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ABSTRACT

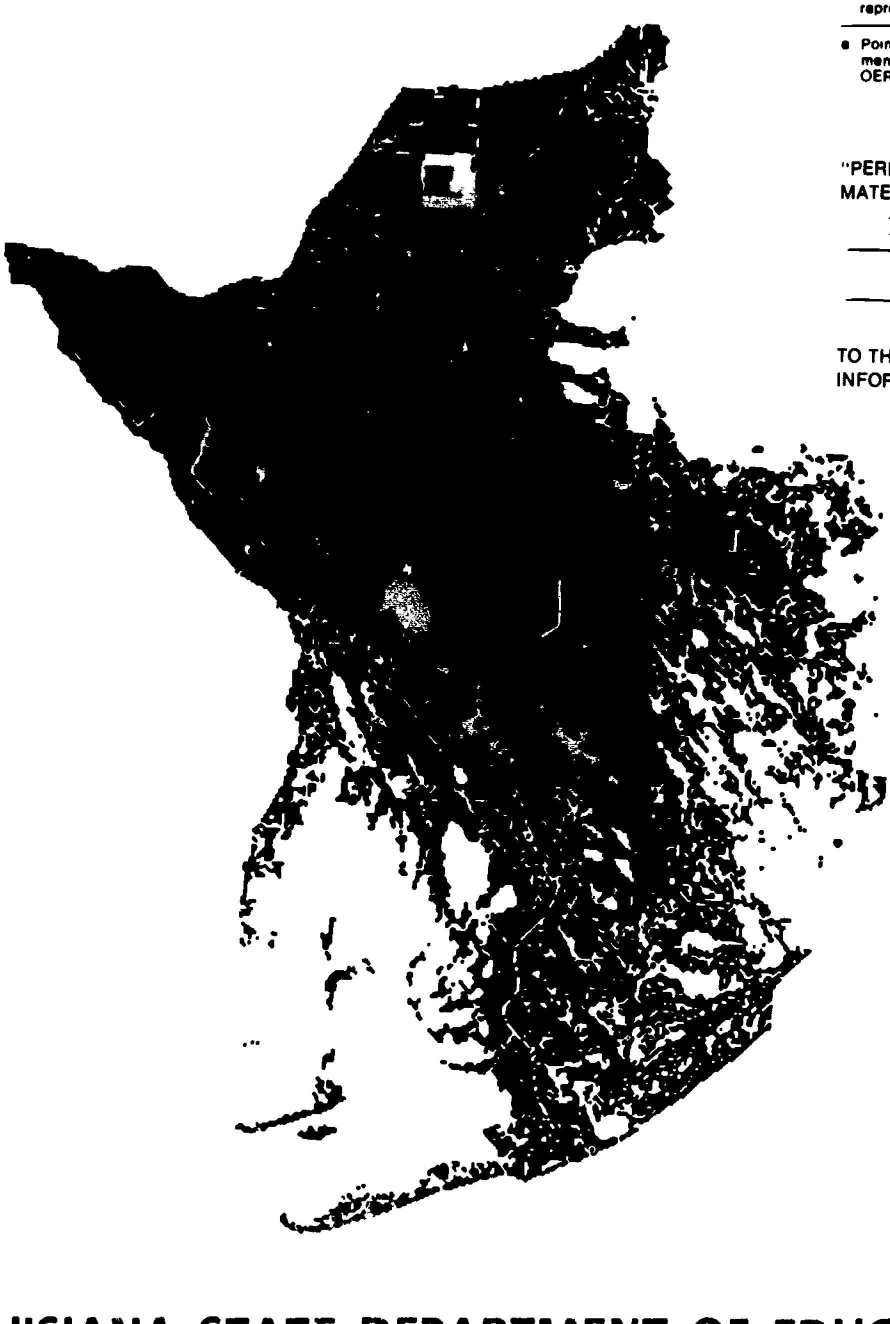
The Louisiana coastal zone is a unique geographic feature. Soil carried by the Mississippi River has been deposited in Louisiana for the last 6,000 years to form the coastal area. All natural features in coastal Louisiana relate to materials and processes associated with the emptying of the Mississippi River into the Gulf of Mexico. The interactions of these two water systems have contributed to the importance of Louisiana as a center of domestic and world trade. Coastal deterioration is a natural phenomenon; however, human activities can accelerate this process. Coastal Louisiana is experiencing increasing rates of wetland loss, wetland alteration, and water quality degradation. This guide presents information which will help to educate the public about the existing problems, particularly information about the Lafourche Parish coastal zone areas. Contents include a listing of figures, foreword, acknowledgements, members of the curriculum committee, rationale and objectives, outline of content, glossary, bibliography, resources, and four appendices. (RT)

LAFOURCHE PARISH

COASTAL ZONE

CURRICULUM RESOURCE UNIT

BULLETIN 1834



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LAFOURCHE PARISH

COASTAL ZONE

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LOUISIANA STATE DEPARTMENT OF EDUCATION

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Foreword

The continued demise of Lafourche Parish coastal wetlands will have many far reaching consequences: some that can be tolerated, many that cannot. The basis for this document is to provide teachers with a "hands on" guide where material can be found on any one of a number of interrelated topics. The ultimate goal is to provide the student with a better, more comprehensive understanding of the geology, history, socioeconomics, and biology of the Lafourche Parish wetlands. One cannot fully appreciate what is being lost until there is an understanding of what one has.

This guide would never have come about if it were not for the desire of the Lafourche Parish Coatal Zone Management Advisory Committee to "bring these issues into the classroom".

The members of this committee are:

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Acknowledgements

We gratefully acknowledge the many contributing agencies and individuals who have 'elped to bring this project to reality. We particularly want to acknowledge the Lafourche Parish Council, the Coastal Zone Management section of the Louisiana Department of Natural Resources, and the Louisiana Sea Grant College Program for the cooperation and support in helping to provide this educational resource for the students of Lafourche Parish, and the state of Louisiana.

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Educational Rationale

The rationale for any curriculum is based on the developer's beliefs about students, student learning, and the course content. The Coastal Zone Resource Unit is based on certain premises.

Premises about Students and How They Learn

1. Students learn better when the impetus and the responsibility for learning are internal rather than external. Most students respond favorably when they have some choice of what and how they learn. This approach often yields greater student satisfaction, commitment, and learning than when all the decisions are made by the instructors.

2. Cooperation improves the quality and quantity of learning. Interaction among students, instructors, and resource people in the community can result in a level of learning and insight superior to that attained in courses where the only sources of data are books and lectures.

3. Instruction should begin with what the students already know.

4. Each student is unique. The curriculum must provide opportunities for the expression and development of the students' individual abilities.

5. Students learn and grow best in an atmosphere of trust and respect.

Generalizations about Content and Subject Matter

The Coastal Zone Curriculum Resource Unit is a project aimed at specialized land-use problems. Land-use problems are similar regardless what type of land (or water) resources are being used. These generalizations relate to land use which include coastal zone land use.

1. The content is not an end in itself, but a means to an end. Students should be encouraged to evaluate facts and ideas pertinent to a problem as the student perceives it. Information is a necessary tool for problem solving, but it is not enough.

2. Students must gain experience in dealing with issues that have a changing base of knowledge and a strong component of social values. Finding solutions to complex problems related to environmental quality, population pressures, transportion, food supplies, energy resources, and land use are among the highest priorities.

3. Pervasive questions about the use of the coastal zone cannot be answered within the realm of a single discipline. They require information from history, political science, economics, sociology and the physical and biological sciences.

4. All knowledge is tentative. A curriculum must provide opportunities for students to discover the incomplete nature of what is known.

5. An inquiry into land use problems in the coastal zone is an ideal vehicle for accomplishing the teaching and learning goals implied by all the previous assumptions. Although local patterns of land use differ, the problems exist in every community. Those problems serve as common denominators for an educational experience in research, problem analysis, and decision making, which use process skills.

General Objectives

The following are general objectives for this module. The module is designed to:

1. reflect and communicate the interdisciplinary nature of the use of the coastal zone.

2. foster the development of skills needed to distinguish relevant from irrelevant information, to recognize bias in interpretations, and to judge the validity of data.

3. foster the development, understanding, and use of problem-solving models and skills.

4. Promote an understanding of the complexity of coastal use problems and the trade-offs associated with alternative solutions.

5. Help students recognize the interdependence of living things.

6. Help students develop skills in gathering, interpreting, and evaluating data.

7. Encourage the development of autonomy and competence in decision making.

8. Recognize, encourage, and capitalize on the diversity of student backgrounds, interests, talents, experiences, and abilities in classroom activities.

9. Promote intellectual growth, changes in the affective domain, and participation in community activities.

Specific Principles and Goals

Within the framework of teaching and learning outlined above, specific content principles and process goals serve as integrating themes for the module activities.

Content Principles

Nine coastal zone use principles underlie the content of the module. Those principles are:

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1. The coastal zone is a finite natural resource that provides the main habitat for much of the living world, including humans.

2. The coastal zone is used for many different purposes. If any area is used for one purpose, its use for other purposes is limited.

3. Coastal-zone use has a historical perspective.

4. Our need for coastal regions is increasing because of our growing population and its changing needs and wants.

5. Many social, political, economic, physical, and biological considerations are involved in coastal-zone use decisions.

6. Each kind of coastal use has consequences, and many of those consequences cannot be reversed.

7. People have different attitudes and values about coastal-zone use. Those differences may cause conflicts when an activity is proposed for a certain piece of land.

8. Coastal-zone use planning is a dynamic process that involves trade-offs among concerned individuals. There is no perfect land-use plan for everyone.

9. Many laws and regulations concern coastal-zone use. Ownership of land places the responsibility for its care on the owner.

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What Is Happening To Our Coast?

Introduction

The Louisiana coastal zone is a geographic feature unique in the world. As Egypt was said to be gift of the Nile River so is Louisiana a gift of the Mississippi River. The Mississippi drains about forty-one per cent of the continental United States and part of Canada (Figure 1.). Soil carried by the river has been deposited in Louisiana for the last 6000 years to form what we now know as coastal Louisiana. All natural features in coastal Louisiana relate in some fashion to materials and processes associated with the emptying of the Mississippi River into the Gulf of Mexico. The Gulf of Mexico is a second major force making the Louisiana Coastal Zone what it is today. The interactions of these two water systems have made Louisiana an important center of domestic and world trade.

Winds, tides, and currents shape the land, deposit or rework sediments, and influence the climate of the coast. Storms originating in the Gulf attack man and land. Gulf resources, such as fish, furs, and petroleum, support great numbers of people in Louisiana and the rest of the country. Less than careful practices in harvesting these resources have caused the coastline to begin to deteriorate. The processes which form the land are not able to keep up with those working against it.

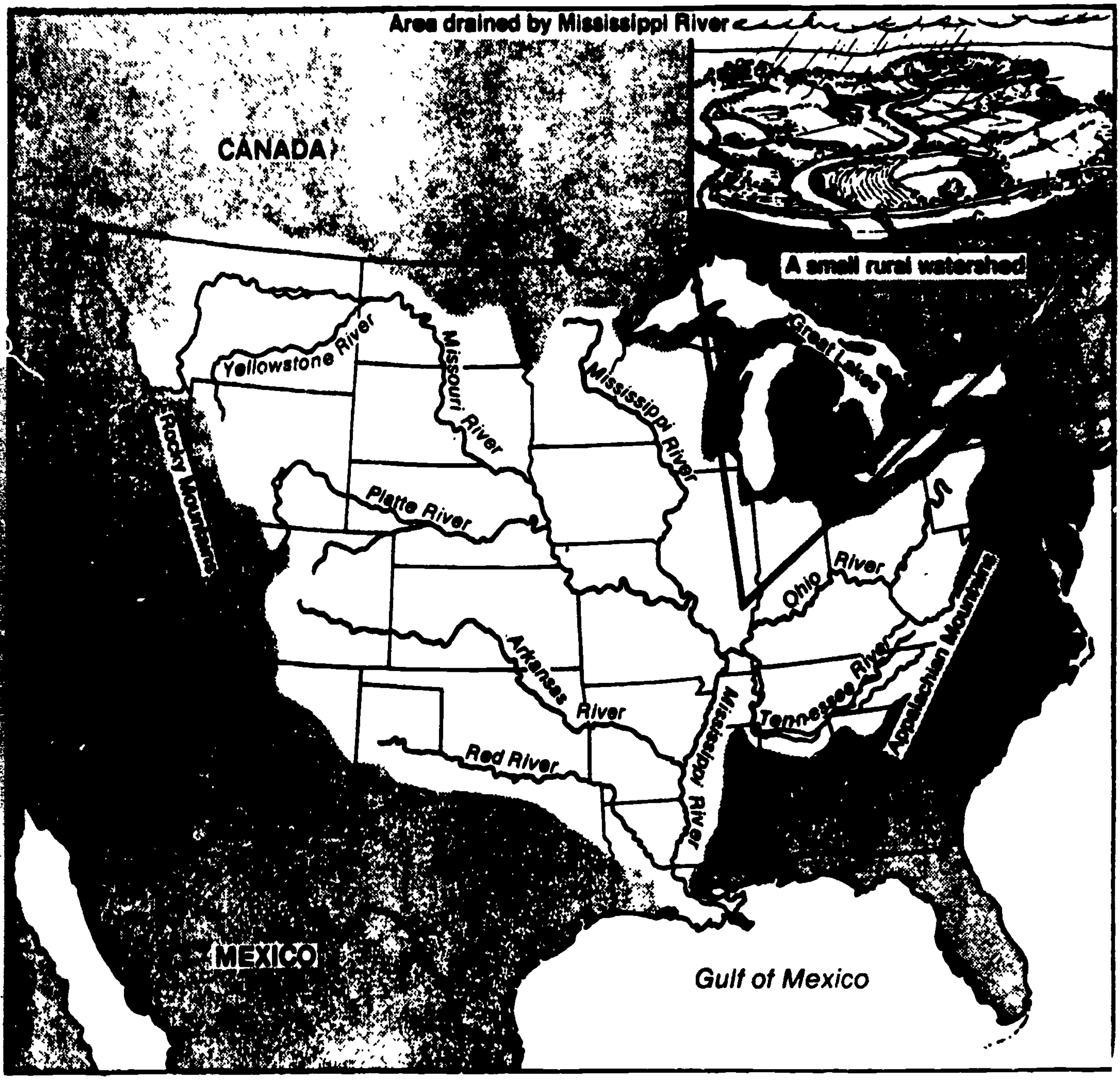

Figure 1. Area drained by Mississippi River.

Each component of the coastal zone contributes to the quality and character of the environment. The natural levee ridge areas, with their relatively higher elevations and firm soils, provide the land areas along which settlement and agriculture can occur with minimum environmental modification. They are a solid base from which man is able to utilize the resources of the coastal zone. The distributary channels provide water access and, historically, have been major routes of transportation. The nearby swamp and marsh basins provide some protection to the ridge areas from coastal storms.

The estuary is the zone where saline and fresh waters meet. These estuarine areas are principal breeding and nursery grounds for many important fish and shellfish. The estuaries are also valuable for their ability to absorb natural wastes and supply nutrients for an extensive food web. Like the rest of the delta zone, the marshes depend upon continuous land building and a balance of fresh and salt water. Changes in elevation or salinity drastically alter the vegetation and wildlife of an area.

The outermost zone of concern is the shoreline itself. Barrier islands, cheniers, and oyster reefs are extremely important aspects of the coastal area. These features buffer inland areas from eroding tides, winds, and dangerous storms. They protect man and estuarine wildlife alike. Barrier islands are built up by the deposition of sand and delta sediment by Gulf currents. The currents move the sediment along the coast, forming long chains of islands. If this process is impaired, the barrier simply erodes away; the coastline is left vulnerable, and is likely to deteriorate.

Coastal deterioration is a natural phenomenon. As the river changes course, the old delta ceases to build and begins to be eroded. Land formation takes place in a new area. Human activities, however, can seriously accelerate coastal deterioration to the extent that far more land is lost than gained. Coastal Louisiana, Lafourche Parish in particular, is experiencing increasing rates of wetland loss, wetland alteration, and water quality degradation.

This resource guide will serve the purpose of educating the public about the problems which exist today---problems which are concerned with the Lafourche Parish coastal zone areas. This guide is not a solution to the problems but will attempt to create an awareness of the problems facing all of us today.

Coastal Morphology

Coastal Louisiana consists of over five million acres of swamps, marsh, cheniers, natural levee forests, open bays and other waterbodies, barrier islands and other habitats. These habitats are invaluable to the State of of Louisiana because they have recreational and aesthetic values, they create an abundance of marine nursery areas and wildlife habitats, and they serve as a nutrient source, as buffers from storms, as a natural filter for biodegradable wastes, as well as many other important functions. A wealth of renewable and non-renewable resources are provided by the coastal zone.

Presently, coastal Louisiana is experiencing increasing amounts of wetland loss, wetland alteration, and water quality degradation. Most of these are naturally occurring processes, such as subsidence, saltwater intrusion, sea level rise, hurricanes and other storms, waterfowl and furbearer eat-outs, and wind and wave erosion. Man's activities, however, have resulted in an increase in the rates at which these phenomena occur. Relative sea level rise in Louisiana has been estimated to be six times the average rate of other coastal areas, due to the amount of subsidence being experienced. Saltwater intrusion, if gradual, creates changes in marsh types and may kill salt-sensitive vegetation. Louisiana is currently losing coastal areas at a rate exceeding 50 square miles per year (Figure 2.). The coastal zone encompasses almost 5.3 million acres. It contains over 40 percent of

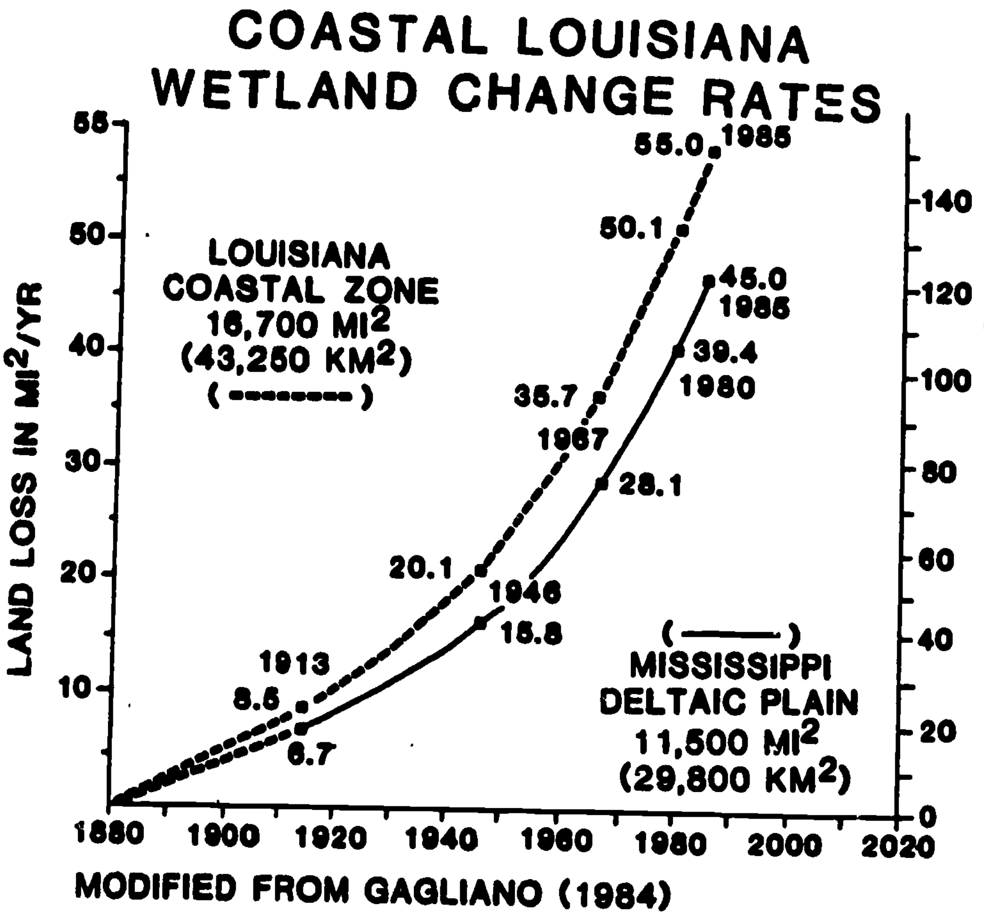

Figure 2. Rates of wetland loss in the Louisiana coastal zone compared with loss in Mississippi deltaic plain.

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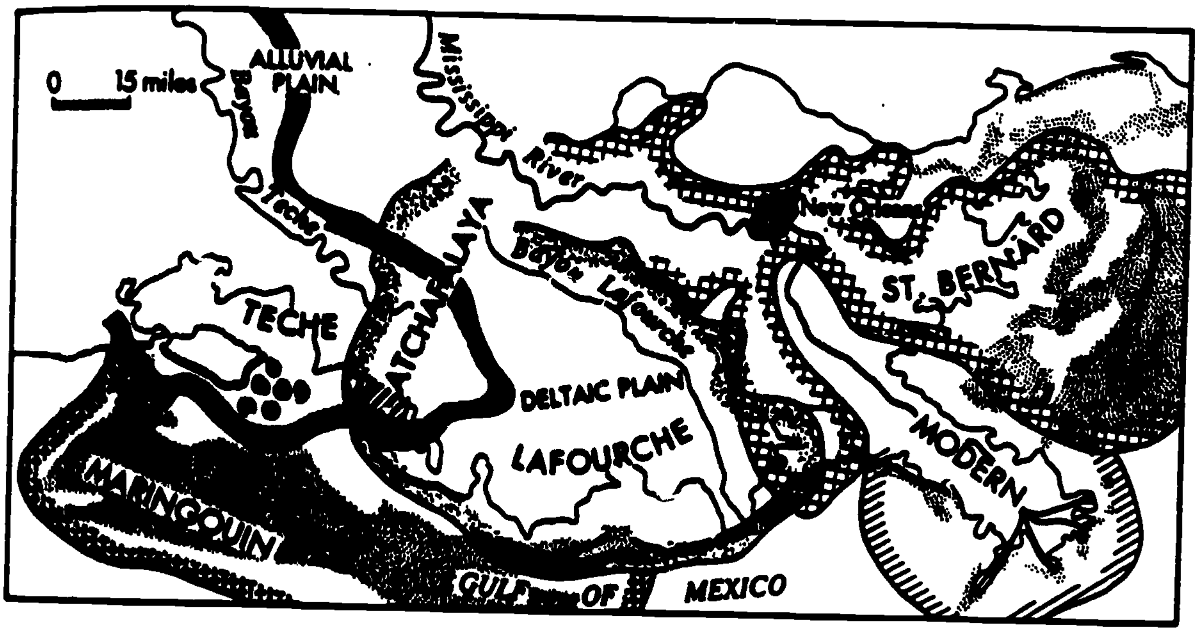
the nation's coastal wetlands and 25 percent of all wetlands in the nation, making it one of the largest and richest estuarine areas in the world. Louisiana consistently ranks first in national fisheries tonnage, which includes fisheries values from shrimp, crabs, oysters, menhaden, and other finfish. It has been estimated that almost two-thirds of all marine commercial fisheries species rely on coastal marshes and estuaries for part of their life cycle. In addition, millions of man-hours are invested by the recreational sportsmen in the pursuit of fish and shellfish, waterfowl, game species and furbearers. All of these species spend all or part of their lives in the coastal marshes and wetlands of southern Louisiana. Thus the importance of preserving these areas cannot be emphasized enough. To understand the total land loss phenomenon we must look back at the history of the Mississippi River.

For over 6000 years the Mississippi River has been delta switching every 1000 years, causing some areas of land to build while other areas deteriorate. The river has created seven major delta complexes containing over sixteen separate lobes extending from southwest Louisiana to the eastern shoreline of Lake Pontchartrain (Figure 3.). These delta lobes experience phases of aggradation and degradation. The former represents the growth phase, when fluvial input and sedimentation rates are at their maximum. When gradient conditions are favorable, diversions are triggered at some upstream points. This initiates the delta-switching process, abandoning a particular river channel and beginning a phase of degradation within the specific lobe. The introduction of sediment to the areas slowly decreases as a result of



DELTA COMPLEX	AGE (YEARS BP)
Maringouin	7250-6200
Teche	5700-3900
St. Bernard	4600-1800
Lafourche	3500-400
Modern	Active
Atchafalaya	Active

Barrier Shoreline

Figure 3. Frazier's (1967) model of the Mississippi River delta plain depicts the sequential deposition of six major delta complexes over the last 6,000 years.

fluvial discharges at another location. The river now changes its course, abandons the old delta lobe and builds a new one. The old lobe will begin to subside as no new sediment is being brought in to compensate for compaction of mud (subsidence). The sea reinvades part of the old delta resulting in rapid transgression.

The Lafourche delta lobe dates back about 2000 years, being built during the fifth shifting of the river. Because of sediment starvation many older lobes are being washed away. Losses have been particularly heavy in Plaquemines, Terrebonne and Lafourche Parishes. It has been projected that Plaquemines Parish will be completely eroded away in 50 years, Terrebonne in 100 years, and Lafourche in 200 years.

An integral part of the degradation phase of the deltaic processes is rapid subsidence and coastal erosion. The silting process has been influenced more by man than by nature. Levees have been heightened and reinforced to prevent floods. This prevents silts and clays from reaching the interdistributary marshes, thereby stopping the yearly buildup of sediment. Louisiana marsh mud contains up to 70% water by weight. Due to the desiccation of these clays by drainage and reclamation, shrinkage and subsidence becomes a problem. Adding to this, the withdrawal of fluids such as groundwater and petroleum from the subsurface removes the support of reservoirs, resulting in collapse of these reservoirs and surface subsidence.

The barrier islands, located from Grand Terre on the east through the Timbalier Islands to the Isles Dernieres on the west, were formed during the destructive phase of delta building and mark the seaward boundary of the old Lafourche delta lobe. The overall role of the barriers is to cushion the impact of the sea upon marsh deposits. Barrier Islands and tidal inlets in the past have been important regulators both of water exchange between the bays and the gulf and of transfer of wave energy from the gulf to the bays. As barrier islands erode and tidal inlets widen, the impact of the sea upon the bay areas and lower marshes increases. The Louisiana barrier shorelines are characterized by erosion and retreat of shoreline as well as high subsidence rates. In the past, retreat rates and erosion were offset by sediment input renewal. Repeated overtopping of the Mississippi River's natural levees in the spring provided sediments necessary to maintain wetlands. Distribution of these sediments within the marshes is provided by tidal forces.

During the spring floods many distributaries receive valuable coarse sediments and deposit them along the shoreline. Bayou Lafourche was an important conduit for river sediment until the early 1900's. Today, the Mississippi River is contained by levees throughout the deltaic plain. Sediments are now no longer being introduced into interdistributary swamps and marshes, but are moved to the steep slopes of the outer continental shelf by way of the passes of the presently active delta at the mouth of the Mississippi River. The only exception to this process is the Atchafalaya Bay delta which is receiving 30% of Mississippi River water flow and is also contributing to mudflat accretion on the Chenier Plain shoreline. This land accretion is not offsetting the massive deterioration of land elsewhere along the coastline. This deterioration is amounting to over 50 square miles per year of coastal land loss in the deltaic plain. New land is not presently being formed outside of the Atchafalaya Basin.

Two major features of the deltaic plain are natural levees and interdistributary marshes. Natural levees border both ancient and active distributary channels. These high ground levees are a few feet above the surrounding marsh. This sand and silt is coarser than the surrounding sediments. Levees are formed during flood stages when the river overflows, depositing the coarsest part of its load next to the channel. Because of the coarseness of these deposits, these natural levees are the best agricultural land and the best building sites.

Between the distributary channels and levees, the land is formed from the very fine silts and clays remaining in suspension after the coarser fractions have been deposited. As these sediments are deposited by the river, a considerable amount of water is trapped between the sediment particles. As time passes, and more sediment is deposited (a process called accretion), the water is gradually squeezed out of the underlying sediment, resulting in a gradual settling of the land. The process of land settling by squeezing water out is called subsidence. This low-lying land is subject to flooding, and forms marshes between the distributaries which are called interdistributary marshes. These marshes are colonized by various semiaquatic plants, including several species of the familiar marsh grass, *Spartina*. *Spartina* grass, unlike many plants, can tolerate salt water, colonizing both salt water and brackish water marshes.

The common salt water marsh grass *Spartina alterniflora* has special salt glands in the leaves that excrete excess salt, and during periods of low rainfall, salt crystals actually form on the grass blades. This ability permits *Spartina* to grow in vast, monospecific stands where no other higher plants can grow, forming the vast expanses of salt marsh. *Spartina* cannot, however, grow under water, and is restricted to growing on land that is at least exposed (out of the water) at low tide. If marsh grass is transplanted to areas that are flooded all the time it will die.

Freshwater marshes are colonized by a greater variety of semiaquatic plants, such as the common cattail *Typha*, in addition to grasses. Freshwater marsh plants can tolerate being constantly submerged, but cannot tolerate any salt, and die if exposed to salt water.

Freshwater marshes are formed much further inland than salt marshes. Because of this, these marshes contain much less silt and clay sediment, and more organic matter from decaying vegetation. Salt marshes also contain organic matter from dead grass blades. Marsh grasses, like most grasses, die back each winter, and produce new shoots and blades each spring. Marshes can balance subsidence with accretion by trapping sediment and organic matter. If sediment input is curtailed, as it has been by high man-made levees along the Mississippi, then new sediment cannot reach the marshes and build them up. Subsidence continues to occur, and gradually the soft land that supports the marshes sinks below the low tide level and remains submerged all the time. The dominant salt marsh and brackish marsh grass, *Spartina*, dies because of the continuous submergence, and eventually the marsh turns into shallow open water.

Another consequence of this sinking of vast stretches of former salt and brackish marshland is that salt water, like any water, "seeks its own level", in this case sea level, and flows farther and farther inland. This flow eventually reaches far enough inland to flood the freshwater marshes, killing the freshwater marsh plants which are not salt tolerant.

There are several ways in which man-made structures hasten the demise of the marshes. Canals which cut through the protective salt and brackish marshes can bring salt water directly into freshwater marshes and swamps which then die because they are not salt tolerant. Dead-end canals in salt and brackish areas kill large areas of marsh. The spoil banks, the long piles of clay and silt made when the canals are dug, which may reach heights of three to four feet above the marsh surface, interfere with the normal flooding and draining of water that occurs with each tide. Water is trapped behind these long piles, which act like man-made levees, causing the marsh to remain submerged and waterlogged. This is a killing stress for the marsh grass *Spartina* which cannot tolerate constant submergence. Large areas die and become open water ponds behind the spoil-banks of dead-end oil access canals in salt and brackish marshes.

Locally, Lafourche and Terrebonne parishes are on the surface of the abandoned Lafourche subdelta that was active between approximately 1700 and 700 years ago (early and late Lafourche deltas). The Mississippi flowed down what is now Bayou Lafourche as far as Thibodaux where it broke up into several distributaries. During the active early Lafourche stage, the major distributaries flowed south along Bayous Terrebonne, Blue, and Little Black. They branched again in the vicinity of Houma forming a dense network of distributaries. A true delta-shaped landmass formed an arc that extended approximately one mile seaward of the Isles Dernieres trend. Lower Bayou Lafourche was nonexistent at this time. The early Lafourche distributaries were then abandoned, and this part of the subdelta began to undergo the destructional phase.

The subdelta then entered the late Lafourche stage when lower Bayou Lafourche became the chief distributary. This diversion was not a sudden event but may have taken up to 100 years to complete. The river broke into a series of distributaries first at Lockport then at Larose, forming small lobes to the east of the present bayou. Eventually, Bayou Moreau became the principal distributary and the delta prograded well beyond the destructional barrier shoreline of the early phase.

About 700 years ago, the Mississippi River abandoned the Lafourche subdelta. Subsidence and coastal erosion have removed surface expressions of the seaward portions of the distributaries allowing Timbalier and Terrebonne Bays to form. These bays have enlarged rapidly as marshland deteriorates. Bayou Lafourche carried some Mississippi River water until 1906 when it was dammed off from the Mississippi at its head at Donaldsonville. As a result, the Lafourche delta has been deprived of fresh water. Rapid deterioration has occurred with distributary levees being reduced in height, width, and length; and marshes have become ponds, lakes, and bays. Saline waters and marshes migrated inland on brackish and freshwater environments. Old deltaic sediments are presently being reworked which now form the beaches at Fourchon and Grand Isle.

Lesson I

I. Louisiana - Here Today, Gone Tomorrow

II. Process Objectives

1. The students will describe two major disaster tendencies of the Mississippi River.

2. The students will be able to draw an illustration of how sediment moves from the Mississippi River to the Gulf of Mexico to form deltas.

3. The students will construct a diagram of the Mississippi River between Baton Rouge and New Orleans labeling the petrochemical industries.

4. The student will illustrate the land building potential of the Mississippi River.

5. The student will construct a model of the processes involved in the Mississippi River's past history of changing its course.

To The Teacher

The purpose of this activity is to make students aware of the serious problems Louisiana faces due to the channeling of and pollution of the Mississippi River. The tape may be obtained from the following sources: Goodbye Louisiana, NOVA #916, Copyright #1982 WGBH, 125 Western Avenue, Boston, MA 02134, 617-492-277 or Bob Daigle, 1111 East 12th Street, Thibodaux, LA 70301. A transcript of the show can be obtained by sending $4.00 to:

NOVA
"Goodbye Louisiana"
Box 322
Boston, MA 02134

To The Students

The following questions are to be answered during the program.

1. How many square miles of Louisiana coastline are washed away each year?

2. Name two disaster tendencies of the Mississippi River.

3. How much sediment passes through the Mississippi daily? What is happening to this sediment?

4. How much of the U.S. is drained by the Mississippi River?

5. Define deltaic river. Why is the Mississippi considered a deltaic river?

6. How much of Louisiana was created through this deltaic action in the last 5,000 years?

7. What are the major goals of the U.S. Corps of Engineers with regard to it work on the Mississippi?

8. How many petrochemical industries are located between Baton Rouge and New Orleans?

9. How does this industrial development affect the quality of drinking water in river parishes of southern Louisiana?

10. Using specific examples to illustrate your answer and the terms listed below explain why the title "Goodbye Louisiana" is so appropriate.

    1. Dredge
    2. Meander
    3. Overbank structure
    4. Still structure
    5. Salt water intrusion
    6. Water overflow swamp

Evaluation

After viewing the film, the teacher should lead class discussions in reviewing and checking answers. Once completed, the following questions can be asked to test concept understanding.

1. What would happen if more Mississippi River water is channeled through the Atchafalaya and less through the main channel?

2. What is being done in St. Bernard Parish to counter salt water intrusion caused by the Mississippi River Gulf Outlet?

3. What has been done to the Mississippi River to prevent it from changing its course?

4. What solutions might be suggested to overcome the following?

   a. Salt water intrusion.

   b. Barrier island deterioration.

   c. Deltaic erosion.

5. What are the human causes for the destruction of our wetlands? How can these be controlled?

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Lesson II

I. Getting in Shape - A Study of Louisiana Changing Coastline

II. Process Objectives:

1. The student will trace the shoreline of Louisiana from an old photograph.

2. The student will trace the shoreline of Louisiana from a recent photograph.

3. The student will compare past and present coastline shapes and features.

4. The student will predict and draw possible coastline features of the future.

To The Teacher

The purpose of this activity is to study the changing shape of the coastline. The teacher may assemble old photographs, old post cards, nautical charts, geologic survey maps, and aerial photographs of coastal regions. Most of this may be obtained from the Coastal Zone Management Coordinator of the Lafourche Parish Council, and/or the Nicholls State University Library.

Activity

1. Place the tracing paper over the earliest map, chart, or aerial photo that you have.

2. Trace the shore outline. Block in areas of man-made structures.

3. Find at least two points that represent permanent, fixed locations on all maps and charts. Mark these clearly.

4. After tracing the shoreline for one year, place the tracing paper on a more recent map.

5. Match the fixed location points.

6. Trace the new shoreline.

7. Label each shoreline with the appropriate data.

8. Again block in areas of man-made structures. Pay close attention to man-made structures such as sea walls and jetties.

9. Repeat with maps of successive dates.

10. Locate historical accounts of hurricanes that affected the coastline. Describe the changes that have occurred on the shoreline through the years.

Evaluation:

Interpretations of observations:

1. Which period of time showed the greatest change in the Louisiana coastline?

2. Were these changes associated with natural or man-made events?

3. How did major storms affect the beaches?

4. Make a drawing that shows what the coastline will look like in the future.

Lesson III

I. Stratification of Sediments

II. Process Objectives:

1. The students will observe and draw a picture of how layers of sediments are dispersed by particle size.

2. The student will develop his/her own suspension formula by collecting various substances to place in suspension.

To The Teacher

After collecting the samples in the activity, shake the jars. This simulates the resuspension of sediments that would occur during cold front passage or during hurricanes. This resuspension might provide most of the sediments since overbank flooding from the Mississippi and its tributaries no longer occurs. After being redistributed in the bays, the material is transported into the marshes by tidal action or by storm surges where it is deposited on the marsh.

40

Activity:

1. Students are to collect various samples of water from nearby ponds, streams, mud puddles, rivers or bayous that have been allowed to settle out.

2. Students collect samples again from the same area after stirring parts of the water bottom with the sample.

3. Allow all samples to settle and observe.

Evaluation:

1. Where are the finer sediments located to the coarser ones? Draw a model of this.

2. How would Mississippi River sediments be deposited at the mouth of the river? Which would settle first and which would flow out into the gulf?

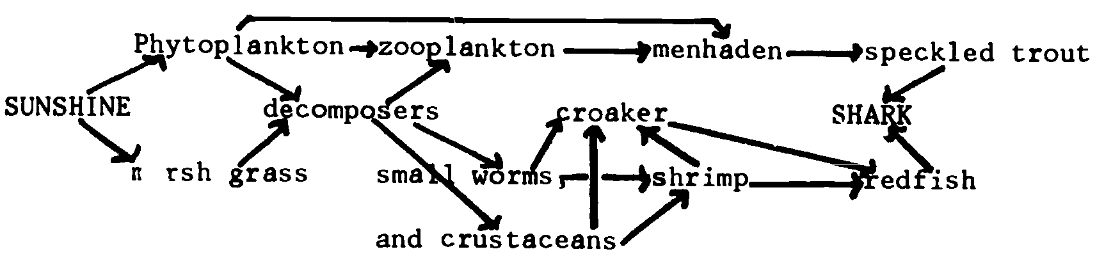
Biology

Coastal Louisiana is blessed with abundant wildlife and natural beauty, all very important to its citizens In order to understand how important, one must first understand the relationships that exist among organisms and between these organisms and their physical environment, their ecology. The scientists that study these relationships, ecologists, are aware that all organisms need energy. Green plants, the producers, can easily meet their energy requirements by photosynthesis, the process which allows energy from the sun to be trapped to form food molecules. Animals, the consumers, must eat plants, or other animals that have eaten plants, to meet their energy requirements. Not only are the molecules of food consumed used for energy, but are also assimilated into the bodies of these organisms during growth.

A food chain is the transfer of energy in the form of biomass from producers to consumers. For example, marsh grass could provide energy for an insect which could be eaten by a frog which could be eaten by a snake.

marsh grass $\longrightarrow$ insect $\longrightarrow$ frog $\longrightarrow$ snake

The transfer of biomass in a real situation is more complicated. A complex transfer of biomass between populations of organisms is called a food web. Example:



The importance of decomposers cannot be overlooked. They are responsible for the rapid recycling of the nutrients locked into dead plant and animal matter. Seasonal changes in an ecosystem, such as a pond, a forest, or a marsh cause a large accumulation of plant material such as leaf litter. In the marshes the plants most responsible for this litter belong to the genus *Spartina*. The two most common species of *Spartina* in coastal Louisiana are *Spartina alterniflora* (oyster grass), and *Spartina patens* (wire grass). Decomposition of this litter occurs, and the complex of energy-rich organic compounds and associated microorganisms is called detritus. Detritus is considered to be one of the most important energy pathways in a food web. The detrital complex provides energy for many organisms that feed in or on the marsh and its estuaries. Flushing action of tides will transport detritus from the marsh surface into the adjacent water bodies, making it available to aquatic organisms (Figure 4.). Photosynthetic activity of *Spartina* and subsequent detritus formation contribute greatly to the productivity of our coastal area. Some energy is also provided by other processes, such as photosynthetic benthic algal and bacterial mats.

Most people in Louisiana do not realize just how productive our coastal marsh estuarine system is compared to other systems. Productivity can be measured in several ways, but basically, it is the quantity of biomass (mass of plants and animals) in some unit of measure like kilograms/hectare or tons/acre that can be produced in a given area, during a designated time period, usually one year. The following table

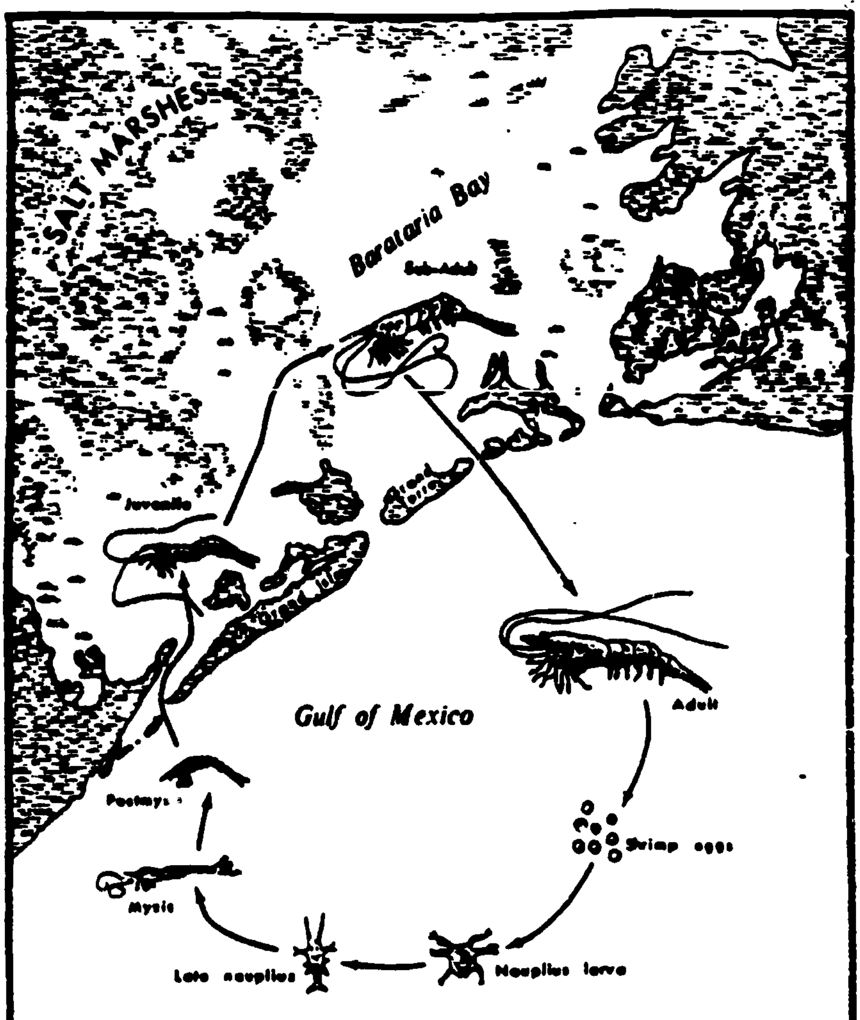


Figure 4. The Gulf shrimp are among several species of marine organisms that depend on the marshes to complete their life cycle. The Louisiana marshes support one of the world's most abundant fisheries.

is a comparison of coastal marsh estuarine systems with other ecosystems.

BIOMASS: Dry weight in tons per acre per year.

DESERT	0.00 to 0.33
DRY AGRICULTURE	0.33 to 1.50
COASTAL MARSH ESTUARINE SYS.	5.00 to 10.00
MOIST AGRICULTURE (RICE)	1.50 to 5.50
COASTAL WATERS	1.00 to 1.50
OPEN OCEAN	0.00 to 0.33

Based on past and present scientific research, there are five major reasons why our coastal areas must be protected.

1. PRODUCTIVITY - Many organisms depend on the marshes as a rich energy source necessary for their survival.

2. SHORELINE PROTECTION - It serves as a hurricane buffer, wave barrier, etc.

3. POLLUTION FILTER TRAPS - Serves as an absorber of pollutants such as raw sewage.

4. WILDLIFE HABITAT - Serves as a major breeding ground and nursery area for many species.

5. ECONOMICS - The economic value of our coastal area can be measured in millions of dollars, involving industries such as seafood, fur, tourist, etc.

All organisms that live in our coastal areas interact in some way, either directly or indirectly, with each other, creating a community of organisms (biotic community). Organisms also interact with their physical (abiotic) environment. Factors such as temperature, salinity, pollutants, etc. all influence populations of organisms. Water quality is the most critical factor in the physical environment of coastal, estuarine areas.

By definition, an estuary is an embayment of water along some shore where freshwater and salt water mix. Three criteria for an estuary are: (1) The area must be coastal. (2) There must be a mixing of waters of different salinities. (3) Water circulation is influenced by the geologic boundaries of the area. Types of estuaries are defined as:

1. Coastal Plain - A drowned river valley; land subsides and salt water moves in to start a marsh. Example: Chesapeake Bay

2. Fjord - A deep valley cut into a shoreline which extends well inland allowing sea water to mix with freshwater. Example: Bay of Fundy in Nova Scotia

3. Bar-Bounded - Barrier islands, which are the remains of old river deltas, protect this type of estuary from the open sea, allowing a marsh to exist. Example: Grand Isle, Barataria Basin

4. Tectonic -	Changes in the earth's surface sometimes allows sea water to move inland over a shoreline creating a marsh. Example: San Francisco Bay area

Salinity (salt content) of estuaries is influenced by several factors. In Louisiana, salt water can be driven inland by tides, wind, storm surges etc. causing salinity to rise sharply. Water from heavy rains driven by a strong north wind can move freshwater toward the coast, lowering salinity. This never-ending change in salinity creates a high variabilty in the environment which organisms must cope with to survive. Many organisms have developed special adaptations for regulating salt content within their bodies.

In addition to salinity, elevation (height above sea level) is also a factor in determining which kinds of communities that can exist in a coastal area.

FIVE COASTAL ZONES BASED ON SALINITY AND ELEVATION

A. SALT MARSH	15 to 32 ppt (sea level)
B. BRACKISH MARSH	3 to 15 ppt
C. INTERMENDIATE MARSH	1 to 3 ppt (mid-elevation)
D. FRESHWATER MARSH	0 to 1 ppt
E. SWAMP	0 ppt (highest elevation)

Each zone has producers and consumers which can tolerate a certain salinity range. However some organisms can tolerate a greater salinity range than others and can exist in more than one zone. Any gradation based only on salinity has many exceptions. Organisms living in the middle zones where salinity varies the most must be the most flexible of all.

Organisms can be categorized according to where they live in the water column. The two principal categories for aquatic organisms are pelagic and benthic.

PELAGIC COMMUNITY - Made up of organisms that live in the water column.

A. Plankton - Small organisms that cannot swim strongly and thus are at the mercy of the water currents; floaters or drifters.

1. Phytoplankton - photosynthesizing, planktonic plants. Example: Diatoms, dinoflagellates

2. Zooplankton - non-photosynthesizing, planktonic animals.

a) Holoplankton - Part of the plankton community their entire lives. Example: Acartia (a microscopic crustacean that can be up to 60% of the plankton)

b) Meroplankton - Part of the plankton community for only part of their lives. Example: Larval shrimp and crabs

B. Nekton - Organisms that are active swimmers.

1. Mammals and reptiles - porpoises and sea turtles

2. Fishes - Sharks, rays, and bony fish

3. Coelenterates and molluscs - jellyfish and squid

BENTHIC COMMUITY - Organisms that live on or in the bottom sediments or attached to some hard substrate such as a shell.

A. Epifauna - live on the surface of the substrate.

   1. Sessile - stationary; oysters, mussels, and barnacles.

   2. mobile - move around on surface; crabs, shrimp, seastars.

B. Infauna - burrow in sediments; worms, some amphipods, shrimp

C. Demersal - fish and other organisms closely associated with the bottom; flounders, croakers, black drum.

To gain a real understanding of this estuarine system would require many years of study. With these materials and the student activities that follow, it is hoped that the students will gain a greater understanding of the problems that affect coastal Louisiana. With a better informed voting public, it is hoped that solutions can be found that will save or help to save our wetlands.

I. Soft Drink Energy Pyramid

(This is a modified version of an activity taken from NSTA packet on Bioconversion.)

II. Background Informati⌐

The success of this activity depends upon secrecy on the part of the teacher! Special instructions are given for the teacher.

III. Process Objectives

The student will ...

1. be able to understand what an "energy pyramid" represents.

2. be able to identify the kinds of organisms that occupy each level of an energy pyramid.

3. learn the meaning of joule.

4. gain experience in measuring with a graduated cylinder and pipette.

5. discover what happens to energy that is not passed on to the next level of an energy pyramid.

6. discover just how little e ergy is passed from one level of an energy pyramid to the next.

IV. To the Teacher:

This activity can be done as a demonstration or it can be used as a class activity. Review the basic progression of a food chain from the primary producer to the final consumer, noting that there is a loss of 90 percent of the energy at each step of the pyramid.

If the activity is to be a class activity, divide the class into groups of four. Each student in a group will be an organism in a food chain made up of grass, a grasshopper, a snake, and a hawk.

V. Activity:

1. Purpose:

   The purpose of this activity is to enlighten students as to the magnitude of energy loss that occurs between successive levels of an energy pyramid.

2. Procedure:

List of materials per group:

1 - bottle containing 1,000 ml of soft drink

4 - paper cups (approximately 120 ml each)

1 - 100 ml graduated cylinder

1 - 25 ml graduated cylinder

1 - pipette 1 or 2 ml, graduated in 0.1 ml

(a medicine dropper will do)

The teacher explains that the 1,000 ml of soft drink arbitrarily represents 1,000 joules of energy coming from the sun. (Energy is usually measured in calories and joules can be used to measure energy or work. 4.19 joules of energy is equal to 1 calorie. 1,000 joules = 238.66 calories.)

a. Each member of the group is given a paper cup. Measure 100 ml of drink and pour it into cup of "grass person." Now pour the other 900 ml of drink down the drain! (Teacher explains that 90 percent of the sun's energy is not fixed by photosynthesis as chemical energy (plant food), and therefore does not become part of the food chain.)

b. Have "grass person" pour 10 ml of the drink (measured carefully with the small cylinder) into the cup of the "grasshopper person." "Grass person" may now consume 90 ml of the drink.

c. Have "grasshopper person" measure 1 ml of this drink (with the pipette) into the cup of the "snake person." "Grasshopper" may now drink the remainder of this portion.

d. Have the "snake person" measure 0.1 ml of this drink into the cup of the "hawk person." "Snake" may now drink the remainder of this portion.

e. "Hawk" may now drink the last drops (if it can be poured out of the cup).

3. Interpretation of Results:

Answer the following questions.

a. What part of the original energy received from the sun did each character receive?

b. What happened to the remainder of the energy received by that part of the pyramid represented by each student?

c. How much more energy efficient

would it have been if "hawk person" could just have eaten (consumed the drink passed on by) "grass person."

d. Relate the food pyramid you have demonstrated today to man's energy problems and his possible solutions of them. (Use your imagination. Consider ideas you may have heard of, such as new energy sources, and try to predict some of our future technology.

4. Repeat this activity using an aquatic food chain. Substitute phytoplankton for grass, zooplankton for the grasshopper, menhaden (or a pogie) for the snake, and a speckled trout for the hawk. Can you think of other examples?

I. Early Man in Louisiana

II. Process Objectives

1. The student will identify the role of Early Man in the coastal regions Louisiana.

2. The student will evaluate the impact of Louisiana's coastal environment on early population patterns and village site selections.

3. The student will evaluate the relationship between climate and how people live.

4. The student will list examples of Indian influences on the development of Louisiana.

III. Setting the Stage:

We generally think of Indians as living in the days of the wild west, chasing buffalo across the prairie on an Indian pony. We seldom envision Louisiana as the home of the Indians, but long before the first European set foot on Louisiana soil, Louisiana was home to the Indian.

The ancestors of the first Indians arrived in North America approximately 30,000 years ago. Scientists theorize that these nomadic people crossed an ice bridge linking Asia and North America at the Bering Straits. Over thousands of years, descendants of these people spread throughout North America.

The information we have on the pre-historic people was provided to us by scientists called archeologists. Archeologists carefully study sites of Indian villages to determine how these people lived. In Louisiana these sites fall into one of three categories: 1) midden site-- which is similar to a trash dump, 2) mounds-- which were either ceremonial or burial, and 3) village sites.

The earliest Indian culture we have identified in Louisiana is the Paleo-culture. These people lived in Louisiana between 10,000 B.C. and 6,000 B.C. Their village sites have been found from the hill country of central Louisiana to the salt domes of Avery Island. Louisiana's environment and climate were much different at that time than it is today. Louisiana was feeling the effects of the Ice age, sea-level was lower, which meant the coast of Louisiana extended further into the Gulf of Mexico. Louisiana was part of the range of buffalo, mastodon and mammoth.

Around 5,000 B.C. the early Indians of Louisiana underwent a cultural change. This group is identified as the Meso- or Archaic-Indian culture. These people were a more advanced culture than the Paleo-Indians. The Archaic-Indians fashioned tools such as knives, axes, and scrapers. They tamed and domesticated the dog, and although they were nomadic, they did not range as far as earlier groups. The Archaic Indians witnessed a drastic change in Louisiana's environment. The end of the Ice Age brought about a rise in temperature and in sea level. Large deltas formed along Louisiana's coastline, and made Louisiana a lush grassland with mild climates.

The best known of the pre-historic Indians belonged to the Neo-Indian culture. These people lived in Louisiana from 2,000 B.C. to 1,600 A.D. The Poverty Point culture lived on the West bank of Bayou Macon in West Carroll parish near Epps, Louisiana. The Poverty Point Indians were an advanced culture of about 5,000 people. This population made Poverty Point one of the largest population centers in North America at this time. The Poverty Point Indians built a total of 11.2 miles of ridges and terraces in geometrical designs. These ridges and terraces were used for ceremonial as well as practical purposes. Huts built on the terraces would be protected from the spring flood.

At the time of the arrival of the first Europeans, Louisiana had a population of between 12,000 to 15,000 Indians. The major language group of South Central Louisiana was the Chitimacha. The Chitimacha Indians lived in the area from Bayou Teche to the Mississippi River. Two tribes of Chitimacha Indians lived in what is now Lafourche Parish.

The Washa lived near Lake Bouef and Kramer, the Chawasha lived near Lake Salvador and Larose. These tribes made a living by hunting, fishing, and gathering.

The Houma Indians, who inhabited Terrebonne and the southern part of Lafourche Parish, were part of the Houma-Muskhogean language group who inhabited the Florida Parishes north of Lake Pontchartrain. The first recorded encounter of the Houma Indians with Europeans was by La Salle in 1682. The Houma Indians were forced from their land as a result of early Indian wars and began a southern migration. Through the desire to trade, and after being forced from their land, the Houma Indians settled along Louisiana coastal marshes.

The early Lafourche Indians adapted well to living in coastal Louisiana. They made their huts from palmetto leaves lashed to wooden frames. The Indians also built dugout canoes called "piragua" by the Spanish---today we call them pirogues. The pirogues were built from cottonwood or cypress trees. The Indians would girdle a band of bark from the base of the tree. After the tree died, they would build a small fire at the base of the tree to fell the tree. Another fire was built to cut the log the length needed for the boat. Hot coals were placed on the log, and as the wood charred, the Indians would scrape away the ash to create a dug-out.

Today the Chitimacha are the only Louisiana Indians living on their ancestral grounds. There are about 40 Chitimacha Indians living on a reservation near Charenton in St. Mary Parish. The Houma Indians have petitioned for federal recognition and have over 9600 members on their tribal role in Lafourche and Terrebonne Parish.

The Indians of the Lafourche region have contributed much to the history and culture of the area, from area names to food. The next time you think about Indians, you may want to envision a cypress swamp with a pirogue gliding through its waters.

IV. Procedure:

1. Organize students into small groups. Have each group research a different aspect of Indian life, such as housing, hunting technique, tools used and developed, agriculture, foods, customs, and rituals.

2. The groups should report to the class on their findings using models as examples when applicable.

3. Students should compare their findings with their modern life style and discuss their conclusions.

4. The models may be set up in the library as a Museum of Early Louisiana Indian Culture.

V. Summary

From the conclusions they have drawn through comparing the lifestyles of early Indians to their own, students should evaluate the value systems of early Indians as opposed to modern man as it relates to the enviroment. Points to be considered are:

1. What demands have we placed on our local environment through population, industry, commercial development?

2. How has our modern life style facilitated our losing the trong bond to nature that the early Indians possessed?

I. European Man in Louisiana

II. Process Objectives

1. The student will identify the role of European man in the exploration and colonization of coastal Louisiana.

2. The student will evaluate the impact of Louisiana's coastal environment on early population patterns and colonial site selection.

3. The student will explain the relationship between climate and how people live.

4. The student will list examples of European influences on the development of Louisiana.

III. Setting the Stage

All too often history is taught as a collection of facts. In this lesson we will attempt to relate the role of European explorers and colonists to the development of coastal Louisiana. We will reinforce the idea that we are speaking of a series of human events that led to modern Louisiana. Coastal Louisiana was both forbidding and inviting as the first Europeans attempted to carve a future here. We will trace their efforts and sacrifices in their quest to settle Louisiana.

IV. Procedure

The early explorers and colonists survived because of their ability to work together. Students should utilize the small group process in completing the following activities:

1. Students should select a group leader. The leader is to act as the head of the voyage and exploration. They will assign tasks and responsibilities.

2. Students should keep a journal of their experiences on this voyage of exploration. They will follow the route of Iberville and Bienville, and should visualize Louisiana as it would have been in 1699.

3. The groups should construct models of the homes they might have lived in, boats they may have used, tools they may have used, prepare a meal they could have eaten, and maps they would have drawn.

4. The materials constructed by the students may be set up in the library as part of their museum of Louisiana's cultural development.

Summary

When the research and displays are completed, compare and contrast the lifestyle and expectations of the European colonists and the early Louisiana Indians:

1. What did they have in common?

2. How did they differ in their expectations, their reasons for coming to Louisiana, their needs for survival?

3. What spirit of cooperation was exhibited by the small group to accomplish a goal?

4. How do students relate to the fact that the events they experienced are the same as their ancestors experienced in order to settle Louisiana?

5. From their journals students should make a comparison of life today and life of the early colonists. The students should compare sources of food, housing, entertainment, medical care, education, and environmental awareness.

European Man in Louisiana

When we look at Louisiana today we see a modern, industrial state. We enjoy the comforts and luxuries of a modern society. This was not always the case. Our modern state had to be formed from a rugged wilderness. The early explorers and colonists endured many hardships in order to remain in what is present day Louisiana.

All too often a society has the tendency to simplify its history: this person explored this, that person settled there. It was not until the Challenger tragedy that we realized the price many of the earlier explorers and colonists paid so that [illegible] may be here today.

The early explorers sought the rich[illegible] that gold and silver would bring. The Spanish had found great wealth in Mexico and continued to explore the area in hopes of finding more. Early Spanish explorers had explored the Gulf Coast as early as 1519. On May 8, 1541, after exploring much of the southeast United States, Hernando De Soto discovered the Mississippi River along the Louisiana-Arkansas border (Figure 5.). De Soto and his men did not appreciate the significance of their find.

France had centered its exploration of the new world in the area of Canada. The French couriers de bois, or fur trappers and traders, found that the fur trade was as profitable as gold mining. Through their dealings with the Indians of the Ohio Valley they had heard of the "Great Water", or the Mississippi River. The first Frenchmen to explore the river were Father Marquette, a Jesuit priest, and Louis Joliet, a courier de bois. They explored the Mississippi as far south as the

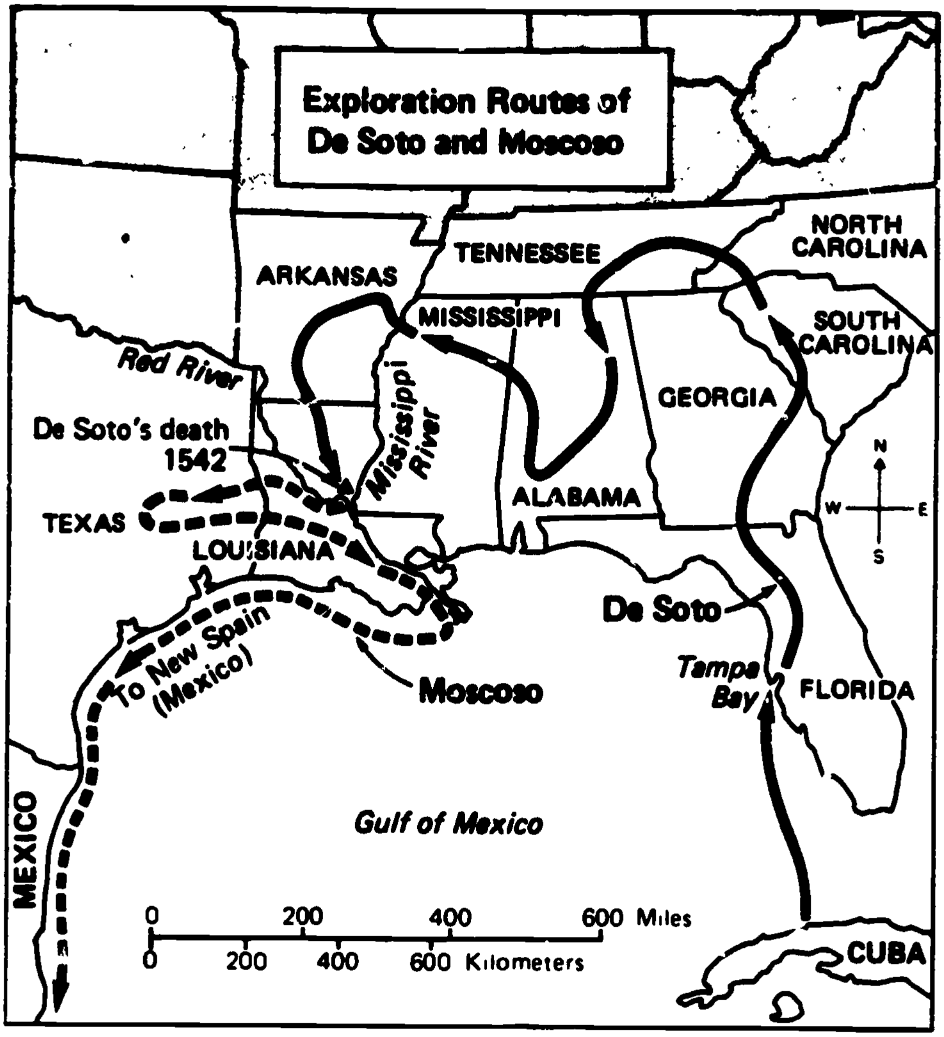


Figure 5. Route of Hernando De Soto.

mouth of the Arkansas River. Because they feared the Spanish along the coastline, Marquette and Joliet returned to Canada. The first Frenchman to explore the Mississippi to its mouth was Rene Robert Cavelier, Sieur de La Salle. La Salle's expedition reached the mouth of the Mississippi on April 9, 1682 (Figure 6.). There, with much ceremony, La Salle claimed all land drained by the Mississippi River and its tributaries and named it Louisiana in honor of King Louis XIV of France. Louisiana was born, covering 41 percent of what is now the United States and parts of three Canadian provinces.

La Salle failed on his return voyage as he attempted to find the mouth of the Mississippi through the Gulf of Mexico. It should be noted that La Salle did not have the benefit of modern charts and maps or navigational equipment and that the mouth of the river was not as clearly defined as it is today.

Following La Salle's failure, Count de Pontchartrain, the French minister of Marine, sent the Le Moyne brothers (Pierre Le Moyne, Sieur d'Iberville, and Jean Baptiste Le Moyne, Sieur de Bienville) to explore and colonize the Loiuisiana territory. Iberville planned his expedition well. In September of 1698, he sailed from La Rochelle, France; on January 26, 1699 he arrived at Pensacola Bay, Florida. Iberville's strategy was to explore the Gulf Coast from small boats to find the mouth of the Mississippi. On March 2, 1699 Iberville discovered a strong flow of fresh water. As he explored up river and made contact with the Indians, he knew he had found the Mississippi River.

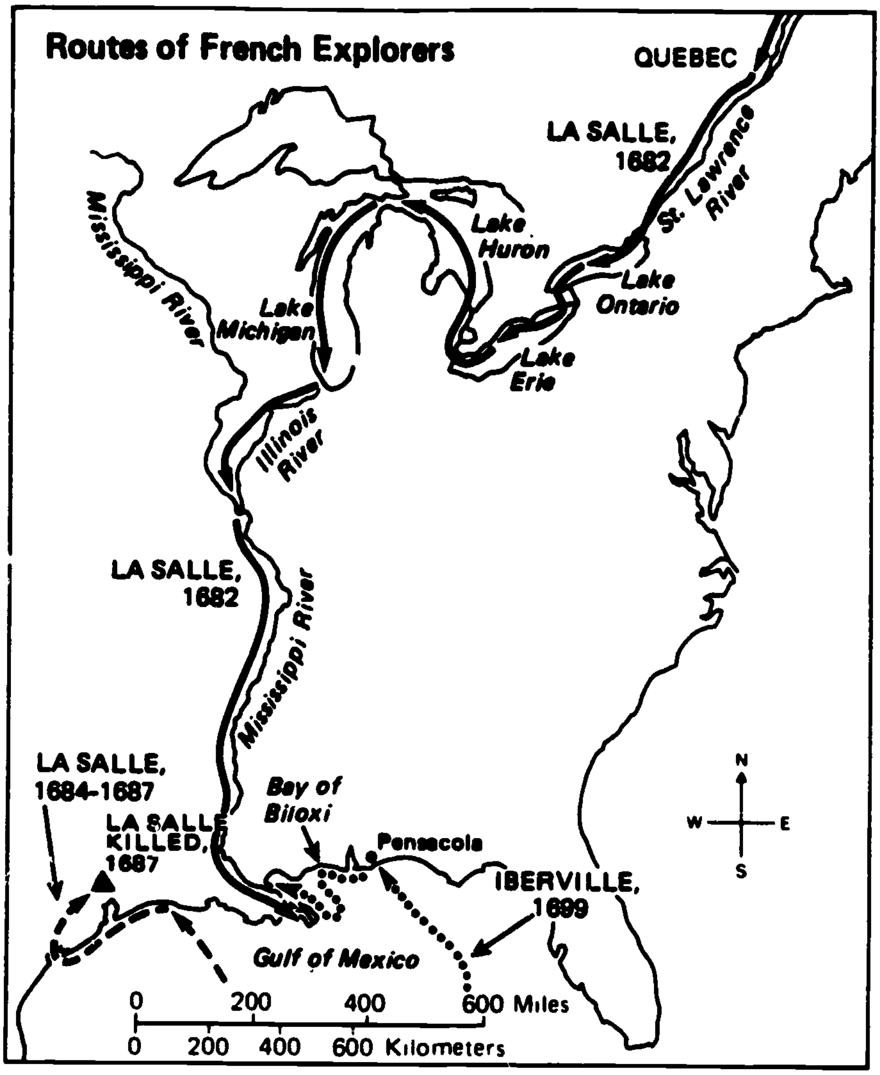


Figure 6. Routes of La Salle and Iberville.

Iberville's early explorations of the region put him in contact with the Houma and Bayougoula Indians. These tribes used a red pole to mark the boundary of their village--the French referred to the area as Baton Rouge. Iberville returned to the base camp at Ship Island through the Amite River. Along the way he passed through and named Lake Maurepas for the son of Pontchartrain, and Lake Pontchartrain for the French minister of Marine. Bienville traced the original route back down the river. Bienville encountered the Chitimacha Indians living on a fork of the Mississippi River. The area was later named La Fourche De Chitimacha; this was Bayou Lafourche.

Iberville's early maps of the Louisiana territory label the area from the Atchafalaya to Lake Pontchartrain as "Trembling Prairie". Today we refer to the floating marsh as "flotant". The distance from the Gulf of Mexico to a suitable site to build a colony caused Iberville to look to the Mississippi Gulf Coast where he built Fort Maurepas on Biloxi Bay.

The first attempt to build any type of settlement in present Louisiana came in 1700 with Fort de La Boulaye about 50 miles from the mouth of the Mississippi in what is now Plaquemines Parish. The fort was inhabited for only a few years and abandoned.

The first permanent French settlement in Louisiana came as a result of the efforts of St. Denis to establish trade with the Tejas Indians in Spanish Texas. St. Denis traveled up the Red River to the site of the Natchitoches Indian village along the Red River, where he built Fort St.

Jean Baptiste de Natchitoches in 1714. In 1718, Bienville convinced the company of the Indies to build a city on the crescent in the river. The chief engineer Le Blond De La Tour objected to the site selection because it was a low marsh location. Bienville named his city Nouvelle Orleans, or New Orleans. The city was nothing more than crude huts that were blown away several times by storms. Flooding was a regular event and the royal engineers finally recommended another site for the city. Bienville persisted, and Adrien de Pouger, the royal engineer, laid out the plans for a city. In 1721, about 470 people lived in what is now New Orleans. Bienville's site selection placed Louisiana's largest city at the state's lowest point of elevation--five feet below sea level.

In the early 1720's, German families settled upriver from New Orleans in an area that became known as the German Coast (i.e. St. Charles Parish and St. James Parish). Their farms helped feed the people of New Orleans. In the 1760's they were joined by the Acadians who had been exiled from Nova Scotia. Over several generations, Acadians, Germans, French and Spanish Creoles and other groups came together to produce cajun culture. From the Mississippi River and the St. Landry and St. Martin areas, these cajuns migrated southward along the bayous to the Gulf of Mexico.

As in the case of all colonies, the prime objective was to develop industry to help the colony to prosper. The early Louisiana colonists were farmers and fishermen, merchants and traders. Two unusal crops grown in the early Louisiana colony were indigo and wax myrtle trees (Figure 7.). The French had experimented with the bayberry or wax myrtle

Figure 7. The bayberry or wax myrtle tree.

tree. For centuries man had used the wax myrtle from Mexico to Pennsylvania. In 1721, Father Charlevoix recommended the development of the wax-bearing plants in Louisiana. By removing berries from the tree and placing them in a cloth sack, then placing the sack in a vat of water over a low fire, the wax could be separated from the berry. The water was heated to about 109 degrees F, causing the wax to form a film on the surface of the water, which was removed and allowed to cool. The greenish-yellow wax was formed into candles. Bienville encouraged the development of the wax industry. Michael de La Rouvilliere wrote of one of the settlers, Sieur De Dubreuil, who manufactured 6,000 pounds of wax. Planters began to develop wax myrtle plantations, with some plantations having as many as 2,000 wax myrtle trees. New Orleans became the center of the wax trade in North America.

When the first Europeans arrived in Louisiana they found a land rich in natural resources. The early colonists were quick to make use of Louisiana's wildlife resources. Furs were a symbol of wealth and nobility in Europe. By that time, fur-bearing animals had become scarce in Europe. Louisiana and New Orleans not only offered the opportunity to trap furs in the large delta region, but also acted as a port of trade for the fur industry of the entire Mississippi Valley. From the time of its founding in 1720, New Orleans became a major fur center. Buffalo, deer, bear, otter, lynx, and fox hides and pelts were all shipped to Europe through the port of New Orleans. In 1763, two New Orleanians, Pierre Laclede and Auguste Chouteau traveled up river to set up trade with the Indians in the Mississippi Valley. They constructed a small fort and trading post where the Mississippi and Missouri Rivers merge. The small fort grew to become the city of St. Louis.

Evidence exists that ths muskrat occurred in Coastal Louisiana marshes as early as 10,000 years ago. The muskrat did not become prominent in the fur trade until the 1900's. Ted O'Neil offers this hypothesis: "---isolated colonies of muskrats existed all along, but were so limited by the lack of food supply and by abundance of predators that they were unobserved by early inhabitants or explorers who studied the coastal marshes". Early trappers trapped mink, otter, and raccoons in the 1800's; they also hunted alligators. Hunters would pole alligators from their holes. To make it easier to find the alligator holes, early hunters began to burn the marsh. The burning brought about a change in the type of marsh vegetation, favoring three-corner sedge, the preferred food of the muskrat. As the food source spread, so did the range of the muskrat. By 1910, the first serious muskrat trapping in Louisiana had begun. Muskrat populations grew at such a rate that in 1912 cattle ranchers in Cameron Parish were paying a bounty of five cents a pelt for them.

As Louisiana muskrat pelts reached the fur market, demand for the pelts grew. Why would a soutnern subspecies be rated so highly in the fur trade when almost everyone knows that animals tend to put on denser furs in colder climates? George Lowery, in his 1981 "The Mammals of Louisiana and its Adjacent Waters" offers this observation, "Muskrats live in water, the temperature of which is 'thermostatically' regulated in one direction by physical laws; it cannot fall below 32 degrees F without some chemical added, such as salt. So they have to be prepared to withstand immersion at temperatures somewhat lower actually than those endured by some Northern Muskrats".

By 1912, fur trapping had become important enough for the state legislature to impose a closed season on mink, otters, muskrats, and raccoons. The law stipulated that these animals could be taken only by licensed trappers and only from November 1 to February 1.

The first statistics on the fur industry in Louisiana were kept for the 1913 trappers season. The report by the then Department of Conservation indicates that 5 million pelts were trapped; more than 4.25 million were muskrats.

A significant event occurred in 1938, although not much thought was given to it a the time. Edward Avery McIlhenny introduced the nutria into Louisiana (Figure 8.). McIlhenny ordered 14 nutria from a dealer in Argentina. One of the females gave birth during transit, and 20 animals arrived in Louisiana. McIlhenny placed the animals in a pen at Avery Island where they multiplied so rapidly that they soon could no longer be contained. Many escaped and a breeding population now existed in the surrounding marsh. Through rumors of the animal's appetite for undesirable aquatic plants, and the price nutria furs brought in 1945-46, many landowners requested breeding stock. The population of nutria in coastal Louisiana reached its peak between 1955 to 1959, when it was estimated 20 million nutria lived in Louisiana's coastal marsh.

Figure 8. Nutria (*Myocaster coypus*).

Two factors combined to stabilize the population of nutria in Louisiana's coastal marsh. The nutria's appetite caused it to eat away much of its own cover vegetation. This lack of cover vegetation compounded the effects of the tidal surge accompanying Hurricane Audrey in 1957, and the low temperatures of the winter of 1962 which dipped to 12 degrees F. Millions of nutria were destroyed by these two natural events. It was within this time period that the nutria surpassed the muskrat as Louisiana's leading fur producer. Several factors contributed to this: 1) knowledge of the proper techniques to process the nutria pelt, 2) the decline in the muskrat population, 3) an increase in the use and value of nutria meat. The meat was used for everything from mink food to human consumption.

From the time of the earliest trappers, the marsh was both a source of income and an obstacle. To reach the deep marsh the trappers would dig small ditches through the marsh called a "trainasse." The trainasse allowed the trapper access to the deep marsh. The trapper generally worked a lease of 100 to 300 acres setting out 250 traps. On a good day he would catch 30 to 90 muskrat, which he would skin on the spot. He would then take the pelts back to his cabin and place them on drying frames.

Every two weeks or so the land manager would visit the cabins in a boat bringing provisions and taking away dried pelts. The highlight of the season came with the big sale at the end of the season. The buyers would bid on each trapper's lot and submit it to the land manager as a sealed bid.

The modern fur industry has changed a great deal. Today' trappers act independently, dealing directly with the buyer. The trapper may operate as many as 300 to 400 traps on a lease that may reach several thousand acres. Most of the marsh cabins are gone, with the trapper taking each day's catch home for processing. Between 1947 and 1967, the number of fur dealers dropped from 40 to 21, the number of buyers from 263 to 128, and the number of trappers from 12,000 to 5,000.

The health of the fur industry in Louisiana is directly related to the health of the habitat. Historically, we have seen the effects of habitat loss on the populations of nutria and muskrat. The loss of Louisiana's coastal marshes would have a drastic effect on the fur industry in Louisiana.

Just as interest in the development of the fur industry grew, so did the interest in a commercial fisheries development. From early colonial times shrimp species were plentiful on the New Orleans market; and no doubt the common names of these, "river shrimp" and "lake shrimp", originated in that city. The term "lake shrimp" referred to the most plentiful of our migratory salt water species, the young of which appeared in lakes every summer, sometimes in great schools.

Early methods of taking shrimp consisted of cutting a burlap sack in half and placing a handful of corn meal inside the sack. The sack was then suspended slightly below the surface allowing the shrimp to enter the sack and feed on the corn meal. Latter methods included dipping or dragging hoop nets and the development of the use of seines. The early fishermen would use seines of about 120 feet in length and 10 feet in width. One man with a rowboat would circle out and back to a lugger, trapping the shrimp in a net.

Seiners who ventured outside, along Grand Isle beaches, or near the mouth of Bayou Lafourche at Fourchon, long recognized a small sea shrimp which they referred to as "Six Barbe" or "six whiskers" (Figure 9.). This name was gradually corrupted to "Sea Bob", which is what they are now called. Large catches of Six Barbe or Sea Bob were made by seining the beaches during favorable weather. The bulk of the Sea Bob catch was dried in the sun on the drying platforms which dotted the coastal bayous and was shipped to Chinese colonies and over the world.

Early shrimp and shellfish were wrapped in moss to keep cool while being transported. Ice boats came after the turn of the century. Also, about this time, gasoline engines slowly came into use. True commercial shrimping did not begin until 1915 with the introduction of the otter trawl from North Carolina. With the advent of power boats and the development of sea-going trawlers, the shrimping grounds were extended, and both drying and canning industries grew by leaps and bounds. Commercial production went from half a million pounds in 1880, to 16 million pounds in 1919, and 32 million pounds in 1920. In 1917, there were 300 seines and only four trawls operating commercially in Louisiana. In 1937, there were 2,313 trawls and 35 seines operating.

Due to the development of refrigeration, new methods of harvesting, canning, packing, new preserving techniques, and rapid transportation,

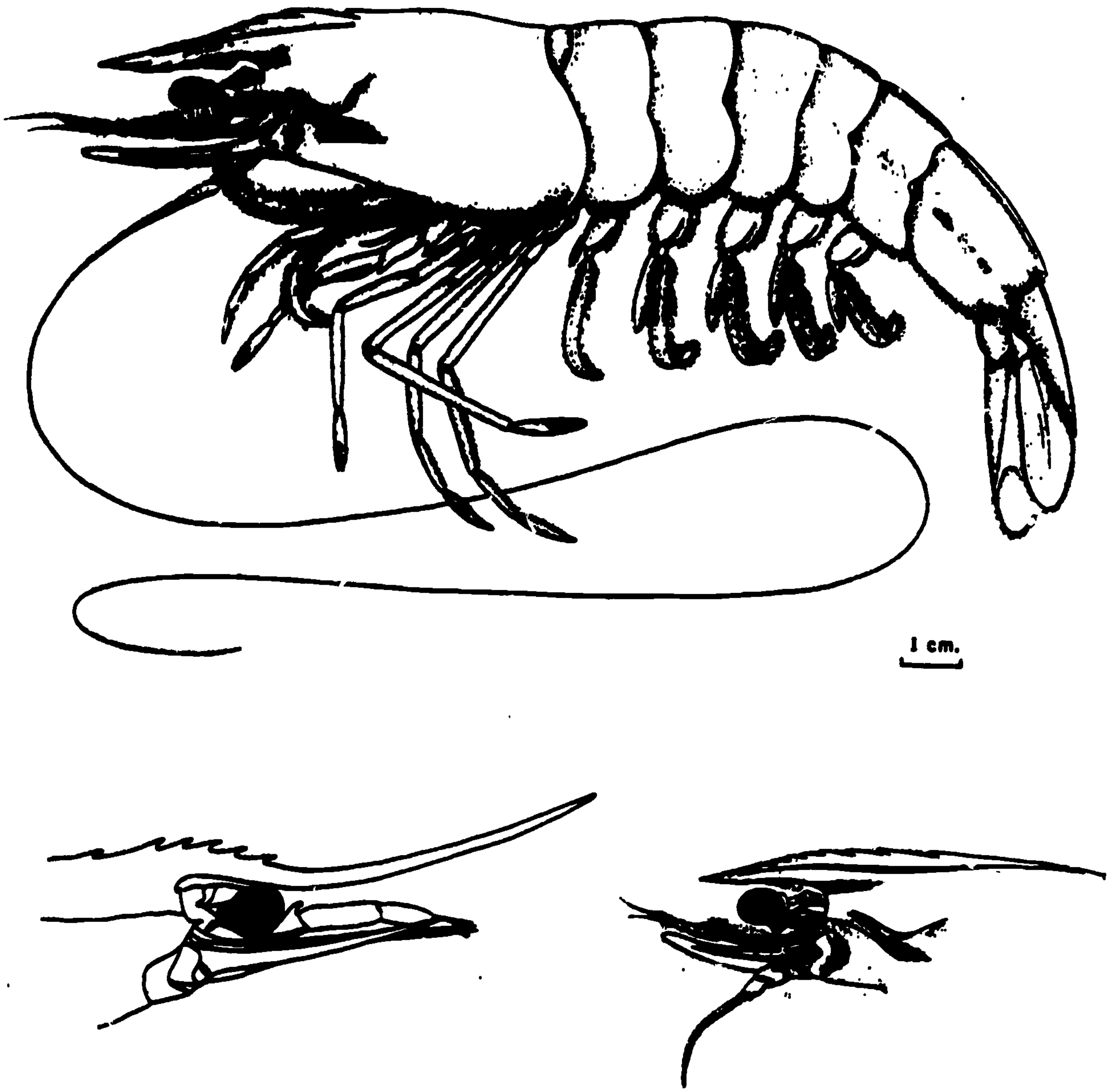


Figure 9.
Above: *Penaeus setiferus*. white shrimp. Below left: *Xiphopenaeus kroyeri*. six barbe or sea bob. Below right: *Penaeus aztecus*. brown shrimp.
These common Louisiana shrimp can be distinguished from each other by comparing their relative rostral lengths. The rostrum (above the eye) is equal in length to the antennal scale (below the eye) in the white shrimp. It is much longer in the sea bob, and somewhat shorter in the brown shrimp.

Louisiana shrimp are reaching world-wide markets never dreamed of before. Today, shrimping is no longer a matter of going out in a small boat and bringing back a payload. Trawler hull designs have been changed, and gear has been developed to handle shrimp faster. Navigation aids such as radar, fish finders, ship-to-shore radio, fathometers, and other gear are now in the reach of not only the big operators, but also the small independents.

Louisiana ranks first in the nation in commercial fisheries production and second in the nation in the value of production. Louisiana's 1980 fisheries production was valued at $750,000,000. Lafourche Parish 1980 seafood production was 20.3 million pounds and valued at $34,000,000. Louisiana is responsible for 25-30 percent of the nation's seafood production. This industry is not based solely on shrimp production. Menhaden, crab, oysters, redfish, speckled trout, white trout and sheepshead are all major contributions to the seafood industry. These species are also dependent on Louisiana's estuarine coastal marsh which acts as a nursery ground for Louisiana's seafood industry. Loss of Louisiana's coastal marsh places the entire commercial seafood industry in jeopardy through lowering water quality by allowing faster run-off of domestic pollution, and the physical loss of the nursery and food production areas for commercial and sport species. Fisheries production is related to the acreage of marsh in the estuary. Marsh loss does not correlate one-to-one with fisheries loss. As land loss increases you will notice a temporary increase in fisheries production due to a short term increase in nutrients provided by the deteriorating marsh.

Residents of Louisiana have long overlooked the value of their coastal marsh. From the time of the earliest settlers, we have attempted to reclaim and manipulate the swamp and marsh areas. The coastal zone area of Louisiana does not easily lend itself to habitation or cultivation. It has become necessary from colonial times to build levees in order for us to build on and farm many areas of Lafourche Parish.

In 1795, Etienne de Bore developed the vacuum pan process for granulating sugar. This established the sugar industry in Louisiana, and increased the demand for agricultural land. As the Acadian immigrants arrived from 1765-1785, they received land grants from the Spanish government. A provision of these land grants was that those residents living along bayous and rivers were to build and maintain a levee on their property.

Man continued his manipulation of Louisiana's coastal marsh through the development of an efficient and economical water transportation network. Within Lafourche Parish, canals were dredged and dug by hand to connect area lakes with Bayou Lafourche. Foret's Canal, above Raceland, leads to Lake Bouef. The Company Canal leads from Lake Salvador on the east bank of Bayou Lafourche through Lockport to the Intracoastal Waterway south of Lockport. The Intracoastal Waterway was dredged connecting existing canals, bayous, and lakes from Texas to Florida. In the south Lafourche area the Clovelly Canal led from Little Lake to Bayou Lafourche, as did the Breton Canal.

The rise of oil prices from $.81 per barrel in 1907 to over $30.00 a barrel in 1985 led to a broad search for oil and gas throughout Louisiana's coastal marshes. Heavy drilling and production equipment could not be moved through the soft marsh, so location canals were dredged. Throughout the 1930's, some 45-90 percent of wetlands loss was due to canal dredging. In 1926, south Louisiana produced 4,162,817 barrels of oil, or one-sixth of the entire state's output. The Leeville and Golden Meadow fields were two of the most active fields in south Louisiana. The Bay Marchand field, just offshore of Fourchon, was among the first large scale offshore oil fields. Its output led to the success of Chevron Oil Company.

In the Louisiana of the 1930's any industry to help the impoverished state was welcomed. The state had few paved roads, a poor school system, and little electric power in the rural areas. The state government was ready to wed any industry which provided jobs and money. The oil industry was the welcomed savior to the government. But the local inhabitant of the oil producing areas of South Louisiana did not share that view of the incoming foreigners and their industry. It was a cultural conflict of poor, hard-working, Cajun fishermen and their families colliding with the well-paid, hard-working, American roughnecks.

The oil industry had developed land-based methods and operations in Oklahoma and Texas. But in Louisiana, much of the oil was under water. The state and national governments received revenues of hundreds of millions of dollars, some of which began modernizing rural Louisiana.

The government encouraged and assisted offshore oil development with little or no restraints toward the local populations or the environment. Outside of the obvious localized oil pollution, no one understood the significant environmental problems being created.

The Leeville and Golden Meadow areas were crisscrossed with location canals. The immediate environmental destruction was of little perceived cost compared to the local jobs and state funds generated. Even a well blow-out in Golden Meadow which contaminated the drinking water and forced evacuation of the town for weeks did not slow or interfere with oil exploration in the wetlands.

The state of Louisiana and its population were happy to allow the oil industry to work unbridled as long as the revenues to the state continued to subsidize progress. The population accepted the environmental and cultural problems because oil kept taxes down and provided money, roads, and other community improvements.

The damage done to the environment by the oil industry and canal digging has become apparent only after awareness was created by the environmental movement of the late 1960's. Before that time, people accepted environmental loss as only a minor problem. It also became evident from biological research in the 1950's, 1960's, and 1970's that the wetlands were not wastelands, but some of the most biologically productive areas on earth.

Man has contributed to the acceleration of coastal land loss in a variety of ways. What does this loss of land mean to Louisiana and its people? It means a loss of jobs, millions of dollars in lost income, and a decline of an aesthetically pleasing area of the state. This progressive loss is a menace to the state's million dollar seafood, fur, and alligator resources. It represents a reduction of the nation's most valuable winter habitat for waterfowl and migrating bird life. Loss of revenues from offshore mineral activities is occurring. It was estimated that for every mile Louisiana's shoreline moved inward, the state lost $35-$40 million in oil and gas revenues, before the state's boundaries were set. Sport fishing along the coast for saltwater species could be altered drastically due to loss of essential nursery areas. The coastal marsh and barrier islands act as a buffer against the tidal surge pushed ashore by hurricanes and storms. In short, the very livelihood of Louisiana and its rich customs and traditions are at stake. The generations of the present and future must be careful not only to correct the mistakes of the past but not to compound them by ineffective means.

We have established that Louisiana's natural resources are rich, and vital to our state's people and economy. We have seen that we have acted carelessly in the use of these resources. We can also see that our responsibility as citizens of this state call for us to take the leadership in finding a solution to these problems.

I. Man Develops Louisiana's Natural Resources

II. Process Objectives

1. The student will compare the activities of native Americans and Europeans and their roles in the development of Louisiana's natural resources.

2. The student will trace the development of the economy of Louisiana's coastal zone and identify the impact of that economic development on Louisiana's coastal zone environment.

3. The student will evaluate the importance of Louisiana's coastal zone as to its economic, environmental, recreational, and aesthetic values.

4. The student will trace development of Louisiana's network of land and water transportation and evaluate its impact on Louisiana coastal zone.

5. The student will list the various types of industrial and commercial development in the coastal zone area and identify the reasons for their location in this area.

6. The student will compare employment opportunities in the coastal zone prior to the development of the oil and gas industry and after the development of that industry.

III. Setting the Stage

Oral history reflects the true experience of a people. It affords an opportunity for students of history to communicate with those who have witnessed the current history of an area. Coastal Louisiana has witnessed dramatic changes in its environment, economy, and population trends in the twentieth century---many of those who have witnessed these changes are still living. Encourage your students to interview and record their conversations with their grandparents, parents, or elderly relatives as a basis for completing the following activities.

IV. To the Student

The knowledge of the past your parents, grandparents, and elderly relatives possess is as important and interesting as any history book ever written. Take the time to learn the role your family played in the history of our area. Only by your doing this will you be able to pass the history on to future generations.

Procedure:

Students should conduct interviews with their parents, grandparents, or older friends or relatives.

Name______________________________________

Age_______________________________________

1. How long have you lived in this area?

2. What did you do for a living?

3. If they were involved in trapping, how was the trapping carried out; if in traveling, how was the traveling done?

4. Fifty years ago the land I am living on today was used for ______________________________________.

5. What did your parents and grandparents do for a living?

6. What roads and canals existed when you were a child?

7. The greatest change I have seen in our area is ______________________.

The results of the interviews should be reported to the class. The results may be compiled and converted to percentiles as follows:

Age over 20-30 40-50 60-70 80-90

Occupations:

hunter

fisherman

farmer

oil field related

commercial

self-employed

other

Other items that should be brought out from the survey are:

1. Average length of time the survey group has lived in the area.

2 What changes in land use have been experienced in the area.

3. How transportation patterns have changed in the area.

4. In what areas the greatest changes have taken place.

Activity II

Many canals were dug in the coastal zone with little or nc permit requirements. Today, permits are required for any canal construction in the coastal zone. Students should contact the local Coastal Zone Management Office or the United States Army Corps of Engineers in New Orleans to obtain copies of permit requirements for canal dredging. Many agencies will provide guest speakers on the subject of Coastal Zone Use.

Once the permit requirements are received, the class should be separated into small groups. Each group should analyze a separate agency's requirements as to why permitting is necessary, what specific areas are covered by the permit, and what the result has been of allowing dredging without permits. The groups should then report to the class on their agency's requirements.

A simulation may be set up using part of the class as a permitting agency, part as an oil company representative wishing to dredge a location canal, and part as an environmental group opposing the canal and favoring directional drilling.

Activity III

The value of Louisiana's coastal zone to the commercial fisheries industry and fur industry is all too often overlooked.

Guest speakers are available through Louisiana Wildlife and Fisheries, Education Section, Post Office Box 15570, Baton Rouge, Louisiana 70895 and the Louisiana Cooperative Extension Service, Fisheries Agent for your area dealing with commercial fisheries and the fur industry in Louisiana.

The Lafourche Parish Coastal Zone Management Office has a slide presentation illustrating the value of the coastal zone to Lafourche Parish and the effects of land loss in the parish. This information can be obtained by contacting the Coastal Zone Management Coordinator at the Lafourche Parish Council Office in Thibodaux. Post Office Drawer 5548, Thibodaux, LA 70302.

Louisiana Wildlife and Fisheries offers the service of a film lending library covering all areas of Louisiana's natural resources and their use. A catalog of the films may be obtained by contacting the Film Library, Louisiana Wildlife and Fisheries, Post Office Box 15510, Baton Rouge, Louisiana 70895.

The Coastal Collection, which is a collection of publications and documents dealing with management practices, resources, and the history of the coastal zone, is available for use in the reading room on the first floor of the library at Nicholls State University at Thibodaux.

Use of this informative collection by the public is encouraged by the University, and there are no user fees.

Components of Land Loss

Introduction

Land loss in the coastal zone is a problem with broad environmental and economic consequences. Land loss, which is land turned to water or land covered with water, is a result of many interacting factors such as flood control, navigation improvement, canalization, channelization, and the biological and geological setting. The wetlands of coastal Louisiana are being converted to open water at a rate greater than fifty square miles a year (Figure 10.).

The cumulative impact resulting from land loss includes changes in water which contribute to increase in salt water intrusion, losses in storm buffering capacity, and diminishing nursery grounds for Louisiana's coastal fish and shellfish resources.

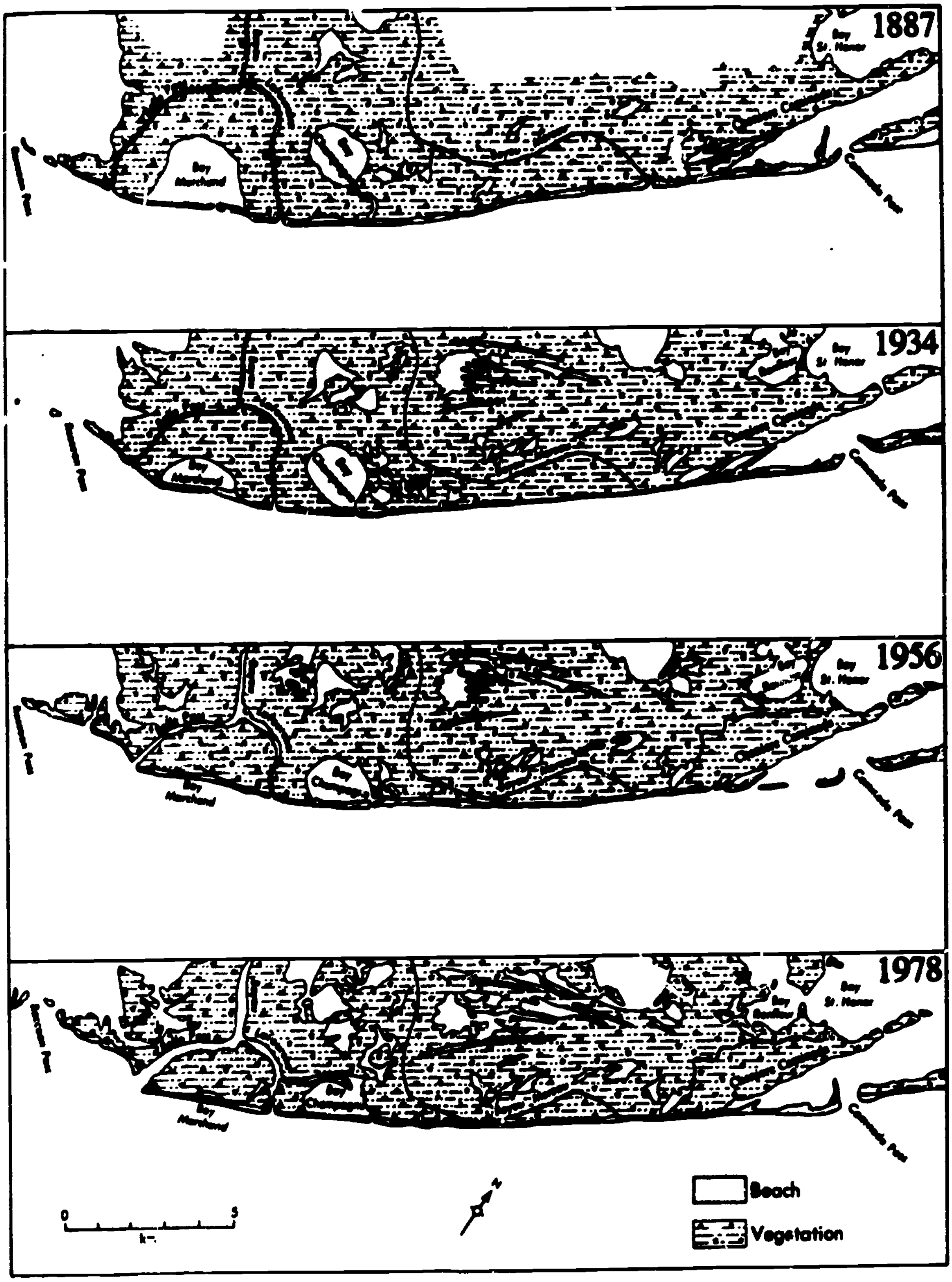


Figure 10. Shoreline retreat; Belle Pass to Caminada Pass.

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Levee Construction and Consequent Impacts

Levees

The meaning of the French word "levee" is "raised". In the flat alluvial plains of Lafourche and southeast Louisiana, the only dry land was natural levee (raised areas). The land was built from the sediment of the river in years when its flow exceeded the flow capacity of the natural river channel. This resulted in continually raising and expanding the natural levee.

When early Indians and European settlers moved into southeast Louisiana, they settled predominantly on these natural ridges. Every few years, when the river flow exceeded channel capacity, the inhabitants experienced the negative effects of flooding.

As the population on the natural levees grew more dependent on the land, the periodic floods became more of a nuisance. There came a time when the population felt that the cost of losing lives, homes, crops, livestock, and businesses was too great. The people decided to construct man-made levees on the natural levees, thereby reducing the frequency and effects of the periodic high river levels.

They also realized that by constructing levees in wet areas, the land could be dried to expand their land-based interests. Each landowner protected his own property from flooding. Sometimes these man-made levees were connected by adjacent landowners resulting in a more effective system.

After the devastating Mississippi flood of 1927, the U.S. Army Corps of Engineers began a massive flood protection and navigation plan. This plan has provided millions of people with protection from flooding, allowed economic growth, improved navigation, and increased farmland. The plan has tremendous popular support. It is only after subsequent geological and biological studies done from the late 1940's to the 1980's, that the negative aspects of this plan can now be seen and understood.

Sediment Starvation

Canals contribute substantially to the land loss problem. Canals currently comprise about 2.5 percent of the total coastal surface area in Louisiana and the percentage is increasing through time. Historically, canals have been dug for drainage and access. Today, the greatest share of canalization is attributed to the oil and gas industry. The primary reasons for the number of canals in Louisiana's coastal zone include navigation, pipeline routes, and access to drilling sites.

Although dredging canals has only directly converted 2.5 percent of the wetlands to open water, their impact is much greater. Spoil banks composed of the material dredged from the canals tend to smother adjacent marshes, converting wetlands to uplands, often interrupting natural hydrologic processes, and blocking the distribution of sediment. Canals oriented perpendicular to water flow can drown a marsh. Canals parallel to water flow tend to lessen freshwater retention and allow greater inland penetration of salt water.

Subsidence

Subsidence, the downward lowering of land, is a continual problem in the coastal zone. Its causes are highly complex. Louisiana's coastal zone is very flat, so even a slow rate of land subsidence can result in large-scale disappearance of marshlands if no additional sediment is provided. The lowering of land that occurs in Louisiana can be divided into two general categories: tectonic subsidence and consolidation or compaction subsidence.

Tectonic subsidence refers to the large-scale downward geologic displacement caused by sedimentary loading and associated settlement processes. This type of subsidence is directly linked to the Mississippi River system, which built the Louisiana deltaic plain during the last 7000 years. Beneath the present active delta as much as 1000 feet of sediments have accumulated, with land subsidence rates estimated at 5 to 10 feet per century. Away from the active delta the rate decreases.

The consolidation/compaction aspect of subsidence is attributed to a variety of causes including overlying weight, subsurface withdrawal, and dewatering. Examples of overlying weight include physical features such as natural levees, man-made levees, buildings, spoil mounds, and even marsh buggy traffic. The net consequence of this overlying weight is the localized surface sinking as sediments are compressed (Figure 11.).

Surface withdrawal of oil, gas, and groundwater also contributes to subsidence. The water table is at or near the surface on a wetland

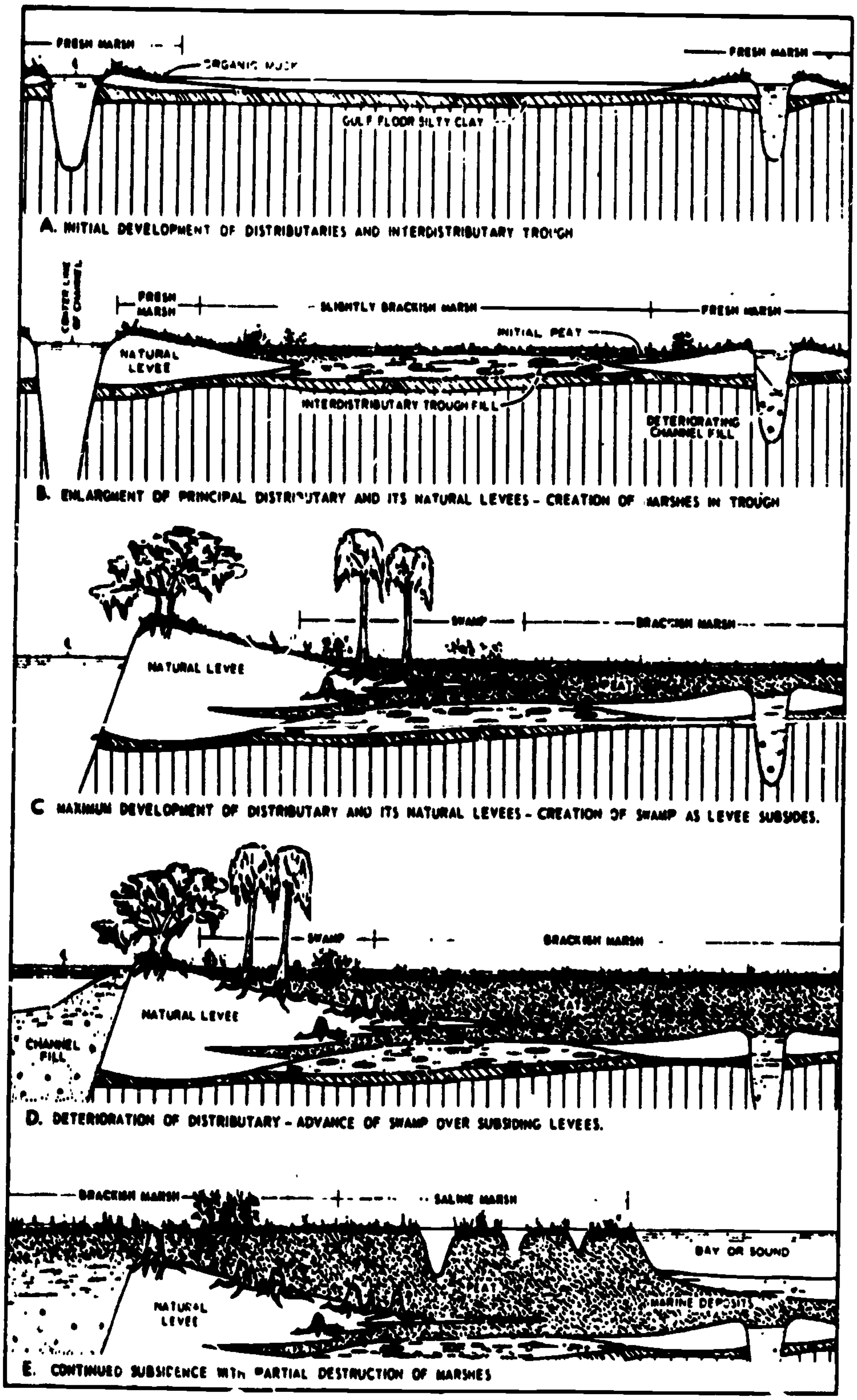


Figure 11. Progressive stages in natural levee development, peat accumulation, and subsidence are illustrated in graphs A-E (Fisk 1955).

environment. When it is lowered because of drainage activities, the dewatered upper soils or sediments are subjected to oxidation, soil shrinkage, and wind erosion. Although "natural" factors, such as marsh burning, have been cited as causing soils to dry out and subside, it is primarily human efforts related to urban expansion, agricultural drainage and reclamation, and flood control that have led to widespread localized surface subsidence.

Marsh Loss

Salt water entering freshwater areas destroys a marsh by killing its plants. If the intrusion is gradual, the fresh marsh may become a salt marsh but will no longer shelter the waterfowl and mammals requiring freshwater. The rapid intrusion of salt water into the marshes is one of man's greatest environmental impacts. By leveeing the Mississippi River and damming Bayou Lafourche, the two major sources of freshwater were removed, leaving precipitation as the only major source of freshwater. Without these two suppliers of freshwater, salt water from the Gulf of Mexico began to intrude into freshwater marshes and swamps.

Another major contributor to salt water intrusion has been the digging of waterways. These canals allow a faster, deeper penetration of salt water into previously freshwater habitat. Natural forces such as hurricanes, storms, and tidal surges also contribute to salt water intrusion by increasing erosion and widening and deepening the passes.

Although the Gulf of Mexico is the main source of salt water, high salinity brines, which are discharged in the production of gas and oil, contribute large amounts of salt to marshes.

The problems that occur with salt water intrusion are complex, causing a number of environmental chain reactions. As the freshwater marshes and swamps are permeated with brackish water, plants that cannot tolerate the higher salinities die. After freshwater plants die, there is a lag period before the establishment of brackish plants. During this lag period, the rate of erosion increases, because there are no plant roots to hold the soil together. The conversion from a fresh to a salt marsh can be felt not only environmentally, but economically as well.

Oceans

Greenhouse Effect

A planet's temperature is determined primarily by the amount of sunlight it receives, the amount it reflects, and the extent to which its atmosphere retains heat. When sunlight strikes the earth, it warms the surface, which then radiates the heat as infrared radiation. However, water vapor, carbon dioxide, methane, chlorofluorocarbons and other gases in the atmosphere absorb some of the energy rather than allowing it to pass through the atmosphere to space. Because the atmosphere traps heat and warms the earth in a similar manner to the glass panels of a greenhouse, this phenomenon is generally known as the "greenhouse" effect.

Since the industrial revolution, the combustion of fossil fuels, deforestation, and cement manufacture have released enough carbon dioxide into the atmosphere to raise the atmospheric concentration of carbon dioxide by 20 percent. Energy experts expect the concentration of carbon dioxide to double by the latter part of the twenty-first century and the concentration of greenhouse gases to double by the year 2050.

Because of this increase in greenhouse gases, it is estimated that the earth's average temperature would increase by 1 or 2 degrees C if nothing else changed. However, this effect would likely be amplified because of the effect on other climate factors. For example, a warmer climate would retain more water vapor, and snow and floating ice would retreat, decreasing the extent to which sunlight is reflected into space, thus causing additional warming. After evaluating all the evidence, the National Academy of Sciences (NAS) panels concluded that the eventual warming from a doubling of the greenhouse gases would be approximately 1.5 to 4.5 degrees C.

Sea Level Rise

Rising sea level hastens the flooding of subsiding lands. Because of the difficulty of separating the effects of subsidence and sea level rise, many researchers have addressed the two factors together under heading "relative sea level rise".

Based on a number of worldwide studies, the commonly accepted rate of present global sea level rise is from 1 to 1.5 millimeters(mm) per year (4 to 6 inches per century). Tidal gauges along the Louisiana coast indicate the rate of relative sea level rise is 9 to 13 mm per year (3 to 4 feet per century). Thus, global sea level rise accounts for only 10 to 15 percent of the relative sea level rise along the Louisiana Coast.

Recent development suggests that sea level could become more important in the future. The "greenhouse" warming effect could cause sea level to rise even more rapidly because of expanding ocean water, melting mountain glaciers, and eventually causing polar glaciers to melt and slide into the oceans.

C. Wave Erosion

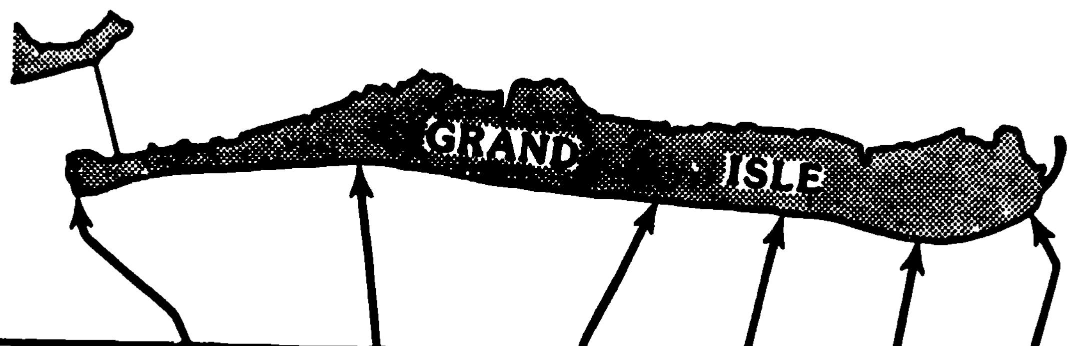
Gulf Shoreline Erosion

Shoreline erosion seems to have increased during the last few decades because of human activities such as jetty construction, reef removal (clamshell and oyster shell dredging), sand mining, and indirect human activity resulting in reduction of available sediment. Other reasons include increased subsidence, sea level rise, and an increased number of hurricanes (Figure 12). Shorelines are eroding at a rate of more than 10 meters per year along much of the barrier coast, the deltaic and chenier plains. The high rates threaten established areas along the coast. The loss of the barrier islands also threatens Louisiana's first line of defense against incoming storm surges. If beaches and marshes disappear, many coastal communities will be subjected to higher storm surges and direct wave attack during severe storms.

Lake, Bayshore Erosion

The wave action deteriorating the shoreline of larger lakes and bays is an important factor. The wave action, unlike in the Gulf which is generated from long distances, is generated within the estuaries and is localized and depends primarily on prevailing winds and boat wakes. Wind-generated wave energy is a function of wind speed, duration, distance across a body of water, and depth. Theoretically, other factors remaining equal, larger bays and lakes would have the higher rates of erosion. Shorelines of lakes and bays facing northwest in winter and south-southeast during summer would be most vulnerable.

HURRICANE BEACH EROSION AT GRAND ISLE



DANNY	-56 ft.	-30 ft.	-66 ft.	-64 ft.	-87 ft.	-28 ft.
ELENA	-21 ft.	-112 ft.	-40 ft.	-3 ft.	-30 ft.	-23 ft.
JUAN	-24 ft.	+40 ft.	+20 ft.	-5 ft.	0 ft.	+10 ft.
TOTAL	-101 ft.	-102 ft.	-86 ft.	-72 ft.	-117 ft.	-41 ft.

August 1, 1985 - Prestorm Survey
August 14, 1985 - Hurricane Danny Impact
August 17, 1985 - Post-Danny Survey
September 2, 1985 - Hurricane Elena Impact
September 3, 1985 - Post-Elena Survey
October 28-29, 1985 - Hurricane Juan Impact
November 6, 1985 - Post Juan Survey

Figure 12. Summary of beach erosion associated with the 1985 hurricane impacts along Grand Isle.

Canal, Bayou Erosion

Bank erosion is causing the widening of canals and natural waterways. The causes are man-made and are more recent and different from the two previous cases of shoreline erosion and bay and lake erosion. Wind and distance across the body of water are less important whereas boat wakes and tidal changes are more important. Tidal hydraulic energy in Louisiana's estuaries increases because of subsidence and widening canals. Although little "hard" data is available, it is likely that boat wake erosion in canals and bayous is more destructive to adjacent marshes than tidal erosion.

Lesson IV

I. What are The Effects of Saltwater Intrusion on Freshwater Plants?

II. Process Objectives:

1. The student will be able to observe the effects of sal water intrusion on freshwater plants.

2. The student will be able to identify a major environmental impact on marsh loss.

3. The student will be able to observe and record plant growth survival.

4. The student will be able to plot on a graph the survival time against the salinity.

5. The students will be able to pool class data to answer post-activity evaluation questions.

To The Teacher:

The student will need to be able to do the following things:

1. Determine salinity with a hydrometer
2. Determine pH
3. Read a thermometer
4. Record observations daily
5. Plot a graph

The materials needed are as follows:

- 10 freshwater semi-aquatic potted plants of one species
- 10 containers of saltwater ranging from 0 to 35 ppt(parts per thousand) salinity
- The pH, light and temperature should be kept as constant as possible. All readings should be made at the beginning of each period. Two months, or until the plants die, is a reasonable time period. "Instant Ocean" can be used to prepare the appropriate salinities.

Pot	1	2	3	4	5	6	7	8	9	10
Salinity (ppt)	0	1	2	4	6	10	16	24	30	35

Activity:

1. Purpose: To determine the effects of saltwater intrusion on freshwater plants.

2. Procedures:

   - Obtain freshwater semi-aquatic plants (marsh grasses or plants).
   - Set up the 10 potted plants in the sunlight.
   - Add only freshwater to one pot as a control.
   - Water each plant with appropriate mixture twice weekly.
   - Record plant growth survival for two months or until plants die.

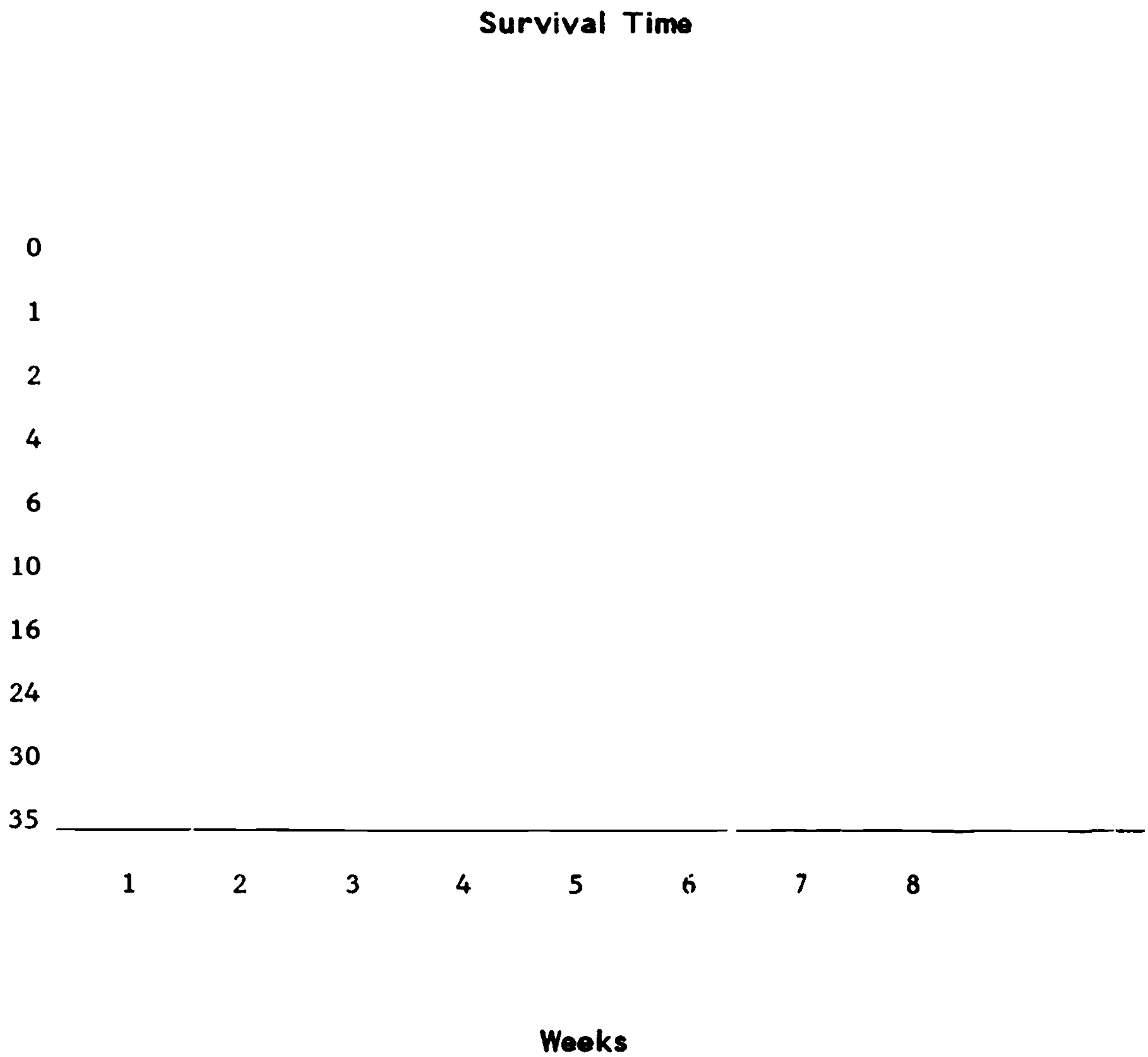
- Have students plot the survival time against salinity in ppt (parts per thousand).
- Have students pool class data to answer evaluation questions.

Data Collected:

Results - Complete the following growth chart.

Percent Salt

Day	0	1	2	4	6	10	16	24	30	35
										1
										2
										3
										4
										5
										6
										7
										8


Survival Time
0
1
2
4
6
10
16
24
30
35
1
2
3
4
5
6
7
8
Weeks

Evaluation:

1. Did the plants grow when salt was present? In what concentrations?

2. What are the implications for freshwater marsh grasses and plants if saltwater continues to intrude?

Lesson V

I. What Are the Effects of Water Level on Plant Growth?

II. Process Objectives:

1. The student will be able to observe growth rates in various levels of water.

2. The student will be able to observe and record plant growth rates.

3. The student will be able to plot on a graph the growth rates against water level.

4. The student will be able to pool class data to answer post activity evaluation questions.

To The Teacher:

The student should be able to do the following things:

1. Read a meter stick
2. Record observations daily
3. Plot a graph

The materials needed are as followed:

Meter stick

Plants

The pH, light and temperature should be kept as constant as possible.

Activity:

1. Purpose:

- To determine the effects of water level on plant growth.

2. Procedures:

- Obtain marsh grass plants or cypress seedlings.
- Place plants in sunlight, in pots of soil from original site.
- Water level should be at soil level in Pot #1 and increased 2 cm in each pot up to 20 cm.
- Add water as necessary to keep water levels constant.
- Record growth rates against water depth for 2 months or until plants die.
- Pool class data to answer evaluation questions.

Data Collected:

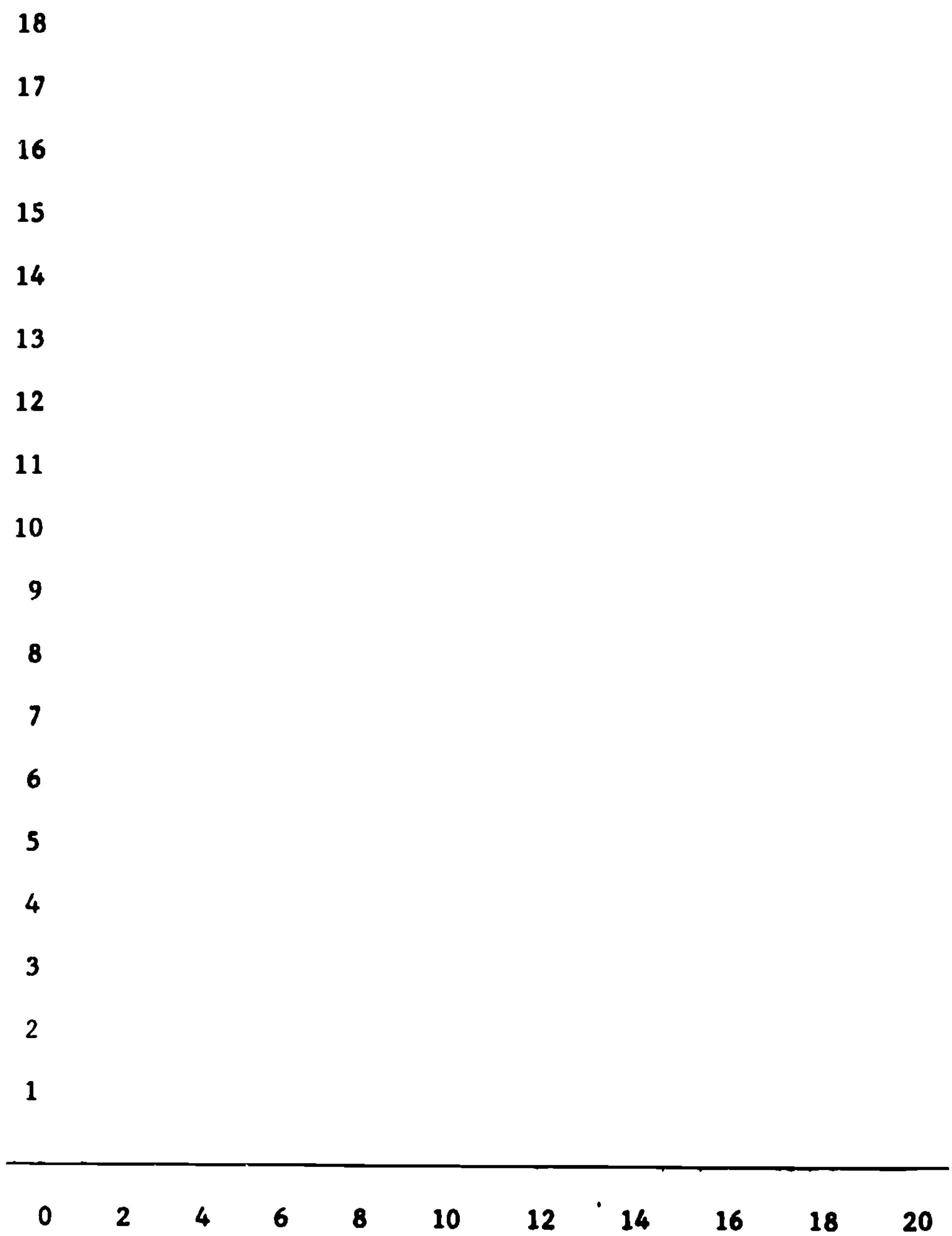
Chart your results.

Water Level (cm)

week	0	2	4	6	8	10	12	14	16	18	20
1											
2											
3											
4											
5											
6											
7											
8											

NOTE: Enter growth in mm/week.

Growth Rate



Water Level (cm)

Evaluation

1. What is the relationship between growth rates and water levels?

2. What are the implications for coastal marsh grasses or cypress seedlings if subsidence and sea level rise continue to occur and existing marshes gradually submerge?

What Can Be Done?

Introduction

The loss of wetlands in Louisiana is becoming increasingly important. In fact, in some cases, it may be completely out of our control. To deal with the problems of erosion and subsidence we must bear in mind that these problems have no immediate solutions. The impact of even long term solutions must consider flood prevention, shipping, petroleum extraction and community development. The ultimate goal of all projects would be to balance subsidence and land loss with sediment diversions. Many projects have been authorized but not fully funded. Any major diversion would not only be costly to the state but might also affect the shipping industry. Either could cost billions of dollars. Rather than fulfill obligations to long-term projects, the state may consider less costly short-term projects which would ultimately encompass long-term objectives.

The state of Louisiana is at a risk. It must appropriate funding and make major decisions as to the implementation of programs immediately. Programs should be directed to diversion projects, modifying patterns of water and sediment flow in marshes, maintaining wetlands with new technology, barrier island restoration, restructuring or redesigning our canal systems, and seeking alternative transportation and flood protection strategies.

Barrier Island Restoration

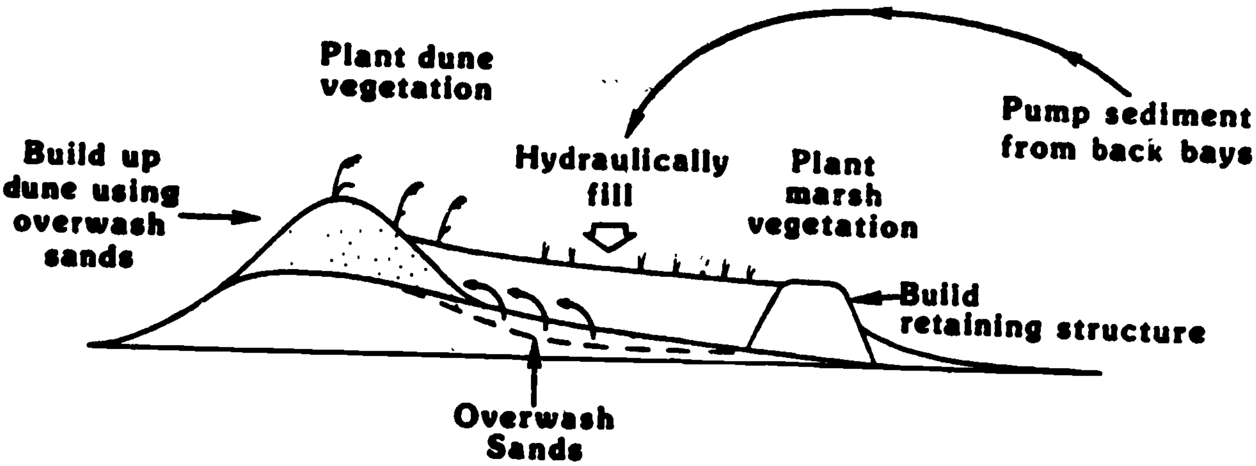
Because our barrier islands represent our "first line of defense against the sea," they have been given the highest priority in curtailing wetland loss. By raising their surfaces and closing breaches, barrier islands will provide storm protection and limit wave erosion of interior marshes. They will also help to prevent additional increases in salinity of the bays behind them by limiting tidal mixing with the high-salinity waters of the Gulf.

The raising of the surface and closure of breaches in the islands would be accomplished in two phases (Figure 13.). The first phase would involve building or adding to sand dunes using sands deposited by overwash from the back side of the dune (side away from beach). A retaining structure such as a levee would be built on the bay side of the island. The area between the dunes and this retaining structure could then be filled in with sediment pumped from the back bay thus raising the elevation of the island. Any manmade canals would also be filled (Figure 14.). Phase II would involve the additional pumping of sand to extend the shoreline seaward. Dunes would be enlarged and the entire area would be revegetated.

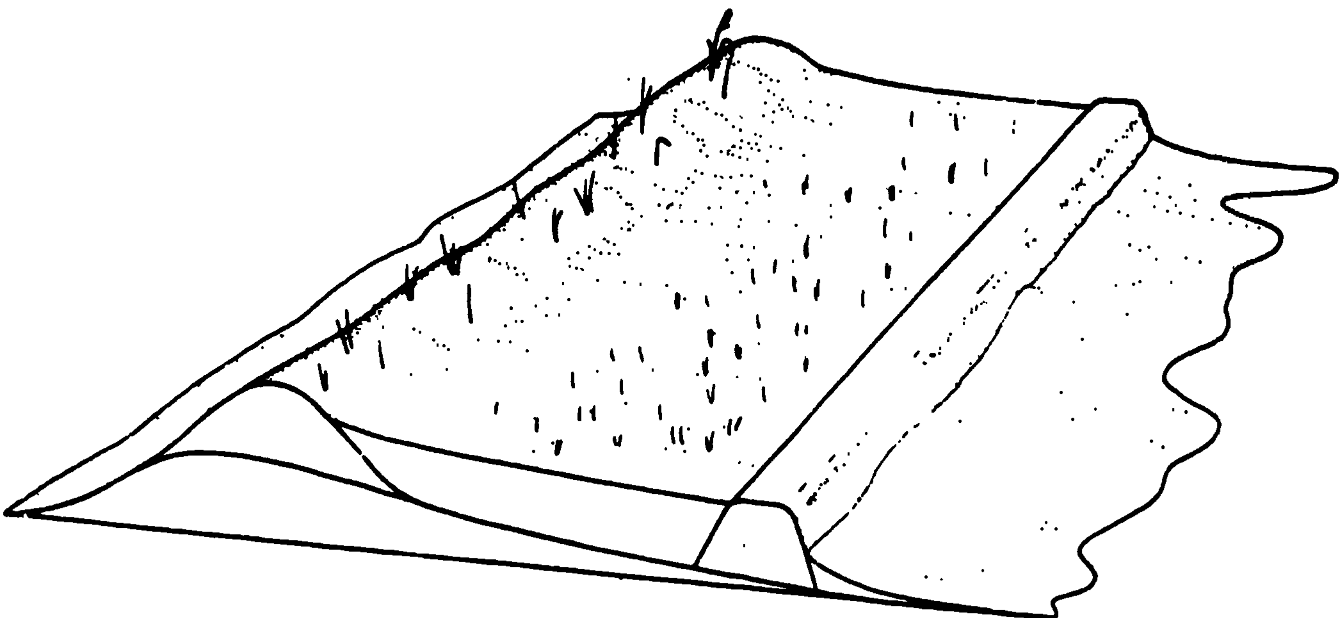
Projects which have been authorized and funded by the Louisiana Legislature for barrier island restoration include Isles Dernieres, Fourchon Island, Shell Island, Timbalier/East Timbalier Islands, Holly Beach, and Grand Isle.

Figure 13. **PHASE I**

SHORELINE AND BARRIER ISLAND RESTORATION



SHORELINE AND BARRIER ISLAND RESTORED



- SHORELINE EROSION REDUCED
- DUNES RESTORED
- ISLAND WIDTH AND HEIGHT INCREASED
- BACK BARRIER RETAINING STRUCTURE COMPLETED
- BREACHES SEALED
- MANMADE CANALS FILLED

Figure 14. **PHASE II COMPLETED**
SHORELINE AND BARRIER ISLAND NOURISHED

- **SHORELINE EXTENDED SEAWARD AND ISLAND ELEVATION INCREASED**
- **DUNES ENLARGED AND REVEGETATED**

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Wetland Restoration

Wetland loss on the east and west banks of Bayou Lafourche as well as other areas in southeast Louisiana has been caused by many factors both natural and man made. Natural losses are caused by subsidence, decay of abandoned river deltas, waves, and storms. Manmade losses result from flood control practices, impoundment, dredging and erosion of artificial channels.

The options for curtailing wetland loss are numerous. A mitigation approach could be applied in many areas. Material dredged for canals could be used to create marsh in much the same way as spoil from the Southwest Pass of the Mississippi is used to build marsh at the mouth of the river.

Because of levee construction, Mississippi River sediments and nutrients are deposited in deep water in the Gulf of Mexico and are unable to contribute to the buildup or maintenance of coastal wetlands.

A class of options collectively called "diversion" would give marsh areas the greatest chance for long-term survival. Freshwater diverted from the Mississippi River would partly offset the freshwater starvation caused by the river levees. Marsh salinities would decrease slowing the rate of marsh loss from saltwater intrusion. Although some sediment would also be supplied, the amounts would not be sufficient to offset current or projected rates of subsidence and sea level rise. Freshwater diversion could provide a short-term solution to buy time while a long-term strategy is put into place.

Another diversion plan would be to allow the Mississippi River to change its course to the Atchafalaya River. Sediments deposited in the shallow waters of Atchafalaya Bay would create marsh rather than being wasted off the present mouth of the river.

Formation of a new delta of this sort would also cause problems for many people. Saltwater would be able to move farther up the Mississippi causing problems for municipal and industrial water supplies. A new course for the river would require Morgan City and other communities along the Atchafalaya River to be either abandoned or protected with ring levees.

Another diversion option would be to separate shipping from the flow of the river. Parallel canals along the Mississippi River Gulf Outlet would replace the Southwest Pass for navigation into the Port of New Orleans. If ships used locks instead of the main channel, it would not matter if the flow of the river were slowed by freshwater diversion structures and new wetlands could form in substantial numbers. (A decrease in river flow allows deposition of sediments causing navigation problems.) The major disadvantage is cost. In addition, shellfish production is some areas would decline, although the long-term reductions in production throughout the state would be far greater if no measures were taken.

Another diversion plan involves Bayou Lafourche. It was an active Mississippi River distributary until it was closed off in 1902. Reopening the bayou might allow a limited amount of freshwater to reach Terrebonne and Lafourche Parishes.

There are many options available to try to curtail wetland loss. The problem is that the conditions that have created wetland loss are intertwined with such indispensable activities as flood prevention, shipping, and petroleum extraction. Projects have been authorized which would slow the rate of wetland loss, but restoring the sediment supply necessary to keep pace with current subsidence would require an end to the current situation in which most of the sediment of the Mississippi River flows into the Gulf instead of the wetlands.

To accomplish this would require major hydrological projects costing billions of dollars. Given the current economic climate of both state and federal governments, it is the opinion of many that not enough can be done in the near future. However, any short-term measures might buy time until long-term solutions can be worked out.

Marsh Management

The concept of marsh management has received considerable attention in coastal Louisiana. The philosophy behind this approach is that human activities have interrupted the natural wetland system so the best hope to save these wetlands is for society to intervene and limit further damage. The most common form of marsh management in Louisiana is to regulate the flow of water in and out of the marsh, with the objectives being to limit salinity, control water level, and encourage revegetation.

In this plan, larger wetland areas (5,000 acres or greater) are divided into smaller tracts. Levees or dikes and some form of water control structure regulate the flow of water. Structures such as weirs, culverts, and sluice gates can be operated to allow juvenile marine organisms some access to internally managed wetlands for use as nursery and feeding grounds. Forced drainage such as mechanical pumping used in populated areas to regulate water flow may prevent the organisms from utilizing the managed areas.

Large areas of land were impounded and drained for agricultural use during the last century and early in this century. Most of these areas have not remained impounded because of soil shrinkage and breaks in levees during hurricanes. Many wildlife refuges have been created by impoundment. Spoil levees from dredged canals have accidentally impounded other areas to some extent. Also, large private impoundments designed to control saltwater intrusion, and control the harvest of fish and shellfish, are becoming increasingly prevalent in the coastal zone. The impacts of these impoundments are significant.

Some wetland areas are utilizing passive (gravity operated) marsh management schemes (Louisiana Department of Wildlife and Fisheries refuges and many privately owned tracts.) These areas maintain proper water levels and maintain vegetation growth best suited for wildlife in those areas. Some commercial crawfish ponds and other aquacultural efforts involve active pumping to achieve desired water levels.

The effects of these management techniques are limited. As sea level continues to rise and subsidence continues, (a collective phenomenon called relative sea level rise), management of water flow will become increasingly more difficult, and it may become necessary to actively pump water out.

Another marsh management technique being used is spraying sediments into the marsh to built it up. The technology of this technique is recent and the cost is being examined. Although there are problems, this method may be helpful in areas that are barely submerged.

Although the goals of many individual plans of marsh management may vary, most plans usually include some sort of water level and salinity control by preventing inflow of excess saltwater and by regulating freshwater (rain, runoff, or introduced freshwater) until the desired water level or salinity is reached.

Diversion

Diversions of freshwater into Louisiana's wetlands would imitate the natural processes that have created and sustained these wetlands for the last several thousand years. Man-made levees cut off the natural distributaries of the Mississippi River from sediment and river water that would otherwise nourish coastal wetlands. Restrictions of natural sediment dispersal results from flood protection and navigation levees, the main channel of the Mississippi River levee, the east and west guide levees of the Atchafalaya Basin, the Avoca Island levee, and the levees of Bayou Lafourche. In addition to this, the Old River Control Structure restricts flows of the Mississippi River into the Atchafalaya Basin. The coastal Louisiana marshes are eroding because of the combination of the effect of sea level rise and coastal subsidence, collectively known as relative sea level rise. Coastal Louisiana is now sinking below the level of the sea because of the lack of river sediment inputs to maintain wetlands.

Presently, the coastal zone accretes at the rate of only seven millimeters a year through the addition of material such as root mass, detrital litter and resuspended bottom sediments. To offset sediment compaction and real sea level rise, marshes need an additional five to six millimeters of sediment per year. The amount of external sediment necessary to raise coastal marshes enough to offset apparent sea level rise must increase, if sea level rise accelerates as a result of atmospheric warming. The only sources of these external sediments are the Mississippi and Atchafalaya Rivers. Any modification to these river systems must consider not only land building potential, but navigation and flood control. Many inland communities will be affected by these factors including the city of New Orleans.

Present Diversion Systems

The Atchafalaya River is the largest distributary system of the Mississippi River. It reaches the Gulf in half the distance taken by the main channel. In 1963, the United States Army Corps of Engineers completed construction of the Old River Control Structure which permits 30 percent of the Mississippi to flow through the Atchafalaya. Although there are restrictions to water flow in the basin, it continues to build deltas in Atchafalaya Bay and to nourish wetlands. Greater diversion of water through the basin would increase this marsh nourishment. One suggestion is to increase diversion from the present 30 percent to 40 or 50 percent except during low flow periods when more flow is needed in the Mississippi to prevent salt water intrusion into the Mississippi. This additional diversion would only be temporary. It would be used until lower Mississippi River diversion projects are in use, then returned to 70-30 percent ratio. Until the other projects are completed, this Atchafalaya diversion would prevent the loss of some sediments beyond the continental shelf at the mouth of the river.

Other diversion projects in progress are at Caernarvon, Davis Pond and Bonnet Carre spillway. These diversions would deliver sediments to the Breton Sound Basin, the Barataria Basin and Lake Pontchartrain area, respectively. These diversion projects are primarily focused on preventing salt water intrusion; not on diverting sediments. These prototype diversions are steps needed to initiate experimental designs for future diversion programs.

Bayou Lafourche Basin

The coastal marshes of Terrebonne and Lafourche Parishes are rapidly deteriorating. Shorelines just south of Port Fourchon are eroding at a rate of 33 to 100 feet per year. Salt water intrusion has made its way up Bayou Lafourche to Lockport, about 50 miles from the Gulf. It will be a major challenge and a costly operation to channel large amounts of water and sediments into this area.

Bayou Lafourche now serves as a navigation canal and drainage ditch. Long ago it functioned as a natural distributary of the modern Mississippi River. The addition of a levee, pumping unit and control structure along the south bank of the Mississippi River at Donaldsonville has changed its function. Also, all back levees from Donaldsonville to Fourchon impose a barrier to water and sediment input into surrounding marsh areas. Restoring Bayou Lafourche to its distributary functions would be an ambitious, but needed, diversion project. The diversion could aid the sinking wetlands of Lafourche and eastern Terrebonne Parishes, and the Barataria Basin. Further diversions near le could introduce additional sediment toward Timbalier Bay. While it seems like a simple solution, a complex technical problem must be overcome. A diversion would cause an accretion of sediment at the headwaters of Bayou Lafourche at Donaldsonville with little sediment reaching the areas of need. Furthermore, recognition of extensive developments along the banks of Bayou Lafourche would compel large scale relocation of communities and businesses.

Lower Mississippi Diversion

Diversions south of New Orleans are primary sites for land building channels. This program should include small diversion structures as well as major structures designed to separate the main flow of the River. The channels at the mouth of the River are becoming too hard to maintain for navigation. Subsidence is occurring at a rate of 2-1/2 to 3 feet per century and settling out in the channel. The physical separation of the navigation channel from the main flow of the River would require an enormous public works projects including a lock system or gates. The new channel must reach deep Gulf waters in the shortest possible route and be constructed so that it does not erode.

Summary

Canals are obviously an important aspect of wetland alteration. The extent of marsh loss, saltwater intrusion, and sediments being deposited are affected by the network of canals in the coastal zone. Natural channels are not deep enough to accomodate the needs of oil recovery, navigation, pipeline, and drainage, so a vast network of canals has been built to accomodate these needs. It has been estimated that 40-90 percent of land loss in Louisiana can be attributed to canalization. The direct loss of marsh by dredging and spoil deposition and indirect loss by changing hydrology, sedimentation, and productivity is great. Spoil banks on canals limit the exchange of water with wetlands thereby decreasing the amount of sediment deposition. Canals indirectly influence land loss rates by changing the hydrologic pattern of marshes which in turn change the productivity of the marshes, the quality of the marshes, and the accretion of the marshes. Wave action will widen canals in time, allowing more saltwater to make its way into the marshes. Generally, where extensive canals exist, land losses are great, and where there are a limited number of canals, land loss is low. The effects of canals are noticeable.

Several researchers have proposed that the use of canals be replaced with less damaging alternatives. A halt to the dredging of canals would decrease the loss of wetlands. Directional drilling has reduced the number of canals needed for oil and gas exploration, and increased use should be encouraged. Air-cushion vehicles would eliminate the need for canals entirely. Federal and state governments could mandate policy changes in regulatory agencies. Such policy could include phasing out or prohibiting construction of new canals, which would also be helpful. However, existing canals will continue to allow saltwater into freshwater wetlands. Existing canals, therefore, as some have suggested, may have to be filled or plugged. Although, the cost may be high, these measures would have a positive environmental effect on Louisiana's wetlands.

Any activity that would have adverse affects on marshes should be avoided. Natural biological productivity, wildlife habitat, species diversity, water quality and other unique features of wetlands should be maintained. Management decisions should be made with long range goals in mind. Even a complete restoration of the original marshes, however, would not prevent wetlands from being submerged in the next century if confinement of the Mississippi River continues.

I. Salinity

II. Background Information

There are many physical parameters that affect organisms and every species has a minimum and maximum tolerance for each. Salinity is a very important parameter because a long-term change in salinity could change the flora of an area, thus altering food chains and food webs. Salt water intrusion is one of the problems affecting the marshes in this manner. The following exercise allows students to investigate salinity.

The term, "salinity", generally refers to the amount of dissolved salts in a quantity of sea water. Salinity is usually expressed in parts per thousand, "ppt", or grams of salt in one kilogram of sea water.

To measure salinity precisely, one would have to measure all the salts in a sample of sea water. This would be a long and tedious process. Most of the methods used to measure salinity are indirect methods which actually measure other physical or chemical properties of sea water and relate them to salinity.

Of the many ways to measure salinity, some are simple and some are complicated. The first of the following two methods, using a hydrometer, is rather simple. The second method, titration, is more complicated but is not beyond the capability of students.

III. Process Objectives

The student will learn how to---

1. take a water sample.
2. read a hydrometer in a water sample.
3. determine the temperature of a water sample.
4. read a salinity chart.
5. prepare titrant and indicator solutions.
6. set up and properly adjust a buret stopcock.
7. determine the salinity of a water sample by titration.
8. plot data on a map.
9. correlate present salinity data with past salinity data.
10. compare populations of organisms that existed in the past with the kinds of populations that exist now in the study area.

IV. Activity:

1. Purpose:

   The purpose of this activity is to teach students how to determine salinity of estuarine water samples and to compare this data to the changes that are taking place in our coastal areas.

2. Procedures:

a. collecting the sample Materials:

water sampler

collecting bottles (preferably plastic)

field notebooks

Collecting bottles should be clean, and each bottle should be numbered. As each sample is collected, records should be kept on exact location of sample site, date, time of day, weather conditions, depth at which sample was taken and other information that may be used in this and other labs. Be sure the sampling method is consistent. Each sample bottle should be tightly sealed so as to prevent evaporation.

If salinity measurement. are done in the field, you will need to keep the same records and include the salinity measurement. A cross reference of accuracy can be made by taking several samples to the lab and checking your field measurements with the titration method for determining salinity.

b. Hydrometer method

To the student - The hydrometer is an instrument used to determine the density of a fluid. Depending on the density of the fluid, the hydrometer will float at different levels. Most hydrometers are calibrated in term of specific gravity, which is the ratio of the density of one substance to that of pure water at 3.98 degrees C. In the metric system, density and specific gravity are numerically the same.

Since temperature is a factor in specific gravity, a temperature reading must be made when the hydrometer is used.

Materials:

hydrometer - heavy liquid specific gravity hydrometer, range 1,000-1,220 (Carolina Biological Supply Co., Catalog Number 72-2580, $9 00)

thermometer - lab grade

hydrometer jar - (preferably clear plastic cylinders)

salinity conversion tables and notebook

Methods:

Pour the seawater sample into a hydrometer jar or plastic cylinder. Float hydrometer in sample. Read specific gravity on hydrometer at the water level (see diagram). Record the specific gravity of the sample. Take the temperature of the sample and record. Use salinity chart to determine salinity of sample and record in notebook.

c. Titration method

To the teacher - The following is a "do it yourself" titration method of determining salinity. It appears complicated but it is very accurate. In addition to determining salinity, there is much to be gained by students learning the technique of titration.

There is a short cut!

LAMOTTE CHEMICAL PRODUCTS COMPANY

POST OFFICE BOX 329

CHESTERTOWN, MARYLAND 21620

TEL. (301) 778-3100

This company makes many small kits which can measure just about anything you want to test for in water. Their salinity titration kit sells for about $21.00 and comes with easy to follow instructions. School supply catalogs carry the LaMotte line. (Ward's, Carolina Biological Supply Co., etc.)

Materials for Titration Method:

1 - 50 ml buret

1 - Erlenmeyer flask

1 - 10 ml pipet

2 - 50 ml beakers

$AgNO_3$ (Silver Nitrate) titrant solution

K_2CrO_4 (Potassium chromate) indicator solution

Phenolphthalein indicator solution

NaOH (Sodium Hydroxide)

distilled water

plastic beads

Clean glassware and careful operations are essential.

Each student should wear an apron and safety goggles.

1. Fill buret with distilled H_2O. Adjust stopcock to deliver drops, and/or a single drop on demand.

2. Pipet 10 ml of sea water sample into the 125 ml flask. Add about 10 ml of distilled H_2O, and 2 or 3 plastic beads.

3. Put 4 to 6 drops of K_2CrO_4 into the flask. This is the indicator.

4. Fill a 50 ml beaker with $AgNO_3$.

5. Pour 5 ml of $AgNO_3$ into the buret. Drain into the other 50 ml beaker. Pour this into sink.

6. Partially fill buret with $AgNO_3$. Turn stopcock to fill the tip. Continue to fill buret until 40 ml of $AgNO_3$ is within graduated scale.

7. Record reading at start and finish so volume of $AgNO_3$ (in ml) can be determined.

8. Drain buret into 125 ml flask of sea water in short bursts (1 ml).

9. Agitate the flask carefully. Do not lose any liquid. Use a stopper.

10. Repeat steps 8 and 9 until the first pink-orange color appears. (Note: A white background will aid in observing color changes.)

11. Agitate well. Flask contents should return to original color.

12. Add $AgNO_3$ drop by drop while agitating flask. When pink color reappears, stopper, and shake vigorously. If pink color remains, this is the end point. Otherwise, repeat 12.

13. Once end point is reached, calculate $AgNO_3$ used. (See 7.) THIS IS THE SALINITY. However, a correction may need to be applied - consult the table below.

NOTE!!

a. Preparation of $AgNO_3$ titrant. Dissolve .7.25 g crystalline $AgNo_3$ in 0.5L distilled wate Then more distilled water to make one liter. Store in a dark brown bottle, out of direct light.

b. Preparation of K_2CrO_4 indicator. Dissolve 5 grams K_2CrO_4 crystals to 100 ml of distilled water.

Although the pH of the sample is not made part of this exercise, good results require a ph of 7-10. Adjust samples having a pH below 7 with 0.1 normal solution of NaOH.

Studying the Data

To The Teacher:

After salinities of the water samples have been determined, the data should be plotted on a map of the area where samples were taken. Student data should then be compared with data collected in the past from the same area. Assuming differences in salinity were found (salt water intrusion), many questions could be asked. Were the differences in salinity due to seasonal changes or do they represent a permanent change?

Compare the species of organisms that lived in study area in the past with the species that now live in the study. Are they the same or are there "new" species? What happened to the species that are not found in the study area today? Compare the salinity tolerances of the "new" species to see if they can now live in the study area because of higher salinities. Do the same for species that are no longer found in the study area to see if there salt tolerances were low compared to present salinities.

Compare the amounts of land area of the study area in the past with the amount of land area present today. Correlate this land loss with past and present salinities.

Glossary

Accretion - gradual buildup of land due to wave action, tides, currents, or alluvial deposits.

Anthropology - The scientific study of the origin and of the physical, social, and cultural development and behavior of man.

Archaeology - The scientific study of material remains of past human life and activity.

Artifact - A tool or ornament showing human workmanship or modification.

Barrier islands - islands off the coastal area that serve as a first line of defense against the sea. (Example: Grand Isle)

Bayou - American, French, or Muskhogean origin. A creek, secondary water course or minor river. A regular term in lower Mississippi and Gulf Coast region.

Boiling Stone - Fire-hardened clay balls found at Poverty Point and presumed to have been used to cook food by being dropped hot into water-filled skin pots.

Brackish - Partially salty water. of 3 to 15 parts per thousand (ppt).

Canalization - the digging of canals throughout the coastal zone for drainage, navigation, pipeline routes, and access to drilling sites.

Channelization - the deepening of a body of water to form a navigational corridor.

Chitimachan - An Indian linguistic or language group composed of the following tribes: Chitimacha, Washa, Chawasha.

Coastal Waters - Those bays, lakes, inlets, estuaries, rivers, bayous, and other bodies of water within the boundaries of the coastal zone which have measurable seawater content (under normal weather conditions over a period of years).

Coastal Zone - The coastal waters and adjacent shorelands within the boundaries established by state law, which are strongly influenced by each other, and uses of which have a direct and significant impact on coastal waters.

Culvert - a covered channel or a large diameter pipe that takes a watercourse below ground level.

Cumulative Impacts- impacts increasing in significance, becoming larger or more severe with every repetition, due to the collective effects of a number of activities.

Distributaries - Branches near the mouth of a river flowing away from the main stream.

Estuaries - a semi-enclosed coastal body of water which is open to sea water and within which sea water is diluted with freshwater.

Floodplain - A plain built up by stream deposition.

Greenhouse effect - the effect of the earth's atmosphere in trapping heat from the sun.

Hydrology - the science that treats the occurrence, circulation, distribution, and properties of the waters of the earth, and their reaction with the environment.

Interglacial - Those periods in time between glacial epochs.

Jetty - a barrier built out from a seashore to protect the land from erosion.

Lafourche (French) - A parish in southeastern Louisiana; the name of a bayou which is an outlet of the Mississippi River and is 150 miles long.

Levee - A dike or ridge bordering a stream to prevent floodings.

Marsh - Wetlands subject to frequent inundation in which the dominant vegetation consists of reeds, sedges, grasses, cattails, and other low growth.

Midden - A refuse heap found adjacent to the village of Indians.

Mississippi River - Indian, Algonquin. Misi for great, plus Sipi for water; so Great Water. The Spanish name was Rio de Flores, River of Flowers; the French name, La Salle's River.

Mitigation - a procedure to rectify impacts by repair, rehabilitation, or restoration of the affected environment, and also as a procedure to compensate for the impact by replacing or providing substitute resources or environments.

Pirogue - Small boat first built by Indians of south Louisiana by digging out trees.

Reclamation - the recovery of land through fill, dredge and fill, or drainage for purposes of creating dry land that can be used for residential, industrial, or agricultural purposes.

Salt water intrusion - the intrusion of salt water into less saline areas and fresh water areas.

Sluice - a passage fitted with a vertical sliding gate or valve to regulate the flow of water in a channel or lock.

Spoil banks - the accumulation of material dredged from the canals placed alongside the canals.

Subsidence - the lowering or sinking of land with respect to its previous level.

Tidal hydraulic energy - the energy associated with the ebb and flow of tides in and out of a coastal region.

Tidal surge - a wave generated by the motion of a vertical wall of water, having a change in height of the surface across the wavefront and a violent eddy motion of the wavefront. This phenomenon is not actually associated with normal tidal processes.

Weir - a dam in a waterway over which water flows, serving to regulate water level or measure flow of water.

Wetlands - Open water areas or areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support,and under normal circumstances, do support a prevalance of vegetation typically adapted for life in saturated soil conditions.

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Resources

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Seeking the First Americans. Prehistoric Indian culture; 1 hour. For a transcript send $3.00 to:

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BOX 1000

BOSTON, MA 02118

Mississippi River. This episode (1 hour) from the series "Making of a Continent" deals with the history of the river. It shows how the lobes were formed, sedimentation in the marshes, and how oil deposits were formed along the coast.

Islands of the Marsh. This video shows life from 1900 to the present, and includes episodes depicting alligator hunting, alligator skinning, and the selling of the alligator hides. Excellent presentation of life in coastal southwest Louisiana.

Lost in Time. This one hour presentation shows Indian culture of the southeast United States. It includes pottery making, trade between the tribes, and the division of labor. For a viewer's guide and transcript, send $4.00 to:

LOST IN TIME

AUBURN TELEVISION

AUBURN UNIVERSITY, AL 36849

Goodbye, Louisiana. This presentation was produced in 1982 by WGBH, Boston for the series NOVA. For a transcript send $4.00 to:

NOVA

GOODBYE LOUISIANA

BOX 322

BOSTON, MA 02134

The Louisiana Shrimp Story. This is a 16mm film which shows all aspects of the shrimp industry. It was produced by and is available from the Louisiana Department of Wildlife and Fisheries.

Crawfish. An excellent presentation of the environmental problems in the Atchafalaya basin that affects crawfish. Pond production is also covered. Copies are $24.95 from:

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Chesapeake Borne. This National Geographic production demonstrates that many of the problems we face are also being experienced in the Chesapeake Bay area. It covers aspects of life on the Bay such as crabbing, oystering, and fishing. There is a very good section showing how menhaden are caught using spotter planes and purse seines.

Wetlands. A comprehensive view of the nation's wetlands, with at least half the program devoted to Louisiana wetlands. Some excellent shots of a conservation area in northeast Louisiana, the Atchafalaya basin, delta, and other coastal areas. Free copies of the resource and study guide are available from:

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For further information on any of these videos or films contact:

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Appendix A

LOUISIANA'S COASTAL WETLANDS
Long Range Planning and Decision Making:

INTRODUCTION

One primary goal of education is to insure that a democratic society continues. Therefore, many of the objectives that are developed in science, social studies, mathematics, language arts, or any subject pivot around the cognitive and affective domains. This unit uses basic knowledge to idenfity and analyze problems and promotes the concept that scientific information and process skills should be used to examine alternatives to solving problems.

Process Objectives: In this unit, the student will:

1. identify and analyze how natural processes have changed the coast;
2. identify and analyze how people have changed the coast;
3. identify specific benefits that have affected the coastal zone;
4. identify and analyze problems that have affected the coastal zone;
5. identify and analyze alternative ideas that may solve coastal issues;
6. apply critical thinking and problem-solving skills to environmental problems;
7. participate in the democratic decision-making process.

This section of the resource unit has been adopted from several units and projects. Two of these units are recomended for teachers to use in their entirety. *Decision Making: The Chesapeake Bay* was developed by the University of Maryland Sea Grant College. The modifications of this project are intended to serve the local regions of the Gulf Coast of Louisiana. It is recommended that teachers obtain a copy of the *Decision Making: The Chesapeake Bay* simulation exercise. This publication is designed for both middle and high school students in biology, environmental science, Louisiana Studies, and/or other social studies courses. It is not intended that these units will replace any existing curriculum, but that they will augment existing material to make the curriculum more relevant to today's issues.

This exercise uses several components. The foundation of the simulation comes from the resource material found in the following sections. A 35 mm slide presentation is available for the teacher to use in teaching the resource unit. The information should be covered prior to any attempt in developing a local simulation. Several video tapes are available and should be used. The simulation "actors" have been modified from the *Project CLASS* format produced by the National Wildlife Federation. References for local material may be obtained from local or state agencies.

SETTING THE STAGE:

Over the past 100 years tremendous changes have taken place in Louisiana, especially along its coast. Maps developed in the 1930's of Louisiana coastal regions have provided the state with a "baseline" level of information to compare the changes that have occurred since that time. The map provided in this unit compares these changes. Figure 15 shows a predicted level of coastal erosion within a fifty year period. This map is not a simulated document, but an actual prediction based on scientific data. The participants should study the predicted changes. These changes may be assumed to all have negative impacts. Participants should, however, examine the consequences on the total environment as well as the consequences on each area that affects humans.

PROCEDURE:

The student should examine all of the maps. The slide program accompaning the Coastal Zone Resource Unit should be reviewed. The following questions are designed to guide your students through the preliminary thinking process.

a. What percentage of Louisiana's coast-line will be lost by the year 2030? Figure 15 shows a map of Louisiana that shows the predicted coast line change over the next fifty years. Use a piece of graph paper, and roughly trace the map over the graph paper. Determine the area of one square within the graph. Count the squares within Louisiana's presently existing coastline. Then count the squares within the predicted coastline. Determine the difference. Make comparisons with sizes of known areas. Discuss the advent of a rise in the sea level. Examine the cities and communities along the coasts of the United States.

b. Use a physical map to determine the elevation of the coastal region. Determine which cities might be inundated with water should the sea level rise.

c. Figure 16 is a map of Marsh island, Iberia Parish obtained from the Department of Wildlife and Fisheries. The Island will be used to develop an alternative simulation as to how wetlands may be used, developed or left alone. Have students break up into 6 or 7 groups. Organize each group into a planning "think tank." Use the questions previously asked to stimulate interest. Encourage students to identify the key coastal issues that may be facing Louisianans in the future. After asking the students to identify these issues, use Tranparency 1 to identify presently accepted issues. Use Transparency 2 to elaborate on each issue listed.

e. igure 17, 18, 19, and 20 are hypothetical maps of Marsh Island, Iberia Parish. These maps show simulated development over the next 30 years. These will be used in the next activity.

LOUISIANA COASTAL ZONE ISSUES

1. **Dredging and disposal of dredged materials** - Dredging is necessary to keep ship channels open. The spoil (material removed for the channel) must be disposed of safely so as not to endanger shellfish beds or other resources. Containment sites have not been found for the spoil. Many sites are badly polluted from Terrebonne/Timbalier Bay and cannot meet the needs of the next 20 years.

2. **Harvesting aquatic resources** - Fish and shellfish from the Terrebonne/Timbalier Bay are a major part of Louisiana's recreational and commercial life. Overfishing, agricultural runoff, sewage, stormwater discharge, and industrial discharge all threaten these living resources. Moratoriums on the taking of red fish are already in effect.

3. **Tidal and nontidal wetlands** - Wetlands play a key role in Louisiana's estuarine environment. They provide basic nutrients in the food chain and habitat for many fish and wildlife species, as well as help protect water quality, give flood protection, and help control shore erosion. Tidal wetlands are protected to a degree, but there is still considerable pressure to alter (fill or develop) wetlands. Freshwater (nontidal) wetlands provide valuable wildlife habitat and food, particularly to waterfowl and fur-bearers. These communities serve as buffers for storm water, aquifer recharge areas, and filters for sediment and pollutants. Agricultural drainage, urban development, and many other activities threaten nontidal wetlands.

4. **Shore erosion** - Erosion, occurring at a rate of over four feet per year, threatens about 140 miles of Louisiana's shoreline. Altering currents with structures along the shore can increase erosion, damage oyster beds, and cause sediment to fill tributaries. Storms can cause much greater erosion damage than normal weather conditions to these developed shorelines.

5. **Use of flood plains** - Building in flood plains risks a great loss of life and property in times of storms, as well as causing changes to biological resources found in those areas. Development of flood plains can increase the extent and frequency of flooding problems. Such development is increasingly restricted.

6. **Use of agricultural lands** - Agricultural runoff is an important source of nonpoint pollution in portions of the bay and its tributaries.

7. **Beach access** - Most Louisiana beaches are along the gulf coastline. Transportation routes must be available to give access to these beaches without damaging natural resources such as wetlands and without damaging existing developments.

8. Onshore oil and natural gas facilities - These facilities include fabrication yards, service bases, pipeline facilities, terminals, refineries, gas treatment plants, and marine terminals.

9. Electric-generating facilities - "Acid rain," nuclear power, localized effects of power plant operation, conservation programs, and the cost of electricity are major considerations in meeting Louisiana's growing energy demands.

10. Ports and Commercial shipping - Louisiana has more waterways than any other state. It has over 40 ports ranging from small oil industry service ports to this nation's largest shipping port, the Port of New Orleans. Ports serve as the staging point between land and water transportation. These shore-based installations enable goods to be transferred to and from ships and likewise from the producer to the consumer. Ports providing services to the shipping industry include, but not limited to: piloting and towing assistance, maintaining channels and navigation markers, reprovisioning with foodstuffs and supplies, and off and onloading. Small ports located hroughout the state act as feeder ports for the larger shipping ports. In order for ports to be competitive, they must maintain their channels, have well kept rail service, highways, and/or barge routes. Ports, unlike many other industries, must be located on waterways and in the Coastal Zone if they are to be successful. Louisiana Ports are located in New Orleans, Baton Rouge, Morgan City, Houma, Lake Charles, New Iberia, and Fourchon. Besides shipping, these ports are also used by the offshore oil and gas industry and the growing seafood industry.

11. Industrial parks - Industrial parks average over 300 acres and provide facilities for several types of industries. These parks have a great economic importance to an area by providing jobs and taxes. Industrial parks also can have great environmental impact with certain kinds of activities and the surrounding areas.

12. Residential development - Louisiana shorelines are increasingly popular for large and small scale residential development. Negative impacts occur when the facilities' demands (such as sewage treatment plants, police, schools, fire) exceed the areas' capacity to pay for them. Sedimentation, nonpoint pollution, and loss of valuable habitat can occur with growth of any size.

13. Sewage-treatment facilities - The impact of sewage facilities on shellfish can be severe when sewage harms the water quality (oxygen, nutrients, and residual chlorine, for example). Sewage-treatment plants also increase high-density development because more treatment capacity is available.

14. Land transportation facilities - In recent years beltways have helped move populations from cities to suburbs. Highways spur development and determine its nature. Problems associated with this phenomenon include the cost of construction and labor for clearing and stripping the land; the use of herbicides; and continued maintenance due to erosion and sedimentation.

15. Forested lands - Baldcypress and water tupelo are found in frequently inundated, poorly drained swamps while oaks, green ash, hackberry, sweetgum, black willow, and others collectively known as bottomland hardwoods are located on higher, better drained areas. Both forest types provide wildlife with food and habitat and significantly contribute to the estuarine food chain by producing detritus.

16. Mineral extraction - According to present estimates, an abundant supply of sand and gravel for general construction exists within Louisiana. Currently there are many sand and gravel companies. Waste fine material (from washing the extracted matter) is a major sedimentation problem for the rivers that feed the estuaries.

17 Recreational, open-space, and natural areas - recreation is defined as "to create anew, restore, refresh; refreshment of strength and spirits after work; a means of refreshment or diversion." To recreate in coastal areas whether by fishing, crabbing, hunting, boating, etc. has always been and will continue to be popular. Recreation fulfills a basic human need of closeness to the natural environment. As the population of Louisiana increases, more recreational facilities are needed. One type of facility needed is natural areas.

Appendix B

MARSH ISLAND

A CONFLICT OF INTEREST

Process Objectives: Students will improve their analyzing, communicating, problem-solving, and decision-making skills by:

. identifying the needs of individual residents concerning the marsh and coastal areas;

2. exploring the problems associated with meeting the needs of all local residents;

3. designing an island development plan which best meets the needs of the people and the environment.

SETTING THE STAGE

This simulation is designed around Marsh Island Wildlife Refuge. This refuge is an actual refuge protected and managed by the Louisiana Wildlife and Fisheries. The hypothetical simulation was developed around this particular area because it is already under a protected refuge status. The simulation is not designed to suggest the possibliiity of developing this area. It is merely an attempt to use an existing area and the background information to prompt students into environmental problem-solving.

The Marsh Island Wildlite Refuge lies between Vermilion Bay and the Gulf of Mexico in Iberia Parish. It consists of over 82,000 acreas. It is bounded on the west by Southwest Pass and on the east by East Cote Blanche Bay making it very remote and accessible from the mainland only by boat. The general terrain is very flat with ground elevations ranging approximately 6 to 12 inches above sea level except along a south beach ramp. In recent years, 80,000 to 90,000 blue and snow geese have wintered on the refuge along with a comparable number of ducks. Alligators are found in large quantity throughout the refuge. As a nursery ground for shrimp, Marsh Island is probably unsurpassed in this section of the state. Literally millions of small shrimp drift into the waterways of the island in the spring and mature and move out in the late summer and fall to be harvested by commercial fishmen in Vermilion Bay and the Gulf. Blue crabs, fish, and many other forms of marine life are found in abundance throughout the waters of the refuge. In spite of the aquatic condition of Marsh Island, large numbers of deer have been present at various times in recent years. The deer were virtually exterminated by Hurricane Audrey in 1957, but a few survived and are now seen frequently. In addition, countless thousands of shorebirds and wading birds utilize the area, all of these combine to create a teaming wildlife colony. The refuge headquarters is located on the north edge of Marsh Island at the mouth of Bird Island Bayou. Patrols are made on the island by refuge personnel to prevent violation of fish and game regulations. Some patrols are made by low level flights over the island. Patrol camps have been constructed at different points on the island in order to provide shelter for enforcemet personnel. The refuge is staffed with a wildlife specialist and maintenenace personnel. Approximately 40,000 acres of marsh, one-half of the total area, has been altered for migratory waterfowl through the use of water control structures and levees. One 9,000 acre impoundment has been constructed, and in the last five years a total of 25 low-sill dams have been constructed.

Prior to the development of the refuge, the mars s were typically tidal flow, with excessive drainage of lakes and potholes. This resultsd in a very unstable water levels on the island which largely prohibited the growth of wigeongrass and other desirable aquatics in the potholes. In adddition, it promoted the production of undesirable marsh plants, such as black rush, that typify well drained, brackish marshes along the Louisiana coast.

PROCEDURE

Figure 16 is a map of Marsh island, Iberia Parish obtained from the Department of Wildlife and Fisheries. The Island will be used to develop an alternative simulation as to how wetlands may be used, developed or left alone.

1. Have students break up into 6 or groups. Organize each group into a planning "think tank ' Determine on a map of Louisiana, where Marsh Island is located. Have students identify key structures on the island, these would include: levees, streams, canals, weirs, lakes, and roads.

2. Figure 17, 18, 19, and 20 are hypothetical maps of Marsh island, Iberia Parish. These maps show simulated development over the next 30 years.

    a. Look at figure 17. What percentage of Marsh Island was covered by marsh 30 years ago?

    b. Look at the development that has hypothetically taken place at each ten-year interval. Identify the factors that influenced the greatest change. Examine the transportation system, industry, and stores.

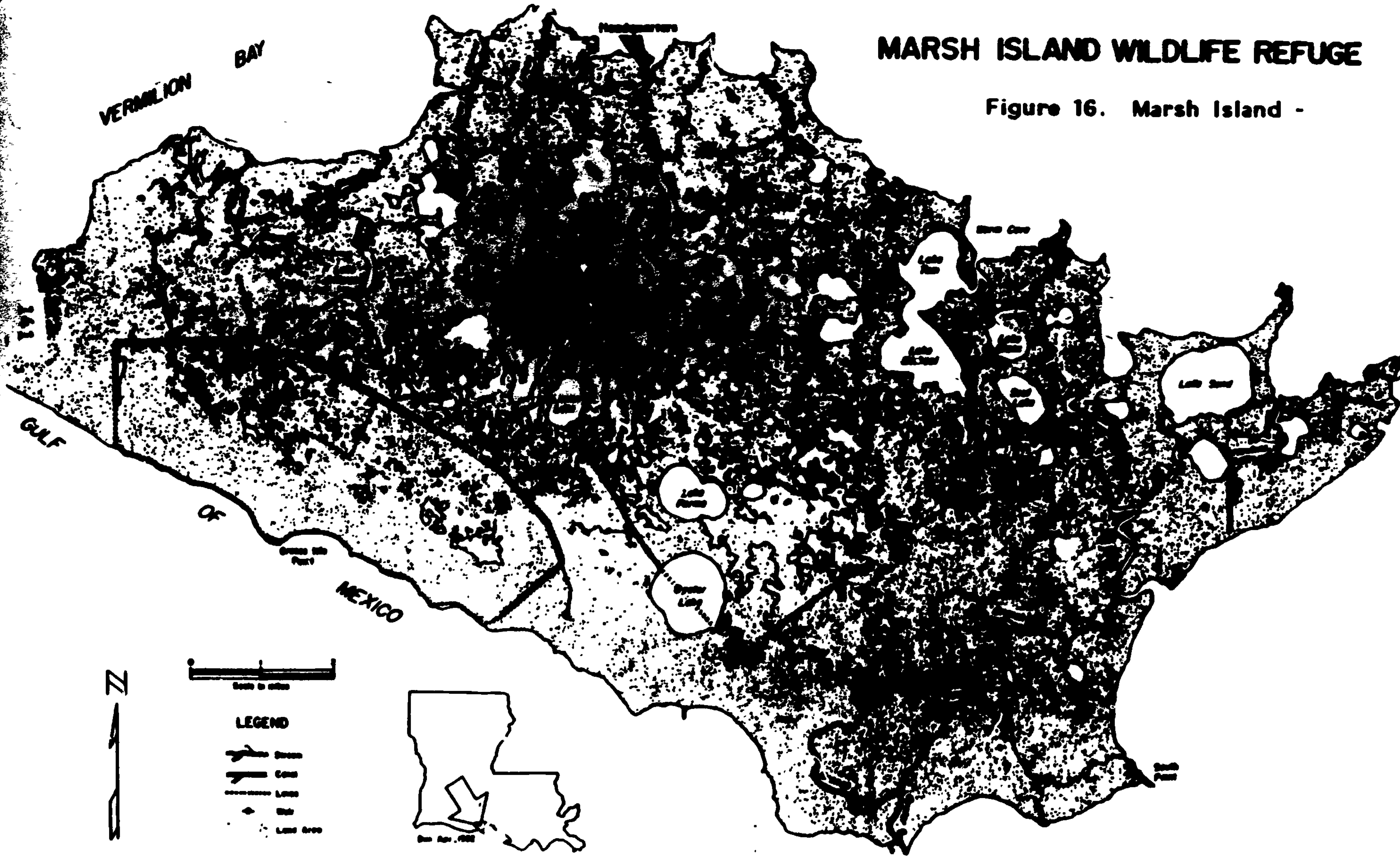


Figure 16. Marsh Island -

Figure 17. Change in a Marsh Island -

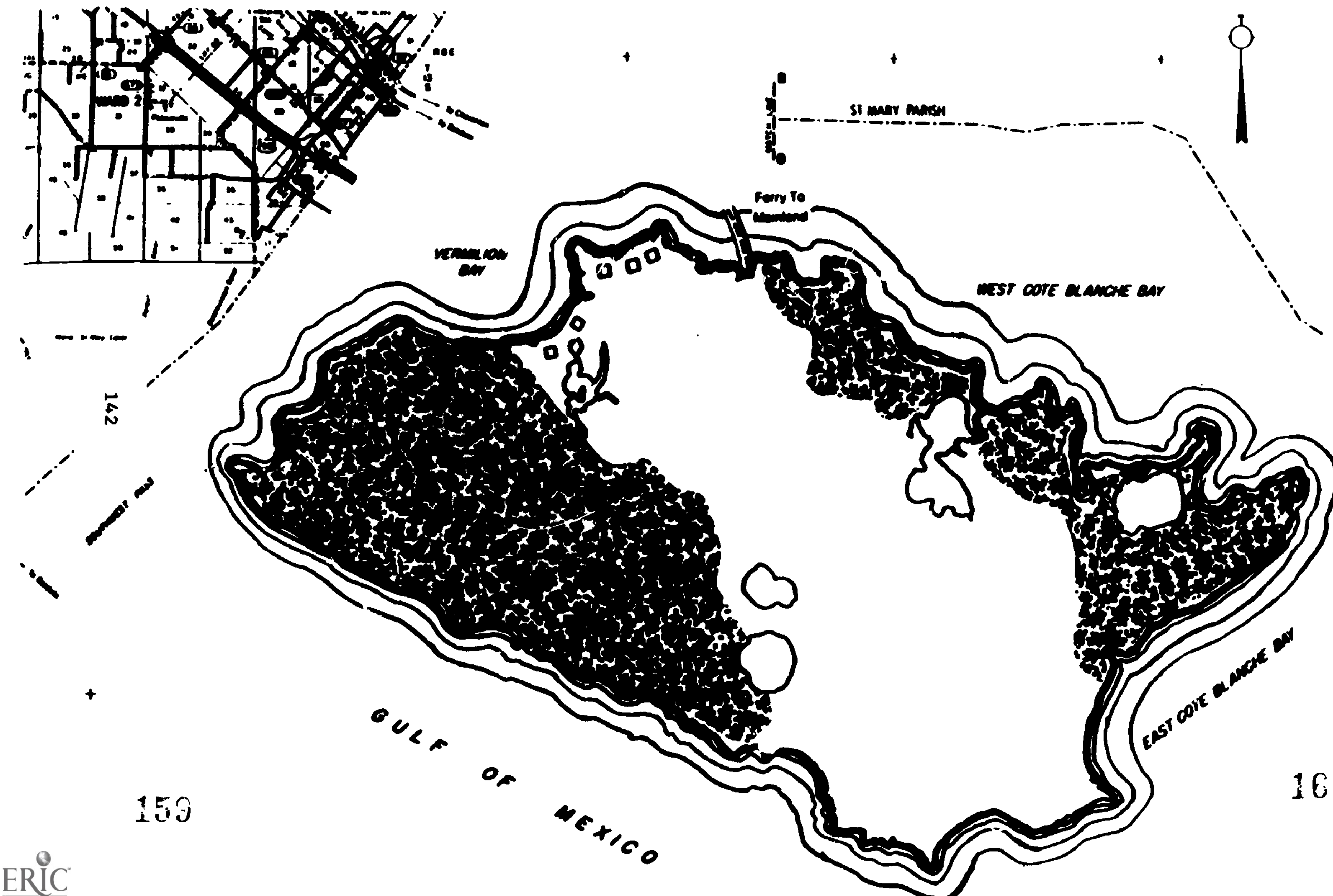


Figure 18. Change in a Marsh Island - Ten Years Later

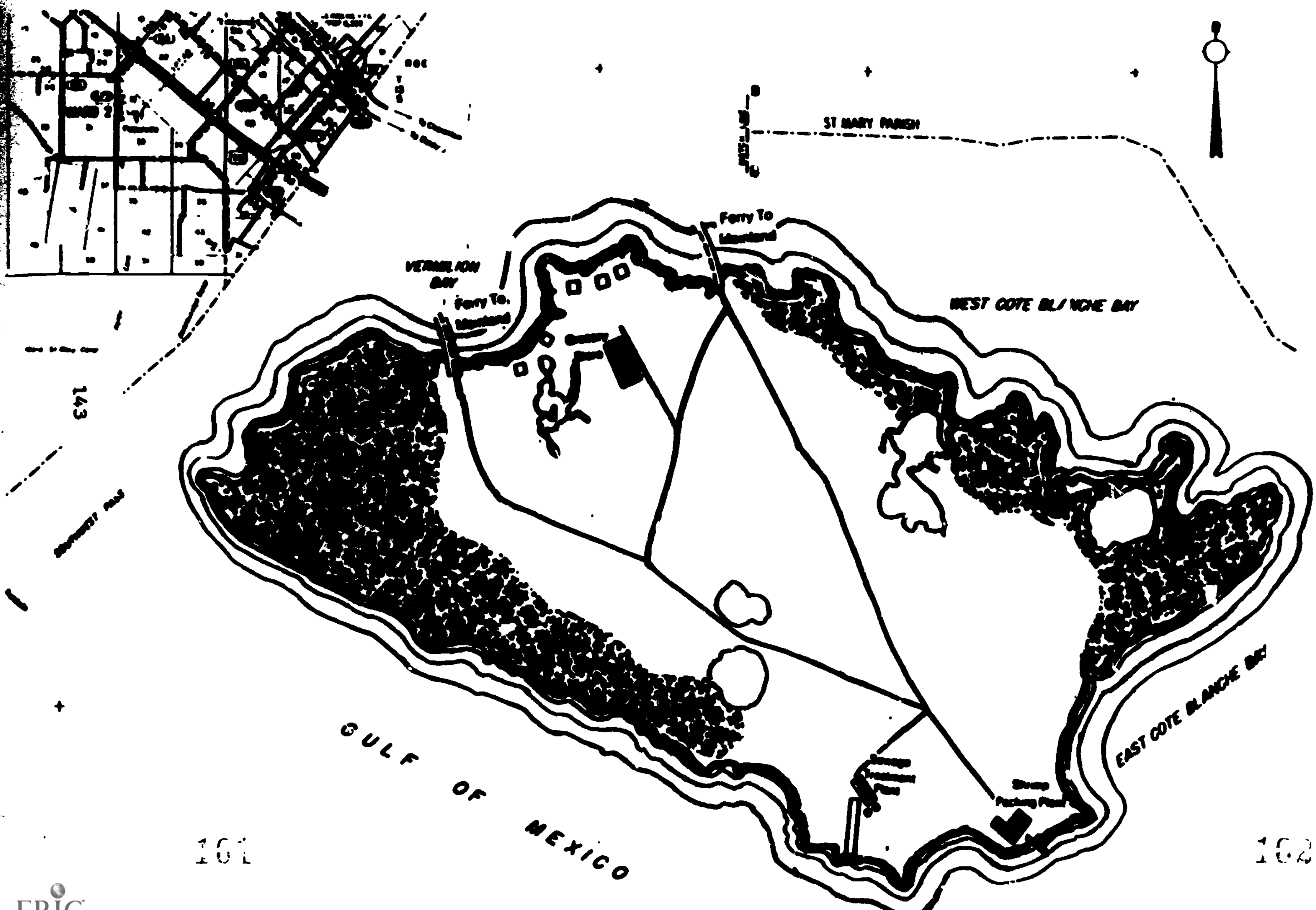


Figure 19. Change in a Marsh Island - Twenty Years Later

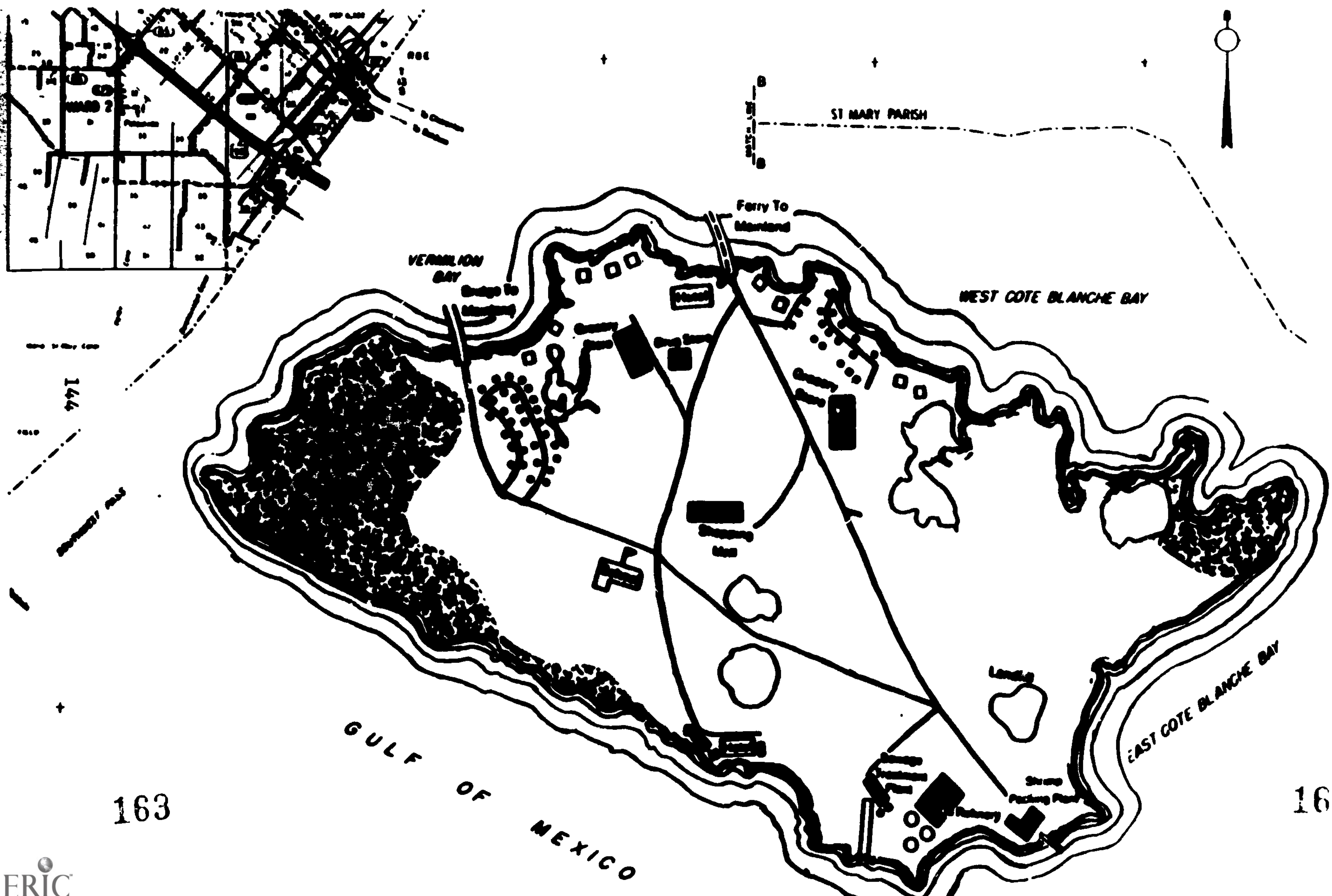
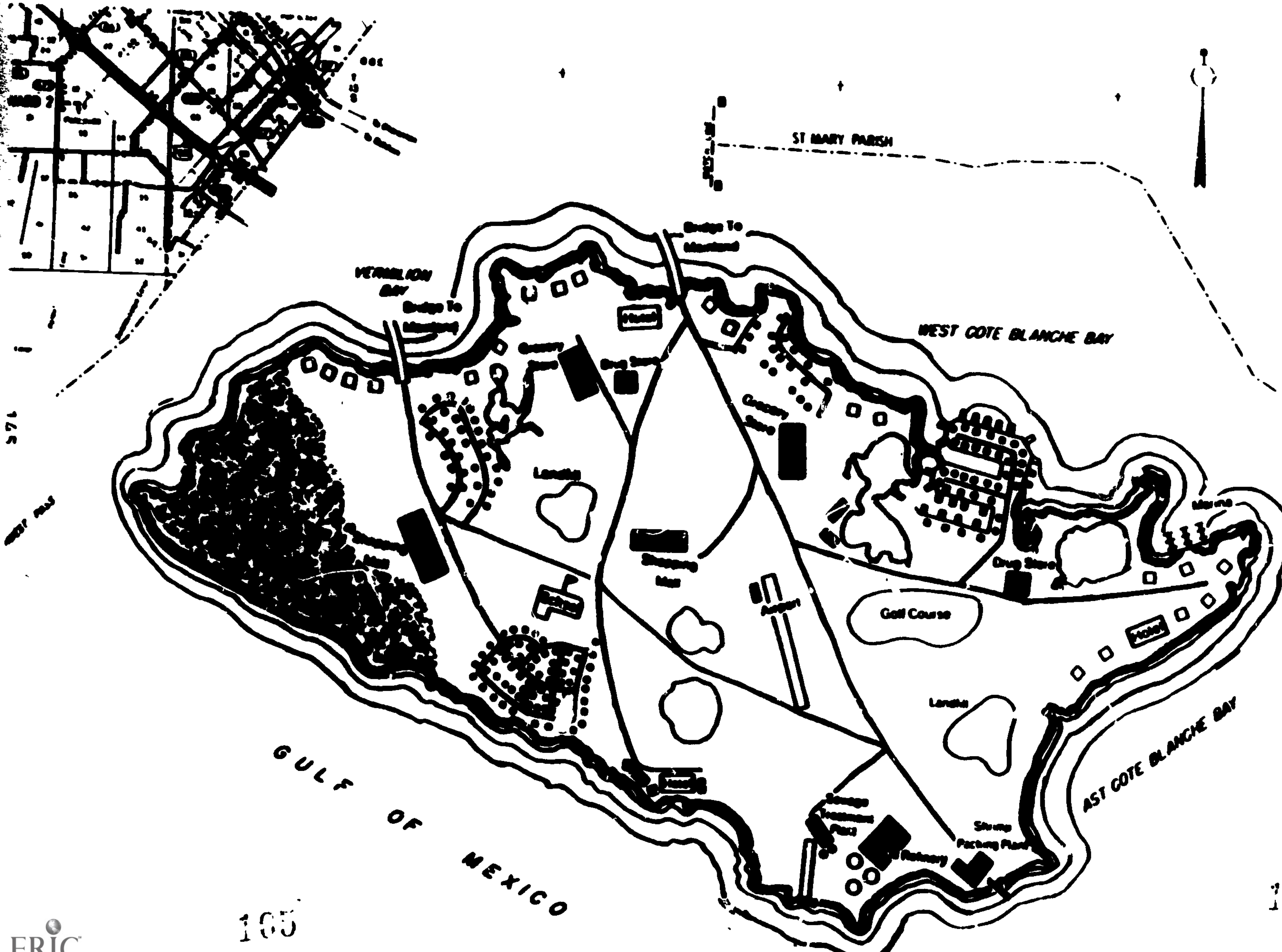


Figure 20. Change in a Marsh Island - Thirty Years Later



c. What percentage of marshland remains in each ten-year interval.

d. Based on the "real" Marsh Island information, what effect would this hypothetical development have on the marsh and the animals living and breeding there?

e. What do you think had the greatest effect on the development of the island?

f. How do people use the island today? How would it be used in the presented scenerio?

g. What are the immediate benefits resulting from the development of the marshes?

h. Could the proposed developments actually take place without affecting the marsh?

i. Why do you think developments such as these have not actually occurred on Marsh Island?

j. Do you think people who moved in 30 years after the development began knew why the island was called "Marsh Island."

3. At this time, the students are ready to initiate the development of their plans for the island. Assume that the island will be developed. Have each group develop plans that should allow for the orderly development of the island and the conservation of its natural resources.

   a. The plans should provide for housing, schools, recreation, waste disposal, and jobs.

   b. The plans should reflect wise planning and balance within the natural system.

The "SIMULATION ROLES" provided in this section describe the feelings of Marsh Island "residents" about the "development" that has taken place on their island and the possible development that will take place in the future. Have several of your students present these "Simulation Roles" in a role-playing exercise to the rest of the class. The exercise could portray a public hearing or a local newscast in which the residents are interviewed. This will prepare your class to analyze their plans from the viewpoints of the residents. After the hearing or newscast, ask your class these questions:

1. Do you think the plans you developed as part of the previous investigation solve the problems you heard expressed in the hearing? How?

2. Is it possible to solve all their problems?

3. Which people seemed to have the interests of the entire group in mind? What did they say to convince you of that?

4. Which people were expressing their own special interest? What did they say that made you feel that way?

PROCEDURE

1. Divide your class into groups of six or eight. Give each group a copy of the "Simulation Roles" to guide them in the appropriate "roles." Act out the "hearing." Have the students review the roles and identify what type of general view their role is portraying. Ask them to conduct library research to obtain additional information concerning the view that "their role" has.

2. Conduct a "hearing" by pulling a panel of judges or decision-makers who will listen to the responses of the role-players.

3. Following the role-playing exercise divide your class again into groups of six or eight. Give each group a copy of the "Simulation Roles" to help jog their memories.

4. Each group should now combine or revise their plans to make one plan that will best meet the needs of all the residents of Marsh Island as outlined in the "Simulation Roles". Their plan can be presented as a map, in a written essay, or as another play.

5. Now compare their new plans with the development which actually occured as shown on maps of Marsh Island included in figures 17, 18, 19, and 20.

   a. Do students feel that recommended growth on Marsh Island was excessive?
   b. What could have been done to curb the growth?
   c. How does the development in their new plan differ from what actually happened in the simulation on Marsh Island?

6. If students feel that the growth on Marsh Island was

excessive, they should now write a series of regulations which would have ensured better use of the land.

a. What restrictions would these regulations impose on homeowners? industry? recreation?
b. Who would be responsible for policing and administering these regulations?
c. What existing plans parallel current policies on Marsh Island?

SUMMARY

You may want to have each group present a new plan and a new set of regulations to the rest of the class. Each plan could be critiqued and compared with the others.

1. Ask the group to list the needs they considered (and the interest groups that expressed those needs) in order of the importance they assigned to those needs.

2. Were all the groups able to satisfy all the different points of view of the local people? If not, what was sacrificed? By whom?

3. Did all the groups sacrifice the same thing? Different things of equal or similar importance?*

4. How will the regulations work to benefit the people?

5. What aspects of each group's plan benefited the entire community?

6. Have the opinions of each group or each student changed as a result of listening to each other critique the plans that have been designed?

7. How does this exercise relate to real-life situations?

8. How do you think compromise and/or decisions are reached in real-life situations?

*This question may bring up the difficulty of placing an economic value on certain recreational pursuits and aesthetic aspects of life. "How valuable is a swamp?" Allow your students to explore this for a while and try to discover a way for the "scenic" value of an area to be measured against the economic value of the area if developed. Is this a fair issue? A fair measure?

SIMULATION ROLES

Contractor "My company has built over half the homes on this island. My estimates are consistently lower than the other builders who bid on these jobs. There is plenty of room for more subdivisions without hurting anything. If the people want to build here, they should have that choice; after all, this is America."

Landowner "I own a lot of land here on this island. People who own land should be able to do what they want with their land. Hey, my family has been paying property taxes on our lands for 35 years. Why should the environmentalists who don't pay the first property tax tell me what I should do with my land. The market has never been better and as long as people will pay the asking price, I'll sell them what they want."

Artist "When I was a little girl I would come over here with my father and brothers who used to tong for oysters. Because I was not much help, they would pull up and put me off close to shore, and I would spend the day on the island while they worked. It was on the island that I taught myself to paint. I have made a living by painting scenes around the island for the last 20 years. This island provides a livelihood for me and I will not sit back and watch all these people destroy Marsh Island. Don't you know what developers have done to other islands around the country?"

Parish Planning Director "This is a unique situation in that you have all these competing interests for this island. Even though Marsh Island is in the Parish, our hands are more or less tied. Remember this parish has no zoning ordinances so there are no real controls or guarantees for a well planned community. I have suggested to the mayor that he put together a committee whose members will represent all concerns. They could develop guidelines or criteria for controlled growth, but so far nothing has been done."

Shrimper "To destroy the marsh is to destory the shrimp. These people moving down here don't know the first thing about how shrimp depend on the marsh. What am I supposed to do when I can't catch no more shrimp and can't feed my family? I don't care if people move here, just as long as we protect the marsh."

Commercial Fisherman- "I'm a commercial fisherman. I harvest oysters from my leases in the fall and winter, and I shrimp during the spring and summer. I am very concerned about the deveopment you propose for the Island. What kind of sewage treatment facility will you recommend for the different types of development you want on the island? My oyster leases are near the island and I don't want polluted oysters. If I sell oysters that are polluted, people will get sick and I may be legally liable for their illness. Oysters feed and grow by straining tiny plants and animals from the water, and they also consume sewage. I make my living from these oysters and if the state Department of Health closes my oyster leases because of water pollution I will not be able to feed my family or pay my bills. I am a second generation oyster fisherman. My father and uncles began harvesting oysters from these waters 50 years ago. We have already lost other leases around the state because of sewage pollution in the water. Can you guarantee that you will not pollute my oysters? With more people on the island, can you guarantee that they will not steal my oysters or bury them with mud kicked up from the bottom by their motorboats? My family has been here for 50 years and now you want to destroy our way of life."

Coastal Zone Management Administrator "The coastal zone management office has been concerned about the cummulative impacts associated wth the development of Marsh Island. We are involved with reviewing permits for projects in those areas of Marsh Island where we have authority such as wetlands and shorelines. In the past we have worked wth petroleum interests and the highway department to minimize impacts. Our guidelines protect most of the wildlife habitat on Marsh Island, but do not include those upland sites where most of the development is occurring.

Retail Store Owner - "You know this whole issue concerns everyone here. Some of the people want it this way, some want it that way. When you really think about it, though, we should continue to develop the island. The way I see it if they didn't want development why were we ever allowed to live here in the first place?"

Vacation Homeowner #1 "I have been coming to this island for fifteen years and I like it the way it is. I want complete peace and quiet on my vacation. I want to see wildlife and nature undisturbed by human activity This island is one of the few remaining wetland habitats for many different kinds of wildlife. Sure, we can destroy this marsh, but how do we know what is happening in other places? How can we make sure there is a place for our wildlife? I think it's about time we accepted our responsibility for the wildlife that has come to depend upon us."

Vacation Homeowner #2 "On my vacation, I want to relax, fish, have a good time with friends and family. I want the peace and tranquility of the marsh.

Chamber of Commerce Member #1 "My business depends on tourists and residents spending money in my hardware store. I am interested in developing this island in such a way that more people will live here and spend their money in my store. It is important to me to have industry, hotels, and housing developments. Without the people who use these facilities, I would go broke, and I have a family to support. In fact, how else are we going to raise the standard of living in this area and improve our quality of life.

Chamber of Commerce Member #2 "My business depends on sportsmen. I sell fishing gear, baits, and rent equipment. I am interested in developing this island is such a way that people are interested in the marsh and fishing will visit it. Therefore, I don't want to see all of the wetlands filled in and developed into golf courses, hotels. or airports. That will put me out of business. My business is to supply the duckhunters, fishermen and other visiters who just want to enjoy nature and to explore the island. These are the kinds of people I want comming to the Marsh Island."

Hotel Owners Representative "I have a 25 room hotel which needs to be 50% filled in order for me to make a profit. You figure out how many rooms need to be filled for me to stay in business profitably. We need attractions for them. We need things that will attract people. We need landing docks and moorings for people who come in their own boats. We need parking lots and stores for these people. We need attractions that are going to make people want to take their vacations here at my hotel. Therefore, we cannot afford to keep these wet areas as they are. The marsh has mosquitoes and it smells bad. You can't swim in it and it is not going to attract normal people. I suggest that we fill it in. We could build a golf course---we could use another one."

Audubon Society Member "I am interested in wading birds and shore birds. If we can keep the wetlands as they are and keep the marshes, these birds will come to breed and raise their young. They are a very important part of our environment. If the marsh is destroyed we will lose many different kinds of birds, and the island people will lose the 3 million dollars worth of business brought by the people who want to visit the marsh. People like me take canoes and quietly observe birds and animals and their habits, take photographs, and write about them. We can't do this if you destroy the marsh. I do not want to see this land developed."

Shrimp Packing Plant Owner "My business depends on a plentiful supply of shrimp. We will not have these shellfish any longer if we continue destroying our wetlands for hotel development, golf courses, private homes, private docks, and the roads and shops you people are planning. We can always put oil refineries and hotels somewhere else, but we can't put shrimp just anywhere. This is a 12 million dollar business on this island! If we destroy the shrimp habitat, I will go broke. My plant will have to close and my employees will be out of work. Just think how high the unemployment rate will be! Then people won't have money to spend on local businesses."

President of the Shrimp Packers Union, Local 461 "My men earn their living processing the shrimp that are caught off the shores of Marsh Island. When I was first a member of this union, the shrimp boats used to bring in 80 tons of shrimp a day to be processed in the plant. We had 200 men working here. Since the bridge was built 20 years ago, more development has occurred and there have been fewer areas for the shrimp to grow. The number of people who work in the shrimp packing plant has been reduced to 100. A hundred people are out of work because of the development that has been allowed on this island. At this point people want to develop more of this land; to take away more of the shrimp habitat and the marshes. If you do this, you are going to put 100 more people out of work."

Biologist for The Fish and Wildlife Service "I have been sent here to study the organisms that live in and depend on the marsh. I have done extensive studies on shrimp, racoons, and oysters, and I have found that these organisms would be eliminated if the marshes are destroyed. The marshes are also an essential habitat during part of the life cycles of many other organisms such as blue crab and red fish. Until we fully understand the importance of the marshes, we cannot afford to do anything that would destroy them. The shrimp and commercial fishing industries would also be destroyed along with local businesses which are supported by people who want to canoe and look for wildlife in the marsh. We could be creating more problems than we are solving if we destroy the marshes."

Permanent Homeowner "I spent a lot of money for my house. When I moved to this development on Marsh Island, it was rather exclusive. We had a marina. Our homes were on the golf course. We had our own docks. We had all the advantages of privacy and yet all the conveniences of a resort hotel down the street with nice boutiques and shops where I could take my guests when they came on the weekends. There was not much traffic and our property was increasing in value because of the type of development here. Since that time an oil refinery has moved in. We have an airport. The development is encroaching on our privacy. More and more people are coming to the island and causing traffic problems, pollution problems. I just wonder if our land values are going to be mantained if we allow any more of this kind of development. I don't want to see any more industry or anything that will detract from its exclusive aspects."

Oil Refinery Manager "When we built our refinery here, I was told there would be plenty of facilities for my men, that there would be places for their families to live, and that I would have no trouble finding people to work here because of the location. We need more low-cost housing for our employees, and I want to see that area that is now nothing but a dirty old marsh, which smells worse than any oil refinery ever did, filled in. And I want to see homes and facilities built there for the people who are going to work in my plant. Otherwise, we are going to have to close and find a place that will take us.

Now that I am here in operation, I find there are a lot of environmentalists, bird-watchers, and people who like to fish and hunt, but they don't have any consideration at all for the man who has to earn his living by working here. They don't consider the fact that in order for them to have all the things that they use to enjoy their activities, they need somebody to refine the oil for their powerboats, trucks, and automobiles."

Bank President "Well, I think we need to have a bit of rational talk around here. I find that an awful lot of my customers are sitting in this room today. Obviously you all have different interests, but you do have three things in common: you all need to earn a living, and you all need a place to live and places to buy goods and services. My job is to run the bank, to give you services that allow you to do all the things each and every one of you wants to do. Now, when it comes down to the bottom line, you've got to be practical. In order to feed your kids and get the luxuries in life that you all seem to want, you're going to have to have industry, you're going to have to have business, and you're going to have to take some of these lands and develop them. Now, it's not a matter of sentiment, and it's not of a matter of those nice birds and animals that live there in the marsh. It's a matter of dollars and cents and your livelihood. I suggest that we all sit down and get together and decide that we are going to do something that is going to keep your bank operating for you people who need the money that it generates."

Appendix C

WETLANDS AND/OR COASTAL AREAS CLASS PROJECTS

Locate coastal areas which exist in your region and contact the Louisiana Department of Wildlife and Fisheries to find out if they are publicly owned. Pick one publicly owned wetland area and invite a representative from the agency responsible for the area to your class to talk about the wetland. Ask them to respond to these questions:

1. What plans does the agency or conservation office have for the area?
2. What plants and animals use the area as a habitat?
3. Is this habitat endangered or threatened?
4. Are any of the species endangered or threatened?
5. What economic values are attached to the coastal region?
6. What efforts are being made to develop a long range plan balancing developmental impacts and protection?
7. What specific efforts are being made to protect the area and any of its unique plants and animals?
8. How does the public use this area?
9. What is the future of this area if present trends continue?
10. What can the class do to assist in the protection or management of the area?

Where possible, take a field trip to the area. Document the trip with slides, film, or video to show the class if they cannot go to the area. Consider tape-recording the sounds of the region. In addition, make comparisons between the wetlands they are studying in class and the local area. Assess the needs of the area and make plans for improvements. For example, a class might work with an agency to set up a nature trail or school study site, or may adopt the area for monitoring change, or for keeping the area clean of debris.

If a privately owned marsh area is identified and the owner has no plans for development, consider working with the owner to develop a study site for use by local schools. Submit articles to the local newspaper to advertise the study site with the owners permission.

You might create a display about a local wetland for another class, the library, or a municipal building. If the area is open to the public, supply directions to the area and other information for visits.

Once you have located a wetland area or coastal area owned by the city or county, find out what their plans are for the wetland. Consider these questions: Do these plans take into account all of the competing demands placed on the coast or wetlands? Do they meet all the needs of people? Has citizen input played an important part in the development of these plans? Are there elements of the plans that you think should and could be changed? Do the regulations apply? What can be done to ensure that unplanned development does not take place in 30 years? Find out about the Coastal Zone Management Act, its effect on the nation's coastal wetlands, and its effect on your community.

Are there local organizations working to protect or maintain wetlands in your community? Find out by contacting the Heritage Foundation Office or the Department of Natural Resources. Find out what they are doing and help publicize their efforts and work with them to identify unique areas.

Study the ecosystem of a pond, bayou, or canal in your area. Identify the elements in the food web. Find out what kinds of organisms are common to the area. Prepare an exhibit that illustrates life in the area. Consider any things you can do to improve the wetland as a habitat for wildlife and as a place for people to visit and use? If so, with permission and advice from experts in wetland ecology, carry out these measures and report them in your exhibit.

RESEARCH PROJECTS

Consider alternative ideas for special projects.

You might explore the historical background of a wetland. Select a developed area on one of the topographic maps of your region which might have been a wetland. Find out if you are right by looking through town records and old photographs, interviewing long-time residents of the area, or examining old maps.

Examine the economic importance of wetlands in your local area.

What businesses or industries are dependent on the existence of marshes? What marsh plant or animal does the industry use? What is the life cycle of this organism? How large is the industry (dollars per year)? Has the industry grown in the last 25 years?

For example, research the impact of the shrimp industry, oyster industry, or other fishing industry in your area. Are there wetland wildlife refuges near you? Local sporting stores, hunting and fishing businesses, restaurants and hotels may depend in some part on the people who come to visit the wetland.

Appendix D

PREPARING AN ENVIRONMENTAL IMPACT STATEMENT (EIS)

Using a Matrix

RESEARCH:

Any negative impact of public or private policy on wetlands or the coastal regions of Louisiana should be researched. Available data should provide background information on specific problem areas.

Preparing an environmetal impact matrix: Develop public or private policies regarding an area to be studied. After a public or private policy has been studied, each group working on an environmental impact statement should evaluate the policies.

First, use the list to checkoff selected specific actions (A-J) that are actual components of each public policy statement under review. To enhance decision-making, refer to Section 1 of the Criteria for Evaluating Environmental Impact. Section 1 breaks down into subcategories each of the proposed actions that may have a negative impact on the coastal region (eg. Marsh Island, or Barateria/ Terrebonne/Timbalier Bay region).

Once you have identified the specific actions for each policy, have each special interest group member vote on the level of negative impact for each specific action. Consult Section 1 of the Criteria for Evaluating Marsh Island and/or Terrebonne/Timbalier Bay Environmental Impact before assessing the level of impact. This list of "Existing Environmental Characteristics and Conditions" facilitates an examination of the possible changes that could be caused by specific proposed actions. Each group member votes according to the following procedure:

0: no impact at all

1: slight impact (some changes, but not negative ones)

2: moderate impact (quite a few changes, some of which are negative)

3: severe impact (many changes, most of which are negative)

The votes of all members are then averaged and written in the appropriate square of the grid to indicate the severity of the impact.

Subcommittee. After your interest group has determined the impact of all polices, send one or more representatives to convene with each of four subcommittees that consist of representatives from each of the interest groups. Each subcommittee will compile the environmental impact matricies for one policy from each interest group onto one consolidated matrix.

Prepare a consolidated environmental impact matrix for the Coastal Zone Management Interest Groups (CZMIG)
The subcommittee will transfer the numerical values (totals) from each of the seven interest groups onto the appropriate square of the matrix transparency. Each number will be color-coded according to the following scheme:

0--7, yellow: slight impact or none
8-14, orange: moderate impact
15-21, red: severe impact

Mitigation of public policies.
In each instance where the sum is 8 or greater, the subcommittee needs to propose ways to mitigate (or minimize) the harmful impact of the policy on the marsh/bay environments and devise guidelines for implementation. These proposed mitigations will be reported back to all members of the Coastal Zone Management Interest Group for consideration.

Each individual then votes either to approve or to reject the mitigated policy and its EIS. A simple majority is required for approval. If not approved, the subcommittee must reconvene and work out a set of compromises acceptable to the majority of the Coastal Zone Management Interest Group delegates. Alternate public policies not selected should be consulted for ideas.

Section 1

Criteria for Evaluating

TERREBONNE / TIMBALIER BAY

Environmental Impact

Proposed actions that may have a negative impact on the Terrebonne/ Timbalier Bay environment

A. Modification of ecosystem
   1. Exotic plants or animals introduced
   2. Biological controls
   3. Modification of habitat
   4. Alteration of ground cover
   5. Alteration of ground water hydrology
   6. Alteration of drainage
   7. River control and flow modification
   8. Canalization
   9. Irrigation
   10. Weather modification
   11. Burning
   12. Surface or paving
   13. Noise and vibration

B. Land transformation and construction
   1. Urbanization
   2. Industrial sites and buildings
   3. Airports
   4. Highways and bridges
   5. Roads and trails
   6. Railroads
   7. Cables and lifts
   8. Transmission lines, pipelines, and corridors
   9. Barriers, including fencing
   10. Channel dredging and straightening
   11. Structures to stabilize channel embankments
   12. Canals
   13. Dams and impoundments
   14. Piers, sea walls, marinas, sea terminals
   15. Offshore structures
   16. Recreational structures
   17. Blasting and drilling
   18. Cut and fill
   19. Tunnels and underground structures

C. Resource extraction
   1. Blasting and drilling
   2. Surface excavation

3. Subsurface excavation and retorting
4. Well drilling and fluid removal
5. Dredging
6. Clear cutting and other lumbering
7. Commercial fishing and hunting

D. Land use activities
1. Farming
2. Ranching and grazing
3. Feed lots
4. Dairying
5. Energy generation
6. Mineral processing
7. Metallurgical industry
8. Chemical industry
9. Textile industry
10. Automobile and aircraft
11. Oil refining
12. Food
13. Lumbering
14. Pulp and paper
15. Product storage

E. Land alteration
1. Erosion control and terracing
2. Mine sealing and waste control
3. Strip mining rahabilitation
4. Landscaping
5. Harbor dredging
6. Marsh fill and drainage

F. Resource renewal
1. Reforestation
2. Wildlife stocking and management
3. Ground water recharge
4. Fertilization application
5. Waste recycling

G. Changes in traffic
1. Railway
2. Automobile
3. Trucking
4. Shipping
5. River and canal traffic
6. Pleasure boating
7. Trails
8. Cables and lifts
9. Communication
10. Pipeline

H. Waste treatment and disposal
   1. Ocean dumping
   2. Landfill
   3. Emplacement of tailings, spoil, and overburden
   4. Underground storage
   5. Junk disposal
   6. Oil well flooding
   7. Deep well emplacement
   8. Cooling water discharge
   9. Municipal waste discharge including spring irrigation
   10. Liquid effluent discharge
   11. Stabilization and oxidation ponds
   12. Septic tanks, commercial and domestic
   13. Stack and exhaust emission
   14. Waste lubricants

I. Chemical treatment
   1. Fertilization
   2. Chemical deicing of highways, etc.
   3. Weed control
   4. Insect control (pesticides)

J. Accidents
   1. Explosions
   2. Spills and leaks
   3. Operational failure

K. Other

II. Existing Terrebonne/Timbalier Bay environmental characteristics and conditions

A. Physical and chemical characteristics
   1. Earth
      a. Mineral resources
      b. Construction material
      c. Soils
      d. Land form
      e. Unique physical structures
   2. Water
      a. Surface
      b. Underground
      c. Ocean
      d. Temperature
      e. Snow, ice, and permafrost
   3. Atmosphere
      a. Quality (gases, particulates)
      b. Climate
      c. Temperature

4. Geological activity
   a. Floods
   b. Erosion
   c. Deposition (sedimentation, precipitation)
   d. Solution
      Compaction and settling
   f. Stability (slides, slumps)
   g. Stress-strain (earthquakes)
   h. Air movements

B. Biological conditions
   1. Plant life
      a. Trees
      b. Shrubs
      c. Gr ss
      d. Crops
      e. Microscopic plants
      f. Aquatic plants
      g. Endangered species
   2. Animals
      a. Birds
      b. Land animals, including reptiles
      c. Fish and shellfish
      d. Ocean bottom (benthic) organisms
      e. Insects
      f. Microscopic animals
      g. Endangered species
      h. Barriers to animal movement

C. Cultural factors
   1. Land use
      a. Wilderness
      b. Wetlands
      c. Forestry
      d. Grazing
      e. Agricultural
      f. Residental
      g. Commercial
      h. Industrial
      i. Mining and quarrying
   2. Recreation
      a. Hunting
      b. Fishing
      c. Boating
      d. Swimming
      e. Camping
      f. Picnicking
      g. Resorts

3. Aesthetics and human interest
    a. Scenic views and vistas
    b. Wilderness qualities
    c. Open-space qualities
    d. Landscape design
    e. Unique physical features
    f. Parks and reserves
    g. Monuments
    h. Rare and unique species or ecosystems
    i. Historic or archeological sites and objects
4. Cultural status
    a. Cultural patterns (lifestyle)
    b. Health and Safety
    c. Employment
    d. Population density
5. Manmade facilities, activities
    a. Structures
    b. Transportation network
    c. Utility networks
    d. Waste disposal
    e. Barriers
    f. Corridors

D. Ecology
1. Ecological relationships
    a. Salt water in water supply
    b. Excessive enrichment of aquatic systems (eutrophication)
    c. Food chains
    d. Others
2. Endangered species
    a. Plants
    b. Invertebrates
    b. Vertebrates

TRANSPARENCY 1

LOUISIANA COASTAL ZONE

ISSUES

1. Dredging and disposal of dredged materials
2. Harvesting aquatic resources
3. Tidal and nontidal wetlands
4. Shore erosion
5. Use of flood plains
6. Use of agricultural lands
7. Beach access
8. Onshore oil and natural gas facilities
9. Electric-generating facilities
10. Ports and Commercial shipping
11. Industrial parks
12. Residential development
13. Sewage-treatment facilities
14. Land transportation facilities
15. Forested lands
16. Mineral extraction
17. Recreational, open-space, and natural areas

TRANSPARENCY 2

LOUISIANA COASTAL ZONE

ISSUES

1. **Dredging nd disposal of dredged materials** - Dredging is necessary to keep ship channels open. The spoil (material removed for the channel) must be disposed of safely so as not to endanger shellfish beds or other resources. Containment sites have not been found for the spoil. Many sites are badly polluted from Terrebonne/Timbalier Bay and cannot meet the needs of the next 20 years.

2. **Harvesting aquatic resources** - Fish and shellfish from the Terrebonne/Timbalier Bay are a major part of Louisiana's recreational and commercial life. Overfishing, agricultural runoff, sewage, stormwater discharge, and industrial discharge all threaten these living resources.

3. **Tidal and nontidal wetlands** - Wetlands play a key role in Louisiana's estuarine environment. They provide basic nutrients in the food chain and habitat for many fish and wildlife species, as well as help protect water quality, give flood protection, and help control shore erosion. Tidal wetlands are protected to a degree, but there is still considerable pressure to alter (fill or develop) wetlands. Freshwater (nontidal) wetlands provide valuable wildlife habitat and food, particularly to waterfowl and fur-bearers. These communities serve as buffers for storm water, aquifer recharge areas, and filters for sediment and pollutants. Agricultural drainage, urban development, and many other activities threaten nontidal wetlands.

4. **Shore erosion** - Erosion of over four linear feet per year threatens about 140 miles of Louisiana's shoreline. Altering currents with structures along the shore can increase erosion, damage oyster beds, and cause sediment to fill creeks. Storms can cause much greater erosion damage than normal weather conditions to these developed shorelines.

5. **Use of flood plains** - Building in flood plains risks a great loss of life and property in times of storms, as well as causing changes to biological resources found in those areas. Development of flood plains can increase the extent and frequency of flooding problems. Such development is increasingly restricted.

6. **Use of agricultural lands** - Agricultural runoff is an important source of nonpoint pollution in portions of the bay and its tributaries.

7. **Beach access** - Most Louisiana beaches are along the gulf coastline. Transportation routes must be available to give access to these beaches without damaging natural resources such as wetlands and without damaging

existing developments.

8. **Onshore oil and natural gas facilities** - These facilities include fabrication yards, service bases, pipeline facilities, terminals, refineries, gas treatment plants, and marine terminals.

9. **Electric-generating facilities** - "Acid rain," nuclear power, localized effects of power plant operation, conservation programs, and the cost of electricity are ma_ considerations in meeting Louisiana's growing energy demands.

10. **Ports and Commercial shipping** - Louisiana has more waterways than any other state. It has over 40 ports ranging from small oil industry service ports to this nation's largest shipping port, Port of New Orleans. Ports serve as the staging point between land and water transportation. These shore-based installations enable goods to be ransferred to and from ships and likewise from the producer to the consumer. Ports providing services to the shipping industry include, but not limited to: piloting and towing assistance, maintaining channels and navigation markers, reprovisioning with foodstuffs and supplies, and off and onloading. Small ports located throughout the state act as feeder ports for the larger shipping ports. In order for ports to be competitive, they must maintain their channels, have well kept rail service, highways, and/or barge routes. Ports, unlike many other industries, must be located on waterways and in the Coastal Zone if they are to be successful. Louisiana Ports are located in New Orleans, Baton Rouge, Morgan City, Houma, Lake Charles, New Iberia, and Fourchon. Besides shipping, these ports are also used by the offshore oil and gas industry and the growing seafood industry.

11. **Industrial parks** - Industrial parks average over 300 acres and provide facilities for several types of industries. These parks have a great economic importance to an area by providing jobs and taxes. Industrial parks also can have great environmental impact with certain kinds of activities and the surrounding areas.

12. **Residential development** - Louisiana shorelines are increasingly popular for large and small scale residential development. Negative impacts occur when the facilities' demands (such as sewage treatment plants, police, schools, fire) exceed the areas' capacity to pay for them. Sedimentation, nonpoint pollution, and loss of valuable habitat can occur with growth of a- size.

13. **Sewage-treatment facilities** - The impact of sewage facilities on shellfish can be severe when sewage harms the water quality (oxygen, nutrients, and residual chlorine, for example). Sewage-treatment plants also increase high-density development because more treatment capacity is available.

14. Land transportation facilities - In recent years beltways have helped move populations from cities to suburbs. Highways spur development and determine its nature. Problems associated with this phenomenon include the cost of construction and labor for clearing and stripping the land; the use of herbicides; and continued maintenance due to erosion and sedimentation.

15. Forested lands - Baldcypress and water tupelo are found in frequently inundated, poorly drained swamps while oaks, green ash, hackberry, sweetgum, black willow, and others collectively known as bottomland hardwoods are located on higher, better drained areas. Both forest types provide wildlife with food and habitat and significantly contribute to the estuarine food chain by producing detritus.

16. Mineral extraction - According to present estimates, an abundant supply of sand and gravel for general construction exists within Louisiana. Currently there are many sand and gravel companies. Waste fine material (from washing the extracted matter) is a major sedimentation problem for the rivers that feed the estuaries.

17. Recreational, open-space, and natural areas - recreation is defined as "to create anew, restore, refresh; refreshment of strength and spirits after work; a means of refreshment or diversion." To recreate in coastal areas whether by fishing, crabbing, hunting, boating, etc. has always been and will cntinue to be popular. Recreation fulfills a basic human need of closeness to the natural environment. As the population of Louisiana increases, more recreational facilities are needed. One type of facility needed is natural areas.

ENVIRONMENTAL IMPACT STATEMENT (EIS) GRID— GENERAL

		Proposed Actions Having An Impact										
		1 Modification of Ecosystem	2 Land Transformation And Construction	3 Resource Extraction	4 Land Use Activities	5 Land Alteration	6 Resource Renewal	7 Changes In Traffic	8 Waste Treatment And Disposal	9 Chemical Treatment	10 Accidents	11 Other
Policy	1											
	2											
	3											
	4											

ENVIRONMENTAL IMPACT STATEMENT (EIS) GRID— EXPANDED

		Proposed Actions having An Impact										
		1 Modification of Ecosystem	2 Land Transformation And Construction	3 Resource Extraction	4 Land Use Activities	5 Land Alteration	6 Resource Renewal	7 Changes In Traffic	8 Waste Treatment And Disposal	9 Chemical Treatment	10 Accidents	11 Other
	Check Off											
Existing Characteristics and Conditions	Earth A											
	Water B											
	Atmosphere C											
	Geological Activity D											
	Plant Life E											
	Animals F											
	Land Use G											
	Recreation H											
	Aesthetics and Human Interest											
	Cultural Status J											
	Man-Made Facilities and Activities K											
	Ecological Relationships L											
	Other M											

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