EP-12

Ohio Sea Grant

OIL SPILL

by

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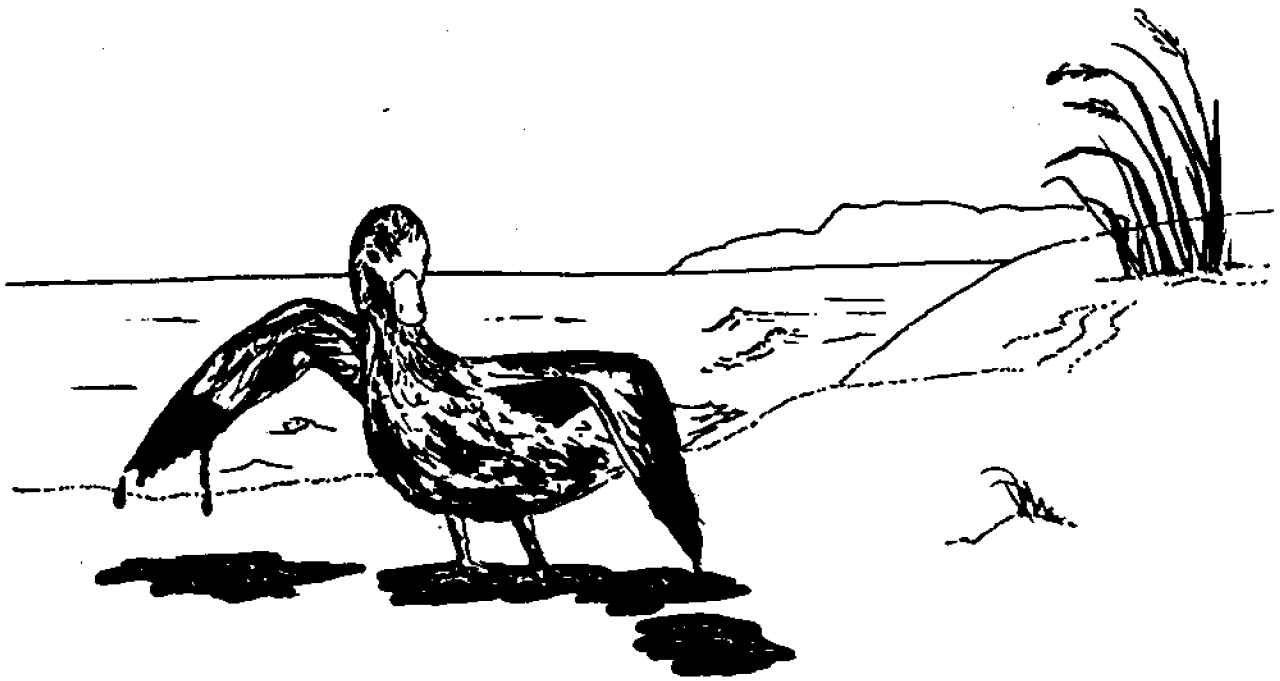

TEACHER GUIDE

OEAGLS-Oceanic Education Activities for Great Lakes Schools

OEAGLS Investigation #17

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Activities B and C are adapted from "The Oil Spill Problem," Project COAST #301, developed by the University of Delaware, Newark, DE.

TEACHER GUIDE

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OIL SPILL

by
Rosanne W. Fortner and Stephanie Ihle
Ohio Sea Grant Education Program

OVERVIEW

This investigation consists of three activities concerning the causes and effects of oil spills and the methods used to clean up these spills in the oceans and the Great Lakes.

Activity A involves the construction of a pie graph that shows the sources of petroleum pollution in water and the interpretation of another pie graph showing the geographic areas most affected. In Activity B, students create a small-scale oil spill in a pan and use various methods to try to clean it up. This helps the students to assess the effectiveness of the methods and to consider what other environmental damages might result from their use. Finally, the effect of oil on living things is illustrated through a dry lab in which dissolved oxygen, pH and plant characteristics are noted in oily and clean water.

PREREQUISITE STUDENT BACKGROUND

Students should have the ability to multiply by a two-digit multiplier, place decimals properly in multiplication, and use a protractor. They should be reminded of basic laboratory safety rules for Activity B.

MATERIALS

Activity A: protractor and pencil for each student.

Activity B: (for each team of students) aluminum "pot pie" pan, water, automotive motor oil (20 ml of 10-W-30 or similar type), 25 cm piece of twine, handful of straw, handful of sand, alcohol burner, matches, wooden splint, paper towels, 1 ml liquid detergent, medicine dropper, safety glasses, newspaper to cover tables.

Activity C: (optional) 250 ml beaker, water, 10 ml oil, aquarium plant (small sprig of *Elodea* or *Anacharis*).

OBJECTIVES

When students have completed this investigation, they should be able to:

1. Describe the major sources of oil pollution in the oceans and Great Lakes.
2. Discuss three ways in which oil may be removed from water.
3. Describe the effects of oil on aquatic organisms.

SUGGESTED APPROACH

Each activity will take about one class period of 40-50 minutes. Ample time should be allowed for discussion of the results of the entire investigation.

A film concerning the oil spill from the NEPCO 140 which occurred in the St. Lawrence River in 1976, is available on a free loan basis from the U.S. Coast Guard, 9th Coast Guard District, Cleveland, OH 44199.

"Six Fathoms Deep," a 30-minute film from the Man Builds - Man Destroys series can be rented (1987 price $40 plus shipping and handling cost) from GPN Films, Box 80669, Lincoln, NE 68501. The film tells the story of several major oil spills and reports some constructive responses to them.

Note: Information to teachers is enclosed in boxes in this guide.

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INTRODUCTION

When oil is poured on rough waters, the surface of the water is calmed. In ancient Greece, sponge divers made use of this fact and carried oil in their mouths when they began a dive. Releasing the oil smoothed the ripples and gave them better light for searching below. Today, mariners will sometimes dump oil to calm ocean waves and make rescue easier.

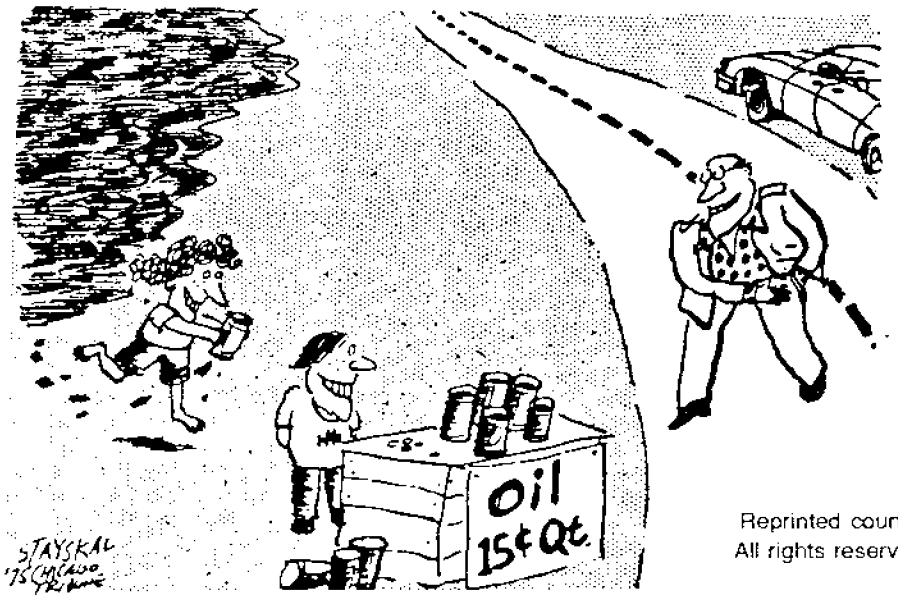
Oil on water is not always welcome, however. Accidents in which oil is spilled in the water definitely do not have a calming effect on people. Our recent history records a distressing number of tanker spills, offshore drilling accidents and mysterious oil slicks of unknown origin.

The Great Lakes, as well as the ocean, have been affected. In 1974, for example, an oil spill from the tanker *Imperial Sarnia* caused damages to the St. Lawrence Seaway which cost about $2,000,000 to clean up. In 1961 another tanker spill on the St. Lawrence River was reported to have caused the extinction of the last colony of Greater Snow Geese.

Who or what is responsible for our oily waters? What are the effects of oil spills on living things in the water? Can an oil spill ever be completely cleaned up?

OBJECTIVES: When you have completed this investigation you will be able to:

1. Describe the major sources of oil pollution in our oceans and the Great Lakes.
2. Discuss three ways in which oil may be removed from water.
3. Describe the effects of oil on aquatic organisms.



ACTIVITY A: WHERE DOES OIL POLLUTION COME FROM?

KEYWORDS: **Metric ton** (2204.62 pounds or 1000 kilograms), **petroleum, ballast**.

The U.S. National Academy of Sciences estimates that 6,100,000 metric tons of petroleum products enter the world's oceans each year. (This is usually written as 6.1 mta. A metric ton is one million grams, or 1.1 regular tons.) About 2.3% of this total, or 0.14 mta, comes from oil spills in the Great Lakes. The petroleum pollution comes from many sources, some natural and some from human activities.

MATERIALS: Protractor, pencil, circle in Figure 1.

PROCEDURE

In this activity you will construct a "pie" graph showing what part of the total petroleum pollution in the oceans comes from different sources. The list on the next page tells how many million metric tons anually (mta) come from different sources. It also tells what percent of the total petroleum pollution this is.

The whole circle in Figure 1 represents the 6.1 mta discussed. You will divide the circle into wedges that look like pieces of pie. The size of each wedge will depend on the amount of petroleum from one source.

To find how big a wedge to draw for each pollution source, you will have to do an arithmetric problem.

1. A circle can be divided into 360 equal parts called degrees. Multiply the percent (column 2) by 360 and write your answer in column 3. If one pollution source is responsible for 10% of the total oil pollution, you would multiply 0.10 (same as 10%) x 360 degrees. Your answer is 36 degrees.

2. There is a copy of Figure 1 on your worksheet. Do all your work there. Place your protractor on a line running from the center of the circle to its outer edge. The point at the center of the protractor base should be on the center of the circle.

Completed graphs should have the sections shown in Figure TG-1. The number of degrees in each wedge should match those calculated in the student charts for this activity. We have rounded to the nearest whole degree. The arrangement of the wedges within the circle may differ because of students' using different wedge sides as base lines.

3. Reading from the bottom line of the protractor around the arc, find the point that represents your answer from column 3. Place a dot the circle at that point.

4. Draw a line from the center of the circle to the edge of the circle through your dot. Label the wedge as shown in the example in Figure 1.

5. Complete the chart on your worksheet and check your work by adding up the numbers in column 3. The total should be 360 degrees by rounding your answers to the nearest degree.

6. Divide your pie graph into wedges as the example shows. Since the graph represents the total amount of oil pollution in the oceans, the entire circle will be filled with wedges when you finish.

SOURCES OF PETROLEUM IN THE MARINE ENVIRONMENT

Source of Petroleum	mta	% of total	Size of Wedge
Natural seepage*	0.60	10	36°
Tanker operations	1.33	22	
Tanker accidents	0.20	3	
Other transportation activities	0.60	10	
Runoff from rivers and cities	1.90	31	
Coastal facilities	0.80	13	
Offshore drilling	0.08	1	
Atmospheric fallout	0.60	10	
Total	36.11	100%	360°

*Leaks from oil deposits. In the Great Lakes, for example, oil seeps into the water from deposits at Oil Springs, Ontario.

(Data from Fate and Effects of Oil in the Sea. Exxon Corporation)

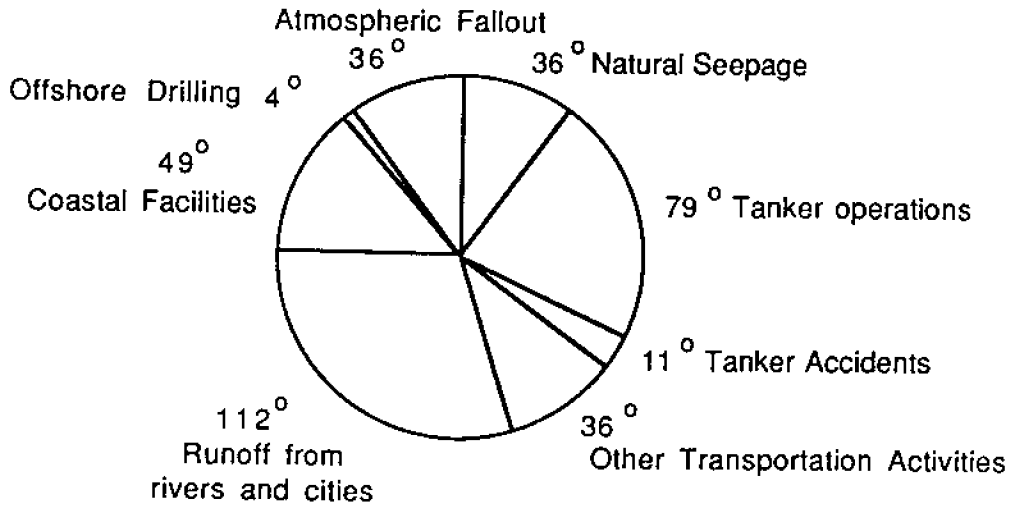
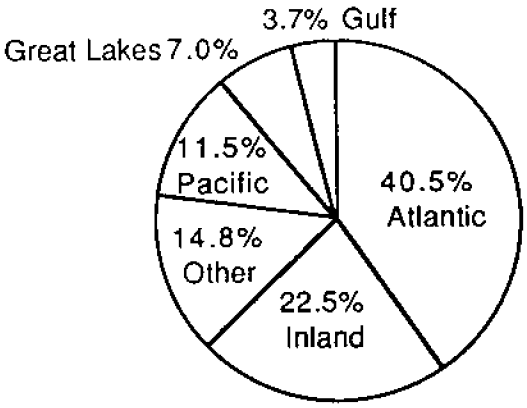


Figure TG1. Completed graph of petroleum pollution sources.

Now look at Figure 2. In this second pie graph you can see how the oil pollution was distributed in the waters of the U.S. in 1984. Notice that the wedge for the Great Lakes is about 1/5 the size of the one for the Atlantic Coast. The area of the Atlantic Ocean is about 115 times the area of the Great Lakes. The damage done by the oil pollution in the Lakes is much more concentrated and therefore does more visible damage than Atlantic oil pollution.

The location of oil spills changes dramatically from year to year. The graph in TG2 shows 1984 spill areas.



U. S. Coast Guard, Polluting Incidents In and Around U. S. Waters. COMDTINST M16450.2G, 1987.

Figure TG2. Oil Pollution Incidents by Area, 1984.

QUESTIONS: Answer the following on your worksheet.

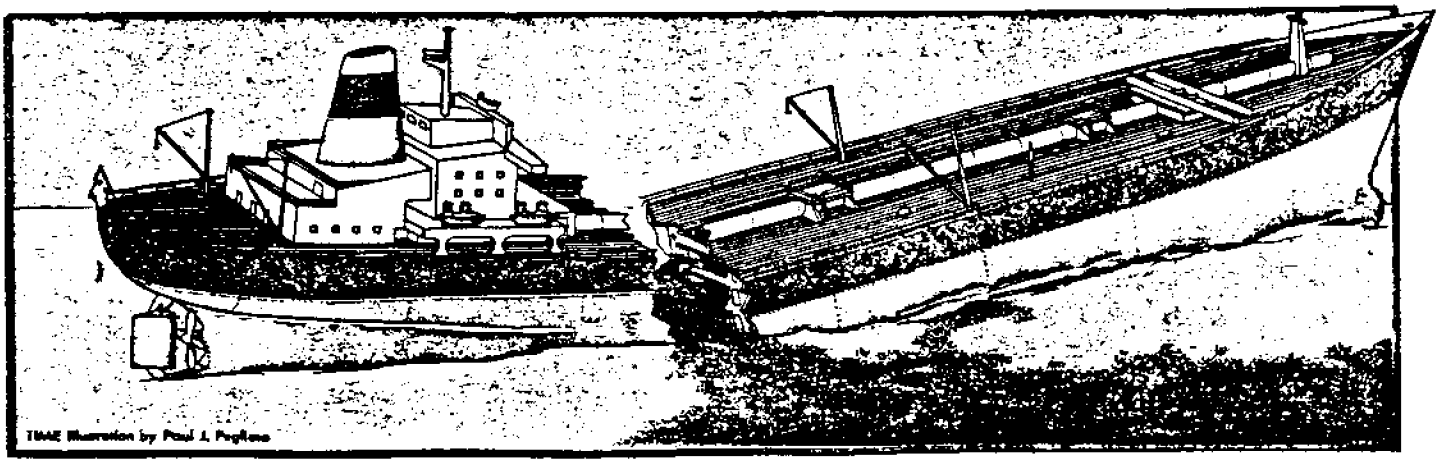
1. Most of the oil spills we hear about involve which one of the wedges in Figure1?

T1. Tanker operations or offshore drilling. Discuss with students some possible reasons why we hear more about these than about municipal oil pollution, coastal facilities as polluters, etc.

Compare this source to other sources of petroleum pollution. Are there sources of oil pollution that do not make the news very often?

Occasional massive spills such as the *Amoco Cadiz* in 1978 and the *Argo Merchant* in 1976 are almost certainly less damaging to the marineenvironment than frequent smaller releases of oil in a confined harbor. (Notice the size of the "Coastal Facilities" wedge.)

When an oil tanker (ship) is carrying no oil, it fills up its cargo space with water so the ship will be stable. A substance used for stability this way is called **ballast**. Ships getting ready to load on a new cargo used to dump the water they were using as ballast. This ballast had picked up oil from the hold, and the oily wastes were flushed out into the harbor.



Reprinted by permission from TIME, The Weekly Newsmagazine; Copyright Time Inc., 1977.

2. Which of the wedges describes this type of pollution source?

T2. Tanker operations. Much of the tanker industry now avoids the oily ballast problem by using the "Load-on-Top" (LOT) technique. During tank cleaning, dirty water is pumped into holding tanks where the oil separates and rises to the surface. Water from under the oil is pumped out and the remaining contaminated mixture stays in the ship. New cargo is loaded in on top of the old oily water.

Today, regulations prohibit the dumping of oily ballast, and haulers reclaim much of the oil that had been lost this way.

3. How could oil get into the water from offshore drilling operations?

T3. Oil could escape from offshore drill rigs by breaks in pipelines, "blowouts" from gas in the wells, storm damage to the rigs' stability, or faulty equipment. An offshore drill rig is extremely expensive, however, and pressure for environmental protection is strong. Oil companies have devised numerous safeguards and maintain close observations of weather, equipment and personnel to prevent problems that would result in a spill. The American Petroleum Institute states that, based on its past records chances of an oil spill from an offshore rig are 5000 to 1.

You may wish to read about the Ixtoc oil spill in 1979 in the Gulf of Mexico. (See Newsweek Magazine issues for August 13, 1979, and August 4, 1980.) The International Joint Commission (a cooperative agency of the U.S. and Canada) has prohibited drilling for oil in Lake Erie because of the risks of such a disaster. Canada drills for natural gas in the lake, but the U.S. does not. The environmental impact of drilling is now under consideration.

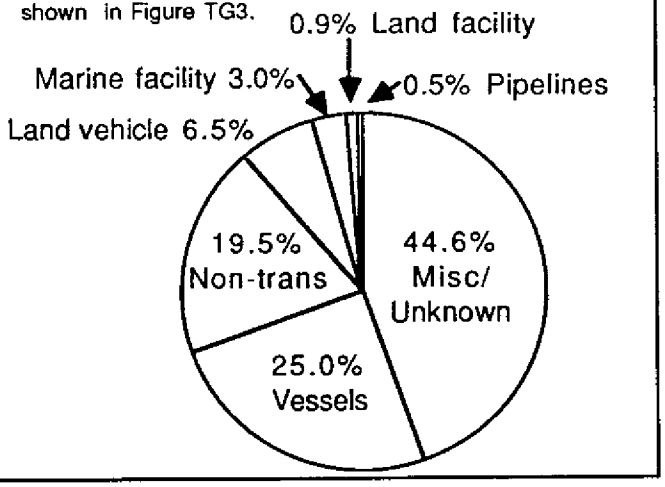
Students may think of other ways oil could escape. Discussions of such problems and other aspects of oil technology are presented in a readable form in the free booklet "Questions and Answers on Petroleum Operations and Offshore Development," from the American Petroleum Institue, 2102 L Street, NW, Washington, DC 20037.

4. From Figure 2, what body of water gets the greatest volume of oil pollution? What kinds of areas are these?

T4. The Atlantic Ocean gets the most oil pollution. This category mainly includes rivers.

5. List some ways that petroleum could get into rivers. (Hint: Refer to Figure 1 for some ideas.)

T5. Petroleum could get into rivers from oil dumped on land, oil dumped into streams, truck, rail or barge accidents, strucural failure of pipelines, local spills at service stations, etc. Be receptive to a wide range of student ideas. Known sources of oil pollution are shown in Figure TG3.



The next time you are riding along the highway, look at the road ahead of you. A well-traveled highway usually has a dark streak running down the center of each lane. The streak is caused by petroleum products such as crank case oil that drips out of vehicles.

6. How could this serve as a source of oil pollution for water?

T6. The "highway streak" could be washed into waterways by rain, snow removal, or street cleaning operations.

7. What could your family do as good citizens to reduce the amount of petroleum products going into our water?

T7. Answers will vary widely. Accept and discuss all possibilities. Some choices might include disposing of waste motor oil properly, keeping cars maintained so they do not drip oil, not letting gasoline overflow from the gas pump, using fewer petroleum products so the United States does not have to import or drill for so much.

ACTIVITY B: HOW CAN AN OIL SPILL BE CLEANED UP?

KEYWORDS: containment, boom, adsorption. This activity originated as part of the University of Delaware's Project COAST. See the REFERENCES list on page 13 for the address for ordering the original complete module.

The moment a spill occurs, nature begins cleaning up. The oil separates into heavier and lighter parts and is spread by wind and currents. Some of it evaporates, like gasoline spilled from the gas pump. Certain types of bacteria called petrophiles consume some of the oil. According to marine affairs specialist E. W. Seabrook Hull, "Within a couple of years no sign of the disaster remains. The oil is gone, and the birds and other marine life are back, as though nothing had happened. This has been shown in the case of *Torrey Canyon*, the *Wafra*, the *Arrow*, the *Argo Merchant*, Santa Barbara and numerous other events."

The sight of oily birds and beaches and the loss of tourist and fishing income make us impatient with the slow dependable processes of a natural clean-up. An oil spill needs to be cleaned up right now, we think. But how can this be done?

MATERIALS: For each team of students: aluminum "pot pie" pan or butter tub, water, 10 ml of motor oil, 25-cm pieces of twine, handful of straw, handful of sand, alcohol burner, matches, wooden splints, paper towels, liquid detergent, dropper, safety glasses, newspapers to cover working surfaces.

PROCEDURES

Success in cleaning up an oil spill depends upon preparedness and rapid action by the spiller and by Federal, state and local agencies. When a spill occurs, it is reported to the nearest U.S. Coast Guard station. The spiller, by law, is suppose to clean up the oil. If the spiller does not clean up the pollution, the Coast Guard takes over and the spiller pays the clean-up costs.

In this activity your team will create an oil spill and try various methods of cleaning it up.

I. Containment

If an oil spill is contained in one area, cleanup is easier and less environmental damage is likely to occur. Containment must be done as soon as a spill is detected if it is to be effective.

1. Add about 2 cm of water to your pie pan or bowl to serve as a lake.

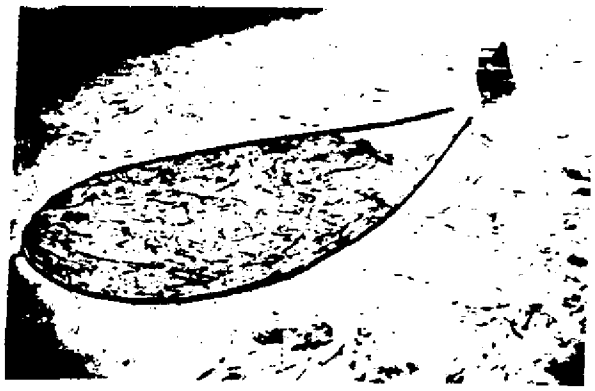
An oil tanker has sprung a leak in the middle of your "lake." Add 2 drops of oil to the water's surface.

Tie the ends of a piece of string together and gently place the circle of string on top of the water, with the oil inside. Slowly add 2 ml more oil inside the circle. Pull the oil to one side of the pan using the string.

NOTE: If any oil is spilled outside the pan, clean it up immediately. Spilled oil causes unnecessary accidents.

2. Does the string keep the oil from spreading over the entire lake? This is how a "boom" operates to contain a spill.

T2. The string should contain the oil. If too much oil is added, however, it will overflow the boom. You may want to adjust the amount of oil students add. For lighter oils, spreading is greater and you should decrease the amount used.



Crude oil and debris enclosed in a boom

U. S. Environmental Protection Agency, "Oil Spills," 1977.

3. Some contained oil can be reclaimed (collected for further use). Use a dropper to try to reclaim some of your oil. About how much oil were you able to reclaim?

T3. Answers will depend on how thorough the students are. Most of the oil can probably be removed, but it will be mixed with water. Further treatment would be necessary before the oil could be re-used.

II. Removal of oil from water

Whether the oil is contained or free, it still must be cleaned up to prevent further environmental damage. Although there are many elaborate techniques for oil removal, some simple and non-technical methods are still widely used.

A. Removal by burning

1. Remove the string from your lake. Pour 5 ml of oil on the water surface.

2. Put on safety glasses and light your alcohol burner. Set fire to the tip of a wooden splint. Try to ignite the oil spill with the splint.

3. Does the oil burn? If so, how long did it burn? Was there any oil left when the flames went out? If the oil did not burn, try to explain why.

T3. The oil should not burn. In trying to explain why, students may explain that "it is wet." In reality, the oil will not burn because it is a type that does not contain flammable substances. Petroleum fractions are separated wtih their uses in mind. Some contain volatile mixtures while others (like this oil) are mostly inert.

4. If the oil is burned, what other damage to the environment might occur?

T4. If the oil burned, damage might occur in the form of air pollution.

5. Is the burning of the oil an effective way to clean up an oil spill? Explain.

T5. No. Not all types of oil will burn, and if they do burn they could cause other environmental damage.

B. Removal by sinking

Ordinarily, oil floats on water because it is not as dense as water. Increasing the oil's density will make it sink to the bottom.

1. If your oil was cleaned up in Procedure A, add 5 ml of new oil to your lake.

2. Sprinkle enough sand on the oil spill to cause it to sink. Does this method remove all (or most) of the oil from the surface?

T2. Most of the oil will sink when sand is added. However, if left standing the oil may escape and bubble to the surface again.

3. When this method is used, what other effects will it have on the environment?

T3. Bottom organisms could be smothered. Contaminants could be trapped in the bottom sediments so that future burrowing animals would be poisoned.

4. What should you know about the water environment before using this method to clean up a real oil spill?

T4. You should know what bottom organisms you would damage and whether the oil is light enough to surface again.

5. Is sinking a good way to clean up an oil spill? Explain.

T5. No. There is too much potential for damaging bottom organisms (such as shellfish) and no promise of permanent oil removal.

C. Removal by adsorption

Certain materials will attract oil to their own surfaces. This is called **adsorption**. You have probably seen pictures of this type of clean up method.

1. Pour 5 ml of new oil into your lake. (You do not need to dump the oily sand from B unless it is deep enough to break the water surface.)

2. Place a small amount of straw on top of the oil. What happens?

T2. Oil sticks to all the surfaces of the straw.

Cleaning up an oil-soaked beach.

U. S. Environmental Protection Agency, "Oil Spills," 1977.

3. How can you remove the oil from the lake now? Check your idea with your teacher, and try the idea if the teacher approves. Did your idea work?

T3. Picking up the straw or burning the straw are the most frequent suggestions. Both work fairly well, especially if clean straw is added and removed several times.

NOTE: If students wish to burn the oily straw, this activity should be supervised outdoors. Black greasy smoke may result.

4. Is adsorption a good way to clean up an oil spill?

T4. This is a better way than most, expecially if the oily straw is mechanically removed instead of burned. In reality, the oily straw would probably be hauled to a land fill, where it will again be a contaminant.

D. Removal by detergents

Household detergents are used to remove oil from laundry or grease from dishes. They do this by breaking up oil drops and dispersing them in the water to form an emulsion.

1. Dump the contents of your lake in the container provided by your teacher. Wipe the lake basin out and add fresh water.

2. Add one drop of oil and one drop of liquid detergent to the lake. Stir the two together vigorously with a wooden splint. What happens?

T2. A milky suspension is formed. Neither drop is visible any more.

3. Does dispersion by detergents let you clean up the oil easier? Explain.

T3. This method does not clean up oil. It only breaks it up into tiny droplets that are not as noticeable. Detergents are sometimes used in this way to speed up natural dispersal.

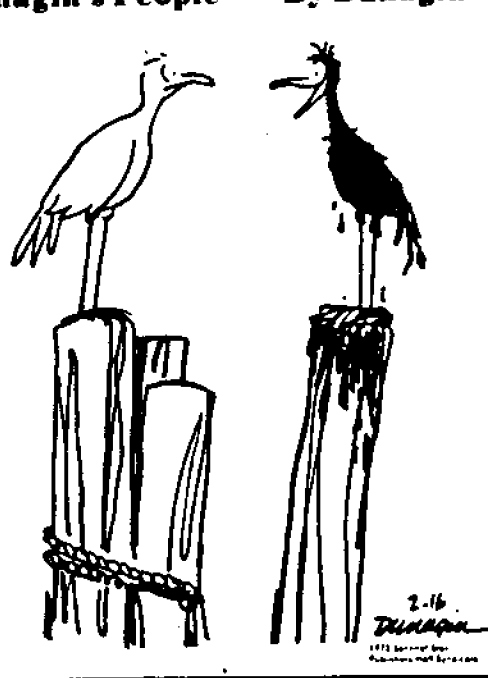
4. How could the environment be damaged by use of detergents?

T4. The detergents could harm water animals and reduce the "waterproof" characteristics of ducks and other water birds.

In actual use, detergents are designed to allow natural clean-up to take place more easily. Results would not be noticeable for a longer period of time.

ACTIVITY C: HOW DOES AN OIL SPILL AFFECT LIVING THINGS?

KEYWORDS: pH, dissolved oxygen, photosynthesis, respiration.



DUNAGIN'S PEOPLE by Ralph Dunagin
© 1973 Field Enterprises, Inc.
Courtesy of Field Newspaper Syndicate.

We have all seen pictures of oily sea birds and heard horror stories of damaged fishing grounds resulting from oil spills. The effects of oil are not always so obvious. In this activity you will investigate how oil changes the water and affects plant functions.

MATERIALS: For each team or one for entire class: 250 ml beaker, water, 10 ml oil, short piece (5-6 cm) of aquarium plant (*Elodea* or *Anacharis*).

If done as a "dry lab," only the chart in the Student Guide is required. D.O. measurement is time consuming and requires numerous dangerous chemicals, so actually doing the experiments in class is not recommended. You may wish to demonstrate the processes yourself, in which case you would need pH test paper (range 5-9) and the materials listed on page 1. Hach Chemical company also prepares field test kits for D.O. These include pre-measured packets of chemicals so that precision is high and danger to users is minimized.

PROCEDURE

A. Changes in water and plant characteristics.

A group of students did an experiment to find out if oil does anything to water and aquatic (water) plants. The covered two jars with black paper so that light could only get in from the top, as it would in a lake. Then they got some "Elodea", a water plant, and cut off two pieces that were the same length and had the same number of leaves. One piece of "Elodea" was placed in each jar of water.

The students decided to observe changes in the appearance of the plants and study two characteristics of the water. They checked the water for dissolved oxygen (D.O.) since they knew that plants and animals take oxygen from the water during respiration.

1. Why is the D.O. test important in a study of bodies of water and life in the water?

T1. Living things must have oxygen for respiration. Low levels of oxygen in the water can cause death.

They also checked for the amount of acid in the water by measuring the water's "pH." A pH number of less than 7 means the water is acidic. The lower the pH number, the more acid the water is.

2. The amount of acid in the water is related to a gas produced by plants and animals during respiration. What is this gas?

T2. Carbon dioxide is produced during respiration.

The D.O. and pH in both jars were measured on the first day of the experiment and recorded in the chart on the next page (Day 1).

Then the students created an oil slick in one of the jars. They used motor oil like the kind that is used in cars. On the next three days they repeated their D.O. and pH tests and recorded the results in the chart (Days 2, 3 and 4).

	Clean Water (Jar 1)		Oil Spill (After Day 1) Jar 2	
Day	D.O. (ppm)	pH	D.O. (ppm)	pH
1	10	7	10	7
2	10	7	9	7
3	10	7	7	6
4	10	7	4	5

3. In which jar did D.O. decrease? In which jar did it stay the same? How can you explain this?

T3. D.O. decreased in the oil spill jar but stayed the same in the clean jar. The plant's respiration is using up the oxygen dissolved in the water and oxygen is no longer available from the air above the water surface. The plant makes oxygen during photosynthesis, but no light is available for this process.

4. The pH in the oil spill went down. If both plants were making the gas you named in Question 2, why did the pH drop in one jar and stay the same in the other?

T4. In the clean tank, extra carbon dioxide (CO_2) can escape into the air. The CO_2 produced by plant respiration in the oil jar stays in the water and causes the water to become more acidic.

$CO_2 + H_2O = H_2CO_3$ (Carbonic Acid)

Photosynthesis in plants requires sunlight, water and carbon dioxide. Respiration requires oxygen.

5. Can the plant in the oil spill get light? Water? Carbon dioxide? Oxygen?

T5. Light - no; Water - yes; Carbon dioxide - yes and Oxygen - yes, but only what is in the water.

6. Can the plant in clean water get light? Water? Carbon dioxide? Oyygen?

T6. Light - yes; Water - yes; Carbon dioxide - yes and Oxygen - yes.

7. How does an oil spill affect photosynthesis in plants? Respiration?

T7. Photosynthesis decreases because there is not light penetrating the water. Carbon Dioxide is available, but the process cannot go on without light. Respiration fails without oxygen.

The students decided to find out if oil was harmful when it got right on the plant itself, so they dipped a piece of *Elodea* in oil and put it in a cup of clean water. Some of the oil floated off, but the leaves remained coated.

8. Could the leaves of the plant get light? Water? Carbon dioxide? Predict what happened to the oily plant.

T8. Light - no; Water - no and Carbon dioxide - no. The plant died within a short time.

Try this yourself with the materials listed on page 9.

B. Changes in animal populations

The National Academy of Sciences report discussed in Activity A listed the findings of scientists about the effects of oil spills on animals.

1. Petroleum products do not remain in marine organisms after the spill has gone. These products are not concentrated as they pass through the food chain. In the Great Lakes, on the other hand, some organisms do accumulate petroleum materials in their fat.

2. Oil on beaches damages shoreline life. Oil seeps downward into sand and remains there for years. Rocky shorelines can clean themselves naturally through wave action, but bays, estuaries and marshes have few waves. Oil spills in such areas are very damaging.

U. S. Coast Guard photograph, "The NEPCO 140 Incident."

3. Oil causes serious harm to birds by coating their feathers. An oily bird does not float, and it has no insulation against temperature changes. Birds also poison themselves by eating the oil that coats them.

4. Oil is sometimes reponsible for smothering communities of animals that live on the sea floor. This is especially important to the shellfishing industry. Most of these areas will eventually become settled again, but some organisms like mussels cannot survive in an oiled area.

In the Great Lakes, the fresh water cannot hold the heavier types of oils on the surface. The oil sinks and enters the bottom sediments and the food chain.

5. Fish are not affected by oil pollution as much as other organisms. A massive spill such as that from the *Amoco Cadiz* in 1978 can kill large numbers of fish, but ordinarily fish are able to escape injury from minor accidents.

6. Different petroleum products have different effects on organisms. Diesel or heating oils are most poisonous, while heavy crude and fuel oils are worse for smothering animals. Oil may be more poisonous to freshwater organisms than to sea life, probably because cold lake water slows down evaporation and oils stay in the environment longer.

Answer these questions on your answer sheet based on your reading of Part B:

1. Why does the oil spilled in the Great Lakes sink to the bottom while oil on the ocean floats?

T1. Since ocean water contains salt, it is more dense and buoys up the less dense oil. In the fresh water of the Great Lakes some oil fractions are heavier than water and will sink to the bottom.

2. Describe an oil spill that <u>could</u> kill large numbers of fish.

T2. The spill would have to be of great extent, covering large areas of surface water. Sunlight and oxygen are prevented from entering the water.

3. What kinds of petroleum products have the greatest effect on organisms? How do these affect the organisms?

T3. Diesel and heating oils poison living things, while heavy crude and fuel oils smother animals.

4. Are all areas of the coastline affected in the same way by oil pollution? If not, explain differences.

T4. No. Different coastal features are affected differently. Rocky shores and heavy wave action break up oil. Rocks do not absorb oil, but plants, sand and mud in bays and estuaries do absorb it. Areas with little wave action hold spills.

5. Why does oil remain in Great Lakes water longer than in ocean water?

T5. The water is usually colder, so less oil evaporates and it flows more slowly so that the oil is slower to disperse naturally.

REVIEW QUESTIONS

1. What are the two major sources of oil pollution in the oceans?

R1. Runoff from rivers and cities, and tanker operations are the major sources of oil pollution in the marine environment.

2. How does nature clean up oil spills?

R2. Wind and currents spread the oil out. Some of it evaporates, and some is consumed by bacteria called petrophiles.

3. List three ways that oil can be removed from water.

R3. Oil may be removed by adsorption, burning, sinking and detergents. Students should list three of the four ways.

4. For the methods you listed in #3, what damage to the environment might occur if these methods are used?

R4. Three of the four answers below:

Adsorption--If adsorbent is mechanically removed, little environmental damage occurs. If burned, however, it creates air pollution.

Burning--Causes air pollution.

Sinking--Lightweight oils will re-surface. Heavy oils may smother bottom organisms and trap contaminants in bottom sediments.

Detergent--Does not really remove oil, but speeds natural processes of clean-up. Could harm water animals and reduce "waterproof" characteristics of shore birds.

5. How does oil affect plants? Birds? Bottom animals? Fish?

R5. Plants coated with oil die without light, water and gas exchange. Plants beneath an oil slick will also die for lack of light.

Birds with oily feathers will drown, die of exposure or poison themselves by eating oil. Bottom animals may be smothered. Fish can usually swim away to unaffected areas, but their food supplies and breeding grounds may be damaged.

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Hull, E. W. Seabrook, 1978. "Oil Spills: The Causes and the Cures." Sea Frontiers 24(6): 360-369. Subjects similar to above. Layman's language, environmental viewpoint.

"Oil Eaters," Time Magazine 106:46. September 22, 1975. Tells of discovery of bacterial genus of petrophiles. Research on effects.

Project COAST materials: #222. Dissolved Oxygen Measured Qualitatively; #301. The Oil Spill Problem. Obtain from Project COAST, 310 Willard Hall, University of Delaware, Neward, DE 19711. COAST #222 is the source of the Activity C and includes extensions of the concept of dissolved oxygen. COAST #301 is the source of Activity B. The original contains student background readings on oil spills, other experiments on oil effects, and activities related to oil spill movements and tanker efficiency. A valuable source of further information and extension materials, but some statistics are out of date.

EVALUATION ITEMS

1. Which source supplies the greatest amount of petroleum pollution going into the oceans?

   1. Natural seepage
   2. Offshore drilling
   3. Tanker operations and accidents
   *4. Runoff from rivers and cities

2. An oil freighter carrying no oil fills its tanks with water to

   1. carry fresh water to cities along the seacoast.
   *2. stabilize the ship.
   3. flush out the cargo space.
   4. carry tropical fish to pet stores in the United States.

3. All but one of the following reasons explain why the Atlantic Ocean gets the most oil pollution. Which one?

   *1. It is the largest ocean.
   2. The world's major cities are located on the Atlantic.
   3. Many oil tankers travel across it.
   4. There is much offshore drilling along the Atlantic coast.

4. A boom is

   1. another name for a very large oil tanker.
   2. the tallest part of an offshore oil rig.
   *3. an apparatus used to contain an oil spill.
   4. the Coast Guard's nickname for oil spills.

5. One method of removing an oil spill is by burning the oil. Sometimes this method does not work because

   1. the oil is wet.
   *2. some types of oil contain no flammable substances.
   3. lighting an oil spill is hazardous business.
   4. burning oil spills are uncontrollably dangerous.

6. Which oil spill removal method does the least environmental damage?

   1. Sinking
   2. Burning
   3. Detergents
   *4. Adsorption

7. When an oil spill occurs in U.S. waters, who is supposed to pay for the clean-up costs?

   *1. The spiller
   2. The taxpayers
   3. The Coast Guard
   4. The Federal government

8. Why does oil float on water?

   1. Oil is usually spilled on the water surface.
   2. Oil is warmer than water and rises.
   3. Ocean currents keep oil pushed to the surface.
   *4. Oil is less dense than water.

9. Photosynthesis in plants requires all but which one of the following?

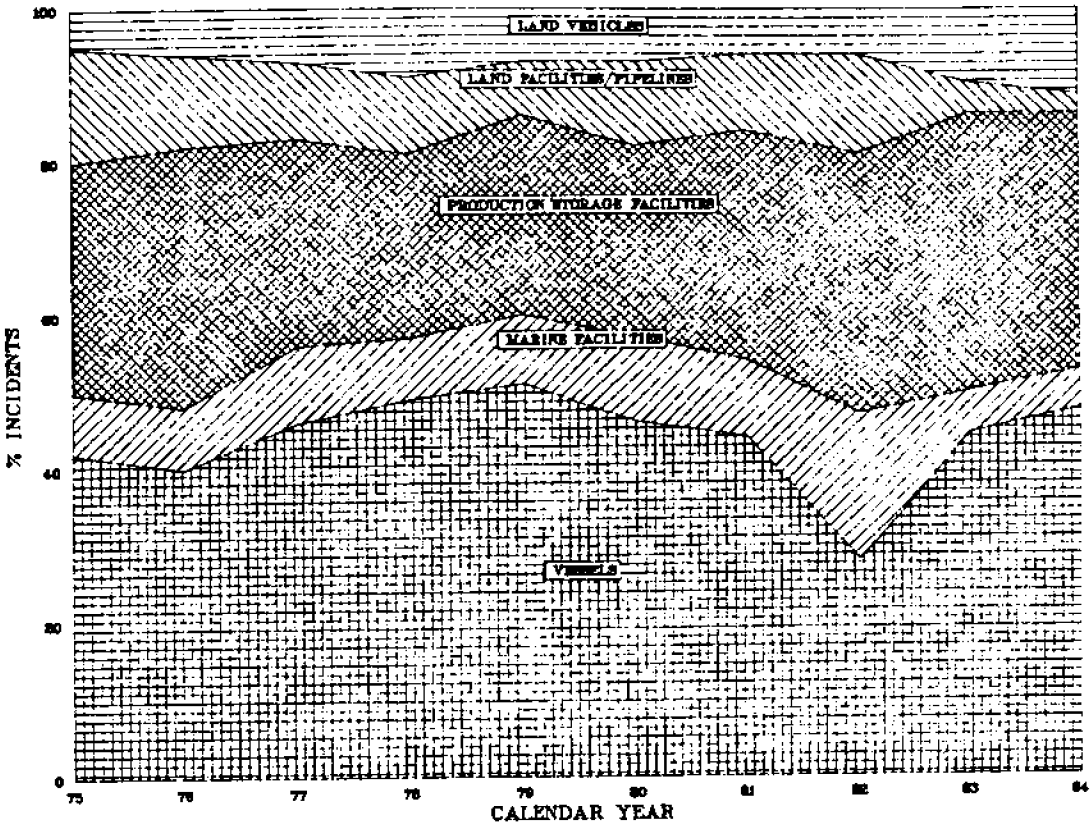
   1. Sunlight
   2. Water
   *3. Soil
   4. Carbon dioxide

10. What effect does an oil spill have on aquatic life?

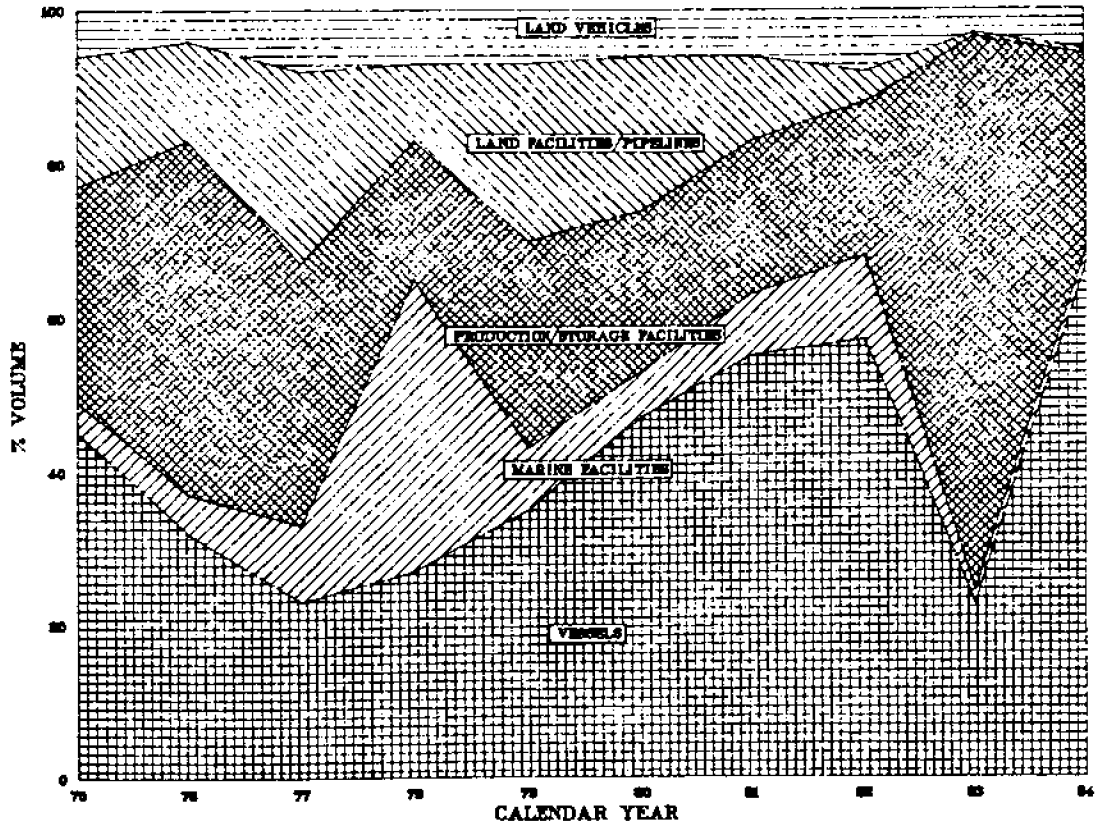
    1. Some organisms suffocate for lack of dissolved oxygen.
    2. Excess acid forms from increased levels of carbon dioxide.
    3. Oil will coat some organisms and restrict life processes.
    *4. All of the above.

APPENDIX

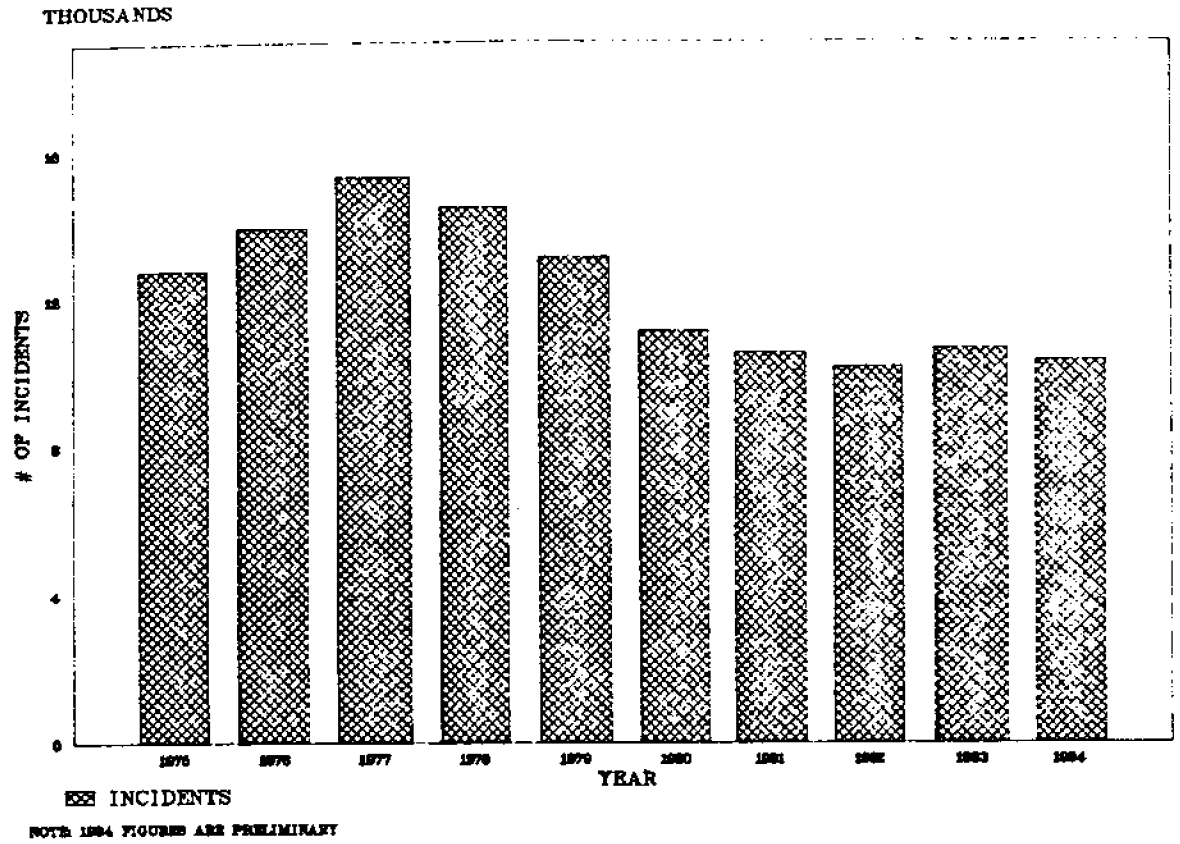
ALL POLLUTION INCIDENTS BY MAJOR SOURCE
(EXCLUDING UNKNOWN)



ALL POLLUTION DISCHARGE VOLUMES BY MAJOR SOURCE
(EXCLUDING UNKNOWN)

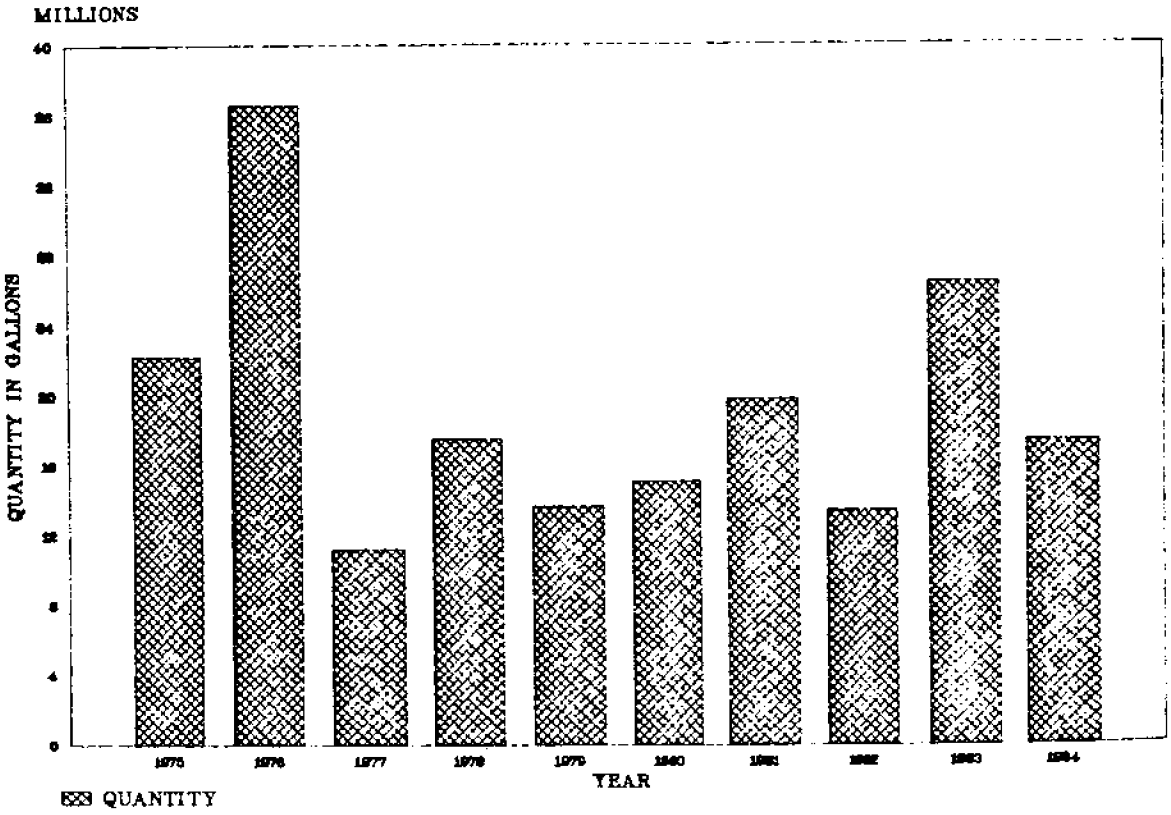


TRENDS FOR OIL AND OTHER SUBSTANCES



NOTE: 1984 FIGURES ARE PRELIMINARY

TRENDS FOR OIL AND OTHER SUBSTANCES



NOTE: 1984 FIGURES ARE PRELIMINARY

U. S. Coast Guard, Polluting Incidents In and Around U.
COMDTINST M16450.2G, 1987.

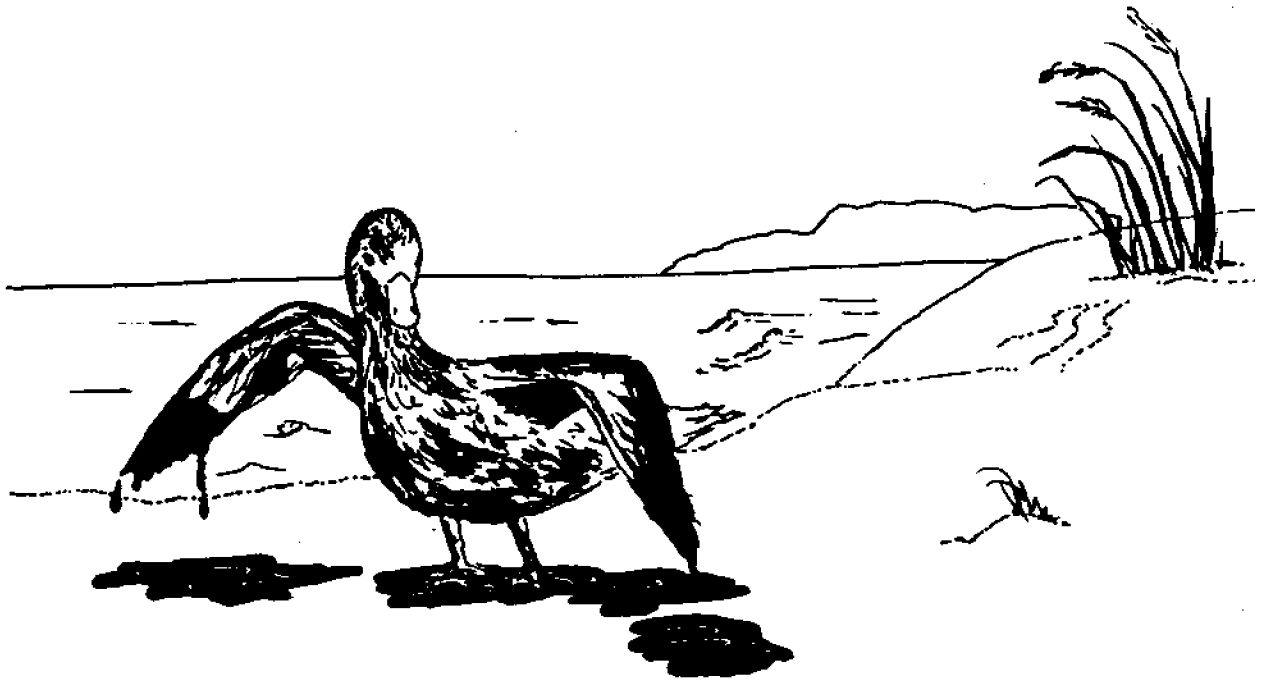
EP-12

Ohio Sea Grant

OIL SPILL

by

Stephanie Ihle, The Ohio State University
and
Rosanne W. Fortner, The Ohio State University



OEAGLS-Oceanic Education Activities for Great Lakes Schools

OEAGLS Investigation #17

Completed March 1980
Revised January 1982 and June 1987

This instructional activity was prepared with the support of the National Oceanic and Atmospheric Administration, Sea Grant College Program Office, U.S. Department of Commerce, under Ohio Sea Grant Project #714077. Funding support was also provided by the Ohio State University's School of Natural Resources and College of Education. Any opinions, findings, conclusions or recommendations expressed herein are those of the authors, and do not necessarily reflect the views of NOAA or the University.

Activities B and C are adapted from "The Oil Spill Problem," Project COAST #301, developed by the University of Delaware, Newark, DE.

OIL SPILL

by

Stephanie Ihle and Rosanne W. Fortner
The Ohio Sea Grant Program

INTRODUCTION

When oil is poured on rough waters, the surface of the water is calmed. In ancient Greece, sponge divers made use of this fact and carried oil in their mouths when they began a dive. Releasing the oil smoothed the ripples and gave them better light for searching below. Today, mariners will sometimes dump oil to calm ocean waves and make rescue easier.

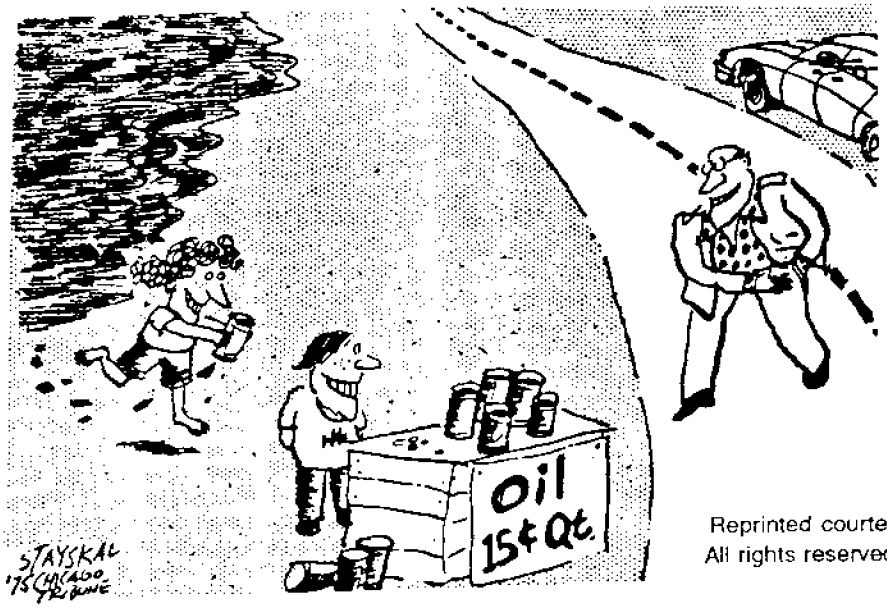
Oil on water is not always welcome, however. Accidents in which oil is spilled in the water definitely do not have a calming effect on people. Our recent history records a distressing number of tanker spills, offshore drilling accidents and mysterious oil slicks of unknown origin.

The Great Lakes, as well as the ocean, have been affected. In 1974, for example, an oil spill from the tanker *Imperial Sarnia* caused damages to the St. Lawrence Seaway which cost about $2,000,000 to clean up. In 1961 another tanker spill on the St. Lawrence River was reported to have caused the extinction of the last colony of Greater Snow Geese.

Who or what is responsible for our oily waters? What are the effects of oil spills on living things in the water? Can an oil spill ever be completely cleaned up?

OBJECTIVES: When you have completed this investigation you will be able to:

1. Describe the major sources of oil pollution in our oceans and the Great Lakes.
2. Discuss three ways in which oil may be removed from water.
3. Describe the effects of oil on aquatic organisms.



ACTIVITY A: WHERE DOES OIL POLLUTION COME FROM?

The U.S. National Academy of Sciences estimates that 6,100,000 metric tons of petroleum products enter the world's oceans each year. (This is usually written as 6.1 mta. A metric ton is one million grams, or 1.1 regular tons.) About 2.3% of this total, or 0.14 mta, comes from oil spills in the Great Lakes. The petroleum pollution comes from many sources, some natural and some from human activities.

MATERIALS: Protractor, pencil, circle in Figure 1.

PROCEDURE

In this activity you will construct a "pie" graph showing what part of the total petroleum pollution in the oceans comes from different sources. The list on the next page tells how many million metric tons annually (mta) come from different sources. It also tells what percent of the total petroleum pollution this is.

The whole circle in Figure 1 represents the 6.1 mta discussed. You will divide the circle into wedges that look like pieces of pie. The size of each wedge will depend on the amount of petroleum from one source.

To find how big a wedge to draw for each pollution source, you will have to do an arithmetic problem.

1. A circle can be divided into 360 equal parts called degrees. Multiply the percent (column 2) by 360 and write your answer in column 3. If one pollution source is responsible for 10% of the total oil pollution, you would multiply 0.10 (same as 10%) x 360 degrees. Your answer is 36 degrees.

2. There is a copy of Figure 1 on your worksheet. Do all your work there. Place your protractor on a line running from the center of the circle to its outer edge. Thepoint at the center of the protractor base  should be on the center of the circle.

3. Reading from the bottom line of the protractor around the arc, find the point that represents your answer from column 3. Place a dot on the circle at that point.

4. Draw a line from the center of the circle to the edge of the circle through your dot. Label the wedge as shown in the example in Figure 1.

5. Complete the chart on your worksheet and check your work by adding up the numbers in column 3. The total should be 360 degrees by rounding your answers to the nearest degree.

6. Divide your pie graph into wedges as the example shows. Since the graph represents the total amount of oil pollution in the oceans, the entire circle will be filled with wedges when you finish.

SOURCES OF PETROLEUM IN THE MARINE ENVIRONMENT

Source of Petroleum	mta	% of total	Size of Wedge
Natural seepage*	0.60	10	36°
Tanker operations	1.33	22	
Tanker accidents	0.20	3	
Other transportation activities	0.60	10	
Runoff from rivers and cities	1.90	31	
Coastal facilities	0.80	13	
Offshore drilling	0.08	1	
Atmospheric fallout	0.60	10	
Total	36.11	100%	360°

*Leaks from oil deposits. In the Great Lakes, for example, oil seeps into the water from deposits at Oil Springs, Ontario.

(Data from Fate and Effects of Oil in the Sea. Exxon Corporation)

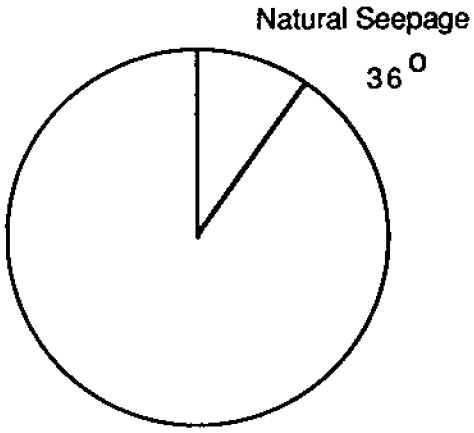
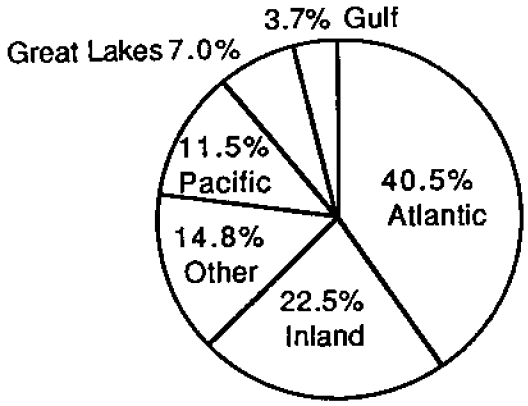


Figure 1. Sources of petroleum going into the oceans.

Now look at Figure 2. In this second pie graph you can see how the oil pollution was distributed in the waters of the U.S. in 1984. Notice that the wedge for the Great Lakes is about 1/5 the size of the one for the Atlantic Coast. The area of the Atlantic Ocean is about 115 times the area of the Great Lakes. The damage done by the oil pollution in the Lakes is much more concentrated and therefore does more visible damage than Atlantic oil pollution.



U. S. Coast Guard, Polluting Incidents In and Around U. S. Waters. COMDTINST M16450.2G, 1987.

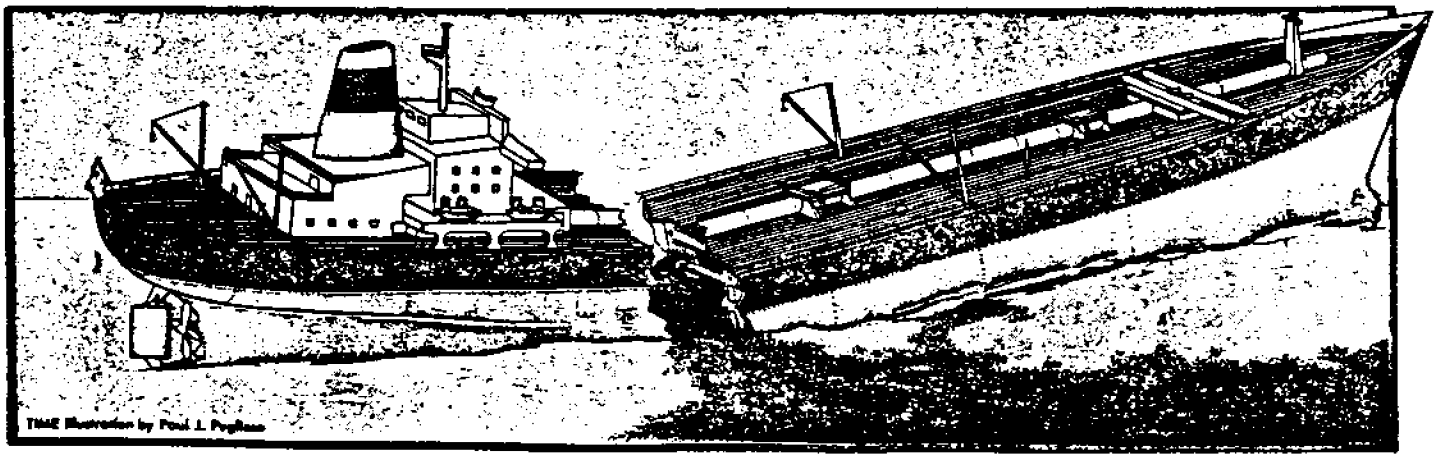
Figure 2. Oil Pollution Incidents by Area, 1984.

QUESTIONS: Answer the following on your worksheet.

1. Most of the oil spills we hear about involve which one of the wedges in Figure 1?

Compare this source to other sources of petroleum pollution. Are there sources of oil pollution that do not make the news very often?

Occasional massive spills such as the *Amoco Cadiz* in 1978 and the *Argo Merchant* in 1976 are almost certainly less damaging to the marine environment than frequent smaller releases of oil in a confined harbor. (Notice the size of the "Coastal Facilities" wedge.)



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When an oil tanker (ship) is carrying no oil, it fills up its cargo space with water so the ship will be stable. A substance used for stability this way is called **ballast**. Ships getting ready to load on a new cargo used to dump the water they were using as ballast. This ballast had picked up oil from the hold, and the oily wastes were flushed out into the harbor.

2. Which of the wedges describes this type of pollution source?

Today, regulations prohibit the dumping of oily ballast, and haulers reclaim much of the oil that had been lost this way.

3. How could oil get into the water from offshore drilling operations?

You may wish to read about the Ixtoc oil spill in 1979 in the Gulf of Mexico. (See Newsweek Magazine issues for August 13, 1979, and August 4, 1980.) The International Joint Commission (a cooperative agency of the U.S. and Canada) has prohibited drilling for oil in Lake Erie because of the risks of such a disaster. Canada drills for natural gas in the lake, but the U.S. does not. The environmental impact of drilling is now under consideration.

4. From Figure 2, what body of water gets the greatest volume of oil pollution? What kinds of areas are these?

5. List some ways that petroleum could get into rivers. (Hint: Refer to Figure 1 for some ideas.)

The next time you are riding along the highway, look at the road ahead of you. A well-traveled highway usually has a dark streak running down the center of each lane. The streak is caused by petroleum products such as crank case oil that drips out of vehicles.

6. How could this serve as a source of oil pollution for water?

7. What could your family do as good citizens to reduce the amount of petroleum products going into our water?

ACTIVITY B: HOW CAN AN OIL SPILL BE CLEANED UP?

The moment a spill occurs, nature begins cleaning up. The oil separates into heavier and lighter parts and is spread by wind and currents. Some of it evaporates, like gasoline spilled from the gas pump. Certain types of bacteria called petrophiles consume some of the oil. According to marine affairs specialist E. W. Seabrook Hull, "Within a couple of years no sign of the disaster remains. The oil is gone, and the birds and other marine life are back, as though nothing had happened. This has been shown in the case of *Torrey Canyon*, the *Wafra*, the *Arrow*, the *Argo Merchant*, Santa Barbara and numerous other events."

The sight of oily birds and beaches and the loss of tourist and fishing income make us impatient with the slow dependable processes of a natural clean-up. An oil spill needs to be cleaned up right now, we think. But how can this be done?

MATERIALS: For each team of students: aluminum "pot pie" pan or butter tub, water, 10 ml of motor oil, 25-cm pieces of twine, handful of straw, handful of sand, alcohol burner, matches, wooden splints, paper towels, liquid detergent, dropper, safety glasses, newspapers to cover working surfaces.

PROCEDURES

Success in cleaning up an oil spill depends upon preparedness and rapid action by the spiller and by Federal, state and local agencies. When a spill occurs, it is reported to the nearest U.S. Coast Guard station. The spiller, by law, is suppose to clean up the oil. If the spiller does not clean up the pollution, the Coast Guard takes over and the spiller pays the clean-up costs.

In this activity your team will create an oil spill and try various methods of cleaning it up.

I. Containment

If an oil spill is contained in one area, cleanup is easier and less environmental damage is likely to occur. Containment must be done as soon as a spill is detected if it is to be effective.

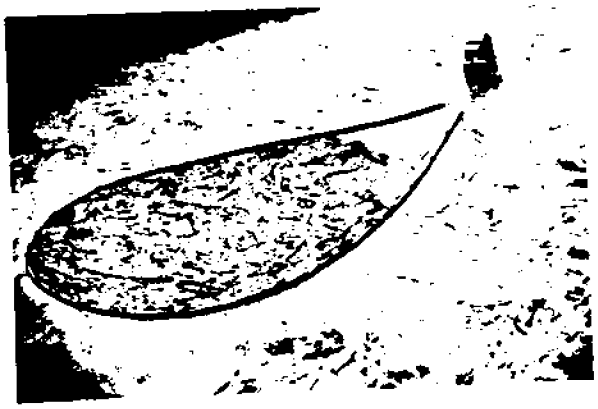
1. Add about 2 cm of water to your pie pan or bowl to serve as a lake.

An oil tanker has sprung a leak in the middle of your "lake." Add 2 drops of oil to the water's surface.

Tie the ends of a piece of string together and gently place the circle of string on top of the water, with the oil inside. Slowly add 2 ml more oil inside the circle. Pull the oil to one side of the pan using the string.

NOTE: If any oil is spilled outside the pan, clean it up immediately. Spilled oil causes unnecessary accidents.

2. Does the string keep the oil from spreading over the entire lake? This is how a "boom" operates to contain a spill.



Crude oil and debris enclosed in a boom

U. S. Environmental Protection Agency, "Oil Spills," 1977.

3. Some contained oil can be reclaimed (collected for further use). Use a dropper to try to reclaim some of your oil. About how much oil were you able to reclaim?

II. Removal of oil from water

Whether the oil is contained or free, it still must be cleaned up to prevent further environmental damage. Although there are many elaborate techniques for oil removal, some simple and non-technical methods are still widely used.

A. Removal by burning

1. Remove the string from your lake. Pour 5 ml of oil on the water surface.

2. Put on safety glasses and light your alcohol burner. Set fire to the tip of a wooden splint. Try to ignite the oil spill with the splint.

3. Does the oil burn? If so, how long did it burn? Was there any oil left when the flames went out? If the oil did not burn, try to explain why.

4. If the oil is burned, what other damage to the environment might occur?

5. Is the burning of the oil an effective way to clean up an oil spill? Explain.

B. Removal by sinking

Ordinarily, oil floats on water because it is not as dense as water. Increasing the oil's density will make it sink to the bottom.

1. If your oil was cleaned up in Procedure A, add 5 ml of new oil to your lake.

2. Sprinkle enough sand on the oil spill to cause it to sink. Does this method remove all (or most) of the oil from the surface?

3. When this method is used, what other effects will it have on the environment?

4. What should you know about the water environment before using this method to clean up a real oil spill?

5. Is sinking a good way to clean up an oil spill? Explain.

C. Removal by adsorption

Certain materials will attract oil to their own surfaces. This is called **adsorption**. You have probably seen pictures of this type of clean up method.

1. Pour 5 ml of new oil into your lake. (You do not need to dump the oily sand from B unless it is deep enough to break the water surface.)

2. Place a small amount of straw on top of the oil. What happens?

Cleaning up an oil-soaked beach.

U. S. Environmental Protection Agency, "Oil Spills," 1977.

3. How can you remove the oil from the lake now? Check your idea with your teacher, and try the idea if the teacher approves. Did your idea work?

4. Is adsorption a good way to clean up an oil spill?

D. Removal by detergents

Household detergents are used to remove oil from laundry or grease from dishes. They do this by breaking up oil drops and dispersing them in the water to form an emulsion.

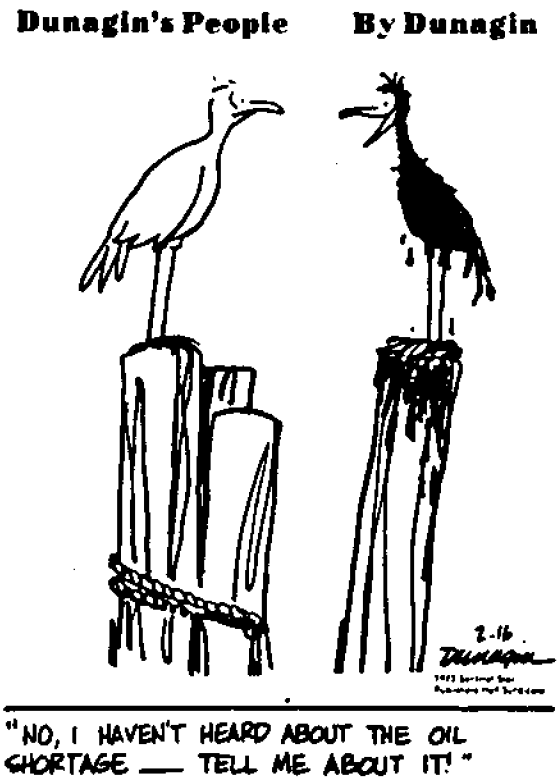
1. Dump the contents of your lake in the container provided by your teacher. Wipe the lake basin out and add fresh water.

3. Does dispersion by detergents let you clean up the oil easier? Explain.

4. How could the environment be damaged by use of detergents?

In actual use, detergents are designed to allow natural clean-up to take place more easily. Results would not be noticeable for a longer period of time.

ACTIVITY C: HOW DOES AN OIL SPILL AFFECT LIVING THINGS?



DUNAGIN'S PEOPLE by Ralph Dunagin
© 1973 Field Enterprises, Inc.
Courtesy of Field Newspaper Syndicate.

We have all seen pictures of oily sea birds and heard horror stories of damaged fishing grounds resulting from oil spills. The effects of oil are not always so obvious. In this activity you will investigate how oil changes the water and affects plant functions.

MATERIALS: For each team or one for entire class: 250 ml beaker, water, 10 ml oil, short piece (5-6 cm) of aquarium plant (*Elodea* or *Anacharis*).

PROCEDURE

A. Changes in water and plant characteristics.

A group of students did an experiment to find out if oil does anything to water and aquatic (water) plants. They covered two jars with black paper so that light could only get in from the top, as it would in a lake. Then they got some *Elodea* , a water plant, and cut off two pieces that were the same length and had the same number of leaves. One piece of *Elodea* was placed in each jar of water.

The students decided to observe changes in the appearance of the plants and study two characteristics of the water. They checked the water for dissolved oxygen (D.O.) since they knew that plants and animals take oxygen from the water during respiration.

1. Why is the D.O. test important in a study of bodies of water and life in the water?

They also checked for the amount of acid in the water by measuring the water's "pH." A pH number of less than 7 means the water is acidic. The lower the pH number, the more acid the water is.

2. The amount of acid in the water is related to a gas produced by plants and animals during respiration. What is this gas?

The D.O. and pH in both jars were measured on the first day of the experiment and recorded in the chart on the next page (Day 1).

Then the students created an oil slick in one of the jars. They used motor oil like the kind in Activity B. On the next three days they repeated their D.O. and pH tests and recorded the results in the chart (Days 2, 3 and 4).

	Clean Water (Jar 1)		Oil Spill (After Day 1) Jar 2	
Day	D.O. (ppm)	pH	D.O. (ppm)	pH
1	10	7	10	7
2	10	7	9	7
3	10	7	7	6
4	10	7	4	5

3. In which jar did D.O. decrease? In which jar did it stay the same? How can you explain this?

4. The pH in the oil spill went down. If both plants were making the gas you named in Question 2, why did the pH drop in one jar and stay the same in the other?

Photosynthesis in plants requires sunlight, water and carbon dioxide. Respiration requires oxygen.

5. Can the plant in the oil spill get light? Water? Carbon dioxide? Oxygen?

6. Can the plant in clean water get light? Water? Carbon dioxide? Oxygen?

7. How does an oil spill affect photosynthesis in plants? Respiration?

The students decided to find out if oil was harmful when it got right on the plant itself, so they dipped a piece of *Elodea* in oil and put it in a cup of clean water. Some of the oil floated off, but the leaves remained coated.

8. Could the leaves of the plant get light? Water? Carbon dioxide? Predict what happened to the oily plant.

Try this yourself with the materials listed on page 9.

B. Changes in animal populations

The National Academy of Sciences report discussed in Activity A listed the findings of scientists about the effects of oil spills on animals.

1. Petroleum products do not remain in marine organisms after the spill has gone. These products are not concentrated as they pass through the food chain. In the Great Lakes, on the other hand, some organisms do accumulate petroleum materials in their fat.

2. Oil on beaches damages shoreline life. Oil seeps downward into sand and remains there for years. Rocky shorelines can clean themselves naturally through wave action, but bays, estuaries and marshes have few waves. Oil spills in such areas are very damaging.

U. S. Coast Guard photograph,
"The NEPCO 140 Incident."

3. Oil causes serious harm to birds by coating their feathers. An oily bird does not float, and it has no insulation against temperature changes. Birds also poison themselves by eating the oil that coats them.

4. Oil is sometimes reponsible for smothering communities of animals that live on the sea floor. This is especially important to the shellfishing industry. Most of these areas will eventually become settled again, but some organisms like mussels cannot survive in an oiled area.

In the Great Lakes, the fresh water cannot hold the heavier types of oils on the surface. The oil sinks and enters the bottom sediments and the food chain.

5. Fish are not affected by oil pollution as much as other organisms. A massive spill such as that from the *Amoco Cadiz* in 1978 can kill large numbers of fish, but ordinarily fish are able to escape injury from minor accidents.

6. Different petroleum products have different effects on organisms. Diesel or heating oils are most poisonous, while heavy crude and fuel oils are worse for smothering animals. Oil may be more poisonous to freshwater organisms than to sea life, probably because cold lake water slows down evaporation and oils stay in the environment longer.

Answer these questions on your answer sheet based on your reading of Part B:

1. Why does the oil spilled in the Great Lakes sink to the bottom while oil on the ocean floats?

2. Describe an oil spill that <u>could</u> kill large numbers of fish.

3. What kinds of petroleum products have the greatest effect on organisms? How do these affect the organisms?

4. Are all areas of the coastline affected in the same way by oil pollution? If not, explain differences.

5. Why does oil remain in Great Lakes water longer than in ocean water?

REVIEW QUESTIONS

1. What are the two major sources of oil pollution in the oceans?
2. How does nature clean up oil spills?
3. List three ways that oil can be removed from water.
4. For the methods you listed in number 3, what damage to the environment might occur if these methods are used?
5. How does oil affect plants? Birds? Bottom animals? Fish?

GLOSSARY

adsorption - the process by which a thin layer of liquid clings to the surface of a solid.

ballast - a heavy substance used to improve stability in a ship by giving the ship more weight when it does not have a full load of cargo.

density - the mass of a substance per unit volume. Because of its salt content, a cup of sea water is more dense than a cup of fresh water.

disperse - to break up and scatter. In an oil spill, floating masses of oil may be dispersed by wind or by detergents.

emulsion - a mixture of two liquids in which one is scattered in droplet form throughout the other.

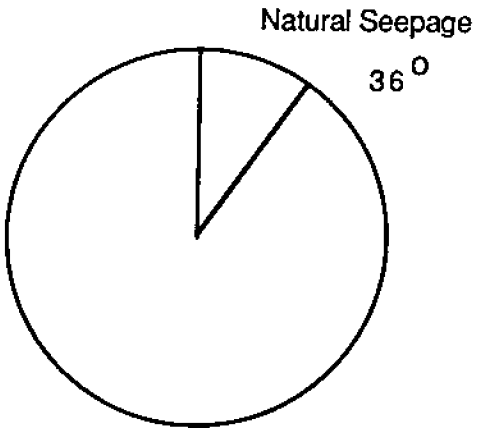
petrophile - literally, an oil lover; a type of bacteria that can use petroleum as a source of energy for growth.

pH - a measure of the amount of hydrogen ions in a substance. More hydrogen ions mean greater acid content and lower pH. A neutral substance has a pH of 7. Numbers below 7 indicate acids, above 7 indicate bases.

Name _____

OIL SPILL WORKSHEET

ACTIVITY A: WHERE DOES OIL POLLUTION COME FROM?



1. Most of the oil spills we hear about involve which one of the wedges in Figure 1? _____

_____

2. Which of the wedges describes the "water as ballast" type of pollution source? _____

3. How could oil get into the water from offshore drilling operations? _____

_____

_____

4. From Figure 2, what body of water gets the greatest volume of oil pollution? _____

Why do you suppose this is true?_____

5. List some ways that petroleum could get into rivers. (Hint: Refer to Figure 1 for some ideas)

_____

_____

How could the dark streak that you see running down the center of each highway lane serve as a source of oil pollution for water?_____

6. What could your family do as good citizens to reduce the amount of petroleum products going into our water?_____

_____

ACTIVITY B: HOW CAN AN OIL SPILL BE CLEANED UP?

In this activity your team will create an oil spill and try various methods of cleaning it up.

I. Containment

1. Follow instructions.
2. Does the string keep the oil from spreading over the entire lake? _____
3. Use a dropper to try to reclaim some of your oil. About what percentage of the oil were you able to contain? _____

II. Removal of oil from water

A. Removal by Burning

1 and 2. Follow instructions.

3. Does the oil burn? _____ If so, how long did it burn? _____ Was there any oil left when the flames went out? _____ If the oil did not burn, try to explain why. _____
4. If the oil did burn, what other damages to the environment might occur? _____
5. Is the burning of oil an effective way to clean up an oil spill? _____ Why? _____

B. Removal by sinking

1. Follow instructions.
2. Does sprinkling sand on the oil spill remove all (or most) of the oil from the surface? _____
3. When this method is used, what other effects will it have on the environment? _____
4. What should you know about the water environment before using this method to clean up a real oil spill? _____
5. Is sinking a good way to clean up an oil spill? _____ Explain. _____

C. Removal by Adsorption

1. Follow instructions.

2. What happens when a small amount of straw is placed on top of the oil? _____

_____

3. How can you remove the oil from the lake now? _____

_____

Did your idea work?_____

4. How could the environment be damaged by use of detergents?_____

_____

D. Removal by Detergents

1. Follow instructions.

2. What happens when a drop of oil and a drop of detergent are added to your lake andd stirred vigorously?

_____

3. Does dispersion by detergents let you clean up the oil easier? _____ Explain.

_____

_____

4. How could the environment be damaged by use of detergents?_____

_____

ACTIVITY C: HOW DOES AN OIL SPILL AFFECT LIVING THINGS?

PROCEDURE A: Changes in water and plant characteristics

1. Why is the D.O. test important in a study of bodies of water and life in the water?

_____

2. What is the gas that is produced by plants and animals during respiration? _____

3. The tests showed that D.O. decreased in the _____ jar but stayed the same in the

_____ jar. How can you explain this?_____

_____

4. If both plants were making the gas you named in Question 2, why did the pH drop in one jar and stay the same in the other?_____

_____

5. Can the plant in the oil spill get light? _____ yes _____ no
   water? _____ yes _____ no
   carbon dioxide? _____ yes _____ no
   oxygen? _____ yes _____ no

6. Can the plant in clean water get light? _____ yes _____ no
   water? _____ yes _____ no
   carbon dioxide? _____ yes _____ no
   oxygen? _____ yes _____ no

7. How does an oil spill affect photosynthesis in plants?_____

_____

How does it affect respiration?_____

8. Could the leaves of the plant get light? _____ yes _____ no
   water? _____ yes _____ no
   carbon dioxide? _____ yes _____ no

Predict what happened to the oily plant. _____

PROCEDURE B: Changes in animal populations

1. Why does the oil spilled in the Great Lakes sink to the bottom while oil on the ocean floats?

_____

2. Describe an oil spill that could kill large numbers of fish. _____

_____

3. What kinds of petroleum products have the greatest effect on organisms? _____

_____

How do these affect the organimsms?_____

4. Are all areas of the coastline affected in the same way by oil pollution? _____ If not, explain differences. _____

_____

REVIEW QUESTIONS

1. What are the two major sources of oil pollution in the oceans? _____

   _____

2. How does nature clean up oil spills? _____

   _____

3. List three ways that oil can be removed from water. _____

   _____

4. From the methods you listed in number 3, what damage to the environment might occur if the methods are used? _____

   _____

   _____

   _____

5. How does oil affect plants? _____

   _____

   Birds? _____

   _____

   Bottom Animals? _____

   _____

   Fish? _____