Oil Spill in a Pan

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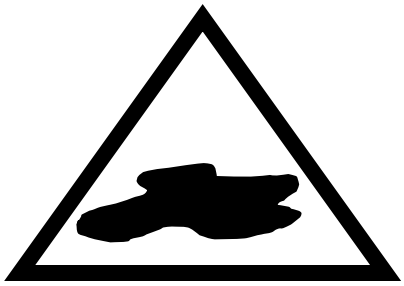
Subject area	**Science**
Grade	**5-12**
Lesson Length	**2 class periods**



Focus/Overview: Students are probably aware that oil and water form separate layers when mixed together, but they may not have thought of this fact in terms of what happens when crude oil is spilled into the environment. In this lesson students will conduct a simple experiment by evaluating the use of various clean-up techniques on an ocean and a wetland model. Students will then compare their efforts with clean-up methods used in the Deepwater Horizon oil spill. They will conclude by writing about what they have learned about oil spill clean-up and state their ideas about the best techniques and why based on their experiences.

Student Learning Objective(s):
The students will…

… evaluate various oil spill clean-up techniques and their efficiencies
… demonstrate use of various clean-up techniques for a simulated oil spill in the ocean and on land.

Louisiana SCIENCE Grade Level Expectations

GRADE LEVEL	TARGET GLEs
Gr 5-8 Inquiry: GLE #38	Explain that, through the use of scientific processes and knowledge, people can solve problems, make decisions and form new ideas (SI-M-B6).
Gr 5-8 Inquiry: GLE #39	Identify areas in which technology has changed human lives (e.g., transportation, communication, geographic information systems, DNA fingerprinting) (SI-M-B7).
Gr 6: GLE #41	Identify risks associated with the production and use of coal, petroleum, hydroelectricity, nuclear energy and other energy forms (PS-M-C8).
Gr 6: GLE #43	Explain how the use of different energy resources affects the environment and the economy (SE-M-A6).
Gr 7: GLE #32	Describe changes that can occur in various ecosystems and relate changes to the ability of an organism to survive (LS-M-D2).
Gr 7: GLE #39 Gr 8: GLE #51	Analyze the consequences of human activities on ecosystems (SE-M-A4).
Gr 7: GLE #43	Identify and analyze the environmental impact of humans' use of technology (e.g., energy production, agriculture, transportation, human habitation) (SE-M-A8).
Gr 8: GLE #20	Describe how human actions and natural processes have modified coastal regions in Louisiana and other locations (ESS-M-A8).
Gr 9-12 Inquiry: GLE #7	Choose appropriate models to explain scientific knowledge or experimental results (e.g., objects, mathematical relationships, plans, schemes, examples, role-playing, computer simulations) (SI-H-A4).
HS Biology: GLE #27	Analyze positive and negative effects of human actions on ecosystems (LS-H-D4) (SE-H-A7).
HS Env Sci: GLE #22	Analyze the risk-benefit ratio for selected environmental situations (SE-H-C4).

HS Env Sci: GLE #25	Discuss how education and collaboration can affect the prevention and control of a selected pollutant (SE-H-D2) (SE-H-D3).
HS Env Sci: GLE #26	Determine local actions that can affect the global environment (SE-H-D4).
HS Env Sci: GLE #27	Describe how accountability toward the environment affects sustainability (SE-H-D5).
HS Chemistry: GLE #47	Assess environmental issues related to the storage, containment and disposal of wastes associated with energy production and use (PS-H-G4).

Ocean Literacy Principles

5. The ocean supports a great diversity of life and ecosystems.
a. Ocean life ranges in size from the smallest virus to the largest animal that has lived on Earth, the blue whale.

6. The ocean and humans are inextricably interconnected.
b. From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.
e. Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (such as point source, non-point source, and noise pollution) and physical modifications (such as changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.
g. Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Materials Needed **(per pair of students)**

- Long, shallow pan or rolling paint pan
- Water
- Vegetable oil (3 Tbsp.)
- Wooden craft sticks
- Small cup (to mix oil/cocoa)
- Motor oil (extension, optional)
- Pipettes or eye droppers (several)
- Small bucket (to collect oily wastes)
- Watch or timer
- Cocoa powder (2 Tbsp.)
- A tablespoon
- Tweezers or tongs
- Eggbeater (extension, optional)
- Turkey baster

Suggested materials to make wetland:

- Modeling clay
- Sand
- Florist foam
- Peat moss
- Yard debris containing sticks and leaves
- Gravel
- Scraps of indoor/outdoor carpet
- Sponges

Oil spill clean up materials:

- Cotton balls
- Paper towels
- Nylon hose
- Straws
- Absorbent pad (rags)
- String or yarn
- Nylon net
- Styrofoam
- Detergents (dishwashing liquid)
- Feathers (2)

Advance Preparation

1. Run off copies of the student worksheet (**Blackline Master #1**) (one per student or student group).
2. Preview Dr. Irv Mendelssohn's video that describes oil impacts on salt marshes (to ensure that you can play it at school; it's a YouTube video). You can find it at http://www.youtube.com/watch?v=syGM13egoc0
3. Gather all the materials necessary for each group to complete the activity.

Background Information

The Deepwater Horizon oil spill was caused by a wellhead blowout at a water depth of 5,000 ft., about 41 miles off the coast of Louisiana on April 20, 2010. It is considered the largest offshore oil spill in U.S. history. There is little that can be done to contain and remove spilled oil that occurs in the open ocean. However, from the beginning of this environmental disaster various clean-up techniques have been used to capture or contain the oil.

This experiment uses household products to simulate sophisticated techniques that are used in oil spill clean-ups. Students will be using mechanical devices, which are considered the least harmful to the environment. Booms, for example, are used to stop oil from spreading and to keep it contained so it can be removed. There are three main types: 1. **Hard boom** is like a floating piece of plastic with a round float at the top and is weighted at the bottom with a "skirt" under the water. If the winds and currents are not too strong, these booms are used to make the oil go in a different direction (deflection booming). 2. **Sorbent boom** looks like a sausage and is made out of material that absorbs oil. The inside of a disposable diaper would act much like a sorbent boom. Sorbent booms don't have the "skirt" that hard booms have, so they don't contain oil for very long. 3. **Fire booms** are seldom used. They look like metal plates with a floating metal cylinder at the top and thin metal plates that make the "skirt" in the water. This type of boom is made to contain oil long enough to burn it. Another mechanical device is a skimmer, which removes oil from the surface of the water. All of these mechanical devices require large quantities of equipment and personnel and are labor-intensive.

Another item based on a household idea is dispersants. A dispersant is a chemical that breaks up oil into small droplets which allows the oil to disperse in the water column. Dish soap acts as a dispersant, breaking the surface tension of grease (oil) to make it easier to get off dishes. Dispersants must be applied soon after a spill, since weathered oils are hard to disperse. Dispersants are supposed to speed up natural dispersion, degradation and evaporation. However, the use of dispersants is controversial because these chemicals may be harmful to wildlife.

Shoreline clean-up involves the physical removal of oil from beaches and marshes. This is the most labor and equipment intensive response method. Removal of oiled sediments in marshes can create environmental problems. Large groups of clean-up workers walking on fragile marshes may do more damage than the oil. There are a variety of shoreline clean-up methods available from physically shoveling oil-contaminated soil to washing oil from the marsh toward an awaiting skimmer. However, no method has yet proved effective for cleaning oil-soaked soils.

Still another alternative response is the "no response" method. Many scientists agree that some areas will eventually recover if no clean-up effort occurs. This depends upon the amount of oil spilled, the kind of oil, the conditions, the type of plants present and where the oil settles.

Procedure

Engage (Introduction)

1. Introduce the lesson to students by explaining that they will investigate various clean up products and methods, such as: skimmers, booms, dispersants (detergents) and mechanical collection with buckets. Discuss with them creative solutions to cleaning up oil spills. Encourage them to experiment with the provided materials during the

following activity. Tell them that the problems they will face are similar to those that occurred with the Deepwater Horizon Gulf of Mexico spill.

2. Explain to students that they will simulate an open-ocean oil spill and try to prevent it from reaching the shoreline. Before the activity, have students make predictions based on a few questions. What will happen when oil is dropped into the water? Will it float, sink, or mix with the water? Can the oil be prevented from reaching the shore? What if wave action occurs?
3. If the oil reaches the shoreline, students will then be responsible for cleaning up the land mass. Which materials will most quickly and efficiently clean oil from the land

Explore/Explain (Activity)

1. Hand out the Student Worksheet **Blackline Master #1** to students.
2. Construct a wetland shoreline by placing a base layer of modeling clay in half of the pan to represent land. Shape the clay so that it slopes down toward the water. Leave the other half of the pan empty to represent the ocean. Fit the sponge, carpet or florist foam over the clay to represent a wetland buffer of grasses, shrubs and trees. Make sure that these materials fill up and fit tightly on top of the clay "land mass" so there are no gaps.
3. Encourage students to create their own "wetland" by adding sand, gravel or other objects to make their wetland unique.
4. Place feathers and other natural materials on the land.
5. Once the wetland is constructed, fill the other half of the pan with water to the base of the land mass.
6. Simulate crude oil by placing 3 tablespoons. of vegetable oil in a small cup and adding 2 tablespoons of cocoa powder. Mix the cocoa powder and oil together until blended with a paddle stick.
7. Very slowly pour simulated crude oil from a height of 1 cm onto the top of the open ocean (away from the land mass). Don't pour too quickly or the experiment won't work. Answer question 1 in the *Thinking about my Observations and Data* portion of the Oil Spill in a Pan Activity Sheet (**Blackline Master #1**).
8. First try containing the oil with booms. Decide on the material to use as a boom and try to contain the oil with it. Answer questions 2 and 3 on **Blackline Master #1**.
9. Try to suck (or skim) some of the contained oil up with a pipette and observe what happens. Answer question 4 on **Blackline Master #1**. Empty the pipette into the waste container.
10. Simulate high wave action due to bad weather by blowing across the surface or fanning the surface with a card. Students should record their results on the Data Sheet. Remove contaminated boom with tongs or tweezers and dispose of in the waste container.
11. Next, use absorbent material to clean up the spill. Place a small absorbent piece of material into the spill. Remove contaminated absorbent materials with tongs or tweezers. Use a watch to determine the amount of time it will take for absorbent materials to clean up oil. Record the amount of time for each absorbent material used. Answer questions 5, 6 and 7 on **Blackline Master #1**. Record your results on the data sheet.
12. Once the oil reaches the shoreline, perform the absorbent materials procedures in step 11 to clean up oil from the land. Answer questions 8 and 9 on **Blackline Master #1**.
13. Fill a pipette with clean water and try to spray oil off the shoreline back into the ocean. Repeat this procedure to test the effectiveness of this method. Use heated water to spray oil off the shoreline and back into the ocean. Answer questions 10 and 11 on **Blackline Master #1**.
14. Dip the feather into oil-contaminated water. Answer questions 12 and 13 on **Blackline Master #1**.

15. Now add a few drops of dish washing liquid to the open-ocean oil spill. Answer questions 14, 15 and 16 on **Blackline Master #1**.
16. Clean up lab stations and dispose of the oil and oily wastes properly. Check with your local Department of Environmental Protection Agency about how to properly dispose of oily waste from the experiment.

Expand (Apply or Practice)

Go over student responses to *Thinking about my Observations and Data* portion of the Oil Spill in a Pan Activity Sheet (**Blackline Master #1**).

Evaluate

1. Discuss with students how they would determine if the area affected by the spill was clean enough. How clean is clean enough?
2. Students will use journals to summarize, in one or two paragraphs, what they learned about oil spill clean-up. They will be instructed to include environmental factors based on their observations during the clean-up activity. In a third paragraph, students should state their opinion of the best techniques to clean up an oil spill in the ocean and onshore.

Extension

1. Perform the same procedure using heavier oil such as motor oil. Compare differences in the amount of time or materials necessary to clean up the oil spill.
2. Also, students can use an eggbeater or a whisk to simulate weathering of the oil over a period of time. Beat oily water for 20 minutes then observe condition of the oil in water. Compare to what happens in the open ocean that is agitated by high winds and strong seas.
3. Have students view Dr. Irv Mendelssohn's, Louisiana State University School of the Coast and Environment, video describing oil impacts on salt marshes (http://www.youtube.com/watch?v=syGM13egoc0).
4. Discuss with students valuable functions of wetlands. Review different types of wetlands found in coastal Louisiana: swamps, freshwater marshes, saltwater marshes and what possible impacts would they expect oiling will have on each wetland type.
5. Ask students if they know someone who was on the Deepwater Horizon oil rig or someone that works in the oil field. Ask if they know of someone involved in the Deepwater Horizon oil spill clean-up.
6. Ask these students to share their knowledge of any experiences these field professionals have been involved in.

References

NOAA Office of Response and Restoration – oil spill resources for teachers and students. http://response.restoration.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id(entry_subtopic_topic)=359&subtopic_id(entry_subtopic_topic)=25&topic_id(entry_subtopic_topic)=1 ***Go to "Responding to Oil Spills" and then to "What's the Story on Oil Spills" for background information on oil spill clean up.***

You Tube video, *Oil Spill Impacts on Coastal Wetlands of the Mississippi River Delta*, The Wetland Foundation. http://www.youtube.com/watch?v=syGM13egoc0

10-min video, featuring Dr. Irv Mendelssohn, Louisiana State University School of the Coast and Environment, impact of oil on salt marshes.

Kesselheim, A.S., Slattery, B.E., Higgins, S., and M.R. Schilling. (1995). Wetland in a Pan, in *The Wonders of Wetlands*, Environmental Concern, p. 212-214.

This lesson is based on the following material:

Trowbridge, B., and B. McKenzie. (1995). Clean-up Technology, in *Alaska Oil Spill Curriculum Grades 7-12, pp.23-27 accessed September 20, 2010 at* http://www.pwsrcac.org/outreach/Curriculum/grades7-12.pdf.

Australian Government/Australian Maritime Safety Authority (2010). Experiment to Clean Up an Oil Spill, accessed July 15, 2010 at http://www.amsa.gov.au/marine_environment_protection/Educational_resources_and_information/Teachers/Classroom_Projects/Clean_up_oil_spill_exercise.asp

This lesson was developed by the Louisiana Department of Wildlife and Fisheries in response to the BP Deepwater Horizon blowout, in collaboration with Louisiana teachers, Louisiana Sea Grant College Program, Audubon Aquarium of the America's, LSU Department of Education Theory, Policy and Practice, UNO Pontchartrain Institute for Environmental Studies, LSU Agriculture Center, SELU Department of Teaching and Learning, Barataria-Terrebonne National Estuary Program and Louisiana Universities Marine Consortium.

Blackline Master #1

Student Worksheet

Name _____
Date _____

Predictions:

1. What will happen when oil is dropped into the water?

2. Will it float, sink or mix with the water?

3. Can the oil be prevented from reaching the shore?

4. What if wave action occurs?

Oil Spill in a Pan Data Table

	Material	Amt. of Time to Clean Up Spill	Estimate % of Oil Cleaned Up	Observations: (left with oiled material, messy, etc.)
Light (cooking) oil				
Light (cooking) oil and Rough water				
Heavy (motor) oil (extension)				
Heavy (motor) oil and Rough water (extension)				

Thinking about my observations and data

1. What happened to the oil when you dropped it into the ocean?

2. How well did the boom work in containing the spill?

3. What types of booms did you use?

   How well did it work in adverse weather?

4. How successful was the attempt to suck or skim oil from the water contained in the boom?

5. How much oil did the absorbent material clean up? How quickly?

6. Does the absorbent material pick up water, too? If so, how can you tell?

7. Does the absorbent material sink or float?

8. What is the condition of the contaminated absorbent material?

9. Do any of the absorbent materials pick up oil effectively on land?

10. How effective was washing the oil off the shoreline back into the ocean?

    Did it work better with heated water?

    How might this affect wildlife that is living onshore?

11. How much of the contaminated soil or sand would you have to remove if you used shovels or other mechanical devices as a cleaning technique?

    How clean do you think this would leave the shoreline?

12. What happened to the feathers when they got oiled?

13. How do you think this might affect a bird that was covered with oil?

14. What happened when the detergent was added to the oil spill in the ocean?

15. Where would the oil in the ocean go after a dispersant is used?

16. How clean is the ocean now that it has dishwashing liquid in it?

KEY: Possible Answers for Student questioning

Predictions: Answers will vary

1) What happened to the oil when you dropped it into the ocean?
   The oil floats, spreads out quickly over the water and breaks up into many little blobs.
2) How well did the boom work in containing the spill?
   Answers will vary. Most answers will be that the boom couldn't contain all of the oil.
3) What types of booms did you use? How well did it work in adverse weather?
   Answers will vary based on type of boom used. Most answers will state that adverse weather or wave action hampered the ability of the boom to contain the oil.
4) How successful was the attempt to suck or skim water from the oil contained in the boom? Did skimming remove water with the oil?
   Skimming some of the oil off the water was a success, but a lot of water was sucked up with the oil.
5) How much did the absorbent material clean up? How quickly?
   Answers will vary with each group.
6) Does the absorbent material pick up water too? If so, how can you tell?
   Yes, water is picked up with the absorbent material, too. You can tell by wringing out the absorbent material and watching the oil and water separate.
7) Does the absorbent material sink or float?
   Initially it will float, but the absorbent material will sink if it is left in the ocean long enough because it will absorb water.
8) What is the condition of the contaminated absorbent material?
   The absorbent material is oily and messy.
9) Do any of the absorbent materials pick up oil effectively on land? Why or why not?
   No, the absorbent material doesn't effectively pick up oil on land.
10) How effective was washing the oil off the shoreline back into the ocean?
    Not very effective, the oil stuck to the materials that were used to create the wetland. Did it work better with heated water? No, the heated water didn't work much better. How might this affect wildlife that is living onshore? The change in temperature would kill shoreline creatures.
11) How much of the contaminated soil or sand would you have to remove if you used shovels or other mechanical devices as a cleaning technique?
    With this experiment, all of the wetland materials are contaminated and this won't work. How clean do you think this would leave the shoreline?
    Not clean at all.
12) What happened to the feathers when they got oiled?
    They get soggy, matted and heavier.
13) How do you think this might affect a bird that was covered with oil?
    Oiling makes it harder for birds to stay warm, stay waterproof and oil is toxic so it can poison the bird.
14) What happened when the detergent was added to the oil spill in the ocean?
    The oil broke up very quickly and moved to the side of the pan.
15) Where would the oil go in a real ocean after a dispersant is used?
    The oil would fall throughout the water column and disperse.
16) Why are dispersants used?
    To break up oil into smaller droplets to speed up the degrading process through weathering, the sun and increased surface area for bacteria to break it down
17) How clean is the ocean now that it has dishwashing liquid in it?
    The oil is still there, but in a different form.