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RESTORATION MONITORING OF FRESHWATER COASTAL HABITATS

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INTRODUCTION

The Estuary Restoration Act of 2000 calls for the restoration of 1 million acres of estuarine habitats by 2010 (ERA 2000). Included in the ERA's jurisdiction are all coastal areas that have "unimpaired connections with the open sea and where the seawater is measurably diluted with fresh water derived from land drainage". Also included under the definition of estuaries are near coastal waters and wetlands of the Great Lakes similar in form and function to estuaries (i.e. wetlands and riparian areas associated with drown river mouths) (ERA 2000). The inland boundary where saltwater and freshwater mixes, changes over time depending on the relative amount of freshwater drainage and recent storm activity. Therefore, the inland limit of estuaries has been extended to the head of tide in marine coastal systems (Federal Register 2002).

The ERA states that any restoration project requesting funds needs to have a monitoring plan to tract the progress of the restoration over time (ERA 2000). This requires upfront identification of restoration goals and the structural and functional characteristics that will be measured over time to track progress toward those goals. NOAA has been tasked with creating a framework for developing monitoring plans and providing lists of characteristics commonly used in restoration monitoring to assist applicants. Literature searches and input from ecologists and restoration experts were used to compile lists of characteristics most commonly measured during ecological or restoration monitoring.

RESTORATION MONITORING: FRAMEWORK AND TOOLS

In NOAA's upcoming document *Science-Based Restoration Monitoring of Coastal Habitats, Volume 1: A Framework for Monitoring Plans Under the Estuaries and Clean Water Act of 2000* each habitat is briefly described and a list of structural and functional characteristics commonly used in restoration monitoring is provided. Practitioners familiar with the science of restoration monitoring may use these lists to see what characteristics have been commonly measured or are recommended by other experts in the field. Those requiring more information than a simple list will benefit from *Volume 2: Tools for Monitoring Coastal Habitats*. Volume 2 goes into more detail about the ecology of each habitat and the relevant structural and functional characteristics that dominate each system, those will influence any restoration effort. Each characteristic suggested for use in a monitoring plan is also described. Examples given in the text and in annotated bibliographies inform the reader and direct them to even greater detail if desired. Additionally, a list of experts who have provided input to this document and are willing to answer detailed questions about each habitat will also be included.

FRESHWATER HABITATS

The freshwater habitats included in these documents are defined as:

Water Column – A conceptual volume of water extending from the water surface down to, but not including the substrate. The water column is a dynamic environment subject to waves, currents, tides, and riverine influences. It is found in marine, estuarine, river, and lacustrine systems.

Submerged Aquatic Vegetation (SAV) - A type of wetland with flowering plants found in shallow, subtidal, or intertidal unconsolidated sediment. SAV is found in areas where light can penetrate to the sediment surface, yet is deep enough to prevent emergent vegetation from becoming established. Hydroperiods for this habitat range from subtidal and intermittently exposed to semi-permanently and seasonally flooded (Cowardin et al. 1979).

Marsh – Transitional habitats between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is covered by shallow water tidally or seasonally. These coastal areas are influenced by floods, tides, and Great Lakes water level fluctuations. The substrate is predominantly undrained hydric soil (Cowardin et al. 1979). Marshes store and filter flood water and runoff, mitigating the impacts of floods and helping to improve downstream water quality.

Deepwater Swamps – Forested wetlands that develop along edges of lakes, alluvial river swamps, in slow-flowing strands, and in large, coastal-wetland complexes. They can be found along the Atlantic and Gulf Coasts and throughout the Mississippi River valley from Louisiana to southern Illinois and are distinguished from other forested swamps by the tolerance of the dominant vegetation to prolonged flooding (Mitsch and Gosselink 2000). The prolonged flood regime and the diversity of physical settings in which they are found creates a different set of structure to which they are adapted and function they provide. Thus differentiating them from Riverine Forests with which they may be associated.

Riverine Forests – Wetlands dominated by trees and usually found along sluggish streams, drainage depressions, and in large alluvial floodplains (Mitsch and Gosselink 2000). In winter and spring, riverine forests can flood with a meter or more of water but by late summer, water levels in most cases recede and expose the soil (Wharton et al. 1982). It is this seasonal dry down and unidirectional flow of water that distinguishes them from deepwater swamps with which they may be associated (Allen et al. 2001, Mitsch and Gosselink 2000). Soils are typically mineral though limited peat accumulation may occur in deeper depressions and wetter areas (Giese et al. 2000).

EXAMPLE HABITAT

A brief habitat description, structural and functional characteristics, and commonly used monitoring measures are presented here for riverine forests. Riverine forests are freshwater habitats that can be tidally influenced. They are, like many coastal wetlands, in desperate need of restoration but they benefit from having had a variety of restoration monitoring studies completed from which one may draw recommendations.

Biological Characteristics – Riverine forests are extremely diverse communities, exhibiting a variety of canopy/ground cover combinations influenced by the hydrodynamics of the associated river (Gregory et al. 1991). Dominant woody vegetation may include: bald cypress (*Taxodium distichum*), cottonwoods (*Populus* spp.), green ash (*Fraxinus pennsylvanica*), silver or red maple (*Acer saccharinum, A. rubrum* respectively), and a variety of oaks (*Quercus spp*.) (Allen et al. 2001, Barnes and Wagner 1981, Mitsch and Gosselink 2000). The presence and abundance of understory vegetation depends upon the amount of light that penetrates the canopy and the local flooding regime. Some areas with open canopies and moderate flooding may have a diverse shrub and herbaceous ground flora. Others, with closed canopies or longer flooding times may be devoid of any ground layer vegetation (Mitsch and Gosselink 2000).

Riverine forests support a variety of wildlife. Many species of macroinvertebrates (crawfish, shrimp, insects, clams, snails, and worms) can be found in riverine forests (Bowers et al. 2000, Wharton et al. 1982). Fish make extensive use of flooded and backwater areas as spawning, nursery, and foraging grounds (Killgore and Hoover 1992, Wharton et al. 1982). Mammals such as: white-tailed deer (*Odocoileus virginianus*), nutria (*Myocastor coypus*), rabbits (e.g., the Eastern cottontail, *Sylvilagus floridanus*), beaver (*Castor canadensis*), and mink (*Mustela vison*) as well as for migrating songbirds, waterfowl, and wading birds all can commonly be found in riverine forest habitats (Guilfoyle 2001, O'Neal et al. 1992, Wharton et al. 1982).

Functional Characteristics

- Sedimentation capture and dispersal
- Floodwater storage
- Habitat (fish, invertebrates, birds, mammals)
- Nutrient transformation and retention

Structural Components

- Physiographic setting
- Hydrology
- Catchment size
- Microtopography
- Elevation
- Large woody vegetation

Common Measures Used in Monitoring - An asterisk (*) denotes a measurement that, at the minimum, should be considered in monitoring restoration performance. Measures without an * may also be measured depending on specific restoration goals. These lists are not exhaustive but represent those elements most commonly used in restoration monitoring.

Physical Characteristics

- Hydrology (water velocity*, volume, and source)
- Hydroperiod* (seasonal timing, frequency, duration, and depth of flooding)
- Turbidity
- Temperature
- Suspended solids

Chemical Characteristics of the Water

- Nutrients (N, P)
- Dissolved oxygen
- Salinity
- PH
- Total organic carbon
- Redox potential

Soil Measurements

- Sediment texture and structure*
- Nutrients (N, P)
- Moisture levels and drainage
- Bulk density
- pH
- Organic content
- Saturation
- Depth of mottling

Vegetation Measurements

- Acreage of reforested area*
- Stem density*
- Cover*
- Seedling survival*
- Species composition and diversity*
- Basal area*
- Biomass yield
- Growth rate
- Mast/seed production
- Plant health or damage
- Canopy closure
- Vertical structure
- Ground layer elements
  - Leaf litter
  - Woody debris
  - Stumps
  - Logs
  - Live vegetation
  - Root masses
  - Brush piles
  - Temporary water

Faunal Measurements

- Diversity and abundance of macroinvertebrates, amphibians, reptiles, birds, mammals as per goals of the project

Other measures

- Toxics

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