OIL ON THE BEACH

FOR THE TEACHER

Discipline
Earth Science

Theme
Systems & Interactions

Key Concept
Oil spilled at sea can travel with currents, tides and waves to the sandy beach where it can harm the animals that live there.

Synopsis
Students use a variety of methods to attempt to clean up an oil spill washing ashore on a simulated sandy beach. They also investigate the role weather plays in changing the properties of the spilled oil and how the oil impacts the animals living there.

Science Process Skills
observing, communicating, comparing, organizing, applying

Vocabulary
benthic, invertebrates, preen, feather barb/shaft, mousse, sheen, floating boom, oil slick, tides

MATERIALS
Note: any oiled items should not be used for food ever again
For each small cooperative group in Fouled Feathers
• 1 cup salt water (save the oiled water for Part 3)
• 1 drop motor oil (10-40W)
• 2 small bowls or petri dishes
• bird feathers
• magnifying lens
• dish detergent (Dawn was used on the Exxon Valdez spill)
• paper and pencil for sketches
For Oil Slick (teacher demonstaration)
• large, flat cafeteria tray or cookie sheet

• 1 cup salt water (save the oiled water for Oil Mousse)
• 1 teaspoon motor oil (10-40W)
• pint container (empty)
• quart of oil (empty)
• gallon container (empty)
• ruler

For Oil Mousse (teacher demonstration)
• oiled water from Fouled Feathers and Oil Slick
• measuring cup
• large bowl
• egg beater
• sand, rock, shells, feathers

optional
• paper and marking pens for mural

For Cleaning the Beach (teacher demonstration)
• three tablespoons used motor oil
• plastic dishpan pierced near the bottom with a nail about the size of a pencil
• bucket
• rocks of various sizes
• small rubber or plastic animals to represent beach organisms
• drift algae and pieces of crab molts and shells or plastic aquarium
• plants placed on sand or glued onto larger rocks;
• saltwater to fill dishpan 3/4 full;
• sand to form sloping beach and cliff in dishpan;
• string, cotton balls, hay/straw/saw dust, styrofoam pieces, spoon, feathers

INTRODUCTION

The image of the open ocean and other marine habitats as an inexhaustible resource to use and abuse, has been seriously challenged by many people. There are many threats to the well-being of the ocean, but oil spills are among the most devastating of all possible catastrophes.

With a growing number of supertankers and offshore oil rigs worldwide, heavy reliance on oil as a primary energy source, and an unstable political and economic climate surrounding the oil industry, there are many possibilities for major oil spills. These oil spills may become disasters for marine life. Over 100 million barrels of oil and other petroleum products are shipped past the northern California coast each year. Improving tanker traffic safety has become a major focus of environmental organizations working to prevent oil spills.

Standard operating procedure for dealing with oil spills involves containment by floating booms (a barrier of floating logs, foam or rubber tubes) and where possible followed by removal of oil from the contained area. Spilled oil is cleaned up by absorption by substances such as straw, sawdust, etc.; skimming; sinking of the oil with sand or dirt; or adding dispersants like

detergent or other chemicals to break up the spill. The method used depends on the type of oil spilled and where the spill occurred. Sometimes several of these methods are used on one spill.

The effectiveness of all these methods depends on weather and wave conditions at sea and availability of clean-up crews and materials. In effect, spilled oil is next to impossible to clean up. Oil which is not immediately recovered is at the mercy of currents, waves and tidal changes which carry the oil to shore. Seabirds and sea otters become covered in oil and are no longer able to keep themselves waterproof and are then at risk of freezing. They also ingest the oil and are poisoned as they attempt to clean themselves by preening. As the oil reaches the beaches, intertidal life which filters the water for food is suffocated, poisoned, or starved. Shorebirds preying on sandy beach organisms are also covered with the oil and poisoned by eating contaminated food or by preening. They may also starve because they cannot find food.

Oil slicks which form after an oil spill soon begin to change both physically and chemically. Oil is made up of many different compounds and some of the lightest parts may evaporate into the air. The remainder of the spilled oil immediately begins to spread out on the surface of the water. Much of this oil can be seen as a dark, black slick that has dire consequences to the animals coming in contact with it. In addition, much of the oil slick spreads out as a very thin, iridescent sheen that can be extremely toxic to seabirds and other marine life. As oil on the water is agitated by wind and begins to weather it changes in about two weeks time to a thick, gel-like substance called mousse. Mousse is a mixture of oil with air and water.

What happens to the wildlife when such a disaster occurs? Who is responsible? How can the damage be repaired? How can we learn from these mistakes to prevent future incidents? How can we reduce our energy dependency on oil? These are just a few of the many questions that we need to consider when planning for our planet's future.

THROUGH
THE ACTIVITIES

Fouled Feathers
Discuss with students and brainstorm: what is oil, how do people use it, where does it come from. Show students some pictures of oil wells on land and in the ocean, tankers, refineries, pipelines and gas stations. Also show them pictures or videos of the results of an oil spill.

Have each group pour a layer of salt water about 1" deep into each of the two small bowls. Have a student drop a single drop of motor oil onto the surface of

the water in one of the bowls to create a layer of sheen. Pretend that this is an oil spill from a tanker just offshore.

Now have the groups dip two bird feathers into the bowl of plain salt water (control). This represents a bird which may have come in contact with the spill. Remove the the feathers, place one on top of the other and place in a well-ventilated or sunny spot to dry. Next, dip two clean feathers into the bowl of sheen. Remove them. Is the oil visible? Place one on top of the other and set alongside the control feathers to dry.

Have the students look closely at the feathers. They can use the magnifying lenses for more detailed examinations. Have them sketch each of the feathers including the barbs and shaft and describe to their group what they observe. What were the results of their experiment? Did the feathers dipped into clean sea water dry quickly and separate from one another? Did the oiled feathers remain matted together? Explain that a bird with matted feathers cannot stay warm on the ocean and will freeze to death.

Now have each group wash the oiled feathers in the dish detergent. Again have them sketch the feather after it dries. Does it still look different from the control feather? In what ways? A bird whose feathers have been "cleaned" with detergent still cannot survive at sea. The detergent removed their natural oils so the feathers appear fuzzy and messed up with all the barbs going in different directions. The birds must be kept warm in captivity until their natural oils are replenished. Help the students label their drawings.

The Oil Slick (Teacher Demonstration)
Demonstrate the way oil leaking from a tanker spreads out to form a slick on the surface of the water. Pour a layer of salt water into the tray. Drop 1 teaspoon of oil on the the water's surface.

Use a ruler to measure the size of the slick that forms. If one teaspoon could cover this much surface area, approximately how much would the 11 million gallons of oil spilled in Alaska cover?

Use the pint, quart of oil and gallon containers to demonstrate how much water was polluted by the spilled oil from the *Exxon Valdez.* Use the following conversions to relate the size of the spill to your students:

96 teaspoons in 1 pint
2 pints in 1 quart of oil
4 quarts in 1 gallon
42 gallons = 1 barrel of oil
1 pint of oil can produce a slick covering approximately one acre (an acre is almost as large as a football field)
1 quart of oil can produce a slick approximately 2 acres in size
1 gallon of oil can produce a slick approx. 8 acres in size

11 million gallons of oil were spilled in Alaska

Oil Mousse (Teacher Demonstration)
Take the oiled water from Part 1 and 2, measure the amount and pour it into a large bowl. Mix the oily water with an egg beater for at least 20 minutes. The froth which forms on top is mousse. This is what happens to an oil slick at sea which is agitated by high winds and strong seas for 2 weeks or more, as was actually the case with the *Exxon Valdez* oil in Alaska.

Have the students skim the mousse off and measure it. Is it more or less than the amount of oil which was poured in the bowl?

Thick foamy mousse may be blown ashore where it remains in the intertidal areas. Pour some of the mousse onto some sand, shells, bird feathers and a few dry rocks to illustrate its tendency to cling to the intertidal animals and shore rather than wash back out to sea
.
Have groups of students pick one of the following scenarios (or make up one of their own) to act out. Have the rest of the class try to guess what they are pantomiming. Alternatively, they can draw a mural depicting one of these scenarios. Have them label the pertinent parts of the animals.
a. Sand crabs live just under the surface of the sand and stick out their feathery antennae in the waves to breathe and capture food. What if their antennae are covered with mousse? Can they still eat?
b. Many shorebirds feed on sand crabs. What happens to the shorebirds if their sand crab food is covered with mousse?
c. Many kinds of crabs live on the sandy beach. Crabs breathe by means of gills which lie just under their top "shell" or carapace. What will happen if mousse gets into their gills?
d. Kelp wrack washed up on the beach is home and food for many small beach hoppers and kelp flies which in turn serves as food for shorebirds. What happens to this small community when it is coated with goo?
e. Shorebirds feeding on the sandy beach may become covered in oil mousse as they search for their prey and rest on the sand. What affect does the mousse have on their ability to capture prey, escape predators and stay warm?
f. What happens to animals such as chitons, snails and limpets which normally crawl across the surface of rocks looking for food? Can they remain attached and move in this gooey stuff?

Cleaning the Beach (includes a teacher demonstration)
Use the plastic dishpan with the hole punched in the side, near the bottom, with the simulated sandy beach sloping up from the hole. Plug the hole with a pencil, cork or nail and fill the dishpan to the "high tide line" (about 3/4 full) with salt water.

Add approximately 3 tablespoons of used motor oil to the surface of the water and watch the oil slick form. It is high tide now in calm weather and the oil slick has not yet reached the beach.

Have the students take turns trying to clean up the oil from the water using a variety of methods. Try at least three different methods and discuss what actual clean-up procedure is being simulated by each of the methods as follows:
string = floating boom
cotton balls = absorbent pads
hay, straw and sawdust = actual absorbents
styrofoam pieces = floating booms
nylon stockings and cardboard pieces = skimmers
spoons = vacuum
feathers = unlucky shorebirds
What method(s) were most successful? least successful? Did any of them work completely?

Remove the plug and allow the water to drain into a bucket as the "tide" gradually changes from high to low. Have students observe the direction of oil movement. At low tide, most of the oil will be seen to be up on the "beach", rather than going out the drain into the bucket. Have the students again try to clean up the oil, this time from the beach. What method(s) are most successful once the oil is on the beach? Is it easier or more difficult to clean the beach or the open water? What affect does cleaning have on the sand, rocks, and shells? Can the plants and representative "animals" be cleaned? How do you think the real animals would be affected by the oil as well as by the cleaning procedures?

Pour the bucket slowly back into the pan so that the oiled "beach" again starts to fill with water as it approaches "high tide". What happens to the oiled beach now? The oil is still there and if the tide rises further than the first time, the mark of blackened sand also rises on the "shore".

Add weather and wave action to simulate the actual conditions by blowing over the surface of the water with a hair dryer or through a straw. What happens to the oil now? After a few more tidal changes, dig down into the sand a few inches and see if any oil is visible.

DISCUSSION
Why are oil spills especially harmful for shorebirds, seabirds and sea otters? (They are no longer able to keep themselves waterproof and are then at risk of hypothermia and freezing. The barbs of the bird feathers stick together and the sea otters pelt becomes sticky and matted which eliminates the air spaces needed to conserve their body heat. Both animals depend on preening to keep

themselves meticulously clean to maintain the air spaces. In the process of cleaning they may become sick and weak from ingesting oil).

Can you safely remove the oil from a feather without harming the bird? How? (Some birds may survive the cleaning process, but they could still die from shock or they may have become to weak too survive. Also, washing may remove the spilled oil, but this also removes the natural oils. The feathers may no longer be waterproof and the birds lose buoyancy. Birds cleaned with detergent must be in captivity for many days until their natural oils are replenished).

The first activities following an oil spill involve attempts to contain the spill to keep it from spreading. What materials did you use to try to contain the spill? Under what weather conditions would these methods be most effective? (Booms only work in calm weather with very little wave action).

Which of the methods you tried used absorption to remove oil? Some people say that these techniques simply move the oil spill from the water to the land. What happens to the oil-soaked material once it is brought ashore?

How do currents, wind, waves and tides affect the oil spill and clean up? What is the effect of weathering on the oil? What effect does this mousse have on the sandy beach environment?

How are sandy beach organisms affected by the oil spill washing up on their beaches? Do the tidal changes take the oil off the beach? Where does the oil appear to go as the tide recedes from high to low? What happens to the oil at an extremely high tide? Do you think that the oil that gets worked down into the sand has any affect on the animals of the sandy beach?

Some clean up methods use sand or dirt to sink the floating oil. Once the oil spill sinks to the bottom, out of sight of people and beyond the range of harming the birds, is the oil a problem for the environment? How? (It may suffocate the benthic organisms or contaminate invertebrates living on the ocean floor which are used as prey for animals such as the sea otter. It may also be brought back to the surface little by little during high tide.)

Who should be responsible for cleaning up and paying for oil spills?

What should be done with the oily materials once the activity is completed? (There are recycling centers which will take the used oil and oily water and materials.)

BEYOND
THE ACTIVITIES

Have students write in interactive journals after each part of this activity is completed. Students can write in their native language or in English about their experiences and feelings. This helps to track their individual comprehension of the results and interpretations of each part of the activity. This also gives students the chance to interact and communicate with the teacher on the content and substance, not spelling of their entries.

Instead of the teacher demonstration in Cleaning the Beach, have students in cooperative groups try to clean up oil spills they create using small bowls and their own smaller, simulated beaches. Alternatively, use the large dishpan and explain to the students that as the tide ebbs out of the pan, some of the oil is carried offshore, represented by their individual pans, where they now try to clean-up the spill.

View videotapes or slides from the *Exxon Valdez* oil spill that occurred on March 24, 1989 in Prince William Sound in Alaska.

Write letters to Congress or the President asking them to work to prevent oil spills.

Visit a bird rescue center or volunteer to help clean birds during an oil spill.