



# Coastwide Reference Monitoring System (CRMS)

funded by **CWPPRA** - the Coastal Wetlands Planning, Protection, and Restoration Act



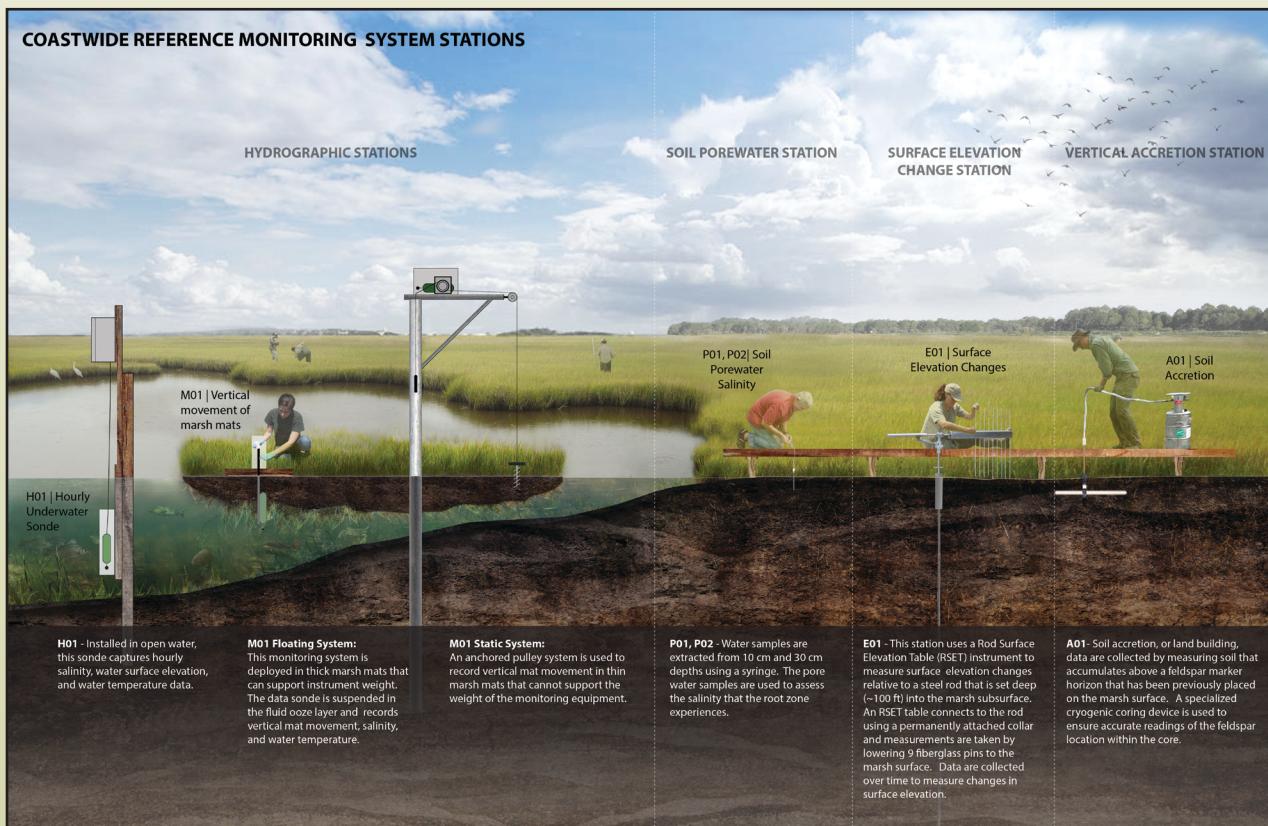
## Overview

In 1990, the U.S. Congress enacted the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) in response to Louisiana's land loss crisis. CWPPRA is a joint federal/state effort that has provided a stable and recurring funding stream to restore Louisiana's wetlands. From 1990 to 2018, the CWPPRA program has authorized 218 coastal restoration and protection projects. The restoration techniques used include: freshwater and sediment diversion, dredged material placement for marsh creation, shoreline protection, terracing, hydrologic restoration, barrier island restoration, and vegetative planting.

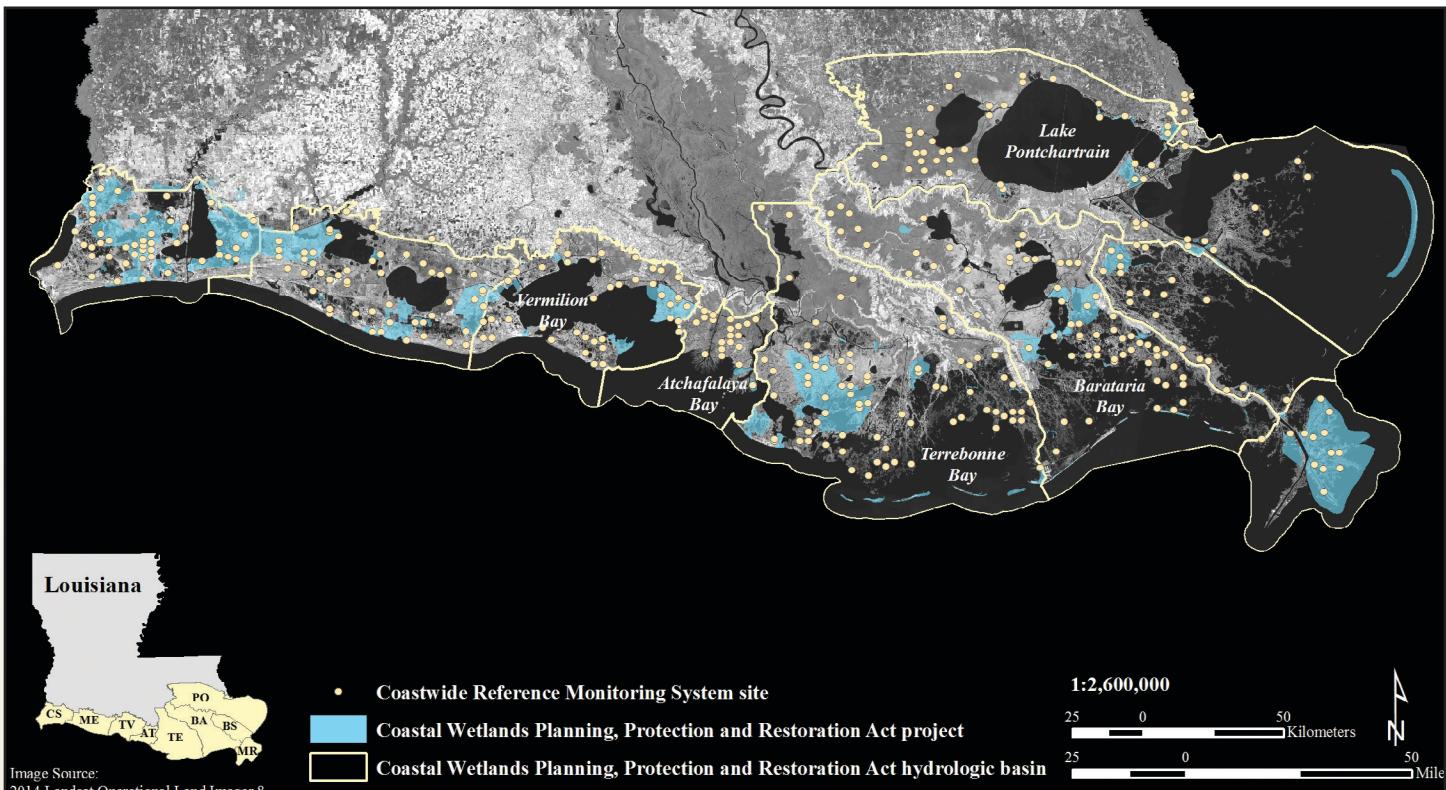
The Coastwide Reference Monitoring System (CRMS) was designed to monitor the effectiveness of restoration actions at multiple spatial scales from individual projects to the influence of projects on the entire coastal landscape.

## Essential Monitoring of Louisiana's Vanishing Coastal Wetlands

- CRMS monitors the effectiveness of restoration actions at individual sites throughout the Louisiana coastal zone.
- As the world's largest coastal monitoring program with publicly available data, CRMS is a model for reference monitoring networks and was commended by the National Academy of Sciences<sup>1</sup>.
- CRMS data feed into interpretable tools that can be used by natural resource managers for project planning and evaluation.
- Scientists and engineers use CRMS data for all stages of CWPPRA project planning and implementation.



**Figure 1.**  
Many stations exist within each CRMS site. Multiple methods are used to record hydrologic, soils, and vegetation (not pictured) data in the field (image credit: LSU Coastal Sustainability Studio)



**Figure 2.** Approximately 390 sites across south Louisiana are part of the CRMS network.

## CRMS Design & Data Collection

The CRMS design includes a suite of sites encompassing a range of ecological conditions of swamp habitats and fresh, intermediate, brackish, and salt marshes. Approximately 390 sites are monitored using standardized data collection techniques (Figure 1) and fixed sampling schedules. The CRMS sites are located within nine coastal basins and four CWPPRA regions, covering the entire Louisiana coast (Figure 2). Sites can be found within and outside of CWPPRA coastal restoration and protection projects. Comparisons of changing conditions are not limited to project influences, but are possible throughout the coastal zone because CRMS was designed as a reference network. The reference network approach

enables assessment of ecological conditions at multiple scales.

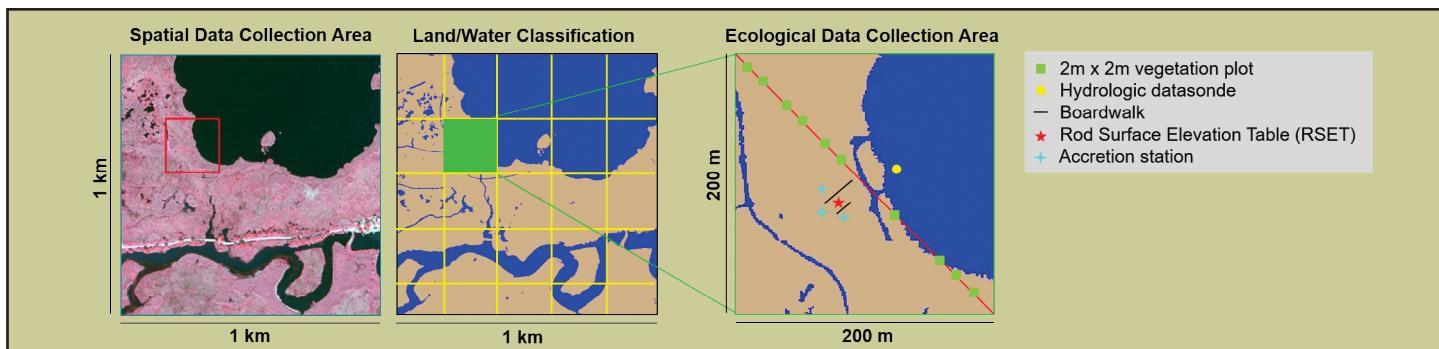
Within a CRMS site, there are many CRMS stations or plots. At each site, data are collected at a broader 1 km<sup>2</sup> and a finer 200 m<sup>2</sup> scale (Figure 3). At the 1 km<sup>2</sup> scale, high resolution aerial photography is used to calculate the ratio of land to water to investigate land change trends through time. Within the 200 m<sup>2</sup> area, data are collected in the field using standardized protocols and consistent sampling intervals. CRMS data include water level, salinity, sediment accretion, surface elevation change, composition and abundance of vegetation, ratio of land to water, and soil characteristics (Table 1). The ten vegetation stations are in a diagonal transect across the 200 m<sup>2</sup> area. The rod surface and accretion stations are nested around a boardwalk. The hydrologic station is generally in a bayou or water body near the boardwalk.

### Key Questions Answered by CRMS

- Did the restoration program reduce coastal wetland loss?
- Did the restoration program sustain a diversity of vegetation types within basins?
- Is the restoration program effective in reducing major stressors (e.g., flooding regime, salinity, elevation change)?

### Data Access

After the data undergo quality assurance and control procedures, data are approved and accepted into the Louisiana Coastal Protection and Restoration Authority's (CPRA) Coastal Information Management System (CIMS) database. Full data sets can be downloaded from CIMS at (<https://cims.coastal.louisiana.gov/>).



**Figure 3.** Spatial data, including remotely sensed imagery, are analyzed in a 1 km x 1 km area at each CRMS site. Ecological data collection occurs within a 200 m x 200 m area. In this smaller area there are accretion, RSET, vegetation, and hydrologic data collection stations.

Calculated or derived data (e.g., averages, marsh classification, elevations, elevation change rates, and CRMS indices) are hosted on the CRMS website (<https://www.lacoast.gov/crms2>). Information is analyzed and summarized in maps, charts, tables, graphs, and indices, and finally incorporated into interactive report cards that are available for free online.

## CRMS Report Card

CRMS data feed into interpretable tools that can be used to assess the condition of individual CRMS sites, restoration projects, hydrologic basins, and the entire Louisiana coast. Analytical teams, made up of agency and academic personnel, use CRMS data to

develop indices for ecological assessment. These data are summarized for each year (2006 to present) in a “Report Card,” which creates charts and graphs for these indices as the data become available.

Each index helps assess a particular aspect of the coastal wetlands ecosystem:

- 1. Floristic Quality Index (FQI):** Used to determine wetland quality based on plant species composition.
- 2. Vegetation Volume Index (VVI):** Quantifies the 3 dimensional vegetative structure irrespective of vegetation species.
- 3. Hydrologic Index (HI):** Assesses the suitability

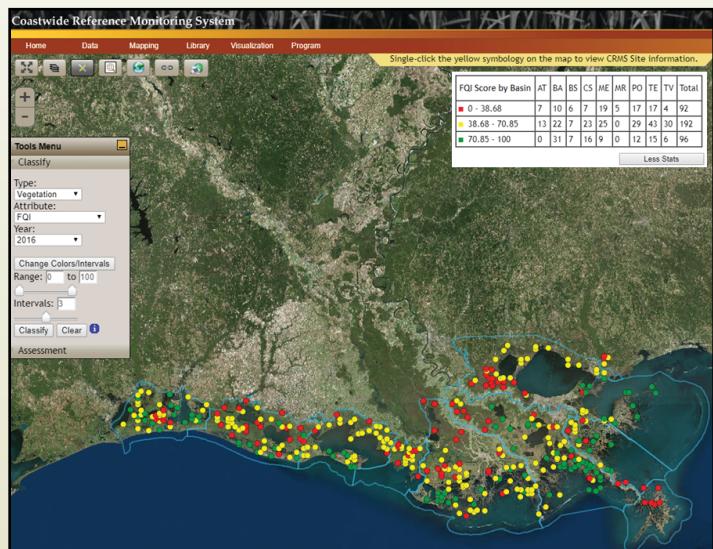
## Available Data Types

**Table 1.** Description of the data types collected at each CRMS site.

Data Type	Parameter	Method	Scale	Frequency
<b>Land Change</b>	Land:Water Ratio	Satellite Imagery	Hydrologic Basin	3 years
	Land:Water Ratio	Digital Aerial Photography	CRMS Site (1 km <sup>2</sup> )	3 years
<b>Vegetation</b>	Emergent Vegetation	Braun Blanquet: % Cover, Species Richness, Height of Dominant Species	Ten 2m x 2m plots per marsh site or nine plots per swamp site	Annually during peak biomass
	Forested Vegetation	DBH, Canopy Cover, Understory Vegetation	Three 20m x 20m forested plots and nine 6m x 6m understory plots per site	3 years during peak biomass
<b>Soils</b>	Soil Characteristics	Core samples, Bulk Density, % Organic Matter, Soil Salinity, pH, and Moisture	3 cores, 18 archived samples per site	6 to 10 years
	Vertical Accretion	Feldspar Plots/Cryogenic Cores	3 plots per site	Twice per year
	Marsh Elevation Change	Rod Surface Elevation Table (RSET)	4 directions per site	Twice per year
<b>Hydrology</b>	Soil Porewater	10 cm and 30 cm syringe sippers	3 samples per depth per site and at vegetation plots	Variable and annually
	Surface Water Salinity, Temp, and Water Level	Submersible Data Logger	In available water within 200m of CRMS site or in a well	Hourly

- of average salinity and percent time flooded in maximizing vegetation primary productivity.
- Submergence Vulnerability Index (SVI):** Assesses the vulnerability of a site to submergence based on its elevation relative to eustatic sea-level rise.
- Landscape Index (LI):** Uses variability and patterns of past landscape configuration to assess future wetland change.

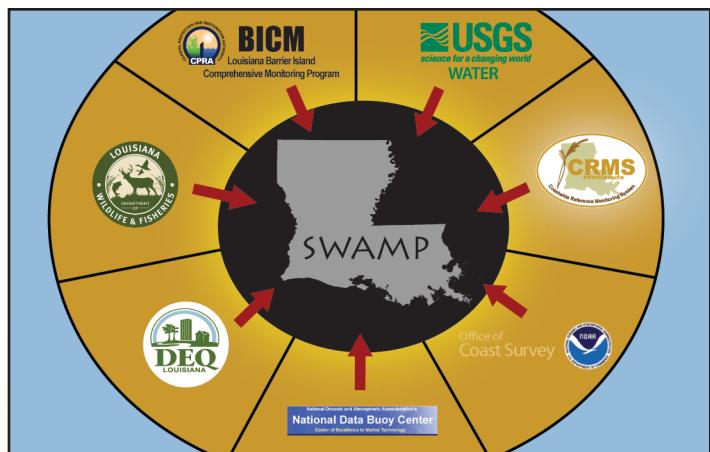
By comparing indices at various times and spatial scales, managers can understand the overall condition of coastal wetlands at an individual site or for the entire coastal zone (Figure 4). For detailed descriptions of each data type, indices, reports, and data descriptions, visit the CRMS website (<https://www.lacoast.gov/crms2>).



**Figure 4.** The CRMS website contains useful data visualization tools, including the ability to map Floristic Quality Index (FQI) scores at CRMS sites across the coast.

## Future of CRMS

With over 11 years of long-term data collection, CRMS data are crucial for evaluation and assessment of CWPPRA's restoration and protection efforts. CRMS data are also used to determine the ecological condition of coastal wetlands in support of Louisiana's Comprehensive Master Plan for a Sustainable Coast. CRMS will become an important element of the System-Wide Assessment and Monitoring Program (SWAMP), a comprehensive network of coastal data-collection activities designed to integrate protection and restoration monitoring for the human and natural systems of Louisiana (Figure 5). SWAMP will support Louisiana's Coastal Master Plan tools, inform adaptive management, and evaluate project effectiveness, socio-



**Figure 5.** The SWAMP data network will leverage data from a variety of sources, including the CRMS program.

economics, and risk reduction. The Natural Resource Damage Assessment (NRDA) and RESTORE Act councils also plan to use CRMS data for their monitoring and adaptive management plans.

The CRMS program is as dynamic as the coastal habitats it monitors. Continuously evolving, the program continues to develop new products and analysis tools to improve project planning and implementation, and to support the evaluation of restoration actions. In addition to the integral role CRMS data play for CWPPRA project planning and evaluation, CRMS data are leveraged to support adaptive management, future scenario modeling, and scientific research.

## References

- National Academies of Sciences, Engineering, and Medicine. 2017. Effective Monitoring to Evaluate Ecological Restoration in the Gulf of Mexico. Washington, DC: The National Academies Press. <https://doi.org/10.17226/23476>.

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