# Chapter 7: **Scientific Evaluation and Monitoring**

Scientific monitoring is the systematic collection of data that provides information on changes in environmental conditions of the project area. The data collected will indicate problems and/or progress toward achieving restoration project goals and objectives (IWWR 2003). Monitoring requires measuring certain habitat attributes or physical parameters at regular intervals before and after project implementation. This record of habitat changes, along with comparison to a reference condition, will indicate if objectives are being met.

Monitoring and project evaluation are important components of systematic project management.

A monitoring plan should be developed in concert with project goals and objectives and strive to evaluate the effectiveness of achieving those goals and objectives.

*For more information, see* **Chapter 3: Goals and Objectives.**

This chapter will provide:

- General introduction to the issues of monitoring and scientific evaluation;
- Discussion of what and how to monitor;
- Discussion of where and when to monitor;
- Guidelines for how to determine tidal hydrology restoration effectiveness;
- Possibilities for how a practitioner can contribute to furthering the science and understanding of tidal hydrology restoration; and
- Scientific evaluation and monitoring highlight project: Fort DeSoto Tidal Hydrology Restoration Project, Pinellas County, Florida.

Additional scientific evaluation and monitoring resources and summary recommendations can be found in the ***Toolkit*** (page 204).

## Background and Reasons for Monitoring

Reasons for implementing scientific monitoring plans have been detailed in numerous publications (Kentula et al. 1992; Thom 2000; Wilber et al. 2000; Diefenderfer 2003; Thayer et al. 2003; Thayer et al. 2005; Thom et al. 2005) and include:

- *Evaluation of project effectiveness.* It is important that specific parameters are measured to evaluate progress toward meeting project goals and objectives. Often public support and agency funding depend on the demonstration of achieving project goals and objectives.
- *Maintenance.* Monitoring indicates needs for maintenance, including invasive species removal, turbidity curtain positioning, floating debris removal, signage, fence maintenance, and repair of engineered structures (e.g., culvert flap-gates).
- *Adaptive management.* Project monitoring allows the practitioner to observe the project area evolution carefully and to employ adaptive management practices when needed (Walters 1986; Steyer and Llewellyn 2000; Thom 2000; Thom 2005). Typical mid-course corrections for tidal hydrology restoration projects might include tidal creek channel modification, vegetation re-seeding or planting, grading, ditch plugging, or even planning for the future construction of additional tidal exchanges.

*Additional goals and objectives references are available in the* **Toolkit** *(page 176).*

- *Enhancement of science and management understanding.* Data are needed to improve our understanding of the effects of tidal restrictions and of tidal hydrology restoration. The synthesis of information from restoration sites can aid future restoration efforts (Neckles et al. 2002). Practitioners learn from both the successes and failures of past projects.

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*A flow meter is used to monitor the effectiveness of the culvert installation at St. Vincent National Wildlife Refuge Tidal Hydrology Restoration Project in the Florida Panhandle.*

*Photo Credit: USFWS*

## Major Components of a Monitoring Plan

*For an overview of the most common components included in a monitoring plan, see the monitoring plan template in the* ***Toolkit*** *(page 205).*

The monitoring plan should be developed concurrently with the design and construction plans and should flow directly from the goals and objectives of the project, including both structural and functional objectives. For each objective, a corresponding measureable **parameter** will be selected. Each parameter will have an associated **baseline** (condition of the site prior to restoration activities), **reference** (condition of a representative site with characteristics desired to be achieved at the restoration site), and **target** (realistic target to be achieved during a specified period of time). Establishment of appropriate parameters and targets allows for implementation of a monitoring plan that will indicate whether the project goals and objectives have been achieved.

Execution of the monitoring plan entails data collection related to each of the selected parameters. (Example Monitoring Data Collection Forms and and example Wildlife Monitoring Datasheet are available in the ***Toolkit*** on pages 206-210.) The methods and timing of data collection will be influenced by numerous factors, including project goals, targets, geographic location, and site-specific conditions. The frequency of data collection and number of samples required is determined by development of a robust statistical and experimental design. With the exception of goals and objectives (see ***Chapter 3: Goals and Objectives***) and experimental design and analysis (beyond the scope of this manual), each of these monitoring plan components, as they relate to tidal hydrology, are described more fully in the subsections that follow.

## What and How to Monitor

There are numerous scientific monitoring parameters that can be measured to examine the ways a tidal system might change following tidal hydrology restoration actions. The goal of a scientific evaluation plan is to select key measurable parameters and create a sampling strategy for those parameters that will provide the most reliable and useful data to help the restoration team determine the project's effectiveness in reaching project objectives.

Examples of useful parameters include:

- *Fauna* (e.g., community composition, diversity, density, presence/absence, biomass, size/age frequency, secondary production, etc.);
- *Water quality* (e.g., dissolved oxygen, pH, nutrients, temperature, etc.);
- *Tidal flooding patterns* (e.g., extent, tide height, tidal prism, periodicity, water velocity, etc.);
- *Soils* (e.g., redox, pore water salinity and chemistry, organic content, vertical accretion, etc.);
- *Native vegetation* (e.g., community composition, percent cover, stem density, underground/above ground biomass, Carbon/Nitrogen ratios, primary production, etc.); and
- *Invasive vegetation* (e.g., presence/absence, percent cover, number of seedlings, stem density, ratio of native to invasive cover, etc.).

Restoration practitioners generally agree on four core categories of scientific monitoring parameters that are applicable for almost all tidal hydrology restoration projects: **hydrology**, **vegetation**, **soil**, and **nekton** (NOAA 2008). Within each of these four categories are specific parameters, or characteristics, that may be appropriate to monitor for an individual restoration project. ***Table 7a*** (page 60) includes specific recommended parameters and related monitoring techniques.

### Structural and Functional Objectives

***Structural objectives*** are objectives focused on the physical aspects that define the habitat, such as the percent cover of vegetation.

***Functional objectives*** are objectives focused on the processes occurring within and between habitats, such as fish utilization or vegetative growth.

NOAA has developed several useful resources to aid restoration practitioners choose appropriate structural and functional objectives and monitoring parameters for their restoration projects:

***Science-Based Restoration Monitoring of Coastal Habitats*** (Volumes 1 and 2) provide a framework and set of tools for developing restoration monitoring plans.

***NOAA's Restoration Monitoring Planner*** is an interactive online tool to assist in developing a basic monitoring plan for restoration efforts in salt marsh, shellfish, or riverine habitats.

These resources can be accessed online at *http://www.era.noaa.gov/information/monitor.html*.

**Setting target values.** Once specific parameters have been selected, target values should be set that relate back to each project objective. A target value is the desired numerical metric to be achieved within a specified period of time.

*For more on relating target values back to goals and objectives, see* **Chapter 3: Goals and Objectives.**

For example, a project objective might be to restore percent cover of wetland vegetation to that of a healthy wetland, or to the reference system. The parameter measured is percent cover of wetland vegetation. For instance, the target value may be 80 percent of reference within three years. Keep in mind that data collected from the reference site allow you to set pre-construction targets – but continuing to monitor the reference site after construction allows you to modify targets as conditions change. (See ***Relying on Reference Sites*** for more information on choosing reference sites.)

Other methods for choosing target values include literature review and collecting information from similar restoration projects completed in the past. Be aware, however, that methods used previously to collect data from earlier restoration sites may not provide appropriate comparison to more current data collection methods. Data collection from nearby reference sites is the preferred approach for setting target values.

In ecological systems, it is not always reasonable to achieve target restoration values (based on pristine conditions) during the monitoring period which is sometimes dictated by funding agency reporting (See ***Principle Monitoring Periods***, page 62) (Thom and Wellman 1996; Simenstad and Thom 1996). Instead, it may be more beneficial to chart the project's trajectory (Kentula et al. 1992; Simenstad and Thom 1996) toward targets and perhaps set intermediate targets, also known as success criteria or performance standards. For example, while the project objective may be to achieve 80 percent cover of marsh vegetation (similar to the reference marsh), it may not be reasonable for the site to reach this high threshold in only one to two years of monitoring before a final report is due to a funding agency. In this case, an intermediate target of 40 percent cover after two years may be more appropriate and satisfy funding agency requirements.

**Relying on reference sites.** Typically, a reference site represents an "ideal" undisturbed habitat and has characteristics similar to the goals and targets of the restoration project. For project evaluation purposes, the restoration site should be compared with the reference site(s) with the goal of increasing similarity over time. Reference sites provide information about the natural range of values for the parameters used in the monitoring program and show the annual variation in these parameters. The monitoring plan should incorporate data collection at the reference site for as long as possible both before (minimum one year) and after project construction (minimum five years) to account for variations in habitat and tidal flow.

Tips for selecting reference sites:

- *Select both up-estuary and down-estuary reference sites for wetland tidal hydrology restoration projects.* This will allow for better comparison of more saline down-estuary or more freshwater up-estuary conditions.

*(continued on page 62)*

CONSIDER

## National Estuarine Research Reserves as Reference Sites

Frequently there are no pristine or nearby reference sites available for comparison and practitioners must seek out suitable surrogates for reference conditions. To this end, consider sites within the National Estuarine Research Reserve (NERR) system. Examination of the data available at NERR sites (or from other reference sites) may help practitioners select the parameters to include in a monitoring plan . Since NERR sites are relatively undisturbed and have on-going monitoring programs (especially focused on water quality), these programs provide data meant to be indicative of pristine conditions. NERR sites can be found in every coastal state (including the Great Lakes) except Louisiana. The Eden Landing Salt Pond Restoration Project in California, part of the South Bay Salt Ponds Project, is utilizing China Camp (a portion of the San Francisco Bay NERR) as a reference site.

*For more information on NOAA's network of National Estuarine Research Reserves, visit the NERRS website at http://www.nerrs.noaa.gov/*

## Table 7a. Core monitoring parameters with recommendations for monitoring specific characteristics.

| | Characteristic | As-Built |
|---|---|---|
| Core Parameter: Hydrology | **Water depth** (Neckles and Dionne 2000) | Above ground: use staff gauge; below ground: use shallow well (slotted PVC pipe) |
| | **Flow pattern** | Direct observation to indicate major pathways and channels on map |
| | **Flow rate** | Measure inflow or outflow with flumes or weirs; measure interior flow with current meters |
| | **Tidal flooding extent** | GPS edge at spring high tide |
| | **Tidal prism** (volume) | Combine site survey and water height to calculate prism |
| Core Parameter: Vegetation (Native and Non-native) | **Community composition** (Kent and Coker 1992; Neckles and Dionne 2000) | Map planting areas and measure density |
| | **Coverage** (Elzinga et al. 1998) | Estimate or measure percent cover |
| | **Survivorship** (when native planting part of design) | Number and type of vegetation planted |
| | **Height** | Estimated or measured height of plants |
| | **Reproduction** | N/A |
| Core Parameter: Soils | **Soil salinity** (Neckles and Dionne 2000) | N/A |
| | **Soil texture** | N/A |
| | **Organic matter** (Craft et al. 1991) | N/A |
| | **Sedimentation** (Cahoon and Turner 1989 for marker horizons; Boumans and Day 1993; Cornu and Sadro 2002 for SET) | Survey topography, establish elevation stakes or Sediment Erosion Table (SET) for later comparison |
| Core Parameter: Nekton | **Species diversity and/or relative abundance** (Note: relative abundance can only be compared for samples collected using same gear) | N/A |
| | **Density or abundance** (#/m2) | N/A |
| | **Species survivorship** | N/A |
| | **Growth** | N/A |
| | **Secondary production** | N/A |
| | **Size** | N/A |

**(Some information reproduced here from IWWR 2003)**

| Qualitative Method | Quantitative Method |
|---|---|
| Record observations of high-water marks, drift lines, etc. | Above ground: use automatic water level gauge; below ground: use shallow well with automatic recorder |
| Direct observation to indicate major pathways and channels on map | Datalogger |
| Estimate as high or low based on visual observation and compared to other nearby sites | Measure inflow or outflow with flumes or weirs; measure interior flow with current meters |
| Walk edge and mark on map | GPS edge at spring high tide |
| N/A | Combine site survey and water height to calculate prism |
| Identify common species and map dominant community types; note invasive species and vigor | Establish transects and/ or quadrats; identify all species; map dominant communities |
| Estimate percent cover | Collect percent cover along permanent transects |
| Visually estimate percent of plants alive | Count plants and determine percent of plants alive |
| Estimate heights of plants compared to previous year's height | Measure height of plants |
| Estimate percent of dominant plants flowering/seeding | Determine percent of plants flowering/seeding by species in plots |
| Taste | Hand-held refractometer at established stations |
| Use soil texture triangle to classify based on feel (Horner and Raedeke 1989) | Particle size analysis of the different soil horizons (Folk 1974) |
| N/A | Soil moisture and organic matter in top layer at stations |
| Establish pre-marked elevation stakes at critical points across site; estimate depth increase or decrease in sediment | Survey topography; SET with marker horizons |
| Seine and/or trap fish to determine presence/absence and relative abundance; identify species | Use purse seines (Hartman and Herke 1987 ), combination seine and block nets (Weinstein 1979), pop nets (Connolly 1994), lift net (Wenner et al. 1996), throw traps (Jordan et al. 1997, Raposa and Roman 2001); fyke nets (Neckles and Dionne 2000); count and identify all species. General information on, and comparison of, different capture techniques (Murphy and Willis 1996, Kneib 1997, Rozas and Minello 1997). |
| N/A | Use purse seines, combination seine and block nets, pop nets, throw traps, or other enclosure gear to determine density by species. Papers that describe use of gear to determine density (Rozas and Minello 1999, Raposa and Roman 2003, Piazza and La Peyre 2007). |
| N/A | Mark and recapture study (van Montfrans et al. 1991; Murphy and Willis 1996). |
| N/A | Otolith analysis (Murphy and Willis 1996); field growth experiments (e.g., Stunz et al. 2002; Posey et al. 2005; Shervette and Gelwick 2008). |
| N/A | Use density, growth, and survivorship data with production model (Roth et al. 2008) |
| N/A | Use variety of quantitative gear to sample most common fish; measure (Murphy and Willis 1996, Kneib 1997, Rozas and Minello 1997). |

- *Consider including a reference site that represents the impaired condition of the project (Cornu & Sadro 2002).* For instance, consider an adjacent impounded wetland that has not yet been restored to serve as a baseline condition over time. This site can show how much the restored habitat has changed, which might be especially important if no pre-restoration data can be collected.

- *Choose reference sites that are close in time and space* and have as many similar characteristics to the disturbed (to-be-restored) habitat as possible.

- *Try to identify several reference wetlands, because wetlands of the same type can vary considerably in their characteristics.* Looking at multiple wetlands of the type you hope to establish can help you understand the natural range of variation of the wetland type (Stedman 2003).

## Qualitative vs. Quantitative Data

Time and budget constraints generally do not allow every aspect of a project to benefit from quantitative data collection. However, qualitative data collection can be informative. Neither quantitative nor qualitative data alone can provide a comprehensive evaluation of how the site conditions at a restored site are evolving to match the target design objectives.

Qualitative data that can be useful for evaluating project restoration effectiveness include (IWWR 2003):

- *Aerial photographs* to show general hydrology, evidence of channelization, and the extent of plant covering at the site;

- *Ground-level photographs* (preferably photo stations) for identification of some plant species, general degree of plant growth, general water levels. Methods also exist to transform repeat photography into a quantitative analysis through techniques such as grid analysis (Hall 2002); and

- *General observations* such as water clarity, floating vegetation or macroalgae, presence of trash, evidence of human use, bird species presence, vegetation condition (stressed, flowering, healthy), presence of invasive plants, evidence of erosion, and the integrity of structures.

Local community volunteers can be invaluable in terms of gathering qualitative assessment data such as ground-level photographs and general site observations.

*For more ideas on ways to involve volunteers in monitoring activities, see* **Chapter 8: Community Support**

> "Monitoring is an investment in the future of the next project – it is not a report card on the current project."
>
> - **Tom Cuba,** *Delta Seven, Inc.*

## Principal Monitoring Periods

There are three principal periods of effective project monitoring and evaluation: baseline ecological conditions, as-built assessment following construction, and scientific monitoring of the ecosystem response to barrier removal.

**Baseline assessment.** The first period is often termed pre-restoration monitoring and establishes the conditions prior to construction work. It provides the baseline to which all future data can be compared. Ideally, baseline data are collected under a range of conditions over a long period of time – at least one year of pre-construction data is critical at both project and reference sites.

**As-built assessment.** The second period requires the team to survey and record the actual construction results, then compare the results to the design and construction plans. For tidal hydrology restoration, the construction plans and the as-built

*Quadrat surveys of seagrass were taken both before and after installation of the new bridge at the Fort DeSoto Park Tidal Hydrology project in Florida.*

*Photo Credit: NOAA*

assessment will likely include information on the openings for water flow (types, numbers, size, invert elevation), velocities of flow across a tidal range, duration and frequency of inundation, and (if constructed or altered) the width, depth, and number of tidal channels. For projects with plantings or invasive species control, assessment would include planting density, invasive species remaining, or other measurable outcomes. As-built data provide the starting point to allow the tracking of the site's evolution, allows resource managers to make strategic adjustments to projects, and provides invaluable knowledge to inform planning and funding of future projects.

If the as-built characteristics do not meet the expectation of the design, then corrections may be possible early in the monitoring phase. The project team should continue to monitor these construction characteristics to determine if corrections are needed in the future.

*For more information on construction monitoring, see* **Chapter 6: Construction and Maintenance**

**Scientific monitoring and evaluation.** The third period of monitoring entails assessing those parameters that indicate if a site can sustain key ecological and biological functions. This stage generally uses the same methods and tracks the same parameters as baseline monitoring and as-built assessments. This monitoring period relates specifically to the goals and objectives of the project and allows for careful comparison of the project site to the baseline condition and reference site(s) over time. It may examine changes in water quality, fish assemblage and biomass, soil characteristics, sedimentation processes, and vegetation composition and coverage.

*A water gauge is used at the Little River Marsh Restoration site in New Hampshire to measure restored water flow through the tidal creeks.*

*Photo Credit: UNH*

## Considerations for Developing Scientific Evaluation Plans

Monitoring strategies should be developed for all three principal phases of monitoring. However, developing a plan for the scientific evaluation phase will take the most time and consideration. Below are some tips for developing effective strategies for short- and long-term monitoring; monitoring frequency and duration; determining the "footprint," or area of impact, of the restoration project; meeting regulatory monitoring requirements; and funding monitoring activities.

**Short-term monitoring.** Monitoring for short-term indicators of effectiveness allows the team to employ adaptive management actions based on actual changes observed. Short-term monitoring of hydrology can be used to verify that construction actions resulted in the desired site changes caused by water movement and the spatial extent of tidal inundation. Vegetation is also an effective parameter for short-term monitoring, especially if the removal of invasive vegetation was part of the project. Both parameters may require frequent data collection in the initial weeks and months following construction, and again periodically throughout the long-term monitoring phase (see below). It may be helpful to consider the short-term plan as a more intensive monitoring period nested within the larger, comprehensive monitoring plan.

**Long-term monitoring.** Long-term monitoring allows for the most robust comparison to the baseline (Thom 2000; Watson and Novelly 2004). The long-term monitoring plan will include the full monitoring strategy – from pre-construction data collection to some time after construction (minimum five years, ideally 20 years or longer) and will collect data under a wide range of environmental conditions. Long-term monitoring will require data collection at given intervals or times of year most appropriate for each parameter. Vegetation and faunal community composition, as well as soil characteristics, can take several years to begin to resemble natural site conditions (Gray et al. 2002, Thom et al. 2002). Budgets are often limited, so decide carefully which parameters

## Determining the Restoration Footprint

As part of monitoring and assessing the impact of a project, restoration practitioners and funding agencies often try to determine the actual area restored by the project (e.g., acres/hectares restored).

For projects where tidal waters are reintroduced to a previously "dry" area, determining the **footprint**, or extent of the site restored (e.g., flooded area), is not difficult. Determining if the objectives of the project have been achieved and over how large an area, however, can be a challenge.

For projects where flow of tidal waters is improved rather than reintroduced, determining the footprint of restored area becomes more complicated. Collecting pre- and post-construction data at *multiple locations* throughout the reference and project sites is critical to determining restored acreage.

Data collection for multiple locations at both sites will provide a spatial component to monitoring that will make it possible to scientifically examine the extent of the site impacted by the project activities.

to measure, the intensity of measurements, and how long the monitoring should continue.

**Frequency and duration.** Natural variability, rate of site change, funding and project timelines, and project goals and objectives determine how often and how long to monitor. Natural variability is more likely to hinder the ability to identify problems or trajectories toward functional habitat conditions in less frequently monitored project and reference sites. However, if funds are inadequate for more frequent monitoring, most parameters should be monitored at least once a year: vegetation during the growing season and animals during breeding, nesting, and/or migration seasons. Hydrologic characteristics should ideally be monitored during maximum and minimum flood and ebb tides, but need not be measured each year. Changes in sedimentary characteristics are often slower than changes to other parameters (Simenstad and Thom 1996), so it is reasonable to monitor these less frequently (every two to three years) but for a longer time (10 to 20 years). Additional recommendations for frequency of monitoring are included in ***Table 7a*** (page 60).

**Funding scientific monitoring.** The funding available for scientific monitoring is typically a small proportion of the total funds allocated to a project. Costs have been found to average 13 percent of total project costs, ranging from 3 to 62 percent (Thom and Wellman 1996).

Decisions related to parameters, techniques, frequency, and duration of sample collections are often the product of budgetary constraint, so the team must plan carefully to ensure the scientific validity of the evaluation process and its utility in informing future decisions. Resources devoted to monitoring may reduce the funds available to restore the project site, but this challenge can be mitigated. For instance, choosing parameters and data collection techniques that are similar to those used in other projects may make data more comparable across sites and improve understanding of the project effectiveness.

Surrogate indicators may provide more cost-effective and feasible options for measuring project effectiveness in the future. For example, monitoring fish populations can be expensive, but it may be possible to estimate fish production by analyzing data for surrogate indicators such as hydrology and vegetation growth (Haas et al. 2004, Weinstein et al. 2005). Additional ways to control costs include using volunteers to collect data and choosing reference sites that have on-going data collection funded for other purposes (e.g., NERRs), with parameters of significance to the restoration site.

*For more on how to defray project costs by using volunteer labor, see* **Chapter 8: Community Support**

**Regulatory-required monitoring.** It is important to note that permits issued by regulatory agencies will also specify required monitoring parameters and reporting schedules. Pre-permit discussions with appropriate regulatory personnel about these requirements allow the team to incorporate these requirements into the evaluation plan, rather than duplicating effort later.

## Advancing the Science of Tidal Hydrology Restoration

It may not be practical, or even efficient, for all projects to receive the level of scientific evaluation described above. All projects should receive basic monitoring to provide some degree of confidence that the design criteria were met. However, practitioners overseeing or partnering on many projects might more efficiently enhance overall understanding of restoration ecology by intensively monitoring a carefully selected subset of projects and evaluating their functionality in comparison to reference sites.

What constitutes basic data as opposed to more in-depth scientific evaluation may be a product of the intensity, frequency, and precision of data collection efforts. For instance, the same type of data may be collected from two sites – focusing on similar core parameters – yet one project may only collect data on an annual basis, using a simple, precise technique for each core parameter, while another site may collect data several times a year, using multiple techniques (of differing precision and accuracy) to describe each core parameter. These two levels of effort would both yield informative results. One provides information about general site conditions in comparison to a reference site, while the other yields much greater information that could aid the advancement of habitat restoration science.

In order to apply the approach of comparison among project sites over time at a regional level, it is recommended that region-specific core parameters (more specific than the four included in this document) be agreed upon and adopted. The Gulf of Maine provides an example of this kind of core characterization (Neckles et al. 2002), resulting in the Global Programme of Action Coalition for the Gulf of Maine (GPAC; see *http://www.gpac-gom.org*) Protocol.

Core variables include:

- Base map;
- Hydrology (including at least the two week lunar cycles, spring, and neap tides);
- Marsh surface elevation data;
- Soils/sediment (pore water salinity);
- Vegetation (percent cover by species, invasive species height, and density);
- Nekton (species composition and richness, abundance by species, length, biomass); and
- Birds (species composition and richness, abundance by species, breeding behavior).

Mimicking this type of regional planning effort to establish core parameters and data collection protocols could greatly enhance the science of tidal hydrology restoration. The Coast-wide Reference Monitoring System (CRMS-Wetlands), developed in Louisiana, is another model that could be utilized and adopted to improve scientific evaluation of restoration projects.

*Baseline (pre-restoration) trawling surveys followed by twice-yearly post-restoration surveys allow for comparison of species composition at the Tarpon Bay Hydrology Restoration Project in Florida.*

*Photo Credit: Florida Department of Environmental Protection*

## Coast-wide Reference Monitoring System (CRMS-Wetlands) and Barrier Island Comprehensive Monitoring (BICM) Programs

CRMS-Wetlands provides long-term data from hundreds of established reference sites throughout the various vegetated habitats of coastal Louisiana. The sites span the range of habitat health, from disturbed to pristine. Monitoring sites were intentionally placed both inside and outside boundaries of existing and planned restoration projects. At each site, aspects of ecosystem structure and function (including elevation dynamics, vegetative assemblage, and hydrologic parameters) are measured (Steyer et al. 2003). The data are made available on-line to the public after thorough quality assurance/quality control. The State Office of Coastal Protection and Restoration (OCPR) works with the U.S. Geological Survey on the management of the CRMS-Wetlands program.

A complementary program to CRMS-Wetlands is the Barrier Island Comprehensive Monitoring (BICM) program, which monitors the mainland shoreline of the Louisiana coast with special emphasis on sandy beaches and barrier islands. Specific parameters monitored include bathymetry, topography, shoreline change, land loss, habitats, and storm impact.

As these program databases grow, they will allow for both project-specific evaluations and cumulative evaluation of the effects of projects on a hydrologic basis and coastwide level (Steyer 2000), and could serve as a model for evaluating wetland ecosystems in other locations as well.

*For further information, please visit the following websites:*
*http://www.lacoast.gov/crms2/Home.aspx*
*http://dnr.louisiana.gov/crm/coastres/project.asp?id=CRMS-WETLANDS*
*http://dnr.louisiana.gov/crm/coastres/project.asp?id=BICM*

*Two areas of causeway were identified for replacement with bridges at the Fort DeSoto Park Project. Only the location identified by the larger circle was completed, including extensive before and after monitoring in the surrounding bays.*

*Photo Credit: Pinellas County*

# Fort DeSoto Tidal Hydrology Restoration Project

*Fort Desoto Park, Pinellas County, FL*

PROJECT HIGHLIGHT

Tidal flow between bays in the Fort DeSoto Park Aquatic Habitat Management Area in Pinellas County, Florida, was severed due to the construction of a dredge-and-fill causeway designed to connect the island chain in the late 1950s. The lack of tidal flow between the bays resulted in extreme summer water temperatures, low dissolved oxygen, high sediment hydrogen sulfide concentrations, stress to seagrass meadows, and low faunal habitat suitability. To relieve these conditions and improve tidal circulation, a portion of the causeway was replaced in 2005 with a 40-foot span bridge. (Plans to construct a second bridge were curtailed due to cost.)

The project's scientific evaluation plan incorporated both impact and reference sites, two years of pre-construction data, and three years of post-construction data (to date), with an estimated cost of $100,000 per year. Indicators of all four core parameters were monitored, including hydrology (temperature, salinity, dissolved oxygen), vegetation (community composition, seagrass density, shoot counts, lengths and widths, epiphytes), soil (hydrogen sulfide concentration), and fauna (macrofauna identification, length, width, weight).

Only three years after construction, a few parameters do indicate a response to the bridge construction. These include improved water quality conditions in terms of extreme temperatures, salinity, and dissolved oxygen. Data suggest epiphytic growth on the seagrass is decreasing in the impact area. It also appears fish populations are responding positively, but the extreme natural variability of this measure makes results somewhat inconclusive. Multiple data set trends toward reference site conditions provide evidence that the project goals are being achieved. Based on this work, project partners agree that construction of the second bridge may be necessary to yield the most complete restoration possible at the park.

Natural variability has made it very difficult to follow a signal of change for any one parameter. Four major tropical storm events followed the bridge opening, and a major red-tide occurred the next year. Comparing pre-construction data to data collected during extreme events is challenging and supports the position that long-term data collection both before and after construction is the only valid way to follow a trajectory of change.

Interestingly, the parameter that will likely have the largest impact on the long-term condition and habitat suitability of the site will also take the longest to respond. Elevated sediment hydrogen sulfide concentrations, which directly impact infauna and seagrass conditions, may require several decades to respond to the improved hydrology and dissolved oxygen concentrations, thereby improving ecosystem health.

*For more information, see the* **Fort Desoto Tidal Hydrology Restoration Project Portfolio** *(page 110).*

*A non-toxic dye was released near the newly constructed bridge when the final barrier to tidal flow was breached. The dispersion of dye is evidence of the tidal flow moving through the new bridge opening.*

*Photo Credit: NOAA*