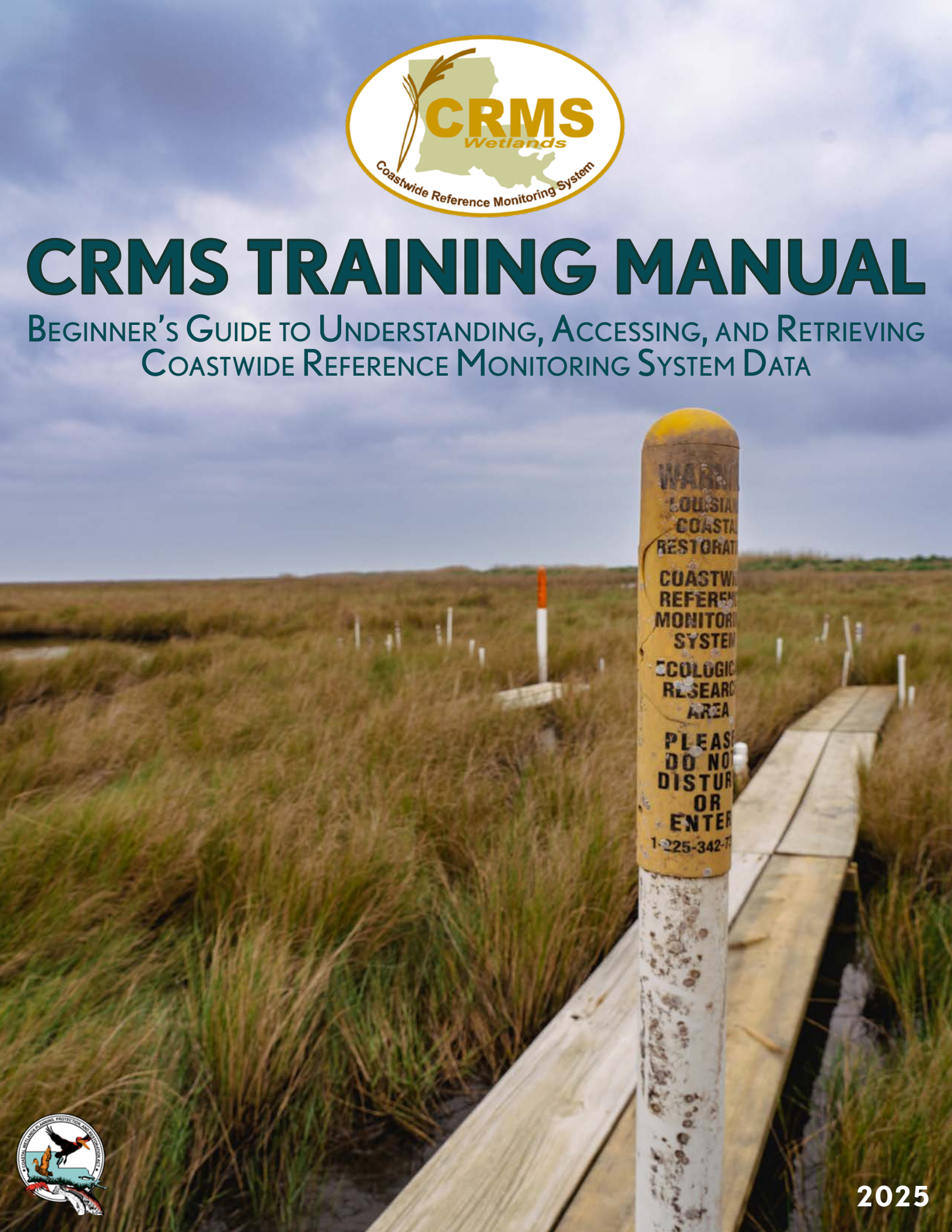
CRMS TRAINING MANUAL

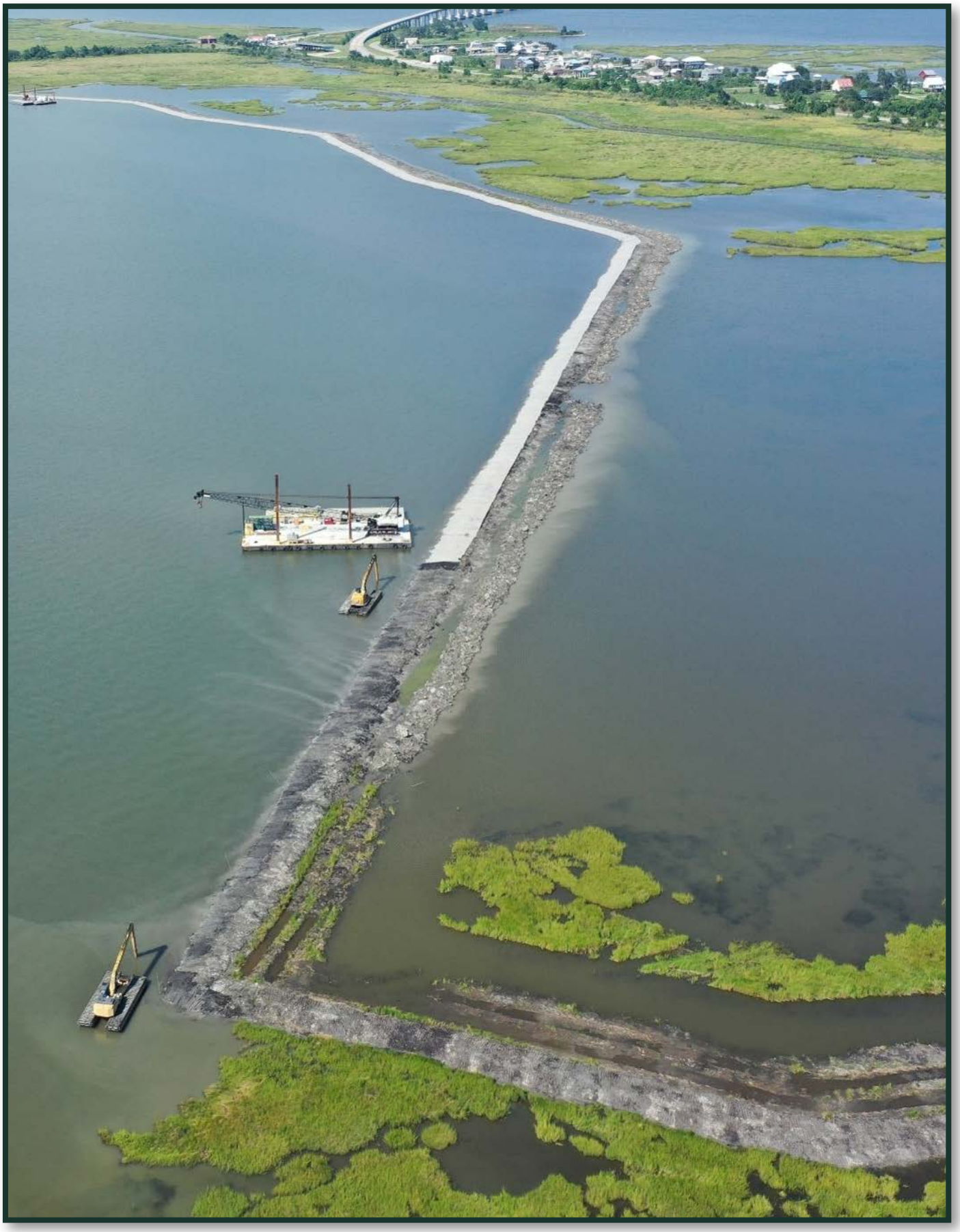
Beginner's Guide to Understanding, Accessing, and Retrieving Coastwide Reference Monitoring System Data



2025

Contents

The original version of this document was created by Susan Testroet-Bergeron, Dona Weifenbach, Cole Ruckstuhl, and Sarai Piazza and released in 2014. This version includes revisions and additions made in 2025 by Lauren Leonpacher, Rachel Villani, Kari Cretini, and Christina Hunnicutt.



New Orleans Landbridge Shoreline Stabilization and Marsh Creation (PO-169), photo courtesy of United States Fish and Wildlife Service (USFWS)

1. What is CWPPRA?

The Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA, pronounced kwip-ruh) is federal legislation enacted in 1990 that is designed to identify, prepare, and fund construction of coastal wetlands restoration projects. Since its inception, approximately 234 coastal restoration or protection projects have been authorized, benefiting over 106,423 acres in Louisiana (2022). The legislation (Public Law 101-646, Title III CWPPRA) was approved by the U.S. Congress and signed into law by former President George H. W. Bush. Visit https://www.LAcoast.gov to learn more about the CWPPRA Program and its efforts to protect Louisiana coastal wetlands.

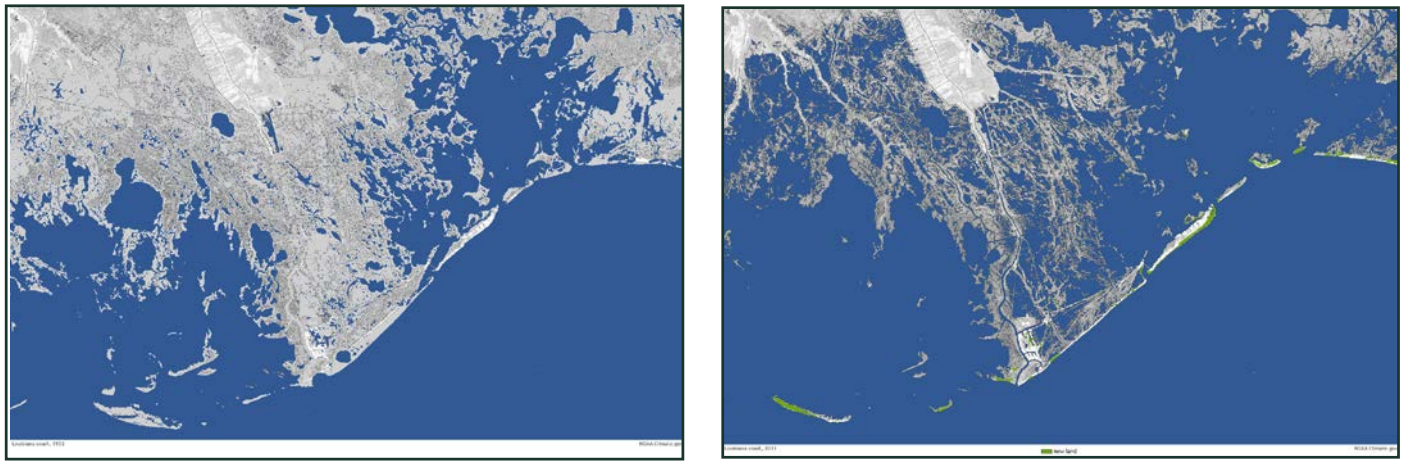


Figure 1. Land loss near Port Fourchon, Louisiana from 1932 (left) to 2011 (right); Maps courtesy of NOAA Climate.gov

1.1 Understanding the Value of Coastal Louisiana

Louisiana wetlands are unique and vital ecological assets. Approximately 4.6 million people reside in Louisiana, with around 2.3 million living in coastal areas. Wetlands offer vital protection to these communities by acting as a buffer against hurricanes and storms. In addition to resources and storm protection, the state of Louisiana supports the U.S. economy by providing approximately $9.3 billion in tourism annually, almost 30% of the commercial fishing landings in the continental United States, $1.8 billion annual impact from recreational fishing, 5 of the nation's 15 largest shipping ports by cargo volume, one-fifth of all waterborne commerce in the United States, and more crude oil production than any other single state (Restore the Mississippi River Delta, 2021).

The land loss dilemma that Louisiana is facing is not only a local emergency but also a national crisis that has far-reaching implications. Since 1990, CWPPRA funds have been instrumental in helping to restore Louisiana's vanishing wetlands. Approximately 40 percent of the coastal wetlands of the lower 48 states are located in Louisiana. This ecosystem is disappearing at a rapid rate, as evidenced in Figure 1. Louisiana has lost up to 40 square miles of marsh per year for several decades – that's 80 percent of the nation's annual coastal wetland loss. Analyses show that coastal Louisiana has experienced a net change in land area of approximately -4,833 square kilometers from 1932 to 2016, which is approximately 25% of the total land area that was present in 1932 (Couvillion et al., 2017).

1.2 The Formation & Value of Louisiana Wetlands

For approximately 7,000 years, the Mississippi River has worked to form what is now known as coastal Louisiana (Figure 2). As the path of the river meandered and migrated across the landscape, it collected sediment from 31 states and 2 Canadian provinces, eventually transporting it to the river's end at the Gulf of America (Gulf of Mexico). As this sediment settled underwater, it began to accumulate. Over time, communities of plants began to flourish in this new habitat. As they grew, their roots trapped more sediment, and slowly, coastal Louisiana came to be.

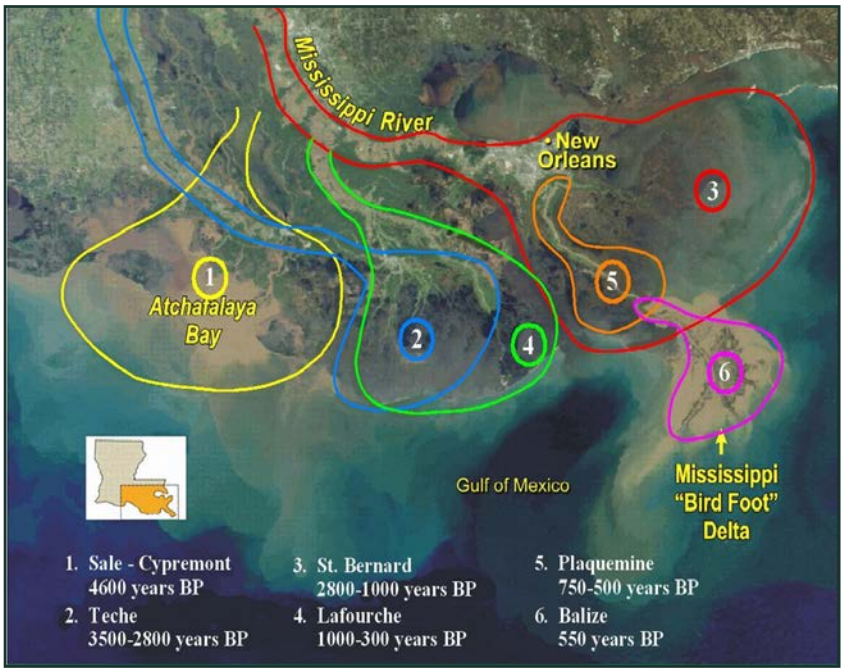


Figure 2. Diagram of the Louisiana coast above shows the development of historic lobes of the Mississippi River, BP=before present. Map Courtesy of Restore the Mississippi River Delta: "How the Delta Formed"

Louisiana's coastal wetlands support coastal communities in a variety of ways. They provide natural resources and protection from storm damage, and act as flood control devices by holding excess flood waters during high rainfall. Wetlands even replenish aquifers (underground water reservoirs) and purify water by filtering out pollutants and absorbing nutrients.

Figure 3. Top: flock of various water birds including Roseate Spoonbills, White Ibises, Snowy Egrets, and Great Egrets, Cameron Prairie National Wildlife Refuge, Photo by U.S. Fish and Wildlife Service; Bottom: adult Bald Eagle, National Conservation Training Center, Photo by U.S. Fish and Wildlife Service

In addition to the ecosystem services they provide to humans, wetlands provide habitat for a variety of wildlife. Coastal Louisiana's wetlands are the breeding grounds and nurseries for thousands of species of aquatic life, land animals, and birds of all kinds – including The U.S. national symbol, the bald eagle (Figure 3). This ecosystem also provides a migratory habitat for over five million waterfowl each year.

People also benefit economically from Louisiana's coastal lands. Louisiana is responsible for a major part of the nation's oil and gas production, shipping commerce, fisheries, fur harvesting, and oyster production. Wetlands are also wonderful recreational resources and are part of Louisiana's growing ecotourism industry. Marine industries in Louisiana employ over 87,000 people and account for $14 billion in revenue (NOAA Office for Coastal Management, 2024).

Additionally, the water management industry, which includes coastal restoration, coastal protection, and urban water management, fuels economic growth faster than any other single business sector in the region (Figure 4). It is the leading employer in southeast Louisiana and the second largest employer along the entire coastal zone (Restore the Mississippi River Delta, 2021).

The cultural diversity that emerges from the coastal region is a remarkable part of Louisiana identity and history. In an effort to preserve the rich heritage and resources of the multicultural Louisiana coast, CWPPRA works to protect the delicate ecosystem. To learn more about the cultural and economic values of Louisiana wetlands, readers are referred to "WaterMarks: Geographic Change Reshapes the Bayou Way of Life" (Coastal Wetlands Conservation and Restoration Task Force, 2019).

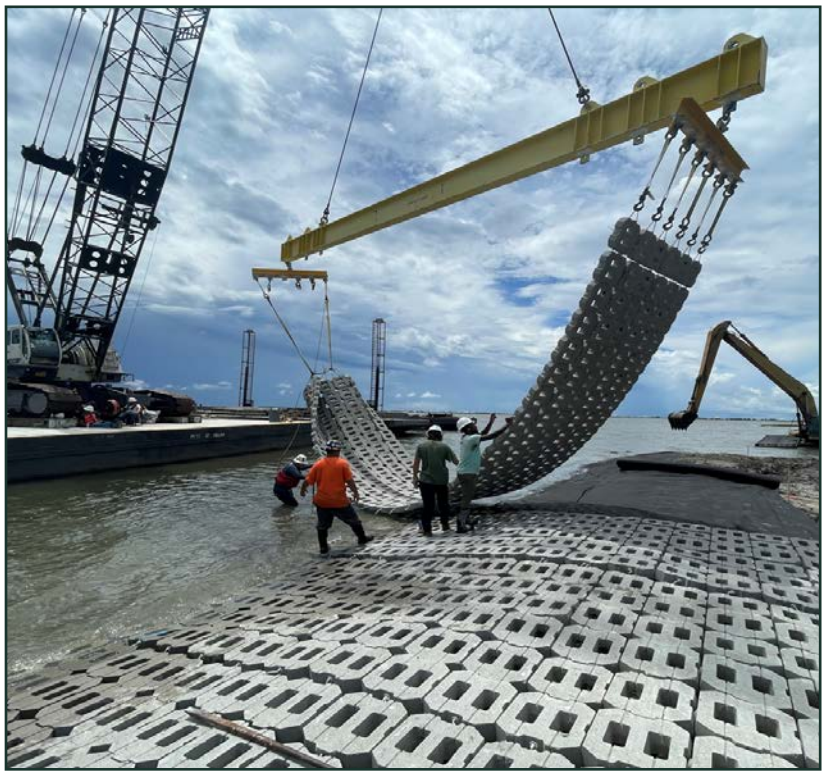


Figure 4. Construction workers lay articulated concrete mats (ACM) as part of the New Orleans Landbridge Shoreline Stabilization and Marsh Creation (PO-169), Photo by U.S. Fish and Wildlife Service

Figure 5. A fishing camp on Bayou DeCade, Louisiana; photo courtesy of Darlene Boucher

Louisiana culture is unique in many ways, but it is not uncommon to find strong ties between people and water around the world (Figure 5). Historically, communities have been established near water for a variety of reasons (agriculture, trade and commerce, transportation, etc.). However, living near a river or coastline has both pros and cons. As communities in south Louisiana grew, they began modifying the landscape to protect themselves from the flooding associated with living near the water. When levees were built along the Mississippi River to reduce flood risks to adjacent communities, the floodwaters responsible for creating the wetlands were then channeled into the Gulf of America, preventing the sediment carried by the water from building the land. Without the annual re-nourishment of sediment and nutrients from the river, wetlands have been sinking and converting to open water. Additionally, man-made canals changed the hydrology (the movement of water) of the area. Natural disasters, such as hurricanes, and human activity have also caused damage to coastal wetlands.

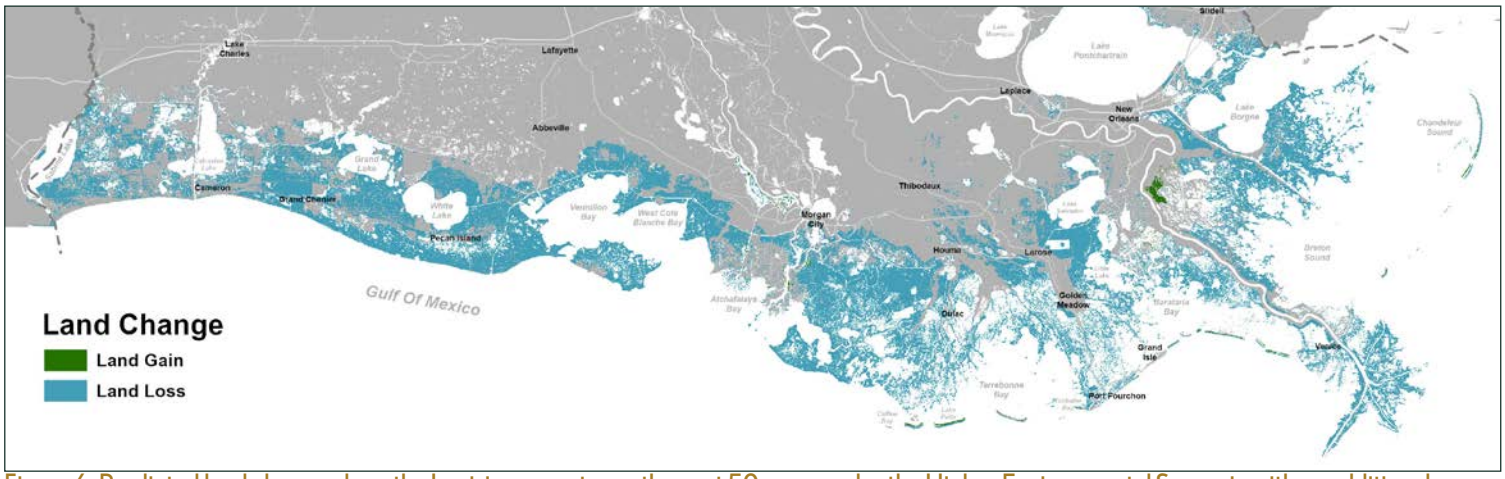


Figure 6. Predicted land change along the Louisiana coast over the next 50 years under the Higher Environmental Scenario with no additional action. Blue indicates areas predicted to be lost, and green indicates areas where land would be created. Louisiana's Comprehensive Master Plan for a Sustainable Coast, Louisiana Coastal Protection and Restoration Authority 2023

To date, Louisiana has already lost coastal land area approximately equal to the size of the state of Delaware. If the current rate of loss is not slowed, Louisiana's Coastal Protection and Restoration Authority (CPRA) projects that an additional 1,100 to 3,000 square miles of land over the next 50 years will be lost, depending on the severity of environmental conditions and the degree of restoration and protection efforts (Figure 6, Coastal Protection and Restoration Authority of Louisiana, 2023). This will result in land loss as well as saltwater intrusion.

1.3 Efforts of the CWPPRA Program

CWPPRA project managers, scientists, and engineers use a variety of techniques to protect, enhance, or restore wetlands. Each restoration project may use one or more techniques to repair delicate wetlands. These techniques include but are not limited to shoreline protection, barrier island restoration, marsh creation, freshwater reintroduction, sediment diversion, hydrologic restoration, marsh management, sediment and nutrient trapping, terracing, outfall management and vegetative plantings.

In addition to overseeing restoration and protection projects across coastal Louisiana, the CWPPRA Task Force implemented the Coastwide Reference Monitoring System (CRMS, pronounced "crims") as a mechanism to monitor and evaluate the effectiveness of CWPPRA projects. CRMS sites are established throughout all wetland ecosystem types across coastal Louisiana, providing multiple reference points to compare over time and distance. CRMS sites are located both inside and outside of CWPPRA project boundaries, allowing users to compare data from restored and unrestored areas to determine project success.

CRMS data can be valuable not just to CWPPRA specialists but to restoration scientists, planners of state and parish projects, researchers, landowners, advocates, and politicians. Information about conditions in Louisiana's coastal region is available at https://www.LAcoast.gov/CRMS.

2. What Is CRMS?

CRMS is the acronym for the Coastwide Reference Monitoring System. The Coastal Wetland Planning, Protection and Restoration Act (CWPPRA) has monitored the health of Louisiana's landscape since its initiation in the early 1990s. Initially, information was collected through aerial photography, on-the-ground assessments, and comparisons of projects to reference sites; but more comprehensive data were needed to improve methods of rebuilding Louisiana wetlands, increasing resistance to erosion, reducing conversion of marshes to open water, and saving the coast from the complications of sediment starvation and ground sinking. In response to these increasing needs, CWPPRA established the Coastwide Reference Monitoring System (CRMS) in 2003.

Figure 7. Top center: CRMS Scientist Rachel Villani uses a rod surface elevation table (RSET) to collect data; Above: A CRMS site in a marsh in Louisiana, showing the access boardwalk and sampling plots, photos by U.S. Geological Survey

Monitoring data include:

- **Water level**
- **Salinity**
- **Sediment accretion**
- **Surface elevation change**
- **Composition and abundance of vegetation**
- **Ratio of land to water**
- **Soil characteristics**

The CRMS project, under the direction of CWPPRA, is one of the largest coastal habitat monitoring networks in the United States. Since inception, the CRMS project has largely been funded by CWPPRA; however, it has also been supported by Deepwater Horizon-Natural Resource Damage Assessment Trustees, National Fish and Wildlife Foundation-Gulf Environmental Benefit Fund, and by the State of Louisiana. The CRMS team effectively delivers data to a variety of audiences with roughly 50 scientists employed to go out into the field to collect data from CRMS sites (Figure 7). Additional analytical teams of scientists, computer programmers, and software engineers coordinate their efforts to publish the large data sets. Today, about 390 CRMS sites are spread throughout coastal Louisiana, allowing scientists to broaden the reach, increase the frequency, and expand the tracking of wetland data.

The information is analyzed and summarized in maps, charts, tables, graphs, and indices, and finally incorporated into interactive reports available online. From identifying areas in need of restoration to evaluating a project's long-term effects on the landscape, the CRMS project contributes to the successful planning, modeling, and study of coastal restoration.

2.1 Data Collection: CRMS Site vs. CRMS Station

CRMS Site

In order to accurately monitor wetlands, large areas of the wetland must be analyzed to determine how much is land and how much is water. The more land that is present, the healthier the marsh. For each CRMS site, spatial analyses (such as land/water data) are conducted at the 1 km^2 scale, which is approximately the size of 187 football fields. However, the majority of on-the-ground data, also known as non-spatial data, are collected within a smaller 200m x 200m data collection area, which is approximately the size of 7 football fields). At CRMS sites, this data includes information about water, vegetation, soil, marsh elevation, and rates of sediment accumulation (known as vertical accretion). A diagram of a typical CRMS site is shown in Figure 8.

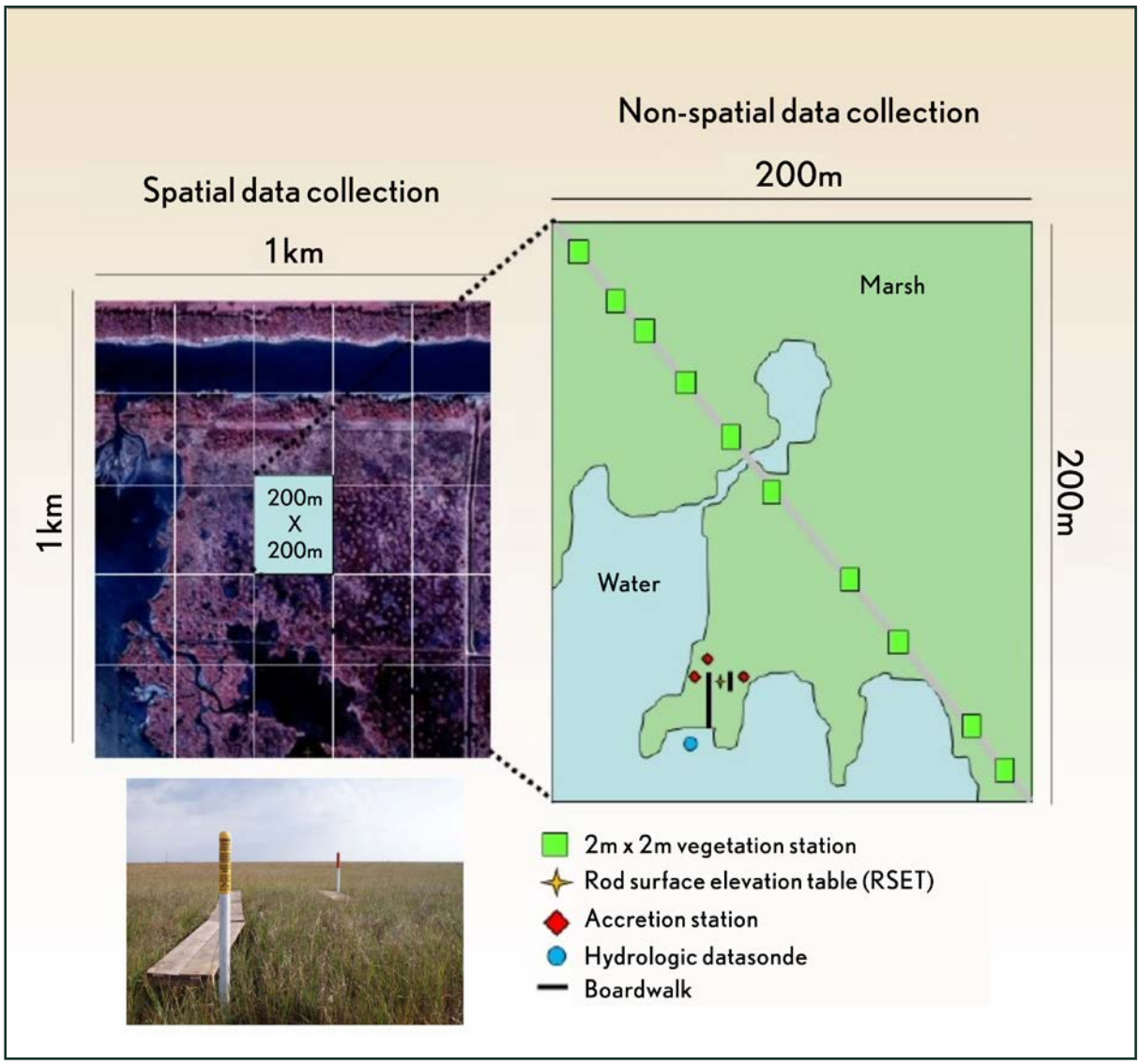


Figure 8. Diagram of a typical CRMS site (top left), photo of CRMS boardwalk (bottom left) by USGS, and layout of CRMS stations (right)

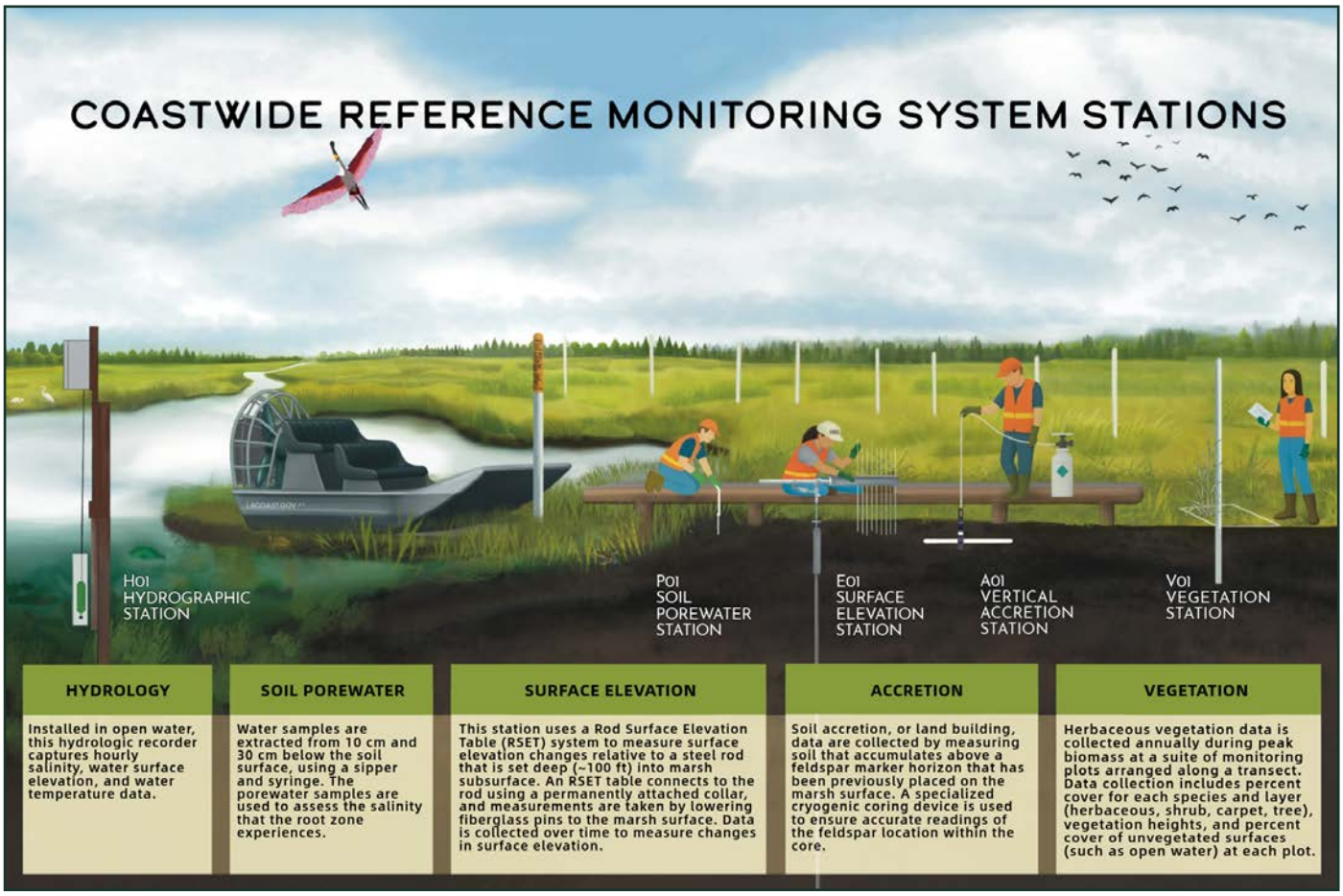


Figure 9. Cross-section diagram of CRMS Site"WaterMarks: Monitoring Provides the Foundation for Coastal Restoration Success" (Coastal Wetlands Conservation and Restoration Task Force, 2018).

CRMS Stations or Data Plots

Each CRMS site has a suite of data collection stations including hydrologic, vegetation, accretion, and surface elevation. Figure 8 shows how the stations are laid out within a CRMS site. The 10 vegetation stations (or plots) are in a diagonal transect across the 200m x 200m data collection area. Figure 9 shows the rod surface elevation table (RSET) station and accretion stations (or plots) nested around a boardwalk. The hydrologic station is generally in a bayou or body of water near the boardwalk.

Data Sampling Periods

The table in Figure 10 shows the types of data collected and standard collection protocol with established sampling periods for each. More information on CRMS data collection and schedule can be found in Appendix 1.

Data Type	Parameter	Method	Scale	Frequency
Land change	Land:Water Ratio	Satellite Imagery	Hydrologic Basin	4 years
	Land:Water Ratio	Digital Aerial Photography	CRMS Site (1km^2)	3 years
Vegetation	Emergent Vegetation	Braun Blanquet: % Cover, Species Richness, Height of Dominant Species	(10) 2m x 2m plots per marsh site or (9) plots per swamp sites	Annually during peak biomass
	Forested Vegetation	DBH, Canopy Cover, Understory veg	(3) 20m x 20m Forested plots per site	Every 3 yrs during peak biomass
	Aboveground Biomass	Live and dead biomass, stem counts, stem height, stem diameter, and total C, N, & P of leaf material	(3) 0.25m^2 clip plot	Every 5 years at select CRMS sites
Soils	Soil Characteristics	Soil profile of bulk density, OM%, soil salinity, pH, and moisture	3 cores, 4cm increments to 24cm depth	6 to 10 years
	Soil Nutrients	Soil profile of total C, N, & P of sediment	3 cores, 4cm increments to 24cm depth	Every 5 years at select CRMS sites
	Belowground Biomass	Profile of live and dead biomass components	3 cores, 8cm increments to 24cm depth	Every 5 years at select CRMS sites
	Vertical Accretion	Feldspar Plots/ Cryogenic Cores	3 plots per site	Twice/yr 2006-2020, Once/yr after 2020
	Marsh Elevation Change	Rod Surface Elevation Table (RSET)	4 directions per site	Twice/yr 2006-2020, Once/yr after 2020
Hydrology	Soil Porewater	10cm and 30cm syringe sippers	3 samples per depth per site and at vegetation plots	Variable at boardwalk, annually at veg plots
	Surface Water	Salinity, Temp and Water Level	Submersible Data Logger in available water within 200m of CRMS site or in a well	Hourly

Figure 10. Types of data collected and the parameters, methods, scales, and frequencies of each

2.2 CRMS Website Resources

CRMS can be accessed on the web at https://www.LAcoast.gov/CRMS. When users first arrive at the page, a homepage similar to the one in Figure 11 is displayed.

There are a variety of data and resources available on the CRMS homepage that can be accessed from the menu along the top of the page:

Data
- Spatial Data – library of aerial photography and land/water analysis
- Tabular Data – CIMS Data Tool & Bulk Data Download

Mapping
- CRMS Map Viewer (Section 3)
- CIMS Map Viewer – CPRA's Coastal Information Management System (CIMS)

Library
- Maps
- Presentations
- CPRA Reports
- CRMS Reporting

Visualization
- Charting (Section 4.1)
- Bulk Charting (Section 4.2)

Program
- Administration
- Contacts
- CRMS Indices

FAQ

Factsheet

Tutorials (Videos)
- Overview
- Charting
- Data Download
- Mapping Viewer

The majority of this guide will focus on the CRMS Map Viewer and the Visualization data retrieval options. However, there are video tutorials available on the website for nearly all of the other resources that the CRMS homepage offers.

Figure 11. Example of homepage of the CRMS website

3. CRMS Map Viewer

There are three ways to access the CRMS Map Viewer.

- Click on the **Mapping** menu item at the top of the webpage to load an interactive map of the Louisiana coast.
- Hover over the word **Mapping**, and a dropdown menu will appear. Choose **CRMS Viewer**.
- Click on the icon labeled **Map** in the center of the CRMS homepage.

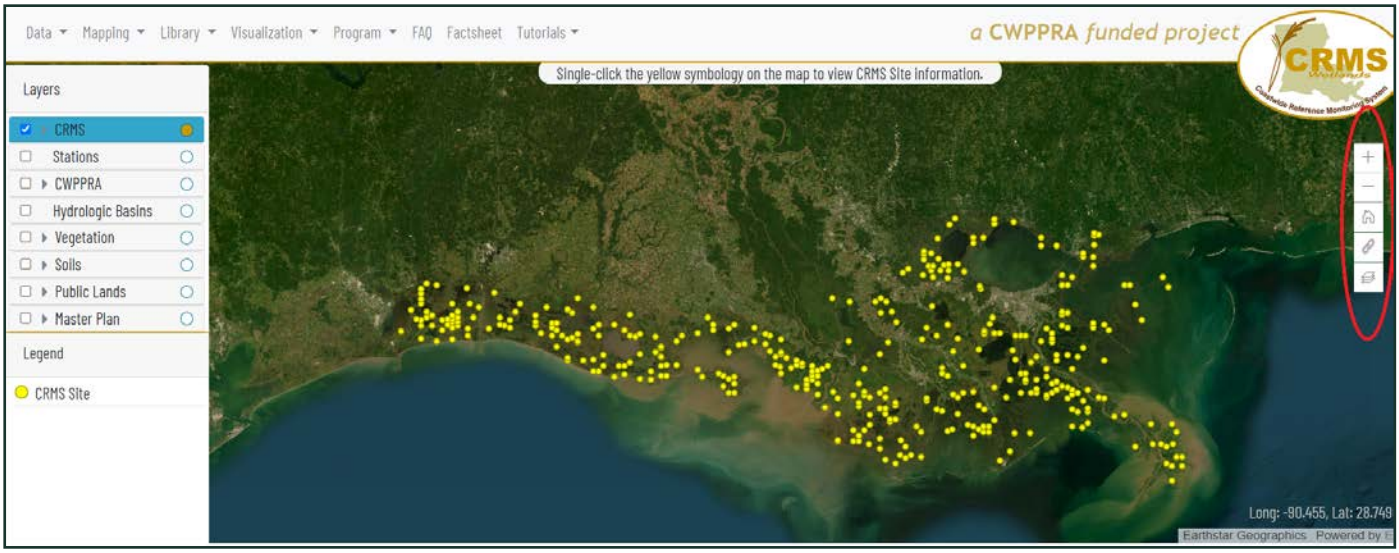


Figure 12. Example of CRMS Map Viewer home page with map navigation tools on right circled in red

3.1 Map Navigation Tools

On the CRMS Map Viewer page, each of the yellow dots indicates an actual CRMS monitoring site (Figure 12). Parameters are measured and recorded at each of these sites. There are map navigation tools located near the top right of the page. From top to bottom:

- The first two icons show plus and minus symbols, which zoom in and out on the map one zoom level at a time.
- The third icon, which looks like a house, returns the viewer to the original zoom setting, which displays the entire Louisiana coastal zone.
- The fourth icon, which looks like two links of a chain, will create a link directly to the current area visible on the map.
- The fifth icon, which looks like sheets of paper, will show or hide the Layers menu. Remember, the layer will be visually displayed, but to access the data, users must activate the layer by clicking the circle to the right of the layer name in the Layers menu. *Note: Users can only have one active layer at a time.*

3.2 Map Viewer: Layers Menu Overview

On the left-hand side of the page, a **Layers** menu is displayed that can be used to view different layers (Figure 13). Clicking on checkboxes on the left side of the Layers menu will load data onto the map.

Note: Click in the checkbox on the left, and the layer will be visually displayed. Click on the orange circle on the right side, and the data becomes active. Clicking on a map item in an active layer will provide information about the layer item.

Example: Activate the CRMS layer; when users click on a yellow dot, a site information box appears. It is important to note that users can only have one orange circle active at a time but can view multiple layers at the same time. When users click on the map, only the data for the active layer will be accessible.

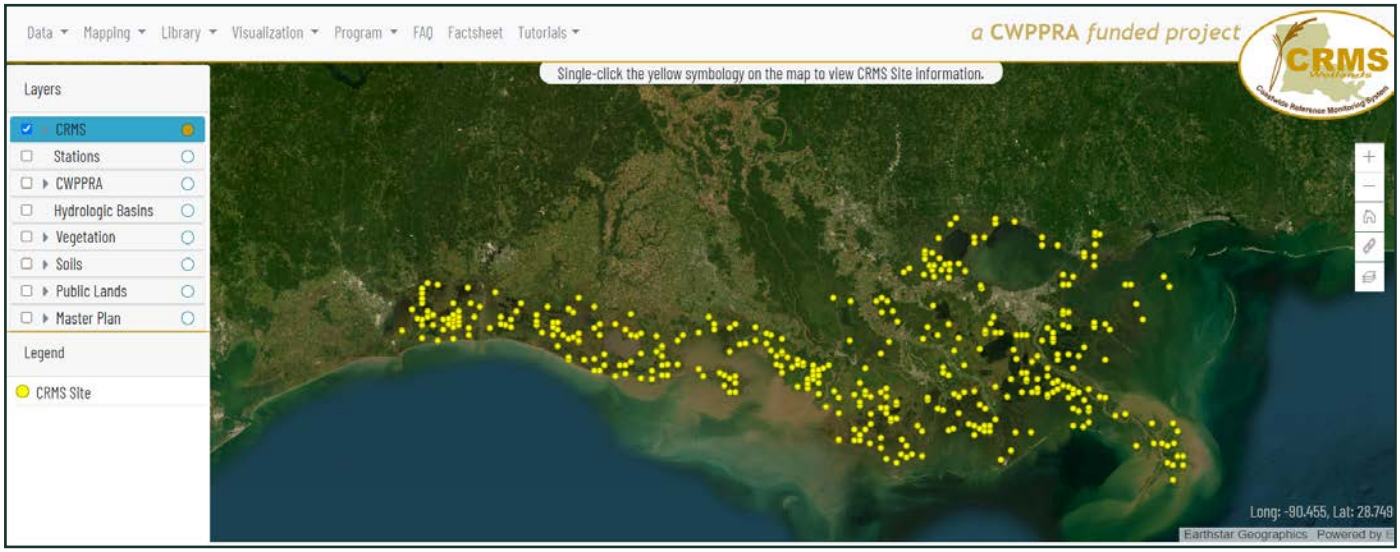


Figure 13. Example of CRMS Map Viewer home page with Layers menu displayed on left

Try this:

1. In the **Layers** menu, click on the box next to the word **CRMS**. The check will disappear and the CRMS data will be removed from the map.
2. Now click the boxes next to **CWPPRA** and **Hydrologic Basins**. Both the CWPPRA projects and the Hydrologic Basins will be displayed on the map (Figure 14).
3. Try clicking on each of the "layers" to note how the map changes. Remember, clicking on the circle to the right makes the layer active and displays its corresponding data.

Note: When done with the example, click the checkbox next to the CRMS layer to re-display the CRMS sites.

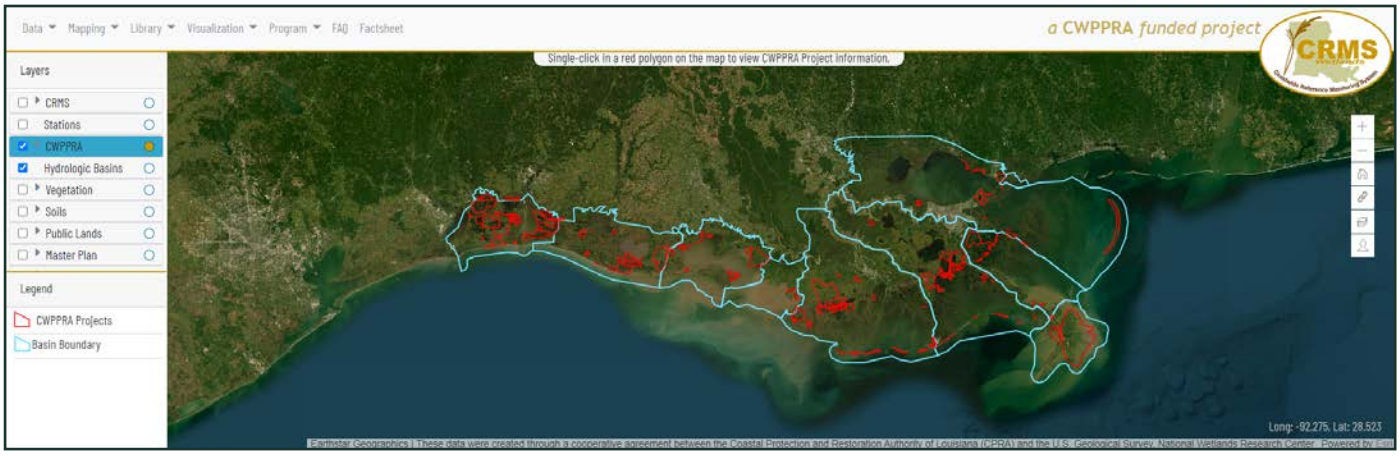


Figure 14. Example of CRMS Map Viewer with CWPPRA basins and project boundaries visible

Within the CRMS layer menu, there are several feature options. Users can download either a KML file of all CRMS sites or a .csv file of latitude and longitude coordinates for all CRMS sites. KML is a common filetype used for GIS programs, including Google Earth. A .csv file can be used to import information into many GIS programs or handheld GPS devices.

Users can also display CRMS-specific information on the Map Viewer, including the **1km Buffer, 200m Buffer, Realtime Hydro Sites,** and **Floating Marsh Sites** (Figure 15). Selecting the 1km or 200m Buffer layers will display the 1km buffer (in blue) or 200m buffer (in yellow) around each CRMS point. Each CRMS site is comprised of this 1 km^2 area, and this is also the boundary used for all land/water analyses. Within the 1km^2 area is a 200m x 200m Data Collection Area – all CRMS data is collected within this boundary (Figure 8). Selecting the **Realtime Hydro Sites box** will display the CRMS realtime hydrology sites as blue circles and the rest of the sites as yellow circles. Selecting the **Floating Marsh Sites** box will display all the CRMS floating marsh sites as red circles and the rest of the sites as yellow circles.

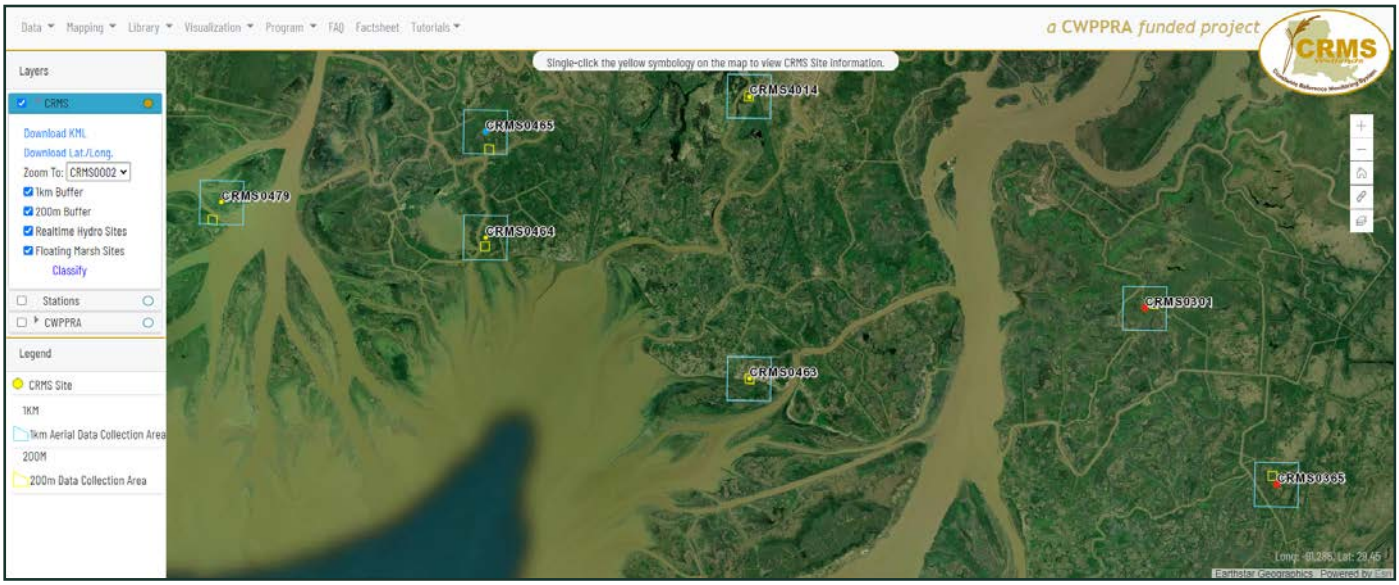


Figure 15. Example of CRMS Map Viewer with buffer boundaries (blue and yellow outlines), realtime hydro sites (blue circles), and floating marsh sites (red circles) indicated

3.3 CRMS Layer: Using CRMS for Site Specific Data

As mentioned earlier, each yellow dot represents a CRMS site. To find out information about a particular CRMS site, click on the arrow to the left of the word CRMS. A drop-down menu will appear, similar to the one pictured in Figure 16. The small black down-arrow just after CRMS0002 reveals a drop-down menu listing all active CRMS sites. Scroll through and select a CRMS site. Use this technique to reveal a drop-down menu for any layer with an arrow next to its name.

Note: The Layers menu can have only one category expanded a time. This keeps the menu from getting too large and going beyond the height of the screen.

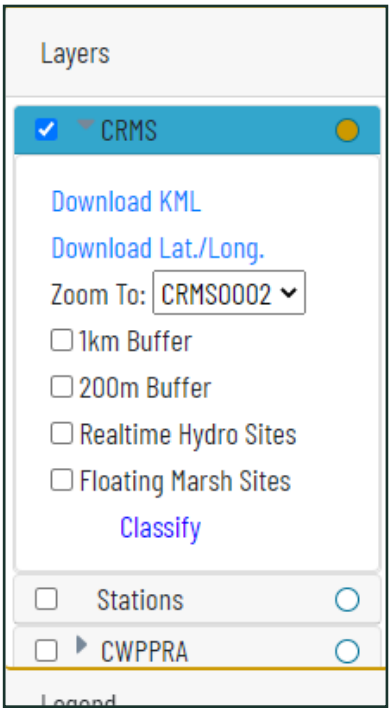


Figure 16. Example of CRMS Layers menu with dropdown displayed

Classify Tool

The Classify tool provides a useful method for showing a large-scale picture of how CRMS sites are classified coastwide. Users can visualize all CRMS sites using the same classification (vegetation, hydro, soil, spatial) so that sites can be compared against each other. Within the CRMS layer, there is a blue "Classify" link. Clicking on that will show a popup where users can select the type of classification to perform, define an attribute, and select a year (Figure 17).

For example, users can visualize all CRMS sites for a particular CRMS index, such as the Floristic Quality Index (FQI). To do this:

1. Activate the CRMS layer and click **Classify** in blue near the bottom of the expanded menu. This will display the **Classify CRMS** popup.
2. For **Type**, choose *Vegetation*.
3. For **Attribute**, choose *FQI*.
4. For **Year**, choose *2019*.
5. Users can change the range of values and number of intervals displayed. The default setting is all available values divided into 3 intervals.
6. Click on **Classify**.

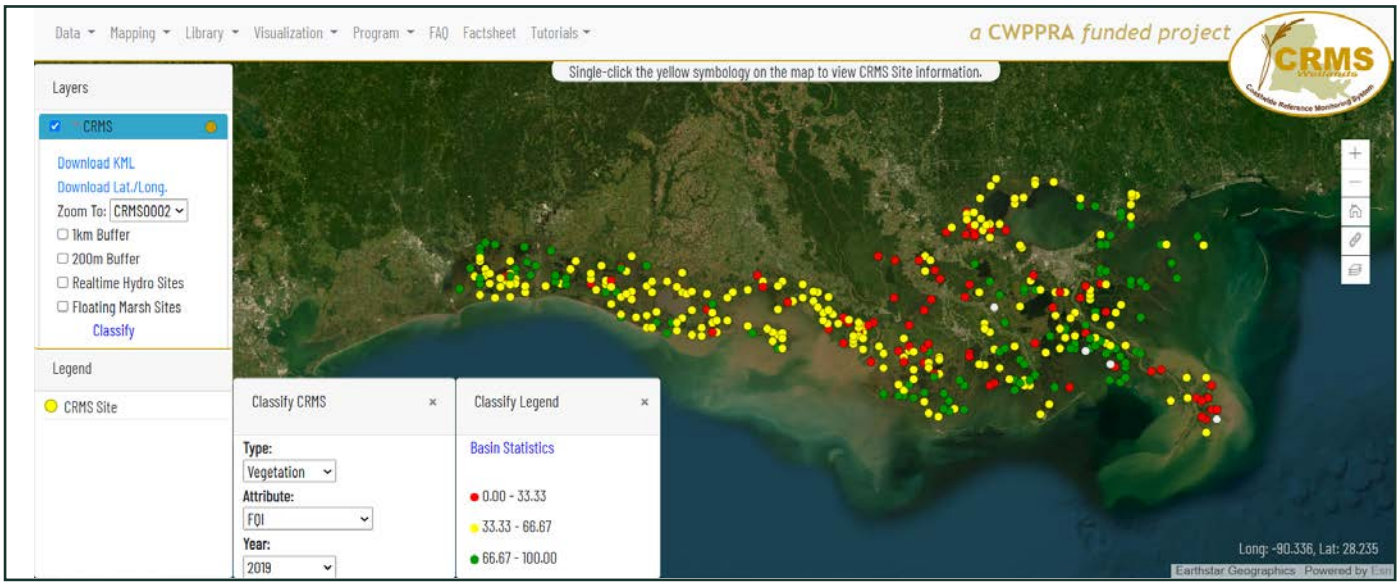


Figure 17. Example of CRMS Map Viewer with sites classified by FQI for 2019

The map will change, and all sites will be classified by the FQI based on field observations of species composition from 2019. This tool can be useful for users interested in investigating only a particular range of scores or values for a particular attribute. For example, users could identify sites with high salinities (i.e. salt marsh) by selecting a small range, and you can define the number of intervals (or break points) within that range.

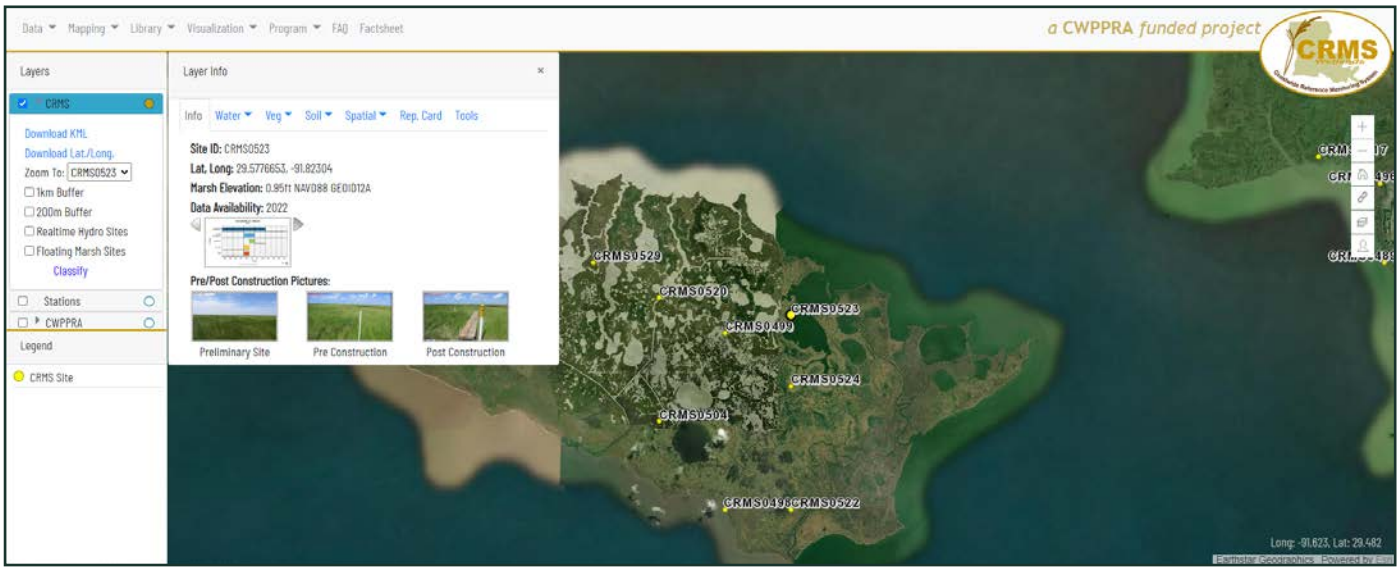


Figure 18. Example of CRMS Map Viewer with CRMS0523 selected and site-specific data displayed

All CRMS Site-Specific Data

1. Use the **Zoom To** drop-down list to select **CRMS0523** by clicking once on the site number, which will be highlighted in gray.
2. When selected, the map will slightly enlarge the yellow site indicator circle for CRMS0523, and an information box will appear. While pressing and holding the shift key, use the cursor to draw a box around the enlarged yellow circle to zoom in on the map (Figure 18).
3. Each of the tabs at the top of the site information box provide facts about the site. Included in the tabbed markers are Information (Info), Water, Vegetation (Veg), Soil, Spatial, Report Card (Rep. Card), and Tools. These tabs will be expanded upon in the following sections.

3.3.1 Info Tab

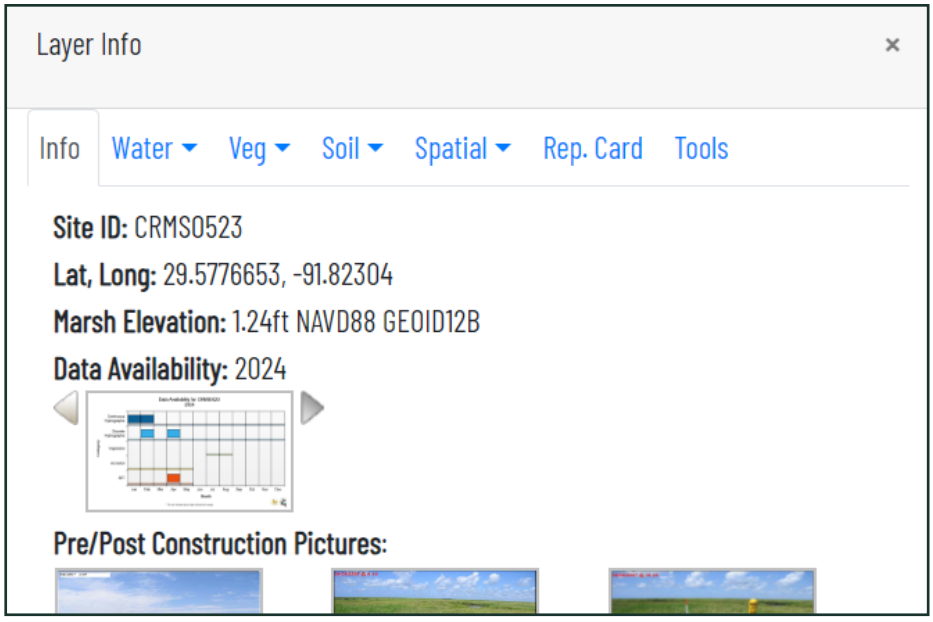


Figure 19. Example of CRMS Layer Info with Info tab displayed

The **Information ("Info")** tab includes the site ID number, the latitude and longitude, marsh elevation, a data availability graph, monitoring site pictures, and PDF reports that includes details about elevation surveys of the site (Figure 19). If a site is located within a CWPPRA project (ex. CRMS0672), the CWPPRA project name and project type will also be included on the information tab. The data availability graph shows what data were collected at this particular site during the identified calendar year. There is a standard data collection protocol with established sampling periods (Figure 10), but in special cases, a site might not have data (ex., a hurricane destroyed accretion plots). Click on the arrows to display what data were gathered each year. By clicking on the data availability graph once, the graph will be displayed larger, showing details such as the months when each data type was collected. Clicking on the graph again will return users to the info tab.

3.3.2 Water Tab

The **Water** tab (Figure 20) includes several subheadings, which can be accessed by hovering over the Water tab and selecting one of the following:

- **Salinity**
- **Water Level**
- **Temperature**
- **Hydro Index**
- **Water Level Range**

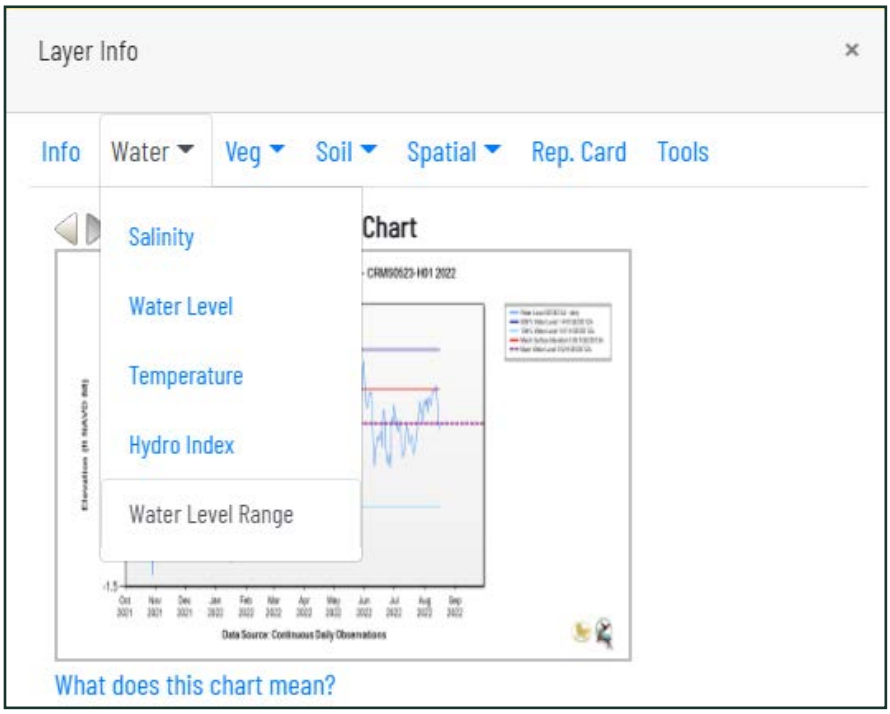


Figure 20. Example of CRMS Layer Info with Water tab displayed

The **Salinity**, **Water Level**, and **Water Temperature** subheadings all display a table of corresponding values for various timeframes and a chart displaying the most recent 30 days of available data for that parameter. Users can also choose to have this chart display the most recent 90 days of available data. To display a different period of record for the data type, choose date ranges in the Visualization/Charting portion of the website (Section 4). *Note: There may be a lag in available data due to data collection and processing timelines.*

Figure 21. Example of the Interactive Hydrology Chart

Click on the graph to enlarge it, and click on it again to reduce it. There is a link at the bottom of each parameter page leading directly to the Interactive Hydro Chart feature, where users can chart multiple stations and parameters against each other for comparison (Figure 21).

The **Hydro Index** and **Water Level Range** pages can help assess site-specific hydrologic conditions. The Hydrologic Index (HI) jointly assesses the suitability of two critical aspects of wetland hydrology (average salinity

and percent time flooded) in the ability to maximize vegetation primary productivity for the 5 different marsh classifications in coastal Louisiana (swamp, fresh, intermediate, brackish, and saline) (Figure 22).

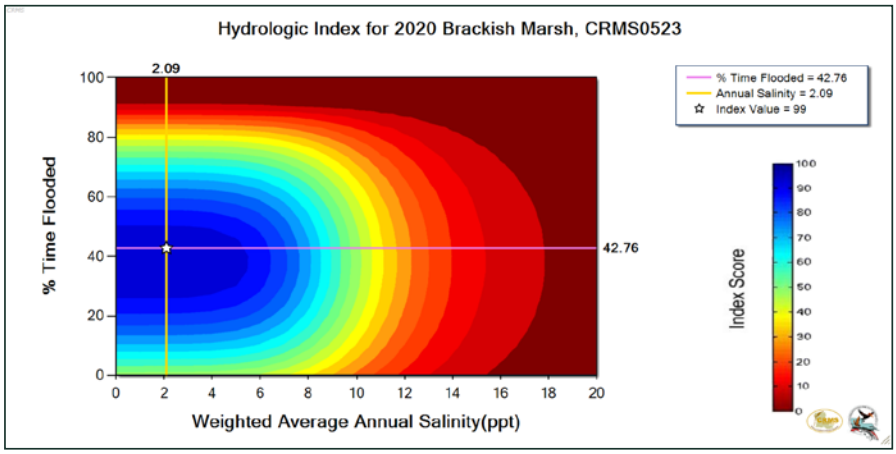


Figure 22. Example of Hydrologic Index chart

The Water Level Range chart (Figure 23) compares site-specific marsh elevation with mean water level and water level observations. Click on each of these subheading names on the Water tab dropdown to investigate the water data for CRMS0523.

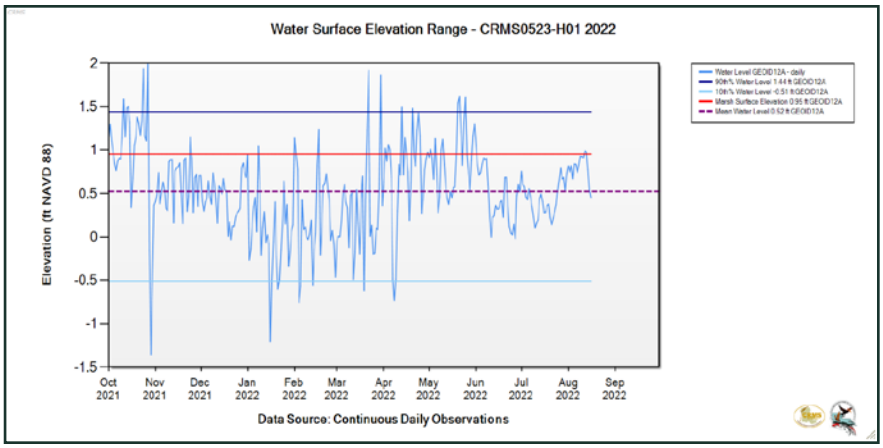


Figure 23. Example of Water Level Range chart

Scientists and educators can use these data to answer important questions about the health of wetlands. Questions such as:

- What might be a cause of the daily changes in salinity?
- Which day during this month had the highest salinity?
- What might be a cause for the spike in salinity?
- What day had the lowest salinity?
- Which organisms are affected by salinity?
- About how many days during the month is the marsh inundated or covered with water?
- How high is the tide on a particular day?
- How low is the tide on a particular day?
- How deep is the water over the marsh surface when the marsh is flooded at a particular CRMS site?

3.3.3 Vegetation Tab

The **Vegetation ("Veg")** tab includes several subheadings:

- **Herbaceous**
- **Forested** [only available for swamp sites]
- **FQI**
- **FFQI** [only available for swamp sites]
- **Marsh Classification**
- **Belowground Biomass**
- **Total Biomass**
- **Nutrients**
- **Community Type**

The **Herbaceous** subheading (Figure 24) provides information about the observed herbaceous vegetation at CRMS sites. Each marsh site has ten 4 m^2 herbaceous vegetation plots situated along a diagonal transect that crosses the 200m x 200m data collection area. Each swamp site has nine 4 m^2 herbaceous vegetation plots situated in a nested layout within the larger forested plots arranged along a diagonal transect that crosses the data collection area. Though the herbaceous plot arrangement at a site varies between marsh and swamp CRMS sites, the data collection protocol is the same.

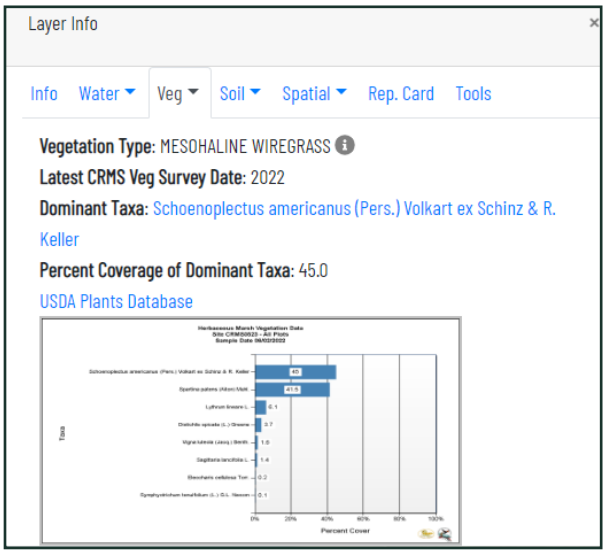


Figure 24. Example of Vegetation tab with Herbaceous data displayed

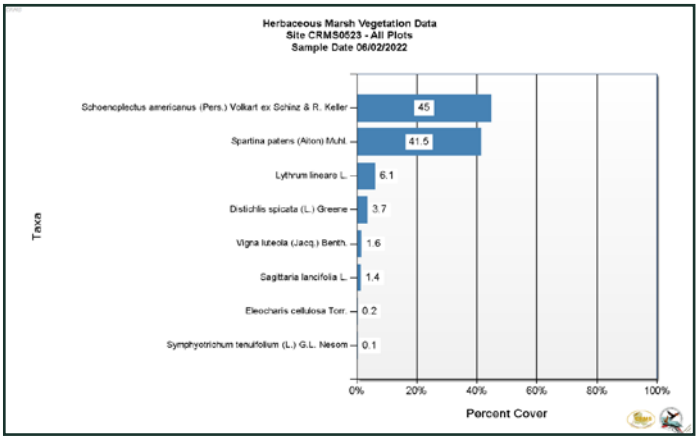


Figure 25. Example of enlarged Herbaceous Marsh Vegetation graph

Click once on the graph to enlarge it and reveal the plant species names and associated percent coverages displayed as a bar graph (Figure 25). The graph automatically shows information from the most recent annual data collection. Click on the graph again to minimize it and return to the original vegetation tab.

Figure 26. View of USDA PLANTS Database website

The Herbaceous subheading also contains a link to the U.S. Department of Agriculture (USDA) PLANTS Database (Figure 26).

The **Forested** subheading (Figure 27) provides information about observed forested vegetation at a CRMS site. Note that this subheading will only be visible for CRMS sites classified as swamp (ex: CRMS0047). Forested sites contain three 400m^2 overstory tree plots, and the nine herbaceous vegetation plots at swamp sites are nested within these larger forested plots (three herbaceous plots per one forested plot). The forested plots are arranged diagonally across the 200m x 200m data collection area.

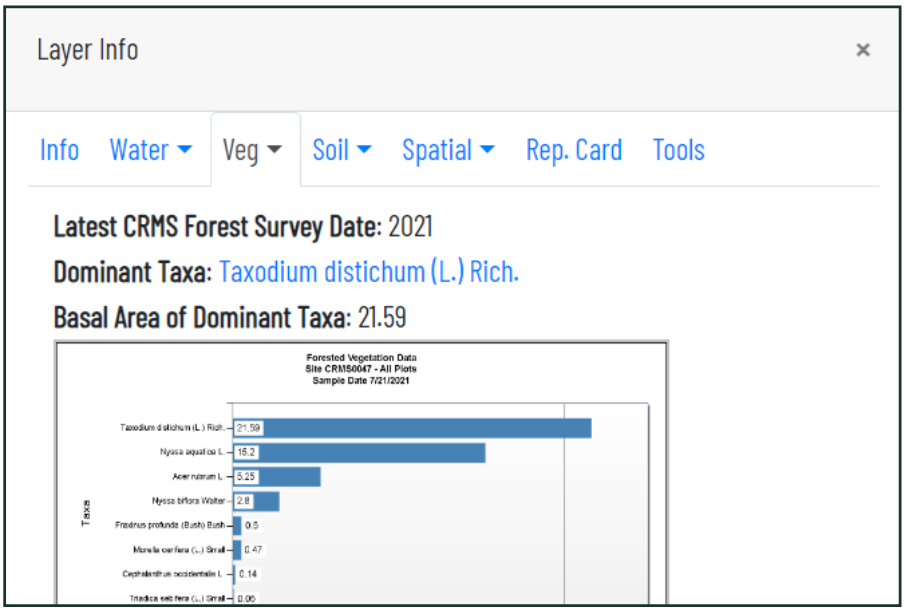


Figure 27. Example of Forested subheading on Vegetation tab

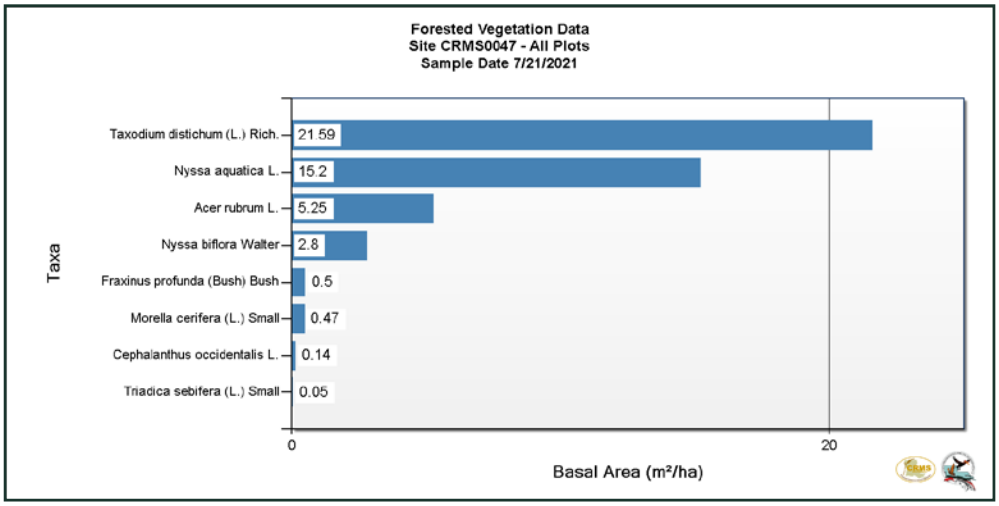


Figure 28. Example of Forested Vegetation graph

Single click on the graph to enlarge it and display the names of the tree species and their calculated basal area (m^2/ha) (Figure 28). The graph automatically shows data from the most recent collection, which occurs every 3 years. Click on the graph again to return to the original forested tab.

The **FQI** subheading contains information about the Floristic Quality Index (FQI) (Figure 29), which was developed to determine the quality of a wetland based on its species composition. The FQI is scored from 0 - 100, which can be calculated at the CRMS station, site, or project scale. To learn more about FQI, click on the "What does this chart mean?" information link under the graph.

The FQI graph displays both the percent cover and the FQI score for each vegetation survey. Each species is identified by name, and a legend is provided to indicate which species corresponds to each color and what the coefficient of conservatism (CC) score is for each species observed.

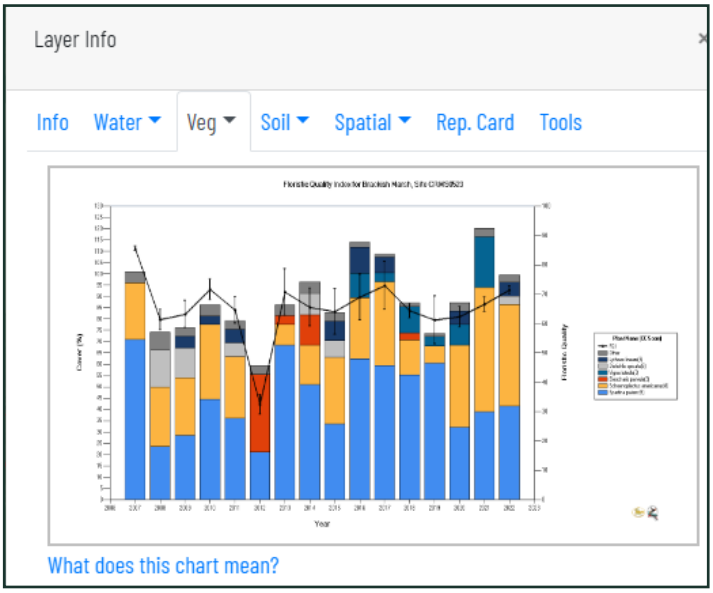


Figure 29. Example of FQI subheading on Vegetation tab

The CC score is a number from 0 - 10 assigned to a plant species by local plant experts using their knowledge of the species' specificity for habitat types (Cretini et al. 2012). Information for all available years is displayed on the graph.

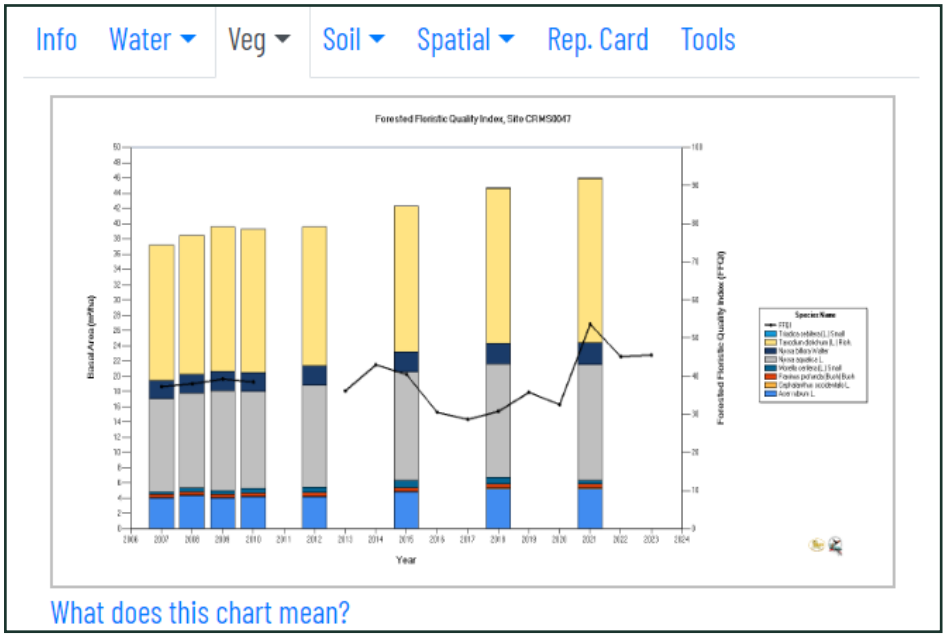


Figure 30. Example of FFQI graph on Vegetation tab

The **FFQI** subheading provides information about the Forested Floristic Quality Index (Figure 30). Note that this subheading will only be visible for CRMS sites classified as swamp (ex: CRMS0047). The Forested Floristic Quality Index (FFQI) was developed for CRMS to:

- evaluate forested wetland sites on a continuum from severely degraded to healthy
- define areas where forested wetland restoration is needed
- determine the effectiveness of future restoration projects in returning specific degraded forested wetlands into healthy ecosystems

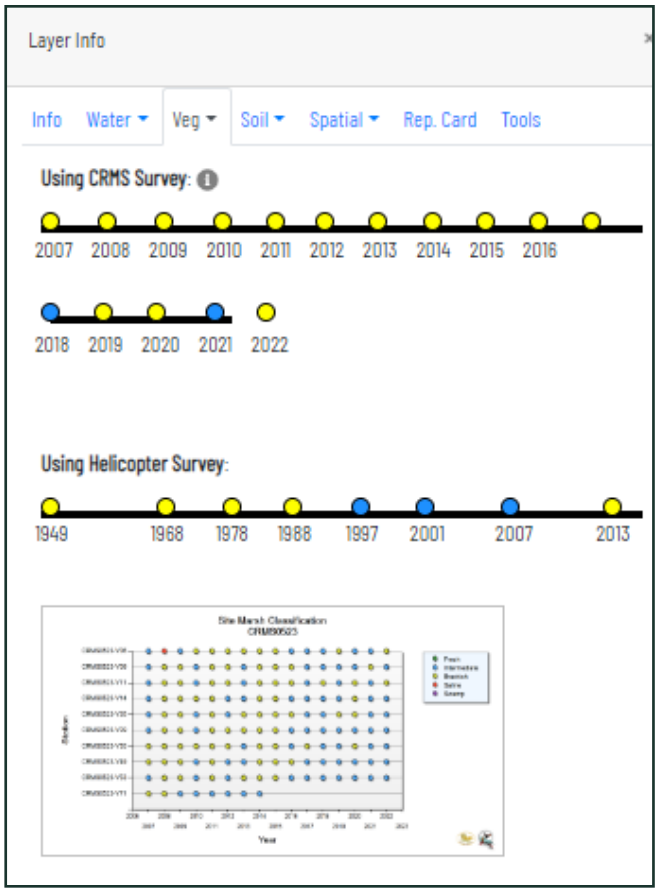


Figure 31. Example of Marsh Classification data on Vegetation tab

The FFQI is scored 0 - 100, similar to FQI explained above. To learn more about FFQI, click on the "What does this chart mean?" information link under the graph.

The FFQI graph displays both the basal area (m^2/ha) and the FFQI score for each forested vegetation survey. Each species is identified by name, and a legend is provided to indicate which species corresponds to each color and what the coefficient of conservatism (CC) score is for each species observed. Information for all available years is displayed on the graph. Note that forested vegetation data was initially collected every year, but collection transitioned to every 3 years in 2012, so there is not data for every single year.

The next subheading under Vegetation is **Marsh Classification** (Figure 31). Marsh classification is important because it helps the scientific community determine whether physical conditions at a site are changing and causing shifts in the vegetation. For example, this information can help determine if a site is becoming more saline due to saltwater intrusion or if a site is freshening due to a freshwater introduction project.

Vegetation data are collected in two ways: periodic coastwide helicopter surveys and annual on-the-ground CRMS vegetation surveys. Vegetation types of fresh, intermediate, brackish, saline, and swamp are assigned to CRMS sites by an algorithm that uses species composition and cover data collected annually from the sites. Every CRMS site is assigned a marsh classification each year using the available vegetation data at the site. A legend to the right of the graph identifies the primary habitat types. The presence of certain species (indicator species) at designated abundance levels can be used to assign marsh types to CRMS sites. Click the "i" button next to "Using CRMS Survey" for more information about these calculations.

The graph in Figure 32 shows that marsh stations (i.e., plots) within a CRMS site can vary in classification. Data can be downloaded as a .csv spreadsheet by clicking on the Download Data link at the lower left of the graph. All available plot classifications by year are shown in this graph.

The graph indicates that the area was primarily intermediate in 2007 and changed in 2008 to brackish or saline.

Questions about what caused that change might include the following:

- Were there drought conditions during 2008?
- Did Hurricane Gustav bring in salt water?

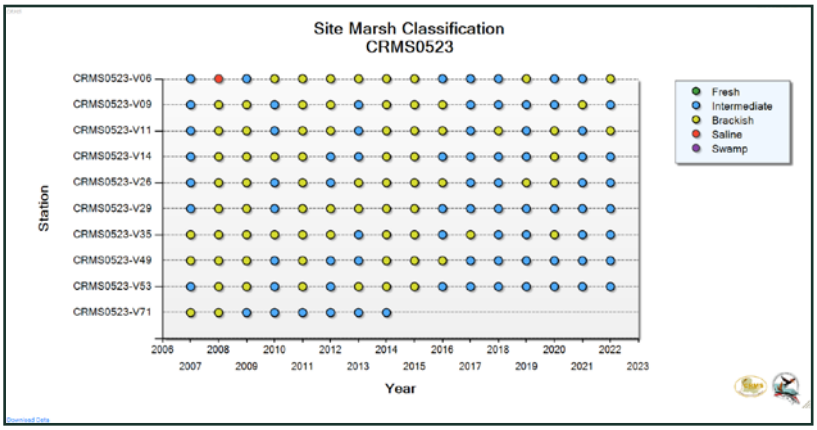


Figure 32. Example of Marsh Classification graph

This graph shows several instances of marsh classification switching back and forth between intermediate and brackish marsh, creating lots of opportunity for possible questions and discussions. These types of data extension questions promote higher order thinking skills in scientists and students alike.

The next two subheadings under Vegetation are **Belowground Biomass** (Figure 33) and **Total Biomass** (Figure 34). Basic measures of wetland condition rely on biomass or productivity measures to improve understanding of the system locally and as a whole, as well as responses of these systems to restoration activities or natural trajectories. Belowground and aboveground biomass samples, along with other plant and

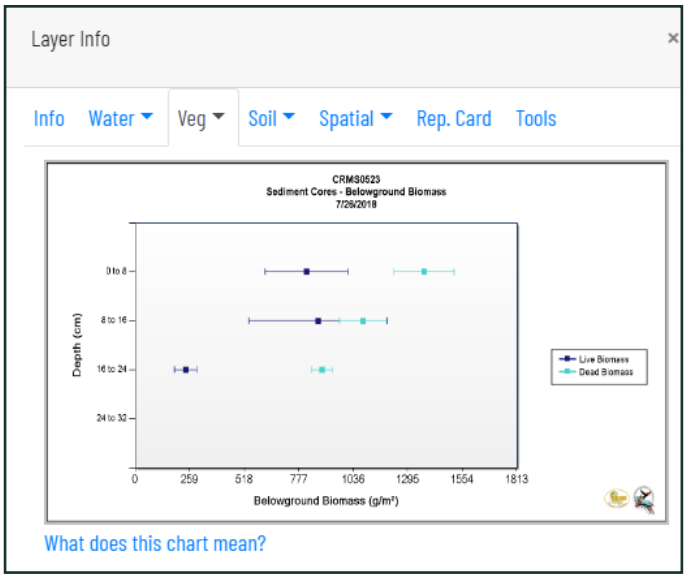


Figure 33. Example of Belowground Biomass graph

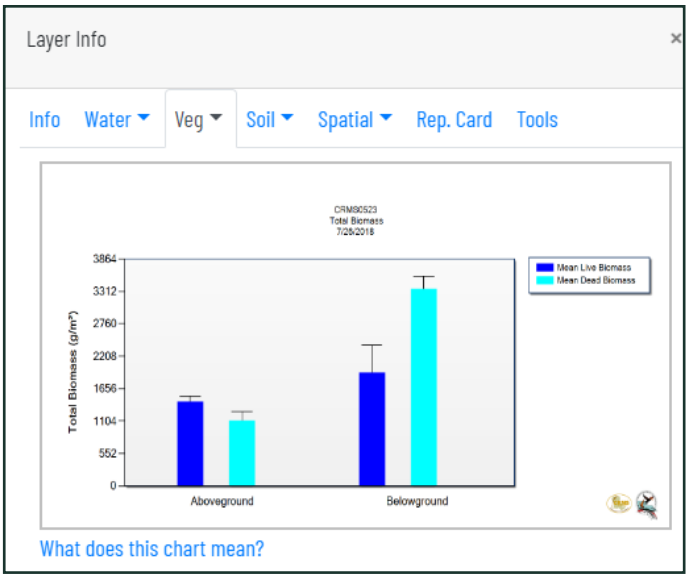


Figure 34. Example of Total Biomass graph

soil characteristics, are collected for the System Wide Assessment and Monitoring Program (SWAMP). These SWAMP samples are collected at a selected subset of CRMS sites in each hydrologic basin. Because of this sampling design, biomass data are not available for every CRMS site. To view a list of sites included in SWAMP sampling, visit the Frequently Asked Questions (FAQ) link on the website banner for a list.

Peak standing biomass represents an indicator of wetland production or productivity. The belowground biomass measures obtained from soil samples at CRMS stations are designed to document changes in wetland above- and belowground biomass to improve understanding of the effects of climate, hydrology, geomorphology, and management activities on coastal habitats and plant productivity. The raw data will also support predictive ecosystem models, as well as answer basic wetland process questions that will help inform restoration decisions. After initial baseline samples are collected, they will be resampled periodically. This biomass sampling is primarily concerned with seven taxa or "target species": *Spartina alterniflora, Spartina patens, Sagittaria latifolia, Sagittaria lancifolia, Zizaniopsis miliacea, Typha spp.,* and *Phragmites spp.*

Click on the graph shown in either subheading to enlarge it and display the biomass volumes and their locations. Click on the graph again to make the graph small and return to the selected tab. More information about sampling procedures can be found by clicking "What does this chart mean?" in the lower left-hand corner of the graph.

The **Nutrients** (Figure 35) subheading features charts displaying data for Total Carbon, Total Phosphorus, and Total Nitrogen. This data is also collected as part of SWAMP sampling at a selected subset of CRMS sites and is therefore not available for every CRMS site. Understanding the nutrient status of plant biomass can be particularly helpful in diagnosing what constituents (macro- and micronutrients) may be limiting wetland production.

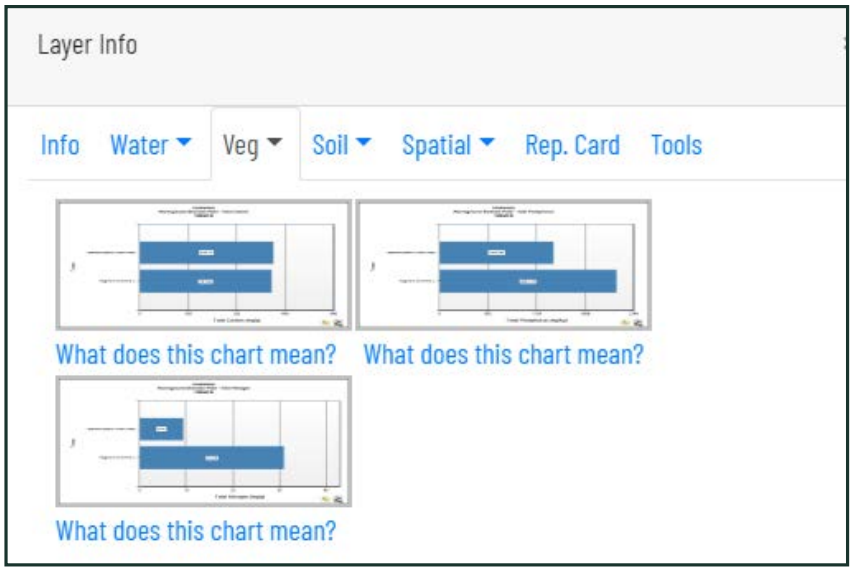


Figure 35 Example of Vegetation Nutrients (Total Carbon, Total Phosphorus, and Total Nitrogen) graphs

Plant tissue nutrient samples are collected in conjunction with the associated aboveground biomass plots. Samples of live leaf material weighing at least 10 grams are clipped from each target species (*Spartina alterniflora, Spartina patens, Sagittaria latifolia, Sagittaria lancifolia, Zizaniopsis miliacea, Typha spp.,* and *Phragmites spp*.) present in the aboveground biomass plot. If a target species is not present, then samples are instead collected of the dominant species present. The mean and standard error (SE) are calculated for each of the three nutrient measures obtained from the live material: "Total Carbon (mg/g)", "Total Nitrogen (mg/g)", and "Total Phosphorus (mg/kg)". Means and standard errors are calculated by Year, Site, and Species.

Single-click on any graph to enlarge it and display nutrient levels and their respective species. Click on the graph again to make the graph small and return to the original nutrients tab. More information about sampling procedures can be found by clicking "What does this chart mean?" underneath each graph.

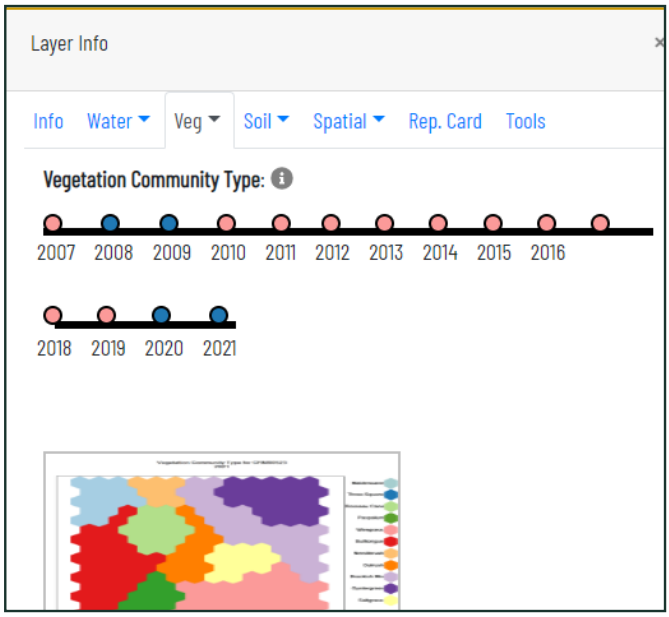


Figure 36. Example of Vegetation Community Type data

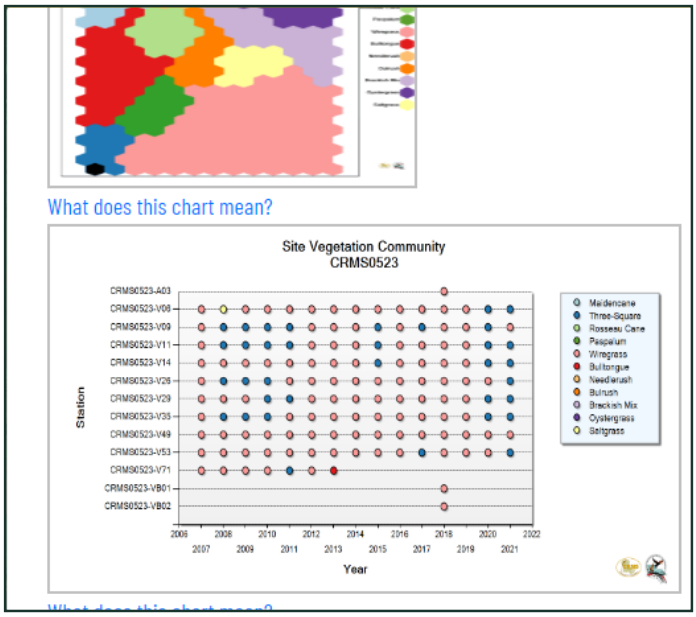


Figure 37. Example of Vegetation Community Type graph

The last subheading on the Vegetation tab is **Community Type** (Figure 36). Using a method that includes vegetation cover, salinity, and flooding data to classify coastal Louisiana marsh vegetation communities, 11 community types were identified across all CRMS sites. One community type is assigned to each CRMS marsh site annually. Classifying coastal Louisiana marsh vegetation communities and tracking change in community type over time is important for coastal wetland management and restoration because changing communities are indicative of changes in environmental conditions (Figure 37).

This method provides a more detailed way of classifying the vegetation and provides more information about community composition beyond the standard fresh, intermediate, brackish, saline categorization. More information about the species composition for each community type can be found by clicking the gray circle icon with an "i" next to the title "Vegetation Community Type".

In Figure 38, the 11 community types are displayed as a grid of hexagons with the number of hexagons in each community type representing the expanse of that community along the coast of Louisiana and the position of each community type indicative of its relationships to its neighboring communities. For example, the wiregrass community type is the most widespread of all marsh community types across coastal Louisiana, which is indicated by the amount of space this community occupies on the chart. There is also variation within the wiregrass community type due to the varying abundances of the co-occurring vegetation species within this community type.

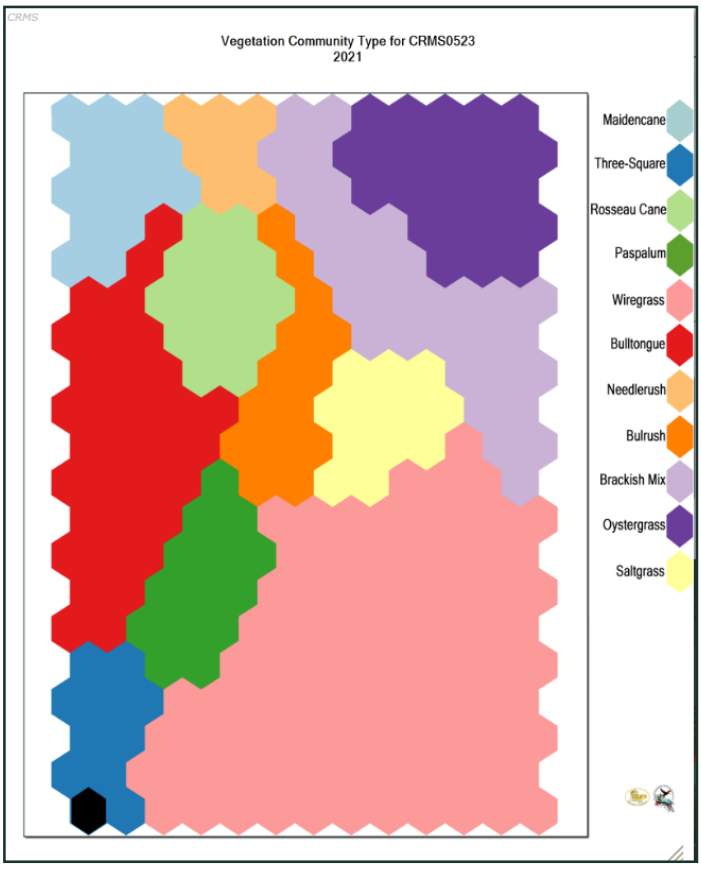


Figure 38. Example of Vegetation Community Type graph

The lower left region of the wiregrass community is more similar to the three-square community, whereas the upper region is more similar to the saltgrass community because of the shared similarity in vegetation species that dominate these other community types.

After viewing the Vegetation tab, questions about plant composition in the area might include the following:

- What year was the first data recorded about plants at this site?
- What year was the last data recorded at this site?
- Which plant is the most common in the most recent year?
- Give the percent coverage of *Spartina patens* from the herbaceous marsh vegetation graph.
- Why is plant diversity important in an ecosystem?
- Which plant(s) make up less than one percent of the plant composition?
- What role do you think plants play in habitat restoration?
- As a student, if you were going to help out with coastal restoration, which type of activity would you prefer to do and why?
- Grow new plants for restoration.
- Volunteer to help with a coastal restoration planting event.
- Write an article in the school newspaper to share information about restoration.
- Create a video to share information about coastal Louisiana.

3.3.4 Soil Tab

The **Soil** tab includes four subheadings: **Percent Organic**, **Bulk Density**, **Nutrients**, and **Surface Elevation/Accretion/SVI** (Figure 39). The primary function of this section is to provide information about the soil at each site. Although all CRMS sites are in coastal wetlands, soil characteristics can vary greatly across the landscape and even within one soil core. For each soil sampling event, 3 soil cores to 24 cm depth were collected and sliced into 4 cm segments. Analyses (for percent organic, bulk density, and nutrient contents) were then run for each segment and averaged for all cores collected during that sampling event.

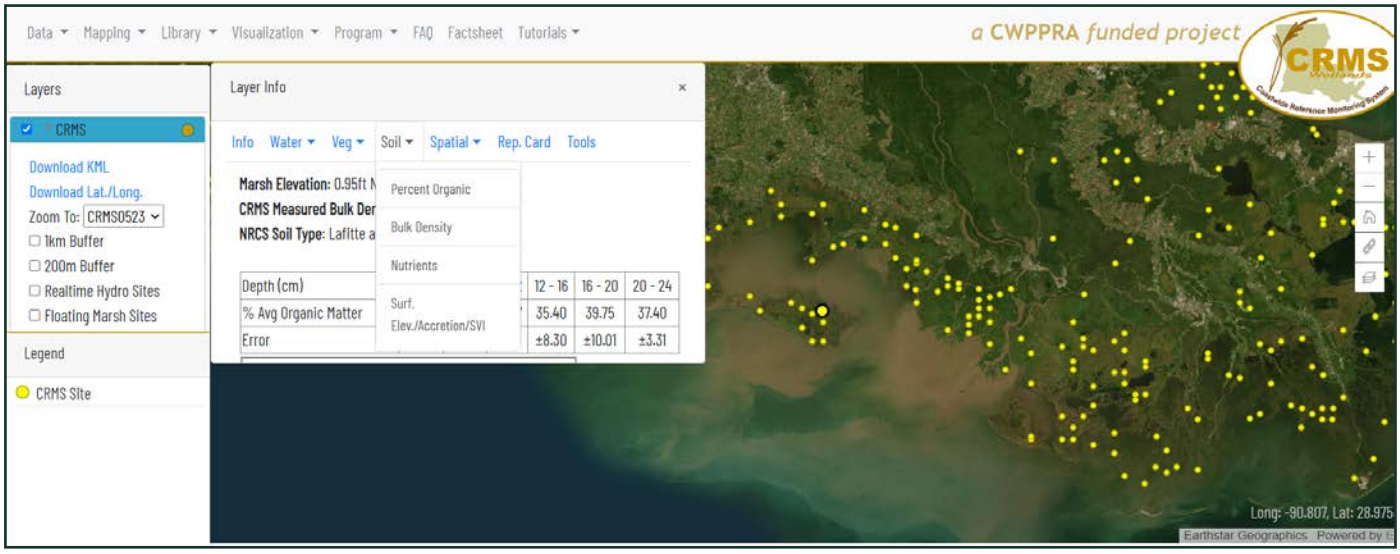


Figure 39. Example of CRMS Layer Info with Soil tab displayed

The **Percent Organic** section includes a table of the average percent organic material by depth, plus standard error (SE), for each collection year. The graph below the table provides the same information visually. Data can be downloaded to a spreadsheet by clicking on "Download data" in the lower left corner of the enlarged graph.

The **Bulk Density** section provides a table of the average bulk density (in g/cm3) by depth, plus standard error (SE), for each collection year. The graph below the table provides the same information visually. Data can be downloaded to a spreadsheet by clicking on "Download data" in the lower left corner of the enlarged graph.

The **Nutrients** section provides information about 4 aspects: Total Carbon, Total Nitrogen, Total Phosphorous, and Carbon Density. Selecting a nutrient displays a table of that nutrient total (in g/kg) by depth for the most recent sampling event. The graph below provides the same information visually.

The **Surf.Elev./Accretion/SVI** section provides information about 3 aspects: Surface Elevation, Accretion, and Submergence Vulnerability Index (SVI). The Surface Elevation and Accretion data help to determine if a location is maintaining a consistent elevation or if is it submerging or emerging through time. *Note: This information is not available for floating marsh sites.*

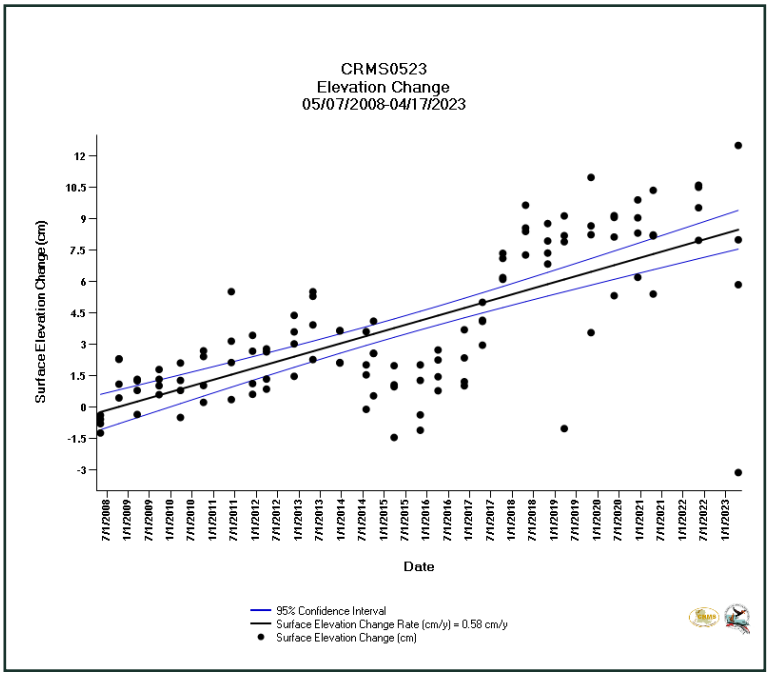


Figure 40. Example of Surface Elevation Change graph.

- **Surface Elevation** (Figure 40): This graph displays surface elevation change over time at the selected CRMS site. Elevation change is measured with the Rod Surface Elevation Table (RSET) and is calculated cumulatively, relative to readings made during initial station establishment. The lines in this figure are linear fits through the elevation change measurements for each direction (n=4 per sample date).
- **Accretion**: This graph displays accretion (cm) over time for each plot set (displayed in a different color and distinguished by establishment date). Vertical Accretion is measured using feldspar marker horizon accretion plots. Plots are established in replicate sets of 3, arranged systematically around the CRMS boardwalk. Original marker horizon accretion plots are established concurrently with initial RSET measurements, and additional accretion plot sets are established every 2 years. All active plot sets at a site are sampled on a systematic rotational basis. The lines in this figure are linear fits through vertical accretion measurements (n=3 plots per sample date and establishment date).
- **Submergence Vulnerability Index (SVI)**: The data for Submergence Vulnerability Index (SVI) is currently offline. This section will be updated once the data becomes available.

3.3.5 Spatial Tab

The **Spatial** tab includes four subheadings: **Land/Water**, **Maps**, **Land Change Matrices**, and **Aerial Photography**.

The **Land/Water** subheading (Figure 41) gives a visual overview of the percent land and percent water present at the selected CRMS site. The arrows directly above the images allow users to view land/water composition of the CRMS site during previous analysis years. A table indicates the number of acres of land and water and the percent of land and water at each CRMS site.

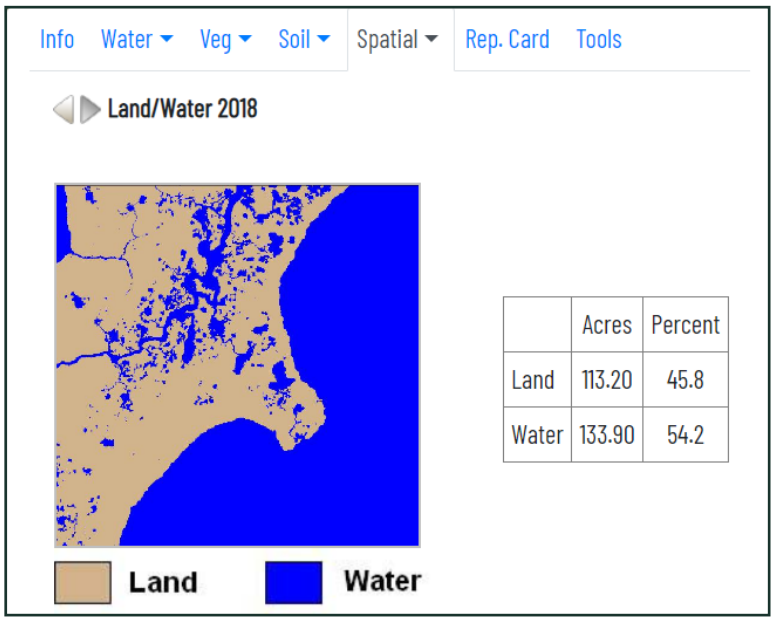


Figure 41. Example of Land/Water display

The **Maps** subheading (Figure 42) displays the land/water classification map for the CRMS site alongside the digital aerial image used to create the land/water classification. The red box indicates the 200m x 200m data collection area for the CRMS site. Select the pdf link to download the image.

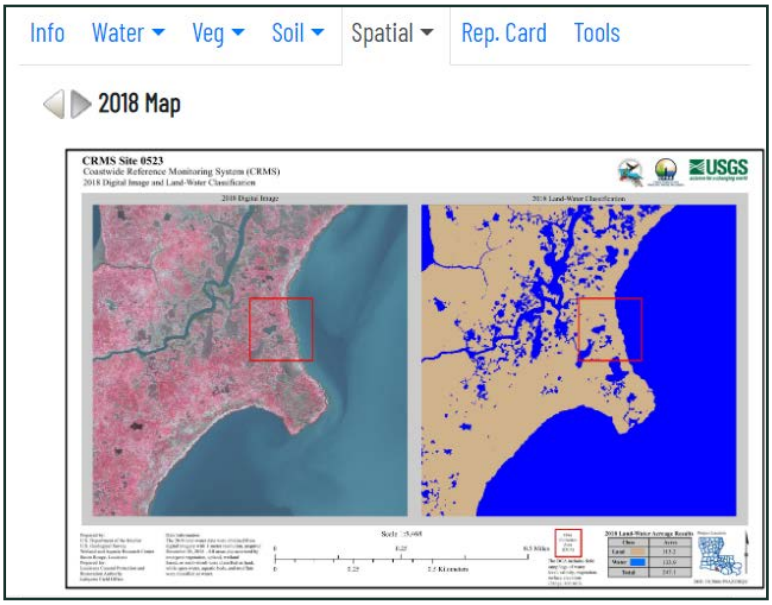


Figure 42. Example of Land/Water Classification Map

Under the **Land Change Matrices** subheading, a map shows how land area has changed within a CRMS site over various date ranges. The possible changes over those date ranges create numerous combinations, which are defined as categories. Each category is color coded and described in the map legend. For example, the "Persistent Land" category is defined as areas of the CRMS site that have remained land over all time periods. Other categories may indicate where new land has formed where water once was. Click "PDF link" at the bottom left to download the PDF version for the selected site.

Under the **Aerial Photography** subheading, the digital imagery collected at a CRMS site can be viewed. Aerial photography has been used widely in the United States since the 1930s to assist land managers in the evaluation of natural resources. The arrows directly above the imagery allow users to view the available imagery tiles.

3.3.6 Report Card Tab

CRMS collects monitoring data for numerous ecological parameters. Using this data, unique indices have been developed by CRMS Analytical Teams, comprised of government, state and academic personnel, to create an interactive report card, which can be accessed by clicking the link at the top of the **Report Card** tab (Figure 43). The report card summarizes data and displays scores and detailed information for individual CRMS sites, restoration projects, hydrologic basins, and the entire Louisiana coast. The report creates pie charts and graphs for a variety of indices. Report Card file sizes can be large and may take extra time to download.

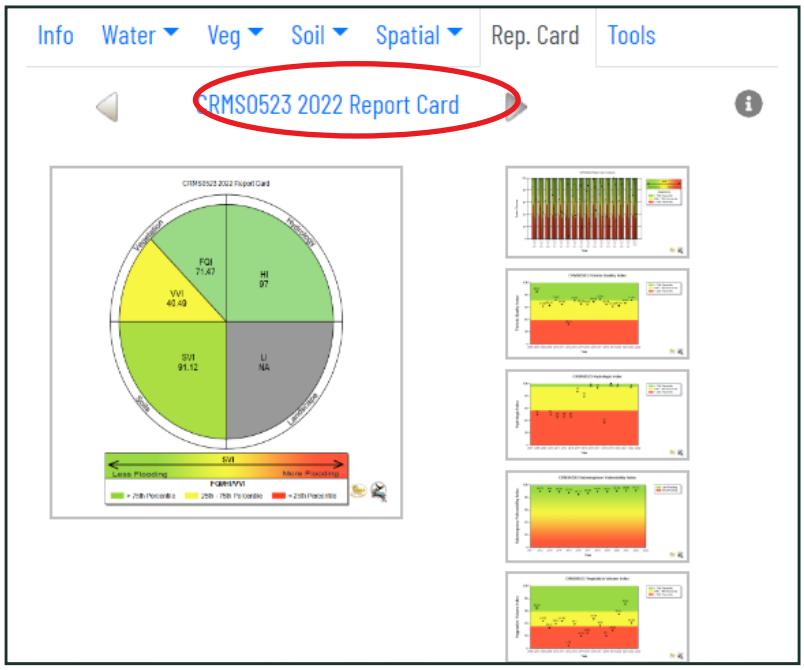


Figure 43. Example of the Report Card tab on the CRMS layer with Report Card link circled in red

Clicking the arrows to the left and right will cycle through report cards available for other years. The graphs displayed on the Report Card tab give a brief visual overview of how the site is performing without the detailed information contained in the report card. Report cards are created for each year that sufficient data are available. Users can also access report cards at https://LAcoast.gov/chart/Charting.aspx?laf=crms by clicking on the "Reporting" tab and then choosing "Generate Report Card."

Click the small "i" button on the top right of the Report Card tab for a description of how CRMS Analytical Teams assessed index scores relative to a baseline distribution, assigning thresholds for good, fair, and poor across all CRMS sites.

Each index helps explain the conditions of a particular aspect of the coastal wetland ecosystem. By comparing indices at various temporal and spatial scales, managers can understand the overall condition of coastal wetlands in Louisiana. Because no regulatory thresholds currently exist for the ecological parameters of interest in the CRMS program, it was not possible to assess index scores based on previously defined values that would indicate an acceptable or unacceptable score. The report card was designed to help resource managers evaluate the ecological conditions and trajectories of change for a site, a restoration project, projects, or even a hydrologic basin.

3.3.7 Tools Tab

The **Tools** tab is the final tab on each CRMS site information box. It includes information on land/water changes over time and coastwide vegetation over time. Click on the year to access the information.

Under **Land/Water** (Figure 44), the data is displayed in both acres and percentage with an accompanying pie graph. The map behind the information box changes to display the land/water map for the year chosen.
Note: The map in Figure 44 is for 2015.

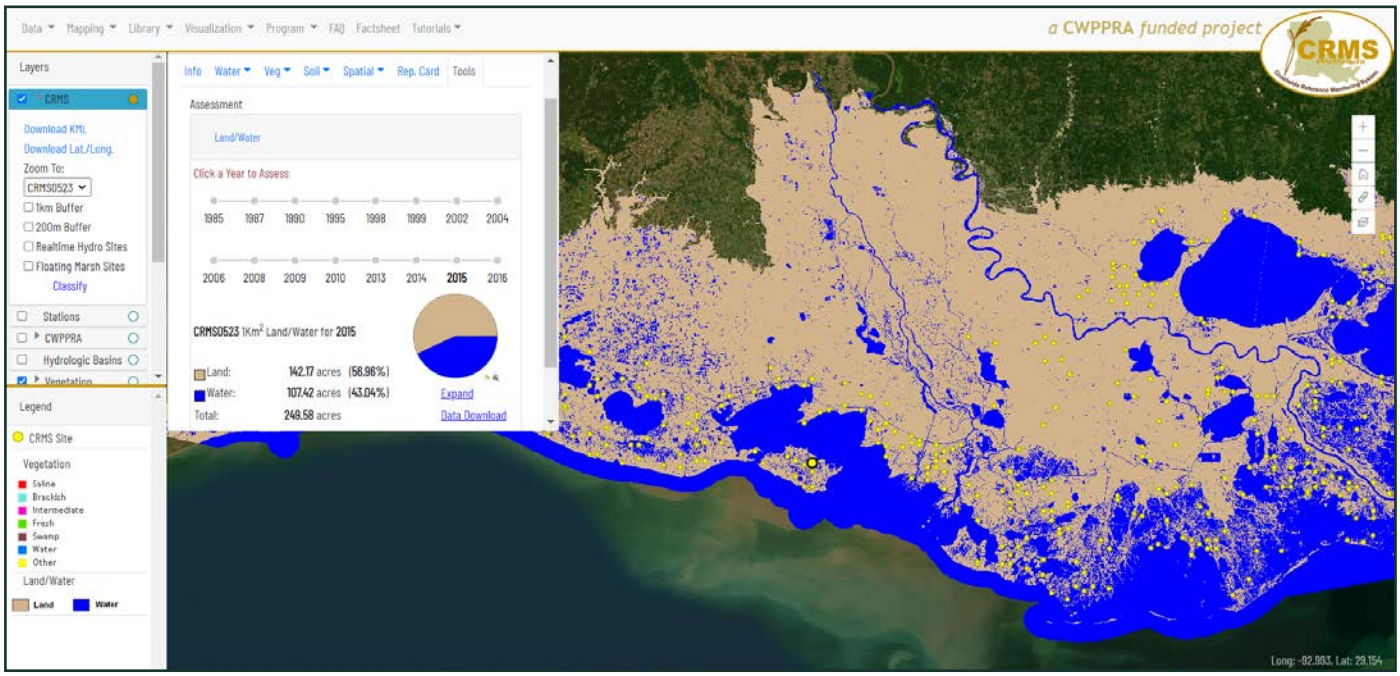


Figure 44. Example of Land/Water expanded on the Tools tab

Under **Coastwide Vegetation** (Figure 45), habitat type data are displayed as both acreage and percentage with an accompanying pie chart. The map behind the information box changes to display the coastwide marsh classification map for the year chosen. *Note: The map in Figure 45 is for 1949 and predates CRMS on-the-ground vegetation surveys. These coastwide vegetation types are based on the helicopter vegetation survey data.*

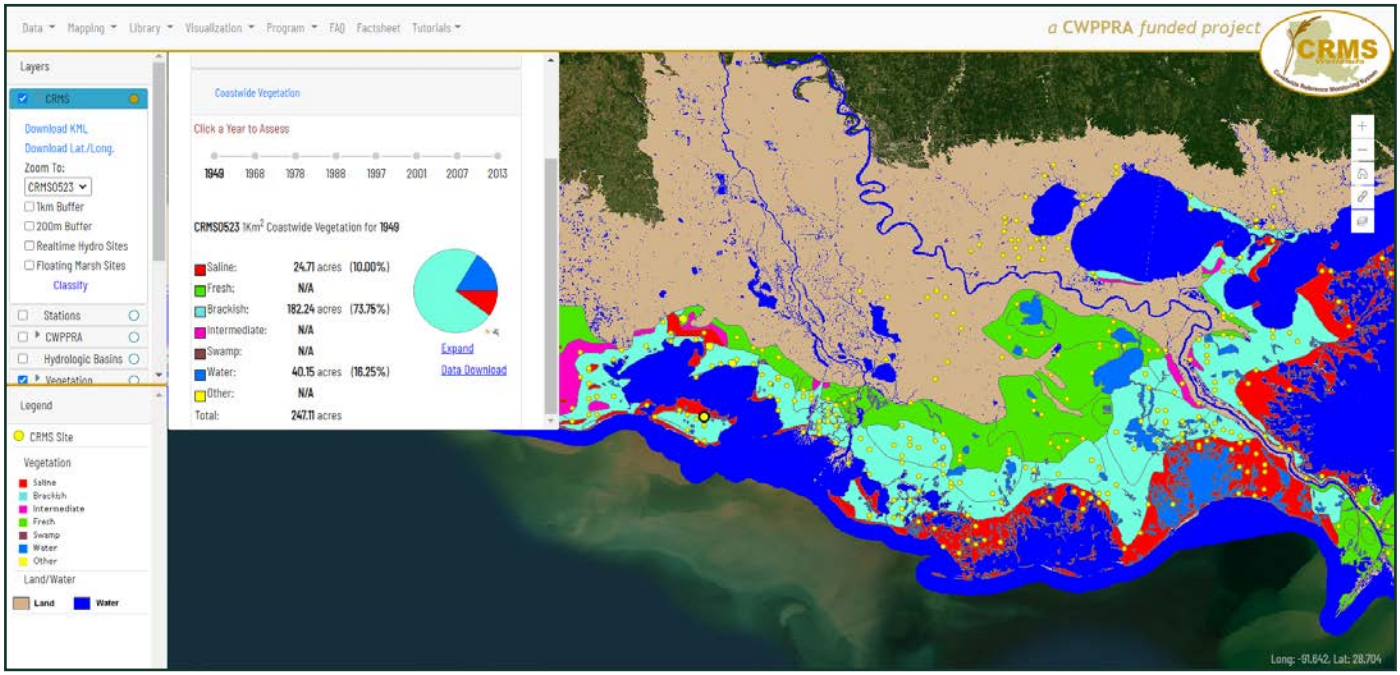


Figure 45. Example of Coastwide Vegetation expanded on the Tools tab

3.4 CWPPRA Project Information Layer

In the Layers menu on the main page of the CRMS Map Viewer, click on the circle to the right of the **CWPPRA** layer text inside the Layers menu. This will make the CWPPRA layer the active layer and will allow the map to display data relevant to it (Figure 46).

By clicking the checkbox on the left, the layer will be visually displayed but not active. Clicking on the orange circle on the right will make the data active. Clicking on a map item in an active layer will provide information about the layer item. Only one orange circle can be active at a time.

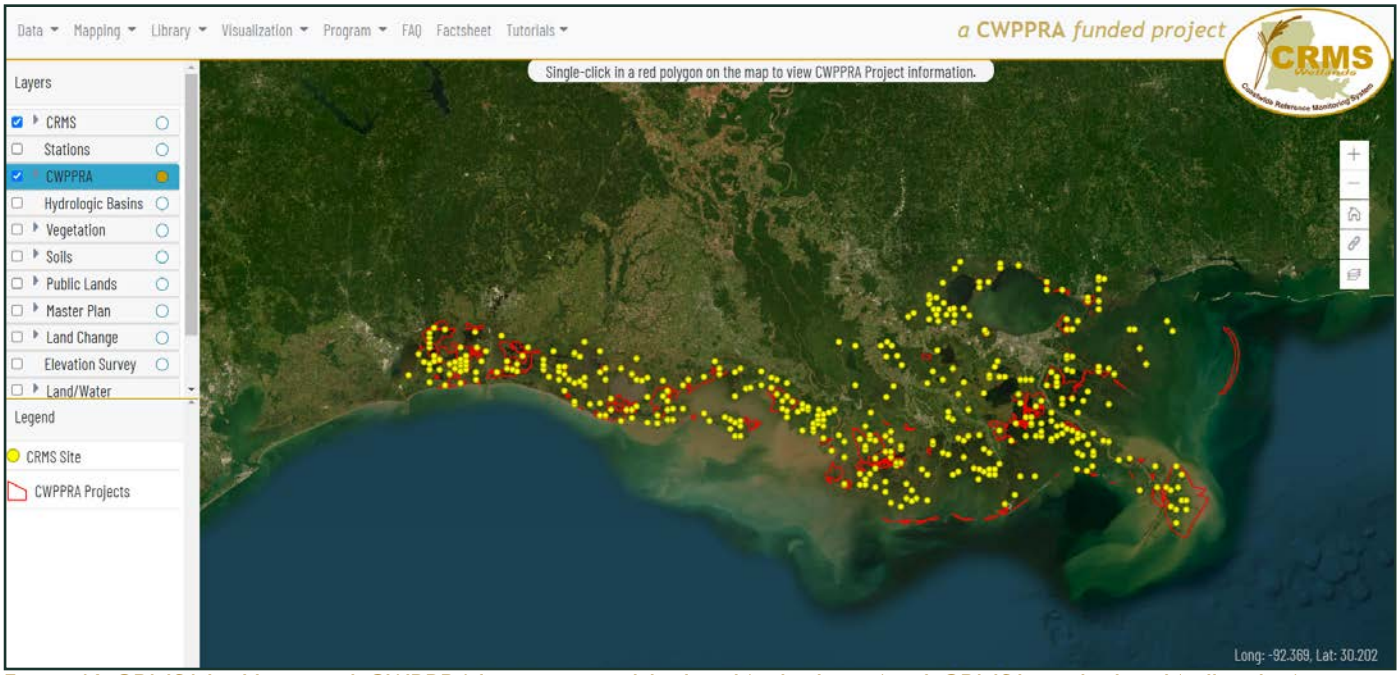


Figure 46. CRMS Map Viewer with CWPPRA layer active and displayed (red polygons) with CRMS layer displayed (yellow dots)

Try this:

1. Click on the gray arrow to the left of **CWPPRA** to expand the **CWPPRA** layer menu (Figure 47). The options include **Zoom To** with a drop-down list of CWPPRA projects, **Constructed**, **Not Constructed**, and **Infrastructure**. Some boxes may be automatically selected already. To choose the items to display or visualize, users may need to uncheck boxes you do not want displayed. A layer is displayed when there is a blue and white checkmark next to its title. The red lines displayed on the map indicate CWPPRA project boundaries.

2. To choose a project, click on the down arrow in the box next to **Zoom To:** or scroll over the map to choose a project. As an example, click the down arrow and choose *BA-20*. This letter/number combination is part of the coastal restoration project naming convention for Louisiana, the letters indicating the basin and the numbers indicating the project number. In this example, the "BA" in BA-20 indicates that this project is in the Barataria Basin.

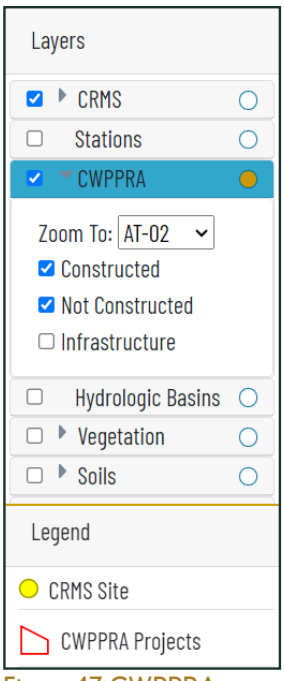


Figure 47. CWPPRA layer menu with dropdown displayed

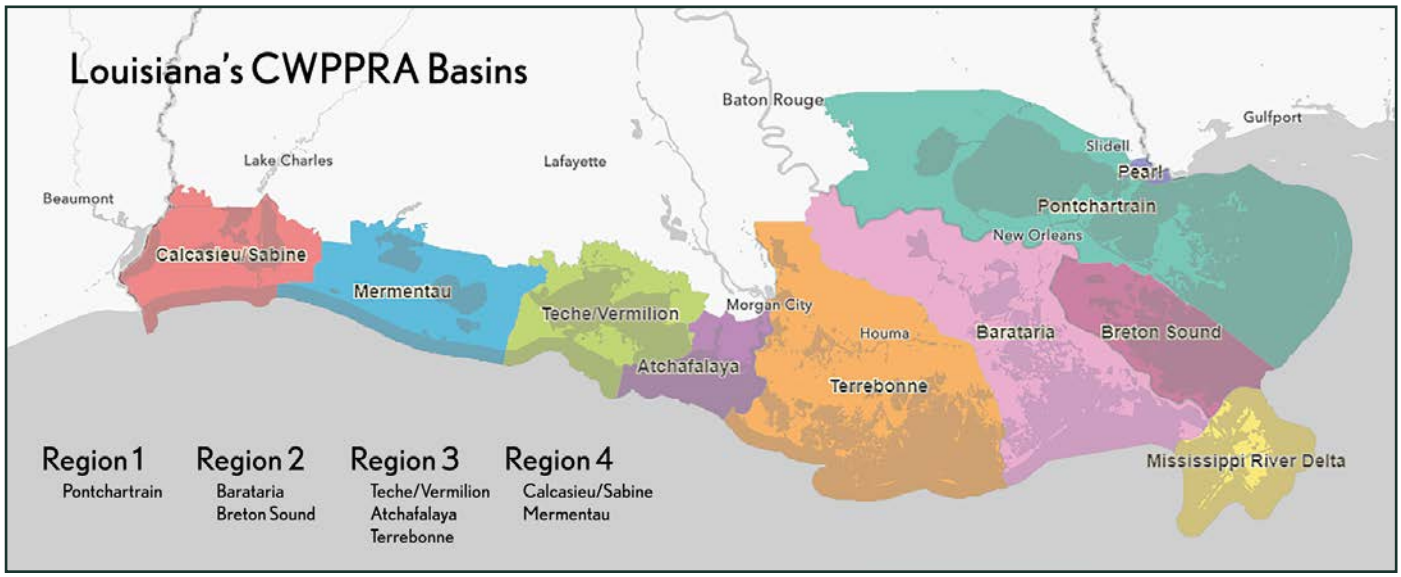


Figure 48. Map of the hydrologic basins in coastal Louisiana as designated by CWPPRA

Note: There are 9 basins in coastal Louisiana for the purposes of CWPPRA (Figure 48). They are listed here with the basin name and 2-letter abbreviation: Pontchartrain (PO), Breton Sound (BS), Mississippi River Delta (MR), Barataria (BA), Terrebonne (TE), Atchafalaya (AT), Teche/Vermilion (TV), Mermentau (ME), and Calcasieu/Sabine (CS).

Instead of using the Zoom To menu, users may choose to select a project area from the map, especially if they do not know the alphanumeric project code but are familiar with the general location. Project BA-20 is the Jonathan Davis Wetland Protection found in southeast Louisiana. When a project area is selected, the map will automatically enlarge and shift to take a closer view of it, and an information box will appear.

3.4.1 Info Tab

The **Info** tab contains information including the **Site ID**, the project **Name**, acronyms for the federal and state **Sponsors**, the **Type** of restoration technique that is primarily being used, any relevant **Links** (including to the general project fact sheet) and lists of the **Objectives** and **Goals** of the project (Figure 49). Click on the link to display the General Project Fact Sheet for BA-20, the Jonathan Davis Wetland Protection project. *Note: The LAcoast website contains a host of information on each project under the Projects tab at* https://LAcoast.gov/new/Projects/Default.aspx.

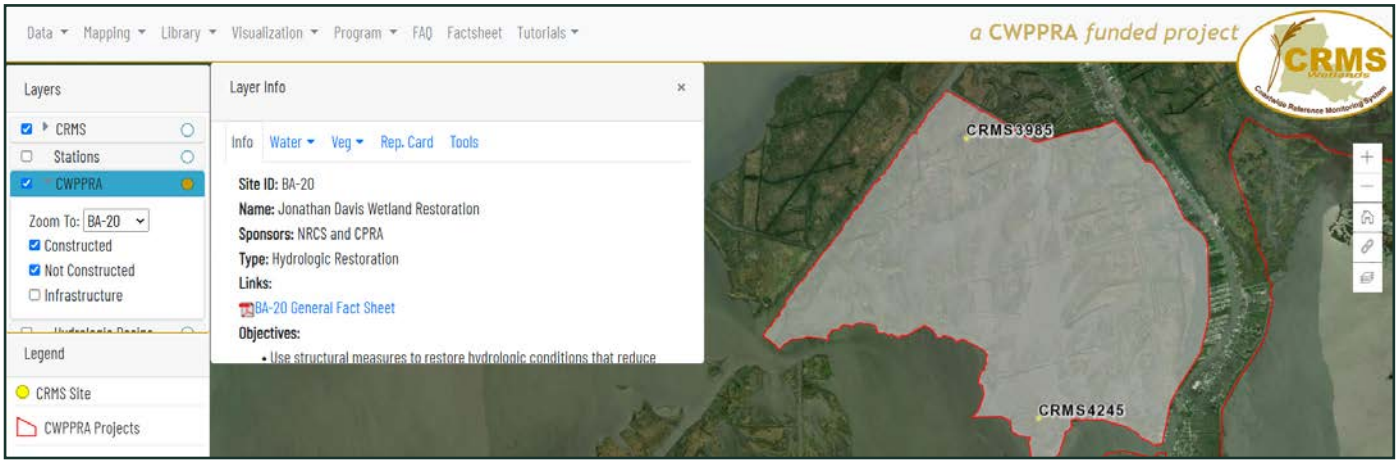


Figure 49. Example of CWPPRA Layer Info with Info tab displayed.

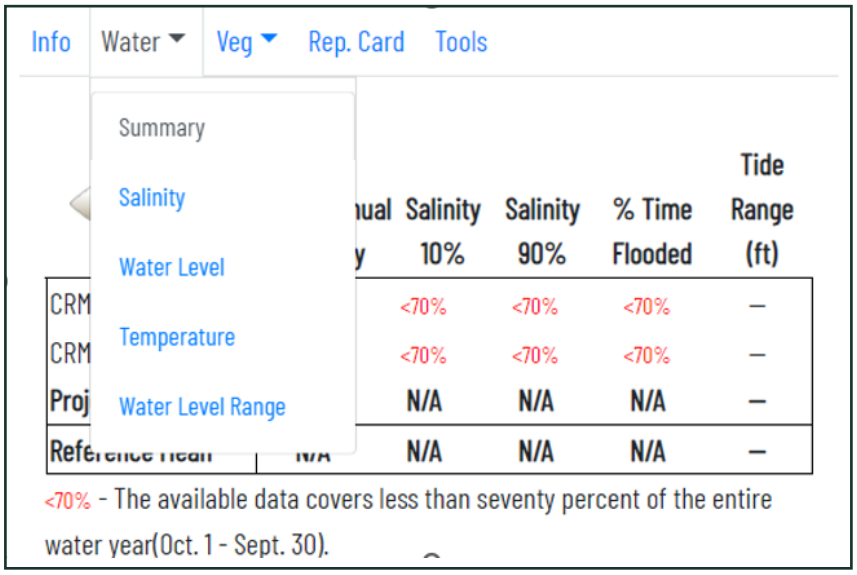


Figure 50. Example of CWPPRA Layer Info with Water tab displayed

3.4.2 Water Tab

The **Water** tab has information about salinity, water level, temperature, and water level range (Figure 50). Hovering over the Water tab will show several subheadings that provide additional graphs and data, including **Summary**, **Salinity**, **Water Level, Temperature**, and **Water Level Range**. Note that some CWPPRA projects may not have CRMS sites located within the project boundary; in those instances, the various water tab subheadings will say "No stations found within this project".

- The **Summary** subheading gives an overview of available water data for this project. If there are any CRMS sites within the project boundary, the station numbers will appear in a table with salinity and flooding summaries.
- The **Salinity** subheading displays a graph of salinity data (in parts per thousand, ppt) collected within the project area.
- The **Water Level** subheading shows water elevation data (in NAVD88, ft) collected within the project area (Figure 51).
- The **Temperature** subheading shows water temperature (in degrees Celsius) collected within the project area.
- The **Water Level Range** subheading shows water elevation (in NAVD88, ft) data collected within the project area as bar charts displaying water level range, marsh elevation, and mean water level for the most recent water year.

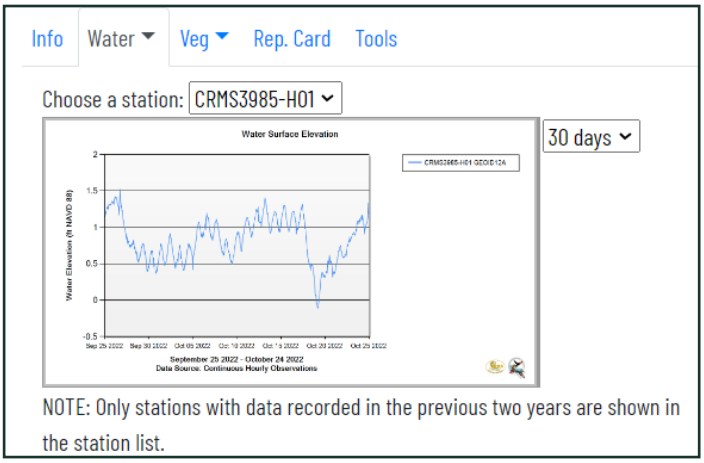


Figure 51. Example of Water Elevation graph

In all of the above cases, if more than one CRMS station is located within the project boundary, there will be a drop-down menu above the displayed graph to select a site. On the right-hand side of each graph is a drop-down menu to display either 30 or 90 days of the most recent available data. These intervals allow for a better understanding of what is happening at each CWPPRA project location. Note that there may be a lag between available data dates and the current date because of the field data collection, review, and upload process.

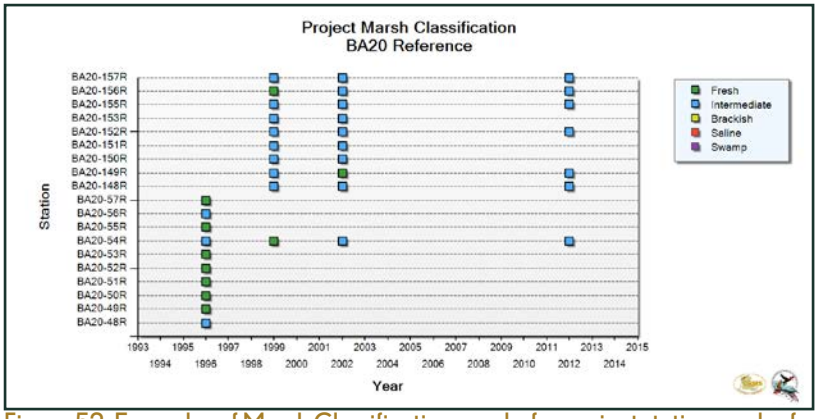
Click on each of the subheadings to explore the data related to the water parameters.

Single click on the graph and the image will increase in size and a "Download Data" link will appear in the lower left corner. Clicking on the graph again will make the graph small and return users to the original tab.

3.4.3 Vegetation Tab

The **Vegetation** tab includes three subheadings: **Marsh Class**, **Project/Ref FQI**, and **Side by Side**.

The **Marsh Class** subheading displays two graphs, one for the project and one for the reference stations (Figure 52). These graphs contain information about marsh type based on plant composition and are classified into fresh, intermediate, brackish, saline, and swamp for project or reference stations.



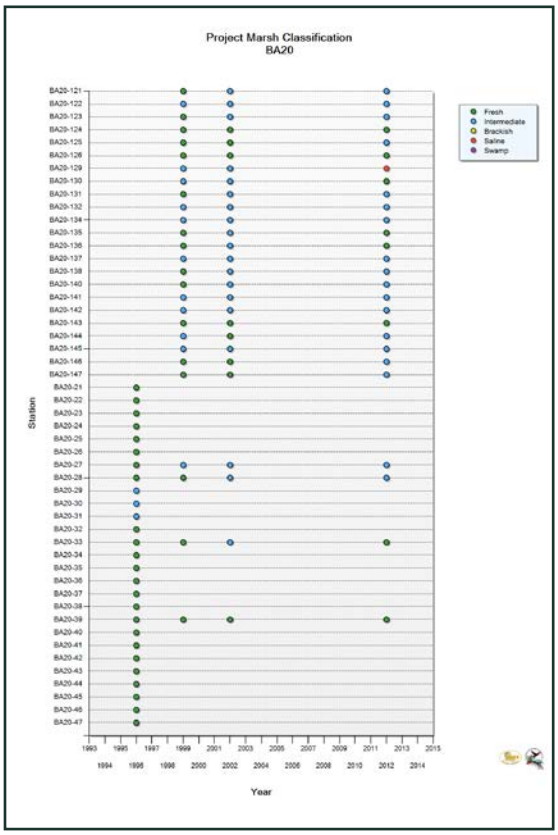


Figure 52. Examples of Marsh Classification graphs for project stations and reference stations

The **Project/Ref FQI** subheading displays a graph of percent cover by species composition and FQI scores for both project stations and reference stations (Figure 53). The term FQI stands for the Floristic Quality Index and was developed for coastal Louisiana to determine the quality of a wetland based on its species composition. The FQI is scored from 0 - 100 and can be calculated at the CRMS site and project scale. On the right side of the graph, there is a legend that includes a list of the dominant species identified during a field survey. Single click on the graph to expand the image; a "Download Data" link will appear in the lower left corner. Click on the graph again to minimize it and return to the original tab.

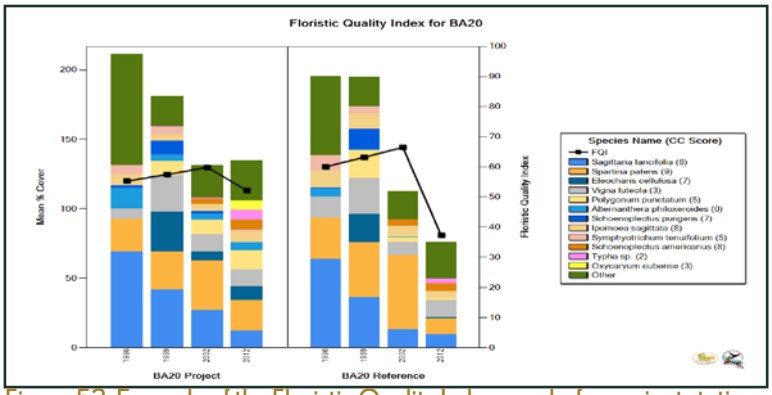


Figure 53. Example of the Floristic Quality Index graphs for project stations and reference stations

The **Side by Side** subheading allows comparison of a project's marsh classification across multiple years (Figure 54). Use the drop-down menus above each map to select the year for data to be displayed.

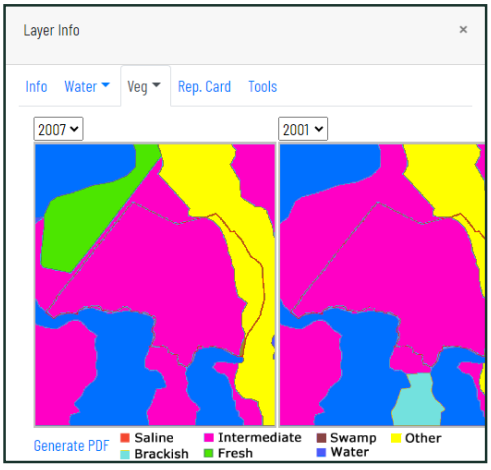


Figure 54. Example of a side-by-side comparison of marsh classification for a project as determined by periodic coastwide helicopter surveys

3.4.4 The Project Level Report Card Tab

Monitoring data for numerous ecological parameters are available. Data have been summarized in a "Report Card," which can be accessed by clicking on the link at the top of the **Report Card** tab (Figure 55). Using CRMS data, unique indices have been developed by CRMS Analytical Teams (comprised of government, state, and academic personnel) to create an interactive report card. The report card summarizes data and displays scores and detailed information for individual CRMS sites, restoration projects, hydrologic basins, and the entire Louisiana coast. The report creates pie charts and graphs for a variety of indices.

Clicking the arrows to the left and right will cycle through report cards available for other years. The graphs available on the Report Card tab are meant to give a brief overview of how the site is performing without going into as much detail as the report card itself. Report cards are created for the project level as sufficient data are available.

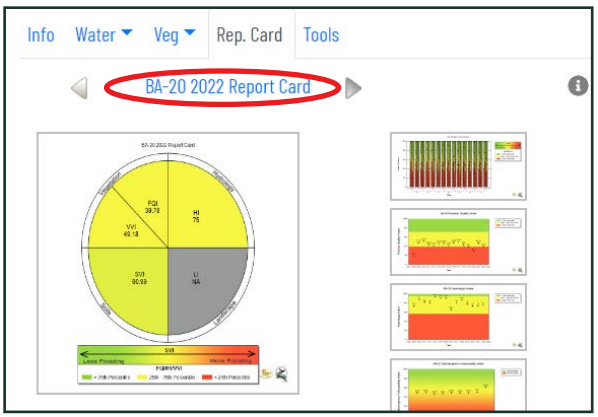


Figure 55. Example of the Report Card tab on the CWPPRA layer with Report Card link circled in red

Click the small "i" button on the top right of the Report Card tab for a description of how CRMS Analytical Teams assessed index scores relative to a baseline distribution, assigning thresholds for good, fair, and poor across all CRMS sites. Each index helps explain the conditions of a particular aspect of the coastal wetland ecosystem. Comparing indices at various temporal and spatial scales can help managers understand the overall condition of coastal wetlands in Louisiana.

Because no regulatory thresholds currently exist for the ecological parameters of interest in the CRMS program, it was not possible to assess index scores based on previously defined values that would indicate an acceptable or unacceptable score. The report card was designed to help resource managers evaluate the ecological conditions and trajectories of condition changes of a site, a restoration project(s), or even a hydrologic basin.

3.4.5 Tools

The **Tools** tab is the final tab on each CWPPRA project. It includes information on land/water and vegetation changes over time. Click on the year to access the information.

Under **Land/Water**, the data is displayed in both acres and percentage with an accompanying pie chart (Figure 56). The map behind the information box changes to display the land/water map for the year that is chosen.

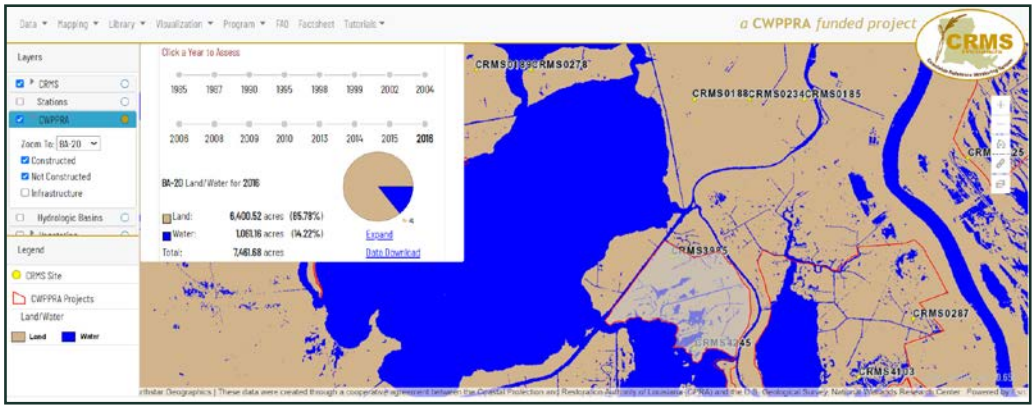


Figure 56. Example of Land/Water expanded on the Tools tab of the CWPPRA layer

Under **Coastwide Vegetation**, habitat type data are displayed as both acreage and percentage with an accompanying pie chart (Figure 57). The map behind the information box changes to display the coastwide marsh classification map for the year chosen.

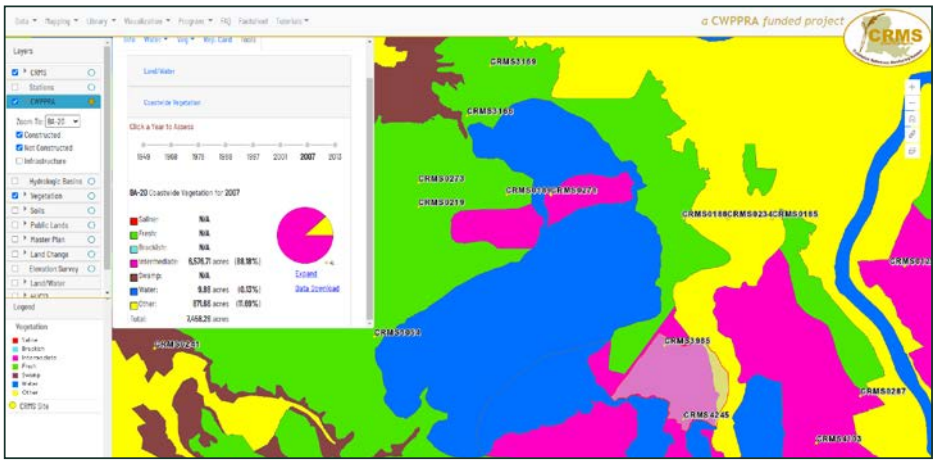


Figure 57. Example of Coastwide Vegetation expanded on the Tools tab of the CWPPRA layer

To learn more about CWPPRA projects and project-specific monitoring, additional information is available on https://www.LAcoast.gov. Information about this website and how to explore its resources can be found in Section 7: Additional CWPPRA Project Monitoring.

3.5 Additional Layers

The additional layers on the CRMS site can be used to view different types of data. Click the checkbox to the left of any layer item to display the data relevant to that layer (Figure 58).

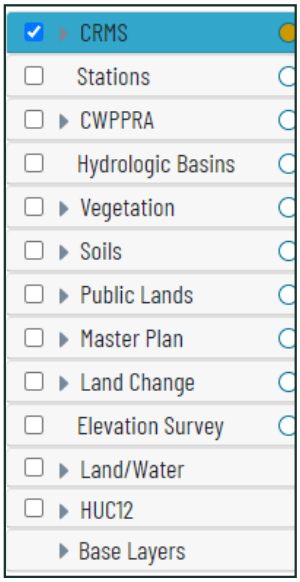


Figure 58. All available layers on the CRMS Viewer

3.5.1 Hydrologic Basins

Hydrologic basins in Louisiana include the area of land where surface water from rain and tributaries drain into the Gulf of America (Figure 59).

Click the circle to the right of **Hydrologic Basins** on the Layers menu to activate that layer. This will display the hydrologic basins for the Louisiana coast outlined in light blue. Clicking on the map inside any of the blue areas will load an information window about the chosen hydrologic basin. The map above shows both the CRMS sites in yellow and the CWPPRA hydrologic basins outlined in blue.

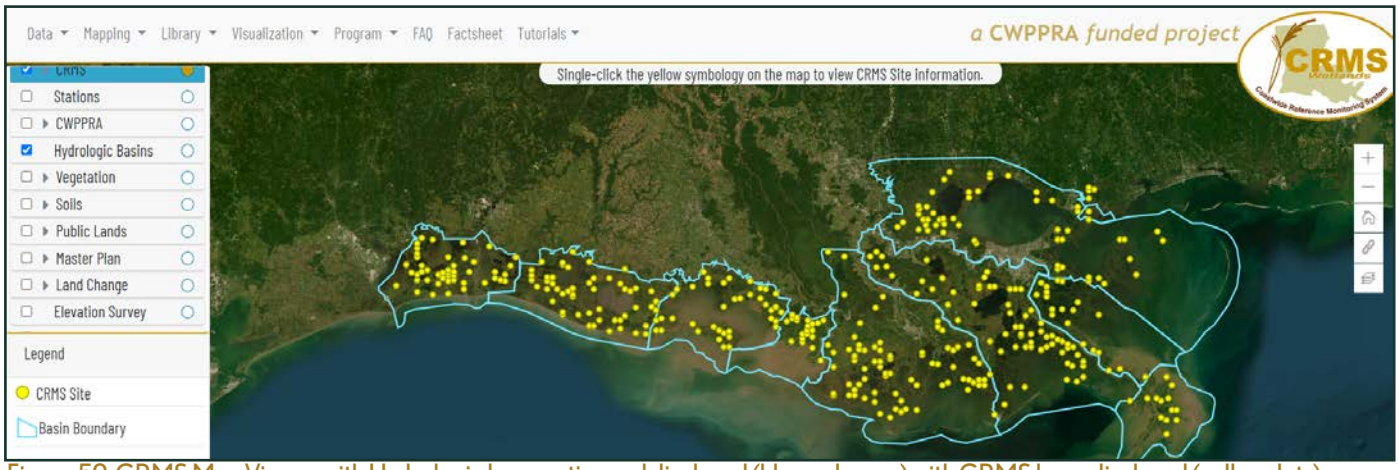


Figure 59. CRMS Map Viewer with Hydrologic layer active and displayed (blue polygons) with CRMS layer displayed (yellow dots)

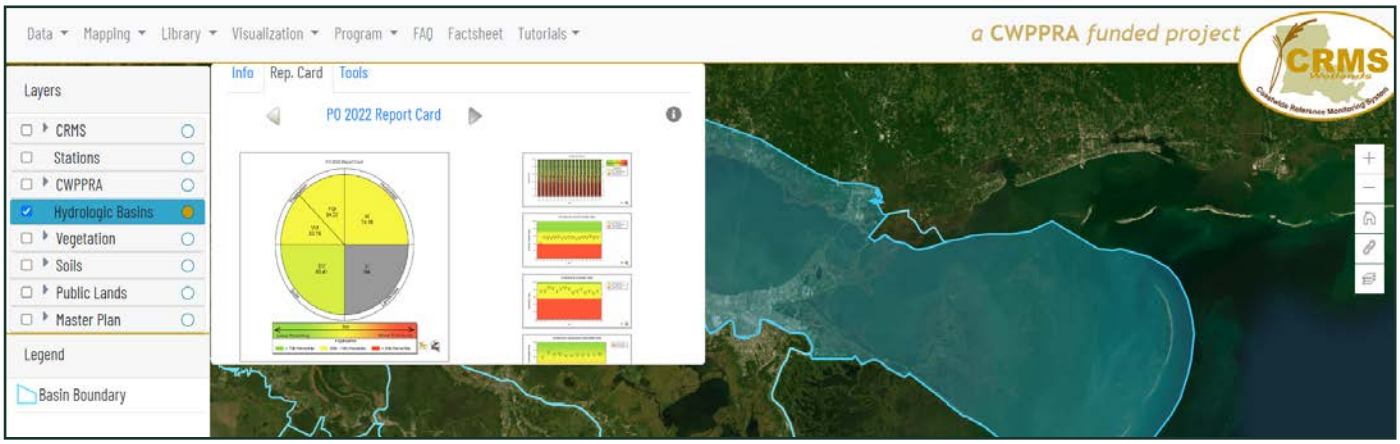


Figure 60. Example of Report Card tab and other available tabs on the Hydrologic Basins layer

The hydrologic basins in coastal Louisiana (as shown in Figure 48):

- Calcasieu/Sabine (CS)
- Mermentau (ME)
- Teche/Vermilion (TV)
- Atchafalaya (AT)
- Terrebonne (TE)
- Barataria (BA)
- Pontchartrain and Pearl River (PO)
- Breton Sound (BS)
- Mississippi River (MR)

In Figure 60, the Pontchartrain Basin is highlighted. The information window includes three tabs containing general information (Info), a Report Card, and Tools. These tabs function similarly to those discussed in previous sections.

3.5.2 Vegetation

The next item on the Layers Menu is **Vegetation** (Figure 61). This layer contains information about the various plants that occur in coastal Louisiana. This information comes from vegetation data collected at over 6,000 points during coastal helicopter surveys. The point data were used to develop either polygon or raster maps (depending on the survey year) that delineate vegetation types coastwide. The vegetation categories are fresh, intermediate, brackish, saline, and swamp. There are also categories for water (such as open water lakes or bays) and other, which is all other non-wetland habitat types (such as upland, agriculture, or developed areas).

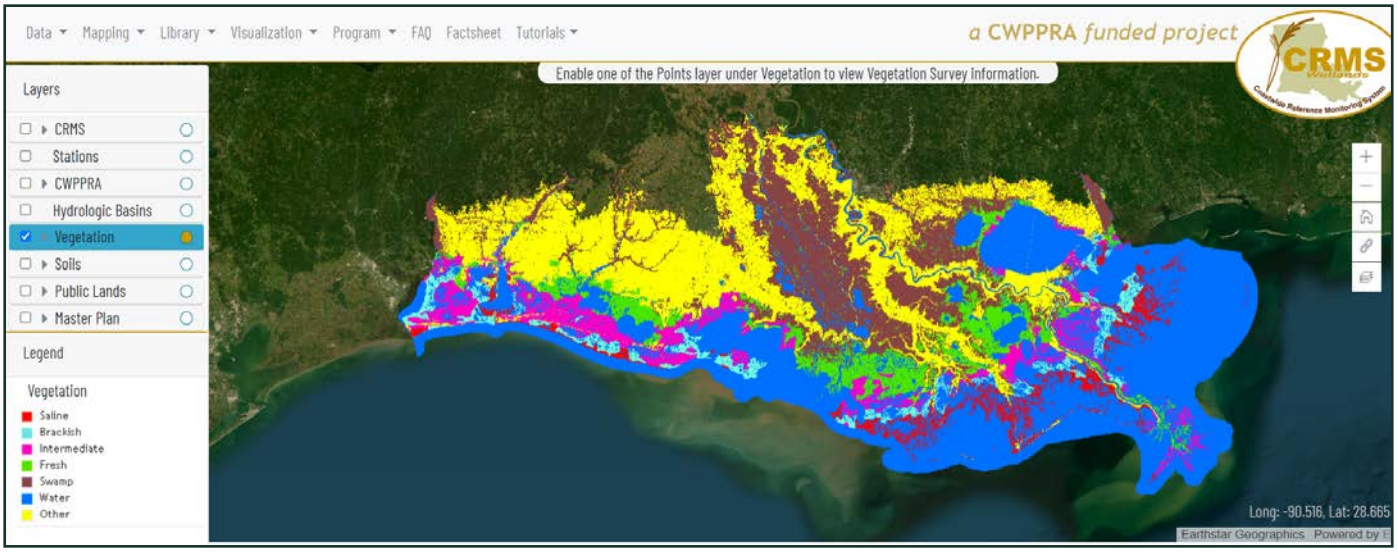


Figure 61. CRMS Map Viewer with Vegetation layer active and displayed (2021 display shown)

Try this:

1. Click on the circle to the right of the **Vegetation** layer title to make that layer active and display the layer of data. The vegetation layer will be visualized on the map, and the data associated with this map will be accessible.
2. Click the grey arrow left of Vegetation to expand the menu. Choose a year in the "Main Layer" to identify the year. For 2021, the vegetation layer is a raster map, which has an expanded extent to include the Atchafalaya Basin, and provides more detail than the normal polygon layers. For all other years, the vegetation layer is a polygon map.
3. Notice that there is a "Main Layer" and a "Diff Layer" (Figure 62). These two layers allow users to compare vegetation over time. To use the vegetative difference layer ("Diff Layer"), choose any year other than 2021 in the Main Layer dropdown. This will turn off the "Raster" radio button and turn on the radio button marked "Polygons." Now a different year from what is selected in the Main Layer can be chosen from the Diff Layer dropdown. Solid colors indicate areas where there has been no change between the selected years, while striped colors indicate changes in vegetation between years.

In Figure 62, red stripes indicate where the marsh type changed from saline in 2001 to brackish in 2007(1), while yellow stripes indicate where the marsh type changed from brackish in 2001 to saline in 2007(2).

Use the (+/-) buttons on the map or the wheel on the mouse to zoom in or out. Be sure to reference the legend displayed under the Layers menu to know what the colors represent in both years. Hovering the mouse over the map in areas of change will create a call-out box that identifies the change in more detail.

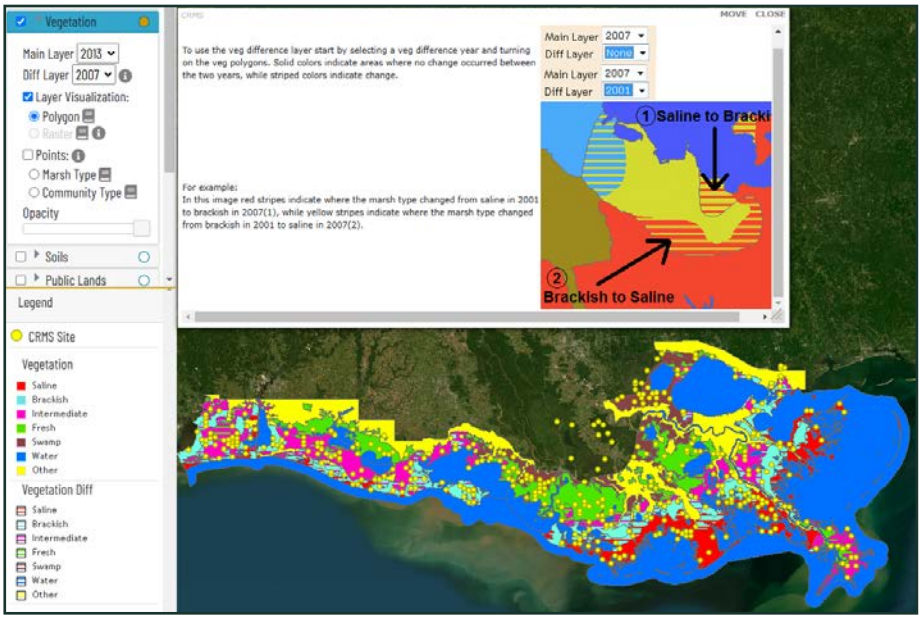


Figure 62. Vegetation layer expanded to show the Main Layer and Diff layer as well as the legends for each layer

Another feature on the Layers menu is a small book icon next to polygon, raster, marsh type, and community type. This book icon will lead to a list of references, data for each year, any available map products, and other associated information. One reference that can be accessed is the 2013 U.S. Geological Survey (USGS) map publication, "Vegetation Types in Coastal Louisiana in 2013" (Sasser et. al, 2014; Figure 63).

By checking the box on the left side of the word **Points**, users can view the Point Visualizations layer. There are two types of points available for visualization with the CRMS vegetation layer, Marsh Type classification and Community Type classification. The Marsh Type points are the helicopter survey vegetation points, which inform the polygon and raster maps discussed above. For more information about these two different point types, click on the small "i" button next to the word Points.

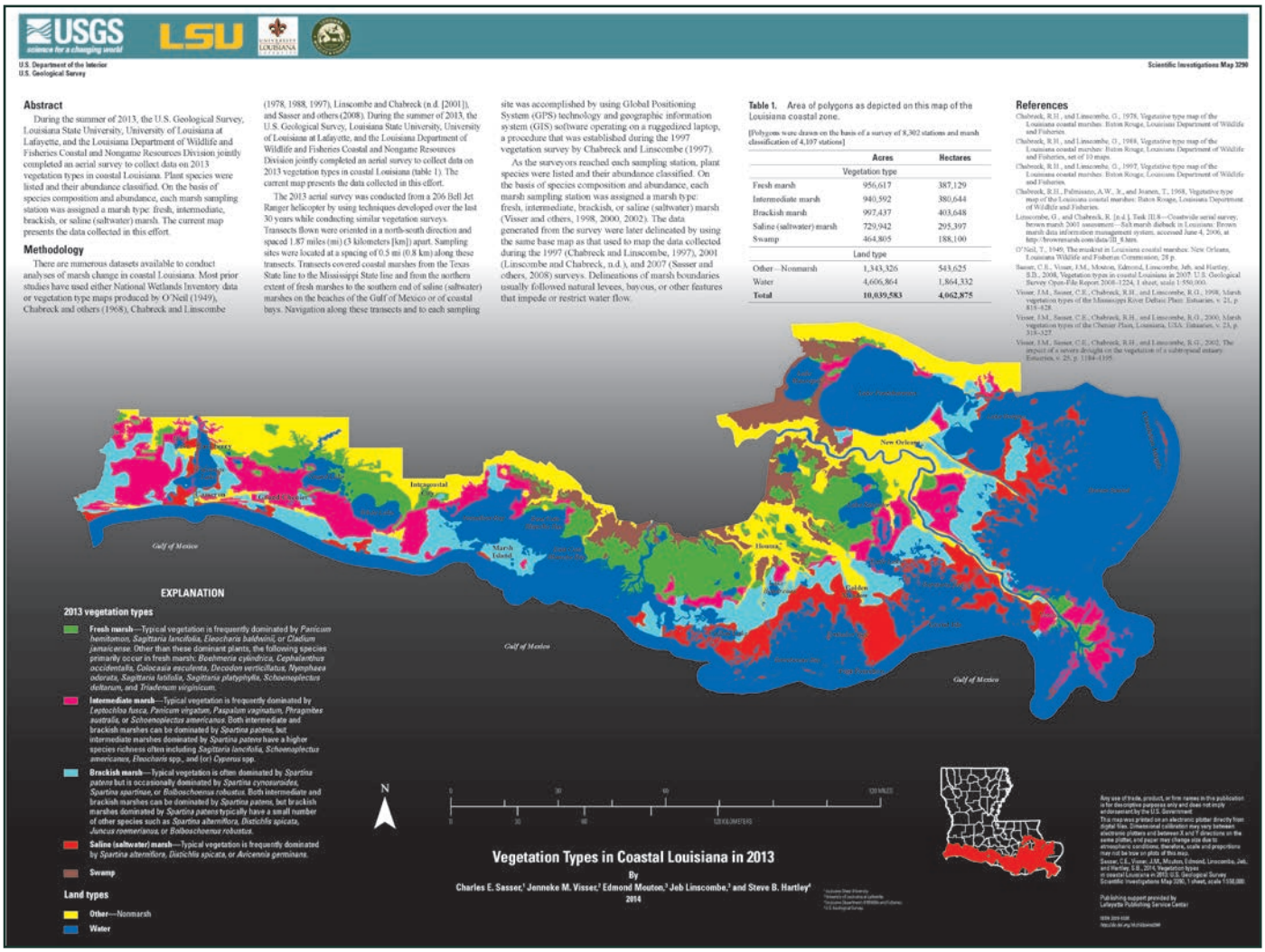


Figure 63. U.S. Geological Survey (USGS) map publication, Vegetation Types in Coastal Louisiana in 2013. Available via the Vegetation layer and at https://pubs.usgs.gov/sim/3290/pdf/sim3290.pdf

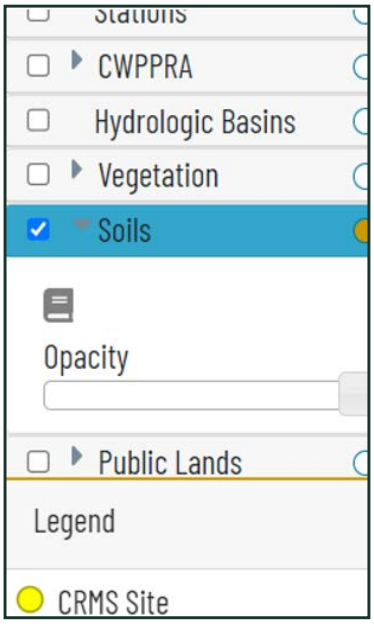


Figure 64. Soils layer menu expanded

3.5.3 Soils

To view the many different soils in Louisiana's coastal zone, click on the circle to the right of the **Soils** layer title to activate that layer and display the layer of data (Figure 64). There are hundreds of different soils in coastal Louisiana. Soil types are recorded in soil surveys conducted by the Natural Resources Conservation Service (NRCS). These soil surveys are then used by farmers, real estate agents, land use planners, engineers, and others who need information about soil resources. In coastal restoration, soils are important in understanding how an area's substrate will work for a restoration project, how different soil types function for water purification, or how substrate supports flood regulation. Soil surveys are also important in identifying which soils support which plants.

The information about various soils can be accessed by clicking on the book icon under the word "Soils." This will open a new browser tab for the NRCS website, which contains all the information about the Soil Survey Geographic Database (SSURGO) soils data. (https://www.nrcs.usda.gov/resources/data-and-reports/soil-survey-geographic-database-ssurgo)

Figure 65. CRMS Map Viewer with Soils layer active and displayed

Once the soil layer is active on the CRMS Map Viewer (Figure 65), the cursor will act as an interface for the soil type. Move the cursor over the area of interest and left-click. The name of the soil will appear in an information box; for example, the soils in green in Lafourche Parish are "Dowling soils" and are frequently flooded (Figure 66).

Figure 66. Example of an information box expanded for the area chosen on the Soils layer

Users can change the opacity of the layer by adjusting the slider (Figure 64) to make the layer more or less opaque, allowing display of the underlying imagery.

3.5.4 Public Lands

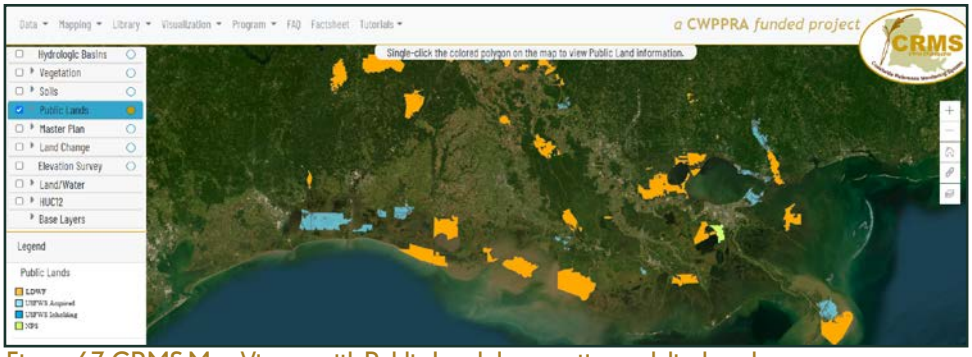


Figure 67. CRMS Map Viewer with Public Lands layer active and displayed

The **Public Lands** layer identifies those lands that are in the public domain (Figure 67). The legend below the Layers menu indicates land owned by the following agencies:

- LDWF – the Louisiana Department of Wildlife and Fisheries (State of Louisiana property),
- USFWS Acquired – the U.S. Fish and Wildlife Service (federal land that is acquired),
- USFWS Inholding - the U.S. Fish and Wildlife Service (federal land that is inholding), and
- NPS – the National Park Service (federal lands)

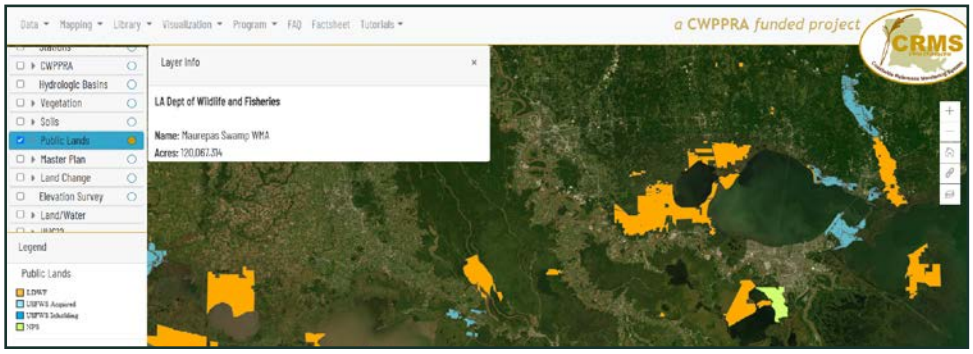


Figure 68. Example of an information box expanded for the area chosen on the Public Lands layer

By left clicking on the colored polygons with the public lands layer active, the name of the location will appear (Figure 68).

3.5.5 Master Plan

The **Master Plan** layer is an overview of the projects used in the creation of the Master Plan by CPRA. When this layer is active, project polygons are visible on the map (Figure 69). Click on a polygon, and a Layer Info window gives information about the project project **Name**, **Type**, **Description**, and a link to the **Project Fact Sheet**.

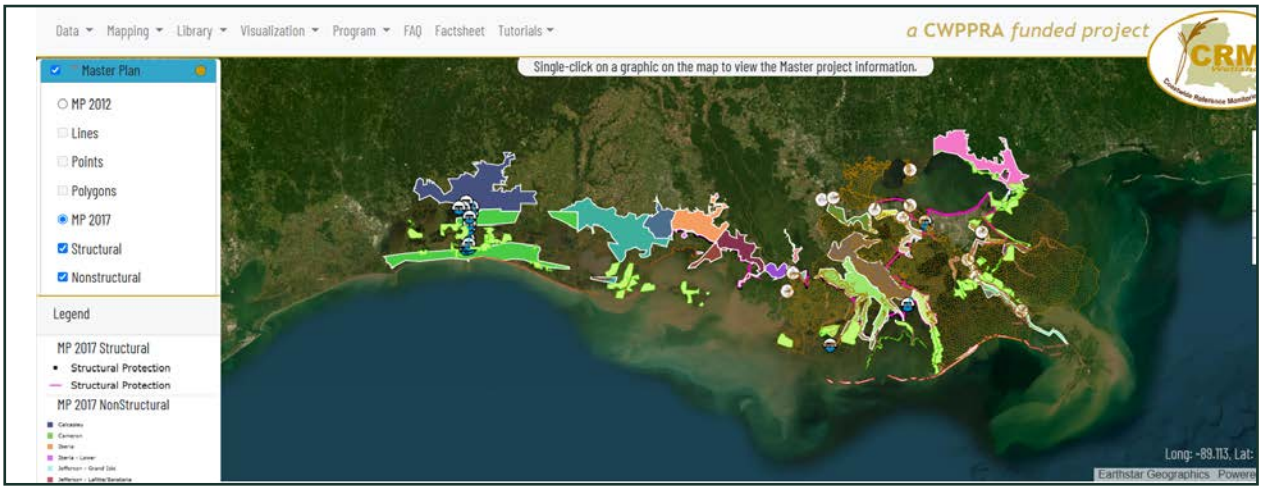


Figure 69. CRMS Map Viewer with Master Plan layer active and displaying MP 2017

Interactive data is available for the 2012 and 2017 Master Plan on the CRMS Viewer, but for deeper exploration, visit the Master Plan Data Viewers:

- The 2023 Master Plan Data Viewer is here: https://mpdv.coastal.la.gov/
- The 2017 Master Plan Data Viewer is here: https://cims.coastal.louisiana.gov/masterplan/
- The 2012 Master Plan is here: https://coastal.la.gov/our-plan/2012-coastal-masterplan/

3.5.6 Land Change

The **Land Change** layer displays coastal Louisiana land change information based on historical surveys, aerial data, and satellite data (Figure 70). There are two options available, "1932-2016" and "1932-2010," each of which contains land change information based on data from the selected date range. The book icon links to the publication for each of the two options. The layer legend indicates what each color of the map means. While the

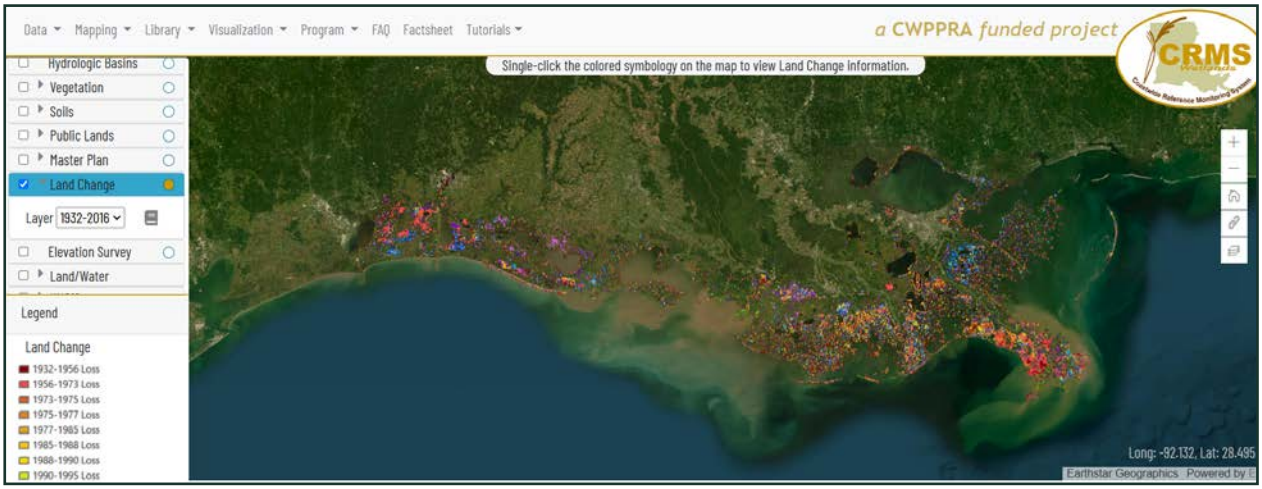


Figure 70. CRMS Map Viewer with Land Change layer active and displaying "1932-2016" land change data

layer is active, indicated by the orange circle to the right of the layer name, click on any area of the map to open an information window that describes the change in that area. Turning on another layer, such as CRMS, CWPPRA, or Hydrologic Basins, while this layer is active gives an idea of the historical land loss within each of these boundaries.

3.5.7 Elevation Survey

The **Elevation Survey** layer provides the locations of primary and secondary benchmarks that have been used during the various elevation surveys at CRMS sites (Figure 71). *Note: Users must be at a certain zoom level to view this layer.* A message will appear indicating that the map must be zoomed in closer to view the layer. This message will be displayed until the appropriate zoom level is reached. Once at the appropriate zoom level, the layer can be activated. When the layer is active, any of the points displayed on the map can be clicked to open an information window. This window displays the Benchmark ID, the CRMS ID if applicable, and the location of the benchmark as longitude and latitude.

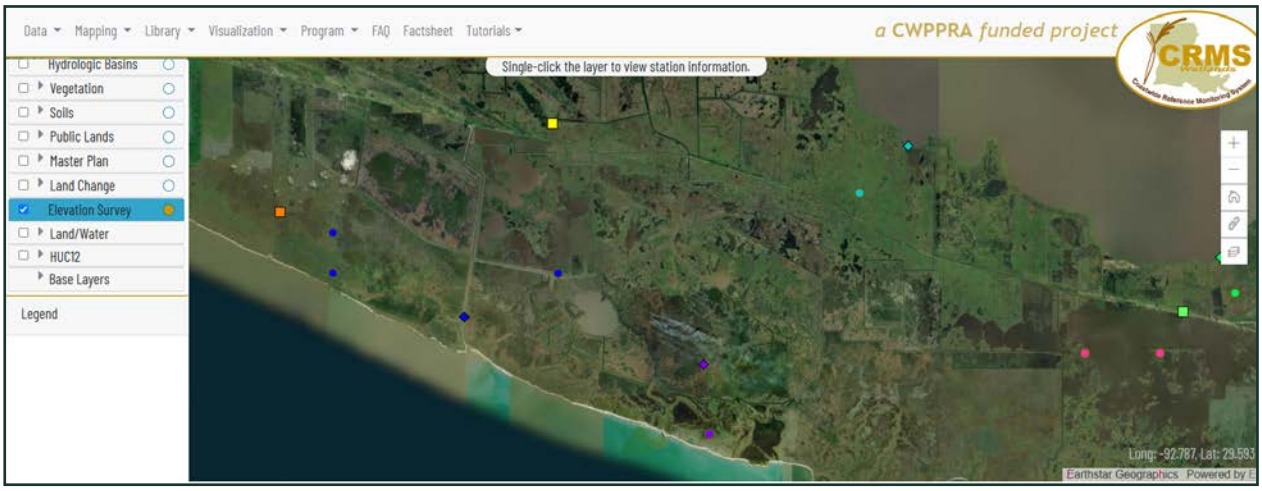


Figure 71. CRMS Map Viewer with the Elevation Survey layer active

3.5.8 Land/Water

The **Land/Water** layer provides historical information about the changing Louisiana coast (Figure 72). The light brown represents the land area, and the blue represents the water area. Click on the bar marked Land/Water, and a drop-down menu appears. Under **Coastwide**, click on the year, and the map refreshes. As a reminder, be

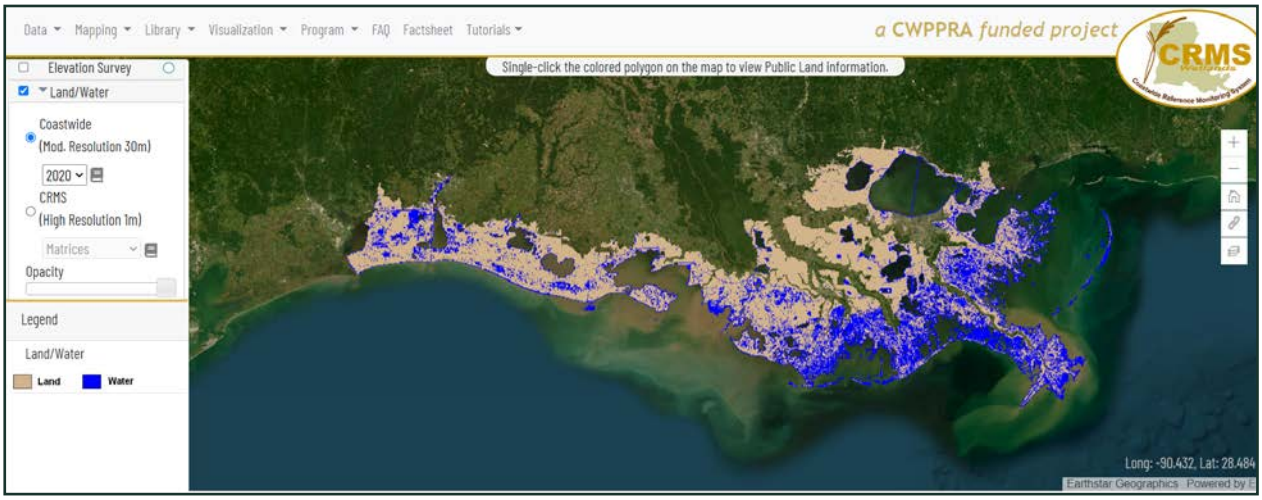


Figure 72. CRMS Map Viewer with Land/Water layer active and displaying the 2020 Coastwide layer

sure the box to the left is checked. Click on the book icon next to the Coastwide year to open a window with links to the data. The coastwide layers were created using satellite datasets. The process is described in each of the links provided.

The **CRMS Land/Water** layer can be viewed by clicking the button next to "CRMS (High Resolution 1m)" under Land/Water. There are several choices in the dropdown including Matrices (Figure 73), 2018 (1 km), 2015/2016 (1 km), 2012 (1 km), 2008 (1 km), and 2005 (1 km). The book icon next to the dropdown opens a window that contains links to the data and maps for each of the years. The CRMS Land/Water layer differs from the Coastwide layer in that the CRMS Land/Water information is determined from aerial photography at a resolution of 1m rather than from satellite imagery, which is at a resolution of 30 m. The land/water information is also available for each CRMS site on the CRMS layer (Land/Water subheading of the Spatial tab, Section 3.3.5).

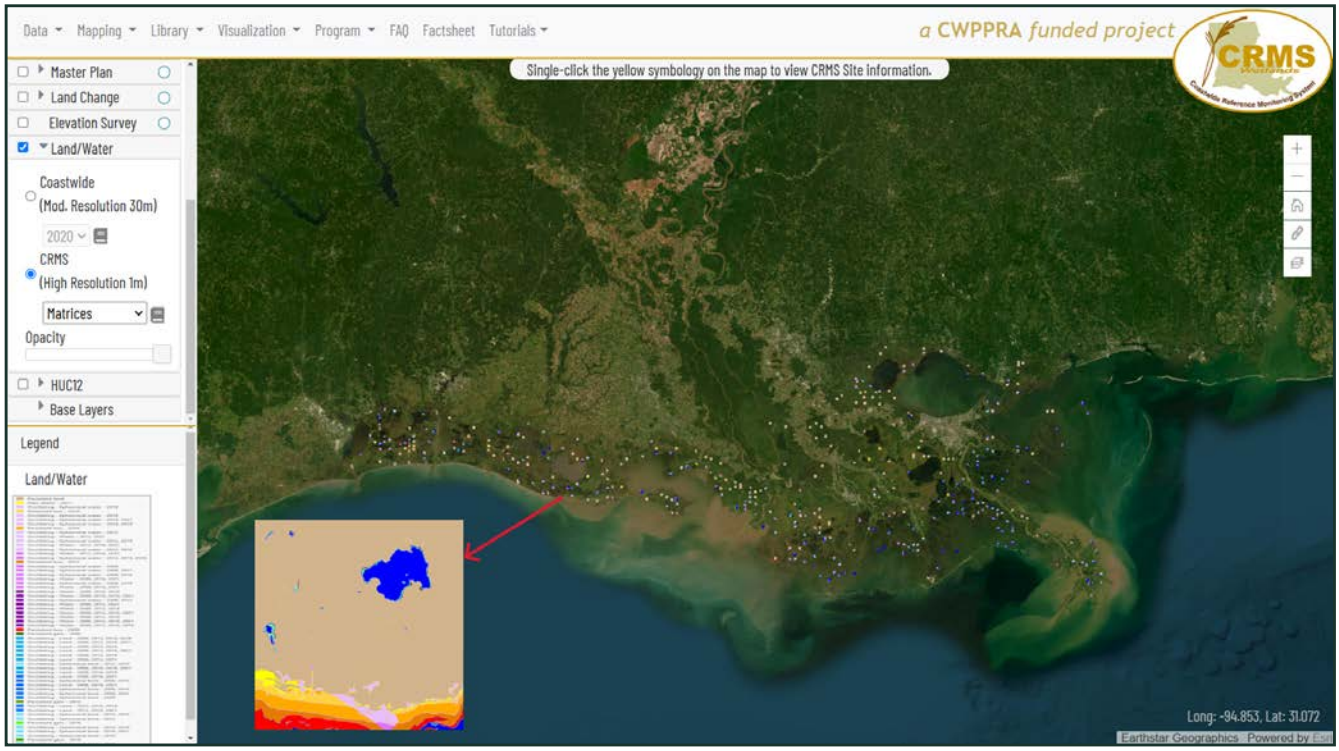


Figure 73. CRMS Map Viewer with Land/Water layer active and displaying the CRMS Matrices layer. Inset is the CRMS Matrices layer zoomed to an individual CRMS site, CRMS0600

3.5.9 HUC12 Layer

The **HUC12** layer displays the boundaries of hydrologic units, as defined by the Watershed Boundary Dataset (WBD) (Figure 74). There are 18 overall units encompassing the United States, with each unit split into progressively smaller units nested within the larger unit. Each unit is identified by a unique numerical code, ranging from 2-16 digits long. This layer displays the hydrologic boundaries down to the Hydrologic Unit Code 12 (HUC12) level for all of Louisiana. In the layer menu underneath the HUC12 title there is a book icon, which links to a document explaining this dataset in more detail.

Figure 74. CRMS Map Viewer with HUC12 layer active and displaying the boundaries of hydrologic units

3.5.10 Base Layer

The **Base Layer** allows users to choose the background map that will appear. Please note there are five general maps to choose from when creating a background map for the viewer, and only one layer can be displayed at a time. The layers include the following:

- **World Imagery**: This is an ESRI-created world imagery layer. For this layer there is a selection of sub-layers. They are identified as DOQQ (Digital Orthophoto Quarter Quad, digital aerial images produced by the USGS), the year, and the color ramp (NC for natural color, CIR for color infrared).
- **Terrain**
- **World Street**
- **World Topography**
- **World Grayscale**

4. Visualization

The **Visualization** menu at the top of the CRMS website homepage has 2 sub-menus: **Charting** and **Bulk Charting** (Figure 75). Both of these tools allow users to display graphs and compare information over time or between projects and/or areas

Figure 75. CRMS website homepage with Visualization menu expanded to show Charting and Bulk Charting links

4.1 Charting

When users click on the **Charting** tab, several data categories appear: Hydro, Vegetation, Soil, Spatial, and Report Card Charts. Clicking on any of the data categories expands it to display the available chart options. When hovering the cursor over any of the chart headings, an example thumbnail is displayed to the right. The charting interface works the same way for each parameter. Follow the example below to walk through the charting sequence (Figure 76).

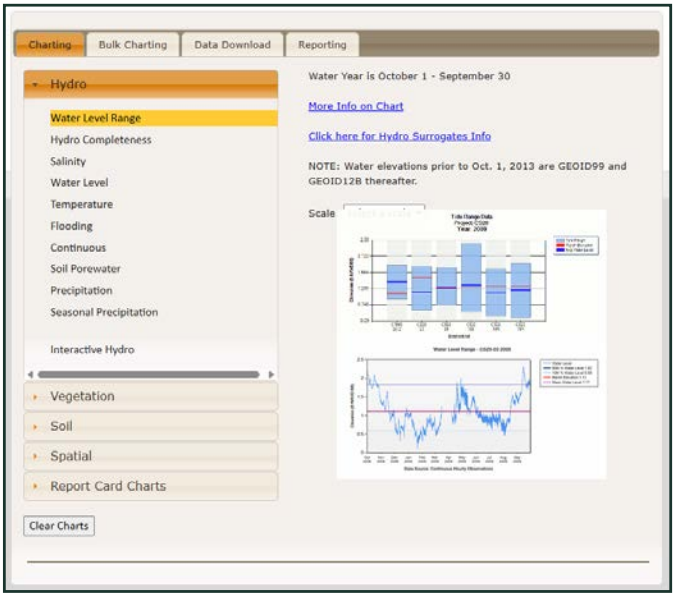


Figure 76. CRMS Charting page with Hydro menu expanded and example thumbnail displayed for Water Level Range

1. Click on Hydro. A drop-down menu will appear.
2. Choose Water Level Range by clicking on the label.
3. Scale: Select a Scale from the drop-down menu. The options are Stations and Multi-Station. Station will give users the choice of 1 particular station, and Multi-Station allows selections of up to 10 stations for comparison. For this example, select Station.

4. Select the dates of choice and click on Apply Date Filter.
5. A box will appear with a list of sites that have data for the selected variable and date range. Choose CRMS0523-H01 (*Note: Refer to Appendix 1 for more information on station naming conventions.*)
6. Click on Submit Request.
7. The graph will appear at the bottom of the page.
8. Single click on the graph to enlarge. As graphs are generated, they will appear at the bottom of the page. The chart gallery enables comparison of multiple charts for a CRMS site or charts for multiple CRMS sites simultaneously.
9. There are several options for displaying additional information on these charts: mean annual water level, mean growing season water level, and include major weather/storm events. Check any of these 3 boxes on the menu to add the relevant information to the selected chart.

4.2 Bulk Charting

Select the **Bulk Charting** tab to load the bulk charting interface. Bulk charting allows users to gather data on a variety of locations and have the data emailed directly to an active email address. Users can select a parameter (ex: marsh class or surface elevation), choose one or multiple CRMS sites, generate graphs with consistent color ramps, and receive the graphs via email. The email contains a .zip file with the user-defined charts and the data used to generate them.

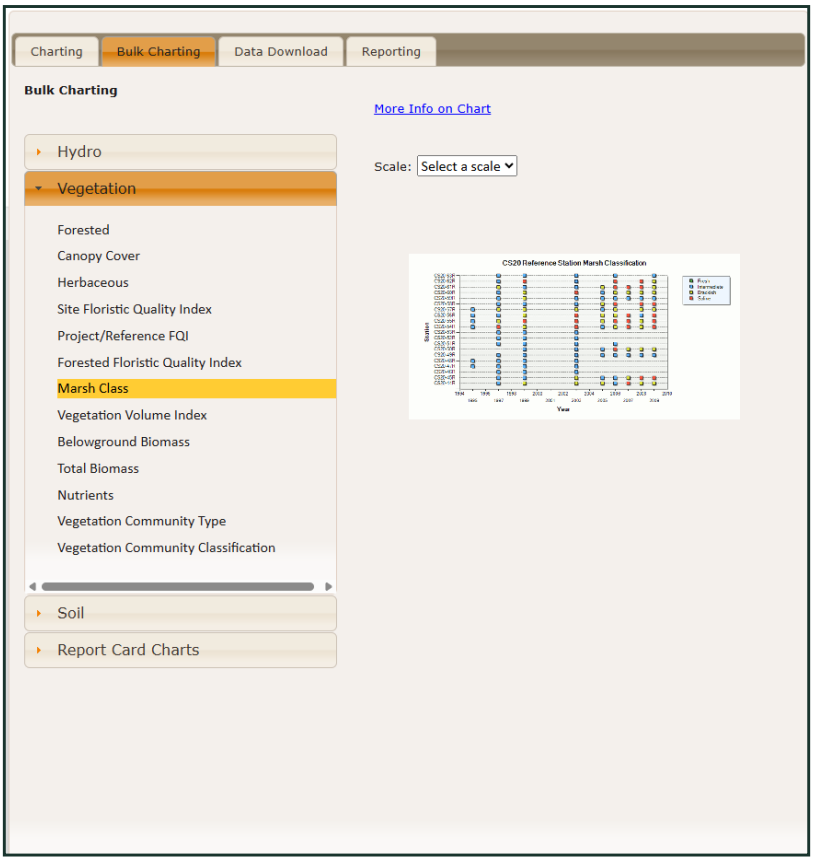


Figure 77. CRMS Bulk Charting page with Vegetation menu expanded and example thumbnail displayed for Marsh Class

Follow the example below to walk through the bulk charting sequence (Figure 77).

1. Choose Vegetation.
2. Choose Marsh Class.
3. Select Site from the Scale dropdown menu.
4. Select Mississippi River Delta from the Basin dropdown menu and All Projects in the Project dropdown menu.
5. Choose Select All under Options to load all the CRMS sites located on the Mississippi River Delta.
6. Type a valid email address in the white box at the bottom right.
7. If users enter an invalid email address, an error message will appear.
8. Choose Submit Request. The following message is displayed: "Chart request has been sent to server. An email will be sent when the charts have been created." It usually takes a few minutes to receive the email. The data will arrive as .zip files, which can be downloaded. *Note: Users may want to download in batches to avoid overloading their email server.*

4.3 Data Download

Click the **Data Download** tab to load the Data Download interface. The CRMS website allows users to download Hydro, Vegetation, Soil, and Spatial data. *Note: the data available through this website are calculated or derived values based on the original data, which are available from the CIMS database (https://cims.coastal.louisiana.gov/).* Follow the example below to practice using the Data Download tool (Figure 78).

1. Select Vegetation.
2. Choose Veg Percent Cover.
3. Select Species Percent Coverage from the Scale dropdown menu
4. Select 2012 to move that year into the selection box on the right.
5. Select Submit.
6. Pick CRMS0523.
7. Type an email address.
8. Select Submit Request. The data will arrive via email as a .zip file, which can be downloaded.

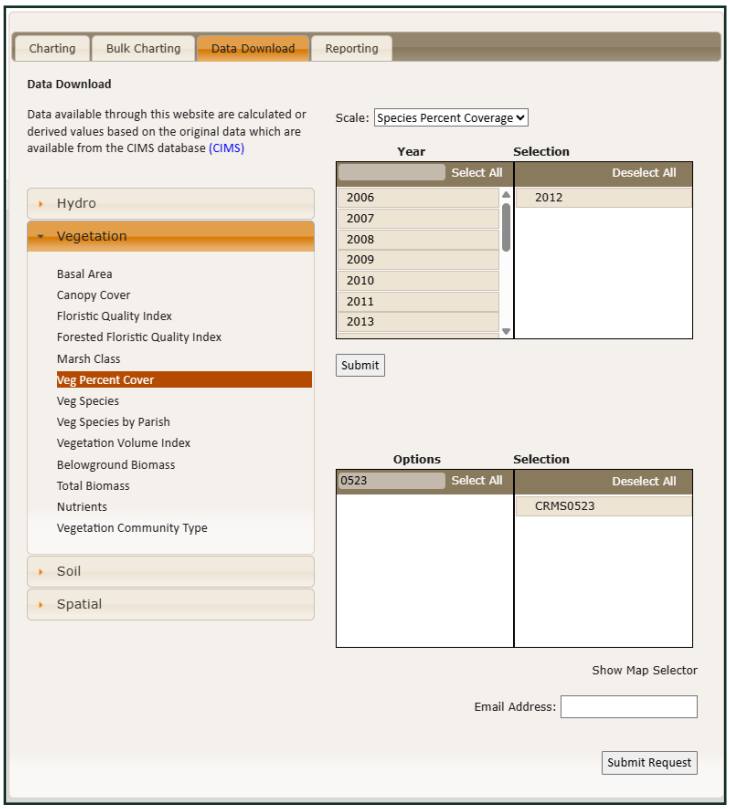


Figure 78. CRMS Data Download page with Vegetation menu expanded and options from example selected

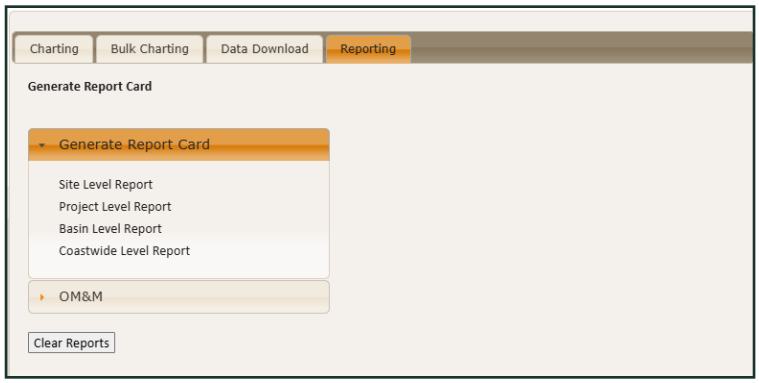


Figure 79. CRMS Reporting page with Generate Report Card menu expanded

4.4 Reporting

The final tab in the Visualization section of the CRMS website is **Reporting** (Figure 79). Reporting allows users to generate report cards for sites, projects, basins, or the entire Louisiana coast. Users can also view Operations, Maintenance, and Monitoring (OM&M) reports for individual CWPPRA coastal restoration projects.

To generate report cards:

1. Select Generate Report Card to choose from a list of report options.
2. Select a year from the dropdown menu that appears on the right.
3. Choose a report from the Selection menu and click Submit Request. The report card is generated at the time of the request so that it contains the most recent available data.
4. Once the report is generated, a link will appear in the lower left corner. Select the link to open the document.

To access OM&M reports for each of the CWPPRA coastal restoration projects:

1. Select OM&M report from the OM&M menu. Thate Number dropdown menu will appear.
2. Select a project number.

Note: CWPPRA project names that correspond to the state numbers can be found at https://www.LAcoast.gov/new/Projects/List.aspx.

5. Additional Tools on CRMS Website

There are several additional tools on the CRMS website that users can continue exploring which are not covered in this manual. The **Library** menu includes maps, presentations, and links to CPRA's CIMS document library search and the CRMS reporting tool. The **Program** menu contains contact information, details about the CRMS indices, and the **Administration** submenu. This submenu provides access to documents in support of CRMS, publications that have cited CRMS, and several administrative documents.

The CRMS program is as dynamic as the coastal habitats it monitors. The program continues to develop new products and assessment tools while providing data for model improvement and scientific research. The CRMS website is the current dissemination mechanism for all activities related to the CRMS program. The value of the CRMS website is that it gathers information from a suite of monitoring sites that encompass a range of ecological conditions and is designed to be a comprehensive resource for CRMS information, products, and data.

The ecological data available through the website are linked to the official Louisiana Coastal Protection and Restoration Authority (CPRA) Coastal Information Management System (CIMS) database, publicly available at https://cims.coastal.louisiana.gov/. CIMS houses all CWPPRA monitoring data, including hydrology, herbaceous marsh vegetation, forested swamp vegetation, soil properties, soil accretion, and surface elevation.

Data provided by the Louisiana CPRA are also available for downloading at https://coastal.la.gov. Select Resources > Library in the banner along the top of the website to access the available information about diversion operations, CIMS, CRMS, public records, document search, and more.

6. Additional CWPPRA Project Monitoring

To learn more about CWPPRA projects and project specific monitoring, additional information is available at https://www.LAcoast.gov (Figure 80).

Figure 80. The Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) home page

To explore CWPPRA Project factsheets and reports, click the **Projects** button (Figure 81) or find a location on the map.

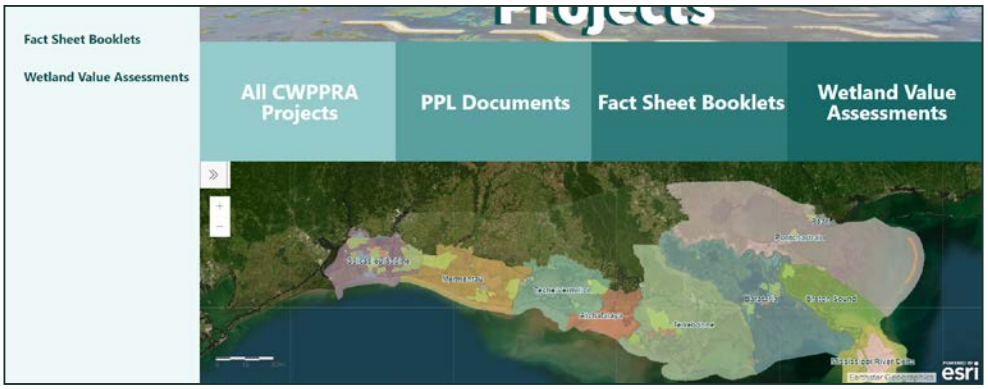


Figure 81. The CWPPRA Projects landing page

Try this:

1. Zoom into the Barataria Basin in the southeast corner of the map using the +/- buttons.
2. Click on the green polygons and locate "Jonathan Davis Wetland Restoration". General project information displays in the window, and additional resources can be found by selecting the More info link at the bottom.
3. Alternatively, click on "All CWPPRA Projects" in the center of the screen and use the filters to find "BA-20" from PPL 2 in the Barataria basin (Figure 82).
4. Click on the link in the Project Name column, and a list of fact sheets, reports, and maps will become available (Figure 83).
5. Click on the title of the report, and a .pdf will open with the information.

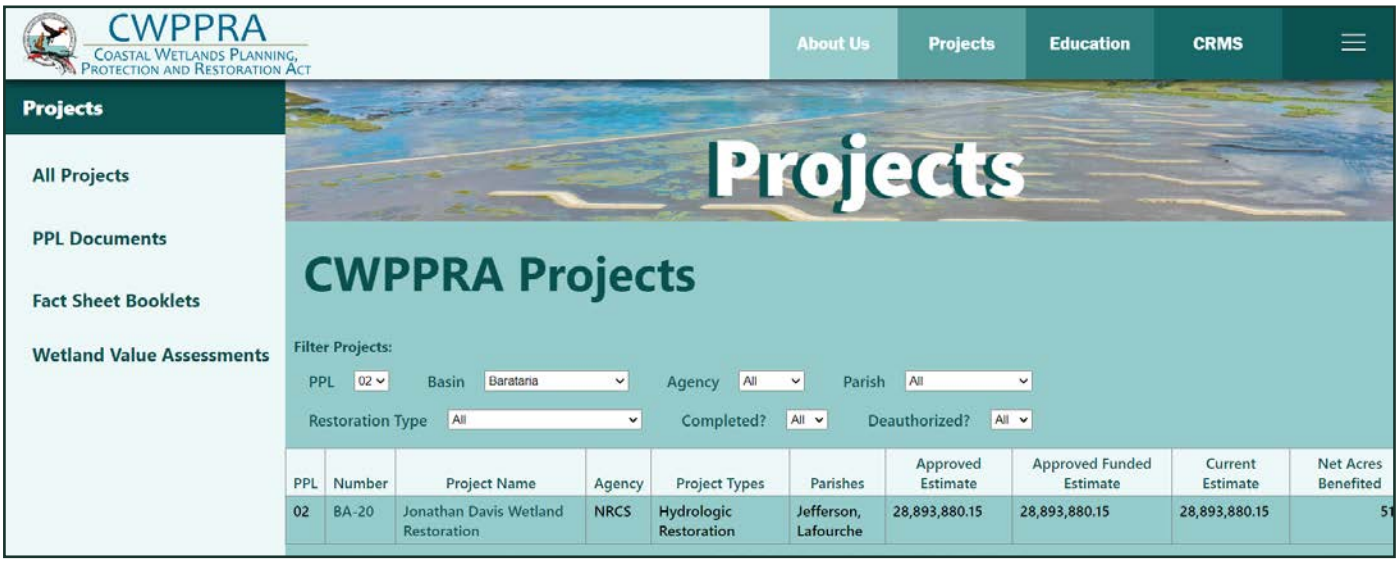


Figure 82. Use of the filter feature on the CWPPRA Projects list page

Figure 83. Example of the CWPPRA Project Info page for Jonathan Davis Wetland Restoration (BA-20)

7. Appendix: CRMS Data Collection Information and Schedule

- For the standard operating procedures: https://cims.coastal.louisiana.gov/RecordDetail.aspx?Root=0&sid=24216
- Download data from CIMS: https://cims.coastal.louisiana.gov/
- CRMS website: https://www.LAcoast.gov/CRMS/

Site information:

- **Hydrographic, Station number (H01)**: Continuous hourly salinity, temperature, and water level data at most sites the data logger is in an open water body or bayou.
- **Station number (W01)**: Continuous hourly salinity, temperature, and water level but the data logger is in a well in the marsh instead of an open water body.
- **Station number (M01)**: Marsh mat stations are established in floating marshes where the marsh mat rises and falls with water level.
- **CRMS sites with real-time hydrologic gages**: CRMS0061, 0282, 0411, 0465, 0568, 0609, 0615, 0651, 2418, 5373. Real-time data available at https://waterdata.usgs.gov/la/nwis/current/?type=flow under the Coastwide Reference Monitoring (CRMS) header near the bottom.
- **Soil Porewater, Station number (P01, P02, P03)**: Discrete collections of porewater salinity and temperature intermittently during the year while continuous hydrographic data are downloaded. Also collected at each vegetation station during herbaceous vegetation sampling in the late summer/early fall.
- **Herbaceous Vegetation, Station number (V01, V02, etc.)**: Species composition, percent cover, and dominant height once annually (late summer/early fall) at 10 stations per CRMS site.
- **Vertical Accretion, Station number (A01, A02, etc.)**: Collected by cryo-coring annually in the spring.
- **Surface Elevation, Station number (E01)**: Collected by rod-surface elevation tables annually in the spring.
- **Swamp Forest, Station number (F01)**:
  - Forested vegetation (every 3 years): species composition and diameter at breast height (DBH) for woody shrubs and trees > 5 cm DBH (late summer/early fall).
  - Canopy cover (annually): canopy cover estimated with densiometer (late summer/early fall).
  - Herbaceous vegetation (annually in the late summer/early fall): same as for herbaceous vegetation as described above.
- **Soil Properties, Station number (S01, S02, etc.)**: Soil properties (pH, salinity, bulk density, soil moisture, percent organic matter, wet/dry volume) are collected upon site establishment, every 10 years in marshes, and every 6 years in swamps.
- **Imagery**: Coastwide satellite imagery is collected annually using Landsat Thematic Mapper (TM) multi-spectral imagery. Aerial photography is collected every 3 to 5 years.

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8. Acknowledgments

We would like to offer our sincere gratitude to the many individuals and members of the CWPPRA community that have made this monitoring program and publication possible. Thank you to the CWPPRA community for their ongoing support of the Coastwide Reference Monitoring System. This unique project offers a detailed look at the data that is currently being collected, recorded, and shared in relation to the Louisiana wetlands.

Special thanks to:

- The CWPPRA Task Force for their foresight in creating a coastwide system to monitor Louisiana's vast coastal wetland habitats.
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- The CWPPRA Monitoring Work Group for their ability to take the project from idea to reality.
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- The CWPPRA Public Outreach Committee for their interest in creating a document that will help the public better access the information. Additional thanks to past and present members of the CWPPRA Public Outreach Committee staff: Cole Ruckstuhl, Josh Coen, Kathy Ladner, Kacie Wright, Lauren Leonpacher, and Kelly Rick. The team has provided repeated review of the materials to ensure that beginners can use this document.

9. Suggested Citations

Data Citation

All CRMS data is publicly available for use by all, for research and educational purposes. Below is the suggested citation for use of this data:

Coastal Restoration and Protection Authority (CPRA) of Louisiana. *YYYY*. Coastwide Reference Monitoring System-Wetlands Monitoring Data. Retrieved from the Coastal Information Management System (CIMS) database. http://cims.coastal.louisiana.gov. Accessed *DD MONTH YYYY*.

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