



# SCIENCE-BASED RESTORATION MONITORING OF COASTAL HABITATS



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## Introduction

The Estuary Restoration Act (ERA), Title I of the Estuaries and Clean Water Act of 2000, was created to promote the restoration of coastal and estuarine habitats. Under the Act, the National Oceanic and Atmospheric Administration (NOAA) is tasked with providing guidance for the development and implementation of monitoring for projects funded under the Act. Even with the diversity of habitats that may need to be restored and the extreme geographic range across which these habitats occur, there are consistent principles and approaches that form a common basis for effective monitoring. *Science-Based Restoration Monitoring of Coastal Habitats* provides technical assistance in the development and implementation of sound scientific monitoring of coastal restoration projects. It is designed to outline the steps necessary to develop a scientifically sound and fiscally responsible restoration monitoring plan and to help identify the characteristics that restoration practitioners consider valuable indicators of functioning habitat. While written under the auspices of the ERA, the principles and approaches put forth in this manual have broad

application in the monitoring of coastal restoration projects. *Science-Based Restoration Monitoring of Coastal Habitats* is written for those involved in developing and implementing restoration monitoring plans including restoration professionals in academia, private industry, governments (federal, state, and local), tribal, volunteer groups, non-governmental organizations, and environmental advocates.

*Science-Based Restoration Monitoring of Coastal Habitats* is presented in two volumes. In the first volume (*A Framework for Monitoring Plans Under the Estuaries and Clean Water Act of 2000*), contains a framework for the creation of a monitoring plan, including an explanation of where monitoring fits into the restoration process, steps to create a monitoring plan, and important information that should be considered when monitoring specific habitats. The second volume (*Tools for Monitoring Coastal Habitats*) contains detailed discussions of the habitats and their characteristics, an inventory of coastal restoration monitoring programs, an overview of federal legislation associated with monitoring, sample monitoring costs, and a discussion of socioeconomic issues associated with coastal habitat restoration.

## HIGHLIGHTS OF VOLUME ONE: A FRAMEWORK FOR MONITORING PLANS

### General Definitions

Background material and definitions are provided to orient the reader. Some examples include:

- **Restoration** – The process of reestablishing a self-sustaining habitat that in time can come to closely resemble a natural condition.
- **Restoration Monitoring** – The systematic collection and analysis of data that provides information useful for measuring project performance at a variety of scales, determining when modification of efforts are necessary, and building long-term public support.
- **Estuary** – Part of a river, stream, or other body of water that has at least a seasonal connection with the open sea or Great Lakes and where the seawater or Great Lakes water mixes with the surface or subsurface water flow, regardless of the presence of man-made structures or obstructions.

### Steps in Developing a Monitoring Plan

The following steps are presented and explained:

- Identify project goals
- Identify the type of restoration project and collect information on similar projects
- Identify and describe the habitats within the project area
- Define structural, functional, and socioeconomic characteristics
- Consult experts
- Determine hypotheses to be tested
- Collect historical data and trends
- Identify reference sites
- Identify monitoring time span
- Identify monitoring techniques
- Design a monitoring review process
- Develop a cost estimate for implementation of the monitoring plan

### Elements of a Written Monitoring Plan

The following elements are presented and explained:

- Background Material (description of the project area, habitat trends, and components, and project time table)
- Project Goals and Objectives
- Monitoring Components (discussion of the habitat characteristics, hypotheses, reference sites, pre-construction sampling, mid and post construction sampling, statistical analysis, data handling, report preparation, and review of the monitoring plan)
- Projected Monitoring Budget
- Participants and Contact Information

### Habitat Characteristics and Commonly Used Measures

- **Structural Characteristics** are presented to explain the defining components/elements of each habitat.
- **Functional Characteristics** are presented to explain defining processes and primary roles of each habitat.
- **Matrices** present cross-habitat views of structural and functional characteristics and the parameters that should be included in an ideal monitoring plan.

### The Habitats

Definitions and monitoring topics for the following habitats are covered.

- |                     |                    |
|---------------------|--------------------|
| • Water Column      | • Rocky Shoreline  |
| • Rock Bottom       | • Soft Shoreline   |
| • Coral Reefs       | • SAV              |
| • Oyster Reefs      | • Marshes          |
| • Soft Bottom       | • Mangrove Swamps  |
| • Kelp & Macroalgae | • Deepwater Swamps |
|                     | • Riverine Forests |

# HIGHLIGHTS OF VOLUME TWO: TOOLS FOR MONITORING COASTAL HABITATS

## Considerations for Monitoring in Each Habitat

The following useful information on each habitat is presented:

- Description
- Structure
- Function
- Common anthropogenic impacts
- Importance of monitoring
- Importance of restoration
- Common measurements
- Annotated bibliography of monitoring literature
- Annotated bibliography of monitoring and restoration protocols/techniques manuals
- Contact information for habitat experts

## Saltwater Habitat Example

**Seagrasses** are vascular plants that are found in soft sediment within shallow estuaries, bays, and lagoons. They have a high primary production rates which drive detritus based food chains and support many organisms. Seagrasses provide habitat and nutrient sources for plants and animals, provide shoreline protection, and enhance water quality.

**Restoration Plans for Seagrass** Seagrass is a valuable resource that is critical to the health and function of coastal waters. In order to improve and sustain seagrasses, site selection, care in planting and incorporation of plant demography into the planning and planting process must be considered. A defensive goal for seagrass restoration is the replacement of seagrass species with an area of bottom coverage that compensates for species loss and comparable shoot density. Seagrass plantings that persist and generate the target acreage may provide rapid functionality of the natural beds. Therefore, experimental studies of seagrass patterns and distribution, structural criteria and biomass, and nutrient exchange must be performed in order to evaluate restoration successes and failures.

**Minimum recommended measurements used in restoration monitoring:**

### Hydrological characteristics

- Pattern of ocean currents
- Tidal regime
- Inflow from upland sources
- Turbidity

### Chemical Characteristics

- Salinity

### Vegetation

- Macrophyte species and composition and percent cover
- Invasive species presence and abundance
- Productivity rate



## Freshwater Habitat Example

**Deepwater swamps** are forested wetlands that develop along edges of lakes, on alluvial river floodplains, 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 southern Illinois to Louisiana. Bald cypress (*Taxodium distichum*), water tupelo (*Nyssa aquatica*), and swamp tupelo (*N. sylvatica* var. *biflora*) are the dominant tree species of these habitats.

**Restoration Plans for Deepwater Swamps** Though once common throughout the southeastern United States, only a small portion of the original deepwater swamps exists today. Historically, losses were due to extensive logging and conversion to agriculture but recently altered hydrology, herbivory from exotic nutria, saltwater intrusion, and sea level rise have further reduced the extent of deepwater swamps. Examples of restoration project goals might be the establishment of a deepwater swamp 1) with tree species similar to a reference site or 2) that provides habitat for migrating waterfowl and songbirds. The goals of the restoration effort will dictate the specific measurements used to track the progress of a project over time. The following list of measures has been suggested by experts in the field for use in every restoration project, regardless of individual project goals. Each measurement represents a fundamental characteristic of deepwater habitats that will affect the outcome of any restoration project.

**Minimum recommended measurements used in restoration monitoring:**

### Hydrological characteristics

- Hydroperiod
- Riverine water velocity and source

### Soil characteristics

- Sediment grain size

### Vegetation

- Acreage of planted area
- Stem density
- Woody species
- Percent cover
- Species composition



## Reference Sites and Cost Estimates

- **Reference Sites** – Methods available for choosing conditions to which a restoration site may be compared, both for the purposes of setting goals during project planning and for monitoring the development of the restored site over time, is presented.
- **Costs Involved in Monitoring** – A general aid in the development of planning preliminary cost estimates of restoration monitoring activities is presented. Estimates on costs of personnel, labor, and equipment are provided on a daily or hourly rate.

## For More Information

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## Socioeconomic Considerations

Socioeconomic goals commonly associated with coastal restoration projects are identified. In addition, metrics used to monitor progress toward socioeconomic goals are examined and an annotated bibliography of references on socioeconomic factors in restoration projects is presented.

## Inventory of Monitoring Programs

- **Purpose** – The inventory is provided to allow restoration practitioners to locate regional and national monitoring programs, through an online searchable database, that may serve as models for the establishment or improvement of their own efforts.
- **Description** – An inventory of coastal monitoring programs in the US that provides the general scope of each program. This inventory is not a comprehensive list or a national repository, nor is it a list of only government programs.
- **Components** – For each program, the inventory will include the name, website, partners, location/region, status, habitat type, metrics, contact information, goals, and other descriptive notes.