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WATER MARKS

Louisiana Coastal Wetlands Planning, Protection and Restoration News

May 2013 Number 47

High Tech in the Marsh...

It's More than Mud and Sand

May 2013
Number 47

WaterMarks is published two times a year by the Louisiana Coastal Wetlands Conservation and Restoration Task Force to communicate news and issues of interest related to the Coastal Wetlands Planning, Protection and Restoration Act of 1990. This legislation funds wetlands restoration and enhancement projects nationwide, designating nearly $80 million annually for work in Louisiana. The state contributes 15 percent of total project costs.

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ABOUT THIS ISSUE'S COVER . . .

Bundled against the chill wind of early spring, a monitoring team sets out in an air boat to a data collection site deep within the marsh. The suite of ecological variables recorded at such sites provides a baseline of conditions and a record of changes used to develop strategies for restoring and preserving Louisiana's wetlands.

Photo: Andy Boudreaux
Coastal Estuary Services

Right: A simple boardwalk to a monitoring site belies the sophistication of the instruments at its end.

NRCS

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For more information about Louisiana's coastal wetlands and the efforts planned and under way to ensure their survival, check out these sites on the World Wide Web:

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Monitoring to collect the facts

Vital Data Guide Restoration Strategies

The patient lies on the examination table. *Doctor, my health is failing. I'm losing body mass and my vital signs are waning.*

Doctor: *How much weight have you lost, and how quickly? Are you malnourished? Do you sense arterial blockages?*

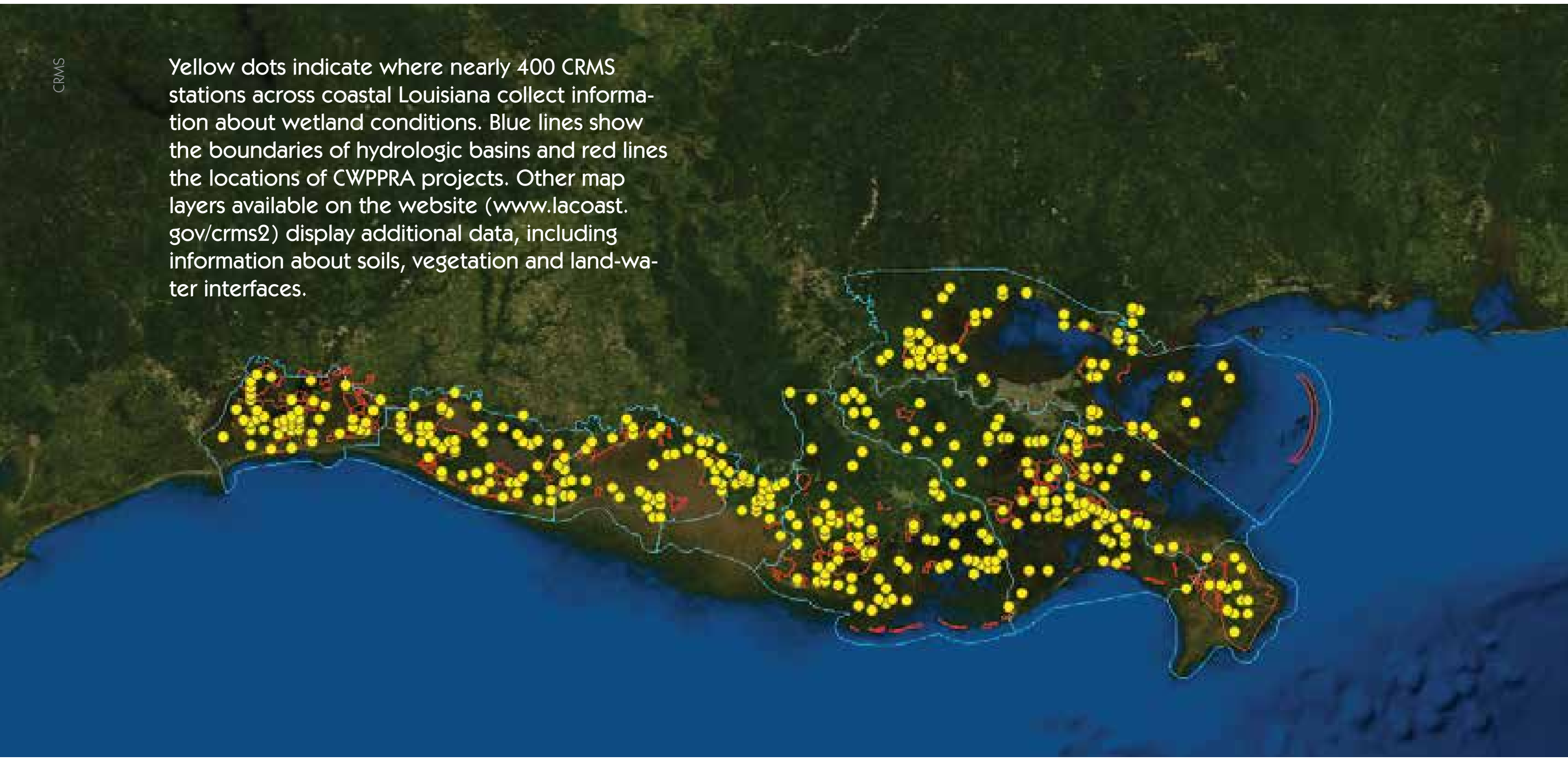
Patient: *I really can't say, doctor. I only know I don't feel like I used to …*

Doctor: *To treat your condition, we need tests! We need records! We need baseline information!*

Assessing the coastal physique

The patient's body is old, vast and complex. She stretches over nearly 7,000 square miles, harbors numerous communities of flora and fauna, and suffers erosion and wear from eons of weather. To improve strategies for restoring her to functional health, teams set out to measure and probe Louisiana, analyze her chemistry and catalog observations of change.

An early leader in coastal restoration, the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) has, from its beginning, monitored the health of Louisiana's landscape. Initially information was collected through aerial photography, on-the-ground assessments and comparisons of project to reference sites. But to improve methods of rebuilding Louisiana's resistance to erosion, reducing conversion of her marshes to open water, and saving her from the fatal complications of starvation and sinking, more comprehensive data were soon needed. In 2003, CWPPRA established the Coastwide Reference Monitoring System (CRMS). Today, 390 CRMS sites, spread throughout coast-



CRMS

Yellow dots indicate where nearly 400 CRMS stations across coastal Louisiana collect information about wetland conditions. Blue lines show the boundaries of hydrologic basins and red lines the locations of CWPPRA projects. Other map layers available on the website (www.lacoast.gov/crms2) display additional data, including information about soils, vegetation and land-water interfaces.


Andy Boudreaux, Coastal Estuary Services

While instruments can collect and send some data remotely, other measures must be taken by scientists going out into the field as the "eyes and ears" of the marsh. Lane Babin took a job checking CRMS sites as a new college graduate seven years ago. "I came straight from the books," he says. "I wanted to do my part."

al Louisiana, broaden the reach, increase the frequency and expand the detail of wetland data.

Capturing the wetlands' vital signs

Lane Babin is one of about 60 scientists employed to collect data from CRMS sites. Once a month for the past seven years, he has visited the 80 or so sites assigned to him.

"We go out in crews of two or three," Babin says, "to be eyes and ears in the marsh. Each trip, at each site, we download hourly data; collect pore water samples; and inspect, clean and redeploy the instruments. Each summer, we survey the vegetation and identify all species within a designated area of every site, and twice a year we measure accretion and change in surface elevation. Less frequently we take soil core samples to determine soil bulk density, percentage of organic matter and moisture content. It's a real hands-on job."

Several CRMS sites transmit hydrologic data in real time via satellites. These data are displayed on the internet within minutes, but data from most sites are collected by agents like Babin. Monitored conditions include

- water levels
- salinity
- sedimentation
- surface elevation change
- composition and abundance of vegetation
- ratio of land to water
- soil profiles

Agents send their reports to the state of Louisiana's CWPPRA partner, the Coastal Protection and Restoration Authority (CPRA.) The information is analyzed and summarized in maps, charts, graphs and indices, and incorporated into interactive report cards available on line. The report cards are used to track ecological conditions and illustrate the influence of restoration. "CRMS report cards are not typical because they summarize wetland data at multiple scales," says Greg Steyer, the coastal restoration assessment branch chief at the U.S. Geological Survey (USGS) National Wetlands Research Center. "You can look at individual CRMS sites to understand small-scale processes, or expand your data selection to evaluate how specific restoration approaches work at a project level. The basin and coastwide scales show the larger, cumulative ecological effects of restoration, and whether or not the restoration efforts are contributing to reduced land-loss rates."

Converting data into action

From identifying areas in need of restoration through evaluating a project's long-term effects on the landscape, the CRMS program contributes to successful coastal restoration in numerous ways.

Developing projects: "Anyone concerned about changes in a wetland can research the area on the CRMS web site to find out what has actually happened," says Dona Weifenbach, manager of CRMS for CPRA. "You could learn, for instance, how the land-to-water ratio has changed, or how vegetation has shifted from freshwater to brackish species. Your concern might lead you to propose a CWPPRA project, using information from CRMS to support your case."

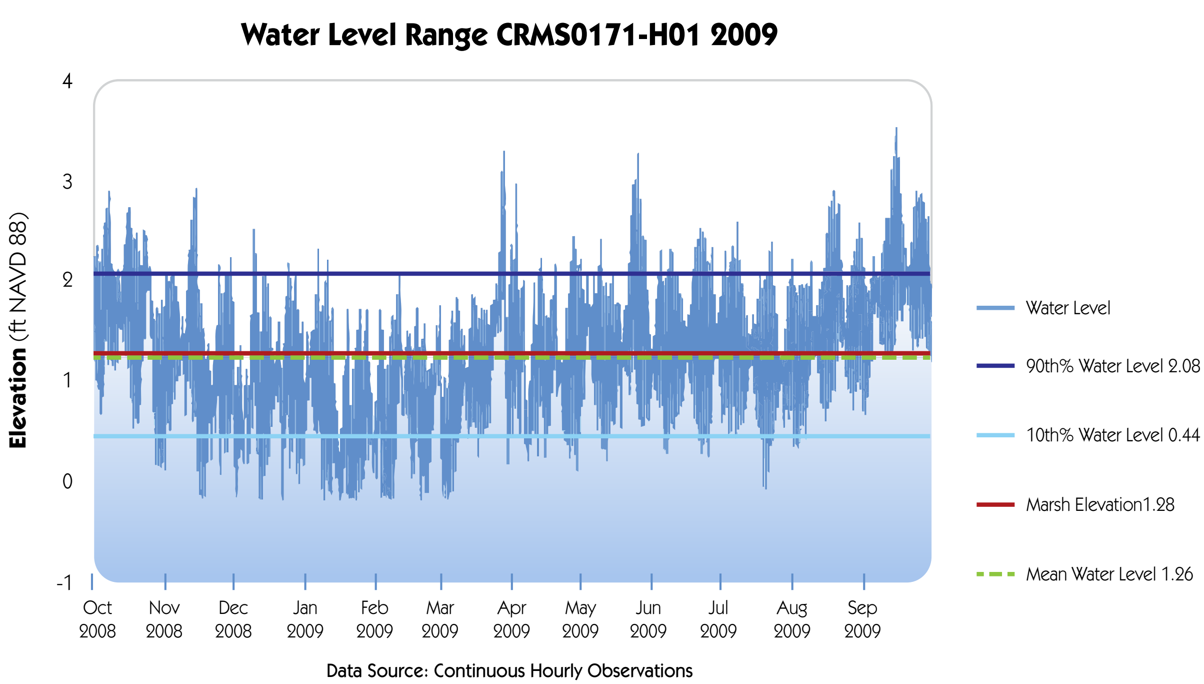
Once an idea is accepted as a candidate, the sponsoring agency may use CRMS data to model the project's anticipated results and develop its design. For example, data indicating how salinity fluctuates in an adjacent water body could warrant the inclusion of water control structures.

Adapting management: Because every project comprises a unique combination of environmental conditions and restoration techniques, it may not immediately achieve its goals. Monitoring provides the information needed to make changes through adaptive management.

"For example, hydrologic data at the East Mud Lake CWPPRA project revealed that the marsh water levels were higher than the target levels designated for the project," says Weifenbach. "This information led operators to adjust the amount of water released through control structures and reach project goals."

Assessing performance: "The primary purpose of CRMS is to support monitoring and evaluation of CWPPRA projects," says Sarai Piazza, USGS program manager for CRMS. "The CRMS network encompasses a range of site conditions, from healthy to degraded. Standardized data collection lets us compare project and reference sites to determine CWPPRA's success."

"Now that we have collected data over a number of years, we can start to detect patterns and understand the influence of restoration on the landscape," says Steyer. "This allows us to evaluate how well our investment in restoration is doing."



Translating numbers into graphs and charts makes statistical information quick to understand. Here the year-long observations of water levels at one CRMS site are charted against the site's mean water level, its extreme high and low water levels and its marsh elevation.

Andy Boudreaux, Coastal Estuary Services

Monitors working in the field observe and record a broad range of wetland conditions. Making the information collected through the CRMS program readily available advances the work of scientists, researchers, citizens and numerous other parties that use the extensive, long-term data to further knowledge of coastal ecology, design wetland protection and restoration projects, guide land-use and development planning and forecast likely future changes.

Years of collecting CRMS data make available a baseline of wetland conditions that is fundamentally important when assessing projects following natural disasters. "After a storm, teams go out to check on CRMS' sites and equipment as well as on ecological conditions in the area," says Weifenbach. "If there is damage, we want to attribute it properly to the disaster. And if we see that project sites are surviving better than surrounding areas, we may want to use that construction technique in the vicinity again."

CRMS' value beyond project boundaries

Although CRMS, a CWPPRA project, focuses on the Louisiana coast, people interested in wetland environments and ecosystem restoration rely on its data for a variety of purposes.

Computer modeling illustrates how complex factors in a dynamic ecosystem interact. In developing plans for coastwide hurricane protection and restoration, the state of Louisiana modeled various possibilities of future conditions such as land change, morphology, vegetative composition, fish habitat and storm-surge vulnerability. "Modeling is only as good as the data it employs," says Piazza. "Because of the breadth of the CRMS program, scientists use it to create and validate their models."

For scientists and researchers in academia, the value of CRMS is not confined to modeling. Andrew Tweel, a PhD. candidate in oceanography and coastal sciences at Louisiana State University, included CRMS data in answering specific questions about how the coast has changed historically and what needs to be done to restore it in the future. "I used the data to measure differences in soil accretion and compare variations in soil composition across the coast," Tweel says. "Soils in highly saline marshes appear to be more sensitive to canal dredging than those in fresher marshes. This knowledge could help shape restoration project development and ensure the most efficient use of resources."

While Louisiana's wetlands may hold a family resemblance to other deltas on the planet and share life experiences of accretion, erosion, development and decline, the data CRMS collects are quite specific to the monitored sites. Nonetheless, the program has universal application. "The questions that CRMS answers are relevant to wetland systems all over the world," says Piazza. "Louisiana's subsiding environment is a proxy for other coastal ecosystems that will be facing climate change and sea-level rise in the future. CRMS data can inform restoration efforts in other wetland systems around the country and across the globe." WM

Future plans build on CWPPRA's experience

Water's Restorative Power Heals the Wetlands

Too much water, too little, too salty, too stagnant, too swift – characteristics of water profoundly influence wetland health and resiliency. Inevitably, coastal restoration projects deal with the balance between land and water. Over the years, CWPPRA has constructed various kinds of hydrologic restoration projects to mimic or restore the natural hydrology and land-building processes that have sustained Louisiana's wetlands for eons.

Siphons and crevasses

Historically, the Mississippi River nourished Louisiana's wetlands by sending sediment-laden floodwaters into the marshes. Levees built to protect human lives and development now keep the river within its banks, resulting in marshes deprived of life-sustaining sediment and nutrients. To restore a measure of the benefits of floods, siphons and crevasses control a limited ingress of river water into the marshes.

A siphon is a pipe inserted into the river below the water's surface and extended over or under any obstruction – levees, roads, railroad tracks – to discharge water into a marsh. Either artificial or natural, a crevasse is a gap cut into the bank of a river distributary. A portion of the river's water flows through the gap, carrying sediment and nutrients into marshes or open water. The actual flow into the receiving area varies depending upon the volume of the river flow and the depth of the gap.

Tom Bernard

Cutting a gap through the riverbank, crevasses allow water to flow into adjacent marshy areas. Crevasses are one of several techniques used in coastal restoration to return sediment and nutrients, benefits historically delivered by floodwaters, to nearby wetlands.

John Foret, NMFS

A unique, self-regulating tide gate was designed for the Black Bayou Hydrologic Restoration project. The structure operates as a fixed crest weir until water levels reach a certain height, at which point floats close the gate. One of the strengths of the CWPPRA program is its capacity to advance the field of coastal restoration by testing innovative ideas and techniques.

CWPPRA has conducted several siphon and crevasse projects. One, the Delta-Wide Crevasses project (MR-09), maintained existing crevasses and constructed new ones to freshen marshes and enhance deposition of land-building sediment into adjacent shallow bays.

Water control devices and hydrologic modifications

Reducing saltwater intrusion, returning drainage patterns to an impounded area and restoring historic tidal exchange – these are all reasons to consider the use of water control structures. Numerous CWPPRA projects combine such devices with other kinds of restoration techniques.

The Black Bayou Hydrologic Restoration project (CS-27) installed weirs, culverts and gates to control water flow; built rock dikes to protect shorelines along the Gulf Intracoastal Waterway and planted vegetation in the marsh to help secure the soil. "We wanted to reduce salinity spikes to encourage the growth of vegetation that increases the accretion of land," says John Foret, NOAA Fisheries project manager. "Salinity spikes and the inundation and drowning of wetland plants in the interior project area declined sharply after construction. However, results were not instant. It takes years for such a large ecological system to recalibrate and for the plant community to respond."

Aerial photographs taken over time show success. Since constructed in 2002, the project area has gained approximately 60 acres a year, while an adjacent reference area continues to lose about five acres a year.

"The results of hydrologic projects often accumulate slowly," says Troy Mallach, a wildlife biologist at the Natural Resources Conservation Service. "We have 15 or 20 years of data now to see how well these projects can reverse trends of land-to-water conversion. If we don't deal with hydrologic problems, other restoration techniques, such as marsh creation, can be undermined."

Foret emphasizes that there is no single silver bullet. "We owe it to the coast to keep many techniques in the restoration tool box. To succeed, we need to use everything in combination."

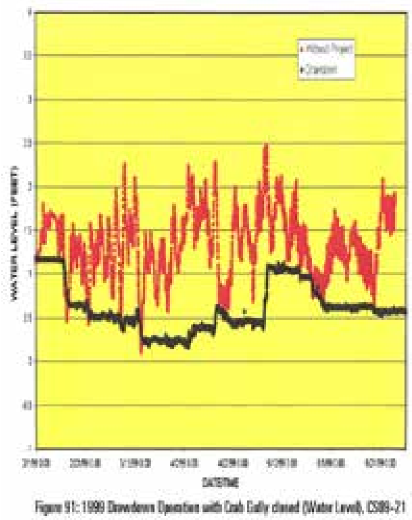
Freshwater and sediment delivery via river diversions

Many environmental scientists and engineers believe that allowing the Mississippi River to flow freely once again would counter the sediment starvation and subsidence that is occurring in the Delta. However, the levees that constrain the river within its banks protect human life and prevent billions of dollars of flood damages. As long as humans can assert their will over the river, the Mississippi is unlikely to flow freely again.

River diversions are designed to tap the restorative benefits of the Mississippi without yielding control of it to natural forces. Freshwater diversions take water with little sediment from the upper levels of the river and discharge it into marshes to counter saltwater intrusion. Sediment diversions reach more deeply into the river to capture water rich in particles of land-building material and convey it into adjacent marshes and open-water areas.

How essential sediment diversions are as a tool for restoring the coast is as yet uncertain. Some observers claim that in 2011, a year of record-high river flows, the West Bay Sediment Diversion project (MR-03) caused between 10 and 25 acres of new land to accrete in its discharge area. Other data indicate the land was built mostly from dredged material and that the high nutrient content of river water can damage marsh vegetation. What is clear is that more time and continued monitoring are needed to determine the true and long-term effects of diversions on land accretion and wetland health.

It is indisputable, however, that diversions can slow the river's velocity and increase natural shoaling, the accumulation of sediment falling out of the water column. The West Bay project anticipated shoaling in a nearby navigation anchorage area and allocated funds for maintenance dredging. But as costs for dredging escalated, CWPPRA found the expense untenable and, in 2010, decided to close the diversion. Then new modeling demonstrated that natural processes, not the diversion, were causing most of the shoaling. With advocates eager to see the diversion's potential benefits continue,



C.H. Fenstermaker & Associates, Inc.

A graph quickly illustrates the difference a project can make. Here, two lines compare how closing ingress of water into Brown Lake might affect water levels during a drawdown operation. The validity of a modeling program is tested by using it to simulate past conditions and comparing the results to actual field observations during the selected period of time.

CWPPRA agreed to keep West Bay open and fund one more cycle of dredging, thus fulfilling its obligation to remove a certain volume of sediment during the project's 20-year lifetime. Meanwhile, state and federal agencies are working with the shipping industry to assume responsibility for keeping the anchorage clear.

John Foret, NMFS

Decidedly low-tech, rock nonetheless does its job in closing gaps in shorelines, breaking wave energy and slowing erosion. Although the material is elemental, determining where to place it and how much of its weight the supporting soil can bear is a feat of engineering wizardry.

Coastal restoration builds on CWPPRA's experience

Beyond acres created and vegetation restored, CWPPRA projects are significant for their contributions to the field of coastal restoration. "We have history to use," says Mallach.

Some lessons derive directly from experience: Hydraulic dredges produce more immediate benefits to marsh creation than do bucket dredges; electrical equipment may become inoperable during hurricanes and needs to be mounted well above the level of anticipated storm surge; an alligator will cross a bank at its narrowest point, leading to breaches as water follows its trail.

Some projects provide data indicating the procedures and technology that best achieve project goals under specified ecological conditions. Mallach recommended structures and techniques used at the East Mud Lake (CS-20) project to reduce inundation and increase emergent marsh at Brown Lake. "Marsh drawdowns are sometimes controversial," Mallach says, "but Mud Lake shows how, when properly conducted, de-watering or partially draining a water body can stimulate growth of marsh vegetation."

Limited funding restricts the scope of CWPPRA projects, but even small ones can serve as models for larger efforts. For instance, Mallach knew the success of the Highway 384 Hydrologic Restoration project (CS-21) in moving fresh water from the Gulf Intracoastal Waterway through wetlands and into Calcasieu Lake. "The project has increased emergent marsh and encouraged more diverse plant life," says Mallach. "Those are changes that we want to introduce in a much larger area, so we are designing the Cameron-Creole Freshwater Introduction project (CS-49) based on the results of the smaller project, Highway 384."

Designed to enhance thousands of acres marsh and build land, the West Bay Sediment Diversion project's most notable contribution may be as a testing ground for this restoration technique. River diversions have become a central component of the 2012 Louisiana Coastal Master Plan. "The opportunity to study a working sediment diversion is valuable to researchers who have few other options for studying this restoration method in the field," says Scott Madere, director of communications at the non-profit organization Coalition to Restore Coastal Louisiana. "If West Bay continues its recent track record of success, it will also help proponents of diversions convince policy makers, and the public, of the worthiness of diversions within Louisiana's coastal restoration strategy." WM

SIMULATING NATURAL-WORLD POSSIBILITIES

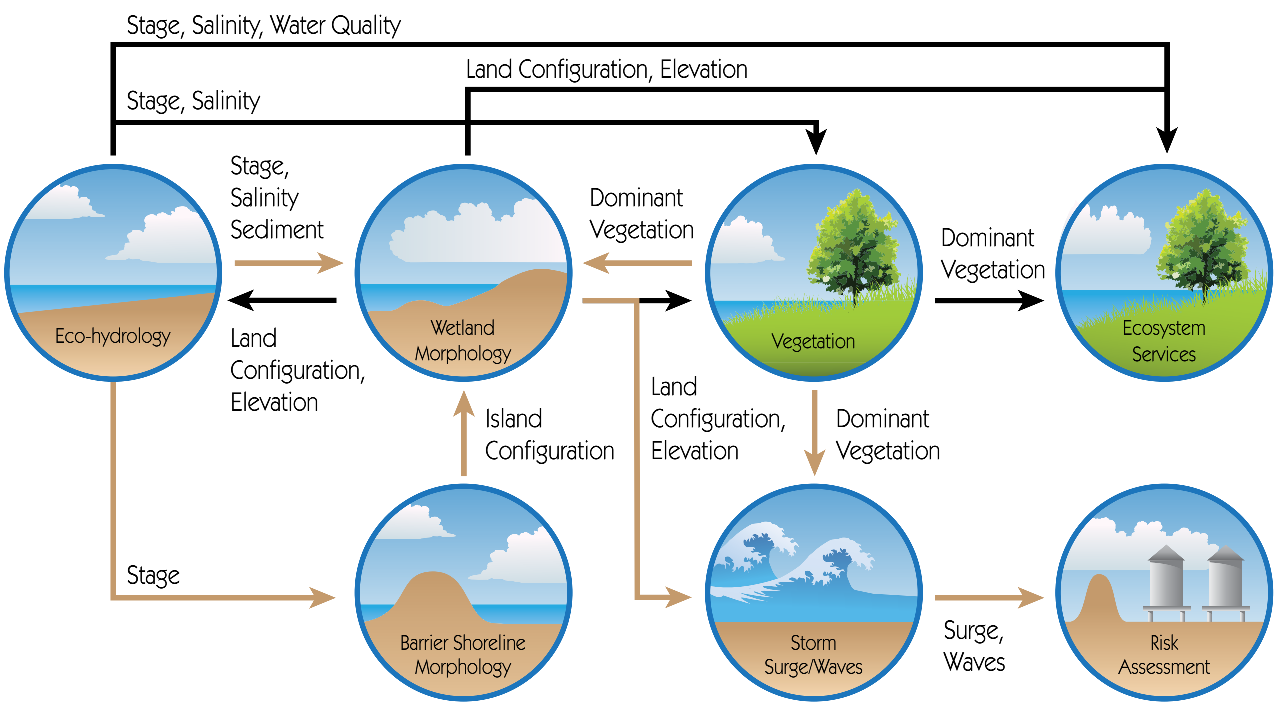
Computer Modeling Explores "What if? . . ."

The uninitiated may think of computer modelers as modern-day alchemists amalgamating numbers, observations and assumptions; adding a dash of magic and chanting a spell of formulas to conjure a picture of the future. To the untrained, converting field data and records of ecosystem performance into numerical relationships is a mystifying process, and predicting the behavior of a large and complex environment over long spans of time the province of prophets and seers.

In actuality, ecosystem modeling is pragmatic and concrete. By combining scientific knowledge about natural processes with empirical observations of a chosen environment, modeling is able to assess an ecosystem's current status and suggest its future conditions. Types of models used to assist designing coastal protection and restoration in Louisiana include

- *hydrologic,* pertaining to the movement and chemistry of water
- *morphologic,* describing the coastal landscape, land-water ratios, elevations and rates of subsidence
- *vegetative,* assessing the coverage, productivity, community composition and health of marsh flora
- *upper trophic level,* evaluating fish, bird and wildlife populations and their coastal habitats
- *risk assessment,* modeling storm surge and wave dynamics and calculating consequent risks of storm damage and interior flooding

Modeling in a Systems Context



Although examining components of the coastal ecosystem separately increases the feasibility of modeling, all modules relate to one another. For instance, information about the kind and quality of vegetative cover is incorporated into predictions of marsh collapse, calculations of storm-surge reduction, and descriptions of change in the upper trophic level. *Graph drawn from Figure 1, Appendix D-1 Eco-hydrology Model Technical Report, Louisiana's Master Plan for a Sustainable Coast*

Tami Collins, Koupal Communications, Inc.

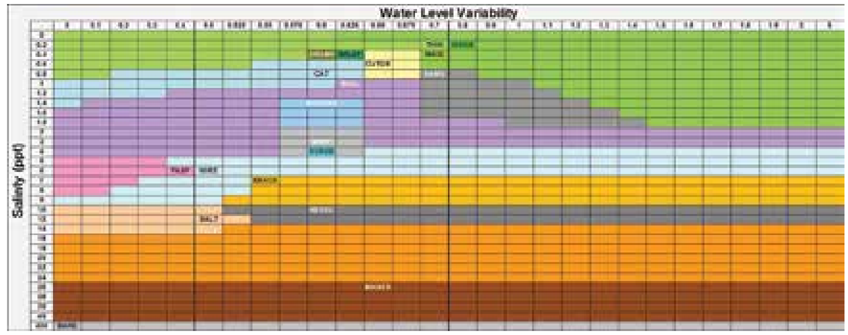
Each type of modeling selects a suite of indicators upon which to base its computations. For example, a model to determine the preferred kind and location of a water control structure would need to simulate hydrologic conditions in the project area. Required data might describe

- channel size, depth and underwater topography
- water levels; velocity; flow direction, pattern and discharge; temperature and salinity
- elevations
- storage capacity of adjacent flood plains
- wind velocity and direction

To predict how building a weir, say, would reduce the rate of saltwater intrusion, this site-specific information might be combined with mathematical formulas expressing known phenomena, such as

- an equation that determines how much water velocity is lost to friction in a channel of a certain size and slope
- a calculation of the rate of flow at various water levels over a weir of a certain shape and elevation
- the reckoning of the volume of floodwater storage in a neighboring marsh

Although models cannot simulate ecosystems with complete fidelity, they are valuable to scientists and engineers evaluating probable results of restoration projects. "Natural processes such as subsidence, sea-level rise and river flows will inevitably change the coast," says Jenneke Visser, an associate professor at the University of Louisiana, Lafayette. "Modeling shows us what those changes are likely to be and how interventions could influence conditions such as the ratio of land to water, the composition of vegetation communities and the landscape's vulnerability to storm surge."



J. Visser and W. Broussard

The predominant water and salinity levels in a marsh determine the species of flora that grow there. Plotting plants that can tolerate various combinations of these two conditions quickly indicates how projected changes in a marsh will influence the make-up and character of vegetative communities and alter wetland habitats.

CWPPRA models reduce guesswork in design

For years, the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) has used models in developing various kinds of restoration projects. "Louisiana's coastal environment is incredibly dynamic, variable and complex," says Greg Steyer, an ecologist and branch chief at the USGS National Wetlands Research Center. "A model represents our best understanding of how a system will behave and shows us what future changes and outcomes are possible. It can simulate ecological processes on large spatial scales and over long periods of time. Modeling is a tool that helps us understand the forces of change and derive effective solutions for reducing wetland deterioration and loss."

CWPPRA has employed various kinds of models in designing its projects. "The Penchant Basin Natural Resources Plan (TE-34) is one of the most extensively modeled of all CWPPRA projects," says Ron Boustany, a natural resources specialist with the Natural Resources Conservation Service. "We used a hydrologic model simulating flow distribution over more than 200,000 acres of wetlands to design methods of moving water from the Atchafalaya River into the southwestern marshes of the Terrebonne Basin. The fresh water will improve marsh health and productivity and reduce land loss in areas where saltwater influences are advancing."

To quantify the advantages of freshwater flow into the Terrebonne marshes, results from the first model were used in a second model to determine the ecological benefits to the area resulting from the additional nutrients and sediments in the freshwater influx. Testing different diversion locations, structural types and operational regimes, the model indicated the best design choices for achieving the desired goals.

Currently, designers are using another model for the Central Terrebonne Freshwater Enhancement project (TE-66). Over decades, Grand Pass, an artificial cut through the Bayou Dularge Ridge on the southern end of Lake Mechant, has eroded and widened, permitting salt water to degrade the fresh and intermediate marshes of central Terrebonne. Incorporating the hydrology of an area about twice the size of the Penchant Basin project, the model is testing the efficacy of structures designed to limit the ingress of marine waters through Grand Pass and increase freshwater conveyance from the Atchafalaya River into the area.

Although many of CWPPRA's projects manage hydrodynamic forces and thus benefit from hydrologic modeling, the program has developed models for other types of restoration approaches as well. Coastal sediment transport models inform the design of barrier island projects, and river diversion models determine optimal conditions and locations along the Mississippi River where diversions could best achieve land-building goals.

Other programs have benefited from CWPPRA's data resources and experience with modeling. The Southwest Study, a project facilitated by the U.S. Corps of Engineers and the state of Louisiana, essentially modeled the entire Chenier Plain for planning purposes. In developing its Master Plan, the Coastal Protection and Restoration Authority of Louisiana relied on data collected by CWPPRA's Coastwide Reference Monitoring System (CRMS) and on the expertise of scientists seasoned in modeling CWPPRA projects.

The capability to predict the influence of restoration activities on the coastal environment enhances each project's potential success and cost-effectiveness. With computers performing as modern Sibyls, high tech finds practical applications in the marshes of Louisiana. WM

Sharon Coogle, Koupal Communications, Inc.

The more salient features a model captures, the more closely it can simulate actual conditions and accurately forecast future ones. Eco-hydrology models for the Louisiana Coastal Master Plan incorporated measures of water quality with numerous other data including descriptions of morphology, hydrodynamics, atmospheric processes and exchanges of water among water bodies and waterways.

WaterMarks Interview with Sue Ellen Lyons

Sue Ellen Lyons has been a noted science teacher for decades, winning more than a score of honors and awards. Published as both a scientist and a science educator, Lyons has written teacher guides, contributed to school curricula development, and served on numerous professional development and planning committees. Presently teaching environmental sciences at the high school and college levels, Lyons reflects on the role of technology in restoration work today.

WATERMARKS: Through teaching, you have been closely involved in the environmental sciences for decades. Has technology changed how science is conducted?

LYONS: Scientists worldwide don't work alone any more. Our modern technology allows us to share data and get immediate feedback from our peers. Science is teamwork now, with disparate partners working together.

Technology has changed our field work – we're using it to gather and compile data on site. For instance, in the past we tested the acidity of water with pH strips or pH meters, taking them back to the lab for analysis. Now we stick a probe in the water and the information goes straight to a computer where it is collated, formatted and immediately accessible to interested parties.

Sue Ellen Lyons

Cultivating civic awareness while teaching students about natural processes leads them to questions of stewardship: "Who is responsible for responding to this situation? What can, should and will I do about it?"

WATERMARKS: Has coastal restoration in Louisiana benefited from these changes?

LYONS: Whatever you're trying to do with data, technology makes it easier. Whether comparing different sites; coordinating efforts among scientists, environmental groups and government agencies; or communicating with various stakeholders, technology increases the speed and accuracy of the process.

WATERMARKS: Compared to things like landscape-scale restoration projects, monitoring seems a bit pedestrian. Why is there so much emphasis on it?

LYONS: Monitoring is the way we check the effectiveness of a restoration project over time. Without monitoring, it's hard to tell if a restored area has become a healthy wetland or to evaluate damage from storms, invasive species, and other factors.

The condition of the wetlands is constantly changing. Pollutants, industrial and urban runoff, storm water or saltwater intrusion – these all compromise the ecosystem. By constantly monitoring water and soil quality, we can predict trends and adjust our management practices. We can calculate if it's possible to restore a degraded area, and if so, how much would it cost and how long would it last.

WATERMARKS: Have changes in technology affected the way you teach?

LYONS: Especially in the environmental sciences, textbooks quickly become outdated, so we rely on internet research and the availability of real-time, real-life data. For instance, in my classes we look at data from monitored sites coastwide to learn about wetlands in general; to determine how conditions differ among fresh, brackish and saltwater marshes; and to assess the ecological health of a particular area.

Students testing something like water quality in a local waterway can compare their data to data from monitored sites all over the coast. They see how parameters of water quality vary in different marsh types. If they observe signs of a compromised wetland – perhaps the growth of plants inappropriate to that kind of marsh – we then look at the environmental processes and the biogeochemical cycles that are at work.

Understanding how an ecosystem functions, students then ask, "How does this affect me, my home, my neighborhood, my city, my state or region, my planet?" And appreciating these natural processes leads to questions about stewardship – "Who is responsible for responding to this situation? What can, should and will I do about it?"

Tinged with the soft colors of dawn, Louisiana's working coast awakens in tranquil beauty, evidence of its damage and decline hidden in the early morning light. Under the guidance of educators such as Lyons, students learn to think beyond facts and figures to consider larger questions of civic participation and responsibility.

The issue of stewardship opens discussions about economics, government and social structure as well as science. Students gain an understanding of how scientists work in concert with governmental agencies, landowners and citizen groups to restore and protect our natural resources. They see the effectiveness of restoration projects, which encourages them to support these efforts in the future as consumers and voters.

WATERMARKS: Are there other ecological issues that technology could address? Do you see anything new on the horizon?

LYONS: I think monitoring may eventually be expanded to include more biological data sets on populations of wetland organisms and invasive or exotic plant species to supplement the data already being collected on wetland flora. This information would be most helpful if applied to native species' restoration, sediment and erosion control and bioengineering.

New technologies – they will arise as science advances and construction practices progress. Many of my students plan careers in the sciences or engineering. They recognize that their quality of life is affected by the environment, and that the nature of ecological problems is inherently interesting.

There's an old saying that if you think education is expensive, try ignorance. The same can be said about wetland restoration. The cost of restoring Louisiana's coast, no matter how expensive, is small compared to the cost of doing nothing – you cannot put a price on Louisiana's wetlands and the ecosystem services they provide. WM

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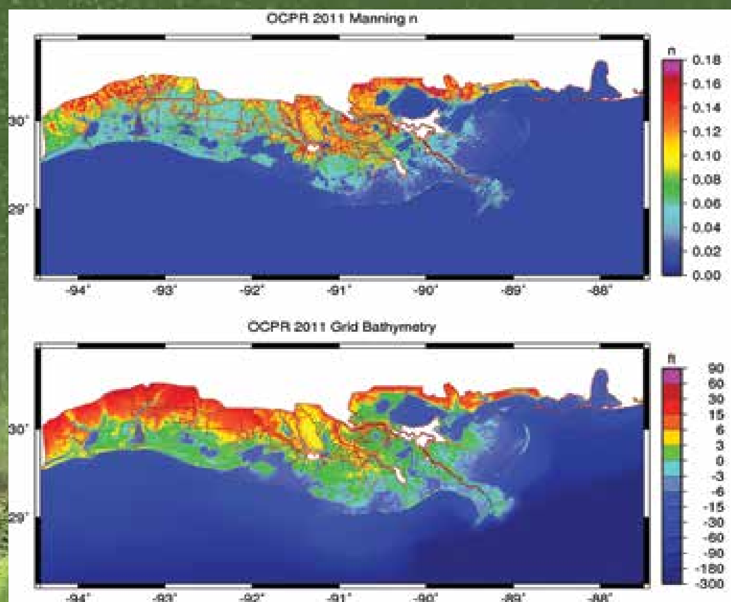
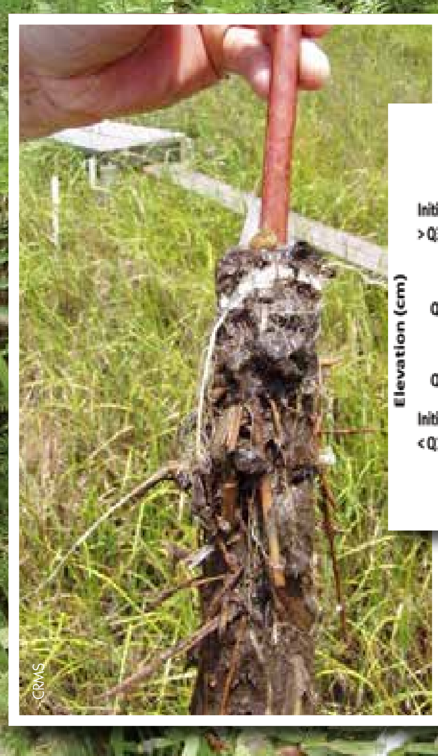
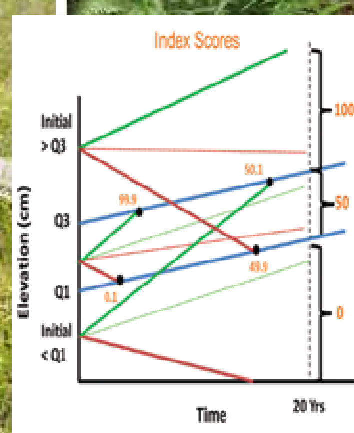


Arcadis

Andy Boudreaux, Coastal Estuary Services



CRMS



CRMS

The CWPPRA-funded Coastwide Reference Monitoring System (CRMS) provides detailed information about ecological variables collected from hundreds of sites across coastal Louisiana. So much data could overwhelm even professionals accustomed to reading numbers and deciphering statistics, but CRMS' interactive report card program makes the information readily accessible to any visitor to its web site (www.la-coast.gov/crms2). To generate a report card, requests for data are made by year and by location, which can be as specific as a single monitoring site or as broad as the entire coast. Graphs, charts and explanatory notes summarize information about such wetland conditions as quality of vegetation, water levels, salinity, vulnerability to flooding and land loss or accretion. Comparisons to other sites and basins and to overall coastal conditions give context to the data.