An Alternative to the "What I Did on Summer Vacation - What I Can Do on Summer Vacation."

OBJECTIVES

The student will do the following:

1. Explore environmentally friendly activities for summer vacation on the Gulf.

2. Create a travel guide for these activities.

SUBJECTS:
Science (Biology, Ecology), Language Arts

TIME:
1 class period for introduction
1 week for research
3 class periods to prepare brochure

MATERIALS:
research for coastal wetlands
travel brochures (for photographs) - available at travel agencies or Chambers of Commerce of coastal cities
paper
colored paper
scissors
glue
staples for actual booklets
student sheets

BACKGROUND INFORMATION

The Gulf of Mexico, America's shining sea, is in trouble. A natural vacation spot, it is in danger from entrepreneurs, tourists, and residents. Students should think about their personal responsibility in preserving the integrity of this area. Normal vacation activities might impact the environment. With some guidance, students can learn how to make the most of a coastal vacation. Amusement parks, miniature golf courses, go-cart courses, water slides are generally the same whether they are in Nashville, Tennessee, or Panama City, Florida. Students should be learning to appreciate their environment, to see the possibilities for entertainment that are indigenous to particular areas. By exploring the different vacation possibilities, students may begin to see an alternative to the generic, often unsatisfying vacation that so many American families take.

Many states and countries have found that "eco-tours" are big business. Money can be made by allowing the public access to naturally beautiful areas with minimal harm to the environment. A discussion of ways to improve the economy of an area without harming the environment could be interesting.

ADVANCE PREPARATION

A. Check with the biology/ecology teacher in your school for materials concerning the environmental problems of the Gulf. Also check the availability of resources in your school library. If materials are scarce, you might want to write to:

The Gulf of Mexico Program
Building 1200, Room 103
Stennis Space Center, MS 39529-6000

or call (601) 688-7940

This agency can send you pamphlets and other materials for resources for students. Student sheets of some of their materials are included.

PROCEDURE

I. Setting the stage

A. Have students write a paragraph about what they might like to do on a vacation to the Gulf.

B. Have some volunteers read their paragraphs aloud.

C. Discuss how some of these activities impact upon the coastal environment.

D. Explain that students are going to make a travel brochure listing environmentally friendly activities for a Gulf vacation.

E. Divide class into groups of four.

F. Have each group select a leader/spokesperson.

G. Hand out and allow time for groups to go over student sheets.

II. Activity

A. Groups should organize and assign duties for completing the brochure.

B. After one week of out-of-class research, students should plan to compile, edit, and publish their work in three days of class time. These brochures may be handmade or computer generated if you have that capability.

III. Follow-up

A. Students should complete their own evaluation sheets. (Included)

B. You should evaluate their work based on:

1. Information gathered (amount and accuracy).

2. Appropriateness of format.

3. Their own evaluation.

IV. Extensions

A. Have students copy their brochures and share with other classes.

B. Arrange for students to give oral presentations to elementary classes on environmentally responsible beach vacations.

RESOURCES

American Automobile Association (members may contact their local offices).

Chamber of Commerce or Tourist Bureaus.

Gulf of Mexico Program, Public Information Center, Building 1200, Room 103, Stennis Space Center, MS 39529-6000. Phone: (601) 688-7940

EVALUATION SHEET

1. What was your job on this project?

2. List three things you learned from this project.

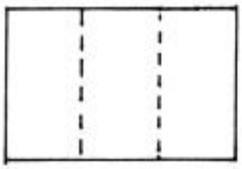
   a. _____

   b. _____

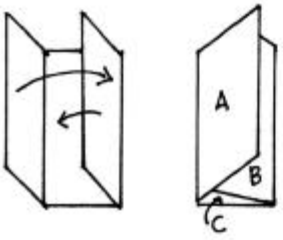
   c. _____

3. How will working on this project affect your life-long attitude toward vacationing at the Gulf? Vacationing anywhere?

INSTRUCTIONS FOR MAKING A TRI-FOLD BROCHURE:



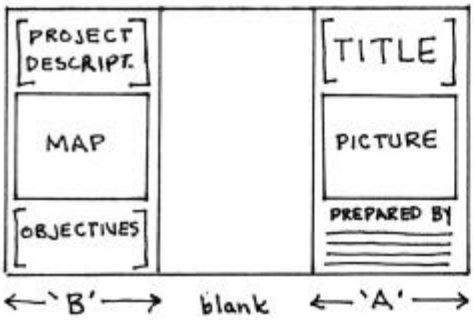
1. Lay your sheet of $8\frac{1}{2}$" x 11" paper out in a "landscape" orientation.
2. Mark off 3 sections, each $3\frac{5}{8}$" wide, with a light or dotted line.



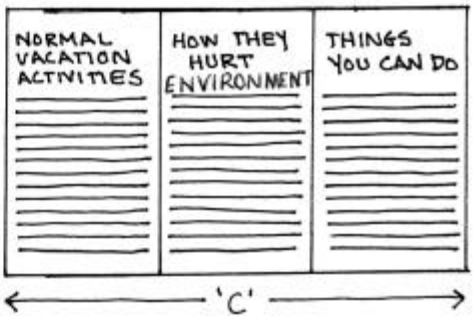
3. Fold the right side over the middle, creating 'page B', the right fold.
4. Fold the left side over, creating 'page A', the front cover.
5. The inside, 'C', is now divided into 3 columns.
6. Unfold the paper and lay it flat to add your headlines, text, and pictures.

USE THE FOLLOWING GUIDELINES FOR THE LAYOUT OF YOUR BROCHURE:

SIDE ONE



SIDE TWO



If using a Desktop Publisher on a computer, remember to select 'landscape' orientation, a 3-column layout, and use the same general guidelines for your brochure.

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UNDERSTANDING MARINE RESOURCES

9-12

OBJECTIVES

The student will do the following:

1. Define “resource.”

2. Determine the resources required for personal wants and needs.

3. Classify the resources as “renewable or nonrenewable.”

4. List and classify marine resources as renewable or nonrenewable.

SUBJECTS:
Social Studies (Economics),
Science (Environmental Science)

TIME:
1 class period

MATERIALS:
blank paper
pictures of resources from magazines

BACKGROUND INFORMATION

People have always instinctively recognized the importance of coastal areas. An investigation of the reminders (shells and bones) of any early coastal village will show how everyday life was connected to the ocean. Along with providing for the dietary needs of the village, the sea provided the raw materials needed for shelter, transportation, economic exchange and social needs. Can you guess how? Today, people still like to live near the coast. It is no coincidence that many of the great cities in the world are located near, or have access via a river, to an ocean. Of the approximately 267 million people living in the U.S. (in 1997), over half of them live in coastal counties.

Animals and plants are a major marine resource. Fish and shellfish, high in protein and other essential vitamins while containing no saturated fats, provide 60% of the world's population with more than 40% of their animal protein. Over 1 billion people receive their entire annual protein supply from the sea. In the U.S., we use five times as much seafood for "fishmeal" in food for poultry and land animals than for human consumption. Marine plants provide less than 1% of our food (compared to 80% from land plants). Some current uses for marine plants include being used in bakery and dairy products, meats, soft drinks, and industrial applications such as tire manufacturing (due to the colloidal and gelling compounds common in seaweed). In the future, marine plants may be a possible food source to feed an ever increasing world population. The ocean contains vast amounts of energy and mineral resources. Besides providing large amounts of oil and gas, new technology is being developed to harness energy generated by the ocean

through tidal, wind, wave, and thermal power. Another resource provided by the ocean is transportation. Tankers and freighters efficiently ship commodities to ports and harbors throughout the world. The wetlands in the coastal areas are a tremendous resource. Coastal wetlands provide the habitat for fish, shellfish, waterfowl, and mammals. Coastal estuaries and marshes are among the most productive areas in the world providing organic matter for the base of the food chain and the spawning grounds for fisheries. Marine recreation is on the rise. People crowd to beaches and costal areas to enjoy fishing, boating, swimming, scuba diving, shell collecting...the list continues. Today, like our ancestors before us, we are rediscovering that the aesthetic joy of the sea can nourish our physical and spiritual well being. Each time resources of the ocean are misused, we jeopardize this enormous, much undiscovered, realm. As inhabitants of Earth, we should always be aware that the future of our planet is intricately bound to the health of our oceans.

Terms

aesthetic: of or relating to the sense of the beautiful; artistic quality or appearance

hydrologic cycle: the cyclical process of water's movement from the atmosphere, its inflow and temporary storage on and in land, and its outflow to the oceans; cycle of water from the atmosphere, by condensation and precipitation, then its return to the atmosphere by evaporation and transpiration.

nonrenewable resource: a resource in a fixed amount; all minerals, coal, crude oil, and natural gas

renewable resource: a resource that can be grown or replenished in some manner from year to year; plants and some animals

resource: natural assets: air, water, soil, oil, gas, coal, trees, minerals, land, wildlife, people; the materials needed for the satisfaction of wants and needs

wants and needs: those things people desire for sustenance and quality of life

ADVANCE PREPARATION

A. Review Background Information and terms. Discuss resources in general.

B. Have each student bring in one picture of a renewable resource and one of a non- renewable resource.

C. Have students also bring in pictures showing use of the ocean as a resource.

PROCEDURE

I. Setting the stage

Have students make a chart with three columns:

NEEDS & WANTS; RESOURCE NEEDED; NONRENEWABLE OR RENEWABLE RESOURCE.

II. Activity

Determine which resources are needed to supply a student's wants and needs, using brainstorming and pictures on display.

A. Students will list their own wants and needs in the first column.

B. Students will list the resources needed to supply these wants and needs in the second column.

C. In the third column, students will indicate whether the resource needed to supply their wants and needs is renewable or nonrenewable (R or N).

III. Follow-up

Answer these questions after the charts are completed.

A. Do you need more renewable or nonrenewable resources to supply your wants and needs?

B. Will you use more or less renewable and/or nonrenewable resources in the future?

C. What resources did you list that either come from a marine environment or could come from one?

D. Make a list of any resource that you have used or might use that comes from the sea. (Review the Background Information)

E. Can you think of some renewable resources from the sea that are not being fully utilized? List these and explain how they could be used.

IV. Extensions

A. Make another chart (marine resources used; renewable or nonrenewable resource) putting marine resources in column one and identifying them as renewable or nonrenewable in column two.

B. Answer these questions about marine resources.

1. Does everyone use the same marine resources?

2. Will more marine resources be used in the future?

3. Which nonrenewable marine resources would you miss the most?

RESOURCES

Arms, Karen, Environmental Science, Holt, Rinehart, and Winston, Inc., Austin, TX, 1996.

Chiras, Daniel D., Environmental Science, High School Edition, Addison-Wesley, Menlo Park, CA, 1989.

Nebel, Bernard J. and Richard T. Wright, Environmental Science: The Way The World Works, 4th Edition, Prentice-Hall, Englewood Cliffs, NJ, 1993.

RIVER INPUT INTO THE GULF OF MEXICO

9-12

OBJECTIVES

The student will do the following:

1. Trace the path of one river that drains into the Gulf of Mexico.

2. Research the major sources of pollution in each major city along the chosen river.

3. Research possible agricultural pollution.

4. Describe how a long river carries pollution all the way down its path to the Gulf of Mexico.

SUBJECTS:
Science (Biology), Social Studies (Geography), Language Arts

TIME:
3 class periods and research time

MATERIALS:
atlas

BACKGROUND INFORMATION

There are 44 major rivers that empty into the Gulf. The freshwater flowing into the salty waters of the Gulf lowers the salinity in parts of the Gulf making possible the rich estuarine life. However, the rivers not only bring freshwater into the Gulf; but they also bring sediment, nutrients, pollutants, contaminants, and debris along with the freshwater. The Mississippi River is by far the largest source of freshwater flowing into the Gulf. Annual freshwater input from the Mississippi averages 724 billion cubic feet.

Estuaries are usually shallow bodies of water, where freshwater from rivers empties into and mixes with ocean saltwater. Highly productive areas, estuaries provide nourishment and suitable habitat to many forms of marine life. Over 95% of the commercial fisheries depend on estuaries at some point in their harvesting cycle. Estuaries are the nursery grounds for many marine fish, shellfish, invertebrates, and mammals. During storm events, estuaries and coastal marshes act as flood buffers to absorb the excess energy and water flow. Along with supplying living and non-living resources and meeting transportation and recreation needs, estuaries and their rivers have long been used for disposing of effluent from sewage treatment plants. This is due to the natural capacity of estuaries and rivers to assimilate and treat waste. But there are limits.

Improper waster disposal exceeding an estuary's assimilative capacity will most often negatively affect marine resources.

Channelization of rivers and waterways threatens estuaries by diminishing the natural buffering capacity of meandering, vegetative rivers resulting in extreme fluctuations of water flow into the estuaries. During storm events, channelization rapidly moves, large amounts of freshwater into the bay causing a salinity decrease that may be detrimental to the shellfish and aquatic plants. Though marine plants and organisms inhabiting an estuary are naturally capable of adapting to fluctuations in salinity, channelization can result in extreme salinity variations that will stress even the most tolerant of marine organisms.

Nonpoint source pollution (runoff from: urban development, highways, septic systems, agricultural areas, and marinas) increases with increased population along waterways leading to the Gulf (see extension). As the population along coastal waterways increases, more homes, roads, parking lots, and buildings will need to be constructed to serve the population needs. During rain events, contaminants (nutrients, oil, grease, metals, bacteria, and sediment) will be washed into the estuary. Excess sediment lowers the penetration of light in the water column. Phytoplankton (drifting plants-usually microscopic) depend on light; therefore, the primary productivity of phytoplankton can be decreased because of excess sediment from construction and farming. Phytoplankton are the bases of the estuary/Gulf food web. But too much nutrients is not a good thing. An excess of nutrients through industrial discharges, faulty septic tanks, lawn fertilizers, and poor agricultural practices can cause a phytoplankton "bloom" (an increase in phytoplankton numbers and biomass) that can lead to "red tides" and "hypoxic areas" (oxygen deficient areas due to decomposition in the Gulf).

Freshwater inflow is not constant and is not evenly distributed throughout the Gulf of Mexico. River discharges peak during late spring but can be altered by unusual weather conditions. Rivers connect the Gulf of Mexico with the interior part of the United States. Many interior cities are vitally linked to the Gulf through transportation of tons of raw and manufactured materials such as wheat and oil.

Some rivers with drainage area over 1000 square miles:

Texas=Rio Grande, Nueces, San Antonio, Guadalupe, Colorado, Brazos, Trinity, Neches, Sabine (TX-LA);

Louisiana=Calcasieu, Atchafalaya, Mississippi, Bogue Chitto, Pearl (LA-MS);

Mississippi=Pascagoula;

Alabama=Tombigbee, Alabama, Mobile;

Florida=Escambia, Choctawhatchee, Apalachicola, Ochlockonee, Suwannee, Withlacoochee,

Peace.

Terms

"bloom" (algal bloom): a sudden excessive growth of algae that can affect water quality adversely; large floating masses of algae; characteristic of a eutrophic lake

channelization: the straightening and sometimes deepening of stream or river channels to speed water flow and reduce flooding. A waterway so treated is said to be channelized. However, channelization can cause unstable situations and may cause adverse environmental impacts.

contaminant: an impurity that causes air, soil, or water to be harmful to human health or the environment; something that makes a substance impure, infected, corrupted, or polluted

delta: a deposit of sand and soil, usually triangular, formed at the mouth of some rivers

discharge: (1) the outflow of groundwater from a flowing artesian well, ditch, or spring; (2) the release or emittance of a substance

estuarine: formed or deposited in an estuary**;** of or having the characteristics of an estuary

estuary: a marine ecosystem where freshwater enters the ocean. The terms usually describes regions near the mouth of rivers, and includes bays, lagoons, sounds, and marshes.

eutrophic lake: a lake containing a high concentration of dissolved nutrients; often shallow, with periods of oxygen deficiency

hypoxic: containing very little or decreased oxygen

nonpoint source pollution (NPS): pollution that cannot be traced to a single point (e.g., outlet or pipe) because it comes from many individual sources or a widespread area (typically, urban, rural, and agricultural runoff)

nutrients: compounds, minerals, or elements needed by living organisms to carry on their functions. Nitrogen, phosphorus, potassium, and other elements are examples of nutrients required for plant growth.

phytoplankton: any of the many species of plants (such as algae) that consist of single cells or small groups of cells that live and grow freely suspended in the water near the surface

point source pollution: pollution that can be traced to a single point source such as a pipe or culvert (e.g., industrial, wastewater treatment plant, and certain storm water discharges)

pollutant (water): any substance suspended or dissolved in water that builds up in sufficient quantity to impair water quality

primary productivity (producers): in an ecosystem, those organisms, mostly green plants, that use light energy to construct their organic constituents from inorganic compounds

red tide: a reddish discoloration of coastal surface waters due to concentrations of certain toxin-producing dinoflagellates. Can cause pulmonary irritations in man and can cause death of marine mammals.

salinity: the amount of salt dissolved in water

sediment: eroded soil material, containing primarily inorganic constituents

ADVANCE PREPARATION

A. Discuss Background Information.

B. Put terms on the board and define.

C. Divide students into work groups of 4, 5, or 6.

D. Check your library for encyclopedias or other books that will have information about the rivers that flow into the Gulf of Mexico.

PROCEDURE

I. Setting the stage

A. Have student groups pick one river that flows into the Gulf of Mexico. Make sure each group picks a different river.

B. Have groups write down the major cities (and states) along the river.

C. Have each student in the group pick a major city along the river. One student in each group should research agricultural practices along the river.

D. Explain that students are supposed to research the industries of their cities to see what possible pollution might be added to the river. They may also want to note other interesting facts about their city or farm practices in the surrounding area.

II. Activity

A. Allow time for students to research their cities.

B. The students need to research what kinds of pollution result from their city's industries or from surrounding agricultural practices. Students should also consider the nonpoint source pollution from their cities.

C. Have members of the group compile their information about industries, agriculture, and nonpoint source pollution.

D. Groups should prepare a report on their river and present to the class. They may be creative with their presentations (such as tell something about the history of the river). They should also have a list of possible pollutants their river may be carrying to the Gulf and the sources of these pollutants.

III. Follow-up

Ask students to answer the following questions after all groups have presented their reports.

A. What are the major pollutants that are transported by rivers into the Gulf?

B. What effects do these pollutants have on the Gulf?

C. Would you feel comfortable eating seafood from the area of the Gulf into which your river drains?

D. Do you think that any of the pollutants your river carried were reduced in toxicity as they traveled down the river?

E. Are all pollutants harmful to the Gulf and the estuaries around it?

F. What could be done to reduce the harmful pollutants that go into the Gulf?

G. Why do you or do you not think estuaries should be protected?

IV. Extensions

A. Discuss “blooms” (algal blooms) and red tides and the problems they cause. Relate this to the river pollution reports.

B. Look into the concept of channelization, the way this occurs, and the problems it causes.

C. What effect do floods have on pollution of these rivers?

RESOURCES

Arms, Karen, Environmental Science, Holt, Rinehart, and Winston, Inc., Austin, TX, 1996.

Chiras, Daniel D., Environmental Science, High School Edition, Addison-Wesley, Menlo Park, CA, 1989.

WETLANDS, USA - MORE THAN SWAMPS!

9-12

OBJECTIVES

The student will do the following:

1. Define wetlands.
2. Construct a wetlands model.
3. Explain the importance of wetlands as ecosystems.
4. Defend the need to preserve wetlands.

SUBJECTS:
Science (Biology, Ecology), Social Studies (Geography), Language Arts
Extensions for: Science, Math, Social Studies, English, Art, Journalism, Business, Music

TIME:
1-2 class periods
plus extension or homework

MATERIALS:
copies of student sheets
for model:
pan
modeling clay
piece of indoor-outdoor carpet
jar of muddy water

BACKGROUND INFORMATION

Wetlands are a prime natural resource and include such areas as swamps, bogs, prairie potholes, cypress domes, riverine bottomlands, coastal marshes and tundral wetlands. Many wetlands are transitional areas located between dry lands and deeper aquatic systems like rivers and lakes. Wetlands are located in various parts of the U.S. All of these damp areas have tremendous importance in terms of productivity. Wetlands provide feeding, spawning, and nursery grounds for finfish and shellfish. They provide habitat for about half of all endangered species of plants and animals. Wetlands lessen global warming by locking up huge amounts of carbon in peat rather than

allowing CO_2 to be released in the atmosphere. They also clean the water by absorbing and filtering pollutants and stabilizing shore lines, and they provide a buffer against floodwaters and storm tides. They may serve as "holding" tanks to recharge wells and aquifers.

Some wetlands develop in low-lying areas where water drains and collects. Others border salt or fresh bodies of water, such as oceans, rivers, or ponds, while still others are isolated in forests and urban areas. As transitional zones between upland and aquatic systems, wetlands often support both terrestrial and aquatic species, contributing to the local and regional diversity of plants and animals.

Two hundred years ago, the United States had 220 million acres of wetlands. Now we have less than 100 million acres. As of 1996, the loss was around 300,000 acres each year. Half of the Florida Everglades is gone; half of Connecticut's coastal wetlands and 2/3 of the prairie potholes are gone. California has only 9% of its wetlands remaining, Iowa 11%, and Indiana and Missouri 13%. Students must learn about wetlands so they can be involved in legislative efforts to halt their loss. Any legislation that weakens the definition and regulation of wetlands will probably cause greater loss.

Terms

bog: freshwater marsh with build-up of peat and high acidity that typically supports mosses adapted to acidic soil conditions (particularly, sphagnum); many are located in colder regions

bottomlands: lowlands along streams and rivers that are typically flooded

cypress domes: small, depressional swamps, typically with tall cypress trees at center, characterized by subsurface hardpan overlain by organic matter

estuary: a marine ecosystem where freshwater enters the ocean. The term usually describes regions near the mouths of rivers, and includes bays, lagoons, sounds, and marshes.

forested wetland: wetland dominated by trees. "Trees" (for the purpose of this definition) are defined as woody vegetation with diameter greater than 3 inches at breast height (approx. 4 feet from ground level).

freshwater marsh: a wetland frequently or continually inundated by freshwater, characterized by emergent herbaceous vegetation

mangrove swamps: tropical, wet, coastal areas dominated by mangroves (trees). Mangroves have extensive root systems which form a dense thicket, providing cover for aquatic life.

prairie potholes: shallow, marsh-like ponds which serve as primary breeding grounds for ducks and

migratory birds found in North Dakota, South Dakota, Minnesota, and Canada

runoff: water (originating as precipitation) tat flows across surfaces rather than soaking in; eventually enters a waterbody; may pick up and carry a variety of pollutants

salt marsh: estuarine habitat submerged at high tide, but protected from direct wave action, and overgrown by salt-tolerant herbaceous vegetation; aquatic grasslands (coastal "prairies") affected by changing tides, temperatures, and salinity

swamp: wetland dominated by shrubs and trees

turbidity: the cloudy or muddy appearance of a naturally clear liquid caused by the suspension of particulate matter

ADVANCE PREPARATION

A. Copy Student Sheets.

B. Have terms and definitions on the board.

C. The teacher may want to show a video of wetlands. Some suggestions are listed below.

The Realm of the Alligator (Okefenokee Swamp)
Creatures of the Mangrove
Life on the Edge
There is a Place

PROCEDURE

I. Setting the stage

A. Discuss terms.

B. Allow students time to read the two student sheets. Discuss the student sheets and Background Information. Ask students how controlling pollution in a watershed helps protect wetlands.

C. Have students describe and discuss conditions of wetlands within their areas (state, county) or other wetland areas with which they may be familiar.

D. To demonstrate how wetlands slow water movement and trap pollutants and sediment, do the following:

1. Using a metal pan or plastic container, spread a layer of modeling clay in the bottom forming a hill in one end. This section will represent the land. Leave the other end of the pan empty to represent a lake or ocean. Make a slope on one side with the modeling clay.

2. Place a piece of indoor-outdoor carpeting to fill the space across the pan along the edge of the clay. The carpeting represents the wetland buffer between dry land and open water. Set the model aside.

3. After reviewing what wetlands are, explain the characteristics of the wetland life, the variety of habitats, and the complexities within.

4. Demonstrate the wetland model by pouring water slowly in the pan on the higher side of the clay. Let students observe where water has settled and where it has been trapped in the piece of carpeting. The water that is slowed in the carpeting represents different functions of the wetland.

5. Apply the slow-moving water notion to the different functions performed by the wetland.

6. Lead a classroom discussion on why wetlands are essential and important in the natural settings and environment.

II. Activity

Have students:

A. Construct an exhibit for the school library that includes maps of local wetlands and explanation of differentiating characteristics.

B. Construct a poster/collage with the following theme: The Importance of Wetlands. Include newspaper/magazine articles and at least 10 illustrations.

C. Write a five-paragraph essay on the importance and the need to preserve wetlands. Additional information from your school/city library may be helpful. Consult English text for correct format.

D. Prepare a lesson on wetlands that you could present to a middle school science club

or class. Include visuals.

III. Follow-up

Play a game with the terms. Write definitions for each word on separate 3x5 cards and do the same with the terms. Give each student one definition and one term. Start game by one person reading his/her definition. The person in the room who has the matching term must say it and then read his/her definition. The game continues until all definitions have been read and identified.

IV. Extensions

A. Science: Make posters illustrating the different kinds of wetlands.

Marshes (palustrine)
Swamps and Floodplain forests (palustrine)
Bogs (palustrine)
Rivers and Streams (riverine)
Lakes and Ponds (lacustrine)
Coastal Wetlands (marine)
Tidal Marshes (marine)
Tundral Wetlands
or
visit and study a local wetland. Identify birds and wildflowers that live there.

B. Math: Find out how much wetland area your state loses per year. (Contact EPA or Geological Survey). Figure how long it will be until your state (if it continues at its present rate) has no wetlands left.

C. History: Choose one diminished wetland area in your state. Research its demise and prepare an "obituary."

D. English: Create a scenario where "progress" demands that a wetland be drained. Students should write persuasive essays (pro or con) about the situation. Give them enough information so that they can internalize and generate a viewpoint.

E. Art: Create a mural (all students can contribute) to celebrate the beauty and diversity of a wetlands area. The mural can be created on heavy white paper and displayed in a common area in your school.

F. Journalism: Publish a "Wetlands Watch" pamphlet with articles, pictures, and interviews about wetlands' problems.

G. Business: Create a scenario where business people must choose between gross profits and the integrity of vital wetlands. Have your students write a thesis statement. Make sure the scenario has balance.

H. Music: Have your students do some creative song writing celebrating the beauty of or mourning the loss of America's wetlands. Recordings of these songs can be played near the mural (art) and the poster display.

RESOURCES

"Consequences of Wetland Loss and Degradation," United States Environmental Protection Agency, March, 1993.

"Economic Benefits of Wetlands," United States Environmental Protection Agency, March, 1993.

EPA Wetlands Hotline - 1-800-832-7828

"More Facts About Wetlands," United States Environmental Protection Agency, March, 1993.

"Values and Functions of Wetlands," United States Environmental Protection Agency, March, 1993.

FUNCTIONS OF WETLANDS

1. Wetlands provide habitats for fish, wildlife and plants. They are critical to the survival of a wide variety of organisms. They also provide food, water, or cover for many species.

2. Wetlands provide critical habitats for endangered species. A number of rare and threatened species depend on wetlands for their survival.

3. Wetlands provide flood control and protection. Some wetlands store flood waters or water that collects in isolated depressions. Wetland plants can help to slow the speed of flood waters to protect nearby properties.

4. Wetlands improve water quality serving as excellent water filters to remove nutrients, wastes, and sediment from runoff water before they reach an open body of water. These nutrients, wastes and sediment may cause algae blooms or decrease the volume of a lake, pond, or river.

5. Wetlands provide shoreline erosion control. Those located between rivers and high ground to help to buffer shorelines against erosion. Wetland plants strengthen the sediment by binding soil with their roots. They also dampen wave action.

6. Wetlands reduce storm damage by serving as buffers between the winds and waves of storms and the coastal areas. Property located behind wetlands along shorelines and large lakes often fares much better during storms than unprotected areas.

7. Wetlands facilitate groundwater recharge. As the water moves slowly through or sits in the wetlands, some will seep down into aquifers below.

8. Wetlands provide a variety of natural products. These range from fish, shellfish, and wildlife to timber, berries, and wild rice.

9. Wetlands provide areas for recreation, rest, and enjoyment. Hunting, boating, and fishing are allowed in many wetland areas. Artists and photographers enjoy capturing the beauty of wetlands in their crafts. Tourists and visitors often find peace and appreciation for these natural areas.

10. Wetlands facilitate education and research. Although much is known about the functions of wetlands, researchers are still studying these environments and the species that thrive there in an attempt to discover more fully the benefits that they bring to humans.

WETLANDS

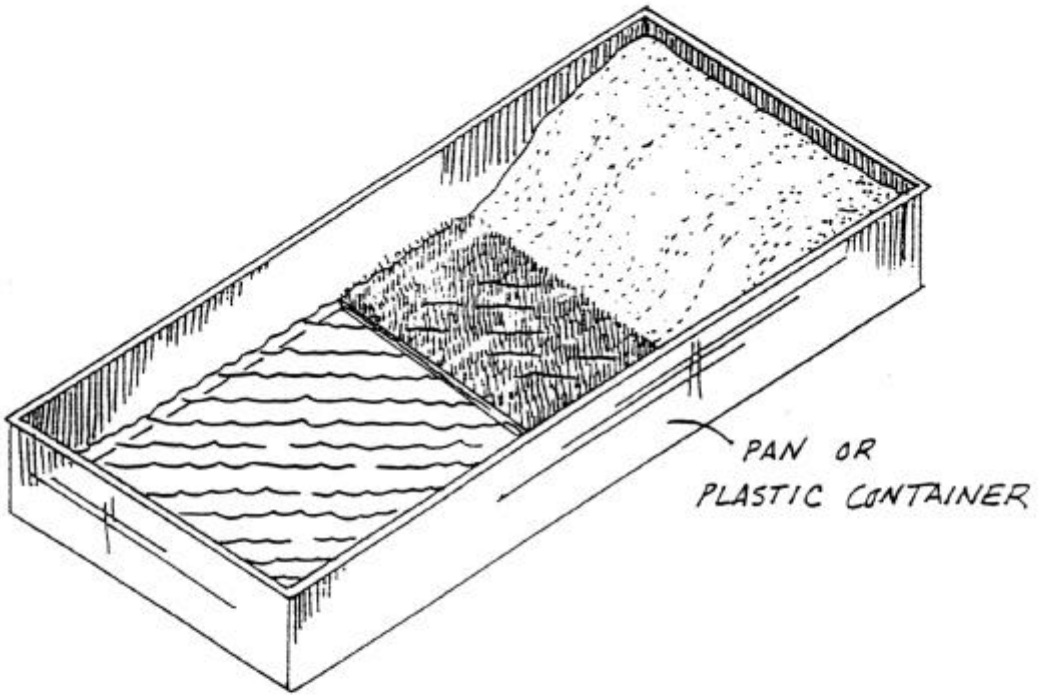
Wetlands are a prime natural resource consisting of swamps, bogs, prairie potholes, cypress domes, river bottomlands, coastal marshes and tundral wetlands (see illustrations). They are often transitional areas located between dry lands and deeper aquatic systems. Wetlands are located in various parts of the United States (see map). All of these damp areas have tremendous importance in terms of productivity and water quality.

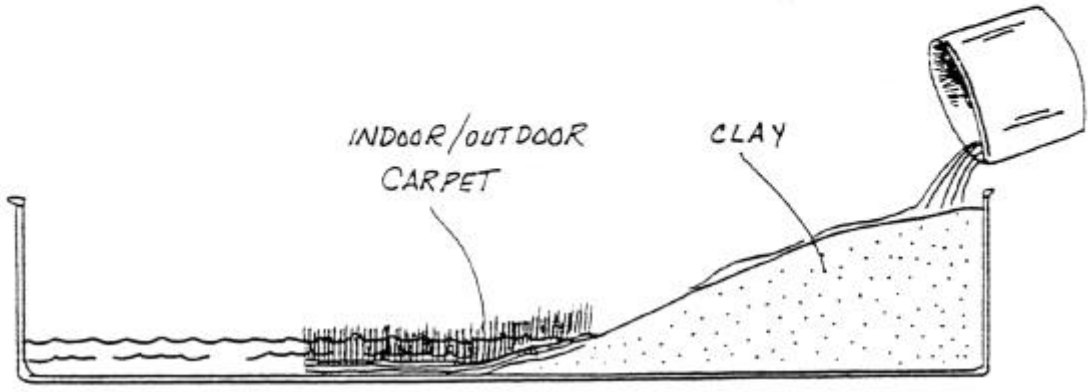
Some wetlands develop in low-lying areas in the landscape where water drains and collects. Others border salt or fresh bodies of water, while still others are isolated in forests and urban areas. As transitional zones between upland and aquatic systems, wetlands often support both terrestrial and aquatic species.

Wetlands have the ability to filter runoff water as it flows back toward sources of surface water. They can serve to remove natural and man-made pollutants from the water cycle. However, they cannot remove them all. As more and more pollutants are added to the environment by the activities of people, the wetlands are less and less effective in purifying water.

Two hundred years ago, the United States had 220 million acres of wetlands. Now we have less than 100 million acres. The loss is around 300,000 acres each year. Half of the Florida Everglades is gone, as are half of Connecticut's coastal wetlands and 2/3 of the prairie potholes. California has only 9% of its wetlands remaining, Iowa 11%, and Indiana and Missouri 13%. Any legislation that weakens the definition and regulation of wetlands will probably cause greater loss.

WETLANDS MODEL





WETLANDS IN THE UNITED STATES

MARSH

BOG

LAKE / POND

SWAMP

RIVER / STREAM

COASTAL

9-12

KNOW YOUR GULF

OBJECTIVES

The student will do the following:

1. Define terms that will help in the study of subjects pertaining to the Gulf of Mexico.

2. Create a polyhedron with the words.

SUBJECTS:
Science (Biology), Math

TIME:
1-2 class periods

MATERIALS:
terms
dictionaries
poster board or heavy construction paper
white paper
scissors
glue sticks
colored pencils
felt tip markers
string or ribbon
student sheets

BACKGROUND INFORMATION

The Gulf of Mexico is one of the United States' greatest resources. Its ecosystems and habitats support a wide diversity of plant and animal life. Nearly 40 percent of total U.S. fishing comes from Gulf fisheries. The Gulf also supports industries like shipping, and oil and natural gas drilling. However, this rich natural resource is in trouble due to pollution of its water. Some of this pollution is caused by the industries, but it is also caused by runoff from the land. Coastal areas are becoming very crowded with people who bring with them an increase in pollution. There are many terms associated with the Gulf area. This activity allows students to become familiar with some of these terms.

Terms

See Student Sheet.

ADVANCE PREPARATION

A. Copy the Word List on the Student Sheet.

B. Collect a classroom set of dictionaries.

C. Copy the teacher sheet with the circle pattern and cut 20-4" paper circles for each student. (The students can cut these, but advance preparation will save time. Also, the teacher should make

one polyhedron ahead of time to show the class.)

D. Assemble circles, markers, glue sticks, colored pencils, string, or ribbon.

PROCEDURE

I. Setting the stage

Introduce your unit on the Gulf of Mexico by sharing the Background Information with your students. Emphasize to them that an understanding of the vocabulary is essential to their discussion of the Gulf.

II. Activity

A. Using the dictionaries, students should define the terms on the student sheet.

B. Give each student 20 circles or have them cut out the circles themselves.

C. Students should fold edges of each circle to make an equilateral triangle.

D. On the side to which the edges have been folded, students should write one vocabulary word and color or decorate it however they choose. Continue until all 20 are completed.

E. The 20 circle/triangles should then be glued together (folded edges out) in this way - 5 on top (paint on top); 5 on bottom (paint on bottom); 10 in middle.
HINT - Glue top together, then bottom, then middle and attach the three sections to each other. This will form the polyhedron. Attach string or ribbon to polyhedron.

III. Follow-up

A. The polyhedrons may be displayed throughout the room.

B. Tear apart one of the polyhedrons or just put terms on 20 circles. Distribute one term to each student and have each one do some research on how this term applies to the Gulf of Mexico. Have students report to the class on their terms. If the term is a structure in the Gulf, they should be able to locate it or areas in which it is found on a map.

IV. Extensions

A. Discuss problems in the Gulf of Mexico.

B. Have students write brief reports using the 20 terms on the Gulf and what they think could be done about some of the pollution problems.

RESOURCES

Gulf of Mexico Program, Public Information Center, Building 1200, Room 103, Stennis Space Center, MS 39529-6000. Phone: (601) 688-7940

Webor, Michael, Richard T. Townsend, and Rose Bierce, Environmental Quality in Gulf of Mexico: a Citizen's Guide, 2nd Ed., Washington, D.C., Center for Marine Conservation, June 1992.

WORD LIST

1. anhydrite
2. barrier reef
3. bathymetry
4. brackish
5. continental shelf
6. coral reefs
7. dolomite
8. eddy
9. escarpment
10. estuary
11. fecal coliform bacteria
12. geology
13. gulf
14. gulf stream
15. lagoon
16. limestone
17. loop current
18. oceanography
19. reef
20. salinity
21. sediment
22. watershed
23. osprey
24. mullet (fish)
25. great blue heron (bird)
26. lesser scamp (salt marsh duck)
27. cordgrass (spartina)
28. salt-marsh aster (plant)
29. tern (bird)
30. brown pelican (bird)
31. nutria (mammals)
32. salt-marsh pinks (plant)
33. monarch butterfly (insect)
34. menhaden (fish)
35. red-breasted merganser (bird)
36. pinfish (fish)
37. redfish (fish-red drum)
38. oyster (mollusk)
39. shrimp (crustacean)
40. flounder (fish)
41. barnacles (crustacean)
42. blue crab (crustacean)
43. hermit crab (crustacean)
44. marsh periwinkle (mollusk)
45. dragonfly (insect)

1. **anhydrite:** a white to grayish or reddish mineral of anhydrous (free from water) calcium sulfate ($CaSO_4$), occurring as layers in gypsum deposits

2. **barrier reef:** a rock or coral reef, aligned roughly parallel to a shore and separated from it by a lagoon

3. **bathymetry:** the measurement of the depth of the ocean

4. **brackish water:** water that is a mixture of fresh and salt water

5. **continental shelf:** a shallow, submarine plain of varying width forming a border to a continent and typically ending in a steep slope to the oceanic abyss

6. **coral reef:** erosion-resistant marine ridge or mound built slowly over thousands of years by coral polyps (tiny animals) bound together with algal material and biochemically deposited carbonates

7. **dolomite:** a mineral [$CaMg(CO_3)_2$] consisting of a calcium magnesium carbonate found in crystals and in extensive beds as a compact rock

8. **eddy:** a current (of water or air) running contrary to the main current

9. **escarpment:** a long cliff or steep slope separating two comparatively level or more gently sloping surfaces

10. **estuary:** a marine ecosystem where freshwater enters the ocean. The term usually describes regions near the mouths of rivers, and includes bays, lagoons, sounds, and marshes.

11. **fecal coliform bacteria:** a type of coliform bacteria found in the intestines of warm-blooded animals that aids in the digestion process and is used as an indicator of fecal contamination and/or possible presence of pathogens

12. **geology:** a science that deals with the structure and history of the Earth and its life, especially as recorded in rocks

13. **gulf:** a large area of a sea or ocean partially enclosed by land

14. **gulf stream:** the oceanic current that brings warm Gulf of Mexico water up along the east coast of the U.S. and across the Atlantic to the British Isles

15. **lagoon:** a shallow body of water, especially one separated from the sea by sandbars or coral reefs

16. **limestone:** a rock that formed chiefly by accumulation of organic remains; consists mainly of calcium carbonate

17. **loop current:** oceanic current that enters the Gulf of Mexico through the Yucatan Channel and/or exits through the Straits of Florida (Parent of the Gulf Stream)

18. **oceanography:** a science that deals with the oceans and includes the delineation of their extent and depth, the physics and chemistry of their waters, marine biology, and the exploration of their natural resources

19. **reef:** a strip or ridge of rocks, sand, or coral that rises to or is near the surface of a body of water

20. **salinity:** the amount of salt dissolved in water

21. **sediment:** eroded soil material, containing primarily inorganic constituents

22. **watershed:** land area from which water drains to a particular surface waterbody

23-45. Some organisms from coastal areas. Students could look these up to find out what they look like; type of organism, life cycle, etc.

Instructions for Polyhedron

Use lightweight poster board or heavy construction paper.

1. Cut 20 circles per student.

2. Fold each circle into an equilateral triangle.

3. Glue the edges of triangles (with edges out);

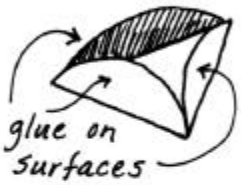
   5 with points up - for top
   5 with points down - for bottom
   10 alternating point up, point down - for middle

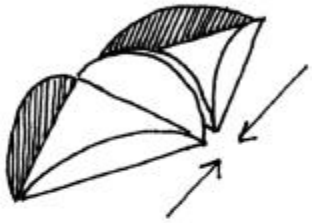
4. Glue top to middle; then middle to bottom.

5. Staple string or ribbon for hanger.

INSTRUCTIONS FOR MAKING A POLYHEDRAL "BALL"

1. Copy and cut out 20 circles using the pattern below.
2. Fold the three sections of the circle up along the dotted lines.
3. Flatten, and have the students write one vocabulary word on the opposite side, keeping the word within the triangle.
4. Refold and use gluesticks to glue the outer circle sections together. (If using poster boards, you may need to staple sections also.)

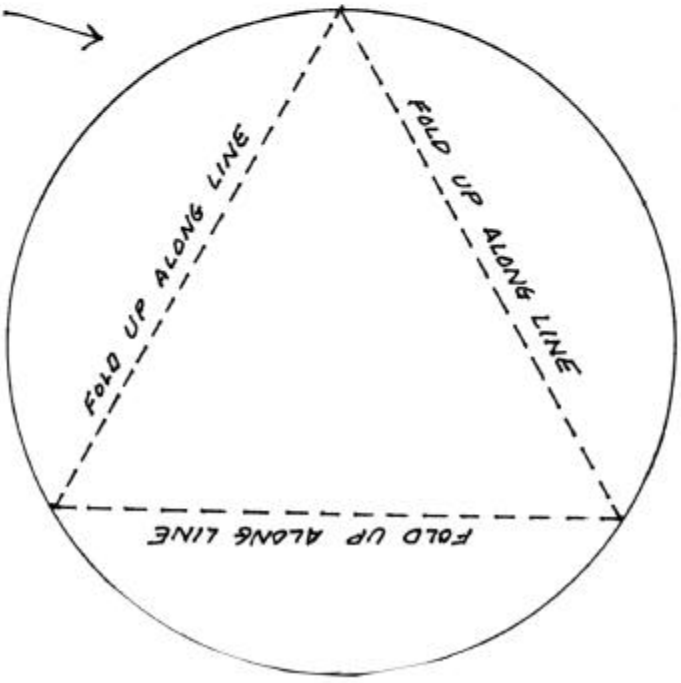




5. Continue to glue sections until all 20 pieces have been used.
6. Keep arcs to the inside.

PATTERN →

Cut 20



SEA MARGIN DIVERSITY

9-12

OBJECTIVES

The student will do the following:

1. Describe various coastal regions.

2. Recognize defining characteristics of each coastal habitat and learn its name.

3. Locate significant coastal waters on a map.

4. Contribute to a model that depicts major coastal habitats.

SUBJECTS:
Science (Environmental Science), Social Studies (Geography), Art

TIME:
2 class periods

MATERIALS:
teacher sheets
acetate sheets
student sheets
blue & brown paint
small diameter wire
plastic trees and plants
Astroturf ® (2 sq. ft.)
plywood 4' x 4' (or larger)
broom straw
flour (at least 10 lbs.)
salt (at least 5 lbs.)
bottle of vegetable oil
water
large mixing bowl
U.S. or world map

BACKGROUND INFORMATION

One of the most dynamic and ecologically important places of our planet is where land, air, and sea meet. These areas have been influenced by changing sea levels over the past thousands of years as well as by the constant action of waves, winds, and tides. Perhaps the most profound influence in modern times has come at the hands of people through their ignorance of the importance of coastal wet areas. Recently we thought of any coastal areas that did not have a white sandy beach as a wasteland that needed draining, filling in, or some other modification that would render it suitable for our needs. We now understand that our label "wasteland" could not have been more inaccurate. Instead, it is one the most fertile, productive places on Earth, serving as a sanctuary and nursery for much of the life in the sea. Many species produce eggs and juvenile stages that require the lower salinity, the mud, or the grassy cover found in numerous coastal habitats, especially estuaries. We also now realize coastal areas' importance as a storm buffer, absorbing the impact of wind and waves so that less damage is sustained inland where greater human populations reside. And finally, their importance as a biological filter has been realized. It is in this role, perhaps, that coastal areas are most important. Many pollutants people produce are naturalized in these vast expanses and even help feed the detrital mill so basic to the entire system.

Coastal regions compose an array of features with a complex shoreline. Not all have the important functions described, but each has unique characteristics that make it an important habitat.

Terms

bay: a body of water partly enclosed by land but with a wide outlet to the sea

delta: a deposit of sand and soil, usually triangular, formed at the mouth of some rivers

detritus: decomposed or disintegrated organic matter (found in water and on land) and associated microbial elements

distributary: a branch of a river that flows away from the main stream

estuary: a marine ecosystem where freshwater enters the ocean. The term usually describes regions near the mouths of rivers, and includes bays, lagoons, sounds, and marshes

fjord: narrow, deep valleys carved by glaciers and flooded by the sea

gulf: a large area of sea or ocean partially enclosed by land

lagoon: a shallow body of water, especially one separated from the sea by sandbars or coral reefs

mangrove swamps: tropical, wet, coastal areas dominated by mangroves (trees). Mangroves have extensive root systems which form a dense thicket, providing cover for aquatic life.

mud flats: large estuarine expanses composed of rich muds exposed at low tides

salt marsh: estuarine habitat submerged at high tide, but protected from direct wave action, and overgrown by salt-tolerant herbaceous vegetation; aquatic grasslands (coastal "prairies") affected by changing tides, temperatures, and salinity

sound: long, broad inlet of the ocean larger than a strait or channel, connecting larger bodies of water

strait: a narrow passage that connects two larger bodies of water

tidal creeks: meandering creek-like channels within salt marshes and mud flats, through which seawater enters and leaves as the tide rises and falls

tidal flats: flat-topped banks of sand and silt that comprise the most elevated portion of the salt marsh

ADVANCE PREPARATION

A. Make transparencies of the teacher sheets “Margins of the Sea” and “Estuary.”

B. Make copies of “Margins of the Sea” and “Estuary” student sheet.

C. Have materials available for the extension activities.

PROCEDURE

I. Setting the stage

A. Discuss what coastal regions are, share the background information, and list all terms and definitions.

B. Ask students how coastal regions have impacted them. (If they have been to the beach, name the seafood they have eaten and understand that each kind may have begun life in a coastal habitat.)

C. Point out coastal regions on a U.S. or world map.

II. Activity

A. Display transparency of “Margins of the Sea.”

1. Locate each coastal region.

2. Discuss the identifying characteristics that make it unique.

B. Display the “Estuary” transparency.

1.Identify and discuss the smaller habitats found in this environment.

2.List ways this richest of coastal ecosystems is so important to marine life and to humans.

C. Point out major coastal regions that can be seen on a large map. Identify estuarine environments of the U.S.

III. Follow-up

A. Review shape, appearance, and characteristics of coastal regions.

B. Hand out student sheet "Margins of the Sea."

1. Have students label each region.

2. Let them check their understanding as the transparency key is shown again.

C. Have students identify coastal regions and estuaries on a map.

IV. Extensions

A. Divide class into groups (determined by number of habitat models being built), **o**r each class could contribute to a single model. Each group (or class) makes modeling clay by mixing 2 parts flour to 1 part salt with water and vegetable oil. The clay is used to mold a model that depicts a coastal habitat. The habitat is placed in one section of the plywood form so that it fits beside others creating an entire coastal region. Straw, astroturf, plastic plants, and wire can be used at students' discretion to make realistic features. Areas under water may be painted blue while land features may be painted brown. The finished product should reinforce the concepts of coastal habitat studies.

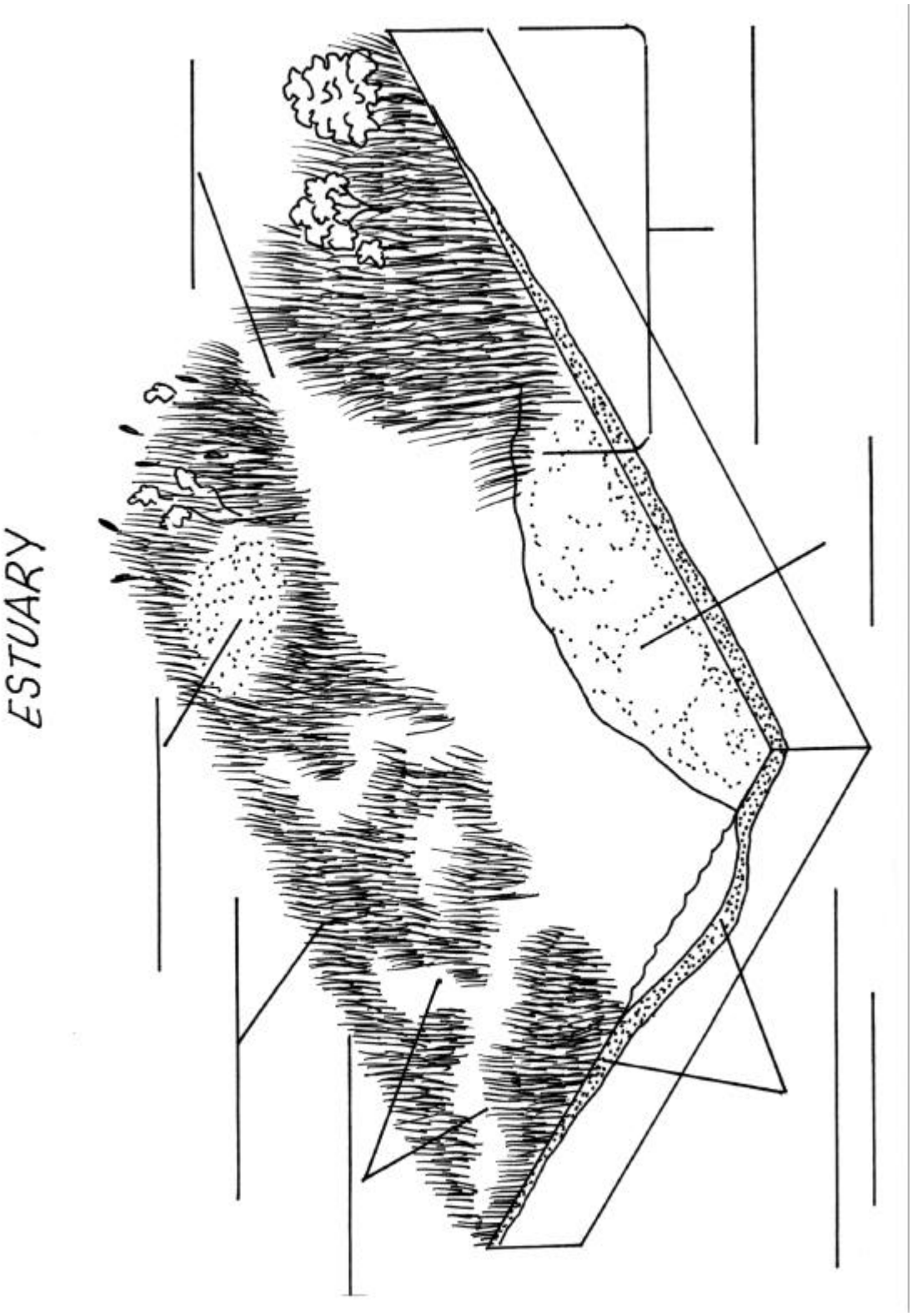
B. Have students research the plant and animal life of their habitat and report their findings to the class.

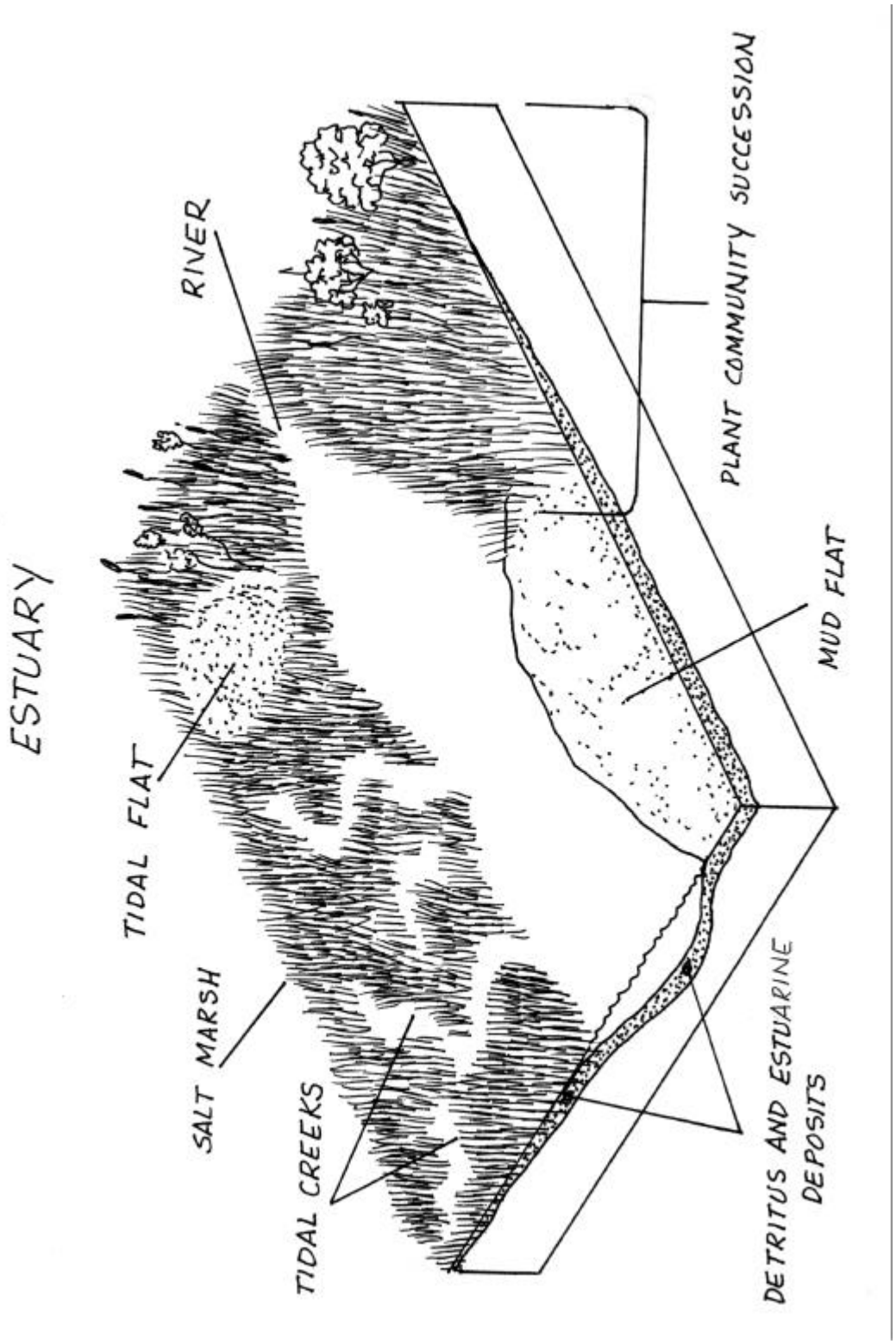
RESOURCES

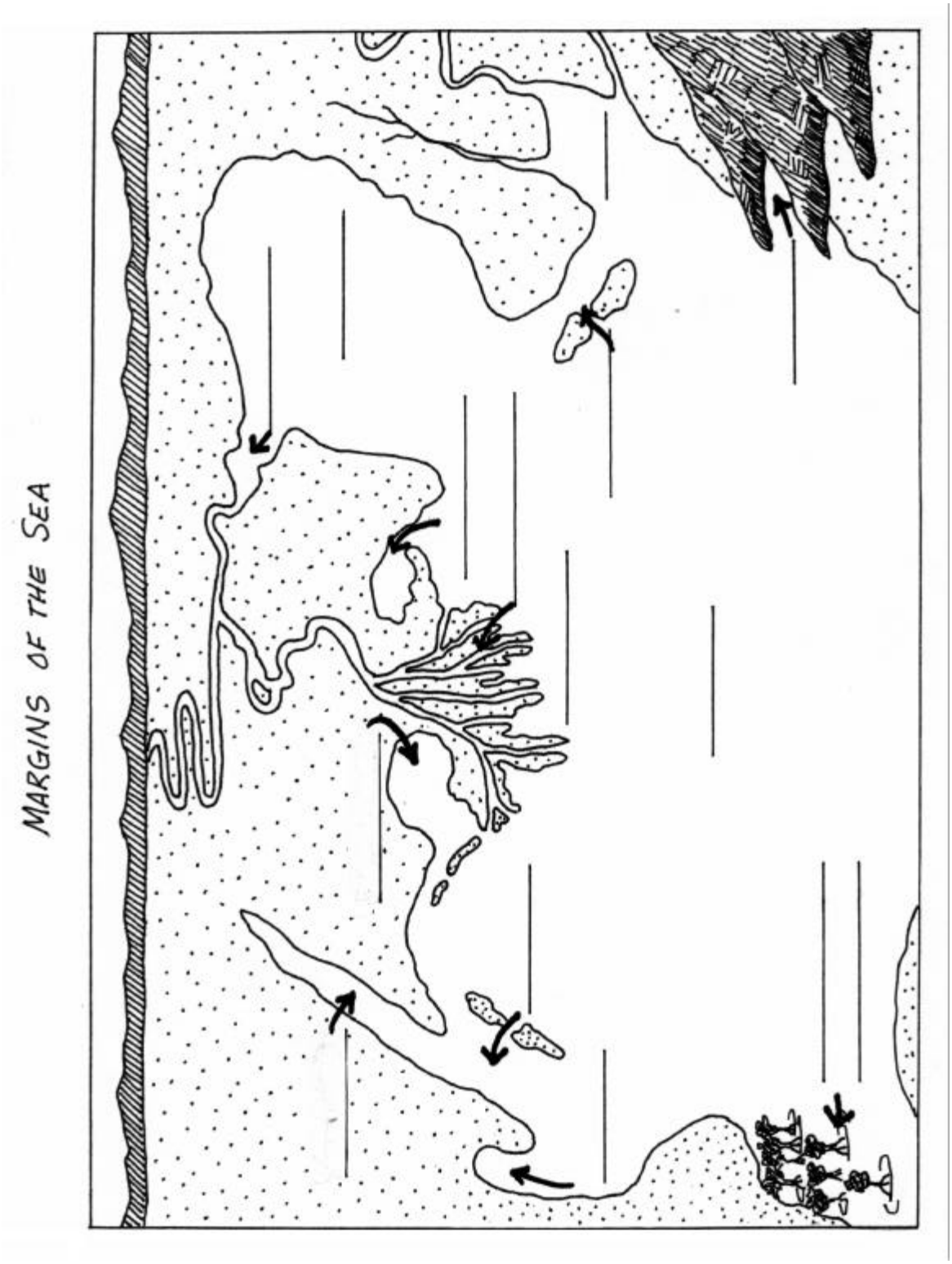
Gross, M. Grant, Oceanography: A View of the Earth, Prentice-Hall, Inc., Inglewood Cliffs, New Jersey, 1990.

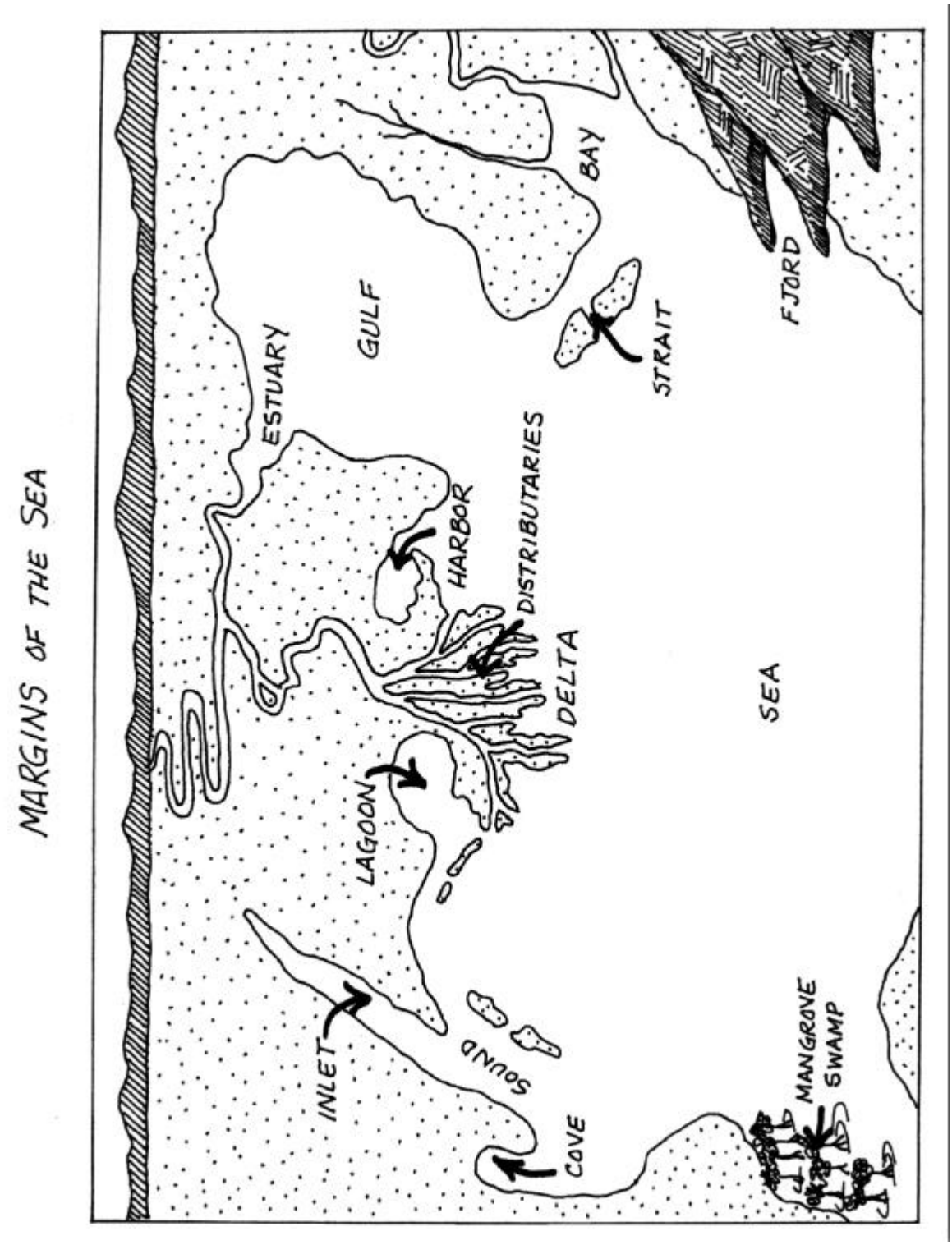
Sumich, James L., An Introduction to the Biology of Marine Life, W.C. Brown Publishers, 2460 Kerper Boulevard, Dubuque, IA, 1992.

3-5 Water SourceBook.


ESTUARY


ESTUARY
RIVER
PLANT COMMUNITY SUCCESSION
TIDAL FLAT
MUD FLAT
SALT MARSH
TIDAL CREEKS
DETRITUS AND ESTUARINE DEPOSITS


MARGINS OF THE SEA


MARGINS OF THE SEA
ESTUARY
GULF
BAY
STRAIT
FJORD
HARBOR
DISTRIBUTARIES
DELTA
SEA
LAGOON
INLET
SOUND
COVE
MANGROVE SWAMP

ESTUARIES: INTERFACE BETWEEN SEA AND LAND

9-12

OBJECTIVES

The student will do the following:

1. Describe the five types of estuaries and functions of estuaries.

2. Identify where estuaries lie in the U.S.

3. Explain the value of estuaries in maintaining the integrity of natural ecosystems, especially coastal ecosystems.

4. State the impact human use and misuse has on estuaries.

SUBJECTS:
Science (Ecology, Biology),
Social Studies (Geography)

TIME:
2 class periods

MATERIALS:
modeling clay
petri dishes (5-6 inch)
or plastic plates
food coloring
ice trays or paper cups
wall map of the United States
5 different colored push pins
maps

BACKGROUND INFORMATION

Ours is a water dependent planet. Our land areas are bordered by the enormous body of water we call the 'sea'. Some of the most dynamic areas on Earth are found at the interface of land and sea, especially in areas we know as estuaries. Estuaries are areas of unusual activity and have production comparable to our most productive agricultural lands - more than five tons per acre per year! There are three good definitions of an estuary: (1) a semi-enclosed coastal body of water that has a free connection with the open sea and within which seawater is measurably diluted with freshwater from land drainage; (2) deep-water tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partially obstructed, or sporadic access to the open ocean and where ocean water is at least occasionally diluted by freshwater runoff from land; and (3) a marine ecosystem where freshwater enters the ocean.

Five important functions of estuaries are: (1) they provide nursery areas for 90 percent of our commercial seafood populations; (2) they provide food for most of these populations; (3) they provide shelter for many small marine animals; (4) they act as a storm buffer to prevent floods and absorb energy from storms such as hurricanes; and (5) they detoxify wastes. Also, we now appreciate the importance of microscopic photosynthetic phytoplankton, benthic plants, and marsh grasses in

keeping the ocean "alive." All of these are found in estuaries. They also provide needed habitat for millions of birds, both local and migratory. Many of our most beautiful birds depend on estuaries and other wetlands.

Estuaries seem to have been relatively rare features during most of Earth's history. As the last Ice Age withdrew and sea level rose, estuaries were formed along the continental shelf. There are five basic formations: (1) Drowned river valley - the classic estuary, wider than deep and triangular in shape. Examples are Chesapeake, Delaware, Savannah, Hudson, and Mobile Bay. It consists of marshes, mudflats, and tidal creeks. These are coastal plain estuaries. (2) Fjord-drowned glacial valley - usually in arctic and polar regions, u-shaped, deeper than wide, small river discharge, large tidal volume, important to shipping; located in Valdez, Alaska, New Zealand, and Norway. (3) Deltaic - the most changeable, fluvial depositions, river discharge great, very subject to waves, tides, longshore currents, storm damage, sediment lay down; locations: Mississippi River, Amazon River, and Nile River. (4) Bar-built - the most dynamic, a series of bars or islands created from offshore deposition of sand, washed down by rivers or from deep water, the sand walks up the continental shelf and stabilizes. Bar-built estuaries are usually laterally extended along shore and are long, narrow, and low. Examples are a sand spit or barrier island. The estuary exists on the leeward side. These can change quickly and are controlled by oceanic movements. Examples of bar-built estuaries are the Mississippi Sound, Cape Cod, Long Island, and Chandeliers Islands as well as many islands along the west coast of Florida. (5) Tectonic - estuaries formed when the Earth's crust shifts suddenly as in an earthquake, volcanic eruption, or a tsunami. Tectonic estuaries have no definite shape, and San Francisco Bay is an example of one.

Worldwide, we have destroyed 50 percent of the estuaries and damaged 25 percent more. The southeastern United States has 90 percent of the estuaries located in the U.S. The Atlantic coast has 30.8 percent, the Gulf of Mexico has 60.1 percent, the Pacific has 7.1 percent, and the Great Lakes region has 2.0 percent. Over two-thirds of the water runoff from the United States drains into the Gulf of Mexico.

The physical environment of an estuary includes intertidal emergent wetlands, seagrass meadows, soft bottoms, hard substrates, and aerial habitat. The biotic component includes: animals-mollusks, arthropods, reptiles, fish, birds, mammals, and an extensive interstitial community; and plants-Spartina, Juncus, Salicornia, Distichles, shrubs, phytoplankton, benthic plants, bacteria. The mud in an estuary can be eight feet thick! The mud is, for the most part, anaerobic and very rich in nutrients. The pulse of the tides, creating a daily or twice daily flushing, brings renewal and diversity of temperature, salinity, and DO (dissolved oxygen).

Limiting factors, such as elevation, tides, temperature, salinity, desiccation, and predation, mean that animals must be adaptable to live in the estuarine environment. Nowhere is the food web more apparent and fragile than in the estuary.

Human impact is the greatest stress. Estuaries are subject to sudden changes due to development, filling, dredging, discharging, and dumping to accommodate human needs. Two-thirds of the human population

lives on one third of the land near the coast! Of course that's where the estuaries are located! Humans redirect the enormous forces of nature and often think nothing will happen. People have only recently begun to appreciate the values and functions of estuaries in the natural world. Small activities have large unforeseen consequences. By-products of human activity such as industrial wastes, heat, solid wastes, agricultural runoff (silt, herbicides, pesticides, organic matter), and private citizen wastes (septic tanks, inadequate oil and chemical disposal, litter), all adversely impact upon estuaries. Some pesticides are retained in the body and build up in the progression of the food chain (biological magnification). Levees eliminate precious sediment. Dams cut off fresh water. Runoff from pavement and roofs causes erosion and carries pollutants to the estuaries killing animals and plants. Overfishing can lead to extinction and destroys the fishing industry. Channelization can contaminate freshwater areas and funnel pollutants without giving the estuary the chance to carry out its detoxifying function.

All this may sound very dire, but most of the harm to estuaries was done before we knew and appreciated their values and functions. Great efforts are now being made to protect our remaining estuaries and even to reclaim estuaries that were damaged or completely destroyed.

Terms

bar-built estuary: type of estuary formed by a series of bars or islands created from offshore depositing sand, washed down by rivers or in from deep water. The sand walks up the continental shelf and stabilizes. A bar-built estuary is usually laterally extended along the shore, and is long, narrow, and low.

benthic: living on the bottom of a lake or sea; pertaining to the ocean bottom

bioaccumulate: to accumulate larger and larger amounts of a toxin within the tissues of organisms in each successive trophic level

biological magnification (biomagnification): bioaccumulation occurring through several levels of a food chain; process by which certain substances (such as pesticides or heavy metals) are deposited into a waterway, are eaten by aquatic organisms which are in turn eaten by large birds, animals, or humans, and become concentrated in tissues or internal organs as they move up the food chain.

biotic: living or derived from living things

channelization: the straightening and sometimes deepening of stream or river channels to speed water flow and reduce flooding. A waterway so treated is said to be channelized. However, channelization can cause unstable situations and may cause adverse environmental impacts.

deltaic estuary: type of estuary formed by a delta

drowned river valley: type of estuary that is wider than deep and triangular in shape

emergent: rising from a surrounding liquid

estuary: a marine ecosystem where freshwater enters the ocean. The term usually describes regions near the mouths of rivers, and includes bays, lagoons, sounds, and marshes.

fjord-drowned glacial valley: type of estuary usually found in arctic and polar regions, U-shaped, deeper than wide, that has a small river discharge and a large tidal volume; important to shipping

fluvial: found in, produced by, or relating to a river

interstitial: of, forming, or occurring in a small or narrow space between things or parts

intertidal: of, or pertaining to a shore zone bounded by the levels of low and high tide

leeward: in the direction toward which the wind blows; of the side of anything away from the wind

levee: an embankment, natural or artificial, built alongside a river to limit high water events from flooding bordering land

tectonic estuary: type of estuary formed when the Earth's crust shifts suddenly as in an earthquake, volcanic eruption, or a tsunami; has no definite shape

tsunami: a huge sea wave caused by a submarine disturbance such as an earthquake or volcanic eruption

ADVANCE PREPARATION

A. Collect materials.

B. Freeze colored water in ice trays or paper cups (the form of the ice does not matter). The equivalent of three square ice cubes is usually sufficient.

C. Put terms and definitions on the board.

PROCEDURE

I. Setting the stage

A. Discuss Background Information.

B. Have students locate the different types of estuaries on a wall map and mark each type with one color of push pin. Discuss estuaries that students may have visited or seen.

C. Discuss how so many estuaries have been damaged or destroyed. Talk about values, natural stresses, and human impact. Try to find solutions for misuse and destruction of estuaries.

II. Activity

This is a sea level rise activity to demonstrate formation of estuaries.

A. Hand out clay and petri dishes and have students construct a coastline with raised areas indicated by the clay in various formations inside the dishes.

B. Give each student or partners, if they work in partners, three cubes of ice and let them place the ice on the clay in the dish. The teacher may want different students to create models that will form the different types of estuaries.

1.As the ice melts, they can see an island get covered or a ditch or valley fill in.

2.Have students look at the different models to see if they can identify the types of estuaries formed. It may be necessary to reform some models if the water did not fill in where expected.

III. Follow-up

Have students:

A. Write a one-page summary about the types of estuaries, their function, and human impact on them. Students should be able to describe the estuary type, give one United States location for that type, discuss benefits of an estuary, and discuss destruction and remediation.

B. Test term knowledge by taking a vocabulary quiz.

IV. Extensions

A. Use the same model to observe circulation patterns and record findings.

B. Discuss food webs in estuaries.

C. Discuss possible results of estuary destruction.

D. Visit an estuary.

E. Trace where your nearest waterbody empties into the sea.

RESOURCES

Arms, Karen, Environmental Science, Holt, Rinehart, and Winston, Inc., Austin, TX, 1996.

Chiras, Daniel D., Environmental Science, High School Edition, Addison-Wesley, Menlo Park, CA, 1989.

Gulf of Mexico Program, Public Information Center, Building 1200, Room 103, Stennis Space Center, MS 39529-6000. Phone: (601) 688-7940

Nebel, Bernard J. and Richard T. Wright, Environmental Science: The Way The World Works, 4th Edition, Prentice-Hall, Englewood Cliffs, NJ, 1993.

Posters of estuaries are available from: National Marine Estuary Programs, and U.S. Environmental Protection Agency (U.S. EPA) Regions (check Appendix R-1 to R-8)

United States Geological Survey maps (see list in Appendix J-1 to J-6 for State Geological Contacts)

EROSION KILLS THE HABITATS THAT FEED YOU!

9-12

OBJECTIVES

The student will do the following:

1. Define the role of barrier islands, shorelines, beaches, and dunes in defending areas of abundant biological activity.

2. Compute the amount of time necessary to have islands "erode away" given a certain amount of erosion per year.

3. Describe the socio-political and economic impact of erosion of coastlines.

SUBJECTS:
Science (Ecology), Math, Social Studies (Political Science, Economics, Government)

TIME:
2 class periods

MATERIALS:
student sheet
ruler
handouts of hypothetical situation and questions

BACKGROUND INFORMATION

Shorelines, beaches, dunes, and barrier islands are often the main defense to protect (estuaries, wetlands, bays, and coastal properties against erosional force such as hurricanes, storms, and tides.

Estuaries, wetlands, coastal swamps, marsh lands, and bays are habitats and areas of extensive biological productivity. If erosion damages or destroys these areas, the economy of a region can suffer; even hunger can result, especially if the local population depends on fish as the major source of food protein.

Coastlines can erode several to many feet per year. For example, along the Gulf of Mexico, erosion rates can be as high as 60 feet per year.

Terms

barrier island: a ridge of sand and gravel thrown up parallel to a coastline by the waves and tides with leaving a lagoon behind it

bay: a body of water partly enclosed by land but with a wide outlet to the sea

erosion: the process of detachment, transport, and deposition of soil material

estuary: a marine ecosystem where freshwater enters the ocean. The term usually describes regions at the mouths of rivers, and includes bays, lagoons, sounds, and marshes

gulf: a large area of a sea or ocean partially enclosed by land

habitat: the place or type of site where a plant or animal naturally or normally lives and grows

wetland: areas that periodically have waterlogged soils or are covered with a shallow layer of water resulting in reduced soil conditions. Wetland areas typically support plant life that is adapted to life in wet environments

ADVANCE PREPARATION

Photocopy Hypothetical Situation sheets and questions.

PROCEDURE

I. Setting the stage

Set up the hypothetical situation with your students. Discuss pertinent terms. Divide class into two groups, one for each country.

II. Activity

A. Have all members of each group perform the required computations, answer the questions about their assigned country, and compare responses. Have each group choose a reporter to present its country's case the next day.

B. On the following day, have each reporter present the group's findings. Facilitate a discussion on options each country might have to try to feed its population.

III. Follow-up

Have students choose actual locations worldwide, research erosion rates, and calculate how many years it would take for one mile to erode at that particular location using a constant rate.

IV. Extension

Have students research ways to slow down coastline erosion and present findings to the class

for extra credit.

RESOURCES

Arms, Karen, Environmental Science, Holt, Rinehart, and Winston, Inc., Austin, TX, 1996.

Chiras, Daniel D., Environmental Science, High School Edition, Addison-Wesley, Menlo Park, CA, 1989.

"Coastal and Shoreline Erosion," The Gulf of Mexico Program Public Information Center, Building 1200, Room 103, Stennis Space Center, MS 39529-6000, (pamphlet) Phone: (601) 688-7940

Jacobson, Jodi, "Swept Away," World Watch, January/February 1989, pp. 20-26.

Nebel, Bernard J. and Richard T. Wright, Environmental Science: The Way The World Works, 4th Edition, Prentice-Hall, Englewood Cliffs, NJ, 1993.

HYPOTHETICAL SITUATION

Countries A and B have shorelines protected by many small, mostly sandy barrier islands. These barrier islands protect areas of great biological activity, and native and commercial fishermen supply much of their countries protein sources from the catches made in these protected areas. Both countries have large, rapidly growing populations and share fishing rights in East Bay. Unfortunately, rises in sea level and the cutting of most of the trees of Country C, an island, have increased wind and erosion rates so that Country B is seeing erosion rates of 72-75 feet per year on the islands, while Country A has a rate of only 10 feet of erosion per year.

DIRECTIONS:

Using the key and assuming the majority of erosion will occur from the side of each island facing the sea, calculate the number of years necessary for the numbered islands of your country to literally "erode away."

For Country A	for Country B
#1	#6
#2	#7
#3	#8
#4	#9
#5	

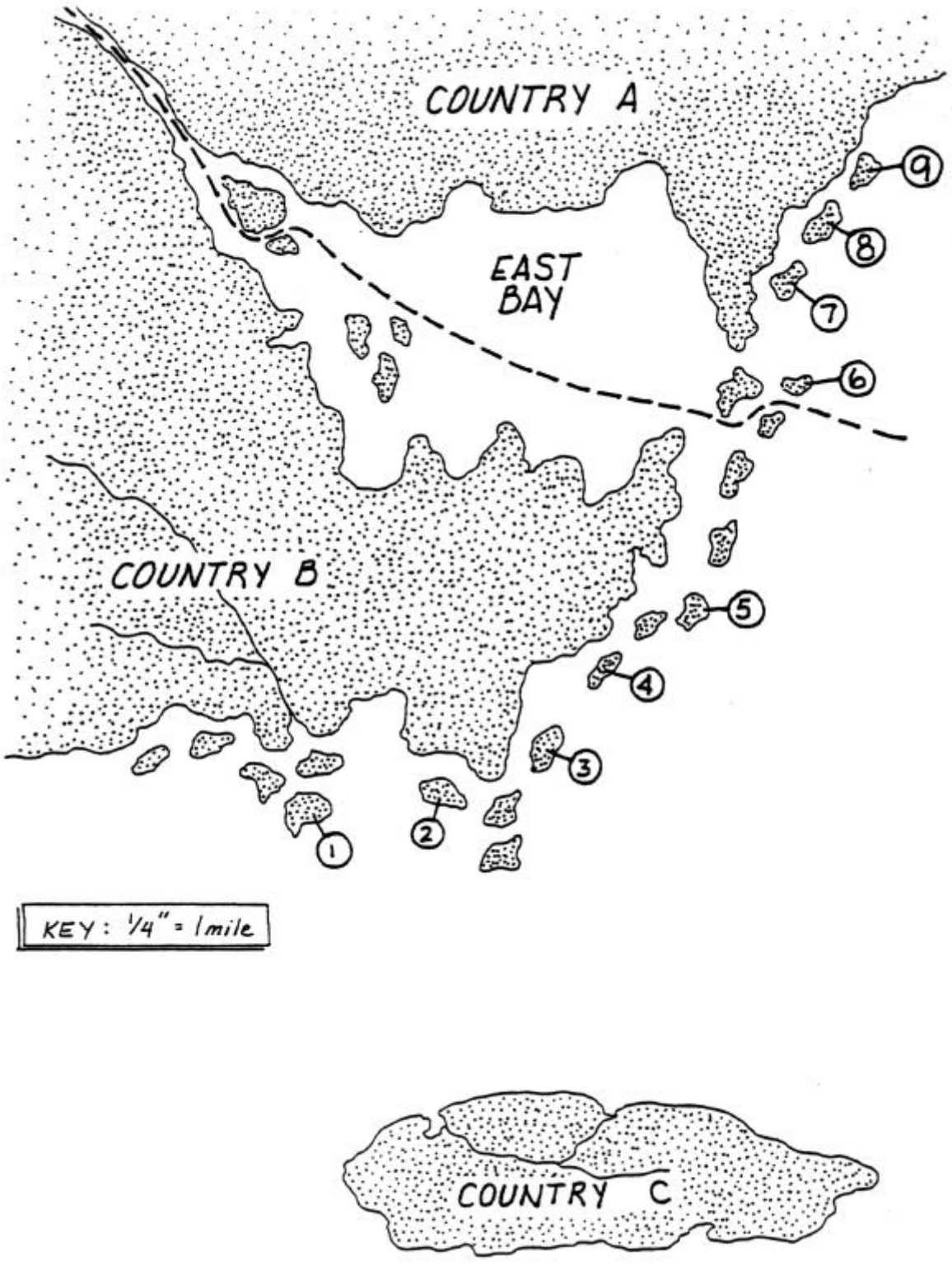
QUESTIONS

Country B:

Suppose that erosion decreases your fishing catches by 50% while your population grows 10%. What could be some possible consequences in your relationship to A? What could be some changes in your fishing patterns?

Country A:

Suppose your fishing catches decrease only 10% in the same time, and your population increases only 5%. How would these changes affect your relationship with Country B?


COUNTRY A
EAST BAY
COUNTRY B
COUNTRY C
1
2
3
4
5
6
7
8
9
KEY: 1/4" = 1 mile

OIL SPILLS

OBJECTIVE

The student will do the following:

1. Explain the effect and effectiveness of techniques (sinking, absorption, and disposal) used to get rid of oil floating in seawater.

SUBJECTS:
Science (Ecology, Chemistry, Biology)

TIME:
1 ½ class periods

MATERIALS:
water (from faucet)
table salt
scale
empty 1-liter bottle with cap
beaker containing heavy-grade motor oil (gear oil 80W) or crude oil
five 250ml beakers
two 10ml measuring cylinders
teaspoons
small dish of sawdust
foam granules (made by breaking up a foam cup)
small dish of plaster of Paris
detergent (dishwashing liquid)
stop watch
waterproof felt-tip marker
student sheet

BACKGROUND INFORMATION

Every year, millions of gallons of oil are released into the environment, either accidentally or intentionally. This oil comes from tanker accidents, blowouts or spills at offshore drilling rigs, and from runoff and dumping of waste oil by people and industries.

In 1979 a huge blowout occurred at the Ixtoc I oil well in the southern Gulf of Mexico. Over 184 million gallons of oil leaked into the environment. It took eight months to cap the well. As horrendous as that seems, releases from offshore wells during normal operations and during transportation of oil add much more oil to the environment annually than occasional accidents.

Oil tanker and supertanker accidents only account for about 10 to 15 percent of the annual input of oil into the world's oceans, but they can be disastrous when they occur. Most of the rest comes from leaks at wells, purging of tanks, and seepage from natural sources. The largest tanker accident to date was in 1983 when the tanker *Castillo de Bellver* caught fire and released 78.5 million gallons into the ocean off the coast of Capetown, South Africa.

In March of 1989, the tanker *Exxon Valdez* hit a reef and released 11 million gallons of oil into the Prince William Sound of Alaska. More than 33,000 seabirds, nearly 1,000 sea otters, and more than 100 bald eagles were killed.

The type and amount of damage from an oil spill depend on a number of factors such as type of oil, weather conditions, what kinds of organisms are in the area, and the season.

Crude (unrefined) oil is actually a mixture of hundreds of different substances. Some are very toxic; some are relatively harmless. Some evaporate into the air, some dissolve in water, some float, and some sink. Some are very sticky and tend to coat whatever they contact.

The effects of an oil spill are many and varied. The most obvious effect is the waste of a valuable resource, the oil itself. While attempts to recover the spilled oil are made, much is lost and much of what is recovered is not usable because of contamination from the clean-up process or the environment.

Some of the components of crude oil, such as benzene and toluene, are extremely toxic (poisonous). Sticky oil coatings smother many organisms. Oil destroys the insulation and buoyancy of marine birds and animals, so that many drown or die of exposure to cold water and air. Fish gills are clogged. Animals that ingest the oil or eat other organisms contaminated by the oil may be poisoned or have their digestive systems clogged.

Oil companies, governmental agencies, and people who are concerned about the environment have tried a number of ways to clean up spilled oil. It is always a difficult, expensive effort. Even as recently as the *Exxon Valdez* spill, many of the methods used were still in the experimental stage; and some of the experiments didn't work well. Sometimes people's efforts to clean up after a spill may do more damage than good.

Terms

benzene: (1) a clear, flammable, poisonous, aromatic liquid, C_6H_6, obtained by scrubbing coal gas with oil and by the fractional distillation of coal tar. It is used as a solvent for fats and in making lacquers, varnishes, many dyes, and other organic compounds; (2) a structural unit in the molecules of organic aromatic compounds.

blowouts: when an oil well blows its top and spews crude oil into the air

crude oil: unrefined petroleum; a mixture of many different hydrocarbons

runoff: water (originating as precipitation) that flows across surfaces rather than soaking in eventually enters a waterbody; may pick up and carry a variety of pollutants

supertanker: a very large ship used to carry crude oil

toluene: a colorless, liquid, flammable, poisonous hydrocarbon, C_7H_8, obtained originally from balsam of Tolu but now generally from coal tar or petroleum; used in making dyes, explosives, and as a solvent; structurally consisting of a methyl radical attached to a benzene ring

toxic: harmful to living organisms

ADVANCE PREPARATION

A. Make copies of the Student Sheet: DATA TABLE.

B. Collect materials.

C. Discuss Background Information with students.

D. Put terms and definitions on the board.

PROCEDURE

I. Setting the stage

SAFETY PRECAUTIONS - Oil is flammable! BE CAREFUL! Be sure to extinguish all flames when carrying out this experiment.

II. Activity

A. Make artificial seawater by weighing out 5g of table salt and adding it to the 1-liter bottle. Fill half the bottle with warm water from the faucet, put on the cap, and shake the bottle until the salt has dissolved. Fill the bottle to the top with water to produce "seawater" with approximately the same concentration found in the ocean.

B. Label five beakers A, B, C, D, and E. Fill each of the beakers ½ full of seawater.

C. Measure out 5ml of oil in the measuring cylinder and pour into beaker A. Repeat this step with beakers B, C, D, and E.

D. Look at the five beakers and record what you see in each one in the Data Table.

E. Sprinkle one heaping teaspoon of sawdust into beaker A.

F. Sprinkle one heaping teaspoon of foam granules into beaker B.

G. Sprinkle one heaping teaspoon of plaster of Paris into beaker C.

H. Measure out 10ml of detergent in a measuring cylinder and pour into beaker D.

I. Do not add any treatment to beaker E. This will be the control beaker.

J. After 5 minutes, look at the five beakers and record on the Data Table what you see in each one.

K. Leave the beakers for 24 hours.

L. After 24 hours, look at the five beakers and record on the Data Table what you see in each one.

III. Follow-up

Write a report on what happened to the oil in each beaker after 5 minutes and after 24 hours. Answer these questions in the report.

A. Which treatment was most effective in making the oil sink?

B. Which treatment was most effective in soaking up the oil on the surface?

C. Did any treatments have no effect on the oil?

D. Which treatment do you think would be most effective at dispersing an oil slick at sea?

E. Would it be practical to use this method in the ocean? If not, why not?

IV. Extensions

A. Ask students to come up with new ways of removing oil from water and test them.

B. Have students come up with their own solutions for cleaning up water and compare theirs with those of other students. They may come up with some that are already used, or they may come up with some that are totally new and interesting. Discuss cost prohibitive cleanup efforts and other real world considerations.

C. Study a feather carefully. Notice its structure, coloring, and feel. Dip the feather into the oil-polluted water and inspect it. Compare the feather to one that was not dipped. Study a small piece of string carefully. Dip the string into oil polluted water and inspect it. Compare the string from Step 8 with a piece that was not dipped. (Notice that the oil coats whatever it touches. This is one of the ways in which oil spills destroy both plant and animal life. Baby sea turtles have been found off Mexico's Pacific Coast choked to death by globs of oil stuck in their mouths and nostrils. Birds lose their ability to fly and float.)

RESOURCES

Arms, Karen, Environmental Science, Holt, Rinehart, and Winston, Inc., Austin, TX, 1996.

Chiras, Daniel D., Environmental Science, High School Edition, Addison-Wesley, Menlo Park, CA, 1989.

Nebel, Bernard J. and Richard T. Wright, Environmental Science: The Way The World Works, 4th Edition, Prentice-Hall, Englewood Cliffs, NJ, 1993.

Roe, Michael L., Environmental Science Activities Kit, The Center for Applied Research in Education, West Nijack, New York 10995, 1993, p. 95.

DATA TABLE

	Appearance of oily water		
	Before additions	After 5 minutes	After 24 hours
A			
B			
C			
D			
E			

IMPACT GOVERNMENTAL REGULATIONS ON MARINE DEBRIS - WRITE A LETTER!

9-12

OBJECTIVES

The student will do the following:

1. Identify the problem of marine debris.

2. Outline some current regulations governing waste n oceans and gulfs.

3. Compose letters to government officials expressing concern over marine debris.

SUBJECTS:
Language Arts, Science (Environmental Science), Social Studies (Government)

TIME:
3 class periods

MATERIALS:
student sheets
magazine and/or newspaper articles on marine debris problem

BACKGROUND INFORMATION

Trash has been thrown into the ocean for generations; but because food, natural fibers, and paper decompose quickly in the ocean, they have not posed a major problem. Also heavy non-degradable materials sink to the bottom. However, lightweight and virtually indestructible plastic products accumulate, impact ocean life, and wash to shore.

Plastic trash from disposable diapers, bags, and banana wrap cover coral and kill the tiny Cnidaria that built the coral reefs. The coral reefs have taken hundreds of years to form and protect islands and coastlines from erosion. Plastic rings surround the feet, beaks, and heads of marine animals and cause starvation, strangulation, and suffocation. Marine animals that eat jellies (commonly called jellyfish) often mistake plastics for their food source and then die from starvation due to gastrointestinal blockage. Many of these plastics float onto the beaches making them unattractive for human recreation. It is not uncommon to find hypodermic needles on the beaches that have washed up because the plastic cylinders float. As much as one ton of litter per mile of coastline has been removed in one day on beaches during volunteer beach

cleanups.

Marine debris can come from any vessel on the water, from drilling platforms, or even as discharges from seaside industries, or from runoff from the land. An international treaty known as the MARPOL Treaty has been established to control disposal of wastes into the ocean. However, the ocean is a big place; and trying to regulate this treaty is almost impossible. Many vessels still dispose of wastes illegally in the ocean.

Terms

banana wrap: plastic that is put around bananas during shipping

Cnidaria: phylum name for a group of invertebrates that includes coral animals, jellies, sea anemones, and the hydra

gastrointestinal tract: the hollow tube that runs from the mouth to the anus in animals

MARPOL Treaty: international treaty that regulates the disposal of solid waste, including plastics

non-degradable: not capable of chemical or biological decomposition

phylum: the principal division of kingdoms. The classification system is the characterization of an organism by its Kingdom, Phylum, Class, Order, Family, Genus, and Species.

runoff: water (originating as precipitation) that flows across surfaces rather than soaking in; eventually enters a water body; may pick up and carry a variety of pollutants

ADVANCE PREPARATION

A. Copy Student Sheets.

B. Obtain a copy of the MARPOL Treaty, if possible, to share with students, from the Government Printing Office, Washington, D.C.

PROCEDURE

I. Setting the stage

A. Discuss Background Information and terms.

B. Assign each student to bring to class and be prepared to give a one-minute summary of one article on marine debris.

II. Activity

A. Have students present one minute summaries on marine debris articles.

B. Distribute Hypothetical Situation and discuss letter format and communication tips.

C. Assign letter and give handouts.

D. Collect letters.

E. Discuss letters. Have students critique and note whether or not essential elements were included.

III. Follow-up

Ask students to see if they can find a more effective way to communicate what John Doe saw. If they fail to find the information in the extension, share that information with the class a few days later.

IV. Extension

Let students know that a form is available for reporting to NOAA: Marine Debris Information Office Atlantic Coast and Gulf of Mexico c/o Center for Marine Conservation any dumping violation witnessed. For extra credit, have a student write the Center for Marine Conservation to obtain a copy of the report form.

NOAA: Marine Debris Information Office Atlantic Coast and Gulf Of Mexico
c/o Center for Marine Conservation
1725 DeSales Street NW
Washington, D.C. 20036

RESOURCES

Gulf of Mexico Program, Public Information Center, Building 1200, Room 103, Stennis Space Center, MS 39529-6000, (handout on Marine Debris Timeline) Phone: (601) 688-7940

Weber, Michael, Richard Townsend, and Rose Bierce, Environmental Quality in the Gulf of Mexico, Center for Marine Conservation and EPA, Washington, D.C. 20036.

Student Sheet

Effective Communication:

1. Limit the length to one page or less; limit the subject to one topic.

2. State your position on the issue, why you hold that position, and what you want to see happen in regard to that issue.

3. If you write about a specific bill before Congress, include the bill name or number in your letter.

General Addresses:

Honorable (Senator's name)
United States Senate
Washington, D.C. 20510

Honorable (Representative's name)
House of Representatives
Washington, D.C. 20515

Student Sheet

Letter Format

Street Address (yours)
City, State, zip
Date

(skip a line)
Name of Business or Individual
Street Address
City, State, zip

Dear Sir/Madam: (use specific name if possible)

Body of letter. Skip line between each paragraph.

Skip a line between last paragraph and closing.

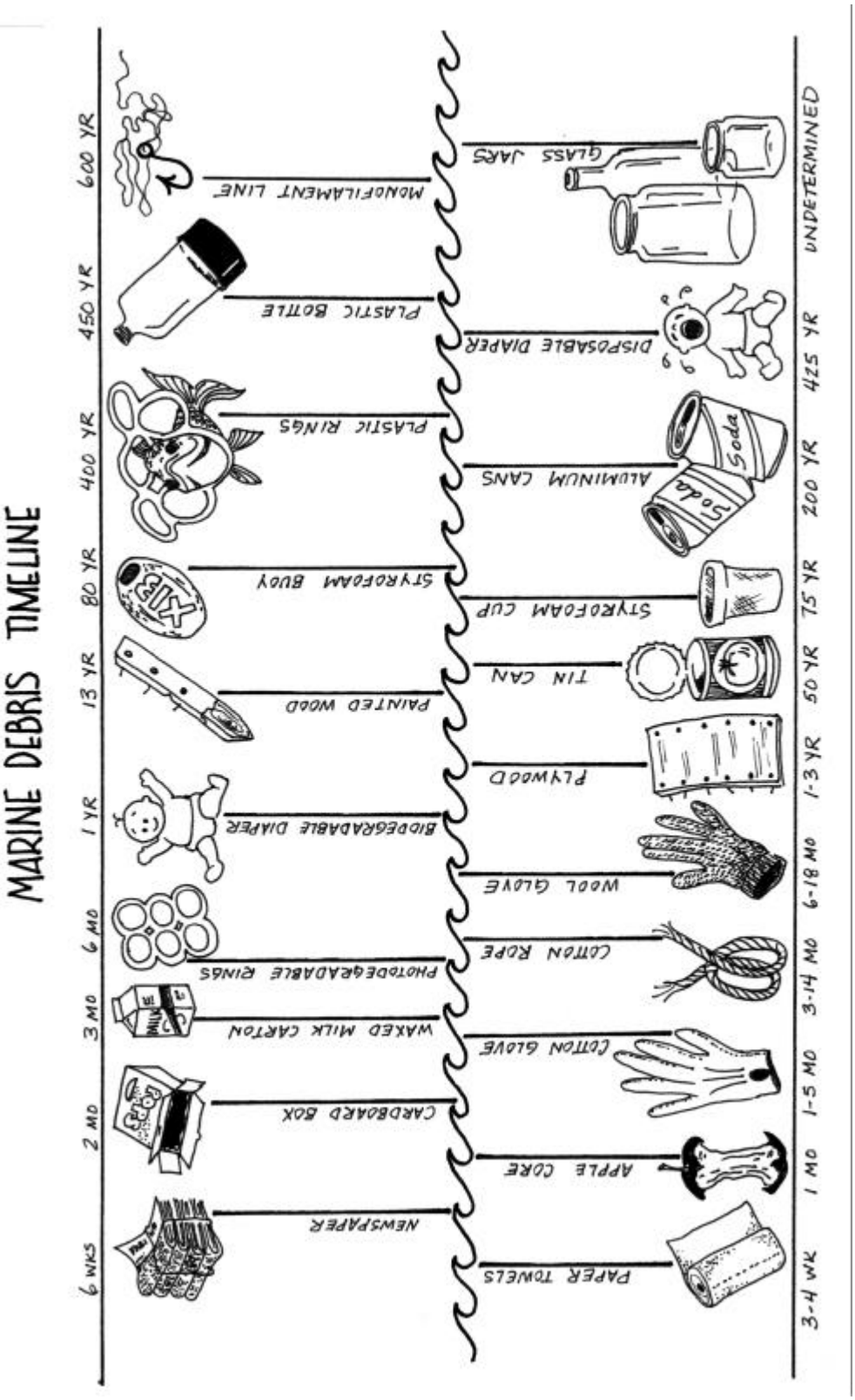
Sincerely,
Your Name
Title

Student Sheet

HYPOTHETICAL SITUATION

John Doe was fishing one mile off the coast in a traffic area for cruise ships. He saw some plastic bags thrown off the ship; one floated near his boat. He hooked the bag, tore the top, and looked inside to find aluminum cans (recyclable), plastic rings (recyclable), and trash.

John knew it was illegal to dump garbage into the water; but he did not know what to do about it. He decided to write his Congressperson to protest the action he had witnessed. He quickly recorded the name of the ship.


MARINE DEBRIS TIMELINE
6 WKS
2 MO
3 MO
6 MO
1 YR
13 YR
80 YR
400 YR
450 YR
600 YR
3-4 WK
1 MO
1-5 MO
3-14 MO
6-18 MO
1-3 YR
50 YR
75 YR
200 YR
425 YR
UNDETERMINED
NEWSPAPER
CARDBOARD BOX
WAXED MILK CARTON
PHOTODEGRADABLE RINGS
BIODEGRADABLE DIAPER
PAINTED WOOD
STYROFOAM BUOY
PLASTIC RINGS
PLASTIC BOTTLE
MONOFILAMENT LINE
PAPER TOWELS
APPLE CORE
COTTON GLOVE
COTTON ROPE
WOOL GLOVE
PLYWOOD
TIN CAN
STYROFOAM CUP
ALUMINUM CANS
DISPOSABLE DIAPER
GLASS JARS

"HOW WATER PROCESSES MOVE SAND"

9-12

OBJECTIVES

The student will do the following:

1. Define longshore current.

2. Explain littoral drift.

3. Demonstrate longshore current and littoral drift.

4. Name six barrier islands in the Gulf of Mexico created by these two processes.

SUBJECTS:
Science (Physical Science, Earth Science, Physics), Social Studies (Geography)

TIME:
1 class period

MATERIALS:
5 gallons of sand
large wet table or equivalent outdoor area
hose with access to water
graph paper
pencils
rulers or measuring tapes
string to line off area used
map of barrier islands of the Gulf of Mexico (or equivalent)
shallows pans
¼ - ½ inch plastic tubing
small funnels to fit on tubing

BACKGROUND INFORMATION

Water affects our whole life. But water affects us in ways that we do not realize until it is pointed out to us. We all enjoy going to the beach and walking, lying, or playing in the sand.

We do not think about the fact that it was water's special capabilities that created the sandy beach we all enjoy and formed many barrier islands that are places of refuge for humans and habitats for wild animals of all kinds.

This activity explores the water processes, such as currents, tides, and wave action, that work to create the sandy coasts of the world. The islands and beaches of the Gulf of Mexico are used as examples, but sandy beaches and sandy barrier islands in any location can be profiled with this activity.

Sandy beaches and sandy barrier islands, such as the beaches and barrier islands found in the Gulf of Mexico, were not created so that humans could have fun in the sand and sun! However, sandy beaches and barrier islands do provide the first line of defense from damage due to storms and wave action. The islands and beaches take the brunt of the attack of waves and storms. They keep freshwater loaded with sediments and nutrients from completely spilling into the ocean. They

maintain the integrity of the valuable estuaries behind them. And--they are a neat place to visit. They were created by water's ability to dissolve and move other substances. (Note: Sandy beaches and bars also occur along rivers, creeks, and lakes.)

Beaches have piles of sand, or sand dunes, that were brought there by the tides, waves, and currents in the oceans. Sand bars are underwater sand hills that were also deposited by ocean currents, waves, and tides. Both the beaches and the bars are very dynamic areas and are subject to removal or growth according to the action of the water's waves, tides, and currents. Sometimes the sand bars become so large that they rise above the water surface. They may then become stabilized with vegetation and may become known as barrier islands. It is important to remember that it was water that deposited these sandy beaches and bars.

In the Gulf of Mexico, the sand was originally deposited by river discharge from erosion of the Appalachian Mountains and the Rockies. Once the sand reached the Gulf, the tide, wave, and current energy took over movement of the sand particles. In the eastern Gulf of Mexico, the longshore current (the current that moves parallel with the shore) moves basically north along the lower part of Florida and then turns westward at the panhandle. As the water moves along the shore, it creates what is called the littoral drift. Littoral drift is the movement of sand in the direction of the prevailing longshore current. This process has been going on for tens of thousands years and has shaped and changed the geography of the land it affects.

The beaches of Florida, Mississippi, and Alabama are known for their white sand shores and sandy swimming areas along these shores. The littoral drift created by the longshore current, tides, and wave action can be demonstrated in the classroom and interesting extensions can be assigned that will incorporate geography, geology, and even art into the lesson. Barrier islands, such as Petit Bois, Dauphin, Santa Rosa, Casey Key, and farther west off Texas - Montagorda and Padre Islands, are actually large ridges or bars of sand that have been deposited by river discharge, wave action, and tides. The island will slowly move in the direction of the prevailing winds and current (littoral drift). One end of the island may erode while the other end of this island grows! It is the capacity of water to move substances that students can explore and demonstrate.

Terms

accretion: the process of growing by being added to

adhesion: the act of sticking (surface attraction) or the state of being stuck together

barrier island: a ridge of sand and gravel thrown up parallel to a coastline by the waves and tides with a lagoon behind it

cohesion: the force by which the molecules of a substance are held together

current: a flow of water or air, especially when strong or swift, in a definite direction; specifically, as a flow within a larger body of water or mass of air

deposition: a laying or putting down (settling out suspended materials in a liquid due to a decrease in velocity of the suspension)

erosion: the process of detachment, transport, and deposition of soil material

littoral drift: movement of materials along the shore

longshore current: a flow of water that runs along the shoreline that is usually strong or swift

osmotic pressure: the force per unit area exerted by a solvent passing through a semipermeable membrane in osmosis, equal to the pressure that must be applied to the solution in order to prevent passage of the solvent into it

plane of turbulence: the flat, level, or even surface in which there is violent, irregular motion or swirling agitation of water

sand bar: a ridge or narrow shoal of sand formed in a river or along a shore by the action of currents, tides, and waves

sand dune: a pile of sand on the shore that is created by wind or water movement of the sand. Most are affected by wind and water.

surface tension: a property of liquids in which the exposed surface tends to contract to the smallest possible area, as in the formation of a meniscus. It is caused by unequal molecular cohesive forces near the surface.

thixotropy: the property of certain gels and emulsions to become fluid when agitated and then settle again when left at rest

tide: the alternate rise and fall of the surface of oceans and seas, and the bays and rivers connected with them, caused by the attraction of the moon and sun. The tide occurs once or twice in each period of 24 hours and 50 minutes.

viscosity: the state or quality of having a cohesive and sticky fluid consistency; a measure of resistence to flow upon applying a force

wave: a ridge or swell moving along the surface of a fluid or body of water as a result of disturbance, as

by wind

ADVANCE PREPARATION

A. Have graph paper on hand.

B. Either conduct small demonstrations in groups using shallow pans, or go outside to have a larger class demonstration with a hose.

C. Collect materials.

D. Go over lab procedure with students.

PROCEDURE

I. Setting the stage

A. Put terms and definitions on the board.

B. Discuss Background Information.

C. Hand out graph paper and other necessary material.

D. Divide students into groups if group work was decided upon.

II. Activity

A. Create an outside “beach” by pouring the sand in a long low “dune” in the selected spot or have student groups pour about a quart of sand in a shallow pan to createa ridge or dune.

B. Line off the sandy area with string. Measure and mark it off in inches or millimeters.

C. If using pans, put plastic tubing at one end of sand ridge and insert funnel in other end of tubing. The water will be poured into the funnel and will have the same effect as the hose. You may want to tilt the pan a little.

D. For pans - have students put graph paper into pan before pouring in sand. Then mark the measurements on paper.

E. Turn on hose with a slow, small flow or slowly pour water through funnel and let students observe how the water affects the sand "bar."

F. Stop the water every minute or two to record the measurements for the movement of sand. You may take measurements on the long plane or short plane across the sandbar.

G. The sand will "erode" at the hose/tube end and "accrete" at the opposite end. Sand is i heavier than water, but water's ability to move other substances will be very apparent.

III. Follow-up

A. Have students make a graph of the data they recorded about the movement of sand. Each inch could be a mile, and each minute could be a year.

B. Ask:

1. Which way was the longshore current moving?

2. How far did the dune/island move in a week? month? year?

3. When would the dune/island be totally removed by the water?

4. Where was deposition taking place?

5. Where did most of the sand accrete?

6. Where was sand eroding?

7. Did the sand erode at the same rate all along the bar? Why or why not?

8. What water processes could you tell were taking place?

IV. Extensions

A. Plot the volumetric flow and velocity of the water that passed over the bar.

B. Plot the volume of sand removed and/or deposited.

C. Study a map of barrier islands and have students name them.

D. Have students do a report on one of the barrier islands in the Gulf of Mexico.

E. Find some local area of soil erosion and photograph or map it. Check it after every storm for a semester and calculate its rate of movement or change. Predict long term effects.

V. Optional Extension

Ask students to study the following questions and respond in the next class period.

A. What happens when a channel or inlet is cut through a barrier island?

1.How does that affect the sand transport?

2.How does man prevent the channel from filling up with transported sand?

3.How does this affect sand transport "downstream" from the channel?

B. What happens if a groin is constructed to trap sand transport or to prevent a developed area from storm waves? How does this affect sand transport on either side of the groin?

C. Obtain nautical charts, areal photographs, or USGS quad maps of shoreline areas with channels, jetties, or groins to examine the beach profile. Estimate direction of littoral drift.

D. Explore the "Wave Theory"

C=L/T Where C = wave celerity (speed at which a waveform propagates)
Where L = wavelength (crest to crest or trough to trough)
Where T = wave period (time between two successive wave crests)

Students can use this equation to estimate the length of time for waves produced by the storm to reach shore.

E. Explore the horizontal velocity

$$u = H/2 \quad X \quad gT/L \quad X \quad 1/\cosh(2(3.14) \times (d/L))$$

Where H = wave height (trough to crest)
Where g = gravity
Where d = water depth

Students can measure wave heights and periods if located near a coast through simple observation. Students can estimate which waves (based on height, length, and periods) produce the greatest potential for transporting sediments. Would a storm producing long or high waves cause more erosion?

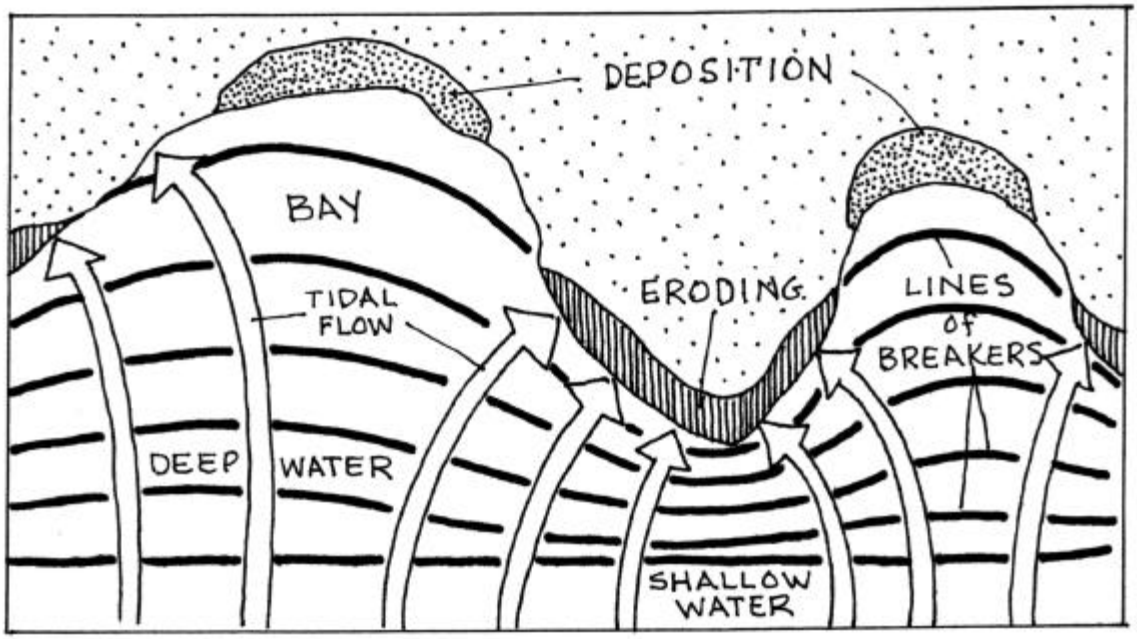
RESOURCES

Arms, Karen, Environmental Science, Holt, Rinehart, and Winston, Inc., Austin, TX, 1996.

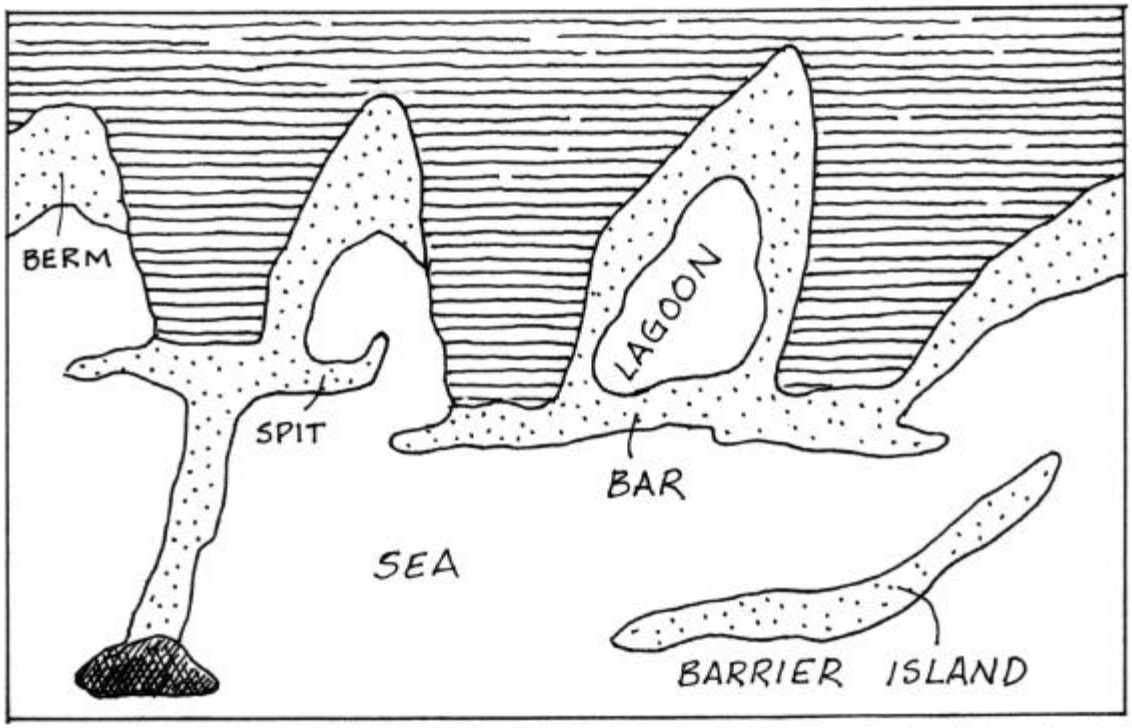
Gulf of Mexico Program, Public Information Center, Building 1200, Room 103, Stennis Space Center, MS 39529-6000, Phone: (601) 688-7940

Student Sheet

TIDAL ACTION AND EROSION



ISLAND AND BAR DEPOSITION



SWEPT AWAY--OR--WHERE WILL YOU BE WHEN THE WATER COMES?

9-12

OBJECTIVES

The student will do the following:

1. Read "Swept Away" by Lodi L. Jacobson.

2. Cooperatively compile a vocabulary list.

3. Discuss the facts and the predictions listed in Ms. Jacobson's article.

4. Write a science fiction-style story of 500-800 words set in one of the locations mentioned in "Swept Away"

SUBJECTS:
Language Arts, Social Studies (Geography, Political Science)

TIME:
2-3 days of class time
1 week of outside work

MATERIALS:
copies of "Swept Away" (see Resources)

BACKGROUND INFORMATION

Students retain vocabulary better when they actually use the words themselves. Cooperatively compiling a vocabulary list from "Swept Away" will allow them to do this.

Many students are intimidated by a creative writing project; but with the facts and predictions in "Swept Away," they have a basis for building a story. This kind of creative work personalizes the problems that are caused by global warming, causing the students to internalize and to think seriously about a very real problem.

Terms

cartographer: a person whose work is making maps or charts

channel: (1) a body of water joining two larger bodies of water; (2) a channel could also be the physical dimensions of a stream or river

channeling: to make a channel or channels in

fossil fuels: hydrocarbon fuels, such as petroleum, derived from living things of a previous geologic time

sedimentation: the process of depositing sediment, or the addition of soils to lakes that is part of the natural aging process

ADVANCE PREPARATION

A. Obtain from the library and photocopy "Swept Away" for each student.

B. Review the list of possible vocabulary words (see Teacher Sheet).

C. The teacher may also want to write a story and share it with students.

PROCEDURE

I. Setting the stage

A. Discuss with the students some popular works of science fiction (Star Trek, Star Wars, 1984, Brave New World). Science fiction usually takes facts and predictions and puts "flesh" on them, creating situations and characters that make us think about ourselves.

B. Divide the class into groups of four to work on vocabulary

1.Each student should read "Swept Away," underlining every word he/she does not know.

2.Each group member should share his/her list with other group members. Those in the group who know what a word means should explain it to the rest of the group. The words left over--the ones no one knows--will be recorded and given to the teacher for a master list.

3.A compilation of the words from each group will be the vocabulary list for this lesson.

II. Activity

A. Give students the enclosed Instruction Sheet.

B. Students should re-read “Swept Away,” this time paying special attention to facts and n predictions.

C. Each student should choose a location mentioned in “Swept Away” for a setting for his/her science fiction story. He/she should create characters and situations that would be appropriate for that location. The time setting should be anytime from 2050 to 2150.

D. Each student should use the facts and predictions in “Swept Away” as a springboard for his/her story.

III. Follow-up

A. Evaluation--Grading criteria should include:

1.Characters appropriate to setting	20%
2.Facts incorporated into story	20%
3.Cohesiveness of story from beginning to end	20%
4.Creativity	40%

B. You may have two English teachers read the stories and choose the top three. For these, give the “Luke Skywalker Science Fiction Award.”

IV. Extensions

A. Ask students to research the concept of global warming and write a brief report on their findings.

B. Find out how much water scientists believe is stored in the polar ice caps. What could this do to coastal regions if it all melted?

RESOURCES

Arms, Karen, Environmental Science, Holt, Rinehart, and Winston, Inc., Austin, TX 1996

Chiras, Daniel D., Environmental Science, High School Edition, Addison-Wesley, Menlo Park, CA, 1989.

Cunningham, William P. And Barbara Woodworth Saigo, Environmental Science: A Global Concern, Wm.

C. Brown Publishers, Dubuque, IA, 1997.

Enger, Eldon D. And Bradley F. Smith, Environmental Science: A Study of Interrelationships, 5th Edition, Wm. C. Brown Publishes, Dubuque, IA, 1983

Jacobson, Jodi L., “Swept Away,” World Watch, January/February, 1989, pp. 20-26

Nebel, Bernard J. And Richard T. Wright, Environmental Science: The Way The World Works, 4th Edition, Prentice-Hall, Englewood Cliffs, NJ, 1993.

POSSIBLE VOCABULARY FOR "SWEPT AWAY"

1. aquifer
2. hydrologic
3. insidious
4. inundation
5. infrastructure
6. subsidence
7. accretion
8. tectonic
9. compaction
10. equilibrium
11. confluence
12. exacerbate
13. prodigious
14. extrapolate
15. encroachment

INSTRUCTIONS SHEET FOR "SWEPT AWAY"

1. Re-read "Swept Away." This time, pay special attention to facts and predictions.

2. You should choose a location mentioned in the article as a setting for your science fiction story.

3. You should create characters and situations in your story that would be appropriate for that location and time.

4. Use the facts and predictions you have noted as a springboard for the plot development of your story.

5. The time setting of your story should be sometime between 2050 and 2150.

6. Your story should be 500-800 words long.