DILUTION AND POLLUTION

6-8

SUBJECTS:
Chemistry, Health, Math, Social Studies

TIME:
50 minutes

MATERIALS:
6 plastic cups per group
100-mL graduated cylinder
water
dropper
spoon
colored powdered drink mix without sugar
colored powdered drink mix with sugar
sugar (2 cups)
student sheet

OBJECTIVES

The student will do the following:

1. Compare pollution amounts in the same quantity of water.

2. Explain how even small amounts of pollution in a given water supply can be harmful.

3. Outline alternative waste removal techniques.

BACKGROUND INFORMATION

Water pollution is often difficult to detect. Large bodies of water have the capacity to dilute and disperse wastes. As a result of dilution and dispersion, the color, smell, and taste of contaminated water may not be any or much different than uncontaminated water. For this reason, seas and oceans have become a huge dumping ground for the world.

In 1988, the beaches on the northeast coast of the United States were closed because medical wastes such as hypodermic needles were washing up on shore. Each year during the 1990s, more than 500 tons of sewage is dumped into the Mediterranean from surrounding countries. Two thirds of this sewage has not been treated at all. Seas and oceans receive thousands of tons of plastic wastes and heavy metals such as mercury and lead.

Minerals are naturally occurring chemicals that are dissolved in small amounts in our water sources. When small amounts of chemicals are dissolved in large bodies of water, the water is a dilute solution. When the levels of these chemicals increase due to ocean dumping, they may become harmful to the plants and animals of the area.

Swimmers in polluted areas can become ill with a variety of infections. Large amounts of contaminants can kill fish or make them unfit to eat. Shellfish such as oysters have the ability to concentrate certain toxins from polluted water in their tissues, making them harmful to eat. Algal blooms flourish in waters polluted with sewage and fertilizers. Much of the oxygen in water is used up during an algal bloom. This oxygen deficiency causes large amounts of fish to die and large deposits of slimy, odorous muck from dead vegetation on the bottom.

Terms

pollution: contaminants in the air, water, or soil that cause harm to human health or the environment.

dilution: the act of making thinner or more liquid by adding to the mixture; the act of diminishing the strength, flavor, or brilliance of by adding to the mixture.

ADVANCE PREPARATION

A. Prepare the unsweetened powdered drink mix for the students to taste. Add small amounts of sugar and have the students keep tasting until the taste becomes sweet. Discuss the addition of the sugar in the drink and how the sugar cannot be seen but can be tasted. Relate this to the presence of chemicals in water.

B. Run off copies of the student sheet.

PROCEDURE

I. Setting the stage

A. Discuss any local bodies of water and the runoff that enters them. Have students brainstorm the various types of chemicals that may enter these waters.

B. Number the cups 1 through 6, using labels or a marker.

II. Activities

A. Mix the powdered drink mix using the recommended amount of sugar.

1. Use the graduated cylinder to place 100 mL of this prepared drink with sugar into cup 1 and 50 mL of water into cups 2 - 6. Have students taste the drink in cup 1 using a teaspoon. Make sure the students taste only 1 teaspoon at a time or you will run out of solution.

2. Now cup 1 is polluted. Place 50 mL of the "polluted water" from cup 1 into cup 2 using the graduated cylinder. Make observations and notes. Is this water less polluted than cup 1? What color differences did you notice? What is the difference in sweetness? (Have one student taste.) Record descriptions in chart.

3. Predict how dark the color will be and how it will taste in cups 3-6. Slowly add 50 mL of the "polluted water" from cup 2 to cup 3. Mix and record observations. Repeat this procedure for cups 4 - 6.

4. When these observations are recorded, compare cup 1 to cup 3, and then compare it to cup 6. Place a white sheet of paper underneath each cup to emphasize the color differences. Note the differences in taste.

B. Each student should complete the chart and answer these questions:

1. What signs were there that pollution still remained in the water even when the solution was diluted?

2. How many more times do you think the polluted water would need to be diluted in order not to cause color or taste changes?

3. Do you think that dilution is a good solution for pollution? Why or why not?

4. Does pollution always remain in the water? If not, where does it go? (Answer: sediments, air, bioaccumulates.)

III. Follow-Up

A. Have each student research at least two alternative waste treatment methods other than simply dilution.

IV. Extensions

A. Design a space ship that has a recycling system of waste and water management.

B. List different types of bacteria that are important in the breakdown of various pollutants in the water.

RESOURCES

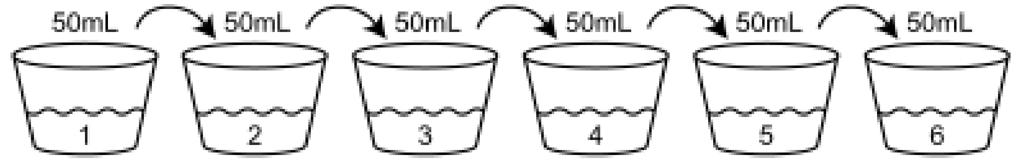
Biological Science: An Ecological Approach, Kendall/Hunt Publishing Company, Dubuque, Iowa, 1992.

Morgan, Sally, Ecology and Environment: The Cycles of Life, Oxford University Press, New York, 1995.

STUDENT SHEET — DILUTION AND POLLUTION

6-8

Directions: Dilute each water sample and record your color and taste observations.



Starting Liquid	100mL Kool-Aid	50mL water	50mL water	50mL water	50mL water	50mL water
Color						
Taste (Sweetness)						

1. What signs were there that pollution still remained even when the solution was diluted?

2. How many more times do you think that the polluted water would need to be diluted in order not to cause color or taste changes?

3. Do you think that dilution is a good solution for pollution? Why or why not?

CLEANING OIL SPILLS

6-8

SUBJECTS:
Chemistry, Drama, Math, Social Studies

TIME:
2 class periods

MATERIALS:
a large, deep pan for each group
water
a small aquarium net
motor oil in a small container for each group
pencils and paper
teacher sheet
student sheet

OBJECTIVES

The student will do the following:

1. List and compare the relative effectiveness of several methods and materials for cleaning up oil spills.

2. Explain why cleaning up an oil spill is usually difficult and only partially successful.

BACKGROUND INFORMATION

Each year more than three million tons of oil pollute the sea. The most visible source of oil pollution is accidents involving oil tankers. Oil spills caused by tankers such as the Amoco Cadiz off the coast of Normandy, France, in 1978 and the Exxon Valdez off the coast of Alaska in 1989 received a lot of media attention. The Amoco Cadiz accident spilled 223,000 tons of oil into the Pacific Ocean, while the Exxon Valdez spill dumped 10,080,000 tons of oil into Prince William Sound. The Exxon Valdez spill affected nearly 1,500 kilometers of the Alaskan coast line. Extensive damage was done to native wild life. These are only two examples of oil spills; there are many more.

Spills such as these, however, account for only a sixth of the oil that pollutes the sea each year. Half of the oil pollution is from land-based sources. Each time a tanker is rinsed, for example, oil is released into the sea. This accounts for one-third of the oil that pollutes the sea each year. Oil spills also occur during loading and unloading of ships in port.

Oil pollution has extreme detrimental effects on the environment. Oil cannot dissolve in water. It floats on or near the surface. Birds whose feathers become coated with oil lose their water-proofing qualities. Birds with oil-coated wings cannot fly well; therefore, many of them drown. Marine mammals, such as seals, also lose the water-proofing qualities of their fur.

Several methods have been used to clean oil spills. A common method is to use detergents and solvents that disperse and break up the oil. These detergents, however, can also have damaging effects on the environment. A process called bioremediation is also being used to clean oil spills. Bioremediation is the use of organisms such as bacteria and fungi to remove pollutants. Organisms that eat oil and oil-based products are called petrophiles. These petrophiles need oxygen, oil, and nutrients to survive and grow in numbers. In the case of an oil spill, oxygen and oil are already in abundance, however, nutrients are not. Nutrients in the form of fertilizers must be added to promote the process of bioremediation.

<u>Term</u>

bioremediation: the use of oil-eating organisms such as bacteria and fungi to remove pollutants.

ADVANCE PREPARATION

A. A day before you begin the activity, ask several volunteers to prepare to role-play a TV newscast team reporting on an oil spill that has just occurred.

B. Ask them to write their own script and to end with the idea that a group of specialists is on the way to clean up the oil spill.

PROCEDURE

I. Setting the stage

A. To begin the activity, ask the news team to give their special report. Videotape these reports if you have a camera.

B. Then, inform students that they have just been mobilized to clean up the oil spill. Let them group into teams of four.

C. Each team should plan how it will clean up its spill. Team members should decide what materials they will bring and what procedure(s) they will use. Suggest that each team bring at least four materials to try (one per student). Brainstorm with students what materials they might use to clean up the spill—detergents, cloth, paper, cotton, and so forth.

II. Activity

A. The following day, students will try to clean up their oil spill. Have each group fill its pan at least 3/4 full with water and pour 15 mL (1 T) of motor oil on the water.

B. Students should try to clean up the spill, using the materials they brought. (Note: You may wish to have aquarium nets available for them to scoop up any oil-absorbing materials they place on the water.)

C. Allow the students to add more oil if needed.

D. Students may retest their oil-spill materials and methods if they wish.

III. Follow-Up

A. Following the activity, ask students to rank the effectiveness of their materials and cleanup procedures. (Use a scale of 1 - 5, with 1 being the least effective and 5 being the most effective.)

B. Let each group report to the class. (They may wish to report as if they were an official panel.)

C. Then guide a class discussion by asking them to explain why it was difficult to remove the oil, how the oil reacted to their efforts, and how they disposed of their oil-coated materials.

D. Ask them to consider what would happen to the environment if large quantities of their clean-up materials were put into the ocean.

IV. Extensions

A. Have teams simulate another oil spill. Have all teams use the same clean-up method, but vary the time each team waits before beginning to cleanup the spill. Have them determine how the lag time before reporting an oil spill might affect the effectiveness of the cleanup.

B. Let students pollute their pan of water with different types of petroleum products and determine which type is easiest to clean up.

C. Have each team write a follow-up newscast to present the results of their cleanup procedures to the class.

D. Have the students discuss at least three reasons why cleaning up an oil spill is difficult and only partly successful.

E. Have the students discuss the following:

1. From your oil spill cleanup activity, which material seemed to be the most effective in removing the oil?

2. Explain what you think might happen if large quantities of your cleanup material were placed in ocean waters.

F. Ask the students to respond individually or in teams to the following:

1. You are in charge of cleaning up a major oil spill. The people in a community affected by the oil spill want to know how you will clean up the spill and how long it will take. What will you tell them? (Explain in detail.)

RESOURCES

Battling Sea Pollution, Prentice Hall Earth Science Video.

Biological Science: An Ecological Approach, Kendall/Hunt Publishing Company, Dubuque, Iowa, 1992.

Dashefsky, Stephen, Environmental Science: High School Science Fair Projects, Tab Books, Blue Ridge Summit, Pennsylvania, 1994.

Morgan, Sally, Ecology and Environment: The Cycles of Life, Oxford University Press, New York, 1995.

Water, the Life-Giving Resource, Prentice Hall Earth Science Video.

Information packet from Exxon detailing their cleanup procedures for the Alaskan oil spill. Packets may be ordered from Exxon.

STUDENT SHEET — CLEANING OIL SPILLS

Directions: Add 15 mL of oil to the pan of water and try your different cleaning materials. Describe how well each cleaned up the oil.

Cleaning Material	What you did and how well it worked
________	
________	
________	
________	

Note: If your material cleaned the oil well, you may have to add more oil to the water before trying a new cleaner.

Which material worked best?

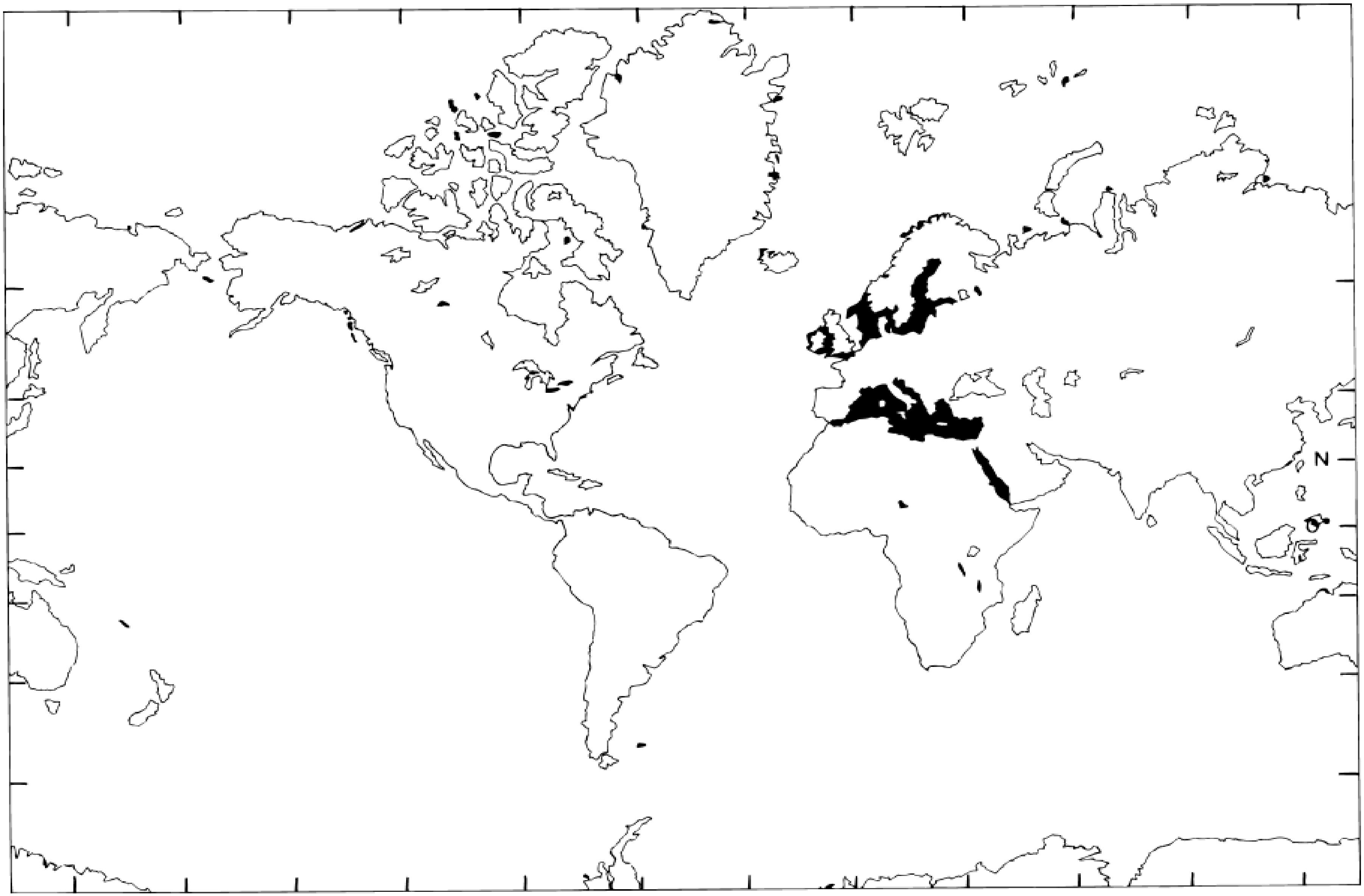
____

Which material(s) did not work well?

____

Would your material(s) work for oil cleanup in large areas? Why or why not?

____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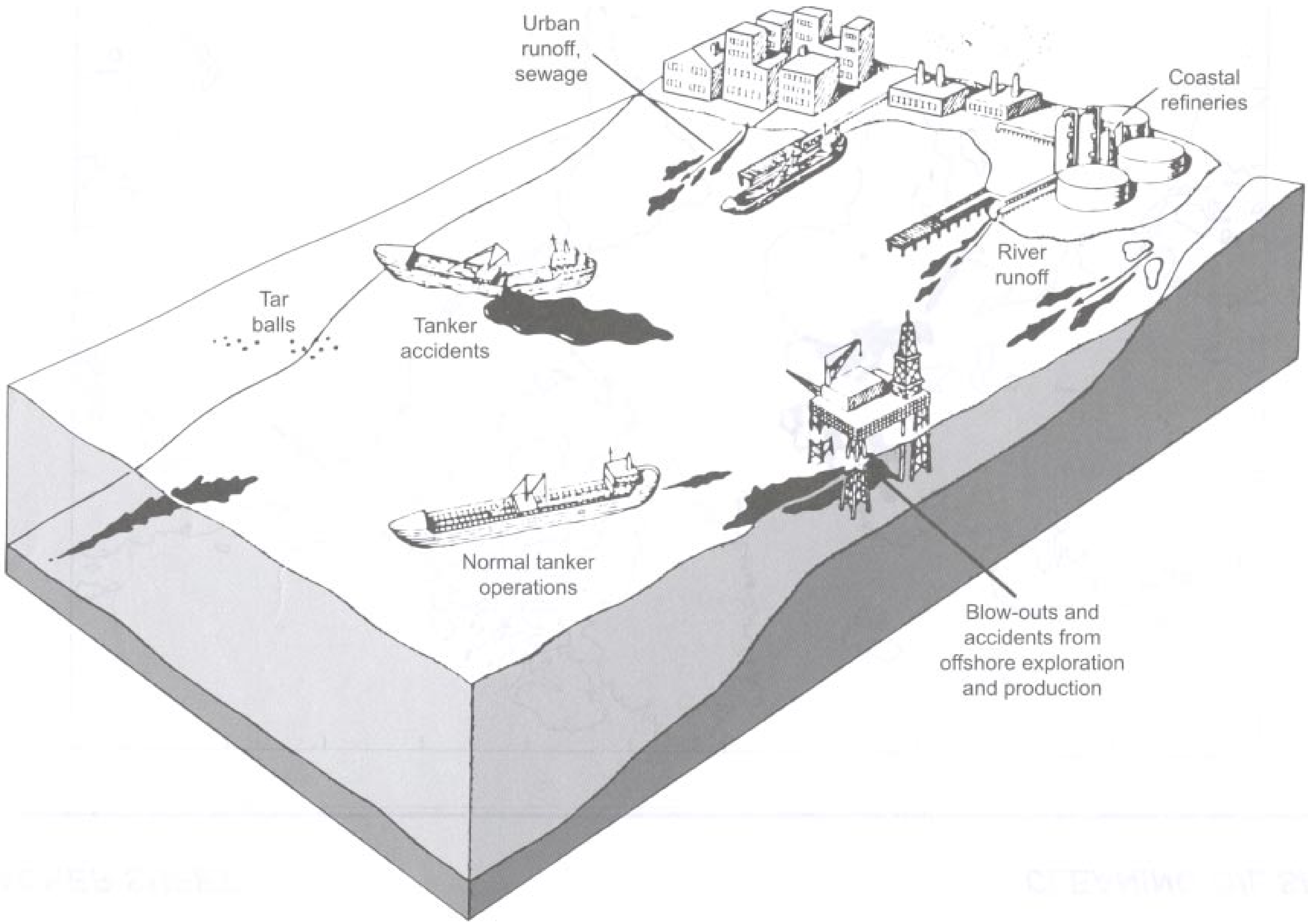

Urban
runoff,
sewage
Coastal
refineries
River
runoff
Tar
balls
Tanker
accidents
Normal tanker
operations
Blow-outs and
accidents from
offshore exploration
and production

EFFECTS OF LOST SALT MARSHES

6-8

SUBJECTS:
Biology, Botany, Ecology

TIME:
2 class periods

MATERIALS:
magazines for "cut-out" pictures
transparencies
pens for transparencies
paper for drawing and charts
teacher sheets
student sheets

OBJECTIVES

The student will do the following:

1. Relate the importance of the salt marsh to the food chain.

2. Compose a position statement that will explain why the salt marsh should not be developed.

BACKGROUND INFORMATION

Salt marshes are coastal wetlands that exist in the intertidal zone. They are among the most productive ecosystems in the world. In fact, salt marshes produce more vegetation than tropical rain forests.

Wetlands perform functions that are helpful to people and the environment. Vegetation of the salt marsh is responsible for dampening the effects of wave action in coastal areas, which reduces the amount of erosion. Wetlands also have the ability to store excess storm water, which helps in flood control. Water is cleaned naturally as it flows through a wetland.

Another very important function of salt marshes is their "nursery" capability. They provide food and shelter to juveniles of many commercial and non-commercial animals. It is estimated that wetlands contribute between 60 percent and 90 percent of the fish caught for commercial reasons. A wide variety of birds depend on wetlands such as salt marshes for both breeding and feeding grounds.

Salt marshes, as well as other wetlands, provide many functions that are both valuable to people and important to the environment. These areas, however, are continuing to be destroyed to make way for commercial or home development. The long-term effects and costs of destroying wetlands will likely outweigh the short-term benefits of using the areas for industry or condominiums.

<u>Terms</u>

ecology: a branch of science concerned with the interrelationship of organisms and their environments; the totality or pattern of relations between organisms and their environment.

ecosystem: an ecological community together with its physical environment, considered as a unit.

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.

ADVANCE PREPARATION

A. Gather magazines with pictures of salt marshes that show their inhabitants, plant life, and migratory life.

B. Gather magazines with pictures relating the importance of salt marshes to human life.

C. Have the following on hand: transparencies, pens, and paper for charts and drawing.

PROCEDURE

I. Setting the stage

A. Give the students the following scenario:

   You are a local citizen whose total income depends on the seafood industry. You are the spokesperson representing the other fishermen in your area. It is your responsibility to convince the local government that it is not in the best interest of your community or of many surrounding communities for a condominium developer to dredge and fill in valuable marshlands in order to build a new condominium. You must include as many visuals as possible in order to get your point across. You may choose from the following materials or add to them if desired: transparencies, poster board, and pictures. You must also choose a speaker to present your report to the federal government.

II. Activity

A. Divide the students into teams to complete the assignment.

B. Have the teams choose a spokesperson who will present the position statements to the local government.

C. Have the teams write their position statements.

D. Have the teams create visuals to be used.

E. Be sure to have the teams choose a moderator to keep the team "on task."

III. Follow-Up

A. Have each team present its position statement and visuals.

IV. Extension

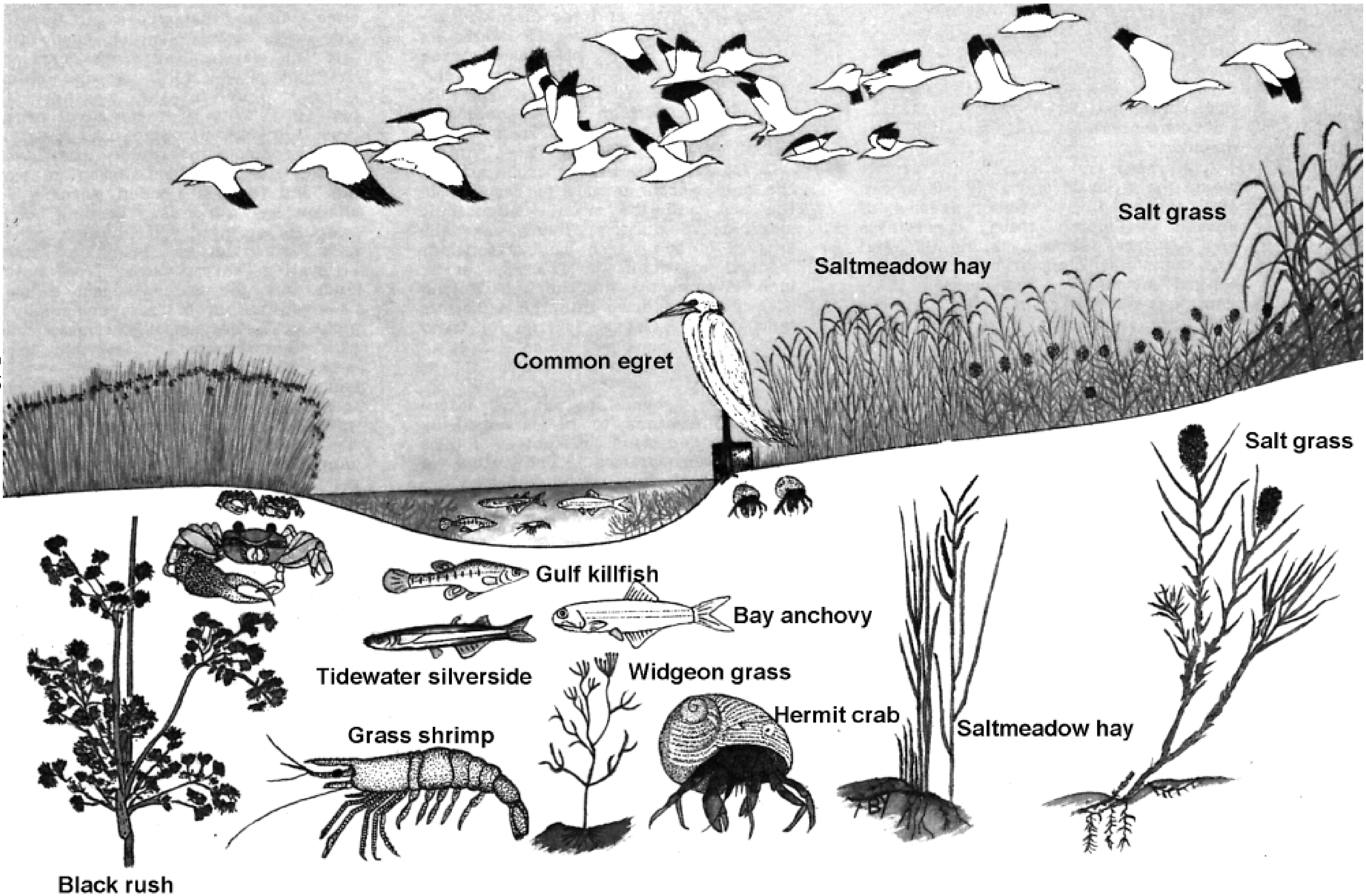
A. Choose teams to debate both sides of the issue. One team will support the developer's position and the other will support the environmentalists.

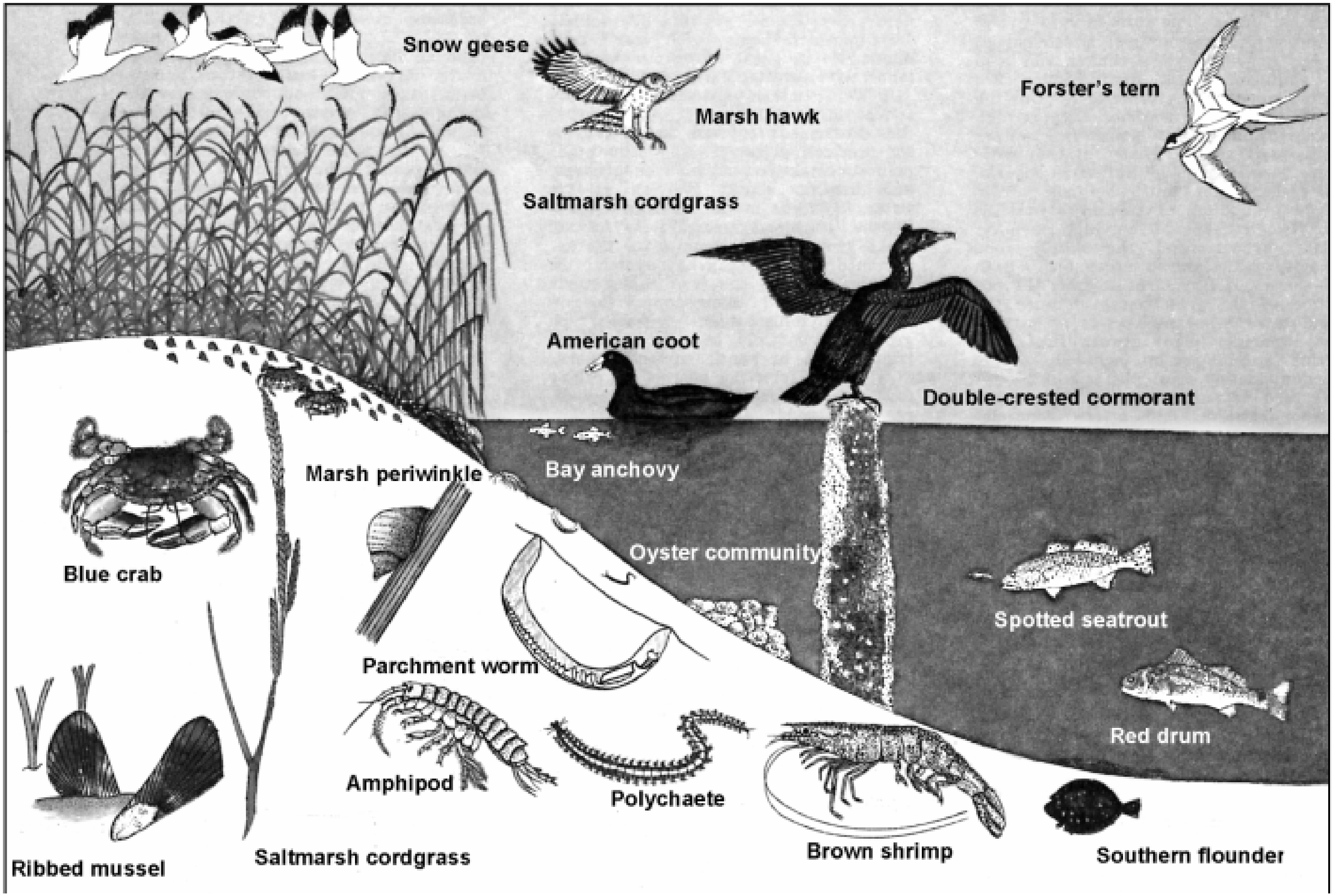
RESOURCES

Dennison and Berry, Wetlands: Guide to Science, Law, and Technology, Noyles Publications, Park Ridge, New Jersey, 1993.

Smithey, William K., American Swamps and Wetlands, Gallery Books, New York, NewYork, 1990.

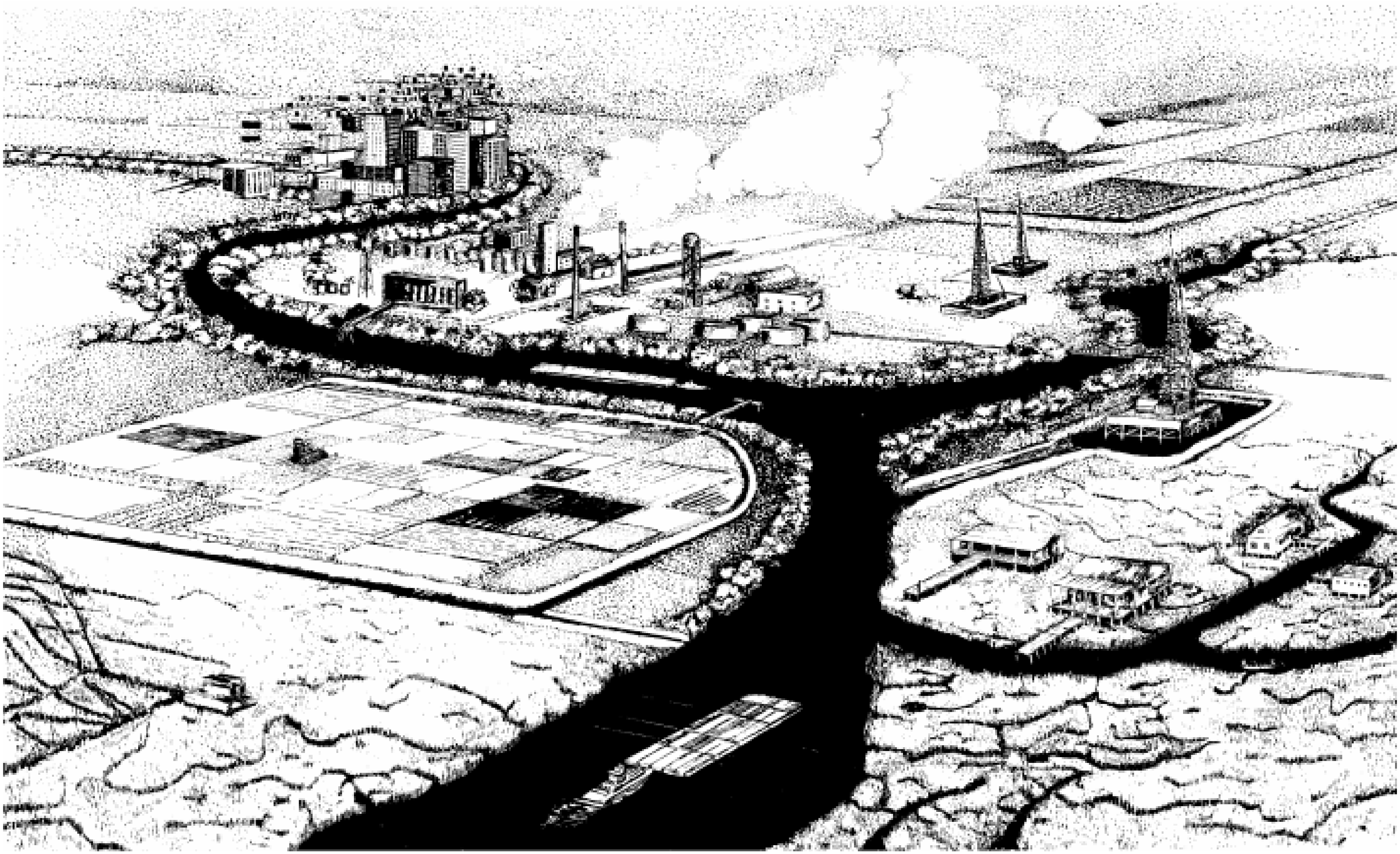
Tidal Salt Marshes: http://h2osparc.wq.ncsu.edu/info/wetlands/types3.html#sur


Salt grass
Saltmeadow hay
Common egret
Salt grass
Gulf killfish
Bay anchovy
Tidewater silverside
Widgeon grass
Hermit crab
Saltmeadow hay
Grass shrimp
Black rush

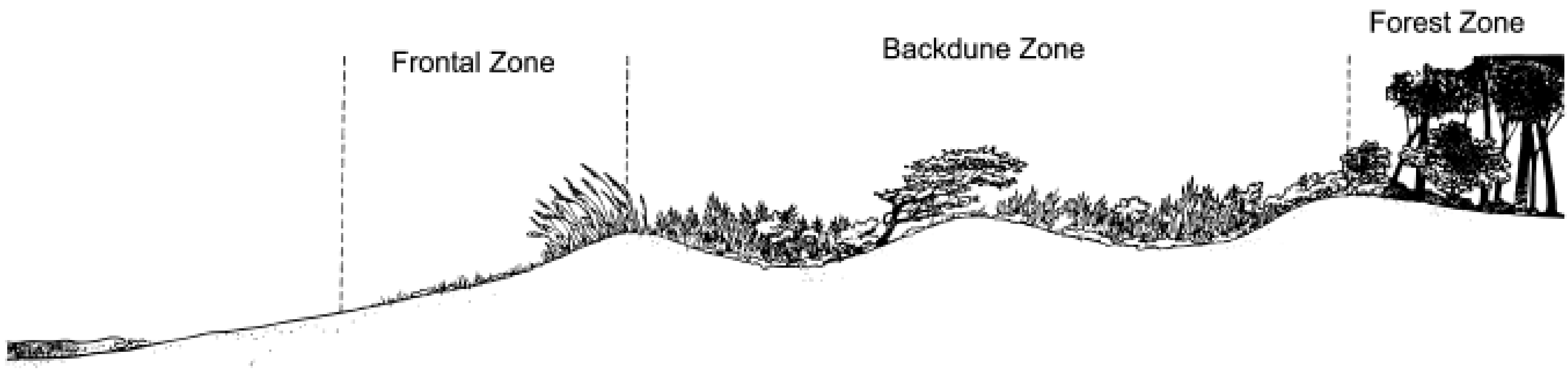

Snow geese
Marsh hawk
Forster's tern
Saltmarsh cordgrass
American coot
Double-crested cormorant
Bay anchovy
Marsh periwinkle
Blue crab
Oyster community
Spotted seatrout
Parchment worm
Red drum
Amphipod
Polychaete
Brown shrimp
Ribbed mussel
Saltmarsh cordgrass
Southern flounder

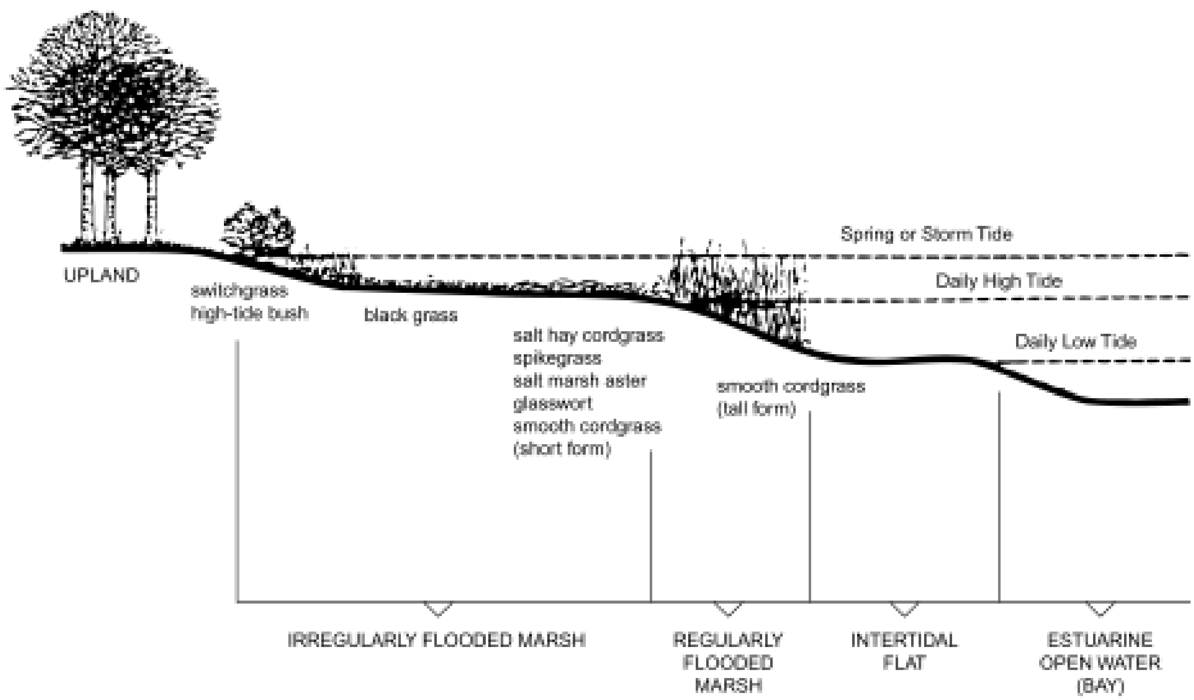
EFFECTS OF LOST SALT MARSHES

6-8



Two-thirds of the human population live on one-third of the world's land area adjacent to ocean coasts. Wetlands are drained for agriculture, housing, and industry. Man alters flooding patterns by constructing road embankments, canals with elevated spoil banks, and levees along streams. Ecological relationships are altered when man pollutes estuarine streams and lakes with sewage, fertilizers, and pesticides.


Frontal Zone
Backdune Zone
Forest Zone



A cross-section of a salt marsh.

LET'S GO FISHING!

6-8

SUBJECTS:
Biology, Ecology

TIME:
50 minutes

MATERIALS:
copies of state and federal fishing regulations for your area
student sheets

OBJECTIVES

The student will do the following:

1. List the freshwater and marine fish that are managed by state and federal regulations.
2. Explain the reasons for fishery management.
3. Discuss ethical/moral/legal reasons for abiding by regulations.

BACKGROUND INFORMATION

Overfishing, decreased habitat, and sometimes deteriorated water quality have caused a decline in some desirable fish populations. Management of a species may be mandatory if a species is to be saved from extinction. The National Marine Fisheries Service and, in most states, Departments of Conservation or Natural Resources are charged with monitoring fishery stocks and imposing regulations when necessary to protect a species. Fishing laws and regulations should maintain healthy fish populations while allowing recreational fishermen their sport and commercial fishermen the ability to make a living.

Regulations are flexible, changing from year to year to reflect changes in fish populations due to harvest, disease, predation, reproduction, weather, and so forth. In a good year, seasons may be extended or limits increased; in a bad year, seasons may be shortened and limits may be decreased. The objective is to maintain optimum numbers, with fish stocks neither depleted nor wasted.

Fishery biologists monitor the numbers of fish by sampling commercial and recreational catch tally reports of tagged fish, data on water quality, fish kills, bycatch, and weather events. After limits and seasons are set, enforcement is the province of the state departments of conservation, game and fish, and marine fisheries officers. Penalties include impoundment, fines, loss of license, and arrest.

<u>Terms</u>

bag limit: the number of a certain fish that can be caught each day.

bycatch: species other than shrimp that are caught in shrimp trawl nets

closed season: a time when a certain fish cannot be caught.

FL (fork length): the length of a fish from its mouth to the fork in its tail.

quota: the number or amount constituting a proportional share.

TL (total length): the length of a fish from its mouth to the end of its tail.

ADVANCE PREPARATION

A. Make copies for each student of the regulations for salt- and freshwater fish, the "catch" worksheets, and enough "fish" (slips of fish names) for each student to receive twenty slips (approximately 75 per page).

B. Cut the fish names apart.

PROCEDURE

I. Setting the stage

A. Discuss the students' knowledge of saltwater and freshwater fishing licenses, limits, and seasons for various game fish, who oversees compliance with regulations, and any anecdotes about confrontations with game wardens.

B. Ask them if they think fishing has changed much over the years (stories from parents or grandparents).

II. Activity

A. Tell the students to imagine they are going on a fishing trip. The weather is perfect, the fish are hungry, and everyone's having a wonderful time. Give them copies of fishing regulations and worksheet, and allow them to "catch" 20 fish each from your stock. Assign half the class to state waters and half to federal waters, and assign certain lakes and reservoirs by row or by lottery.

B. Ask the students to list on their worksheet each fish they caught, its size, and whether it was legal. Don't forget bag limits—even if the fish are legal size, you can only keep a certain number.

C. After they are all finished, find the tournament "winners" by number of fish, size, total number of fish inches, or any other categories you choose.

D. Select a couple of students to be "game wardens," checking on the legality of the "keepers" listed on the students' worksheets.

E. Ask the students the following questions:

   1. Were any illegal fish kept? Why might a fisherman try to bend the law a bit?

   2. Why shouldn't he or she?

III. Follow-Up

A. Ask the students to prepare graphs of their catches. Compare legal limits in state versus federal waters.

IV. Extensions

A. Invite a game warden as a resource speaker to class. Ask him or her to tell of the education and training required for his or her job description and to tell of interesting experiences he or she has had.

B. Find out more about the monitoring process. Visit a fish hatchery or tagging station. Ask a wildlife biologist to demonstrate the tests he or she makes on tagged fish (age using scales or otoliths, size, weight, range from release point, etc.).

RESOURCES

Cook, J. Coastal Concepts. Dauphin Island Sea Lab Special Report # 87-003.

Local Fish and Game, Wildlife Resources, or Marine Resources Departments.

Robins, C. Atlantic Coast Fishes. Houghton Mifflin, Boston, MA, 1986.

ling 30”
ling 33”
king mackerel 22”
spanish mackerel 14”
spanish mackerel 11”
bluefin tuna 28”
bigeye tuna 10 lb.
yellowfin tuna 6 lb.
white marlin 66” FL
sailfish 56” FL
red snapper 16”
vermillion snapper 10”
lane snapper 8”
misty grouper 10”
Nassau grouper 21” TL
black seabass 9”
Mako shark 50”
black seabass 11”
jewfish 300 lb.
red snapper 18”
scamp 6”
nurse shark 46”
lane snapper 7”
redfish 36”
bluefin tuna 24” FL
king mackerel 19”
mutton snapper 13”
ling 27”

ling 38”
king mackerel 20”
spanish mackerel 20”
red drum 12”
bluefin tuna 72”
bigeye tuna 6 lb.
yellowfin tuna 8 lb.
sailfish 58” FL
swordfish 65 lb.
red snapper 14”
yellow snapper 11”
gray snapper 12”
warsaw grouper 12”
black grouper 20” TL
amberjack 27”
blacktip shark 35”
amberjack 30”
red snapper 16”
red snapper 15”
scamp 18”
nurse shark 34”
lane snapper 8”
red drum 34”
bigeye tuna 8 lb.
king mackerel 23”
mutton snapper 14”
ling 34”
cobia 33”

king mackerel 24”
red drum 18”
redfish 20”
bluefin tuna 24”
bigeye tuna 7 lb.
blue marlin 85” FL
swordfish 60 lb.
blue marlin 90”
gray snapper 14”
mutton snapper 10”
red snapper 15”
speckled hind 7”
scamp 6”
jewfish 100 lb.
sand shark 30”
amberjack 36”
red snapper 17”
red snapper 14”
gag grouper 19” TL
tiger shark 60”
redfish 43”
cobia 33” FL
sailfish 58”
blue marlin 88”
mutton snapper 9”
speckled trout 15”
speckled trout 16”
striped bass 16”

striped bass 18”
black bass 10”
walleye 6”
sauger 12”
white bass 10”
yellow bass 12”
crappie 10”
crappie 13”
bream 6”
bream 7”
bream 8”
bream 9”
bream 11”
rainbow trout 10”
rainbow trout 13”
smallmouth bass 13”
largemouth bass 15”
speckled trout 13”
pompano 12”
striped bass 15”

striped bass 12”
black bass 16”
walleye 11”
sauger 14”
white bass 15”
yellow bass 13”
crappie 11”
crappie 10”
bream 6”
bream 7”
bream 8”
bream 10”
bream 12”
rainbow trout 9”
rainbow trout 14”
smallmouth bass 12”
largemouth bass 16”
pompano 16”
pompano 11”
striper 18”
striper 11”

black bass 14”
sauger 10”
sauger 15”
white bass 13”
crappie 9”
crappie 8”
crappie 8”
bream 7”
bream 8”
bream 9”
bream 10”
bream 13”
gar 15”
gar 20”
gar 24”
bream 12”

Assign half the class to be in federal waters, the other half in state waters. Assign certain lakes and reservoirs by rows or lottery.

A SAMPLE STATE RECREATIONAL FISHING CHART

SPECIES	ZONE	WHEN	BEST	SAMPLE STATE	FEDERAL	
					Size/Bag Limit	Size/Bag Limit
Amberjack	3, 4	year round	May – August	28” FL/3	same	
Black Grouper	4	year round	February – April	20” TL/5	same	
Bluefish	1, 2, 3	April – October	May – June	none	none	
Cobia (Ling)	2, 3, 4	April – October	April – May	37” TL/2	33” FL/2	
Croakers	1	year round	year round	none	none	
Dolphin (Mahi Mahi)	3, 4	May – October	July – October	none	none	
Flounder	1, 2	year round	November – February	none	none	
Jack Crevalle	1, 2, 3	April – October	July – August	none	none	
King Mackerel	2, 3, 4	April – October	July – October	none/2*	20” FL/2	
Pompano	2	April – October	April – October	12” TL/none	none	
Red Drum (Red Fish)	1, 2	year round	October – November	16” min – 26” max TL/3	CLOSED	
Sheepshead	1, 2	October – March	December – March	none	none	
Snapper (Red)	3, 4	year round	May – September	14” TL/7**	same	
Snapper (Vermillion)	3, 4	year round	May – September	8” TL/none	same	
Spanish Mackerel		2, 3	April – October	May – June	none/10	12” FL/10
Speckled Trout	1, 2	year round	September – December	14” TL/10	none	
Tarpon	1, 2	July – October	August	60” TL***	none	
Tuna (Yellowfin)	4	May – September	May – September	none	7 lbs.	
Wahoo	4	May – September	May – September	none	none	

LEGEND FL = Fork Length, measure tip of snout to fork in tail. TL = Total Length, measure tip of snout to tip of tail.

* = When federal season is closed, King Mackerel Bag Limit is reduced to 1 per person.

** = Bag Limit of 10 other snapper species combined (Gray, Mutton, and Yellowtail only) in addition to a limit of 7 Red Snapper.

*** = $50, tag required to possess, kill, or harvest each tarpon.

Zones: 1 = Bays, shorelines, wharves, inland waters, etc. 2 = Inshore waters of Gulf, off or near jetties, in surf, etc. (0-1 mile).
3 = Offshore blue water in open Gulf (1-9) miles). 4 = Deep water (10-60 miles).

NOTE: Bag Limits are PER DAY. Sample state waters = 0-3 miles; neighboring state waters = 0-9 miles. Federal waters = state boundary-200 miles.
ALL information subject to change. Contact State Marine Resources 968-7576.

FISH	SIZE	KEPT OR THROWN BACK

PICTURES, PEOPLE, AND POLLUTION

6-8

SUBJECTS:
Art, Biology, Language Arts

TIME:
one school day field trip plus 50 minutes in class

MATERIALS:
disposable camera for each group of five students
garbage bags
notebook for each student

OBJECTIVES

The student will do the following:

1. Chart types of marine litter, the causes, effects, and solutions for this problem.

2. Create a photo essay.

BACKGROUND INFORMATION

Certain visions and words automatically come to mind when describing a beach, lake, river, or pond: long expansions of snow white sand; sparkling, clean water with gulls methodically diving in and out; and rivers overflowing with an abundance of fish and other seafood.

The ocean covers about 70 percent of the Earth's surface. It is home to millions of fish, crustaceans, mammals, microorganisms, and plants. It is a vital source of food for both animals and people. Fishermen catch over 90 million tons of fish each year. Fish are the principal source of protein for many developing countries.

People also depend on the sea for many of their medicines. Marine animals and plants contain many chemicals that can be used to cure human ailments: an estimated 500 sea species yield chemicals that could help treat cancer.

Unfortunately, people have treated the sea as a dumping ground for thousands of years. Tons of garbage and sewage are dumped into the ocean each year. Industrial waste is also dumped into the sea. Types of marine pollution include heavy metals, toxic chemicals, pesticides, fertilizers, sewage, oil, and plastics.

Marine pollution frequently originates on land, entering the sea via rivers and pipelines. This means that coastal waters may be dirtier than the open seas, with estuaries and harbors badly affected. Some pollution enters the marine environment from the air when poisonous gases and aerosol particles drop into the sea. Additional pollution is actually created at sea by activities such as dredging, drilling for oil and minerals, and shipping.

<u>Terms</u>

pollution: contaminants in the air, water, or soil that cause harm to human health or the environment.

water pollution: the act of making water impure; the state of water being impure.

ADVANCE PREPARATION

A. Collect magazine pictures and articles or newspaper articles on types of marine litter.

PROCEDURE

I. Setting the stage

A. Show a video about marine pollution.

B. Use the magazine or newspaper articles and pictures to lead a discussion on types of marine pollution.

II. Activity

A. The students will be divided into groups of four or five and taken on a field trip to a local beach, lake, or river to photograph types of marine litter. Each group will be given a disposable camera.

B. Students will collect and chart the types of marine litter found to use for a school-wide display on marine litter.

III. Follow-Up

A. Have each group compile a photo-essay to present to the class.

B. Have the students prepare and display their collection of marine litter for the entire school to view.

IV. Extensions

A. Students can display their collection of marine letter at a local library or even another school.

B. Students can present their displays and photo essays at the school P.T.A.

RESOURCE

Marine Pollution: http://www.panda.org/research/facts/fct_marine.html

PLASTIC WASTE

6-8

SUBJECTS:
Chemistry, Ecology, Social Studies

TIME:
50 minutes

MATERIALS:
plastic waste from home
outside or plastic litter
student sheets

OBJECTIVES

The student will do the following:

1. Describe the effects of plastic waste on aquatic wildlife.

2. Identify specific actions they can take to help remedy the problem.

BACKGROUND INFORMATION

Plastics are made from synthetic resins such as acrylic, cellophane, celluloid, Formica™, and nylon, which are moldable when they are heated. For this reason, plastics can be made into different shapes and put to a variety of uses. Some plastics become resistant to heat after they have been molded. This type can be used for cooking since it does not melt from the heat.

Plastics are extremely versatile, cheap to make, and lasting. For these reasons, plastics have revolutionized life in the twentieth century. Houses, offices, factories, cars—all contain items made from plastic. Because of their many benefits and favorable properties, the use of plastics is unlikely to decline.

The advantages of using plastics, however, can lead to disadvantages for the environment. The fact that plastic is cheap means that very often it is used to make low-value items such as bags and bottles that people do not bother to keep. It is also used by manufacturers and shops for packaging. This means that it usually gets thrown away as soon as people get their purchases home.

People throw away thousands of tons of plastic each year. It is estimated that by the year 2000, the amount of plastic we throw away will increase by 50 percent. Examples of plastic pollution include plastic holders for beverage cans, plastic bags, and lost or discarded fishing line. As a result of plastic pollution, millions of mammals, birds, reptiles, and fish die every year.

Plastic waste creates particularly severe problems at sea, where it entangles marine wildlife and gets eaten. A recent US report revealed that 100,000 marine mammals die each year because they eat or become entangled in plastic rubbish. Entangled plastic may kill slowly over a period of months or years, biting into the animal, wounding it, and causing it to lose blood or even limbs. Worldwide, 75 seabird species are known to eat plastic articles, which remain in their stomachs, blocking digestion, and possibly causing starvation. The world's sea turtle population has been greatly affected by plastic pollution. Turtles choke on plastic bags that they have mistaken for jellyfish. Plastic litter can be found on land as well as in the marine environment. Plastic holders for beverage cans, plastic bags, and lost or discarded fishing line on land can also be damaging to wildlife.

Terms

aquatic life: plants, animals, and microorganisms that spend all or part of their lives in water.

litter: rubbish discarded in the environment instead of in trash containers.

marine: of or relating to the sea.

nonbiodegradable: materials that cannot be broken down by livings things into simpler chemicals.

pollution: contaminants in the air, water, or soil that cause harm to human health or the environment.

ADVANCE PREPARATION

A. Have students collect and save every piece of plastic waste produced in their home for a two-day period.

B. Have students clean all plastics at home before bringing them to school.

C. If possible, enlarge the plastic code system to poster size or make a transparency of it.

PROCEDURE

I. Setting the stage

A. Discuss plastics in background information. Ask students questions about places where they have seen plastics lying around.

II. Activities

A. Ask students to separate their plastics into categories according to the Plastic Code System and list them on the Plastic Code Analysis Sheet. Have them classify the plastics in terms of how they might be perceived by aquatic wildlife as food, e.g., very likely to be perceived as food, somewhat likely, or unlikely. Have the students with plastic code 1 items hold them up for the class to see. Repeat with each code number so students have a good idea of which items belong in each category. Identify the species that might attempt to eat the plastic.

B. Ask the students to hypothesize about how these materials might affect aquatic animals. Provide literature for them to check their hypothesis.

C. Ask students to summarize what they have learned about the potential hazards to aquatic wildlife from plastic waste material.

D. Ask students to list their collected litter by classifications given to plastics by the American Plastics Council. Which were most prevalent? Why?

II. Follow-Up

A. Invite the students to survey the school yard for plastic litter. Then have them separate the plastics into categories and identify them. Why might these certain types of plastics be found on a school campus? Investigate the negative impact on animals in the community. If there is damaging plastic litter in the school yard ask the students to create an action plan that will increase awareness of the problem and help take care of it by setting up a plastic recycling depot.

III. Extensions

A. Have students contact local environmental, animal welfare, and wildlife groups to see what is being done about the impact of litter on local wildlife and if specific help is needed.

B. Have students establish a litter patrol. Target areas in your school yard. Establish scheduled tours of these areas to pick up plastic and other forms of litter.

RESOURCES

Aquatic Project Wild, Western Regional Environmental Education Council, 1987. Project WILD and Aquatic WILD, PO Box 18060, Boulder, CO 80308-8060, (303) 444-2390.

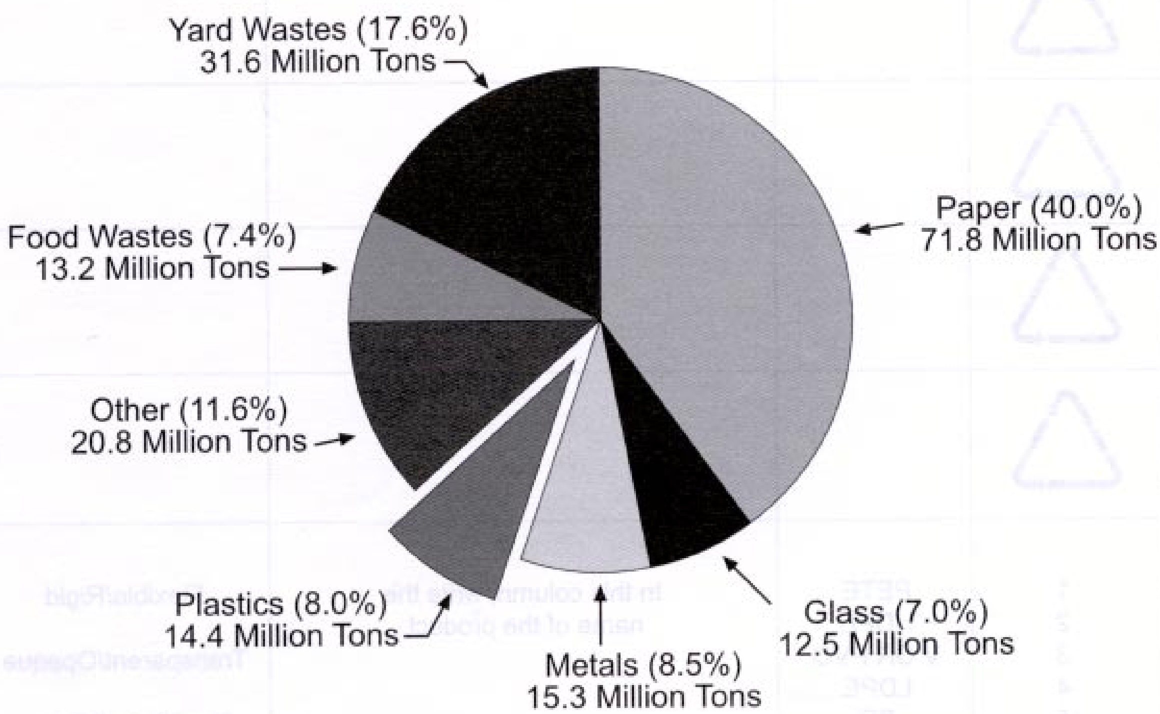
EPA Environmental Fact Sheet: http://es.inel.gov/techinfo/facts/epa/plstc4fs.html

Plastic Pollution: http://www.panda.org/research/facts/fct_plastic.html

Plastic Container Code System
(found on the bottom of coded containers)

Code	1	2	3	4	5	6	7
Abbreviation	PET	HDP	V	LDP	PP	PS	OTHER
Full Name	Polyethylene Terephthalate	High Density Polyethylene	Vinyl	Low Density Polyethylene	Polypropylene	Polystyrene	Other resins or a mixture of resin types
Percentage of Total Bottles	20 - 30%	50 - 60%	5 - 10%	5 - 10%	5 - 10%	5 - 10%	5 - 10%
Can Be Transparent	Yes	No	Yes	No	Yes	Yes	Yes
Typical Containers	soft drink, instant coffee	milk, laundry detergent	liquid dish soap, peanut butter	grocery bags, coffee can lids	deli tubs, bottle caps, straws	foam cups, trays, egg cartons	catsup and syrup bottles

Materials Generated in MWS by Weight, 1988



(Source: Characterization of Municipal Solid Waste in the United States: 1990 Update: U.S. EPA)

Plastic Code Analysis

NUMBER SYMBOL	LETTER CODE	PRODUCT	OBSERVABLE PACKAGE PROPERTIES
1 2 3 4 5 6 7	PETE HDPE V OR PVC LDPE PP PS OTHER	In this column, write the name of the product.	Flexible/Rigid Transparent/Opaque Translucent/Color White crease when crushed

POLLUTION . . . POLLUTION . . . POLLUTION

6-8

SUBJECT:
Art, Chemistry

TIME:
2 class periods

MATERIALS:
poster board
markers
magazines for pictures

OBJECTIVES

The student will do the following:

1. List specific types of water pollution.

2. Design a poster or T-shirt logo depicting specific types of water pollution.

BACKGROUND INFORMATION

Household chemical, fertilizers, and heavy metals are all hazardous materials. Worldwide, over 70,000 different chemicals are used daily, and each year between 50 and 1000 new synthetic compounds are introduced. More than six billion tons of waste are disposed of annually in the United States. Of that, 270 million tons—enough to fill the New Orleans Superdome 1500 times—are hazardous. Some of this waste is chlorine, which destroys aquatic habitat by upsetting the levels of the water and killing certain species of blue-green algae. Pesticides such as DDT have brought several bird species to the brink of extinction. Heavy metals, such as mercury, in water supplies can have a damaging effect on unborn fetuses. The list of hazardous materials could go and on. Some specific types are described in the following information.

Many of the shelves, coasts, lakes, and estuaries within U. S. waters, particularly near urban centers, contain polluted sediment. Heavy metals, radioactive waste, organic chemicals, and nutrients have been introduced to these environments through natural processes, by intentional disposal, and by accidental spills. The contaminants are derived from both point sources, such as industrial discharge and sewage treatment plants, and non-point sources, such as agricultural and urban runoff and atmospheric deposition. The presence of such materials in the Nation's coastal waters and lakes and their accumulation in sediment have created problems associated with health and safety, biological resources, and recreational activities. Dredging and environmentally sound disposal of contaminated and non-contaminated material is essential to the commercial viability of many U.S. ports. There is considerable public concern and political attention focused on the impact of past and present use of our waters as waste disposal sites.

It's easy to blame industry for putting toxic chemicals in the ocean, but have you looked under your sink or on the basement shelf lately? As much as 25 percent of all toxic waste originates in the home. Anything we put down the sink or toilet will eventually make its way to the ocean. Toxic chemicals are present in many cleaners, paints, antifreezes, solvents, and prescription drugs.

About 97 percent of marine litter comes from people who unthinkingly or intentionally throw garbage onto beaches or into the water. The other 3 percent is lost fishing gear. Pollution is not only an eyesore , it can injure, or even kill, marine wildlife. Animals often become entangled in ropes, six-pack rings, nets, and other refuse. Plastic bags, plastic fragments, and foam pieces are often mistaken for food. In one study in which 58 seabirds were sampled near the British Columbia coast, 75 percent had plastics in their stomachs.

When the Exxon Valdez ran aground, it spilled 42 million liters of oil. However, according to the Southam News Agency Environment Project, every year in Canada alone, 300 million liters of motor oil "vanish" into the environment. That's equivalent to seven and one-half Exxon Valdez disasters each year. Where does the oil go?

In reality, oil spills or engines leaking onto roads and driveways, or spilled fuel from automobiles and boats, all must go somewhere. These petroleum products are most often washed down storm drains where they ultimately flow out to the ocean. Oil spilled directly in the sea is another serious problem. It is estimated that 10 million liters of oil enter Georgia and Juan de Fuca Straits from the bilges of ships and pleasure boats each year.

Air pollution is not just a problem to the air – it's also a problem to the ocean. Car exhaust, wood burning, industrial emissions, sprayed herbicides and pesticides all add contaminants to the air which fall back to Earth when it rains. These polluting particles often fall directly in the ocean since most human populations live near the coast. Once air-borne pollutants enter the ocean, they can be absorbed by animals and plants in the plankton and enter ocean food chains.

Human sewage can contain intestinal bacteria, disease-producing organisms, viruses and eggs of intestinal parasites. About half of the dry weight of human solid waste is bacteria. One of the bacteria present in the feces of humans and other animals is the coliform bacteria, *Escherichia coli*, or *E. coli*. Ocean water samples are tested for the presence of *E. coli* using a "coliform count." Beaches are often closed and shellfish harvesting prohibited due to high coliform counts.

Terms

pollution: contaminants in the air, water, or soil that cause harm to human health or the environment**.**

marine pollution: pollution found in the oceans, bays, or gulfs.

ADVANCED PREPARATION

A. Show a video on marine animals and their habitat.

B. Gather materials/products that cause pollution and magazines with pictures of products of pollution.

PROCEDURE

I. Setting the stage

A. Have a discussion using many visuals (especially actual products of pollution), pictures, or slides to help students identify types of pollution.

II. Activities

A. Have students do research to identify specific types of pollution. Research should include the following:

1. Disposal of pollutants.

2. Intended use of pollutants.

B. Students will design a poster or T-shirt depicting types of pollution.

III. Follow-Up

A. Students will turn in a written report on water pollution and its effects on the environment.

IV. Extensions

A. Students may present their reports in class.

B. Clubs might adopt the logo to be placed on their club T-shirt (Example: Science Club).

RESOURCES

365 Ways to Save Our Planet, Page a Day Calendar, Workman Publishing, New York.

Hazardous Waste: http://www.runet.edu/~geog-web/GEOG340/HazWasteProb.html

Marine Pollution: http://www.panda.org/research/facts/fct_marine.html

Pollution: http://walrus.wr.usgs.gov/docs/natplan/pollution.html

http://oceanlink.island.net/marpoll.html

SALT TOLERANCE OF PLANTS

6-8

SUBJECTS:
Botany,Math,Geography

TIME:
The experiment runs over a six-week period; in-class time 2-3 periods

MATERIALS:
four plants per pair of students
markers
poster paper
salt
rulers
student sheets

OBJECTIVES

The student will do the following:

1. Identify plants which can tolerate various levels of salt.

2. Demonstrate the steps of the scientific method by working through a classroom experiment.

3. Compare classroom results to actual plants found in a wetlands habitat.

4. Locate geographic areas of natural wetlands.

BACKGROUND INFORMATION

Salt marshes are a type of coastal wetland that occurs in temperate estuarine environments. These areas are flooded by incoming tides carrying saltwater. Salt marshes can also receive an inflow of freshwater from rivers, runoff, or groundwater. Freshwater inflow is important in diluting the salinity of the system. Salinity is the major stressor in this type of wetland system and limits species to those that have evolved adaptive mechanisms for living in a salty environment. Plants that have adapted to living in salty environments are called halophytes.

Salt marshes are flooded during high tide. As the tide recedes, land becomes exposed again. During this time the marsh often receives freshwater runoff. The plants in the high marsh, or irregularly flooded part of the marsh, are only covered on extremely high tides. The plants of the low marsh, or regularly flooded part of the marsh, are flooded daily by high tides. This produces an obvious distribution of plants that are adapted to specific conditions within the marsh. Plants are found in distinct zones as a result of salinity and tidal fluctuations. Plants living in the low marsh are limited to species that are extremely tolerant of water-logged soils.

Smooth cordgrass *(Spartina alternaflora*) is an example of a species that grows in the low marsh. Irregularly flooded marsh vegetation is more diverse. Species that grow in this area include salt marsh hay *(Spartina patens*), salt grass *(Distichlis spicata),* black grass *(Juncus gerardii)*, and black needle rush *(Juncus roemerianus)*. Both smooth cordgrass and black needle rush have a “short” and “tall” form. In both species, the tall forms occupy the areas closer to open water (low marsh). The short forms occupy the areas that are less frequently flooded (high marsh).

<u>Terms</u>

habitat: the arrangement of food, water, shelter, and space suitable to animal’s needs.

marsh: wetland dominated by grasses.

population: the organisms inhabiting a particular area or biotope.

salinity: an indication of the amount of salt dissolved in water.

wetland: an area that is regularly wet or flooded and has a water table that stands at or above the land surface for at least part of the year.

ADVANCE PREPARATION

A. Contact any wetlands research area, if possible, and request information on the plants associated with the various water levels found in wetlands. Display in the classroom any posters or resource information that may be available.

B. Discuss background information with students. Show a film by Bill Nye, the Science Guy, about wetlands.

PROCEDURE

I. Setting the stage

A. Explain the importance of wetlands to students. Ask them to think about various reasons why some plants might not grow in a wetland environment.

II. Activity

A. Students will work with a partner. Each pair will need four plants of the same species and as close to the same size as possible. Make sure that each group uses different types of plants so that many different groups are represented.

B. Students will measure each plant and various mixtures of water and saltwater over a period of time. The experiment must last at least one month for results to be effective.

C. Keeping accurate records is extremely important so that the resulting graphs are accurate and easily comparable.

D. At the end of the experiment, each pair produces a graph of the data that has been collected. Use different colors to represent each of the four plants. Line graphs and bar graphs work well and are easy to see at a glance.

E. As a class, compare which plants grew better than others and therefore were better able to tolerate the salt.

III. Follow-Up

A. If possible, take a field trip to a local wetlands area. Any marsh, bog, or similar area will do. Observe the plants that are located in the area.

B. Each pair will produce a poster of plants found in a typical wetlands environment.

IV. Extensions

A. Use a world map and locate areas which may have natural wetlands and then research them to see if the habitats are still undisturbed.

B. Students will write letters to local, state, and government agencies that govern the destruction of wetlands, either for development or agriculture. Students will research programs that affect wetlands and remember the EPA wetlands hotline: 1-800-832-7828.

RESOURCES

The Alabama Cooperative Extension Service Publications, 1994.

Bill Nye the Science Guy videos. Available from Bill Nye, Outreach Dept., KCTS, 401 Mercer, Seattle, WA 98109.

Dennison and Berry, Wetlands: Guide to Science, Law, and Technology, Noyles Publications, Park Ridge, NJ, 1993.

Irby, B., McEwen, M., Brown, S., and Meek, E., Marine Habitats, University Press of Mississippi, Hattiesburg, MS.

Project Wet: Curriculum and Activity Guide, Watercourse and Western Regional Environmental Education Council, 1995. Obtain from Project Wet: Water Education for Teachers, 201 Culbertson Hall, Montana State University, Bozeman, MT 59717-0057 (Fax: 406-994-1919; e-mail: rwwet@msu.oscs.montana.edu).

Tidal Salt Marshes: http://h2osparc.wq.ncsu.edu/info/wetlands/types3.html#sur

Directions: Record your procedures and observations on this sheet. Write the actual dates (every three days) at the top of the chart. You will graph your results on a separate sheet of graph paper. (NaCl is sodium chloride, or salt.)

Date													
Plant 1 water only	height												
	color												
Plant 2 water & NaCl													
Plant 3 water & _____ NaCl													
Plant 4 water & _____ NaCl													

SEA LEVEL RISING

6-8

SUBJECTS:
Earth Science, Math, Geography, Language Arts

TIME:
5 class periods plus a day for field trip

MATERIALS:
notebook and pencil for information gathering
appropriate materials (suggested by students) for writing and presenting proposals (overhead transparencies, computer-generated visuals, pictures, samples taken, etc.)
teacher sheets

OBJECTIVES

The student will do the following:

1. List suggestion strategies for coping with possible effects of sea-level rise in coastal areas.

2. Investigate and graph the sea-level stages from one year to the next.

BACKGROUND INFORMATION

Increasing atmospheric concentrations of carbon dioxide and other greenhouse gases (Example: methane, nitrous oxide, ozone in the troposphere and stratosphere, and chlorofluorocarbons) are resulting from human activities such as the burning of fossil fuels. Increased carbon dioxide levels could cause the climate to warm. Scientists refer to this process as global warming. Global warming could result in changes in rainfall patterns, changes in sea level, and changes in ecosystems. This amounts to a serious environmental threat has never before been experienced in human history.

The global mean sea level may have already risen by around 15 centimeters during the past century. Climate change is expected to cause a further rise of about 60 centimeters (2 feet) by the year 2100. Forecasts of a rising sea level are based on tentative climate model results, which indicate that the Earth's average surface temperature may increase by 1.5-4.5^{o}C over the next 100 years. This warming would cause the sea to rise in two ways: through thermal expansion of ocean water and through the shrinking of ice caps and mountain glaciers. Sea level would not rise by the same amount all over the globe due to the effects of the Earth's rotation, local coastline variations, changes in major ocean currents, regional land subsidence and emergence, and differences in tidal patterns and sea-water density. Higher sea levels would threaten low-lying coastal areas and small islands. The forecasted rise would put millions of people and millions of square kilometers of land at risk.

ADVANCE PREPARATION

A. This activity could be used during a unit on current environmental issues.

B. Prior to the activity, students should have studied global warming and sea-level rise in other coastal regions.

PROCEDURE

I. Setting the stage

A. This activity may be conducted in any coastal area.

B. Students will take a field trip to a shore to gather data for this activity.

C. They can observe (1) a marsh area, (2) a ship-building or industrial area, (3) a waterfront area, (4) a residential area, or (5) an unpopulated beach.

D. At each area, the teacher will indicate the height to which the sea level might rise if it rose two feet.

Students will understand that this amount of sea-level rise cannot be accurately determined at this time, and that an educated guess will have to be made. This should not affect the impact of the activity.

E. For the marsh area, students will note how the predicted sea-level rise would affect plants and animals. They will also note if there is sufficient undeveloped upland area for the marsh to move further inland.

F. For the other areas, students will concentrate on buildings and other structures that would be affected and the economic impact in terms of job loss, etc.

II. Activity

A. In class, students will use the information they gathered to develop a long-term strategic plan for the area.

B. They will form three planning teams—one representing the marsh area, one the ship building or industrial area, and one the waterfront property.

C. Each team will elect a "Coastal Planning Manager."

D. Using ideas from coastal action plans for sea-level rise in other coastal areas and their own ideas, teams will develop a series of proposals to help deal with the problems they identified.

E. Each team will present their proposals to the class. (Teams may decide on the manner in which they want to record and present the proposals.)

F. The class may suggest modifications to the proposals. When proposals are finalized, they will be typed and copied for each student.

III. Follow-Up

A. Students can present proposals to local government officials. They can urge the officials to consider the possible effects of sea-level rise in long-range planning.

B. Using a computer, students can print out their finalized proposals in large type or banner-style. They can then post these in a highly visible area of the school.

C. Students can start an "Environmental Solutions" display. Beginning with sea-level rise strategies, they would list and display solutions for each environmental crisis they study.

IV. Extensions

A. Ask students to imagine they are a city official in a coastal area. Have them describe the problems they envision concerning sea-level rise and strategies they would suggest for coping with them.

B. Have students identify the causes of the predicted rise in sea level. What strategies could they suggest for reducing the possibility that a rise in sea level will occur?

C. Have students describe the ideal coastal city, taking into account the predicted rise in sea level. Have them draw a map showing the locations of structures in their city.

RESOURCES

Biological Science: An Ecological Approach, Kendall/Hunt Publishing Company, Dubuque, Iowa, 1992.

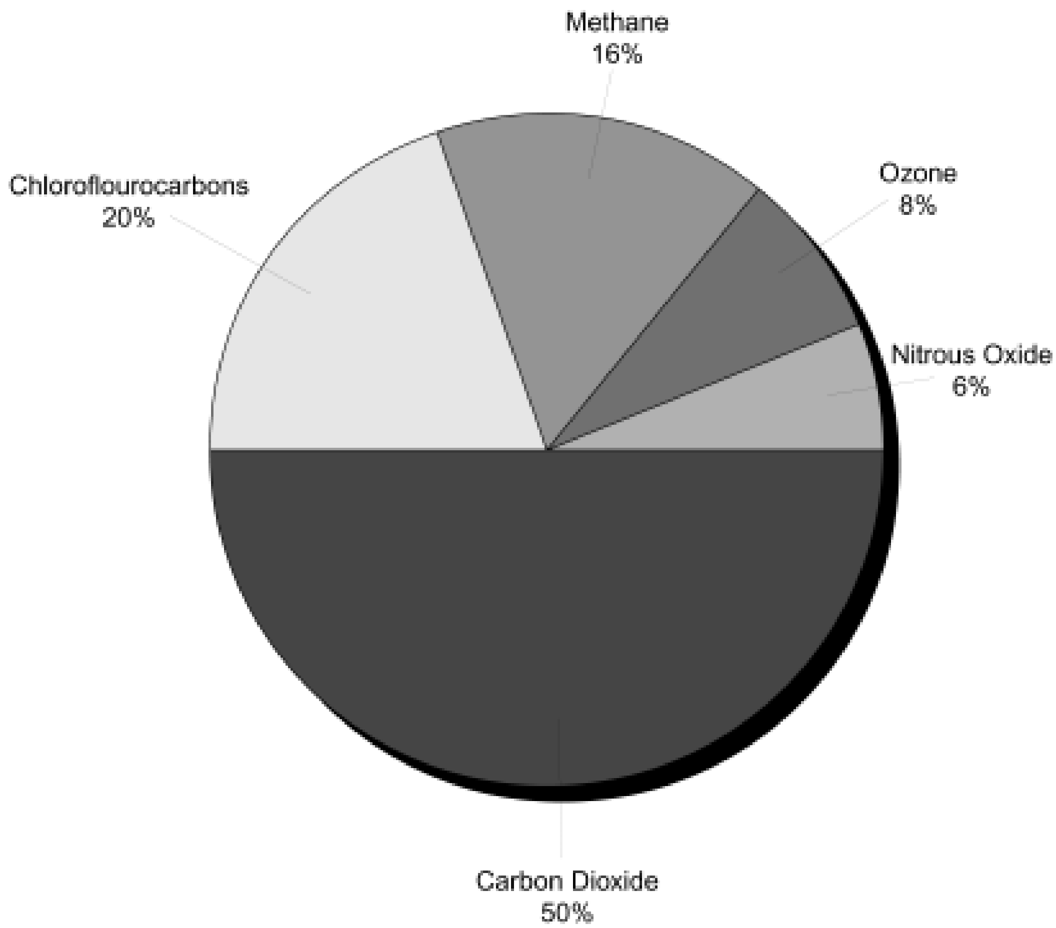
Climate Change and Sea-Level: http://www.unep.ch/iucc/fs102.html

Cownaw, Gregory. “The Significance of Rising Sea Levels,” The Science Teacher, January, 1989.
Global Warming: http://se.eorc.nasda.go.jp/GOIN/JMA/htdocs/jmamajor/gwarm.html

Earth Science, Prentice Hall.

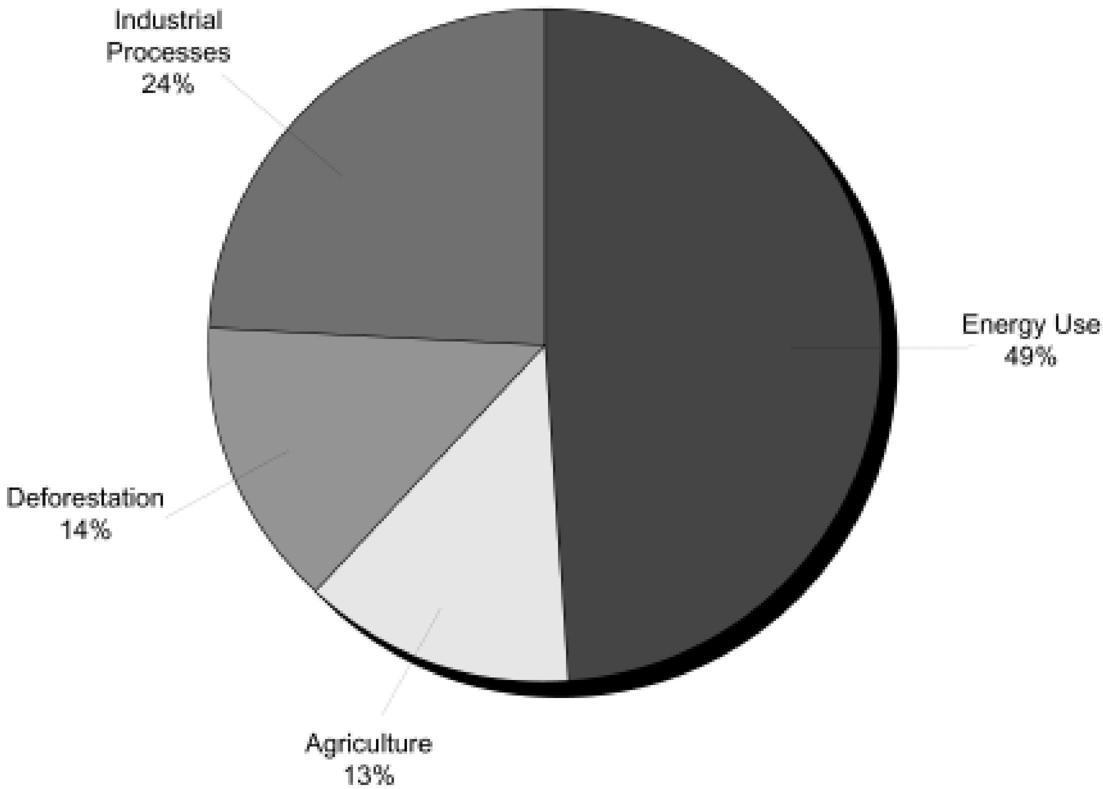
Handout titled “Planning for Relative Sea Level Rise,” and The Rising Seas, Video (28 min.), Educational Dimensions/McGraw-Hill, 1988.

Marine Law Institute, University of Maine School of Law, April, 1992.



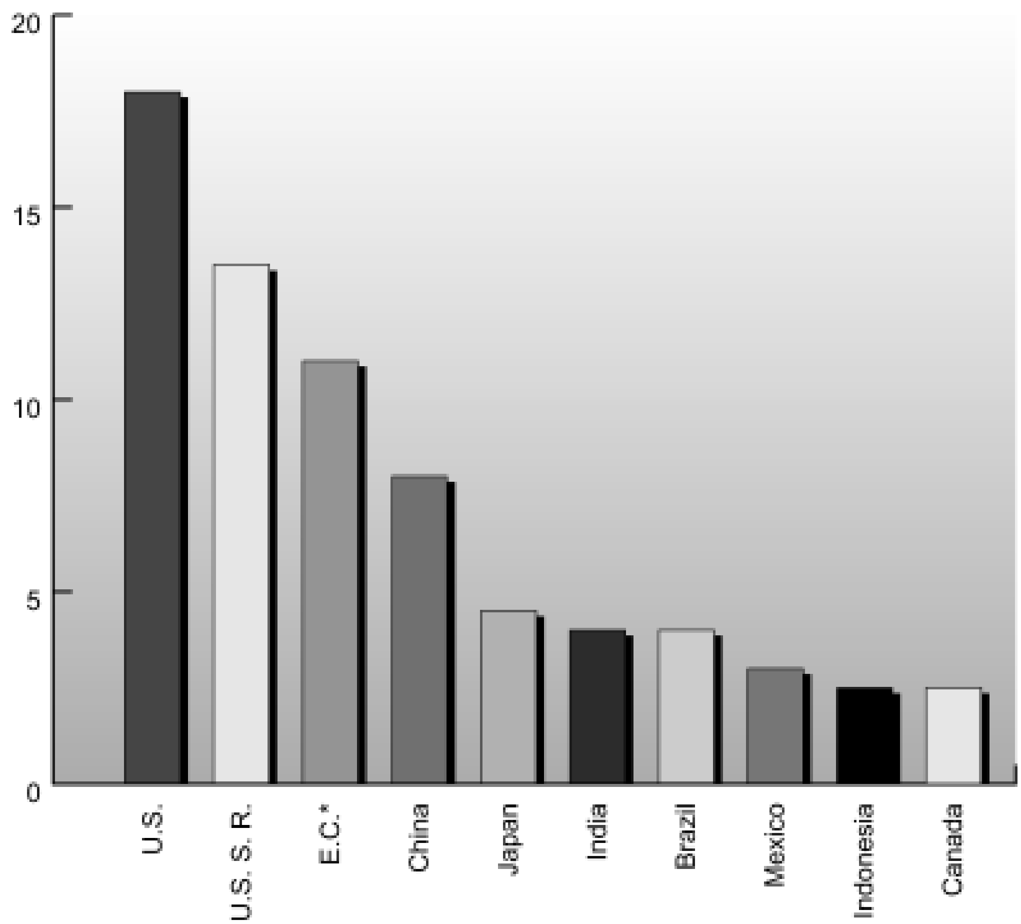
Relative contribution to global warming (percent of expected climate change) by anthropogenic (human-caused) releases of gases into the atmosphere. Notice that while far less methane and flourocarbons are released than carbon dioxide, they still are very powerful "greenhouse" gases.

Source: World Resources Institute and the United Nations Environment Programme.



Contributions to global warming by different types of human activities in 1990.

Source: Data from World Resources Institute.



Countries with the highest greenhouse gas emmissions in 1989. These countries account for two-thirds of all global warming.
* The European Community (EC) is comprised of 12 countries in Western Europe.

Source: Data from Intergovernmental Panel on Climate Change.

WAVE ACTIONS

6-8

SUBJECTS:
Earth Science, Physical Science

TIME:
2 class periods

MATERIALS:
1 plastic basin per group
sand
variety of small plants (monkey grass, etc.)
small houses (such as those from a Monopoly™ game)
drawing paper
markers or colored pencils
one aquarium for demonstration purposes
teacher sheets

OBJECTIVES

The student will do the following:

1. List ways in which the actions of waves affect shorelines.

2. Predict the impact of beach erosion when coastal vegetation is removed.

3. Compare high-energy wave environments with low-impact tidal zones.

BACKGROUND INFORMATION

A tremendous amount of energy exists in ocean waves. A wave is formed when the water's surface is disturbed. Waves consist of two motions: the forward progress of the energy of the wave (this energy originally came from the wind) and the circular motion of the water particles, which are being displaced by the moving energy.

There are different levels of energy attributed to various shorelines. This variation in tidal energy causes the formation of different habitats and, therefore, a significant difference in the organisms found living there. Waves and local currents interact with the shoreline, creating a high-energy environment.

The sediments that form our beaches are constantly moved and reshaped by winds, waves, and currents. A 50-meter wide beach can be created or removed by a single violent storm. Similarly, barrier islands and sandbars appear and disappear over time.

Early inhabitants of coastal areas recognized that the coastal beaches were hazardous places on which to live, and they settled on the bay side of barrier islands or as far upstream on coastal rivers as was practical. Modern residents, however, place high value on living on beach front property.

Construction on beaches and barrier islands, however, can cause irreparable damage to the whole ecosystem. Vegetation on beaches holds shifting sands in place. Damaging or removing beach vegetation to make way for construction promotes beach erosion and eliminates habitats for indigenous coastal species.

<u>Terms</u>:

crest: something forming the top of something else, such as the crest of the wave.

indigenous: native to or living in a specific area.

longshore current: a current that moves parallel to the shore.

trough: the lowest point in a wave; also a channel for water; a long channel or hollow.

wave frequency: the number of waves that pass a certain point in a given amount of time.

wave height: the distance from a wave's trough to its crest.

wavelength: the distance from a certain point on a wave, such as the crest, to the same point on the next wave.

ADVANCE PREPARATION

A. Discuss the shoreline with your students. List the vocabulary words on the board and discuss each definition.

B. Prepare plastic trays with sand and divide plants into group size numbers for the student groups.

C. Set up an aquarium of soil, freshwater, and plants. Leave this in the classroom as a demonstration of a calm lake environment with low tidal impact.

PROCEDURE

I. Setting the stage

A. Show students the materials and have them design (as a group) how they will use them to represent a shoreline.

B. Ask the students if they have ever been to a shore. List on the board some of the characteristics that they noticed. Pay particular attention to whether or not plants are mentioned.

C. Have students make a visual comparison between the particles of sand and some gravel from a local area.

II. Activity

A. Divide students into cooperative groups of four students. Each group will use one basin, sand, and plants to design a beach-front environment. They may use any features (such as Monopoly™ houses, etc.) to make the beaches as individual as they wish.

B. Fill the basin with water up to the created shoreline.

C. Ask students what the main differences are between their shoreline and the simulated lake environment in the teacher demonstration.

D. The students will tilt the basin back and forth, very slowly at first, to simulate the actions of waves. As the intensity gets greater, they will notice any changes in the beach environment.

E. Next, have the students remove all plants, and have some groups flatten out any dunes that had been created. They may want to leave buildings in place. Create wave action again with the tilting of the basin. Pay close attention to any changes in the shoreline.

III. Follow-Up

A. Ask your students to look for newspaper articles that are related to beach erosion. Read and discuss them in class.

B. Have the students turn in (by group) a written description of their shoreline and the consequences of wave action on it.

IV. Extensions

A. Take a field trip to a local shoreline, if possible. Have students draw what they see and compare this to their classroom shore.

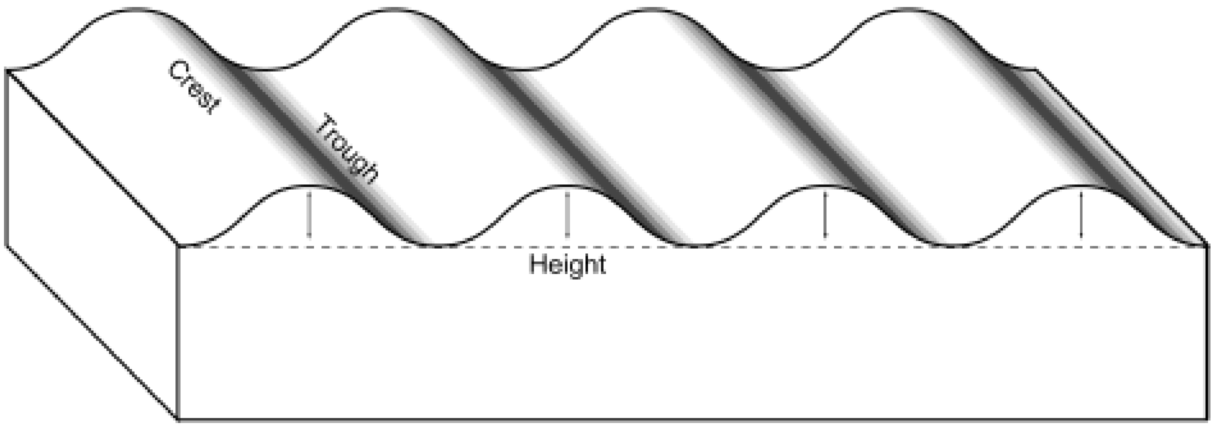
B. Ask the students to use reference materials to discover the various animals that live in an active high-energy wave zone and design a bulletin board to reflect these animals and how they have adapted to such a dynamic environment.

RESOURCES

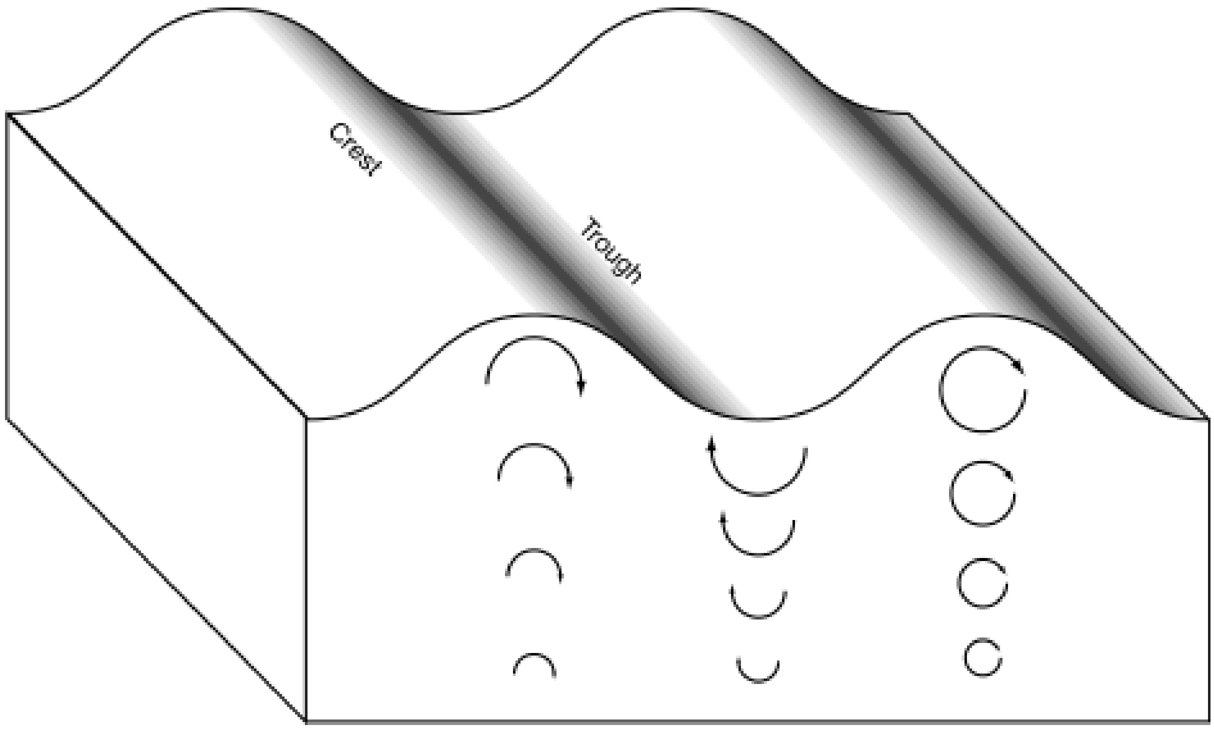
Cunningham, William P. and Barbara Woodsworth Saigo, Environmental Science: A Global Concern, Wm. C. Brown Publishers, Dubuque, Iowa, 1995.

Duxbury, Alison B. and Alyn C. Duxbury, Fundamentals of Oceanography, Wm. C. Brown Publishers, Dubuque, Iowa, 1996.

Ocean Waves: http://www.users.interport.net/~jbaron/waves.html



Parts of a Wave



Water Movement in a Wave

ROLE-PLAYING GAME

SUBJECTS:
Ecology, Drama

TIME :
2 class periods

MATERIALS:
copies of the illustrations of the farm and proposed development
copies of the character descriptions
student sheets

OBJECTIVES

Students will be able to:

1. List ways that development can impact wetlands and its habitants.
2. Present the interests of townspeople affected by development.
3. Present the reasons for the state, county, or town to purchase land or change zoning laws to preserve wetland as a student learning center.

BACKGROUND

Wetlands provide a healthy habitat for many different species of plants and animals. They depend on this environment for their survival. The total percentage of wetlands is decreasing every year at a rapid rate. This depletion is caused by many factors, most all caused by humans. Humans have blocked rivers, which are the main source for the water in these areas. The dams are built to provide energy, water, and food to the inhabitants upstream. Another reason that wetlands are disappearing is development. The moist rich soil is very attractive to farmers. Most farmers do not realize the effect they are directly having on the environment. Birds and other species of wildlife that once lived in the wetland are forced to find somewhere else to live.

Terms

development: a process by which the natural environment is altered to serve the needs of humans.

proposal: a plan for some activity that must be approved by one or more other people.

wetland: an area that is wet or flooded and has a water table that stands at or above the land surface for at least part of the year.

ADVANCE PREPARATION

A. Discuss with students the importance of wetlands and the diversity of organisms that live there.

B. Photocopy the illustrations of the Old Tillage Farm and the proposed development. A sketch or enlarged photocopy of both situations could also be hung on the board for marking up at the public meeting.

C. Discuss the Robert's Rules of Order for the actual town meeting.

PROCEDURE

I. Setting the Stage

A. The purpose of this activity is to have students play the roles of townspeople with conflicting interests at a public hearing on a new development that may have a negative impact on local wetlands.

B. Stress how their decision could affect different aspects of the environment in the future.

II. Activity

A. Hand out the illustrations of the Old Tillage Farm and the proposed development.

B. Next, read the situation to the class.

C. Assign the character roles to different students (or have them draw character names). Students who don't have specific roles to play can be townspeople.

D. Give them time to develop and become their characters as well as develop their positions on the issues. Students should talk with each other in character and develop relationships with other townspeople having similar feelings.

E. When it is time for the public meeting, the planning commission chair (either the teacher or an appointed student) should introduce the chair of the Waterton Zoning Board of Adjustment and start the meeting by having the developer present his proposal. Each person should take a turn presenting his/her views. The planning commission chair should decide how much exchange is allowed during the discussion. Alternatives to the developer's proposal should be sketched and discussed. The meeting should end with the chair of the Waterton Zoning Board of Adjustment reaching a decision that tries to protect the wetland ecosystems and address the needs and concerns of the community.

III. Follow-Up

A. Discuss the town meeting. Talk about issues that were brought up and how important they were to the real issue of development. How realistic was the town meeting?

IV. Extension

A. Visit a city council meeting in your area. Write a report predicting what effects a proposed development in the area may have on the environment.

RESOURCE

This wetland "Role Playing Game" is reprinted with the permission of the author, Catherine Kashanski, Vermont Agency of Natural Resources, Water Quality Division, 9 Bailey Avenue, Montpelier, VT 05401.

THE SITUATION

Waterton is a small rural community of 950 residents. Its village center has a general store, hardware store, and a small service station. Most people in Waterton know each other or at least know of each other. No major change or development has occurred in town up until this time–growth has been slow and incremental. Recently, however, the Old Tillage Farm was sold to a development company in order to pay inheritance taxes when Sarah Tillage died. The developer has plans to subdivide the land and build 14 new houses. The farm includes Perch Pond, a shallow pond with a large marsh and shrub swamp on its northern end, as well as a wet meadow wetland located on Creeping Creek, downstream of the pond. The proposed development calls for filling the wetland along Perch Pond to make a lawn and to dredge the pond to make it deeper for swimming. In order to reach four of the homes, a road would be built across the downstream wetland, filling in about a half acre. As currently proposed, the developer would need a variance to have this many houses built on this land. The zoning allows for five-acre lots and the farm is only 55 acres total. The townspeople are divided over the development and will discuss the site plan at tonight's planning commission meeting. This meeting is held jointly with the Zoning Board of Adjustment, which has to approve or disapprove the variance request. People have been talking and preparing for this meeting for weeks.

CHARACTER DESCRIPTIONS:

AMY TILLAGE: You are the oldest child of Sarah and Paul Tillage and had to sell the family farm when your mother died recently. Your father died awhile ago. You hated to sell it, but you don't live in Waterton anymore. You and your siblings couldn't afford the inheritance tax without selling the farm. Unfortunately you didn't talk to the Appletrys and the Foleys before you sold the land to Alterland Development Company. Both of these neighbors were interested in buying portions of the farm. You have heard that they are upset with you. You are going to the planning commission meeting to see if there is any information you can offer that would help protect some of the characteristics of the farm that you love–the pond where you caught small fish and frogs, the wetland adjacent to the pond where you watched ducks raise their ducklings, the wetland along Creeping Creek where you picked irises, and the woodlot where you had trails and hiding places.

JOHN APPLETRY: You and your wife, Molly, own the house and orchard across the road from the Tillage Farm. You are outraged at the developer's plans for the farm. You don't blame Amy Tillage for selling the place, but you are somewhat hurt that she didn't think to find out if you were interested in some of the land. You had asked Sarah once about leasing her corn field and putting some more apple trees in there. Your kids played in and explored the wetland and pond beyond the cornfield–catching insects and having cattail sword battles when they were little, hunting ducks when they were older. You are attending the planning commission meeting to comment on the site plan for the project. You are opposed to agricultural land changing to high-density suburban residences.

BILL DOZER: You are a representative from Alterland Development Company and the project manager for the Tillage Farm site. You are from a city far away and feel this may work against you in such a small, close-knit community. You have invited Peggy Perc to the meeting as she is from the neighboring town and is an Alterland Development Company investor. Your plan calls for 14 houses to be built on the Tillage Farm. You have proposed more than you need to build in order to give yourself a better negotiating position. Since Waterton is a small community with no industry, you feel your housing plan can help the area by adding to the tax base. You are aware that filling the wetlands will probably be an issue, but you have a backup strategy: You could build another pond down by the road to replace the wetland you fill. A pond by the road would be good for fire protection and is certainly more useful in your mind than the area through which the road will pass. That area doesn't even have water in it in August.

PEGGY PERC: You live in a neighboring town and are an investor in Alterland Development Company. Bill Dozer has asked you to attend the Waterton planning commission meeting with him. Bill wants your sense of what the planning commission members and the zoning board of adjustment members are thinking after he makes his proposal. He thinks that since you are from the area, you will have a better feel for how people are reacting. Actually, you already know what some people are feeling because when you stopped in the Waterton General Store for your Sunday paper, you heard discussions. You know the Appletrys are mad and the Foleys are upset. You also know that Phoebe Byrd will be ready to speak about the wetland issues that will come up at the meeting. You think that Bill ought to be ready with different development proposals that will use less land. You think that the project will still make money for the company even if he builds fewer, more-expensive houses.

MARY FOLEY: You and your husband, Peter, own the horse farm across the road from the Tillage Farm. Like the Appletrys, you and Peter would also have tried to buy some of the farm. You are interested in owning the wooded area north and east of Perch Pond. It would give you more land on which to ride your horses. You are hoping that there is still a chance for you and the Appletrys to buy some of the land, especially if the development company is not allowed to build all the houses it has proposed.

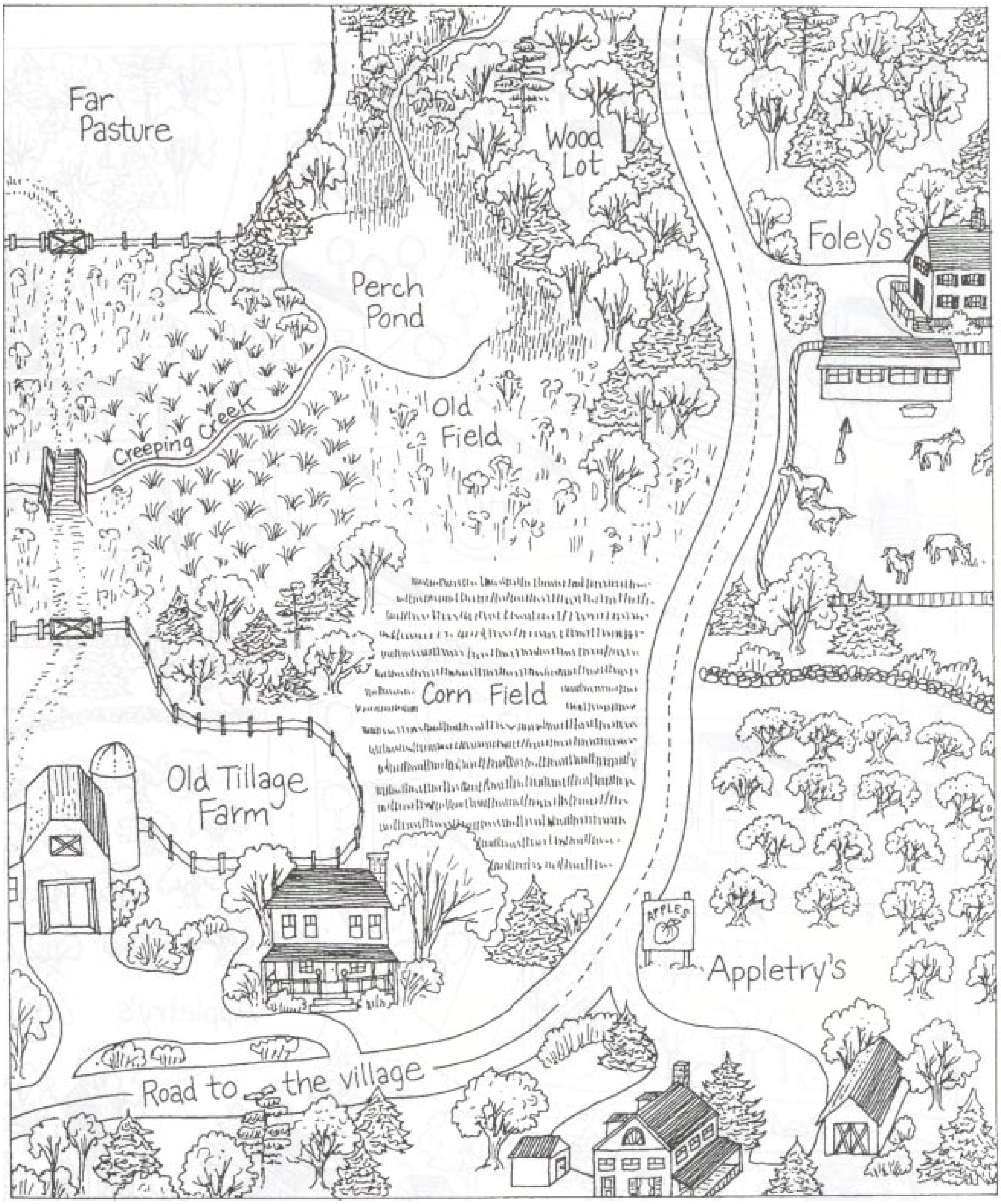
SUSAN BREADLOAF: You own and run the general store in town. You have heard many discussions around the coffee pot at your store about the plans for the Tillage Farm. You know that the Appletrys and Foleys are really upset about the proposed development and are going to fight the project. You aren't sure what to think about it. You don't like to lose farmland or see places like Perch Pond become off-limits to the local kids. Your son used to go to the pond with the Appletry kids when he was younger. But your son will finish high school soon and you haven't saved much money for college, so you would love to have the added business more people would bring.

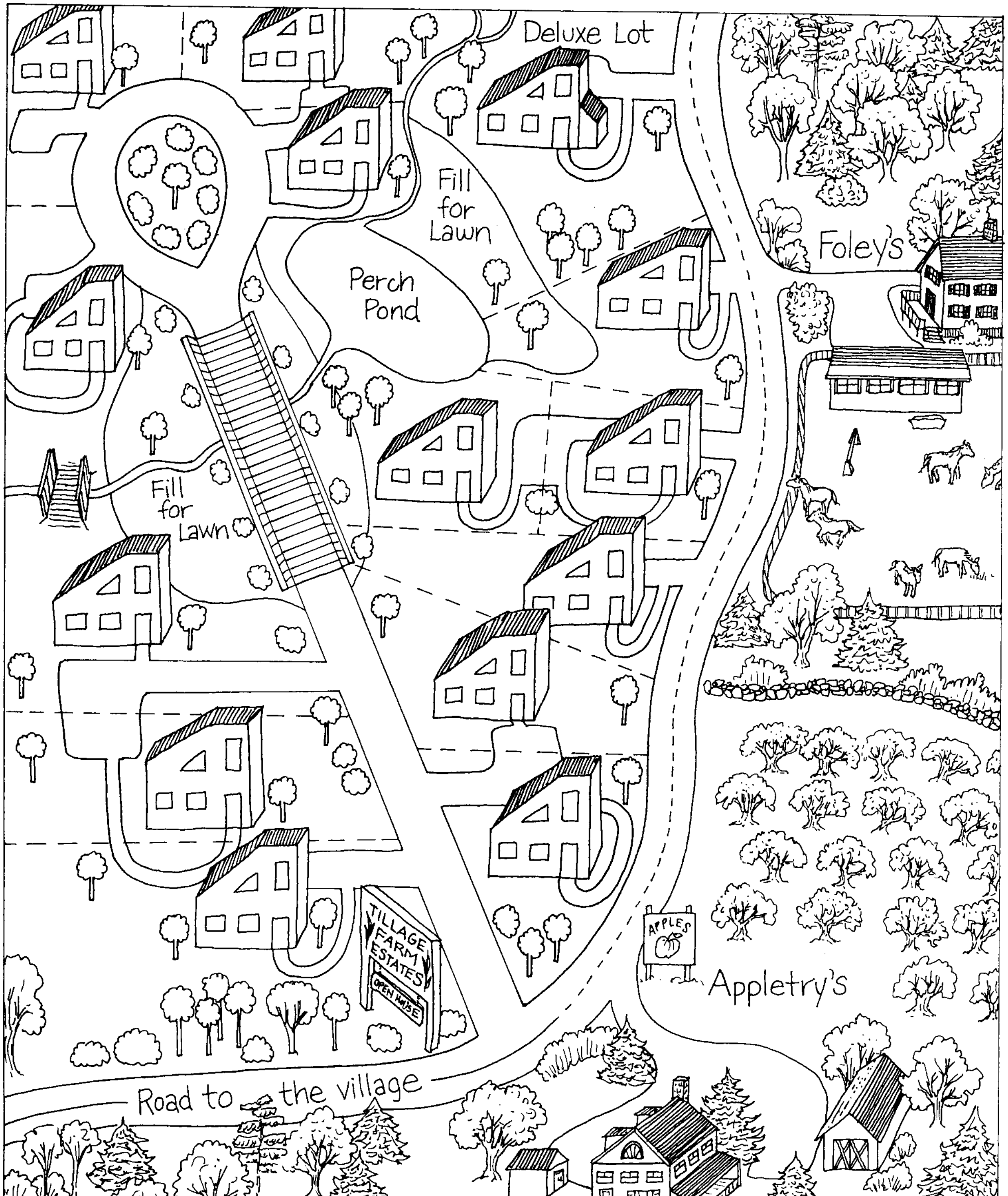
DICK RHODES: You are the road commissioner for Waterton and have lived in the town all your life. You haven't been too involved in the discussions about the proposed development on the old Tillage Farm, but you have heard about the Appletrys and the Foleys being upset. Your friend, Willy Variance, is the chair of the Zoning Board of Adjustment, so you have seen a draft of the site plan. You think it would cost a lot of money to fill in the wetland in order to put a road through it. The cows cross the stream at the wooden bridge below the wetland, and you think that is where a road should be built.

PHOEBE BYRD: You are a member of the area Audubon chapter and a local expert on plants and animals. You were horrified to learn about the development planned for the Old Tillage Farm, especially the amount of wetland to be filled. You haven't been to Perch Pond and the adjacent marsh for a while, but you do know that a marsh wren, a rare bird, has nested in this wetland at least once. You will talk at the planning commission meeting to explain how important wetlands are and to ask that the commission not allow the project as it is planned.

HANK BOARDMAN: You do logging as well as operate a portable sawmill. You are familiar with the Old Tillage Farm because you cut some trees for firewood for Sarah Tillage. You think that the developer ought to be able to do as he chooses with the land although you don't like the idea of so many new people coming into town. Since you might get work clearing land or working on the custom houses, though, it might be good for you.

WILLY VARIANCE: You are the chair of the Waterton Zoning Board of Adjustment, and your group must decide if Alterland Development Company will be allowed to build 14 houses on the Old Tillage Farm. You have heard that many people are coming to the meeting to hear the plans and to make comments about them. You are ready to listen to everyone's comments and try to make a decision that will be the best for your town.


Far Pasture
Wood Lot
Foley's
Perch Pond
Creeping Creek
Old Field
Corn Field
Old Tillage Farm
APPLES
Appletry's
Road to the village


Deluxe Lot
Fill for Lawn
Foley's
Perch Pond
Fill for Lawn
TILLAGE FARM ESTATES
OPEN HOUSE
APPLES
Appletry's
Road to the village

WATER FILTRATION

SUBJECTS:
Art, Chemistry, Language Arts

TIME:
2 class periods

MATERIALS:
two 2-liter plastic soda bottles
scissors
1/4 cup topsoil
water
plastic quart container with lid
paper coffee filter
builder's sand
crushed charcoal briquettes
clock
teacher sheet
student sheets

OBJECTIVES

The student will do the following:

1. Define potable and identify water that is potable.
2. Depict an illustration of the water treatment cycle.
3. Identify problems with treating dirty water.

BACKGROUND INFORMATION

Wetlands serve as highly effective surface water purification systems by reducing the effects of sedimentation in rivers, lakes, and estuaries. When turbulent, sediment-laden water encounters masses of wetland plants, it loses its energy and adds its sediments to the wetlands soil. These sediments may carry potentially harmful substances such as excess nutrients, which may lead to eutrophication, as well as pesticide residues and heavy metals with the potential to bioaccumulate.

The real "workhorses" in this natural water purification plant are the microbes. These tiny organisms are able to take many types of toxins and break them down into harmless substances. Those which cannot be broken down are likely to become sequestered within ever-increasing volumes of organic debris. These systems are so effective that they are often utilized by wastewater treatment plants.

How To Purify Water
Boiling is probably the best way to purify water. There is some debate about how long water needs to be boiled before it is safe to drink. Opinions vary from three minutes of a rolling boil to even just a few seconds. There are many water purification devices on the market; all use one or more of the following techniques to clean water:

Micropore filter: tiny holes that big germs can't pass through. This will stop larger microorganisms, such as amoeba and giardia, but bacteria and viruses will pass through.

Iodine: a filter, usually in the form of a membrane, containing a potent form of iodine that latches on to microorganisms as they pass through and kills them. Viruses are killed quickly; the larger germs may require several minutes to be effectively neutralized.

Charcoal: does not have much anti-bacterial effect, but it will remove bad odors and tastes, and some chemical pollutants. It is sometimes provided as an addition to the regular water purification device.

The flashlamp system is a new method still being developed. The high-intensity light generated by the flashlamp system has the ability to actually break DNA strands, and in doing so alter the chemical composition of a substance to render it both harmless and unable to reproduce. Moreover, the sheer intensity of the light produces a kill rate that can effectively decompose viral and microbe contaminants. Treating recirculated water with light is attractive because it does not contribute mineral salts or toxic residues that limit the potential for subsequent reuse of treated water.

<u>Terms</u>

hydrologic (water) cycle: the cycle of the Earth's water supply from the atmosphere to the Earth and back that includes precipitation, transpiration, evaporation, runoff, infiltration, and storage in water bodies and groundwater.

microbe: a microorganism (microbiological organism).

potable: fit or suitable for human consumption, as in potable water.

ADVANCE PREPARATION

A. Prepare an overhead of the attached water treatment cycle.

B. Prepare a water filter using a plastic liter soda bottle with the bottom cut off, the label peeled off, and a one-hole stopper carrying a short length of glass tube inserted into the small end of the soda bottle. Put a little cotton wool in the bottom and then a layer of small clean pebbles. Wash some coarse sand well and place a layer above the pebbles. Next wash some fine sand and make a thicker layer in the filter. Grind up some wood charcoal and make it into a paste with water. Spread the charcoal paste evenly over the surface of the sand. Secure some very muddy water and pour in the top of the filter. Collect the filtrate in a clean glass placed below the filter. (See diagram.)

PROCEDURE

I. Setting the stage

A. Conduct the above experiment and ask for volunteers to drink the potable water.

B. Ask the class to brainstorm ideas of what potable water is. Ask them what word they might confuse with potable.

C. Give the class the correct definition of potable water for their notes. Ask the class to brainstorm ways their school gets potable water.

D. To introduce the water treatment cycle, read <u>The Borrowers A float</u> by Mary Norton.

E. Produce the overhead and compare it to the borrowers' journey and the conducted experiment

F. Have students illustrate cartoons about the borrowers' journey down the drain, thorough a pipe and into a river.

II. Activity

A. Explain to the students how they will recreate the water treatment system for their classroom.

B. Divide the class into cooperative groups.

C. Have each group make muddy water by mixing 1/4 cup of topsoil with water in a quart container. Put the lid on the container and shake.

1. Now make a water filter by cutting the top off a soda bottle about 4 inches below the spout (the teacher should help). Turn the top upside down and rest it in the remainder of the bottle.
2. Wet some sand and put a 1-inch layer in the coffee filter.
3. Put a 1-inch layer of crushed charcoal on top of the sand. Then cover with another 1-inch layer of wet sand.
4. Slowly pour about 1 cup of muddy water into your filter. Be sure to leave some muddy water so you can compare it to the filtered water.
5. Time how long it takes the water to begin filtering. Is the water that passed through the filter cleaner than the water in the other container?

D. Have the groups record their findings and present them on the attached chart.

III. Follow-Up

A. Have the students answer the following questions.

1. Compare the muddy water and the filtered water, explaining how sand can clean the water.

2. What parts of this experiment represent steps used by water treatment plants?

3. Why could or couldn't you use it to make a powdered drink?

IV. Extensions

A. Have groups draw new cartoons that depict the borrowers' journey through the class filter system.

B. Brainstorm problems that could arise in the class's filter system.

RESOURCES

Johnson Cynthia C. Waterways, Division of Public Information St. Johns River Water Management District, 1991.

Norton, Mary. The Borrowers Afloat, ISBN 0-15-2105340-4.

Water Purification Techniques: http://www.achilles.net/~petert/water.html

Polygon Industries Inc., author: Water Purification: http://www.polygon1.com/waterpurification.html

Water Purification Capabilities: http://hermes.ecn.purdue.edu:8001/http_dir/Gopher/agen/agen521/Lessons/Wetlands/purification.html

Directions: Draw a diagram of your filter, then record the data you collect.

Filter Set-Up:

Step 1: Cut the soda bottle off 10 cm below the spout. Turn the top upside down in the rest of the bottle. Put a coffee filter in the bottle.

Step 2: Wet some builder's sand and put a 2.5 cm layer in the coffee filter.

Step 3: Put a 2.5 cm layer of crushed charcoal on top of the sand, then cover with another 2.5 cm layer of wet builder's sand.

Step 4: Slowly pour 250 mL of muddy water into your filter. Save some muddy water to use as a comparison.

Step 5: Time how long it takes the water to begin filtering and record what the water looks like.

Time	What the Water Looked Like
Time 0	
30 seconds	
1 minute	
1 minute, 30 seconds	
2 minutes	
2 minutes, 30 seconds	
3 minutes	
3 minutes, 30 seconds	

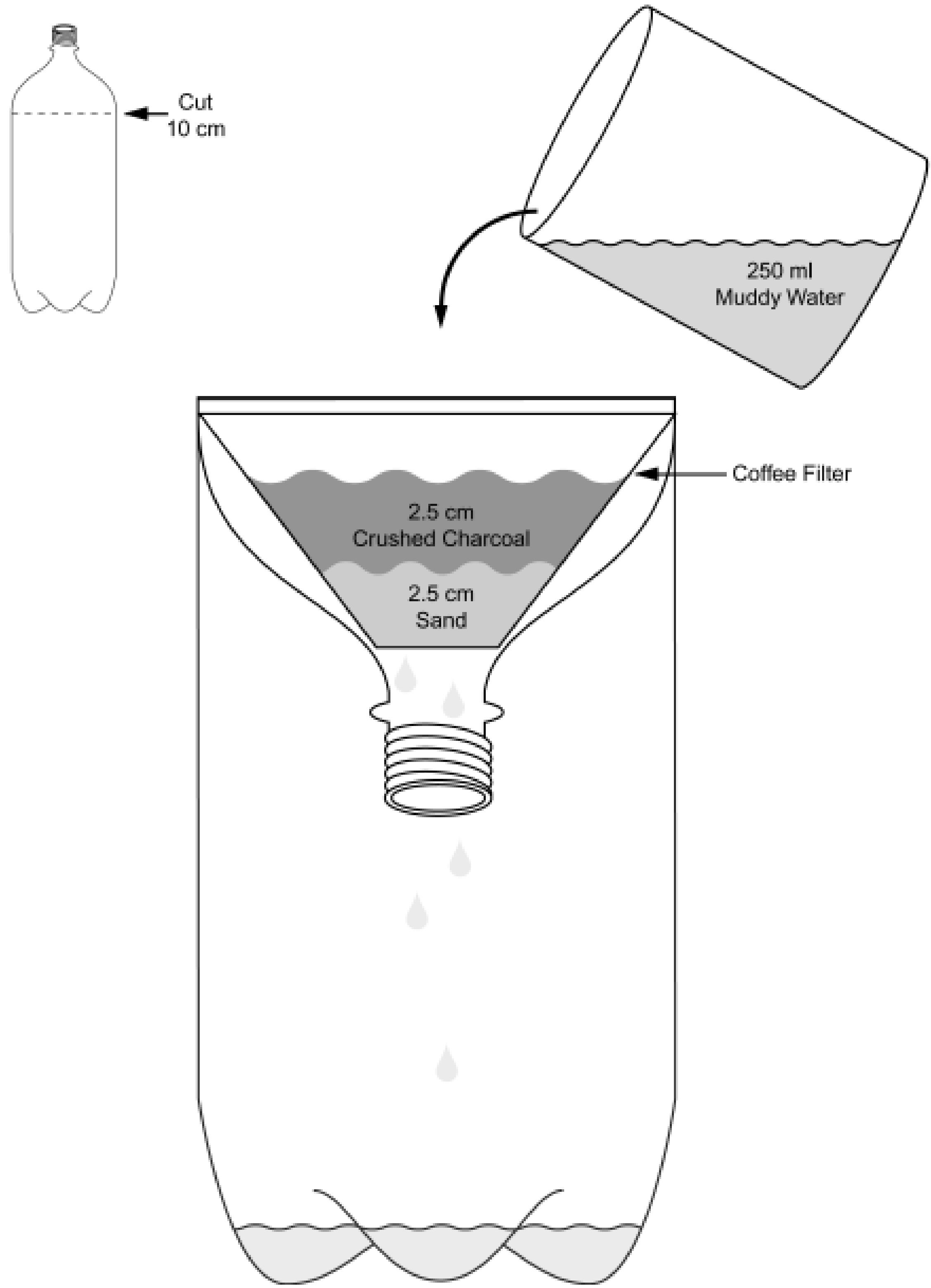
Please answer the following questions:

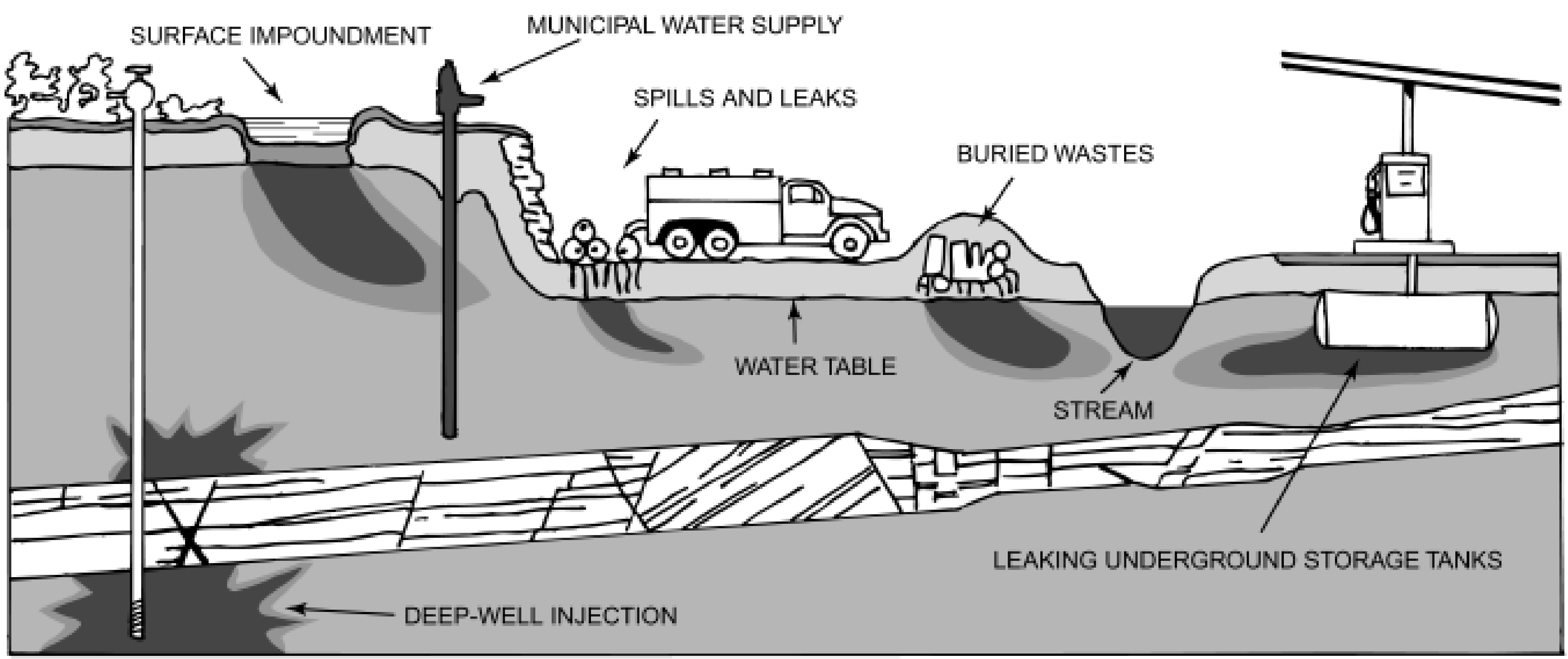
1. How did the filter clean the muddy water?

2. Is the water potable? Why or why not?

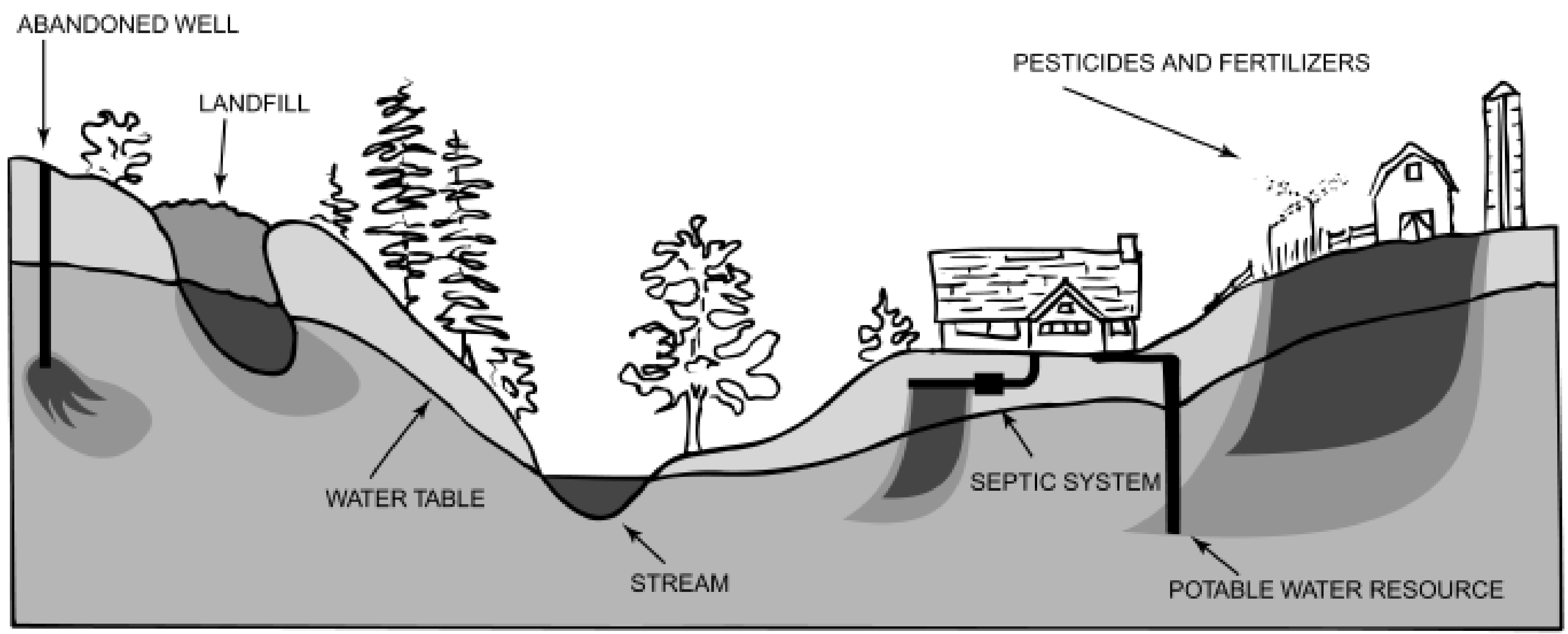
3. What could still be in the water?

4. What parts of your experiment represent steps used by water treatment plants?


Cut
10 cm
250 ml
Muddy Water
Coffee Filter
2.5 cm
Crushed Charcoal
2.5 cm
Sand



Industrial and Commercial Contamination Sources



Municipal and Rural Contamination Sources