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Putting down roots in environmental literacy: a study of middle school students' participation in Louisiana Sea Grant's Coastal Roots Project

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PUTTING DOWN ROOTS IN ENVIRONMENTAL LITERACY: 
A STUDY OF MIDDLE SCHOOL STUDENTS’ PARTICIPATION IN 
LOUISIANA SEA GRANT’S COASTAL ROOTS PROJECT

A Thesis

Submitted to the Graduate Faculty of the 
Louisiana State University and 
Agricultural and Mechanical College 
in partial fulfillment of the 
requirements for the degree of 
Master of Arts

in

The Department of Curriculum and Instruction

by
Rachel L. Somers
B.S., University of Miami, 1999
May 2005
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Abstract

Few people realize that in Louisiana land is lost to open water at about a rate of 24 square miles a year, faster than anywhere else in the world (Barras, Beville, Britsch, Hartley, Hawes, Jonston, Kemp, Kinler, Martucci, Porthouse, Reed, Roy, Sapkota, & Suhayda, 2003). Not only is the public low to moderately environmentally literate, there is a need to reach students early on to ensure the greatest benefit. This is the main reason why Louisiana Sea Grant’s Coastal Roots Wetland Seedling Nursery Project (Coastal Roots) came into inception. The goal of the project is to improve environmental literacy of participating students, by fostering a sense of ownership through raising wetland plants. An environmentally literate person combines his/her knowledge of ecology with values that will lead to action (Morrone, Mancl, & Carr, 2001).

The addition of a formal education component to Coastal Roots was needed to increase students’ environmental knowledge. Therefore, six lesson plans were developed by the researcher to give students a broad view of Louisiana wetland habitats and deltaic geology and administered by teachers in three middle schools. The 7 and 8 grade classes were purposefully selected based on roughly equivalent ability of the teacher and students. Teachers were observed teaching lessons to their treatment classes. Students were pretest and posttested and 4 treatment students from each school participated in a group clinical interview. Pretest and posttest results were examined using the statistical randomized block design with repeated measures showed a significant ($t < 0.0001$) improvement of knowledge for the treatment group. There was no statistical difference among schools or between grade levels of students. The results from the qualitative dimensions support the classroom-tested, innovative unit materials developed for this
study appear to be applicable to similar environmental science learning situation throughout the Deep South. These results supports the hypothesis that included educational unit can improve the environmental literacy of students’ participation in Coastal Roots.
Chapter 1

Introduction
An Environmental Crisis

“Louisiana’s land loss crisis presents an emergency of untold cost to our state and nation. Since the 1930s, one million acres of wetlands have converted to open water, and without bold action on a scale never before attempted in the United States, Louisiana will lose another one million acres in the next 40 years. In the short-run, the problem is no less disturbing; every 30 minutes, a parcel of wetlands the size of a football field disappears. The implication for the nation’s coastal resources are devastating. If current trends continue, nearly 40% of our nation’s coastal wetlands will disappear” (COFCL, 2002, p. iv).

Louisiana’s vast expanse of coastal wetlands is abundant in natural resources, from the natural gas and petrochemical industries, to the commercial and recreational fishing industries, to agriculture and tourism. Even the fabric of what people picture when they think of Louisiana is vanishing along with the state’s economy. Infrastructure and culture are sinking below the Gulf tides.

An understanding of what wetlands are and how these habitats are important socio-economically and ecologically is vital to develop a literate community of voters. One of six recommendations made by the Governor’s Committee of the Future of Coastal Louisiana is to “raise public awareness... both statewide and nationally... (as) a starting point for a renewed coastal restoration effort – an effort that all Louisianans must support if we are to preserve our state’s future” (COFCL, 2002, p. vi).

An Environmental Education Goal

“The United States government passed and reauthorized the National Environmental Education Act with the Office of Environmental Education established within the Environmental Protection Agency (EPA) to provide national leadership to increase environmental literacy” (Wishart & Porter, 2003, p. 45).
The National Science Teachers Association (NSTA) had made a position statement on using natural resources in teaching environmental education. The NSTA board stated that “It is imperative that students at all levels develop an understanding of how humans relate to natural systems, and realize the importance of making wise individual and social decisions in respect to the use of natural resources and the maintenance of environmental quality,” and that students should “establish a firm knowledge of fundamental scientific principles in order that they might better comprehend, explain, and predict the consequences of human actions on natural systems” (NSTA Board of Directors, 1985).

Science education of middle schools students should primarily function as way to “explore science in their lives and to become comfortable and personally involved with it” (NSTA Board of Directors, 1990).

The Wetland Issues Based Education Project

Coastal Roots Wetland Seedling Nursery Project (Coastal Roots), established in 1999, is a multi-disciplinary, hands-on, minds-on project for elementary through high schools students. The objectives are (a) to construct and conduct on-going nursery projects on school grounds, where students will grow native wetland plants, (b) to learn about wetland issues including wetland loss, restoration and conservation, and (c) produce wetland plants to take on a restoration fieldtrip. Seventeen schools participated in this project which was developed by the Louisiana Sea Grant College Program at Louisiana State University in partnership with Louisiana State University Department of Horticulture and Agricultural Center.
At present, Coastal Roots consists of students raising seedlings on their school campus from seed. Each year, students go with the teacher on a fieldtrip to plant their seedlings in a local wetland. The teacher, on his or her, own fills in the blanks to the program.

The Problem

Some educational researchers suggest that teachers are not focusing on building students ecological foundations; instead they tend to focus on values and attitude to improve environmentally responsible behavior (Morrone, et. al., 2001). Currently, Coastal Roots falls into this category because the goal to assist teachers and students in developing an attitude of stewardship toward our natural resources and to provide for them a constructive active learning situation in which they can explore strategies for sustaining our coastal ecosystems is not being met. To fulfill the active learning objective of Coastal Roots goal, six wetland issue lessons were developed to introduce students to wetland ecosystems, wetland issues and deltaic geology.

Coastal Roots will benefit because an addition of a set curriculum to provide students and teachers with a more unified understanding of wetland concepts and issues. The specific topics for the lessons are based on the needs of the teachers participating in the project.

With a general curriculum to follow teachers will be able to make sure that the main objectives of the program are met, then they can expand it to fit their own and their students needs and interests (Bennet, 1988-89).
The Design of the Wetland Issues Lesson Plans

The development of the lesson plans started a year prior with several brief email questionnaires being sent to the participating teachers. Each teacher in the project was sent questions: a) concerning how he/she used the project, b) why he/she got involved in the project, c) what aspect of the project he/she found to be most beneficial to his/her students, d) what scientific topics students had trouble comprehending, and e) what improvements that he/she would like to see made to strengthen Coastal Roots.

Eight of the teachers responded to the emails. Several teachers mentioned that the program could be improved by making “available resources to the classroom teachers that are doing coastal roots, for example, I have a number of Barataria-Terrebonne estuary videos that I have used.” And another suggested “standard based lesson plans will help a great deal... I was never a big plant researcher, so I am learning just as much as the kids about the trees needs and the types of soil that each species thrives in.” One of the concepts that several teachers mentioned their students had trouble understanding was subsidence. From these communications six lessons were designed to give students an understanding of what wetlands were, their functions and values, common types found in Louisiana and an introduction to deltaic processes.

The 7E learning cycle and instructional model was chosen as the lesson plan design because it ensures that the crucial components of the learning cycle are met. This model is based on a method to elicit students' prior knowledge, which gives the teacher a starting point to engage students in construction of new knowledge. Then students are to explore (e.g. observe, develop hypothesis, draw graphs) after which, the teacher explains the concepts using scientific terminology. Next students elaborate, apply their knowledge.
to a new domain and finally extend it to a new context. Lastly, student learning is evaluated through formative and summative evaluations (Eisenkraft, 2003).

As we have come into the twenty-first century the (information age), people are inundated with a variety of sources all vying for their attention. Students expect to be entertained and teachers compete with many flashy distractions for students’ attention. It is becoming a more visual world. Therefore the lessons were designed with a visual component reaching more learning types and allowing for dual coding of information. All six lessons use graphics and five include a short video from two to a little over six minutes long that drive home the main point of the lesson.

Lessons not only have to engage students but they also have to meet strict education standards set by the state and these standards have specific actions that students must be able to perform, skills called GLEs: “grade level expectations” that lead toward the mastery of the standard. Therefore each lesson that was developed was based on at least one of these GLEs in the subjects of science, math, social studies and art.

The Purpose of the Study

The study was designed to see if the addition of lessons on wetland issues will improve the environmental literacy of middle school students participating in Louisiana Sea Grants Coastal Roots project.

Students should have an educational opportunity to see why their local wetland habitats are valuable, to have an understanding of basic concepts of these systems, to be able to communicate about it effectively and make sound decisions based on facts.
**Research Question**

Does the inclusion of lessons on wetland issues improve the environmental literacy of students participating in the program?
Chapter 2

Review of Literature
Environmental Literacy

A basic definition of environmental literacy is having a foundation of understanding how the natural world functions and how humans interact with the natural world. After more than 20 years researchers still have not accepted a common definition of environmental literacy (Morrone, et. al., 2001). Many researchers agree that this is a problem, although at least there is some agreement.

“A common definition of environmental literacy which satisfies everyone may never be written. However, what most professionals in the field of environmental education do agree on are the concepts or strands which should be included: knowledge, skills, affect, and behavior. These are the foundations upon which the assessment of environmental literacy should be based.” McBeth (1997)

There are several good definitions developed by educational researchers.

Golley (1998) states environmental literacy is more than the ability to read about the environment, one must also develop a sense of the spirit of place. It begins with experience of the environment which ignites the curiosity and “teaches us that we live in a world that is not of human making that does not play by human rules.” (Golley, 1998, p. x)

“Environmentally literate individuals are equipped with more than just knowledge about ecology; a completely literate person combines knowledge with values, which leads to action” (Morrone, et. al., 2001, p. 34).

McBeth’s (1997) working definition of an environmentally literate person is one who uses critical thinking, problem solving, and effective decision-making skills to weigh all sides of an environmental issue. A person is able to take responsible actions to resolve environmental issues because he/she has obtained the cognitive processing skills
to make informed decisions. His definition is based on Roth’s (1992) four strands of environmental literacy: knowledge, skills, affect and behavior.

Disinger thinks that it “derives its focus from four basic issues that take it well beyond the typical boundaries of science education, or any of the traditional disciplines: the interrelationships between natural and social systems; the unity of humankind with nature, technology and the making of choices; and developmental learning throughout the human life cycle” (Disinger, 1992, pp. 4-5).

The greatest progress towards an agreed-upon definition of environmental literacy occurred in 1994, when the North American Association of Environmental Educators (NAAEE) developed an environmental Literacy Framework that focuses on the following dimensions: cognitive (knowledge and skills), affective, environmentally responsible behavior, and involvement in environmentally responsible behavior. See appendix B for the complete framework with addenda.

The Need for Educational Programs that Promote Environmental Literacy

To get a picture of the state of environmental literacy in the United States a survey of environmental education showed an overall measurement of low to moderate environmental literacy (Volk & McBeth, 1998). They determined that the most promising ways to improve environmental literacy are through instructional programs and methods especially in the areas of “community investigations and citizenship participation and in environmental studies/management course” (Volk & McBeth, 1998, p. i).

Not only is the public low to moderately environmentally literate, there is a need to reach students early on to ensure the greatest benefit. “Young people’s environmental attitudes are particularly important because young people ultimately will be affected by
and will need to provide solutions to environmental problems arising from present-day actions.” (Bradley, Waliczek, & Zajicek, 1997).

Research has shown that without integrating ecological concepts into other subjects teachers are unable to develop environmental literacy in students. To improve environmentally responsible behavior educators must introduce materials on ecological concepts that are environmentally significant and “environmental interrelationships implied by these concepts” (Wilke, 1995, p. 28).

Programs that promote environmental literacy need diversity in the kind of program evaluation. In the United States, there has been limited use of qualitative evaluations in the fields of aquatic resource education and environmental education (Marcinkowski, 2001).

Environmental Literacy Building Programs

The NAAEE environmental education standards were developed to be used as guidelines to develop environmental literacy in students and environmental educators and to develop environmental curriculum that had a main goal to improve environmental literacy through education (McBeth, 1997).

In 1997 an independent commission on environmental education reviewed environmental education teaching materials to see if they were reaching the overall goal of environmental literacy. They found that good materials covered topics with appropriate depth and accuracy, and students and teachers both suffer if they do not have access to these types of resources (Salmon, 2000). The commission found that using the environment as an integrating concept (lessons that use mathematics and social science and include human interactions with the environment) can inspire students. They also
noted that there was a lack of teaching materials that presented “basic subjects that would need to be covered if students were to gain the knowledge necessary to make wise decisions about the environment” and that materials failed “to provide real information” (Salmon, 2000, p. 7). Some other recommendations by the commission are for educators to place “primary emphasis on acquisition of knowledge” and that teaching materials “should provide more substantive content in natural science and social science than they now provide” (Salmon, 2000, p. 7).

The design of environmental education curriculum should develop functional, cultural and critical environmental literacy. Functional literacy involves basic knowledge of ecological concepts. Cultural literacy ties in the values that the environment provides for society. Critical literacy is to use functional and cultural environmental literacy to take appropriate actions (Morrone, et. al., 2001). When these methods are used “some researchers have reported that junior high and high school students exposed to environmental courses demonstrate an increase in responsible environmental behavior and an increased awareness of environmental issues.” (Bradley, et al., 1997, p.102). The results from this research showed “that increased knowledge may help improve environmental attitude. Granted, outside influences such as life experiences, socioeconomic status, and culture probably influence environmental attitudes as well.” This proves that attitude can be influenced by classroom instruction. (Bradley, et al., 1997, p. 104).

Some programs go beyond just providing knowledge and awareness, but have found that decision making and action components aid in the improvement of environmental literacy. It has been determined in studies conducted by Culen (1994), Holt (1988),
Jamaluddin (1990), Ramsey (1993), Ramsey and Hungerford (1989), and Withrow (1988) that students’ perceived skill in the use of environmental action strategies has been significantly increased when students were exposed to issue-related instruction (McBeth, 1997).

**Wetland Education Programs and Materials**

Wetland loss is a worldwide issue and is a popular subject of environmental education curriculum because wetlands “are numerous and can be found close to most places of learning, making them interesting and excellent sites for environmental education” (Wishart & Porter, 2003 p. 46).

Good wetland education should fall within the concept of good environmental education that develops knowledge, experiences and skills to be able to evaluate issues and make informed decisions and actions (Wishart & Porter, 2003). Some national and regional wetland educational programs that achieve this goal are Environmental Concern, Inc. and the Watercourse’s WOW! The Wonder of Wetlands, JASON Expedition: Disappearing Wetlands, and some materials such as Environmental Protection Agency’s A World in Our Backyards and U.S. Geological Survey National Wetlands Research Center’s Fragile Fringe: A Guide for Teaching About Coastal Wetlands. It is most important to evaluate these kinds of programs to see what, if any, effect they have on environmental literacy of the subject. The following is a closer look at research done internationally on changing adults’ and children’s attitudes and understandings of wetlands.

A study was done in England to assess perceptions of wetlands and “educational failings as a barrier to wetland restoration” (Rispoli & Hambler, 1999 p. 467). This study
used a social survey among four social groups, and an informal interview-based survey to identify other perceived obstructions to wetland restoration. The researchers of this study concluded that posteducation did not affect attitude and that women were more favorable to wetland restoration than men. One impediment toward wetland restoration was that individuals felt restoration was impossible or a waste of money, the researchers suggested a reason for this response was because men and women were not knowledgeable in restoration ecology. Rispoli and Hambler (1999) found that there was a “will to conserve wetlands and to restore them… [and] education should focus on the remaining misunderstandings and misapprehensions [of wetland restoration]” (p. 478).

In Canada, there has been a push to support wetland education with a 10 year vision of programs to produce individuals that understand and “celebrate Canada’s wetland heritage, appreciate the tremendous values wetlands provide for their personal well-being, realize the vulnerability of wetlands and are inspired to take action to protect and restore wetlands in their communities” (Wishart & Porter, 2003, p. 43).

The Canadian researchers based the need for wetland education progress on the fact that “people are both the problem and the solution relative to wetland conservation; human actions result in negative, neutral or positive consequences for wetlands. The outcome depends on the level of ecological literacy of those involved” (Wishart & Porter, 2003, p. 44).

A wetland based issue and action instructional program developed by Marcinkowski, Anderson, Drag, English, Lunsford, and Sward (2000), focused on a particular geographic region, the Greater Everglades Watershed because it allowed “scientific/ecological foundations to focus on the natural history and ecology of the
region” and allowed for a “wider range of region-specific problems to be addressed” (Marcinkowski, 2001, p. 108). The program included a content background to aid in the understanding of complex problems related to restoration in a watershed.

Another wetlands-based issue and action instructional program was developed by Culen in 1992 called *Wetlands: A Major North American Issue*. The subjects who participated in the research of this program included 15 classes of seventh and eighth grade students. The major finding of the researchers was curricula provided “the necessary knowledge about environmental issues, tools to adequately review these issues, and citizenship skills to help resolve these issues” which were essential in promoting responsible environmental behavior of the subjects (Culen & Volk, 2000, p. 9).

**Testing Environmental Literacy**

The Middle School Environmental Literacy Instrument (which will be referred to as the MSELI for the remainder of the paper) as discussed by McBeth (1997) is an assessment method made of two tests: one to test students foundations or familiarity of ecological knowledge, and a second one that is made of two parts: the first focusing on students’ perceived knowledge and skills of environmental action and behavior, and the second on issue identification and on appropriate actions to take to make a change (McBeth, 1997).

McBeth (1997) cited Roth (1992), who had found most instruments that existed to assess environmental literacy were either designed for specific one-time use or focused only on traditional aspects of environmental literacy. McBeth (1997) saw the need for longitudinal assessment to evaluate how environmental education has progressed and where it should go.
The MSELI used several different categories of questions, open-ended and Likert-like in the demographic and issue analysis and citizenship action sections, and open-ended and multiple-choice questions in the issue awareness and ecological foundations sections.

The variables tested by Wilke (1995) were familiarity of issues, ecological foundations, self assessed environmental action knowledge, self assessed environmental action skill, self assessed environmental action taken (environmental behavior), environmental issue statement selection, issue analysis score, and action plan selection. Project director Wilke (1995) found that middle and high school students involved in the study did performed poorly on measures of environmental literacy. Even though student scores varied significantly between participating groups, he found no clear pattern emerge between groups.

Wilke (1995) also stated that parallel studies had been conducted using the middle school instrument, the studies found students who had participated in a one-semester research-based environmental education program scored substantially higher than any of the groups of students involved in the study. These comparisons showed that students exposed to substantive environmental education curriculum improved their scores on environmental literacy.

Culen’s *Wetlands: A Major North American Issue* pretest and posttest consisted of eight multiple choice questions and 10 true/false on wetland related ecological concepts and on overt environmental behavior. Students were asked to list any actions he/she taken in each category. Culen and Volk found no significant difference results from pretesting between groups. They used two levels of treatment, one group received
information on science foundations, issue awareness, issue investigation and evaluation, and citizenship action; the second treatment group received information only on science foundations and issue awareness. They found no significant difference between the two treatment groups but found both groups did significantly better than the control group on the posttest (Culen & Volk, 2000).
Chapter 3

Materials and Methods
Overview

The main purpose of this study was to see if the environmental literacy of middle school students participating in Louisiana Sea Grants Coastal Roots project was improved by the addition of a formal education component. To increase students’ knowledge of wetland and coastal ecosystems and their related issues, six lesson plans were developed by the researcher to give students a broad view of Louisiana wetland habitats, wetland functions and values, wetland issues, and deltaic geology. To assess the validity of the lessons a mixed methods approach was used to gather quantitative and qualitative information. The researcher developed, refined and administered pretest and posttests to gather quantitative information. Qualitative information was used as a means for a more in-depth look into what students had learned. Classroom observations and group clinical interviews were conducted; these methods provided additional opportunities to view a student’s ability to communicate a knowledge of wetlands.

An application for exemption from institutional oversight form was sent to Louisiana State University’s Institutional Review Board for Human Research Subject Protection, because exposing the subjects to the treatment was not harmful nor personally invasive.

Subjects

The schools participating in the research were picked purposefully, based on teacher performance. Both treatment and control groups at each school were selected from middle schools participating in Coastal Roots. From each class, within the treatment group two boys and two girls were picked randomly to be interviewed.
The majority of schools participating in Coastal Roots were at the middle school level and the teachers at these schools had incorporated the program directly into the science classes, therefore three middle school classes were chosen out of the seventeen elementary through high schools participating in Coastal Roots.

A total of 155 seventh- and eighth grade-students participated in the research. The schools involved consisted of one public middle school, BGMS, on the fringe of New Orleans, and two Catholic schools, LGMS and NGMS, in the city of Baton Rouge. See appendix B for demographic details. These schools were chosen because the teachers had participated in Louisiana Sea Grant’s Coastal Roots Project for at least two years and because the teachers were of relatively equal teaching caliber and had similar enthusiasm toward the project.

BGMS is a public middle school located outside of the greater New Orleans metropolitan area. The school is situated at the edge of the town across the street from the Mississippi River in a small town flanked by several petrochemical plants. The school is made up of several buildings connected by covered walk ways. Two seventh-grade classes from this school, both under 20 students each, participated in the research. The classroom is large and flanked with aquariums and terrariums. The classes are run in a block schedule allowing for 90 minutes of class time.

LGMS is a parochial school located in a medium-sized city, off a busy road and across the street from several small businesses. Behind it are low-income apartments and houses. The school is part of a larger church property and is situated next to the church and its community center. In front of the school is a large field containing a baseball diamond and bleachers separating the school from a busy street. The school itself is made
up of several small, one-story buildings. The sole eighth-grade class at the school was chosen as part of the treatment group. It is the largest class that participated in the research, with a total of 32 students placed into the smallest classroom. The length of the class periods were 45 minutes. Because LGMS only had one eighth-grade class there was not a class for the control group. LGMS is similar demographically to NGMS; therefore one of the two classes participating in the control group at NGMS represented the control group for LGMS.

NGMS parochial school is located off of a moderately busy street in a middle- to upper-class neighborhood in the same city as LGMS: both schools are run through the same diocese. The school is located next to the church and across the street from several other church-owned buildings. The school itself is made up of several small buildings. This school had the largest classroom, about twice the size of an average classroom, with four lab tables in the back. The three eighth-grade classes, with a little over 20 students per class, participated in the research—two as control groups and one as the treatment.

The total size of the treatment group was comprised of 76 students (n = 76) and the control group of 79 students (n = 79). Because of absences for various reasons, a number of students, eight from the treatment group and six from the control group, did not complete the pretest and posttests and therefore these students were not included in the statistical analysis.

Procedure

Both quantitative and qualitative methods were used to measure change in students’ environmental literacy. The quantitative methods included formative pretest and (summative) postinstructional tests. The qualitative methods were used to determine if
students retained long-term knowledge and use of terminology of lesson topics, and to 
see if students had become sensitive toward coastal wetland loss issues.

**Table 1. Time Period of Research**

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Teachers took on average 2 to 3 weeks to teach lessons to their students during 
the months of November and December; observations were made during this 
time.

At each school the pretest was administered to both the treatment and control 
groups on the same day. Prior to the test the researcher explained to the students the 
purpose, procedure, and the voluntary nature of the research, as well as the benefits. 
Before the preinstructional test was administered the purpose and directions of the test 
were explained to the students.

The completion period of the lesson administration at the schools varied from two 
to three weeks. All teachers taught the lessons in a consecutive order and each new lesson 
was taught at the following class time. During lesson administration observations were 
conducted by the researcher who visited each of the three schools four times to observe 
each of the lessons administered twice. The observation method used was Spradley’s 
(1980) “grand tour” model, a comprehensive observational strategy. There was some
minimal interaction of the investigator with the subjects during the observation period. This included answering questions from the teachers and aiding the teacher in answering operational questions of the students about the lessons directions.

The observations allowed for an opportunity to find flaws in the lesson plans and to see if adequate instructional material was provided to the teachers to relay the main points of the lessons to the students. Observations allowed the researcher to see the classroom dynamics, including student-to-teacher and student-to-student communication.

**Lesson Plans.** The lessons were developed using a multi-disciplinary approach and written in the 7E model. To view lesson plans in their entirety see appendix C. The topics for the lessons were chosen based on communications with the teachers of where their students were having trouble understanding concept or process. With the current emphasis of high standards for educational materials each lesson was designed to meet one or more Grade Level Expectation (GLE).

Each lesson also included a visual component a short video to reinforce the main concepts of the lesson. Each video clip was compiled from several sources and the clips were edited to get a whole view of the main lesson concept. With the use of methods to reach the needs of different learning styles, a greater majority of the students could be reached. Another emphasis in science education is group work; therefore each lesson included a group work activity. The lessons were designed to be taught in a sequential order, introducing basic information about wetlands and then relate it to the other lessons. The lessons progressed through an understanding of what makes up a wetland, to the values it provides humans, to interactions with the wetlands and their causes and effects, and finally to the geology of a delta plain to help students understand why there is
wetland loss in Louisiana. The decision to use a sequenced order to the lessons is supported by research that showed components of environmental literacy can be positively impacted by instruction that have a logical and meaningful order.

“We cannot teach scientific and ecological concepts in isolation and simply expect the learner to see societal implications. Neither can we teach socio-political understandings and expect the learner to automatically apply them to environmental problems and issues. And we most decidedly cannot teach environmental actions without the concurrent development of skills in accessing and processing information and without the analytical and evaluative dimensions of decision-making.” (Volk & McBeth 1998, p. 46).

The research results further stress “Lessons about environmental issues can be coupled with lessons in mathematics to give students a deeper understanding of probability and a broader information base that could be used to inform more thoughtful decision making”(Arvai, Campbell, Baird, & Rivers, 2004, p. 38). “Studies of environmental issues can be coupled with lessons in history and social science to help students to overcome the availability bias. Here, in exploring preferences about environmental management options, students should be encouraged to explore and incorporate the history and the social implications of the issue they are facing” (Arvai, et. al., 2004, p. 38). Each lesson developed also included either mathematics, social studies, or art GLE.

Lesson Plans Developed for the Research:

1. Marshes, Swamps and More – Students will be introduced to three characteristics of wetlands and common wetland types in Louisiana.

2. Valuable Wetlands – Students will learn about the numerous natural resources and functions that wetlands provide.
3. Surviving the Storm – Students will gain an understanding of what storm surge is, then relate it to a real-life situation by making a map of a wetland, finding a place on the map to build a “camp”, and finding out what happens when a hurricane hits.

4. Summing up Subsidence – Students are introduced to subsidence, what it is, and the natural and human factors that cause this process.

5. Salty Channel – Students are introduced to the concept of saltwater intrusion and its impacts on a freshwater marsh habitat, by acting out a scenario.

6. Shape Changer – the Story of a Delta - Students will learn the delta cycle. Delta formation combines all of the information from the prior lessons.

Wetlands Knowledge/Awareness/Issues Test. Pretest and posttests consisted of the same 10 open-ended questions. These questions were picked to assess long-term memory or knowledge gained from the six lesson plans. Questions 1, 2, and 5 specifically focused on content knowledge of wetland environments specifically Louisiana’s.

1) What are three characteristics of a wetland?
2) Name three types of wetlands we have in Louisiana?
5) How are wetlands beneficial/valuable to people in Louisiana?

Questions 3, 4, 6, and 7 focused on students’ content knowledge of Louisiana’s geology. Question number 6 on erosion was asked, but no single lesson focused specifically on the topic, though it was mentioned in several of the other lessons.

3) How was south Louisiana formed?
4) Are we or are we not losing land in Louisiana? Give some reasons why.
6) What is erosion?
7) Have you ever heard of the word “subsidence”? If so, define the word.

Question 8 specifically focused on students’ ability to connect what was taught in school to current issues in the media and to further see their personal connection to the issue.
8) (A) Have you ever seen on television, heard on the radio, or read in a newspaper or magazine about efforts by the Louisiana government to help prevent coastal erosion? Explain where. (B) If so, do you think this is a problem that will affect you? Explain why.

Questions 9 and 10 focused on comprehension of graphical or tabular representation of data which are both basic science literacy skills. The question topics were relevant, 9 a graph of the Mississippi River’s average flow rate over a year’s time, and 10 a table of when different Mississippi River deltas formed. Neither question needed a student to know background information on the subject to be able to answer the questions. The table from question 10 was in lesson 6 so students may have been more familiar with it when they took the posttest.

Open-ended questions were used instead of multiple-choice to decrease the possibility of students correctly guessing the answer. The use of open-ended questions allowed one to see if the student understood the concept enough to properly communicate their comprehension through writing. One of the most important parts of science is the ability to communicate.

The Interview Process. Only the treatment group was interviewed. Four students and the researcher read aloud as a group an article from the National Geographic Magazine entitled “Gone with the Water” (Bourne, 2004) that focused on Louisiana’s wetlands and land loss issues. This article was picked to accompany the interview because it connected the content information in the lessons to what is currently happening in Louisiana. The article also contained several concepts students learned in class that could work as retrieval cues for students to access information stored in their long-term memories. A prop was used in the question portion of the interview; the prop was made of a metal paint tray with blue and green clay spread across the surface to resemble a
coastal wetland. To answer questions students manipulated the prop with addition of clay or the researcher manipulated clay with the aid of student directions.

The interview protocol is located in appendix F. Because of students’ questions to the researcher and their interests, the amount of questions asked varied slightly, though all primary questions on the protocol were asked. The interview was recorded on audio tape and, during transcription, students names were removed to maintain anonymity.

Experimental Test Reliability and Validity

The experimental pretest and posttests developed were similar in assessment of environmental literacy to other developed tests because their focus was mainly on ecological knowledge and environmental issues. Most studies of environmental literacy focus on one or more components; the majority focus on assessment of ecological knowledge, followed by knowledge of environmental issues, and a few studies focus on responsible environmental behavior (Volk & McBeth, 1998).

Volk and McBeth’s (1998) study showed that there was a diversity of instruments used to measure environmental literacy because most researchers chose to generate their own. This research supports the suitability of the development of an experimental pretest and posttest by the researcher that focuses specifically on wetland knowledge, awareness, and issues. To further ensure that the experimental test was reliable and valid the testing instrument was examined by a professional test-maker of state science assessment tests, who examined questions for clarity, desired answer, and relevance to lesson subject matter.
Data Analysis

The researcher used a rubric to grade the pretest and posttests of the control and treatment groups. See appendix E. The rubric was used to convert each answer to a question a numeric value that was used in quantitative analysis. The statistical power analysis of a randomized block design with repeated measures was used to determine experimental and sampling error. The experimental error included the school plus treatment and the sampling error was comprised of the student within the school plus treatment. An analysis was not done to see if there was a difference in environmental literacy between sexes because prior research literature has not shown significance. Volk and McBeth’s (1998) review of environmental education literature showed that some studies did find significance for gender but most did not, therefore gender does not appear to be a key variable when measuring for environmental literacy.

The qualitative analysis of observation and interview answers was done in the following manner. Observations were analyzed for similar cultural themes using Spradley’s (1980) participant observation method to develop domain analysis of cultural meanings in social situations. The group clinical interviews were first transcribed, then answers to questions among schools were analyzed.
Chapter 4

Results and Discussion
Overview

The inclusion of a mixed methods approach to analyze this research study was beneficial because information from both the quantitative and qualitative dimensions were used to support outcomes in each section of the results chapter.

Observational Analysis

During observations the researcher attempted to only observe, although on several occasions the researcher nominally participated. Such participation included clarification questions by the teacher, answering a student’s question that the teacher could not answer, aiding teachers in answering basic questions about blackline masters (worksheets).

Based on the classroom observations very minor changes need to be made to some of the lessons. The third lesson entitled Surviving the Storm overestimated students’ ability to draw a map from descriptive paragraphs and the time that it would take students to cut out and paste objects onto paper. Therefore the suggested length of the lesson will be changed to two 45-minute class periods. The teachers made several minor changes to the lesson plans to meet the needs of their students.

The teacher at BGMS made a minor modification to lesson three, Surviving the Storm. Numbers were added for the latitudinal coordinates and letters for the longitudinal coordinates for each square on the grid map to make it clearer for his students to answer a question on the student worksheet.

The teacher at NGMS modified lesson two, Valuable Wetlands, by turning the group activity into a matching activity in which each students matched the values to the
objects that could be used to represent them. Then as a class they discussed their answers and why they chose them, so the main points of the lesson were still accomplished.

The teacher at LGMS made a very minor modification to lesson four, Summing up Subsidence, by creating a student handout from the overhead transparency that visually describes the causes of subsidence. On this handout the names of the causes of subsidence were removed and students filled them in as the represented image was described.

Overall students appeared to understand the directions and were able to do the lesson. Many students looked as though they enjoyed the video clips by their responses of laughter. The length of the videos seemed appropriate because many students said “that was it?” when the video ended and during the video students were not working on other tasks, therefore their attention remained on the video. Observing the class gave the researcher a better understanding of the class dynamics and it allowed the researcher to see if the teacher was able to reach the lessons goals completely in the time allotted. It also allowed the researcher to see if the students found the lesson to be of interest and if the lessons were too difficult or too simple.

Pretest and Posttest

Using a randomized block test with repeated measures statistical analysis on treatment and control groups’ pretest and posttests were run using SAS 8.2 software. A significant difference in the posttest results between the treatment and control groups was found. There was no significance difference shown between students at the three schools, nor differences because of grade level. There was a significant difference among students within schools and treatment. There was no difference in the pretest and posttest scores of
the control group, but there was significant difference in the treatment group in pretest and posttest scores. There was no difference in the performance on the pretest between the treatment and control groups. These results can be seen in the following graphics.

<p>| Table 2. Contrast of the Mean Scores Between and Within Groups on Wetlands Knowledge/Awareness/Issues Test |
|-------------------------------------------------|-------------------------------------------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Control</th>
<th>Treatment</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
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<td>9.43a</td>
</tr>
<tr>
<td>Posttest</td>
<td>9.12a</td>
<td>15.65b</td>
</tr>
<tr>
<td>Significance</td>
<td>0.83</td>
<td>&lt;0.0001***</td>
</tr>
</tbody>
</table>

***Significant at p< 0.01; adjusted with Tukey-Kramer.
Means across rows having different letters have a significant difference between treatment type and means down columns having different letters have a significant difference within treatment type.

Mean Scores of Students' Test Performance

Figure 1. Pretest and Posttest Mean Scores on Wetland Knowledge/Awareness/Issues Test Between and Within Treatment Groups.
Further analyses of individual pretest and posttest performance were accomplished by examining the distribution structure with a double stem-leaf plot. Figure 2 illustrates a positively skewed unimodal distribution of the treatment students’ individual posttest scores reflecting the statistically significant results of improved environmental literacy. The double stem-leaf plot visually displays the almost mirror image distribution of the control group students’ individual performance between tests, reflecting no significant difference between pretest and posttest performance. Finally the double stem-leaf plot shows between groups there is a very similar unimodal distribution of individual pretest test performance. Therefore treatment and control groups had similar levels of environmental literacy before treatment.

<table>
<thead>
<tr>
<th></th>
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<th>Posttest</th>
</tr>
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<tbody>
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</tr>
<tr>
<td></td>
<td>3322</td>
<td>0</td>
</tr>
</tbody>
</table>

| **Control** | 2       | 2       |
|             | 2       |         |
|             | 1       |         |
|             | 7       | 1       |
|             | 555554  | 4444455 |
|             | 333333222222222 | 222222233333333 |
|             | 11111111100000000 | 000000000011111111111 |
|             | 999999999999999999999 | 889999999999999999 |
|             | 7777666666 | 666666666666666 |
|             | 5555     | 4445555 |
|             | 332      | 2       |

**Figure 2. Double Stem Leaf Plot of Student Performance on the Wetlands Knowledge/Awareness/Issues Test**

The double stem leaf plot shows the almost mirror image of test scores between the control group’s test performance reflecting no change of environmental literacy. It shows a significant increase in environmental literacy of treatment group between tests.
Mean score performance for each test question was examined to see if there was any similarity or differences within individual schools or among individual schools for both the treatment or control group. Then the treatment or control schools mean scores to each question were compared to the combined mean score per question of the respective schools.

**Comparison of Control Group Mean Score of Answers to Pre- and Post-tests**

![Comparison of Control Group Mean Score of Answers to Pre- and Post-tests](image)

**Figure 3. Comparison of the Control Group’s Mean Score of Answers to Individual Questions on the Pretest and Posttesting of Wetlands Knowledge/Awareness/Issues Test**

Numbers on top of each bar represents the maximum possible score for each question.

Figure 3 displays the control group’s performance on each question between the pretest and posttest. Ideally the graph reflects no change of knowledge between the tests. Control students did not know the answers to questions 3 and 7, which relate to content
knowledge on deltaic geology. Question 3 asks how southern Louisiana was formed and question 7 asks what subsidence is. An unexpected improvement between the pretest and posttest of the control group is on question 8, which reflects student’s environmental awareness of issues. One reason for this change could have come about because students watched a relevant television program between testing or because of piqued curiosity in the subject matter or by chance. Again unusual result is the decrease of knowledge about Louisiana wetland types (question 2) between NGMS’s pretest and post-scores, although the resulting change seen my not represent a significant difference and could be due to human error.

![Comparison of Treatment Groups Mean Scores Per Question](image)

**Figure 4. Comparison of the Treatment Group Mean Score of Answers to Individual Questions on the Pretest and Posttesting of Wetlands Knowledge/Awareness/Issues Test**

Numbers on top of each bar represents the maximum possible score for each question.
Figure 4 displays the treatment group’s performance on each question between the pretest and posttest. The graph should reflect that there is a change of knowledge between the tests. This increase of content knowledge of the treatment group is visible examining questions 1, 2, 3 and 7. These questions reflect the understanding of wetland characteristic, wetland types, formation of south Louisiana, and subsidence in that order, Students on average scored the maximum points possible for question 6 which students defined erosion and question 9 which students’ ability to read a graph was tested. The results showed that the lessons did not need to focus on these concepts or methods.

Two of the treatment classes showed no improvement of understanding for several questions, while the other two classes improved. This happened for BGMS on question 5 (wetland values and function) and for LGMS on question 8 (environmental issues awareness). It is not known why these schools did not improve understanding of these subjects.

NGMS students on average received the maximum points possible for their answers to question 4 (is land loss occurring if so why?) This improvement could be from the instructor reviewing this information with the class on several occasions. BGMS treatment students were the only ones to improve their ability to read the table on delta formation. It could simply be because these students were given a handout of the overhead with the table on it, though no instruction or perhaps an explanation about the table was given to the students by the instructor. The other class that the researcher observed teaching the related lesson did not review the table.
Interviews

A majority of the students correctly answered the main interview questions. If students did not answer correctly the first time or did not completely answer the question, the researcher asked more probing questions to help cue students to the correct answer. The researcher was somewhat surprised to find out that none of the students’ families subscribed to National Geographic. The researcher noticed that in one interview two of the students dominated the responses and a few students were quick with a response, not even allowing the researcher to finish the question. From the student responses, all seemed to have a good grasp of the concepts and have stored them in their long-term memory. Several of the students in the interview groups used the proper scientific terms in their responses. Of the three groups, the students at NGMS most often used scientific terms correctly in their responses. The students from BGMS, needed more prompting to answer some questions. This may be due to their younger age or the distractions that occurred during the interview. At the BGMS interview the tape recording device started to malfunction, so the interview was restarted and another recording device was used. Other disturbances to the interview at BGMS occurred when, at separate times, two students passed through the interview area.

1. Do any of you receive National Geographic magazine at home? Have any of you read this article?

Student Response

NGMS  •  None of the students’ families subscribed to National Geographic magazine and none of them had seen the article before.

BGMS

LGMS
2. Does anyone have any questions about the article?

Student Response

LGMS  • What about what they said about the drinking straw? That we have channel pulling water closer to Louisiana so that the land is eroding. Referring to: “when you stick a straw in soda everything goes down” (Bourne, 2004)

The student at LGMS brought up a good question. She did not understand the metaphor the author used to give a simple definition to depressurization. At the next interview the researcher made sure to discuss this concept with the NGMS students because depressurization is a contributing factor to subsidence.

3. What did you find most interesting from reading the article?

Student Response

NGMS  • About the oil, that is causes erosion
          • Did not know we had so many oil rigs
          • Land loss rates

BGMS  • How much land we are losing
          • The thing that most interested me was how much land we lose a year and how they are trying to build a gate in the levee to make the annual floods
          • In 33 minutes how much land its lost

LGMS  • How the house vanished from the first picture (referring to the image of a man holding a photo of his grandparents house above his head standing in
the chest deep water where the front yard once was).

- How much land from Louisiana is gone now
- There is a very large amount of oil we have coming from Louisiana

Students in general were surprised at how fast and how much land is and has been lost from coastal Louisiana. It was also interesting to see that students did not believe that Louisiana is an important source of oil for the nation, especially since the cities and towns they live in are surrounded by petrochemical plants and many of their parents or family members are employed at one.

4. Has learning about the wetlands had any change in your attitude about raising the wetland trees in your school’s nursery?

Student Response

NGMS
- Yeah
- We planted a cypress tree at my house

BGMS
- Missing: tape recorder failed to record, prior to change to a second recorder

LGMS
- Our trees at the school well there not (finished by another student) There not doing so well
- Students tangent response to the question: I heard that they use our Christmas trees, to like, put them in a bag, to stop erosion (Did you do that?) yeah

The purpose of this question was to elicit an answer of students’ environmental concern or lack of, and to see if students make a connection between raising the trees and
content knowledge about wetlands. Students showed environmental concern with their positive answers.

5. What do you remember about some of the concepts you learned, such as subsidence?

Student Response

NGMS • I did not know about hydrophytes

Students were asked to recall the other wetland characteristics

• Hydrology

• Hydric Soils

What is the term when land sinks?

• Subsidence

BGMS After the river builds the land what happens to the land naturally?

• It erodes away

• Sinks

What is the scientific word for sinking land?

• Its subsidence

LGMS What is subsidence?

• The wearing away of the land

• Where the water goes over the land

• The sinking of the land

The NGMS students had a better grasp of the scientific terminology and understanding of the concepts, than the other two schools. This could be because the
instructor at the school has a tendency to repeat the important information from the prior day’s lesson.

6. Will one of you show me how a delta builds using the prop. How does the Mississippi River build land?

Student Response

NGMS • It builds a little bit, and like more, and more it raises it more and more each time (as girl places clay on either side of the “river mouth” building out first then to the side). It looks like a bird’s foot. Can I make the bird’s foot?

BGMS (researcher manipulated model with student answers):

Here is our river how does land build?

- It (Mississippi river) takes mud from all the other states
- The sediment from the river, all the mud picks up and it lays down
- It (Mississippi river) slows down so the sediment stays

Do you want to show how it gets laid out?

- It goes here and then some starts to build around the mouth

LGMS • It carries like, the river carries sediment down and it starts to build up land out in the Gulf or out where ever it is going

Which way does it build it?

- It like build out then like this on both sides

Where does it go next?

- Further out into the ocean

When the delta switches course what happens to the land?
• It subsides
• It sinks

At all schools the students seemed to have a good grasp of delta formation. At each school a female student volunteered to build the delta on the prop out of clay.

7. Where is the different wetland types located, using the mouth of the Mississippi River on the prop? (freshwater marsh, salt marsh and swamp)

Student Response

NGMS • Because the river is fresh water, so it (the freshwater marsh) is right by the river so it is would probably be fresh

BGMS • (location of salt marshes) Most of the time it would be off to the side away form the mouth of the river

LGMS • Salt or brackish (marshes next to the river mouth)
• Freshwater marshes (next to the river mouth)

Students and researcher used the prop with the newly constructed delta to point out the locations of different wetlands types. From the answer you can see that students sometimes did not get the correct answer immediately, though with further probing by the researcher, asking what kind of water is found in rivers versus the Gulf of Mexico, students quickly gave correct answers.

8. What if we dig a channel into the marsh (place a channel on the prop)?

Student Response

NGMS • Salt water comes into freshwater marshes, (then what happens?) it kills the
plants and animals (does it really kill the animals?) they move further in land.

- (If the vegetation dies what can happen?) its from salt water, erosion
- (What happens to the channel?) it gets wider

BGMS - Because the plants are not used to the saltwater and it can destroy the plants and so it exposes the soil and causes erosion

LGMS - Its just kind of dying off, the plants are dying and the animals are leaving
  - It starts to erode
  - To subside

Students were willing to answer how human-made channels caused saltwater intrusion to occur in freshwater wetlands and what affect the salt water had on the plants and animals. It is possible that students had the knowledge and the terminology to describe this situation, because the lesson on this subject is a class play activity where they each acted out a role of a freshwater or salt marsh inhabitant.

9. Where is the majority of land loss occurring (using the aid of the National Geographic “Lost Coast” image)?

Student Response

NGMS - I think the interior (of the marsh)

BGMS - It looks like its (land loss) inside

LGMS - Similar question: Is subsidence/land loss just a problem along the edge of Louisiana, along the coastline?
  - No its like everywhere
This question was accompanied by the researcher demonstrating an example of how interior marsh loss occurs.

At the end of the interview several students from different schools said that it was very helpful to have a visual model to aid in the understanding and manipulation of concepts.
Chapter 5

Summary and Conclusions
Summary

The students studied who were participating in the Coastal Roots project benefited from the inclusion of an educational component that focused mainly on content knowledge of wetlands and deltaic geology. The students in the treatment group significantly improved their content knowledge of wetlands and deltaic geology. This improvement can be seen by comparing the average pretest score to posttest: students averaged 6 points more out of 23 above their pretest performance resulting in a 26 percent improvement. In contrast the students in the control group on average did not improve their content knowledge of wetlands and deltaic geology during the duration of the study. The quantitative information was supported by the responses of students’ participation in the group interviews and that demonstrated this new content knowledge made it into the students’ long term memory.

One limitation to the study was only a small portion of the schools participating in Coastal Roots were willing to participate in the research. This limited the ability to generalize the results.

Conclusions

“In the end, we will conserve only what we love, we will love only what we understand and we will understand only what we are taught” (Dioum, 1968).

This research study showed that the addition of six highly innovative lesson plans developed to introduce students to wetland ecosystems, wetland issues and deltaic geology can improve students’ ecological knowledge. It addressed the concern that often in environmental education student only received value- and attitude-focused lessons to
improve their environmentally responsible behavior. The research also provided Coastal Roots with a carefully designed, classroom-tested, constructivist-type, active-learning-based science unit, which appeared to help students to develop an attitude of stewardship toward our natural resources.

**Future Research**

For future research, several changes should be made to the materials and methods. Included with the lessons should be a description of how to use the material in the classroom. An example would be to suggest that more than one class period be devoted to each lesson concept. Another form of assessment should be used along with pretest and posttest to get a better understanding of student general environmental literacy.

This new assessment could be modeled after the MSELI (McBeth, 1997) which is a comprehensive, unbiased instrument that is appropriate to examine longitudinal assessment of environmental literacy.

A study should be developed to look into why students have certain misconceptions about wetlands. Specifically, we need to find out why students overwhelmingly answered that a type of wetland in Louisiana is a “bayou”. A bayou is a waterway with slow current. Did students accidentally write it instead of “bog” because they are more familiar with the word “bayou” or do they really think that a bayou is a type of wetland? This is an important question to answer for science instructors in the South, as is the reasoning behind other student misconceptions. These misconceptions must be addressed in order for students to further develop scientific understanding without gaps or flaws.
“In general information that is encoded in terms of a rich and detailed representation of the world is likely to be more accessible than material that is processed in terms of a simpler or more impoverished scheme” (Baddley, 1999, p. 117).
References


Appendix A

School Demographics
## Schools Demographics

<table>
<thead>
<tr>
<th>School Name</th>
<th>Parish</th>
<th>Public/private</th>
<th>Grade</th>
<th>Number of Students</th>
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</tr>
<tr>
<td>NGMS</td>
<td>East Baton Rouge</td>
<td>Private</td>
<td>Eighth</td>
<td>77</td>
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<tr>
<td>LGMS</td>
<td>East Baton Rouge</td>
<td>Private</td>
<td>Eighth</td>
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Appendix B

Environmental Literacy Framework
Environmental Literacy Framework – with addenda
Revised, April 23, 1994

I. Cognitive dimensions (knowledge and skills)

A. knowledge of ecological and socio-political foundations

Ecological foundations have been extensively developed and are consistently revisited in different parts of the country. However, socio-political foundations are in their “developing stages.” Though in need of refinement, their importance is increasingly recognized in the EE field. If one bases decisions solely upon knowledge of ecological foundations without the complement of socio-political ramifications, significant errors are possible.

B. knowledge of and ability to identify, analyze, investigate and evaluate environmental problems and issues

Both this point and the next two imply the need for skills such as critical thinking, problem solving and group cooperation. Issues could be categorized under the following five categories: human population, biodiversity, land use, natural resources and pollution.

C. knowledge of and ability to apply environmental actions strategies seeking to influence outcomes of environmental problems and issues

D. ability to develop and evaluate an appropriate action plan for the resolution of environmental problems and issues

Together, these four capabilities are what enable an individual to get involved in the behaviors outlined in section IV.

II. Affective dimensions

A. recognition of the importance of environmental quality and the existence of environmental problems and issues

In addition to the aesthetic and ethical reasons for environmental maintenance, the reality of human dependence upon a healthy environment must be incorporated into that understanding.

B. empathic, appreciative and caring attitude toward the environment

C. willingness to work toward the preservation and/or remediation of environmental problems and issues

III. Additional determinants of environmentally responsible behavior

A. belief in their ability, both individually and collectively, to influence outcomes of environmental problems and issue

B. assumption of responsibility for personal actions that influence the environment

These have been listed as “additional determinants” because the cognitive abilities and the desires which spring from affective dimensions are very strong contributors to an individual’s actual actions.

IV. Personal and/or group involvement in environmentally responsible behaviors

Environmental action can be small personal changes in the way an individual chooses to live, on up to extensive/intensive group environmental action efforts. Since each “level: could be described as “equally desirable,” the following categories were designed to describe different “types” of action, which would allow assessment of varying levels of involvement.
A. ecomanagement – e.g., actions such as using a more energy efficient form of transportation, reducing consumption of energy or water, improving wildlife habitat, recycling, etc.

B. economic/consumer action – e.g., purchasing products in returnable/reusable containers, avoiding purchase of excessive packaging, avoiding items with toxic by-products, providing financial support to an environmental organization, boycotting products considered to be damaging to the environment, etc.

C. persuasion – e.g., using informal discussion to encourage another to support a positive environmental position or action, distributing “pro-environment” literature, signing a petition, encouraging another individual or group to stop some kind of destructive behavior, writing a letter to a person/group/company to stop an action that has negative environmental consequences, giving a speech, etc.

D. political action – e.g., writing letters or speaking directly to elected officials on behalf of an environment issue, supporting by time or finances a candidate or lobbying group based upon an environmental issue, running for or serving in an official capacity with the intent of supporting pro-environmental positions or actions, etc.

E. legal action – e.g., reporting violations in pollution/littering, fishing, trapping or hunting laws or plant or animal collecting to the authorities, working with authorities to patrol areas for enforcing environmental laws, providing information or testimony at a legal hearing or participating in a lawsuit against a person/group who has violated a law aimed at protecting the environment, etc.
Appendix C

Lesson Plans
Focus
This lesson introduces students to the three characteristics of wetlands and common wetland types in Louisiana.

Background Information
A wetland is an ecotone, a transition zone between aquatic and terrestrial ecosystems. A wetland is commonly defined by these characteristics hydric soils, hydrology and hydrophytes.

Hydric soils are soils that have low oxygen content to anoxic (no oxygen) and filled with water. Hydric soils develop in areas where the ground is saturated, the water table is near the surface or just below, or the ground is submerged in up to 3 meters of water. This type of soil can not support aerobic respiration that upland plants need to survive. Hydric soils are composed of organic or mineral matter and are well drained, able to drain out water quickly, to very poorly drained soils. Organic soils contain decaying plant matter and this organic soil is referred to as peat when the decomposed plant matter is still identifiable. Mineral soils contain mainly sand, clay, and silt. Wetland soils range from highly organic to highly mineral.

Hydrology is the circulation and distribution of water and determines the type of wetland. The hydrology causes the variation of water depth, duration and frequency of flooding, flow of water, and is influenced by the topographic location. Some wetlands are only seasonally saturated, during the growing period, and last for enough consecutive days to support hydrophytes (water plants) or hydrophylllic (water loving) vegetation.

Hydrophytes are plants that have adapted to living wet soils. These soils may be periodically to permanently flooded. Hydrophytes come in many different forms, trees, bushes, grasses, floating or submerged plants. One way they have adapted to these stressful conditions is to have modified root structures which allow oxygen to get into the roots even during periods of flooding. Pneumatophores are an example of a modified root structure and can be found on black mangroves (Avicennia germinans) as part of the root system that
extends out of the water to supply oxygen to the roots. Many other hydrophytes contain *aerenchyma tissue*, air spaces, in the roots and stems, which allow oxygen to travel from aerated portions to the roots even in flooded conditions. Some wetland trees have buttressed trunks, where the tree gets wider at the base to support the tree in standing water. Bald cypress (*Taxodium distichum*) is buttressed and has another support feature “knees”, portions of the root that bend up out of the ground.

The term wetland does not have one distinct definition, so one can find several different definitions of a wetland. For examples of several formal wetland definitions, see Blackline Master #1 and #2.

Wetlands are found all over the United States from coastal areas to the Alaskan tundra. Louisiana has 40 percent of all coastal wetlands in the continental U.S. Louisiana has more than just coastal wetlands; there are also inland swamps, marshes, pitcher plant bogs and wet prairies.

Swamps are wetlands that are vegetated by trees and shrubs (woody vegetation) and are periodically flooded. Swamps in Louisiana are dominated by bald cypress and water tupelo (*Nyssa aquatica*) trees. Near Fourchon and Grand Isle, Louisiana there is a unique kind of swamp, a mangrove swamp. The mangrove swamps are dominated by black mangrove trees which will reach up to two meters. Black mangrove in most of its range is known to reach up to 50 feet in height, but not in Louisiana because Louisiana is the most northern extent of its habitat range. The trees here are shorter because the climate is cooler and the trees are subject to freezing.

Marshes are dominated by *herbaceous* vegetation, grasses and sedges. Marshes are often constantly flooded and found in low lying areas of inland and coastal regions. The coastal marshes are inundated by the tides, which bring in nutrients and flush out wastes. Marshes can be supported on a variety of soil types from clay to highly organic peat (decaying plant matter). There are a variety of marshes in Louisiana including freshwater, intermediate, brackish, and salt.

Another type of wetland is a bog. Bogs can be found on top of hills or in low lying areas, all bogs have acidic peat soils, but the vegetation varies from moss to berry bushes. In Louisiana there are a few pitcher plant bogs located north of Lake Pontchatrain.

Although wetlands vary greatly in appearance, they still have three common characteristics no matter where they are located geographically all have hydrologic conditions that support hydric soils and hydrophytes.
Learning Objectives
Students will:
- Use illustrations and writing to communicate their understanding of a wetland
- Develop a definition of a wetland
- Be able to describe the difference between a marsh and a swamp

Procedure
Note: Students will use one colored pencil for the first part of the lesson to draw and write about what they think is a wetland. After formal definitions of wetlands and the differences between common wetland types in Louisiana are explained, students will add to their drawings and descriptions using a second colored pencil.

Elicit
Tell students they will be participating in the Coastal Roots Project, joining 16 other schools in the state. Inform students last year’s class planted wetland plant seeds and now they will raise these seedlings. In late fall or winter, on a field trip they will plant these seedlings to help improve a wetland habitat. In the early spring, students will plant seeds and raise the seedlings on the school campus for the following year’s class to plant.

Show students pictures of past planting field trips and tell students about the species of plants that they will be growing.

Engage
Inform students that they will learn about wetlands this semester. To find out what students already know about wetlands, hand out “What is a Wetland?” (Blackline Master #3). Explain to students that they will draw a wetland. Students will include as much detail and information as possible to describe a wetland. To assist students in coming up with an idea of what to draw and write about a wetland, ask students to pick a wetland that they have seen, or visited, and to use that experience to come up with detailed information. Ask students to include information such as: Where it is located (on a hill, near a river, etc.)? Is there water? What types of plants are found there? What makes these plants unique from desert and upland plants? What types of animals live there? What is the ground/soil like? Students should include any other information to help develop a description.

Explore
Students will split into groups to share their drawings and descriptions. Choose one person from each group to be the recorder, as each member has shared his/her drawing; the recorder will write down the characteristics from each description and determine similarities (Blackline Master #4).
Each group will share with the class one similarity from their drawings and descriptions. Write them down on the board or overhead. Continue until all of the groups have shared their answers.

**Explain**
Show students pictures of Louisiana wetlands (Blackline Masters #5, 6 and 7) and describe the unique features of each.

**Freshwater marshes** are dominated by herbaceous (non-woody) plants. Freshwater is a less stressful habitat for plants therefore there is great diversity of plant life in a freshwater marsh. In the picture you can see wild rice (tall thick grass), bull tongue (wide long leaves), and arrow weed (arrow shaped leaves), but there are many more plants including smartweed growing low to the ground and cow pea a vine. Standing water is in this marsh, it is very low to the ground and is covered by the thick layers of vegetation, but with each step you sink and leave little puddles as reminders of where you have been.

**Salt marshes** are also dominated by herbaceous plants, but are only located in coastal areas. The salt in the water and soil make it a very stressful habitat for plants therefore there is a low diversity of plant life in a salt marsh. The dominant plant of Louisiana salt marshes is smooth cord grass (*Spartina alterniflora*), the grass seen in the photo.

**Swamps** are dominated by trees, in the picture it is cypress tree. Point out the buttressed base of the trees and the knees. Cypress swamps are found in freshwater but mangrove swamps are found in saltwater so the salinity of the water is not a defining characteristic.

Then explain the three characteristics of a wetland.

As a class, use the information from the definition and the similarities from the groups to develop an accepted definition for a wetland.

**Optional:**
If time allows go over the formal definitions of wetlands (Blackline Masters #1and2), noting the differences between them. Ask students why would there be so many definitions and how different definitions cause problems. Point out that as knowledge grows on a subject matter definitions change. Scientists do not always agree and further understanding can be gained through these disagreements.

Make sure to go over any unfamiliar vocabulary terms:
hydric soil - soils that have low oxygen content to anoxic (no oxygen) and filled with water
hydrophytic vegetation – more than one hydrophyte
hydrophyte – a plant that is adapted to living in flooded conditions
inundation – flooding, covered in water
physiochemical – chemistry relating to the physical and chemical properties of substrates
biotic – having to do with living organisms
anthropogenic – human made
peatland – a generic name for a wetland with highly organic soils, found in temperate climates
fen – a wetland that has organic soils and herbaceous plants

**Elaborate**
Ask students to use a different colored pencil to make changes to their drawings and description to reflect their new knowledge.

**Evaluate**
Give students a short quiz (Blackline Master #8)

**Extend (Optional)**
The purpose of this optional extension is to prepare students to collect scientific data on the planting field trip. The data collected will be used to determine if the site is a wetland.
- Split the class up into three groups: water, vegetation (plant), and soil. Ask students “How can we find out if the location where we plant our trees is a wetland?” “What conditions do we look for?” “How can we test for these conditions?” “What equipment will we need?”

Tell each group that they will be researching to find out these answers. They will make or use scientific equipment to take samples and collect data. Then on the planting fieldtrip they will use the information they have gathered and tools to find out if the planting location fits the description of a wetland.

Data that could be collected: composition of soil, salinity, pH, dissolved oxygen, and vegetation.

Equipment that could be used: refractometer, corer, strainer, CBL probe, and plant identification keys.

**References**

Formal Definitions of Wetland

There are several definitions of wetlands because each has a different purpose and is used by different agencies. Some definitions are to enforce laws, others for regulation purposes and others for common terminology among nations. The below definitions are a compellation of the current formal and legal definition of a wetland, cited from Mitch and Gosslink 2000.

(1) U.S. Fish and Wildlife Service Publication by Shaw and Fredine 1956 otherwise known as Circular 39:

The term “wetlands”…refers to lowlands covered with shallow and sometimes temporary or intermittent waters. They are referred to by such names as marshes, swamps, bogs, wet meadows, potholes, sloughs, and river-overflow lands. Shallow lakes and ponds, usually with emergent vegetation as a conspicuous feature, are included in the definition, but the permanent waters of streams, reservoirs, and deep lakes are not included. Neither are water areas that are so temporary as to have little or no effect on the development of moist-soil vegetation.

(2) U.S. Fish and Wildlife Service 1979 Classification of Wetlands and Deepwater Habitats of the United States (Cowardin et al, 1979):

Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water….Wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.

(3) International Definition, Ramsar Convention (Navid, 1989; Finlayson and Moser, 1991):

Areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish, or salt including areas of marine water, the depth of which at low tide does not exceed six meters.


A wetland is an ecosystem that depends on constant or recurrent, shallow inundation or saturation at or near the surface of the substrate. The minimum essential characteristics of a wetland are recurrent, sustained inundation or saturation. Common diagnostic features of wetlands are hydric soils and hydrophytic vegetation. These features will be present except where specific physiochemical, biotic, or anthropogenic factors have removed them or prevented their development.
Two legal definitions of wetland used in the U.S today

   The term “wetlands” means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. (33 CFR 328.3(b); 1984)

   The term “wetland” except when such term is part of the term “converted wetland” means land that –
   (A) has a predominance of hydric soils:
   (b) is inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions; and
   (C) under normal circumstances does support a prevalence of such vegetation. For the purposes of this Act and any other Act, this term shall not include lands in Alaska identified as having high potential for agricultural development which have a predominance of permafrost soils.
WHAT IS A WETLAND?

Draw a picture of a wetland and label each part. Use the lines below and back of the page to describe the characteristic of a wetland.
Similarities of Wetland Descriptions

Group members’ student #s:

____________________________________
____________________________________
____________________________________

Below, write down the common characteristics of the group’s drawings and their written descriptions of a wetland.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
Louisiana Freshwater Marsh

Photo Credit: Rachel Somers
Louisiana Salt Marsh

Photo Credit: Robert Ray
Louisiana Swamp

Photo Credit: Louisiana Sea Grant College Program
Quiz #1

1. What are three characteristics of a wetland?
   A. 
   B. 
   C. 

2. Fill in the Venn diagram below to compare and contrast a marsh to a swamp?

   MARSH
   [Diagram]
   SWAMP

3. Define a wetland.
Valuable Wetlands

By Rachel Somers

Focus

Students will learn about the numerous natural resources and functions that wetlands provide.

Background Information

Wetlands in Louisiana provide nursery habitat for many species of fish and shellfish that can be recreationally or commercially harvested. Coastal wetlands are the first resting point for migratory birds traveling north from South America and the last stop as they return south. Wetlands are also home to waterfowl. Fur bearing animals such as muskrats, mink, beaver and the nonindigenous nutria call wetlands home. Even the alligator lives in wetlands and is harvested for its pelt and meat.

Louisiana wetlands, besides the bountiful resources of fish and wildlife include very profitable resources that lie underneath the earth, oil and natural gas. Another profitable use of Louisiana wetlands is to support ecotourism allowing many people to enjoy these aesthetically pleasing habitats.

Wetlands function as a filter; wetland plants remove organic and inorganic materials improving the water quality. Wastes such as phosphates and nitrates are used by plants to help them grow. Wetland plants and wetlands are used in some waste water treatment plants for this reason. Wetlands act as a sponge because accumulated peat provides much surface area for water to collect around. This spongy function absorbs flood waters. The massive root systems of wetland plants hold sediment in place and prevent erosion. The plant stems and trunks slow down the water flowing past them, allowing sediment to drop out of the water column and accumulate.

Learning Objective

Students will:

• Demonstrate their knowledge of wetland function and values through oral and written communication

Procedure

Note: Before class cut out the wetland function cards (Blackline Master #3).
**Elicit**
Spend a few minutes reviewing characteristics of a wetland and the different types by asking the following question: What are the three characteristics of wetlands? Next lead the class into the lessons topic by asking these questions: What is a value? What is a function? Reflecting on the main characteristics of a wetland what would be a function or value of a wetland? Introduce the video to validate their answers.

**Engage**
Students will watch the video segment. During viewing students will write down as many wetland functions and values that are mentioned in the video. See Blackline Master #1.

**Explore**
Tell students that they will be learning about several more wetland functions. Show students the overhead of “wetland functions” (Blackline Master #2). Go over each function with the students, using the background information to aid in the explanation. Emphasize that even though humans have developed many technologies that can replace some wetland functions not all are replaceable. Ask students to include three additional functions to their list from the video.

**Explain**
Split students into groups of three to four. Each group will be given a wetland function. See Blackline Master #3. The students will collaborate to decide which everyday object from the list (Blackline Master #4) could be used to describe a wetland function and explain why they chose the object. See Blackline Master #5 for student worksheet “Wetland Metaphor”.

**Elaborate**
Each group will share with the class their results and explanation.

**Evaluate/ Extend**
Now students have an understanding about the different functions and values of wetlands. Ask them to write three to six sentences how their life would be affected if there were no more wetlands. See Blackline Master #6.

This lesson was modified from "Wetland Metaphors" in WOW! The Wonders of Wetlands: An Educator’s Guide.

**References**

Wetland Functions and Values List

Write down the different functions and values of wetlands that you see while watching the video and three others that are discussed in class.

1. _________________________________________
2. _________________________________________
3. _________________________________________
4. _________________________________________
5. _________________________________________
6. _________________________________________
7. _________________________________________
8. _________________________________________
9. _________________________________________
10. _________________________________________
# Wetland Functions

<table>
<thead>
<tr>
<th>What wetlands do for us</th>
<th>Technologies developed to replace natural functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>The organic matter (peat) stores water</td>
<td>Irrigation systems</td>
</tr>
<tr>
<td>Maintain surface water</td>
<td>Dams for irrigation</td>
</tr>
<tr>
<td></td>
<td>Irrigation pipes and machines to transport water to crops and domestic animals</td>
</tr>
<tr>
<td>Slows the flow of water</td>
<td>Regulating gate locks</td>
</tr>
<tr>
<td>Processing sewage; cleansing nutrients and chemicals</td>
<td>Sewage treatment plants</td>
</tr>
<tr>
<td></td>
<td>Silos of manure from domestic animals</td>
</tr>
<tr>
<td>Maintains drinking water quality</td>
<td>Water purification plant</td>
</tr>
<tr>
<td></td>
<td>Nitrogen filtering systems</td>
</tr>
<tr>
<td>Providing food for humans and domestic animals</td>
<td>Increase agriculture production</td>
</tr>
<tr>
<td></td>
<td>Import more food items</td>
</tr>
<tr>
<td>Providing shelter</td>
<td>Roofing materials for thatched roofs</td>
</tr>
<tr>
<td>Sustaining anadromous fish populations</td>
<td>Aquaculture and mariculture</td>
</tr>
<tr>
<td>Sustains wetland-dependent plants and animals</td>
<td>Improve and create habitat</td>
</tr>
<tr>
<td>Species diversity; storehouse for genetic material</td>
<td>Replacement not possible</td>
</tr>
<tr>
<td>Bird watching, sport fishing, boating, and other recreational values</td>
<td>Replacement not possible</td>
</tr>
<tr>
<td>Aesthetic and spiritual values</td>
<td>Replacement not possible</td>
</tr>
</tbody>
</table>
## Wetland Function

<table>
<thead>
<tr>
<th>Wetland Function</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorbs water from runoff, retains moisture for time even if standing water dries up</td>
<td>A resting place for migratory song birds</td>
</tr>
<tr>
<td>Strains silt and debris from water</td>
<td>Provides a nursery that shelters, protects, and feeds young wildlife, especially birds, fish, and shellfish</td>
</tr>
<tr>
<td>Mixes nutrients and oxygen into the water</td>
<td>Filters impurities, excess nutrients and toxins from water</td>
</tr>
<tr>
<td>Neutralizes toxic substances</td>
<td>Provides nutrient-rich food for wildlife and humans</td>
</tr>
<tr>
<td>Habitat for diverse wildlife</td>
<td>Helps cleanse the environment</td>
</tr>
<tr>
<td>Wintering place for migratory waterfowl</td>
<td></td>
</tr>
</tbody>
</table>
Object List

Pillow
Antacid
Sponge
Soap
Whisk
Strainer
Garden
Coffee Filter
Cradle
Hotel
Zoo
Write the wetland function from the card in the space below. Then use the “Object List” to decide which object best represents the function, and write it in the space provided.

Function:

Object: ____________________________________

Explain in the space provided below why the object was picked to represent the wetland value or function.

_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
Quiz #2

Answer in three to six sentences.

How are wetlands important to me and what would it be like if they were gone?
Surviving the Storm

By Rachel Somers

Focus
Hurricanes and tropical storms are a constant threat in Louisiana, wetlands are very important in protecting homes and property from the flooding of these storms.

Students will gain an understanding of what storm surge is. Then relate it to a real-life situation, by making a map of a wetland, finding a place on the map to build a “camp”, and finding out what happens when a hurricane hits.

Background
Storm surge is the deadliest part of a hurricane or tropical storm. It is an abnormal rise in sea level and is estimated by subtracting the astronomical tide from the observed storm tide. In a bay or a cove, the trapped storm surge can raise the water level along the shore 10 to 20 feet above normal, possibly topped by 40 foot waves. Depending on the storm, wind strength, and direction, effects of flooding from storm surge can last for days.

One of the most beneficial functions of wetlands is the ability to absorb water. A stretch of healthy wetlands 2.7 miles long can reduce storm surge by one foot. Coastal Louisiana is covered by thousands of acres of wetlands. Unfortunately, in many areas along the coast these wetlands are deteriorating and sinking, decreasing the ability to efficiently reduce storm surge. With a majority of the coastal wetlands deteriorating or disappearing, the effects from tropical storms and hurricanes are felt further in land.

There are a few exceptions where the full potential of wetlands to absorb storm surge remains intact. These areas include the mouths of the Atchafalaya and Mississippi Rivers' and locations of freshwater diversions, where land is actually building and where wetlands are very healthy.

Learning Objectives

Students will:
• Develop a working definition for storm surge
• Draw a map from reading a paragraph
• Understand how wetlands help prevent flooding from storms

Grade Level: Middle School (6-8)

Duration: One 50 minutes class period

Materials:
• Video – “Storm Buffer”
• Images of flooding from storm surge (optional)
• Location cards (BM#1)
• Piling cards (BM#2)
• Video Questions (BM#3)
• Flooding Image (BM#9)
• Mapping Key (BM#8)
For each student:
• Mapping Grid (BM #5)
• Colored pencils
• Scissors
• Calculator (optional)
• Cut-outs page (BM #6)
• “Piece of Paradise” (BM #4)
• Hurricane hits (BM#7)
• Glue

National Standards:
Science in Personal and Social Perspectives, Content Standard F: Risks and Benefits, Natural Hazards

Louisiana Grade/Standards/GLE:
8/G-1A-M2/3
7/N-5-M/5
7/M-5-M/22
8/G-5-M/30
8/M-6-M/30
8/N-8-M/30
Procedure

**Note:** Prepare location cards (Blackline Master #1) and piling height cards (Blackline Master #2) in advance. Copy the location cards so that the name of the location is on one side of the paper and the description of the location is on the other side. Make enough copies of each card type for the class (one per student). Place the location cards in one bag or bowl and the piling height cards in another.

**Elicit**
What are some effects of hurricanes and tropical storms? (flooding, damage from winds, loss of electricity, etc.)

Inform the class that today they will learn about storm surge, which causes flooding from tropical storms and hurricanes. First the class will watch a short video and review the key points. See Blackline Master #3.

**Information to review:**
Ask students "How many miles of healthy marsh/wetlands will absorb one foot of storm surge?" If needed elaborate that the full potential of wetlands to absorb storm surge remains intact. (2.7 miles)

Write on the board: 2.7 miles of healthy marsh reduces/absorbs one foot of storm surge.

As a class develop a definition of storm surge, and write it on the board. Tell students to write this definition on Blackline Master #3.

**Engage**
Now that students have an understanding of what storm surge is and how wetlands protect us from storm surge; they will be putting this information to use.
"You will be purchasing a 0.5 sq mile piece of property to build a camp."
First students will work in groups to map out the land and choose a location to build a camp.

**Explore**
Separate students in to groups of three, one person from the group will pick up supplies for each of the group members: the reading assignment, “Piece of Paradise” (Blackline Master #4), mapping grid (Blackline Master #5), cut-outs (Blackline Master #6), colored pencils, scissors and glue.

Each group will work together, read “Piece of Paradise” to develop a map of the marsh.

Next inform students that they will work on their own for the remainder of the activity.
Walk around the class carrying the two bags or bowls holding the piling height and location cards. Ask students to choose one card from each bag/bowl. Explain to students that one card will determine the height of the pilings for their camp and the other card will determine the location where they can build their camp.

Next students will find a location on the map to build their camp and draw it on the map.

**Explain**
Inform students that there is a hurricane coming in the direction of their camp. It is hurricane Lily with a storm surge of 11 feet.

Students will fill in the worksheet (Blackline Master #7) and calculate the height of the storm surge at their camp. The number that they will be using to calculate storm surge will be modified from actual value of one foot per every 2.7 miles of healthy marsh. Students will use the value of one foot per every 2.5 miles of healthy marsh.

If there is time, students will calculate the storm surge from a second hurricane. The second hurricane is Georges with a storm surge of seven feet.

**Elaborate**
Students will answer the worksheet (Blackline Master 7), and discuss the effect of the storm on their camp with the class.

Make five tables on the board one for each location on the map. Students will fill in the height of the pilings, and if the camp was flooded.

**Evaluate**
Ask students to look at the data in the tables and to decide which location was the least likely to flood. Using the data in the tables ask students to decide which is the shortest height of the pilings that was needed to prevent flooding from hurricane Lily.

**Extend**
End with a discussion of the threat of storm surge from a hurricane in your area. Use the map from Coalition to Restore Coastal Louisiana's *No Time to Lose* booklet, of a category three hurricane flood damage to aid in the discussion. See Blackline Master #9.
References

Definition of Storm Surge.
http://www.crh.noaa.gov/lmk/coast.htm

What type of damage can they do?
http://www.nssl.noaa.gov/edu/hurricane/

Storm Surge Data. National Hurricane Center
http://www.nhc.noaa.gov/pastall.shtml


<table>
<thead>
<tr>
<th>Location Cards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seaside View</td>
</tr>
<tr>
<td>Great Deal</td>
</tr>
<tr>
<td>Lakeside</td>
</tr>
<tr>
<td>Highway Access</td>
</tr>
<tr>
<td>Platinum Club Member</td>
</tr>
</tbody>
</table>
## Location Cards

<table>
<thead>
<tr>
<th>Build your camp within one and a half miles of the shoreline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to the navigational canal</td>
</tr>
<tr>
<td>Build your camp within one half mile of the canal</td>
</tr>
<tr>
<td>Build your camp within one half mile of the lake</td>
</tr>
<tr>
<td>Build your camp within a half mile of the highway</td>
</tr>
<tr>
<td>For our most valuable customers, camp can be built anywhere on the property</td>
</tr>
<tr>
<td>Piling Height Cards</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>three feet</td>
</tr>
<tr>
<td>six feet</td>
</tr>
<tr>
<td>nine feet</td>
</tr>
<tr>
<td>twelve feet</td>
</tr>
</tbody>
</table>
Video Questions

What is storm surge?
___________________________________________________________
___________________________________________________________
___________________________________________________________

How do wetlands protect people from storm surge?
___________________________________________________________
___________________________________________________________
___________________________________________________________

How many miles of healthy marsh/wetlands are needed to reduce storm surge by one foot?
___________________________________________________________

Class definition of storm surge:
___________________________________________________________
___________________________________________________________
___________________________________________________________
Piece of Paradise

Read the paragraphs below to make a map of a wetland area. Use colored pencils to differentiate the different features. Make a map legend on a separate piece of paper, include symbols and scales. Take the cut-outs page to acquire the lake and highway pieces to attach to the page.

"Your Piece of Paradise" a vacation community is located on a beautiful eleven by eight and a half mile area of salt marsh in South Louisiana. This community has two bays, a lake, and access to a navigational channel.

The larger bay is located in the southeast corner of the property. The eastern bank of this bay runs northwest for 1.5 miles, where the mouth of a half-mile, wide navigation channel is located. The navigation channel head straight north into the marsh along 7 miles of this property. The western bank of the bay runs southwest for a mile and then straightens out heading due west for 3.5 miles.

Now you have reached the smaller but wider bay. Its eastern bank runs northwest for a half-mile, then west for 1 mile. The western bank runs southwest for a half-mile, and then west for two and a half miles to the western end of the property.

The shallow lake is 26 square miles in size, plenty of great fishing. The center of the lake is located five miles west of the eastern side of the property, and four miles south of the northern edge of the property.

The highway comes into the property on the 2.5 miles north of the southwestern corner and leaves the property 1.25 miles south of the northeastern corner of the property.
Hurricane Hits Piece of Paradise

Fill in the following information.

What location did you build your camp at?
________________________________________________

What are the coordinates of your camp?
_________  _______  _______  _______  _______
direction  distance  direction  distance

How many miles of from the coast is your camp? __________

How many miles of water are between your camp and the coast? __________

How many miles of paved surface (highway) are between your camp and the coast? __________

How many miles of healthy marsh are between your camp and the coast? _____
(To determine how many miles of healthy marsh are between your camp and the coast: Add the miles of water to the miles of paved surface, then subtract that distance from the distance of your camp to the coast.)

How many feet of storm surge can be absorbed by the healthy marsh that lies between your camp and the coast? Use the following equation.

_____miles of healthy marsh \times \frac{1\text{ foot}}{2.5\text{ miles}} = _____\text{ feet}

Storm surge of hurricane Lily: _________ feet

How high off the ground is your camp? ________________

What was the height of the flood waters when it reached your camp?
_______________ feet

Did your camp flood? ________________
Map of Piece of Paradise
Each section of the grid equals 0.5 miles.
Cut-outs
Key for Map of Piece of Paradise
Flooding from a category three hurricane

Figure 12. Projected flooding from a slow Category 3 hurricane. (Storm track shown in red)
Summing Up Subsidence

By Rachel Somers

Focus
This lesson introduces subsidence, what it is, and the natural and human factors that cause this process.

Background Information
Basically, subsidence is sinking land and can be caused by several processes. Human intervention can speed up this natural process.

On a delta plain the land sinks under its own weight. Sediment deposited by the river is loosely packed and has space in between the solid particles. This space is filled with dissolved gas and water. As the land starts to settle, the sediment on the bottom layers become compact, forcing out the dissolved gas and water and the land sinks. In a natural delta system, each spring the river overflows its banks and brings in a new layer of sediment counteracting the natural compaction process.

In Louisiana, delta building has occurred in the southeastern portion of the state. This area is called the Deltaic Plain and extends east from Vermillion Bay in the Atchafalaya Basin to the Chandeleur Islands; it contains thick Mississippi River sediment layers (around 100 meters deep on average). Subsidence in this area occurs at a faster rate than the southwestern portion of the state. The sediments in southwestern coastal Louisiana are much shallower (about 8 to 10 meters deep on average) and the subsidence rate is much slower.

Southwestern coastal Lousiana is called the Chenier Plain extending from the Vermillion Bay in the Atchafalaya Basin west to Marsh Island. The word chenier comes from the French word “chene” meaning oak. This type of land formation consists of parallel ridges made of sand, fine silts and clays, usually with trees on top. The oldest ridges are found farther inland and mark the location of the former shorelines.

Compaction of the upper layer of sediments not only causes the removal of dissolved gas and water, it also pushes down on the sediments below. The newest layers of sediment formed during the Holocene push down on the sediment layer from the Pleistocene. The weight of these layers deforms the Mesozoic layer below pushing it down and to the side; this process is call coastal down-warping. Coastal down-warping, the weight of the new layers moving the older layer, also causes subsidence.
Other natural causes of subsidence are faults. There are hundreds of small fault zones in Louisiana. These are areas where the land pushes together or spreads apart causing the land around them to sink, rise, or tilt. The faults in the coastal zone cause sinking of the surrounding land and the most intensive of these areas are found in the lower Deltaic Plain.

Yet another cause of subsidence is localized consolidation which can be natural or human induced. This happens in areas where there are large trees or other structures (such as buildings), and the weight from these objects pushes down on the sediment below increasing consolidation in the immediate area.

The major way humans have increased the rate of subsidence is by building levees. Not only have levees prevented flooding, the process that brings new sediment to build the land, but levees decreased the amount of sediment reaching Louisiana. Locks and channels built by humans decrease the flow of the river, sediment falls out of the water column decreasing the amount of sediment to be carried further down river by the current.

Another way humans have increases subsidence is by the removal of oil and natural gas. When these products are removed from the earth a hole is left underground and the weight of the land above the hole pushes down and fills in the space.

Learning Objectives
Students will:
- Understand that some processes are caused by several factors acting together
- Understand that humans can affect a natural process

Procedure

Elicit
Show students a picture of New Orleans at Algiers Point (Blackline Master #1). In the photograph one can see a large shipping vessel in the water, the levee that contains the Mississippi River and the surrounding area with houses below the river.

Ask students where was this picture taken? In the background of the image, point out the cathedral in Jackson Square. The picture was taken in New Orleans. What is wrong with this picture? The boat is above the houses What do they think is happening to the land in this picture? The land is sinking What is the name for sinking land? (Subsidence)
Engage
Students will watch a video to find out what subsidence is and some of the reasons why this natural process can become a problem.

Explore
Show the class the graphic ‘Subsidence Factors (Blackline Master #2). Explain ‘A’ through ‘F’ and describe that when these processes are added together they make up what causes the visible signs of the subsiding landscape. Look back at the background section to describe the processes of ‘A’ through ‘F’.

Explain
Describe to the class the differences between the Deltaic and Chenier Plains. To enforce student understanding, handout “Sediment in the Louisiana Plains” (Blackline Master #3) to the students to fill in with colored pencils.

Elaborate
Discuss with the class why subsidence is faster in the Deltaic plain then the Chenier plain. (More sediment from the Mississippi River, therefore there is more weight from the thicker layers of sediment, this pushes out the dissolved gas and water at a faster rate, causing the delta plain to sink faster.)

Evaluate
Students will take a short quiz (Blackline Master #4).

Extend
Have a discussion with the class about climate change. “If the world mean temperature is rising (it is), then there will be less water in the form of ice and the oceans will rise (sea level rise). What does that mean for people that live in coastal areas? Why would Louisiana’s coastline be more threatened then other areas?” First Louisiana’s coastline is flat; the elevation change is very gradual. Secondly, there is subsidence, sinking land and rising water means that land will submerge faster and the coastline will recede at a faster rate than other areas.

References
McQuaid, John and Mark Schleifstein. In Harm’s Way. Times-Picayune. For article - http://nolassf.dev.advance.net/hurricane/harmsway_1.html For image only - http://nolassf.dev.advance.net/hurricane/images/wateraroundus_algierspoint.jpg


What Is Wrong With This Picture?

Photo credit: J. McQuaid and M. Schleifstein, Times Picayune
Subsidence = A+B+C+D+E+F

- **A** = Oil Removal
- **B** = Localized consolidation
- **C** = Compaction of new sediments
- **D** = Tectonic Activity (fault lines)
- **E** = Compaction of older sediments
- **F** = Weight of above layers pushing down and moving oldest layer

Legend:
- Water
- New sediment (holocene)
- Older sediments (pleistocene)
- Oldest layer (mesozoic)
Sediment in the Louisiana Plains

Directions:
Color in the deltaic plain red, from Vermillion Bay to the top of Atchafalaya River east to Mississippi including the Chandeleur Islands.

Color in the chenier plain blue, from Vermillion Bay west to Marsh Island.

Color in the coastal zone yellow.

River Sediment Layer Thickness
- Deltaic Plain ~100 meters
- Chenier Plain ~ 8 to 10 meters
Student # ______

Subsidence Quiz

1. What is subsidence?

2. Name one natural and one human cause of subsidence.
Salty Channel

By Rachel Somers

Focus
In this lesson students are introduced to the concept of saltwater intrusion and its impacts on a freshwater marsh habitat by acting out a scenario.

Background Information
Man-made channels have made it easy for people to transverse the marsh. Man-made channels are straight unlike natural bodies of water, which meander. These channels allow a direct path for saltwater to travel inland affecting naturally freshwater areas; this process is called saltwater intrusion.

When saltwater moves into a freshwater area its effects are slow and subtle on the freshwater species currently inhabiting the area. Freshwater fish species and other mobile freshwater invertebrates will move further inland away from the salty water. The freshwater fish must leave because they not adapted to regulate osmosis in saline water. Unfortunately, freshwater plants can not uproot. They are not adapted to the saline environment and if the salinity concentration continues to increase the freshwater plants will eventually die. When the freshwater plants die, bare land is exposed and becomes more vulnerable to erosion by natural causes such as storms or human causes such as wake from boat traffic. As freshwater species die with the increased salinity level, more salt tolerant species move in and replace them.

Not only do man-made channels bring in saltwater but these channels disrupt the sheet flow of water across the marsh. The ground dug up to build these channels maybe deposited along side the banks, forming ridges. The marsh behind the ridge is then cut off from its source of water and nutrients. With lack of nutrients and freshwater, the plants behind the ridge start to suffer and may die. Once the plants die a small shallow lake forms and will grow in size. Sometimes instead of placing the dredge material along the channels edge it is used for beneficial purposes, filling in shallow lakes to counteract subsidence when financially feasible.
Learning Objectives

Students will:

• Describe how human actions have modified coastal Louisiana through the use of man-made channels

Procedure

Note: Before the lesson prepare the plant and animal cards. Use three colors of paper one for the freshwater species as second color for the saltwater species cards and a third color to differentiate the otter (It can live in both salinity regimes) from the other species. See the species list to separate out the plant and animal cards by habitat preference (Blackline Master #1).

Laminate the cards to make them last for future use. To allow students to wear the card, use a hole-puncher to make the holes in the top corners of the card, attach a piece of yarn or string.

Elicit

No prior knowledge will be discussed until after students have participated in the activity.

Engage

Tell the students that they will become a wetland habitat. Hand out plant and animal cards to students. If there are more students than plant and animal cards make more plant cards from both the fresh and salt habitats.

Rearrange the room to allow students room to act out their parts and to make room to eventually lay out the rope.

Explore

Students will act out the scenario as the teacher reads it. See Blackline Master #2.

Explain

Tell students to keep in mind this activity as the watch a short video on saltwater intrusion.
Elaborate
After the video ask the students “How did the scenario we acted out relate to the video? What is saltwater intrusion?”

Discuss the changes that occurred to the marsh during the activity. Use the following question to aid the discussion:
How did the habitat change? (It went from freshwater to saltwater).
How did the saltwater get into our habitat? (Through the man-made channel).
Were all the plants and animals affected? (No, the otter remained).
Why do you think the otter was able to adapt? (The otter was not affected by the salinity change, the otter eats fish and a food source remained, etc.)

Evaluate
Evaluate students on participation in the scenario and class discussion.

Extend
Relate the topic of saltwater intrusion and man-made channels to subsidence. Ask students where does subsidence occurs? (Mostly in the interior of the marsh is where subsidence occurs).
Discuss as a class how man-made channels may play a part in this process. (When man-made channels are made, material (dirt) is removed. This dredged material is sometimes placed along side of the man-made channel. As more material is remove the pile gets bigger and forms a small levee. Ask students to think back to what they learned today and from the prior lesson, to answer the following question: Why is the small levee a problem? Does it have an affect on the marsh behind it? How?

References

Freshwater Marsh Plants and Animals

Crawfish (*Procambarus spp.*)
Bluegill (*Leponis marcrochirus*)
Large Mouth Bass (*Micropterus salmoides*)
Otter (*Lutra canadensis*)
Cattails (*Typha spp.*)
Cow Pea (*Vigna luteola*)
Royal Fern (*Osmunda regalis*)
Smartweed (*Polygonum sagittatum*)
Wapato (*Sagittaria latifolia*)

Saltwater Marsh Plants and Animals

Redfish (*Sciaenops ocellatus*)
Menhaden (pogy) (*Brevoortia patronus*)
Flounder (*Paralichthys lethostiama*)
Brown shrimp (*Penaeus aztecus*)
Otter (*Lutra canadensis*)
Salt grass (*Distichilis spicata*)
Smooth cord grass (*Spartina alterniflora*)
Black needle rush (*Juncus roemerianus*)
Wiregrass or Marsh Hay (*Spartina patens*)
Scenario

Start the scenario by making a freshwater marsh using some of the students in the class. All students that received plants and animals cards that fall into the category of freshwater species will go to the front of the classroom to act out their part. (The fish can swim between the plants, the otter can eat a fish. The plants can sway in the breeze.) Once the students have started to act out their roles and this habitat is described, it is time to cause a change.

Tell the students. “People have decided they want to dig a canal straight through this marsh to have faster access to a salty bay.”

Make the man-made channel by taking two pieces of rope or string, fifteen feet long, and lay them parallel to each other so that the rope/string traverses the freshwater marsh. (Lay it in the middle of the students).

Tell students “saltwater is slowly moving its way up the channel. The saltier water is bothering the bluegill, large mouth bass, and crawfish. All of these animals decide to leave the marsh and move further inland.” (Ask students with bluegill, largemouth bass and crawfish cards go sit at their desks).

“Time has passed and more saltwater has moved inland, salt tolerant fish, such as menhaden, redfish, and brown shrimp now swim in the channel.” (Ask students with these cards to come up and start to swim in the channel).

“The saltwater is killing the freshwater plants. The freshwater plants along the side of the channel die.” (Students that are freshwater plants along side the channel go and sit down.)

“Boats use the channel to go out in to the bay the wake from the channel washes away the exposed bank and the channel grows wider.” (The rope/string will be separated to make a wider channel.)

“Salt tolerant plants such as wiregrass and black needle rush start to grow in the marsh. Southern flounder are now found swimming in the marsh.” (Students with these cards should come up and act out their roles).

“As more time goes by the rest of the freshwater plants die and are replaced with salt tolerant species such as smooth cord grass and salt grass.” (The rest of the students with freshwater plants cards will go to their desks and the last students with the salt tolerant plant cards will get up to act out their role).

Let the new salt marsh community act out its roles for a while. Then ask the students to stop, quietly reflect on the activity and take their seats.
Blue Gill
Large Mouth Bass
Otter
Cattail
Cow Pea
Royal Fern
Smart Weed
Wapato
Black Needle Rush
Wiregrass
Flounder
Menhaden
Brown Shrimp
Redfish
Crawfish
Salt Grass
Smooth Cord Grass
Shape Changer – The Story of a Delta

By Rachel Somers

**Focus**
This lesson on delta formation combines all of the information from the prior lessons. Students will learn the delta cycle.

**Background Information**
Deltas are built when the river overflows its banks during spring floods. Sediment (sand, silt and clay particles) carried by the fast-moving current of the river are deposited as flood waters slow. This process is called accretion.

Deltas form in open bays; the sediment from the river starts to pile up under the water onto either side of the river mouth forming subaqueous (underwater) levees. As more and more sediment is deposited the subaqueous levees eventually break through the water’s surface and new land forms.

The new land is called a mudflat, which once enough elevation is gained can support plant life. Freshwater marshes develop, and farther away from the river, brackish and salt marshes will grow.

The delta will continue to grow. Soon it will have natural levees, eventually the elevation will be great enough to support trees, and swamps will form at the base of the natural levees.

As a delta builds farther out into its receiving basin (the open bay), it lengthens the path of the main distributary channel of the river. Soon, it will become the longest and most inefficient path for water to take to reach the receiving basin. Rivers prefer the shortest and most efficient paths to their receiving basins and will change course to find that path.

The Gulf is the Mississippi River’s receiving basin. The Mississippi River has switched its course six times in the past 7,000 to 8,000 years. The river mouth moves like a hose full of water. It takes about 100 years for a delta to switch course.

What happens to the Delta after the river abandons it? First the land starts to subside because less sediment is deposited. As the land subsides saltwater
moves further inland and the brackish marshes grow in size. Eventually, the land near the levees sinks to the point where it does not have enough elevation to support swamps and the swamps slowly turn into marsh.

A new land formation appears when the delta is abandoned -- barrier islands. There are several ways that barrier islands form. One way is when wave action causes the sand to fall out forming a beach or a spit. When a hurricane comes, these spits can split off and form barrier islands. Another way is when wave action causes the beach to build, while the marsh behind subsides below the water’s surface, leaving the former beach to become a barrier island. Eventually, all barrier islands sink below the water’s surface and are referred to as shoals.

The delta cycle ends as an open bay, just as it started. The river may switch course back to this channel as the main outlet and the cycle will start over again.

Learning Objectives
Students will:
• Learn about the deltaic cycle and when in the cycle specific land features form

Procedure

Elicit
Ask students to think back on the last five lessons. What are some processes that have changed the shape of Louisiana’s coastal wetland? Erosion, subsidence, human actions (building man-made channels)

Engage
Explain to students that they will be watch a video clip on delta formation, that the video will tie together the concepts that they have learned from the previous lessons.

Explore
After the video, split students up into groups, each group or student will receive a color copy of the “Delta Cycle” (Blackline Master #1) a each student will receive a worksheet (Blackline Master #2). Students will work in groups to answer the questions.

Explain
Go over the answers on the worksheet as a class. Give further explanations as needed using the background as a resource.
Elaborate
Show students the overhead of the Louisiana’s deltas (Blackline Master #3). Point out on a Louisiana map where each of the deltas formed by the previous main channels of the Mississippi River.

Evaluate
Students will take a quiz. See Blackline Master #4.

Extend
Show students the animated land loss maps from “Exploring Coastal Louisiana with Boudreaux” CDROM.

Show students the PowerPoint presentation “The Source,” it reviews many of the topics covered in the lesson as well as previous lessons. It provides additional information on the structure of a river, and images of barrier island and chenier formation.

References

*Exploring Coastal Louisiana with Boudreaux* (CDROM). USGS National Wetlands Research Center. Lafayette, LA.

Delta Cycle

- Delta Formation: Sediment deposited, water flow increases
- Delta Deterioration: Less sediments, decrease water flow

- Open Bay
- Barrier Islands
- Mud Flats
- Marshes
- Swamp

- River Switches Course

- Mud Flats
- Freshwater Marsh
- Saltwater Marsh
- Land Building Underwater
- Freshwater

- Swamp
- Beach
- Barrier Island
- Land
The Delta Cycle

Use the graphic of the delta cycle to answer the following questions.

1. This graphic starts at the sliver titled open bay. It is the first step to take place for a delta to form. The second sliver has the first true land feature.

What is the land feature? _____________________________________

Look at the red arrow labeled delta formation. What is the river carrying into the bay?
_________________________________________________
_________________________________________________

2. Now that the delta has grown in size and vertically, plant life is able to be supported.

What is the dominate type of marsh? _____________________________

3. Before the delta switches course, the land continues to build vertically and can now supports a greater diversity of plants including trees.

Where are the swamps located? ________________________________

Why are the swamps at this location? _____________________________
_________________________________________________
_________________________________________________

4. After the delta switched course, which wetland habitat grew in size and what new land form appears? ______________________________

Why did these changes occur? _________________________________
_________________________________________________
_________________________________________________
_________________________________________________
## Past and Present Mississippi River Deltas

<table>
<thead>
<tr>
<th>Delta Name</th>
<th>Formed Years Before Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maringouin</td>
<td>7,500-6,000</td>
</tr>
<tr>
<td>Teche</td>
<td>5,700-3,900</td>
</tr>
<tr>
<td>St. Bernard</td>
<td>4,700-650</td>
</tr>
<tr>
<td>Lafourche</td>
<td>3,500-400</td>
</tr>
<tr>
<td>Modern / Bird’s Foot</td>
<td>900-0</td>
</tr>
</tbody>
</table>
| Atchafalaya                 | started filling receiving basin 1850s
                                      | became subaerial in 1973                        |
Quiz 6

How do deltas form?

When during the delta cycle do barrier islands form?
Appendix D

Wetlands Knowledge/ Awareness/ Issues Test
Please answer the following ten questions to the best of your ability. You will not be graded on the amount correct. This is just to see what you already know.

1) What are three characteristics of a wetland?

2) Name three types of wetlands we have in Louisiana?

3) How was South Louisiana formed?

4) Are we or are we not losing land in Louisiana? Name some reasons why.
5) How are wetlands beneficial/valuable to people in Louisiana?

6) What is erosion?

7) Have you ever heard of the word “subsidence”? If so, define the word.

8) (A) Have you ever seen on television, heard on the radio, or read in a newspaper or magazine about efforts by the Louisiana government to help prevent coastal erosion? Explain where.

   (B) If so, do you think this is a problem that will affect you? Explain why.
9) Use the graph below to identify which month of the year has the fastest flow rate.
Place answer here: ___________________

10) Use the table below to answer the following question.
Which two deltas were forming 4,000 years before present?
Place answer here: _________________________

<table>
<thead>
<tr>
<th>Delta name</th>
<th>Formed Years Before Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maringouin</td>
<td>7,500 – 6,000</td>
</tr>
<tr>
<td>Teche</td>
<td>5,700 – 3,900</td>
</tr>
<tr>
<td>St. Bernard</td>
<td>4,700 – 650</td>
</tr>
<tr>
<td>Lafourche</td>
<td>3,500 – 400</td>
</tr>
<tr>
<td>Modern/Bird’s Foot</td>
<td>900 - 0</td>
</tr>
<tr>
<td>Atchafalaya</td>
<td>Started filling receiving basin in 1850s, became subarerial in 1973</td>
</tr>
</tbody>
</table>
Appendix E

Test Rubric
Grading Scale - 23 pts possible

Number ___  School Name ________________________________
              Grade ______________

Please answer the following ten questions to the best of your ability. You will not be graded on the amount correct. This is just to see what you already know.

1) What are three characteristics of a wetland?
   0 - no and wrong answers
   1 - for one characteristic
   2 - for two characteristics
   3 - for three characteristics

2) Name three types of wetlands we have in Louisiana?
   0 - for no or wrong answer
   1 - for 1 type of wetland
   2 - for 2 types of wetlands
   3 - for 3 or more types of wetland

3) How was South Louisiana formed?
   0 - for no or wrong answer
   1 - for one word correct answer
   2 - for more than one word correct answer

4) Are we or are we not losing land in Louisiana? Name some reasons why.
   0 - no or wrong answer
   1 - for yes
   2 - for yes plus one reason
   3 - for yes plus more than one reason
5) How are wetlands beneficial/valuable to people in Louisiana?
   0 - for no or wrong answer
   1 - for 1 value
   2 - for 2 values
   3 - for 3 or more values

6) What is erosion?
   0 - no or wrong answer
   1 - for correct answer

7) Have you ever heard of the word “subsidence”? If so, define the word.
   0 - no or wrong answer
   1 - for yes
   2 - for yes plus definition

8) (A) Have you ever seen on television, heard on the radio, or read in a newspaper or magazine about efforts by the Louisiana government to help prevent coastal erosion? Explain where.
   (B) If so, do you think this is a problem that will affect you? Explain why.
   0 - no or wrong answer
   1 - for yes to the first part
   2 - for yes to the first and second part
   3 - for yes to the first part and a more than one word answer to the second part
9) Use the graph below to identify which month of the year has the fastest flow rate. (1= January, 2= February, etc.)

Place answer here: ____1 - for April ____

![Graph of Average Monthly Flow Rates of the Mississippi River](image)

10) Use the table below to answer the following question.

Which two deltas were forming 4,000 years before present?

Place answer here: ___1 - for Teche or St. Bernard_____
___ 2 - for Teche and St. Bernard_____ 

<table>
<thead>
<tr>
<th>Deltas of Mississippi River System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Delta name</strong></td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Maringouin</td>
</tr>
<tr>
<td>Teche</td>
</tr>
<tr>
<td>St. Bernard</td>
</tr>
<tr>
<td>Lafourche</td>
</tr>
<tr>
<td>Modern/Bird’s Foot</td>
</tr>
<tr>
<td>Atchafalaya</td>
</tr>
</tbody>
</table>
Appendix F

Interview Guide
Interview Guide

Prop: colored clay in a metal paint tray to be used as an aid in demonstrating students understanding of coastal wetlands.

Introduction: The purpose of this interview is just to go over some of the concept to see what you remember from the lessons. It is informal and your names will not be used. First we are going to start by reading the article “Gone with the Water” the topic of this article is Louisiana wetlands and land loss issues. It came out in the National Geographic magazine’s October 2004 edition. Everyone will read a portion of the article and then afterwards we will answer some questions. Feel free to ask questions on anything that you do not understand.

While reading the article, interviewer discussed the images from it with the students.

Questions:

1. Do any of you receive National Geographic magazine at home? Have any of you read this article?

2. Does anyone have any questions about the article?

3. What did you find most interesting from reading the article?

4. Has learning about the wetlands had any change in your attitude about raising the wetland trees in your school’s nursery?

5. What do you remember about some of the concepts you learned, such as subsidence?

6. Will one of you show me how a delta builds using the prop. How does the Mississippi River build land?

7. Where is the different wetland types located, using the mouth of the Mississippi River on the prop? (freshwater marsh, salt marsh and swamp)

8. What if we dig a channel into the marsh (place a channel on the marsh)?

9. Where is the majority of land loss occurring (using the aid of the National Geographic “Lost Coast” image)?

At the conclusion of the interview, students were asked if the had any further questions then thanked for their help.
Appendix G

IRB Proposal
IRB Research Proposal

IRB #:_________ LSU Proposal #:_________ Revised: 03/24/2004

LSU INSTITUTIONAL REVIEW BOARD (IRB) for 578-8692 FAX 6792
HUMAN RESEARCH SUBJECT PROTECTION Office:203 B-1 David Boyd Hall

APPLICATION FOR EXEMPTION FROM INSTITUTIONAL OVERSIGHT

Unless they are qualified as meeting the specific criteria for exemption from Institutional Review Board (IRB) oversight, ALL LSU research/projects using living humans as subjects, or samples or data obtained from humans, directly or indirectly, with or without their consent, must be approved or exempted in advance by the LSU IRB. This Form helps the PI determine if a project may be exempted, and is used to request an exemption.

Instructions: Complete this form.

Exemption Applicant: If it appears that your study qualifies for exemption send:

(A) Two copies of this completed form,
(B) a brief project description (adequate to evaluate risks to subjects and to explain your responses to Parts A & B),
(C) copies of all instruments to be used. If this proposal is part of a grant proposal include a copy of the proposal and all recruitment material.
(D) the consent form that you will use in the study

To: ONE screening committee member (listed at the end of this form) in the most closely related department/discipline or to IRB office.

If exemption seems likely, submit it. If not, submit regular IRB application. Help is available from Dr. Robert Mathews, 578-8692, irb@lsu.edu or any screening committee member.

Principal Investigator ______Rachel Somers__________ Student? __Y

Ph: ______578-6344_ E-mail_rsomer1@lsu.edu ______ Dept/Unit ______EDCI____

If Student, name supervising professor _Dr. Wandersee_ Ph: ______578-2348____

Mailing Address _LSU – Sea Grant Bldg rm 202__ Ph 578-6344____

Project Title _Putting Down Roots in Environmental Literacy: A Study of Middle School Students _______

Agency expected to fund project ______N/A____

Subject pool (e.g. Psychology Students) ______middle school students (8 classes)_____

Circle any "vulnerable populations to be used (children <18, the mentally impaired, pregnant women, the aged, other). Projects with incarcerated persons cannot be exempted.

I certify my responses are accurate and complete. If the project scope or design is later changed I will resubmit for review. I will obtain written approval from the Authorized Representative of all non-LSU institutions in which the study is conducted.

PI Signature ______________ Date ______ (no per signatures)

Screening Committee Action: Exempted ____ Not Exempted ____  Category/Paragraph

Reviewer _____________ Signature ______________ Date _____

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Part A: DETERMINATION OF "RESEARCH" and POTENTIAL FOR RISK

This section determines whether the project meets the Department of Health and Human Services definition of "research" and if not, whether it nevertheless presents more than "minimal risk" to humans that makes IRB review prudent and necessary.

1. Is the project a systematic investigation designed to develop or contribute to generalizeable knowledge?

(Note "systematic investigation" includes "research development, testing and evaluation"; therefore some instructional development and service programs will include a "research" component).

YES

NO

2. Does the project present physical, psychological, social or legal risks to the participants reasonably expected to exceed those risks normally experienced in daily life or in routine diagnostic physical or psychological examination or testing? You must consider the consequences if individual data inadvertently become public.

YES  Stop. This research cannot be exempted--submit application for IRB review.

NO  Continue to see if research can be exempted from IRB oversight

3. Are any of your participants incarcerated?

YES  Stop. This research cannot be exempted--submit application for IRB review.

NO  Continue to see if research can be exempted from IRB oversight.

4. Are you obtaining any health information from a health care provider that contains any of the identifiers listed below?
A. Names
B. Address: street address, city, county, precinct, ZIP code, and their equivalent geocodes. Exception for ZIP codes: The initial three digits of the ZIP Code may be used, if according to current publicly available data from the Bureau of the Census: (1) The geographic unit formed by combining all ZIP codes with the same three initial digits contains more than 20,000 people; and (2) the initial three digits of a ZIP code for all such geographic units containing 20,000 or fewer people is changed to '000'. (Note: The 17 currently restricted 3-digit ZIP codes to be replaced with '000' include: 036, 059, 063, 102, 203, 556, 692, 790, 821, 823, 830, 831, 878, 879, 884, 890, and 893.)
C. Dates related to individuals
   i. Birth date
   ii. Admission date
   iii. Discharge date
   iv. Date of death
v. And all ages over 89 and all elements of dates (including year) indicative of such age. Such ages and elements may be aggregated into a single category of age 90 or older.

D. Telephone numbers;
E. Fax numbers;
F. Electronic mail addresses;
G. Social security numbers;
H. Medical record numbers; (including prescription numbers and clinical trial numbers)
I. Health plan beneficiary numbers;
J. Account numbers;
K. Certificate/license numbers;
L. Vehicle identifiers and serial numbers including license plate numbers;
M. Device identifiers and serial numbers;
N. Web Universal Resource Locators (URLs);
O. Internet Protocol (IP) address numbers;
P. Biometric identifiers, including finger and voice prints;
Q. Full face photographic images and any comparable images; and
R. Any other unique identifying number, characteristic, or code; except a code used for re-identification purposes; and
S. The facility does not have actual knowledge that the information could be used alone or in combination with other information to identify an individual who is the subject of the information.

☐ YES Stop. This research cannot be exempted—submit application for IRB review.

☐ NO Continue to see if research can be exempted from IRB oversight.

Part B: EXEMPTION CRITERIA FOR RESEARCH PROJECTS

Research is exemptable when all research methods are one or more of the following five categories. Check statements that apply to your study:

1. In education setting, research to evaluate normal educational practices.

2. For research not involving vulnerable people [prisoner, fetus, pregnancy, children, or mentally impaired]: observe public behavior (including participatory observation), or do interviews or surveys or educational tests:

   The research must also comply with one of the following:

   either that
   a) the participants cannot be identified, directly or statistically;
   or that
   b) the responses/observations could not harm participants made public;
   or that
c) federal statute(s) completely protect all participants' confidentiality;

or that

3. For research not involving vulnerable people [prisoner, fetus, pregnancy, children, or mentally impaired]: observe public behavior (including participatory observation), or do interviews or surveys or educational tests:
- all respondents are elected, appointed, or candidates for public officials.

4. Uses only existing data, documents, records, or specimens properly obtained.

The research must also comply with one of the following:

either that:

a) subjects cannot be identified in the research data
directly or statistically, and no-one can trace back from research data to identify a participant;

or that

b) the sources are publicly available

5. Research or demonstration service/care programs, e.g. health care delivery.

The research must also comply with all of the following:

a) It is directly conducted or approved by the head of a US Govt. department or agency.

and that

b) it concerns only issues under usual administrative control (48 Fed Reg 9268-9), e.g., regulations, eligibility, services, or delivery systems;

and that

5. Its research/evaluation methods are also exempt from IRB review.

6. For research not involving vulnerable volunteers [see “2 & 3” above], do food research to evaluate quality, taste, or consumer acceptance.

The research must also comply with one of the following:

either that:

a) the food has no additives;

or that

b) the food is certified safe by the USDA, FDA, or EPA.

NOTE: Copies of your IRB stamped consent form must be used in obtaining consent. Even when exempted, the researcher is required to exercise prudence in protecting the interests of research subjects, obtain informed consent if appropriate, and must conform to the Ethical Principles and Guidelines for the Protection of Human Subjects (Belmont Report), 45 CFR 46, and LSU Guide to Informed Consent; (Available from
OSP or
http://appl022.lsu.edu/osp/osp.nsf/$Content/LSU%20IRB%20Documents
HUMAN SUBJECTS SCREENING COMMITTEE MEMBERS can assist & review:

COLLEGE OF ARTS AND SCIENCES:  MASS COMMUN/SOC WK/AG:
Dr. Noell  * (Psych)  578-4119   Dr. Nelson    (Mass C)  578-6686
Dr. Geiselman * (Psych)  763-2695   Dr. Archambeault(Soc Wk)  8-1374
Dr. Beggs    (Socio)  578-1119   Dr. Rose       (Soc Wk)  578-1015
Dr. Honeycutt(Comm.Stu.)  578-6676  Dr. Keenan* (Hum Ecol)  578-1708
Dr. Dixit (Comm Sc./Dis)  578-3938  Dr. Belleau (Hum Ecol)  578-1535

ED/LIBRARIES/INFO SCI    BUSINESS
Dr. Kleiner (Middleton)  578-2217    Dr. Biswas (Marketing)  578-8818
Dr. Culross (Education)  578-2254
Dr. Landin* (Kinesiol)  578-2916
Dr. MacGregor (ELRC)  578-2150
Dr. Munro* (Curric & I)  578-2352

(* = IRB member)
Student Assent Form

I, ____________________________ agree to let my answers on the pretest and posttests to be used for the sole purpose of the LSU research study on general concepts relating to wetlands in science teaching conducted by Ms. Rachel Somers. I understand my grades on these tests will remain anonymous. My teacher will not see the results, nor will the score affect my grades in my science class.

I also agree as part of this study to participate in the six lessons on general wetland concepts. I am willing to participate in a group interview at the conclusion of this study. The interview will focus on concepts that I have learned about wetlands and my experience in the Coastal Roots program.

At anytime I may decide to stop my participation in the study, and in doing so my test scores will not be used in the research study. There are no known risks in participating, but, in doing so, I will be helping LSU make the Coastal Roots program even better.

Student Signature __________________________ Age _______ Date____________

Witness Name ___________________________
Witness Signature ___________________________  Date__________
Parental Permission Form

Project Title: Putting Down Roots in Environmental Literacy: A Study of Middle School Students’ Participation in Louisiana Sea Grant’s Coastal Roots Project

Performance Sites: Harry Hurst Middle School, Our Lady of Mercy School, and St. Louis King of France School.

Investigator: The following investigator is available for questions
Ms. Rachel Somers
Louisiana State University Departments of Sea Grant and Curriculum & Instruction
Daytime (225) 578-6344 or in the evening (225) 751-1048
My faculty advisor, Dr. James Wandersee, can be reached at LSU (225) 578-2348

Purpose of the Study: The purpose of the study is to see what affect Louisiana Sea Grant’s Coastal Roots: Seedling Nursery Program for Wetland Restoration has on students’ environmental literacy.

Inclusion Criteria: Seventh and eighth grade students in the selected science classrooms.

Study Description: At the beginning and end of the first semester students will take a pretest and posttest on general concepts relating to wetlands. Their test scores will remain anonymous and the scores will not be seen by their teachers nor used as grades in their classes. During the semester students will be taught by their teacher six lessons written by the investigator on wetlands and coastal issues. The investigator will observe the instruction of four of the lessons to gather qualitative data. Several randomly selected students will be interviewed in a group setting at the conclusion of the study. The interview will focus on concepts that they have learned and their experience in the Coastal Roots project. The interview will be recorded and the children’s names will be changed to protect their identity.

Benefits: Your child’s participation in the study will help to see how beneficial the Coastal Roots project is in helping students and teachers in utilizing native plant nurseries to improve learning in science classes.

Risks: There are no known risks.

Right to Refuse: Participation is voluntary, and your child will become part of the study only if both you and the child agree to the child’s participation. At any time, either you or the child may withdraw from the study without penalty or loss of any benefit of which they might otherwise be entitled.

Privacy: Results of the study will be published, but no names or identifying information will be included for publication.

Financial Information: There is no cost for participation in the study, nor is there any compensation to the subjects for participation.

Student Name _____________________________

Guardian Signature __________________________________________ Date _______________

Or the guardian has indicated to me that he/she is unable to read. I certify that I have read this consent form to the guardian and explained that by completing the signature line above he/she has given permission for the child to participate in the study.

Signature of Reader __________________________________________ Date _______________
Vita

Rachel L. Somers is currently a Marine Education Specialist at Louisiana Sea Grant College Program in Baton Rouge. Originally from Madison, Wisconsin, she moved to Miami, Florida where she graduated from the University of Miami in 1999 with a bachelor’s in marine science/biology. She has just completed her master’s program in Science Education at Louisiana State University. For more than three years she has assisted in running and developing Sea Grant’s marine education programs. Other jobs include: (a) member of the education staff at Audubon Louisiana Nature Center and (b) Delta Service Corps Member serving at the Barataria-Terrebonne National Estuary Program. Rachel’s interests include drawing and painting, triathlons, reading, cooking and outdoor activities. The degree of Master of Arts will be awarded to Rachel L. Somers at the 2005 Spring Commencement.