Submitted to: The Earth Scientist
April 13, 2009

Linking the Geologic with the Biologic: Ecological Stewardship as a Means to Teach Geology Related to Coastal Land Loss

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ABSTRACT

A common misconception among the public with respect to coastal land loss in Louisiana is that many think that Louisiana's coast is retreating and that this retreat is responsible for the land loss reported by the media in recent years. In reality, Louisiana's land loss is related not to the retreat of coastal beaches, but to the change of interior marshes to open water. This interior land loss is related directly to the natural subsidence of former deltaic lobes of the Mississippi River and has been exacerbated by the leveeing of the Mississippi River, upriver damming of both the main river and its tributaries, closure of distributaries, and tropical storm events. In order to assist teachers in teaching about the geologic processes involved in Louisiana's coastal land loss and the restoration efforts underway to save Louisiana's coastal habitats, the LSU Coastal Roots Program was begun in 2000 as a means to introduce students to these critical issues facing Louisiana's citizenry. Currently, students in grades 2-12 in 36 public and private schools across south Louisiana raise native seedlings and grasses in school-based plant nurseries. Once a year, on a field trip to a partner restoration site located in Louisiana's coastal zone, students transplant their crop of restoration seedlings. This vegetative planting trip enables students to see a site impacted by habitat loss and provides them an active learning situation in which they can make a positive impact in the larger community.

Introduction. Louisiana's coast faces a perilous future. The first levee on the Mississippi River was constructed in New Orleans shortly after its founding in the late 1700's. Since that time, human mediated processes, such as alterations to the natural hydrology, closure of distributaries, oil and gas exploration, extraction and related canal dredging, and the harvesting of wetland forests have interfered with sediment delivery to the current delta. Levees and the closure of distributaries have significantly separated the river from its surrounding delta and have resulted in high rates of land loss across Louisiana's coastal zone (Committee on the Restoration and Protection of Coastal Louisiana, 2006; Louisiana Coastal Wetlands Conservation and Restoration Task Force, 2003). Louisiana has lost 1,900 square miles of land since the 1930's (Barras et al., 2003; Dunbar et al., 1992). Future land loss (2000-2050), with consideration for existing restoration projects and diversions, is projected to be 513 square miles (1329 square kilometers), with an annual loss rate of 10.26 square miles (26.6 square kilometers) per year (Barras et al., 2003). Hurricanes Katrina and Rita in 2005 resulted in an estimated land loss of 217 square miles (526 square kilometers) (Barras, 2006). These two storm events alone represent nearly half of the projected net land loss for 2000-2050.

The land loss experienced in Louisiana is not due to the retreat of Louisiana's coastal beaches. Instead the loss of land is in the interior marshes. This marsh land loss is due in part to subsidence-driven relative sea level rise. Simply put, the marshes are sinking. Prior to levee building and distributary closures, sediments delivered to the marshes kept pace with the rate of subsidence. With sediment deprivation, as the marsh sinks, the marsh plants become stressed and die, and in other places, the marsh is undercut by wave action (erosion) at the marsh-water interface (Nyman et al., 2006). The result is interior marsh land loss and the conversion of these areas into open water.

The land loss in Louisiana has serious state and national economic ramifications. Louisiana is the largest producer of shrimp, oysters and blue crab, with a fisheries industry valued at over $2.85 billion (Bourque, 2007). Many of these fisheries rely on intact estuaries and adjacent marshes for a portion of the life cycle

of the organisms. For instance, shrimp release their eggs in the Gulf of Mexico. As the larva mature, they migrate into the estuarine waters of the marsh, where they feed and shelter until they migrate back to the sea as subadults (Louisiana Sea Grant College Program, n.d.). With the breakup of the marsh, the productivity of these fisheries is expected to decline. Other industries, such as tourism, oil and gas, agriculture and commercial shipping will be impacted as the marshes deteriorate. Despite the obvious value of the commodities produced by these industries to the nation, convincing the nation to invest in saving these fragile coastal lands has been a long and arduous process. The Coast 2050 Executive Summary gives a clear call to action, “Stewardship requires us to care for and nurture what we have and what we are given” (Louisiana Coastal Wetlands Conservation and Restoration Task Force, 1998, p. 11).

Overview and Structure of the LSU Coastal Roots Program. The LSU Coastal Roots Program was initiated in 2000 to provide a sustained hands-on school-based stewardship activity that offers students an opportunity learn about coastal issues and have a hand in taking positive actions to preserve and rebuild our coast. In this program students grow native plants in school-based plant nurseries. Each participating school is partnered with a long-term restoration site and grows the plants needed specifically by the site. The project provides a means for students in grades 2 through 12 to give back to their larger community by becoming active stewards of their natural resources. The program currently has 36 active schools participating in 16 parishes (counties) across south Louisiana.

The LSU Coastal Roots Program involves three components: nursery production, a habitat restoration trip, and supporting learning communities. The cost to join the program is $1200, which covers the costs involved in establishing their school-based nursery (e.g., an automatic irrigation system, plant cells, trays, ground cloth, and fencing). Yearly expenses, which include bus transportation and substitute teacher pay, are about $300 and are covered by the school. Funds obtained by Coastal Roots staff through grants and contracts cover staff salary and travel, seeds and soil, and professional development expenses for participating teachers (stipends and materials).

Nursery Production. When schools enter the program, students help to install their school-based plant nursery (Blanchard, 2007; Coleman & Bush, 2002). Students dig the irrigation trenches, cut and glue the PVC pipe together for the irrigation system, lay the gravel and ground cloth, and build the dog kennel that is used to enclose their 10’x10’ nursery production area. This initial activity takes about three hours to complete. [insert Central8.21.08 about here]

A long-term restoration partner is identified for the school. This partner site is selected based on how far the students can travel from their school on their restoration trip and the type of plants (trees or grasses) that the teacher would prefer to grow. The manager of the site is asked for the names of restoration plants needed at the site. Coastal Roots staff either purchase tree seeds from a local seed vendor or make arrangements with the U.S. Department of Agriculture’s Golden Meadow Plant Materials Center in Golden Meadow, Louisiana, to obtain starter grass plugs. Schools growing tree seedlings are asked to grow two different species. This ensures that should one tree crop fail, the school will still have the second species to plant on their restoration trip. Schools growing trees can potentially grow 980 seedlings. Schools growing grasses can potentially grow 768 grass plugs. Currently, tree species being planted by schools in the program include southern baldcypress, live oak, water oak, nuttall oak, longleaf pine, tupelo gum, swamp red maple, and black cherry. Grass species include smooth cordgrass, bitter panicum, and seashore paspalum.

In early spring students plant the seeds or grass plugs in their plant nursery. Over the spring and summer students and teachers manage the irrigation system, fertilize the plants, and keep the perimeters and plant cells weeded to ensure that their plants are as robust as possible. A preliminary plant count is submitted to Coastal Roots office along with possible planting dates for their restoration planting trip.

Restoration Trip. Schools plant their nine-month old tree seedlings from late October through the end of January. The seedlings are dormant during this period and transplanting them at this time will allow them to begin to establish their root systems before they start putting on new leaves in the spring. This is also the best time to avoid field trip nuisances like reptiles, mosquitoes, ticks, and biting gnats. Once at the site, schools plant as many of their seedlings as possible during the time they have available. This is

generally around 400-600 seedlings. Plantings take place on a school day and are completed in about two to three hours. Coastal Roots staff facilitate the planting event and provide dibbles (a tree planting tool), seedling sacks, and containers of time-released fertilizer. Staff demonstrate how to properly plant the seedlings and enlist the chaperones and teachers to help ensure that the seedlings are properly planted. After the field trip, the empty reusable plant cells are taken back to school and are cleaned by the students and are stored for use the following spring. The restoration cycle begins again the next spring. [insert 2009-01-07 PLANTING Christ Epis Font 08 in this area]

Supporting Learning Communities*.* Twice a year, at the Winter Workshop and at the Summer Institute, teachers come together to learn from experts about coastal issues, as well as each other. In the Winter Workshop, the focus is on best practices in seed germination, grass propagation, and nursery production. Teachers take home their seeds and soil at the end of this meeting. At the Summer Workshop, guest speakers, field trips, and specific activities are presented and related coastal resources are shared. The location of this meeting moves each summer with the intention of giving teachers a different coastal location to learn from and experience. [insert IMG_5957 about here - optional]

The LSU Coastal Roots Program operates in grades 2-12, thus, there is no written curriculum. Instead, each teacher determines how the program will be integrated at their school. Teachers make use of published lessons and other coastal resources identified by Coastal Roots staff (see Resources). In May 2009, American Wetlands Month will be celebrated with the inauguration of the Louisiana Wetland Ambassador Day. Each of the Coastal Roots schools, as well as schools participating in Bayouside Classroom, a water quality monitoring program supported by staff at the Louisiana Universities Marine Consortium (LUMCON) in Cocodrie, Louisiana, may select two students to accompany their teacher for a special six hour learning experience at LUMCON. Highlights will include sessions on water quality testing, net and bucket fishing, plankton, plant, and bird identification, marsh coring, and a voyage on the R/V *Acadiana*. This activity was proposed by teachers during the 2007 Summer Institute. They wanted to be able to bring students out to the coast to learn first-hand about some of the coastal issues facing Louisiana. These students will then take what they learn at the Wetland Ambassador Day and bring it back to their classmates.

Resources to Assist Learning. Teachers participating in the LSU Coastal Roots Program have a number of resources available to them through the program website (http://coastalroots.lsu.edu/). Resources include program information, nursery instructions (information on seed preparation and plant nursery production, specific information about restoration plants that are grown in the program, and information about managing the container yard and automatic irrigation system), and specific information for teachers participating in the program (e.g., professional development workshops, process and cost to enter the program, potential sources of grant money).

A number of Louisiana-based agencies have invested in K-12 resources that focus on coastal issues facing south Louisiana (see Resource List for URLs). An example of an activity that helps students recognize the consequences of coastal land loss is one entitled, “Wetlands Loss = Fisheries Loss” (Activity 2-6) from the *Educators Guide to the Barataria-Terrebonne National Estuary* (Blanchard, 2006). In this activity, students simulate the break-up of a healthy marsh and record the area and perimeter of the remaining marsh pieces in a data table, which they analyze. In this activity, students can draw conclusions based on their data about how the area and available perimeter of the marsh is connected with fisheries populations. They find that as the marsh breaks up, there is initially an increase in the marsh perimeter (i.e., available fishery nursery area) even though the total area of the marsh is declining. Eventually, a tipping point is reached where both the area and perimeter are both declining rapidly. When students graph their results, this relationship becomes apparent. Scientists think that our Louisiana coast is somewhere near the top of the curve and that while our fisheries are not yet in decline, they will be soon.

Conclusion. Since its inception in 2000, the LSU Coastal Roots Program has facilitated 3,454 students in grades 2-12 in planting nearly 29,000 student-grown seedlings and grass plugs on 88 restoration trips to partner restoration sites. The program offers a means to help make students aware of coastal issues, builds scientific knowledge about some of the ways these issues are understood and addressed, and

provides a meaningful way for students to take responsible action based on that awareness and knowledge.

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Resources:

Barataria-Terrebonne National Estuary Program Website for Educators
http://educators.btnep.org/

Main website for educators (All products are FREE to the public). It has a host of comprehensive source of information and activities for formal and nonformal educators. The activities are created specifically for students K through 12th grade. Videos, DVDs, Field Trip guide, Workbooks, Educational Resource Guides, Maps, Workshops, etc. To obtain materials, call 800-259-0869.

Educator's Guide to the Barataria-Terrebonne National Estuary
http://educators.btnep.org/default.asp?id=64

The BTNEP Educator's Guide to the Barataria-Terrebonne National Estuary is a comprehensive source of information and activities for formal and nonformal educators. The activities are created specifically for students K through 12th grade.

LaCOAST.gov
http://www.lacoast.gov/

This website contains multiple resources: educational information, maps of coastal Louisiana (including restoration projects, pre and post hurricane, land loss, aerial photographs and teaching aids), multimedia resources, and reports.

Lake Pontchartrain Basin's Lessons on the Lake
http://www3.selu.edu/turtlecove/lessonsonthelake

A free interactive tool to learn more about watersheds, in particular the Lake Pontchartrain Basin. The Lake Pontchartrain Basin, in Louisiana, is part of the much larger Mississippi River watershed which covers more than half of the United States.

Louisiana Sea Grant College Program, Louisiana Marine Education Resources website
http://lamer.lsu.edu/

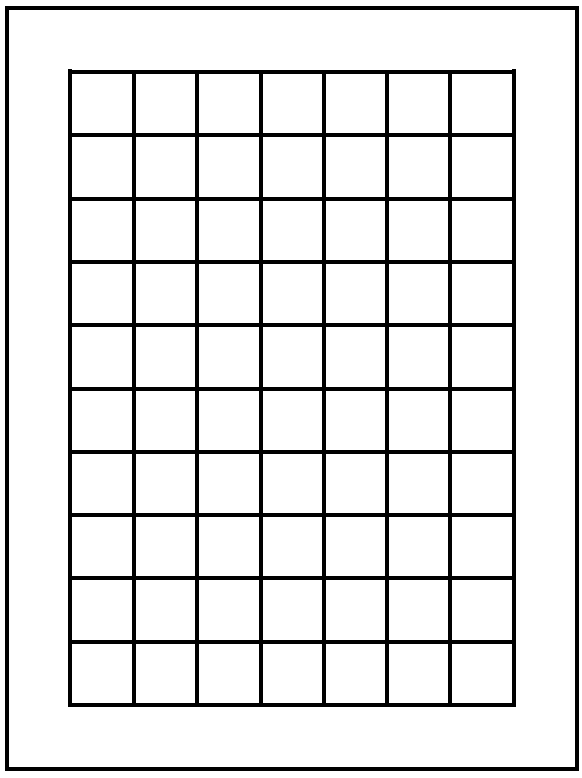
A website containing educational information and activities focused on Louisiana's coast and the Gulf of Mexico, including the Dead Zone, Ocean Commotion, Native Fish in the Classroom and EstuaryLive Louisiana activities.

Wetlands Loss = Fisheries Loss

Before levees and other human activities, Louisiana's coastal marshes stretched out along the coast in a more or less continuous band with only occasional marsh ponds and tidal inlets cutting through them. As the rate of subsidence increased to a level that exceeded the rate of marsh sedimentation, the once continuous marsh began to break up into smaller and smaller segments. The health of the marsh affects the productivity of our estuaries and bays, which are nursery grounds for many species of animals, including commercial fish.

This exercise looks at what happens to the fisheries productivity as the marsh breaks up.

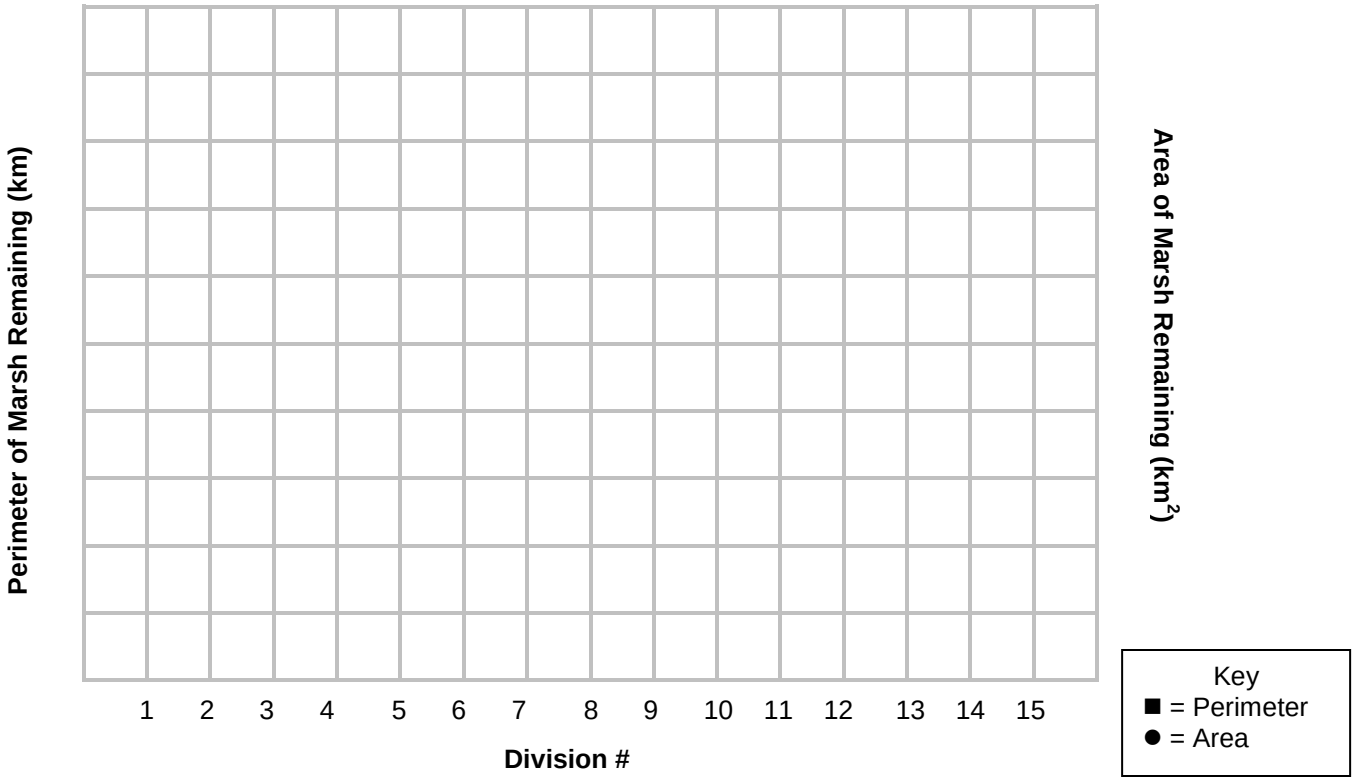
1. Think of the area below as a map of a 7 km by 10 km piece of the marsh. Each square is 1 km on its sides. The fringes of this marsh area are especially important nursery areas for juvenile species of commercial fish, crabs and shrimp. At this stage, what is the perimeter of this piece of marsh? Record this perimeter in your data table. What is the area of the marsh? Record this area in your data table. (Division 1)
3. Human activities have resulted the breakup of your marsh, therefore, divide your marsh in half by shading in one <u>vertical column</u>. Now your once continuous marsh is broken into two pieces. What is the total perimeter of your two pieces of marsh now? Record this total perimeter in your data table. What is the area of the two pieces of marsh? Record this area in your data table. (Division 2)
4. Nutrias invade this marsh area. Divide your two pieces of marsh in half again by shading in a <u>horizontal row</u> through both of your pieces. Record the resulting perimeter and marsh area in the data table.
5. Continue subdividing your marsh pieces, removing *alternating* horizontal rows and vertical columns, until you have no marsh remaining. At each division, record the resulting perimeter and area in your data table.



Graph your data on the next page.

Division	Perimeter (km)	Area (km^2)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		

Total Marsh Perimeter and Area During a Simulated Breakup of the Marsh



What does your data (both perimeter and area) tell you about the breakup of the marsh?

If 1,000 juvenile fish, crabs and shrimp thrive on 1 km of marsh perimeter, what happens to their populations as the marsh breaks up?

How will this affect Louisiana's commercial fisheries?

Photo captions

Central8.21.08 - A typical LSU Coastal Roots nursery. Photo by Ann Blanchard.

2009-01-07 PLANTING Christ Epis Font 08 – Students planting their loblolly pine seedlings on a restoration planting trip to Fontainebleau State Park. Photo by Pam Blanchard.

IMG_5957 – A teacher pulling in a plankton trawl on a field trip during the 2008 Coastal Roots Summer Institute. Photo by Pam Blanchard.