Clean Wave of the Future

Overview:

- As a classroom, students and teacher discuss causes, frequency, effects of, and clean up methods of oil spills
- In groups, students make a typical natural fiber "boom." Then they test it against a store-bought synthetic version OR against their own redesigned natural fiber boom. In either case, they must follow the steps of the scientific method.
- Groups write science reports
- Groups present findings to class

Part 1: Handout and Classroom Discussion

1. Discuss oil spills: What are the sources of oil spills? How often do they occur? What are the environmental impacts of oil spills? How are oil spills cleaned up?
2. Watch the videos of hair/fur/waste fleece booms soaking up motor oil (or spend a day doing the classroom demo.)
3. In class, discuss the pros and cons of natural fiber booms. Compare with other oil spill cleanup methods. Discuss the social, economic, and logistical consequences of using booms made of waste fiber rather than synthetic materials.
4. Discuss/review experimental design and the scientific method.

Part 2: Group Activity

1. In groups, students make a typical natural fiber boom (see handout.)
2. They follow the steps of the scientific method to test the efficiency of the boom. They may test the typical natural fiber boom against a store-bought synthetic boom, "sock" or "pad" (available at auto-supply stores) OR against their own redesigned natural fiber boom. Or they may test a new method of constructing natural fiber booms against the method demonstrated in our video.
3. Write science report including: Abstract, Introduction, Methods, Results, Discussion/ Conclusion

Part 3: Presentations

1. Each group presents findings to class

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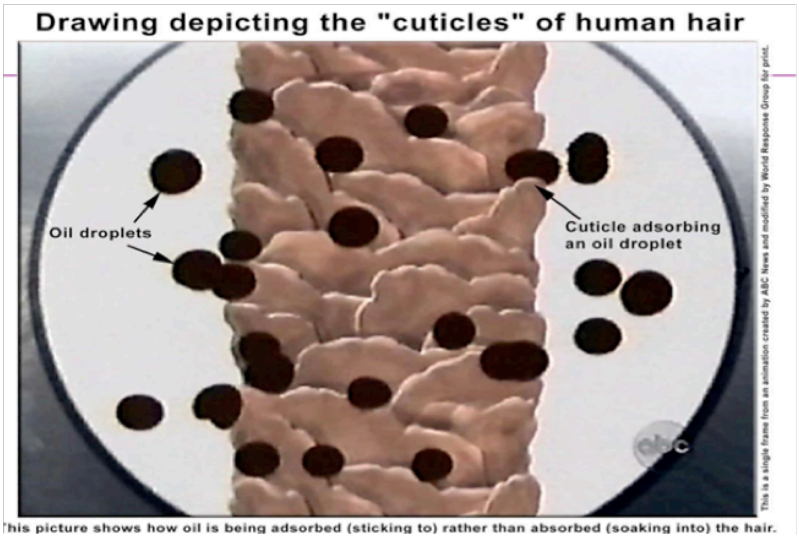
The Scientific Method



This picture shows how oil is being adsorbed (sticking to) rather than absorbed (soaking into) the hair.

Remember that hair, fur, and fleece "a**d**sorb" rather than "a**b**sorb" oil. In other words, the fiber doesn't soak up the oil- the oil droplets stick to the outside of the fiber (think wet dog- it doesn't puff up like a sponge, but slicks down). For this reason, rigid fiber booms are used as a wall to stop advancing oil, and floppy booms or hair mats are used to remove larger quantities of oil from the water.

1. **Ask a question.**

   a. For example: How can we make better booms from waste fibers? Or, which works better- synthetic boom or fiber boom?

2. **Do background research.**

   b. What are some problems that hair booms have come up against? Think about how hair booms work, how they are made, and the different environments they are used in.

3. Construct a hypothesis.

   c. We think that synthetic booms will adsorb oil faster/slow than natural fiber booms, or we think that xyz is the best way to construct hair booms, etc.

4. Test your hypothesis.

   d. You must have control- in this case, the typical natural fiber boom or typical natural fiber boom construction- to test against.

5. Analyze your data and draw a conclusion.

   e. Write a lab report including: Abstract, Introduction, Methods, Results, Discussion/Conclusion.

6. Present your findings to the class.

   f. Communicate your results

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Avenues To Explore

1. **Materials**

   a. Fur vs. hair vs. fleece. Or a mixture of both? Different percentages? Nylons vs. burlap? Other materials?

2. **Efficiency of Assembly**

   b. Watch Matter of Trust's Youtube video "How to Make a Hair Boom."

3. **Shape/size of boom**

   c. Think about volume vs. surface area. Hair mats are similar to hair booms but are thick, flat mats instead of sausage-shaped, meaning they have more surface area to adsorb oil. However, constructing hair mats requires skilled textile workers. Because of the collapsed textile industry in the US, most hair mat construction takes place overseas.

4. **Buoyancy**

   d. What to attach to make it float best? How will it perform in still water vs. running water?

Multiple hair booms inside industrial netting with piece of pool noodles added to make them float. The use of pool noodles is another example of a synthetic material being used with the natural materials.

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Oil Fact Sheet

Info taken from our website and from www.epa.gov

Every year, an estimated 706 million gallons of oil enter our planet's oceans. The EPA estimates that there are 14,000 oil spills per year. These spills occur not only in coastal marine environments, like the devastating Deepwater Horizon oil spill of 2010, but also in freshwater environments like streams and rivers.

Where is all this oil coming from?

Oil "spills" don't just happen occasionally when tankers or rigs that spring leaks. According to the EPA, the greatest source of spilled oil by far is ***households.***

Source	Amount of Oil
Used motor oil from vehicles, improperly disposed (dumped down drains or spilled on driveways)	363 million gallons
Routine ship maintenance and washing containers	137 million gallons
Air pollution	92 million gallons
Natural seepage of oil bubbling up from the sea bottom	62 million gallons
Large spill accidents	37 million gallons
Offshore drilling	15 million gallons

One typical 5-quart oil change improperly dumped can contaminate millions of gallons of freshwater.

How harmful is spilled oil ?

Oil harms aquatic organisms by poisoning or smothering them. Inhaling oil can damage the central nervous system, the liver, and the lungs. Ingesting oil damages the digestive tract and can lead to starvation. Exposure to oil may cause long-term reproductive problems. Even animals not directly exposed to oil can be affected: animals that eat oil-tainted prey can themselves become reservoirs of toxic oil.

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How Harmful is Spilled Oil?

Oil harms aquatic organisms by poisoning or smothering them. Inhaling oil can damage the central nervous system, the liver, and the lungs. Ingesting oil damages the digestive tract and can lead to starvation.

Exposure to oil may also cause long-term reproductive problems. Even animals not directly exposed to oil can be affected: animals that eat oil-tainted prey can themselves become reservoirs of toxic oil. More likely, though, predators will avoid contaminated prey and become malnourished or even starve.

Oil-coated dead seal after the Cosco-Busan oil spill in San Francisco, 2007

In freshwater, oil can adhere to sediment and destroy the breeding grounds and mud-dwelling animals of river or lakebeds. In can be trapped in eddies or slower-moving streams, exposing nearby animals for a long time. It can contaminate groundwater and ruin our drinking water reservoirs. It coats riverbeds and poisons animals like frogs and shorebirds that rely on the habitat and vegetation there for food and shelter.

In the marine environment, oil can destroy coral reefs and tidal flats by settling on them and smothering the many tiny animals that thrive there. Seabirds covered in oil lose their ability to fly, float, and stay warm: they often drown or freeze to death. And in environments like salt marshes and mangrove swamps which host sensitive and/or slow-growing plants, even small amounts of oil can wreak havoc on the ecology of the area.

How Are Oil Spills Cleaned up?

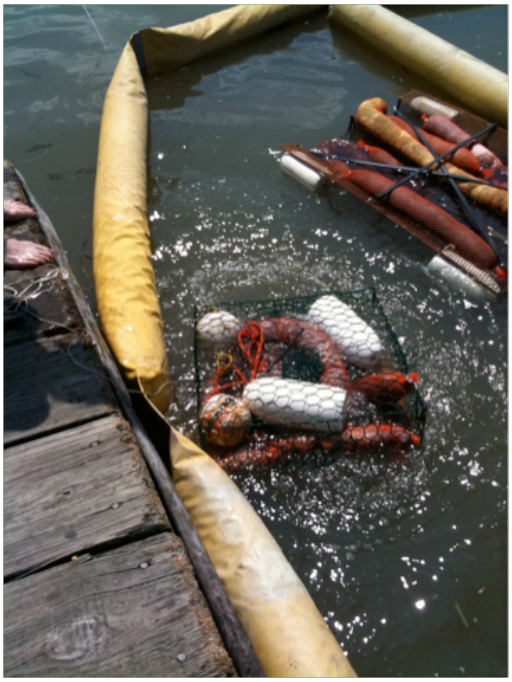
The following methods are often applied in tandem and depend on conditions such as salinity, water temperature, water currents, waves and swells, and proximity to people.

1. **With chemicals.** Chemicals are added to the water to disperse or congeal the oil, to delay it from reaching the shore. For example, the chemical dispersal agent Corexit was added to the waters off the coast of the Gulf of Mexico after the Deepwater Horizon spill in 2010. While dispersants like Corexit can delay the arrival of oil on beaches, it does not remove oil from water and can actually be quite toxic to sea life and people working to clean up the oil spill.

2. **With biological agents.** Over time, oil will degrade naturally to some extent. "Seeding" the contaminated area with oil-consuming bacteria, fungi, or yeast speeds up this process. Another option is to add nutrients like nitrogen and phosphorous in an effort to "fertilize" the water, increasing the growth of naturally occurring oil-eaters.

3. **Mechanically.** The oil is physically removed from the water, whether by a skimmer, barrier, or boom.

Booms being deployed in the Gulf of Mexico, 2010



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Booms!

Booms are buoyant structures meant to absorb oil or to act as barriers to trap and section off oil and preventing it from reaching especially sensitive areas. Booms can be filled with synthetic or natural sorbent materials. The synthetic materials are generally plastics derived from oil. Natural sorbent materials have included hay, peat moss, sand, clay, and...HAIR, FUR, and FLEECE!

Boom Disposal....

Synthetic booms:

1. **Recycled**
   Those made with polypropylene can be recycled (often into car parts) after being centrifuged to remove adsorbed oil and water. (Keep in mind, thought, that only about 5-10% of oil is usually recovered from oil spills.) However, many synthetic booms are made from other materials, and the extracting usable oil requires special equipment. Synthetic boom recycling is not widespread.

2. **Buried in landfills**
   Used oil booms aren't considered to be hazardous waste and are therefore disposed of in the same landfills that take household waste, causing concern in regards to groundwater contamination. While these landfills are regularly monitored, it could be years before a problem surfaces.

3. **Incineration**
   a) Air Curtain Incinerator (ACI): ACIs allow for the complete combustion of materials due to circulating air. This method works fast, but it can lead to air quality problems.
   b) Waste to Energy- Waste-to-energy facilities are allowed to burn oil spill debris and oily material as long as it does not exceed 5% of the total waste stream. When burned, the heat energy is collected and converted into electricity. This method of disposal can be costly due to transportation costs based on the distance to the facility.

Watch and Discuss

Watch the following demonstrations of hair/fur booms:

Oil Boom Demo
http://www.youtube.com/watch?v=2Q0cL4GsSqw

How to Make a Hair Boom
http://www.youtube.com/watch?v=aHuWyFVo62o

Hair Soaks up Oil Spills
http://www.youtube.com/watch?v=EwQOD_Ir2vQ

And check out http://www.epa.gov/emergencies/content/learning/booms.htm for more information about the design on booms!

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Questions for Discussion

1. **Do you think natural fiber booms work?**

2. **What are some benefits and disadvantages of using...**
   a. Chemical agents like Corexit?
   b. Biological agents?
   c. Synthtic booms?
   d. Natural fiber booms?

3. **Explain how the following factors might affect the efficiency of hair booms:**
   a. salinity
   b. water temperature
   c. water currents, swells, waves
   d. weather
   e. proximity to people
   f. debris in water
   g. casing of booms

4. Hair, fur, and fleece float differently. Fur and fleece float just above the surface of the water. Hair floats just below the surface of the water. Oil floats at the surface of the water, but sinks somewhat as it gets dirty. How might a boom designer using natural fibers take this into account?

5. Every day, salons, groomers, and farms throw away hair trimmings, fur, and waste fleece. Yet most booms are made from synthetic oil-derived materials. In other words, we are drilling for oil to create products to soak up spilled oil. How do the benefits of using this abundant waste material weigh against the advantages of using synthetic booms?

6. Today more and more scientists, engineers, and inventors are developing products that turn waste materials into useable resources. One example is Tom Nosker, an engineer and professor at Rutgers University, who invented a way to break down and recycle polystyrene, a plastic that had previously been thought unrecyclable. Now he uses it to make plastic lumber. Another example is boating enthusiast Namon Nassef, who found a way to use heat exhaust from his boat's engine to sterilize sewage from the boat's onboard toilets. This eliminates the need to use environmentally unfriendly chrmicals when disposing of waste is being considered by RV companies, airlines, and the US military.

   a. What does an inventor need to promote a great idea? What might block such inventions from being successful?

   b. In the Tom Nosker example, recyclable plastic was being wasted because no one had invented a way to break it down and reuse it. In the Namon Nassef example, heat- a byproduct from running the boat's engine- was being producted but not being utilized. Can you think of other example sof everyday materials or energy that is being wasted? How might it be reused?

7. The hair mat is a patented technology that is currently produced overseas. Producing the hair mat depends on the skills of textile workers. In the US, the textile industry has largely been abandoned, and for this reason the hair mat is produced overseas. This is part of a larger trend in the United States against skilled hands-on work, producing physical products, and in favor of office and computer work, whose products are more abstract. However, in working with farmers, groomers, marina workers, and others, Matter of Trust has found that there is still a need in the US for people with excellent hands-on skills.

   a. What do you think is causing the shift away from production in the US?

   b. What would be your ideal job- working with your hands? Working an office or with computers? A combination?

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Your Assignment

Gather into groups.

1. After watching Matter of Trust's You tube video, "How to Make a Hair Boom," make a natural fiber boom. See attached handout for instructions.
2. Try out the boom. With permission, use real motor oil, carefully following the instructions on the enclosed sheet, "Oil Spill and Hair Demo." Otherwise, try out the hair boom in a bucket of water with vegetable oil instead of motor oil.
3. Can you think of a way to improve the boom? Do you think synthetic material would work significantly better? Test the natural fiber boom against:
   a. Another natural fiber boom of your own design, OR
   b. A synthetic oil spill material (oil-absorbent "pads" are available at auto supply stores) OR
   c. Test a new method of construction against the original method of construction
4. Refer to the sheet in this handout labeled "The Scientific Method" and follow the steps to test your design/idea.
5. Write up your findings in a scientific report and present it to the class.
   Be sure to include:
   a. *Abstract:* A one paragraph summary of your whole report
   b. Introduction: Discuss the question at hand, what aspect of the hair booms you plan to test, and why?
   c. Methods: Explain how you performed your experiment- be straightforward and specific. The "Methods" section both explains what you did and provides instructions for anyone who wants to repeat your experiment exactly.
   d. Results: What was the outcome of your experiment? This is a good place to include any charts, graphs, or tables.
   e. Conclusion/Discussion: What did the results of your experiment mean? Was your hypothesis correct? Why or why not? We would also like you to discuss the social, logistical, and political consequences of your conclusion. How could your findings work in the real world?

6. Present your findings to the class. Suggestions for good presentations: Powerpoint, handouts, large charts/illustrations, your newly designed boom, and/or a demonstration.

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