM approach uses a range of reference values rather than a single success criteria. This idea of developing a database for long-term use is necessary to obtain a more thorough understanding if natural wetland systems, their fluctuation in equilibrium and trends.

Example 4: Measurement Selection in Aquatic Systems the Index of Biological Integrity

The Index of Biological Integrity (IBI), developed by Karr (Karr and Dionne 1991; Karr 1993) is designed to provide a cost-effective method for evaluating the biological conditions in streams. The IBI focuses on attributes of fish communities to evaluate the effects of humans on streams and watersheds. An IBI is developed based upon sampling of these attributes in a disturbed stream, and ranking them according to their deviations from values expected at an undisturbed reference stream. When several attributes are combined and scaled, the sites can be graded as having an excellent, good, fair, or poor biological integrity. This method has been applied throughout much of the United States, and has been tested in estuarine systems in New England (Deegan et al. 1993).

Example 5: Measurement Selection in Wetlands by the EPA

The most specific guidance on selection of restored wetland monitoring parameters comes from the EPA (Kusler and Kentula 1990; Kentula et al. 1992). Kentula et al. (1992) presents a list of 26 wetland system variables, justification for selection, suggested uses, and general procedures. The variables are divided into categories of general information: morphology, hydrology, substrate, vegetation, fauna, water quality, and additional information. These variables are well justified in the scientific literature, and many have been investigated directly by the EPA Wetland Research Program.

The EPA, through its Environmental Monitoring and Assessment Program (EMAP; Hunsaker and Carpenter 1990), has been developing parameters to monitor the status and trends of the ecological conditions of the ecosystems of the United States. For wetlands and surface waters, EMAP has developed a list of 20 and 18 "candidate indicators' for surface waters and wetland ecosystems respectively. Each of these indicators is graded high, medium or low relative to 12 selection criteria. The selection criteria identify the following about an indicator:

- Can it be correlated with unmeasured ecosystem components?
- Is it applicable on a regional basis, is related unambiguously and monotonically to an environmental value or habitat value?
- Can it be easily sampled?
- Does it exhibit a low measurement error?
- Is it cost effective?

Although EMAP was not designed to monitor restoration sites, the analysis of ecosystem indicators is useful in selecting defensible and relevant parameters for this purpose.

Example 6: Measurement Selection in the U.S. Army Corps of Engineers Civil Works Program

Circular No. 1105-2-210 (Corps 1995) identified structural and functional characteristics of the ecosystem that are potential useful for measuring the progress of restoration projects.

The circular provided a discussion of the following characteristics:

Structural	Functional
water quality	water storage, recharge, supply
water quantity	floodwater and sediment retention
soil condition	transport of organisms, nutrients, etc.
geology	oxygen production
topography	biomass production, food web support
flora and fauna	nutrient cycling
concepts (patch size, edge, etc.,)	shelter detoxification of wastes
morphology	energy flow

Example 7 Measurement Selection in Water Quality Assessments by the EPA

The EPA (1991a, 1991b) has attempted to develop biological criteria for water quality assessments in a variety of system types. Biological criteria are not universally recognized in the United States because they have not been developed to a state that allows for broad application. Biological water quality criteria can be developed for local areas and used for monitoring changes in the conditions in a particular watershed or stream. These same criteria could also be used to assess the changes in water quality associated with restored systems.

Example 8: Regional Parameter Selection in Coastal Wetlands in Southern California

Based upon more than ten years of research on constructed wetlands in southern California's coastal zone, Pacific Estuarine Research Laboratory (PERL, 1990) considered the following functions and characteristics essential for the success of restoration projects in southern California coastal wetlands:

- provision of habitat for wetland dependent species
- support for food chains
- transformation of nutrients
- maintenance of plant populations
- resilience (ability to recover from disturbances)
- resistence to invasive species (plant or animal)
- resistence to herbivore outbreaks
- pollination
- maintenance of local gene pools
- access to refuges during high water
- accommodations of rising sea level

These functions are directly measurable and have been justified through research. Because this list was developed specifically for the region and system type, it can be used in the planning process to define the vision and goals for the project. The monitoring program can then develop performance criteria and measurable parameters with confidence that they will be highly relevant and sensitive indicators of the progress of the system.

Example 9: Regional Parameter Selection in Seagrass Systems

Seagrass systems occur in most coastal waters of the United States, where they form important habitats for a variety of fish and aquatic invertebrates. They are one of the most productive habitats but have suffered severe losses and are under constant pressure from coastal development (Thom 1990). Fonesca (1990) found that seagrass restoration has historically resulted in a net loss of habitat primarily because performance goals and criteria were inappropriate. He recommended the following goals for which criteria can be formulated:

- development of persistent cover
- generation of equivalent or increased area
- replacement with the same seagrass species that suffered impact
- restoration of faunal production.

These goals are applicable to seagrass systems throughout the United States.

Example 10: Regional Parameter Selection in Coastal Wetlands in Louisiana

The Coastal Wetlands Planning, Protection, and Restoration Act (CWPRA) was established to provide guidance and means to implement projects that stop further loss of Louisiana's coastal wetlands and that restore coastal wetlands in the region. As part of the effort under CWPRA, monitoring protocols were developed to provide guidance on minimum monitoring standards to assess performance of restored systems relative to goals, and to provide information for developing costs for restoration programs (Steyer and Stewart 1992).

Subgroups of technical experts developed protocols in seven categories: water quality, hydrology, soils and sediments, vegetative health, habitat mapping, wildlife and fisheries. Monitoring plans were developed for nine project types: freshwater introduction and diversions, sediment diversions, marsh management, hydrologic restoration, beneficial use of dredged material, shoreline protection, barrier island restoration, vegetative planting, and sediment nutrient trapping. Variables (i.e., measurable elements) are developed for each monitoring category and prioritized for each project type.

Priorities range from a primary objective (Priority 1) through lower priority-long term evaluation (Priority 4), with an additional priority, as needed, unique to a specific project (Priority N). Cost estimates are provided for instrumentation, analysis and related items. Methods are provided in varying degrees of detail for the variables.

Example 11: Regional Parameter Selection in Estuarine Habitats in the Pacific Northwest

Simenstad et al. (1991) developed the Estuarine Habitat Assessment Protocol (EHAP) to provide a standardized approach and sampling protocols for assessing the performance of restored or constructed estuarine systems in the Pacific Northwest. EHAP proposes characteristics (termed attributes) of estuarine habitats that promote fish and wildlife use and fitness. These attributes indicate the potential to provide a specific function, which can provide design criteria for habitat restoration. The attributes selected were based upon a comprehensive survey of approximately 200 estuarine scientists in the region and were supported by published information such as those listed above. A total of 105 "protocol" species" were identified, which included fish, invertebrates, birds and mammals. The occurrence of the species in each major habitat type is shown, and the reason for the occurrence (e.g., feeding, rearing, reproduction, resting) is provided. Finally, specific methods for sampling attributes of each habitat that are related to the occurrence of the protocol species are described. The EHAP further identifies three levels of sampling complexity: minimum, recommended, and prefered.

Discussion:

Consideration was many approaches to monitoring including, but not limited to those programs listed above. In general, most restoration and mitigation monitoring plans support an approach that assesses both the physical stability and habitat function of a created/enhanced wetland.

To insure the quantitative, comparable nature of data from this monitoring effort, the approach and methodologies prescribed by the EHAP (Simenstad et. al., 1991) will be used to the greatest extent possible while still considering the plans listed above such as the HGM Model. EHAP is a framework upon which this plan is based, it is considered the most applicable and employs the widest array of parameters and guidance in comparison with the other guidance provided by EPA, the U.S. Army Corps and others.

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