# Coastal Restoration Now… What's working? What do we need?

*By Elizabeth Coleman*

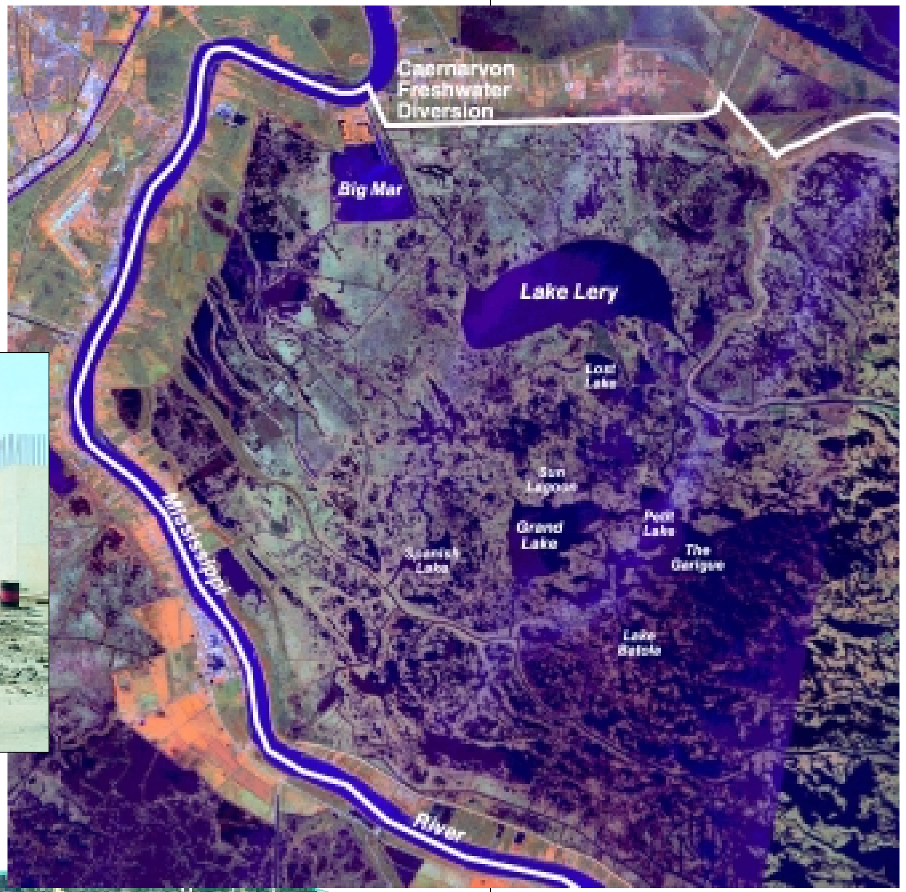
*It seems as if the combined forces of nature, time, and human error will not be appeased until Louisiana's coastal wetlands have entirely disappeared. The loss, over a million acres since the 1930s, has already been catastrophic and, at the present loss rate of about 30 square miles per year, an additional 1,000 square miles of coastal Louisiana will wash away by 2050. Gone will be precious nursery habitat for fish and shellfish; nesting and feeding grounds for migratory waterfowl and wildlife; storm surge protection for vulnerable coastal communities, ports, and roads; a buffer against wave and storm damage for oil and gas pipelines, production platforms, and shore-based processing facilities; abundant playgrounds for boaters, anglers, and hunters.*

The entire nation has an economic stake in the welfare of Louisiana's coastal marshes: They are the cradle of nearly a third of the total commercial fish and shellfish harvest in the lower 48 states. Seventeen percent of the nation's oil and 25 percent of its natural gas are mined in the state's offshore waters. Louisiana's four major ports handle more than 20 percent of U.S. foreign waterborne trade.

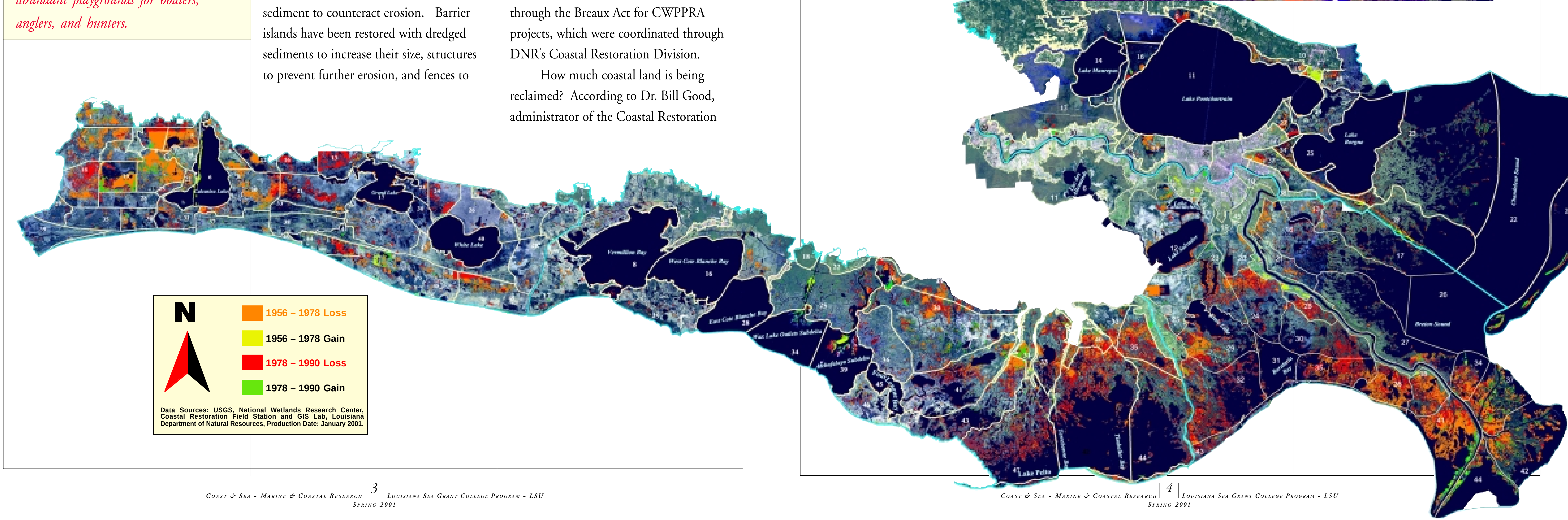
A variety of projects for rebuilding coastal wetlands have been underway for the last decade, the majority implemented through the Louisiana Department of Natural Resources' Coastal Restoration Division. River diversion structures send nourishing sediment and water from the Mississippi River into deteriorated marshes. Shoreline protection devices, such as breakwaters, groins, and revetments, absorb wave energy and trap sediment to counteract erosion. Barrier islands have been restored with dredged sediments to increase their size, structures to prevent further erosion, and fences to trap sand and stabilize beaches. In degraded areas, fences made of discarded Christmas trees have slowed wave action, trapped sediments, and encouraged new marsh development.

Along with support from the state's Wetlands Trust Fund (fed by a varying annual percentage of the state's mineral revenues), most of these projects are funded with $40 million a year from the federal Coastal Wetlands Planning, Protection, and Restoration Act of 1990 (CWPPRA). Also known as the Breaux Act for its author, Senator John Breaux of Louisiana, CWPPRA represents a partnership between the state and five federal agencies and is one of the largest and most diverse programs ever undertaken to restore the structure and function of a major coastal ecosystem. Between 1990 and 1997, almost $250 million were provided through the Breaux Act for CWPPRA projects, which were coordinated through DNR's Coastal Restoration Division.

How much coastal land is being reclaimed? According to Dr. Bill Good, administrator of the Coastal Restoration Division, CWPPRA projects are expected to reduce by 13 percent the 1,000-square-mile loss projected for 2050. "In addition," says Good, "the Davis Pond and Caernarvon freshwater diversion projects will prevent another 9 percent of anticipated loss, which makes a combined total of 22 percent."



*The Caernarvon freshwater diversion structure was finished in 1992. Photo and location map courtesy of Coastal Restoration Division, DNR.*



Data Sources: USGS, National Wetlands Research Center, Coastal Restoration Field Station and GIS Lab, Louisiana Department of Natural Resources, Production Date: January 2001.

*Is this a reasonable percentage of prevented loss? Is there untapped technology that would enable us to do the job better and faster, or gaps in knowledge that need to be filled? What are our constraints? In June of 2000, the Louisiana Sea Grant College Program and NOAA's Coastal Services Center convened HabTech 2000, a conference at LSU's Pennington Center in Baton Rouge to explore these questions. Invited to participate were people closely involved with the implementation of restoration projects—the coastal managers, scientists, and engineers who evaluate them, oversee their operations, and make them work—as well as people from private industry, academic and research institutions, and government agencies who were familiar with coastal restoration issues. In three sessions, conference participants were asked to identify key restoration problems, the obstacles that prevented solutions, and the information and technological innovations needed to overcome constraints.*

## How Do We Predict Wetland Loss and How Do We Know When Restoration Is Successful?

The coastal ecosystem along the northern Gulf of Mexico is so complex and variable that it is difficult to detect early, often subtle, habitat changes that signal the onset of chronic loss. Surprisingly, years of ecosystem research and mountains of data produced on Louisiana's coastal wetlands have not provided up-to-date regional inventories of ecologically important habitats, a deficiency that conference participants agreed must be corrected in order to assess the rate at which critical habitats are being lost and their relative value.

Needed are new, innovative methods for determining loss. To induce habitat loss and then apply restoration treatments in small, controlled experimental plots, a standard approach, does little to illuminate interactions between large-scale disturbances and restoration efforts. A monitoring method that combines both natural and controlled experimentation and includes long-term field work on a regional scale would produce more realistic data.

A major challenge is the need to develop indicators of change in coastal landscapes that call attention to coastal environmental issues. People usually recognize changes in coastal areas in terms of tangible things that affect them personally. For example, when fishermen seem to be catching few redfish, they may conclude that there's a decline in redfish populations caused by habitat loss. Although the decline may also result from nonenvironmental problems such as overfishing, such indicators are useful in getting public attention.

Conversely, people may discern some tangible changes, but fail to recognize a wider problem. Along the coast of Mississippi, for example, individual bulkheads do not appear to have catastrophic implications, but the cumulative effects of many bulkheads across the coastal system are likely to have serious consequences for the productivity of shallow-water fishery species.

*Coastal replanting project. Photo courtesy of Coastal Restoration Division, DNR.*

A troubling issue is the lack of criteria to determine success. When coastal managers don't know the natural life span of habitats undergoing restoration, it's hard to say whether a project has been successful. Mangroves, thought to have a long life span, can be accurately assessed only after decades. Salt marshes may appear healthy after one or two years, but may erode or subside over a longer period. Needed, said the group, are more studies of the population biology and demography of wetland plants to help evaluate success on different time scales.

Frequently, restoration monitoring is directed at project-specific goals, although CWPPRA agencies are charged with evaluating how well the program restores and protects the entire coastal system. Impacts on coastal wetlands have been so severe, however, that unaffected reference areas for detecting change are hard to find. A new coastwide approach to restoration monitoring, now being developed, will measure important indicators, such as changes in sea level, land elevation, salinity and hydrology, sediment accretion, vegetation, and habitat. The full range of ecological variables will be examined at 600 to 700 stations across Louisiana's coast. Such a systematic approach is necessary to gauge program success, not simply to demonstrate change.

## How Do We Plan? Decision-Making Tools

Session participants considered the range of products, processes, and services available for modeling coastal problems and solutions. Models simulate the effects of a restoration project on people as well as on an ecosystem and must integrate the skills of many disciplines, such as engineering, biology, sociology, economics, and hydrology. CWPPRA planners, for example, often use the Wetlands Value Assessment (WVA), which shows the expected 20-year results from a restoration project, and the Habitat Evaluation Procedure (HEP), which compares a study habitat to an optimal habitat of the same type.

Numerical models, which attempt to depict the physical and biological landscapes within the coastal zone, depend on available data that describe salinity, water depths, wave amplitudes, speed and direction of water movement, winds, vegetative types, and various other factors. Physical and ecosystem models are relatively reliable for long-term projections, that is, from 30 to 70 years, and vegetative models more accurately depict consequences in the near future. Models developed for use in other parts of the country are seldom directly applicable to problems in the north-central Gulf of Mexico region and must be adapted to local conditions.

Although models are critical in the design and monitoring of projects, session participants said that their value is diminished because appropriate data sets are not available for project sites. Data used by numerical models often appear in complex and confusing formats that are difficult to interpret. Standardization of data among agencies would be extremely valuable in making models more accessible and useful to decision-makers, who would thus place more confidence in model results.

Legislative funding restrictions may impede the development and applications of models. For example, the Breaux Act (CWPPRA) does not provide for the support of model development even when the research could accelerate the implementation of restoration projects. With no reliable or consistent source of funding for modeling, the private sector looks to university scientists for the development and testing of prototype models. The application of university-developed models, however, may fall to the private sector. Engineers, hydrologists, biologists, and others sometimes modify the original models as they apply them to the practical problems of coastal restoration and enhancement. Eventually, a gap appears between university- and industry-evolved models, which may lead to flawed conclusions about project performance.

Public management agencies and universities need to renew emphasis on public outreach.

A major problem is the "language gap." Within disciplines, professionals commonly talk to their peers in technical terms, including acronyms and phrases that may not be understood by scientists and engineers in other disciplines. Transferring important ideas or information to people outside government and university circles has become a major challenge. This need is addressed by the Louisiana Cooperative Extension Service, whose Sea Grant-supported agents and specialists concentrate on marine and coastal issues, translating technical ideas into information usable by people who don't function in the daily world of scientific and government jargon.

Economic and social models exist but are not yet widely applied in planning coastal restoration projects. For maximum impact, government planners should include these models in decision making, especially for the larger, more complex projects. Concerns about the effects of a project on people are usually expressed only in the political process. As one pundit in the session observed, "Decisions are made on science, all right…political science, not hard science."

In some instances, session participants said, project decisions are not based on modeling analysis, but on expert opinion. Participants were concerned that model results often undergo intense scrutiny by decision-makers but, once given, expert opinion is rarely questioned. This often leads to "instant experts" whose biases could be detrimental in the planning of expensive and important coastal projects.

For the foreseeable future, numerical models will continue to inform decision-making and grow in importance as they become more sophisticated and projects become more complex. Session participants generally agreed that the private sector will become more involved in modeling services when business people perceive that potential long-term contracts are available to pay for the cost and implementation of coastal models.

## Doing the Job: Engineering Practices and Problems

Participants reviewed engineering technology and methods associated with coastal restoration and identified novel "best practices" and innovations for conserving and restoring coastal wetlands. The session, attended by engineers, land owners, coastal managers, and university scientists included three presentations selected to illustrate examples of practices in recent projects. Two were case studies of fundamentally different types of projects, island restoration and sediment delivery. (See pages 10 and 12 for descriptions of the two projects discussed in this session.) The third was a description of new and innovative technology employed in CWPPRA restoration projects by the Louisiana Department of Natural Resources' Coastal Restoration Division. Session participants discussed each presentation in order to develop consensus on technologies that worked well and those that failed to perform as expected. The group also identified needed technology and management practices.

One of the case studies reviewed the restoration of East Timbalier Island. This project was an effort to enlarge the island by pumping dredged material from submerged areas three to five miles away and recreating its natural topography with frontal dunes rising above a low marsh platform sloping into the bay. The other case study examined the Big Island project, designed to reestablish riverine freshwater and sediment delivery processes in the northern portion of Atchafalaya Bay, thus building new land where plants and wildlife could flourish.

The various steps in planning, construction, managing, and monitoring coastal restoration projects like these have evolved into a high-technology business. Computer-based information tools such as geographic information systems for mapping and analysis; data bases for integrated project management and monitoring; and software for merging information from other databases are needed to provide complete and accurate environmental assessments. Geographic Positioning Systems are invaluable for pinpointing oilfield facilities, monitoring locations, and oyster lease boundaries; measuring subsidence; determining dredge positions; making hydrographic surveys; and tying local project coordinates to standard maps. Aerial and satellite photography yields distortion-free images of Louisiana's flat, low coastal zone, reducing the need for extensive control surveys. Marine acoustic devices map bottom and subbottom sediments. LIDAR, an airborne system that transmits downward laser beams and detects the reflected image by means of an optical telescope, is used for terrain mapping. It may also prove feasible for mapping coastal bathymetry, as it can resolve bottom images in shallow water at depths about three times greater than human vision can penetrate. With computer simulation models, coastal ecosystem responses to coastal conditions and processes such as sea level changes, salinity, storms, winds, and currents can be determined. Engineers use simulation models to investigate coastal wave erosion, sand movement, sedimentation processes, and performance of hydraulic structures.

*A sand fence, Isles Dernieres. Photo by Robert Ray.*

New construction technology helps to protect existing wetlands as well as restore degraded ones. New types of gated structures provide variable water-level control through remote monitoring and feedback via satellite. Such structures range in size from the Caernarvon freshwater diversion structure down to smaller ones that regulate water levels over a few hundred acres of marsh. Various types of automated water control structures with self-regulating gates are under evaluation for use in Louisiana, as is a cantilevered float-equipped tide gate that allows water to flow continuously but blocks high-salinity wedges from the area.

Erosion control and wave-damping strategies have included both successes and failures. Brush fences formed from discarded Christmas trees have been moderately successful in trapping sediment, but perhaps the major benefit of this project is the heightened awareness of the need for coastal restoration. On a larger scale, terraces—or earth embankments—constructed in open bays reduce the strength of waves that would otherwise attack the retreating edge of the marsh. Geotubes, large reinforced plastic tubes filled with sand used for wave damping, and floating tire breakwaters were tested but not found to be successful.

Horticultural technologies are used in some restoration projects where fill materials will erode if not immediately stabilized. Native plant species are preferred for this purpose, because the ultimate goal is to restore natural ecosystem functions and values, and selective breeding is used to propagate suitable strains of native plants that can thrive under local conditions. For plant strains and varieties that are difficult or impractical to propagate through natural seed production, alternative techniques such as vegetative reproduction, plant tissue culture, and artificial seed production have been developed, primarily through the work of the U.S. Department of Agriculture's Natural Resources Conservation Service.

*Building a Christmas tree fence. Photo courtesy of Coastal Restoration Division, DNR.*

The Coastal Restoration Division is responsible for the maintenance and operation of many projects requiring continuous monitoring and control of a large number of devices operating at remote stations. The use of satellite and microwave communications in areas that lack dependable telephone service, allows these functions to be automated.

What is the future? "We're constantly searching for and evaluating technology, both old and new," said Coastal Restoration's Good. "We need technology that makes people more productive and our projects less expensive, more reliable, and longer lasting."

In some fields, such as remote sensing and information processing, said Good, there is a virtual explosion of new developments, but technological advances are hard to come by in hydraulic design and earth-moving equipment. "The bounds of human creativity are limitless, but gravity is immutable."

Good identified such needs as new engineering designs for shoreline stabilization structures and methods for preventing them from sinking; continued progress in the development of plant materials and propagation techniques; improved methods for mapping water depths; a data base on pipeline locations; reliable performance data on new developments in the design of tide and flood gates, self-regulating tide gauges, and other hydraulic devices; and the development of coastwide analyses of economic risks and reliability for new projects.

"The merits of what we are doing now may not be determined for many years," said Good. "We need to implement methods for establishing engineering reliability and risk analysis techniques to guide us in the selection of projects and design options."

However, new technology must be approached with caution, Good warned, as the coastal engineering field abounds in examples of failed approaches and systems. Performance data for failed devices, structures, and projects are needed as much as success stories. Engineering "folklore" has many stories about projects intended to stop erosion that actually increased it, a breakwater that produced dangerous rip currents and severe beach erosion, a rubber tire breakwater that sank from the weight of fouling organisms. "If we have a tool in the kit that has worked for 20 years, perhaps it's worth trying to apply it in a novel way before inventing a 'new wheel,'" said Good.

# ISLAND RESTORATION: LESSONS FROM EAST TIMBALIER

*East Timbalier Island, breached by a hurricane. Photo courtesy of Coastal Restoration Division, DNR.*

Louisiana's barrier islands provide greatly needed protection for coastal marshes. They buffer the impacts of storm surges, temper the eroding power of waves, and reduce saltwater intrusion. East Timbalier Island in Lafourche Parish is one such island, part of an east-west island chain that separates Timbalier and Terrebonne bays from the Gulf of Mexico. Consisting mainly of beach, low dunes, and marsh, the four-mile-long island provides important habitat for birds and mammals and protects bayside oil and gas facilities from the destructive power of the gulf. But the island was steadily eroding, and the construction of rock jetties three miles eastward interrupted a renewing supply of sediment. Moreover, storms and wave action had continually taken their toll and, in 1992, the island was breached by Hurricane Andrew. At the rate the island was eroding, its life span was estimated in 1997 to be about 11 years.

A CWPPRA project was designed to increase the height and size of East Timbalier Island by restoring 225 acres of continuous beach, dune, and marsh habitat along 15,000 feet fronting the Gulf of Mexico. Eroded portions of the island's shoreline were to be filled and raised with material dredged and pumped in from designated borrow areas and placed in sand containment dikes constructed in two feet of water around the island's perimeter on the seaward side. The newly created beachfront would be protected from wave-induced erosion by adding rock to an existing rubble breakwater that fronted the island.

Shortly after the work began in 1999, the contractor, Picciola & Associates of Larose, Louisiana, encountered a number of surprises that forced the engineering company to make changes in procedures, objectives, and project costs—and provided valuable lessons for future restoration efforts in coastal Louisiana. The nature of Louisiana's coastal soils dictated a change in equipment. Before the project started, sand content in samples taken from borrow locations was at least 70 percent, but when dredging began, high-quality sand deposits were quickly exhausted and the borrow deposits were dominated by a mixture of silt, sand, and clay. The dredge originally chosen by the contractor because of its efficiency with sand excavation did not perform well with silt-clay soils and had to be replaced by a different type. Moreover, a significant amount of additional dredging had to be done, because the fine silt in the soil tended to wash out, and more fill material was needed to do the job. What sand there was in the fill deposits had a fine texture, retained water, and was hard to "stack" and contain at the island's fill sites.

Between 1997, when the site surveys were performed, and 1999, when restoration began, the island had suffered further severe erosion.

*East Timbalier restoration site. Photo courtesy of Coastal Restoration Division, DNR.*

Water depths of 15 feet were found at sites that had earlier been charted as beach or intertidal habitat. At the eastern end of the island where containment dikes had been planned for two feet of water, depths were discovered to be at least eight feet. Consequently, the planned use of retention levees to contain dredged fill at the island's eastward end was rendered impractical, as the sand dikes, exposed to strong ocean waves and currents in deep water, would simply wash away. Containment dikes were abandoned in favor of open beach fill extending to the rubble breakwater.

Thus, the island's planned elevation could not be achieved. Rather than the elevated dune-like ridge envisioned at the outset, the project created a broad, low, nearly flat mass of sand with dunes that spilled laterally into the bay behind the island and were contained on the gulf side by the rubble breakwater. The project fell 3,600 feet short of the planned length of 15,000 feet and total acreage restored amounted to 217 acres, or 96 percent of the project plan. Despite the reduced acreage and shortened length, fill materials amounted to more than 3,000,000 yards, 800,000 yards more than were anticipated. The final cost per acre, $41,300, represented an increase of $1,800 per acre over the design estimate.

Other problems included waves and swells from Hurricane Bret, which eroded 5,000 cubic yards of newly placed beach fill, and unforeseen hazards, such as uncharted buried pipelines, one of which was a high-pressure gas line that ruptured in the course of excavating material for a spoil retention levee.

*In a dune and marsh creation project slated for the summer of 2001, DNR plans to close New Cut, a hurricane-caused breach between East and Trinity islands in the Isles Dernieres barrier island chain (Terrebonne Parish). The islands' shoreline is among the most rapidly declining shorelines in the U.S. Photo courtesy of the Coastal Restoration Division, DNR.*

# GROWING A DELTA

The environmental significance of the new delta growing in Louisiana's Atchafalaya Bay cannot be overstated, as it is the only place in the state's coastal zone where significant amounts of land have been building through natural processes. Here, the lower Atchafalaya River discharges into the bay and, since the floods of 1973, sediment deposits have been building in the shallow bay waters. The subsequent colonization of these deposits by natural vegetation has created about 12 square miles of habitat for waterfowl, reptiles, and mammals. The flourishing new delta soon became a state wildlife management area.

Over the last decade, however, delta growth virtually stopped. The principal conduit for river water across Atchafalaya Bay is a 20-foot-deep navigation channel maintained by the U.S. Army Corps of Engineers. The channel, with its flanking banks of dredge spoil, is efficient in carrying river water to the Gulf of Mexico, but it restricts the sedimentation that would otherwise occur if the discharging river plume were able to expand inside the bay. With no new additions of sediment, the delta has remained static.

To offset this, two projects were initiated. One, the Big Island mining project, dredged new channels to distribute sediment in the bay, thus encouraging the formation of wetland habitat through natural sedimentation. The other, the Atchafalaya sediment delivery project, used the material dredged in channel construction to actually create new land. At the projects' end, the contractor, Mayer, Brown, Cunningham, & Gannuch of Baton Rouge, created eight miles of sediment-carrying distributary channels and placed 3.4 million cubic yards of dredge material to create 900 acres of marsh in artificial delta lobes. The spoil deposits were colonized by marsh plants almost as soon as they formed, confirming the viability of the natural seed bank in the dredged sediments.

In contrast to the East Timbalier Island project, these projects went smoothly, with no problematic surprises, primarily because accurate information about the project site was available. The only hazardous condition encountered, a 30-inch high-pressure gas line, was identified well in advance of construction and special care was taken to avoid it. Though relict oyster shell reefs were unexpectedly discovered during dredging, these were salvaged and the shell deposited on the marsh surface to provide nesting habitat for birds.

*Site of Big Island mining and sediment delivery project, Atchafalaya Bay. Spoils A, B, C, and D were created by the project through dredging of Breaux's Pass. Passes A, B, C, D, and several others were dredged or enhanced, and fill material was added near Bill Savant Point. Photo prepared by the U.S. Geological Survey, National Wetlands Research Center, for the Louisiana Department of Wildlife and Fisheries.*