Cleaning it Up!

Major Topic: Environment – Oil Spill

Length of Unit: 5 -90 minute classes

Unit Summary: This hands-on unit focuses on a variety of methods to contain and clean-up an oil spill. Students will be challenged with the problem of having a recent oil spill in the water supply. They will work in teams to help the environmental engineers build an oil containment and clean-up system. The students will work in groups to test the effectiveness of clean-up methods, then design, build, and test a method to contain and remove the oil from the water. The students will observe and compare the clean-up effectiveness and the cost from viewpoints of an environmental engineer and an oil company owner. The groups will discuss the long-term effects of the emotional, political, economic, and environmental costs of an oil spill and clean-up. The students will also learn about the environmental issues that an oil spill has on a salt marsh ecosystem, construct a food web and investigate the impact of physical environmental changes. The groups will evaluate their methods and present their findings.

Interdisciplinary Connections: The students will be using reading skills through research articles and communicating their findings and evaluations by writing statements. Mathematics will also be integrated through measurement and graphing.

Understanding Goals: Students will learn how environmental engineers develop equipment and procedures to help reduce environmental impact from accidental oil spills. Students will work in teams to design and build a system out of everyday items that will eliminate oil from a classroom water supply. They will test their system, evaluate their own results and those of other students, and present their findings to the class. Additionally, students will investigate the interactions of populations in a Salt Marsh Ecosystem and the impact of physical environmental changes to the food webs.

Essential Questions:

- How can you work together in groups and use teamwork to solve a problem, since science is a social activity?
- What are some ways that human activities impact an ecosystem?
- Can you develop and explain an understanding of the interrelationship of science, technology, engineering and mathematics?
- How can you apply scientific concepts, skills, and processes to everyday experiences?

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Student Objectives:

Students will be able to:

LS.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which
d) models and simulations are constructed and used to illustrate and explain phenomena;

LS.10 The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic, change over time, and respond to daily, seasonal, and long-term changes in their environment. Key concepts include
b) factors that increase or decrease population size; and
a) eutrophication, climate changes, and catastrophic disturbances.

LS.11 The student will investigate and understand the relationships between ecosystem dynamics and human activity
b) change in habitat size, quality, or structure;
d) population disturbances and factors that threaten or enhance species survival; and
e) environmental issues

Differentiation: The students will work in groups. The groups will be mixed with high and low students. The students can be assigned jobs within the groups so that they can successfully accomplish tasks based on their strengths.

Blooms Taxonomy	21st Century Skills
Creating	Critical Thinking
Evaluating	Problem Solving
Analyzing	Communication
Applying	Creativity & Innovation
Understanding	Collaboration
Remembering	Information & Media Contextual
	Learning Global/Multicultural

Performance Tasks:

Students will:

- Investigate the best methods to clean-up an oil spill
- Build an oil containment and clean-up system
- Evaluate the effectiveness of their solutions and others

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- Construct a Salt Marsh Ecosystem and discuss human factors
- Present finding to the class

Evidence of formative assessment:

Pre-Assessment Discussions:

Brainstorm different methods for cleaning up an oil spill (Record their answers on the board). Discuss which ways would be effective to clean up the spill and any ideas on the expense of each.

Post-Assessment Documents:

- The Student Worksheets- Oil Spill Activity
- The Student Worksheets- Oil Spill Solutions
- The Student Worksheets- And Now, the Spill's Cost Comes Into Focus
- The Student Worksheets- Salt-Marsh Ecosystem Food Web

Evidence of Summative Assessment:

- Group Presentations

Technology

Hardware	Software
Computers Internet Connection Projection System	Word Processing Internet Web Browser

Resources from the web:

- Teach Engineering: Oil Spill Cleanup Lesson
- Try Engineering: Oil Spill Solutions Lesson
- www.education.noaa.gov
- www.doe.virginia.gov
- Tracking the Oil Spill in the Gulf

Supplies:

- Oil- vegetable oil mix with cocoa powder to create "crude oil"
- Paper towels
- String
- Toothpicks
- Dawn detergent
- cotton balls

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- straw
- spoons
- pipets
- graduated cylinders
- beakers
- aluminum foil
- bird feathers
- absorbing cloth pads (cut into squares)
- aluminum pie pans or dissecting trays
- sand
- small pompoms
- seashells
- glue
- scissors
- The Student Worksheets- Oil Spill Activity
- The Student Worksheets- Oil Spill Solutions
- The Student Worksheets- And Now, the Spill's Cost Comes Into Focus
- The Student Worksheets- Salt-Marsh Ecosystem Food Web
- USA Today Article: And now, the spill's cost comes into focus

Vocabulary:
Bioremediation, Dredging, Dispersion, Ecosystem, Water Supply, Waste Management, Abiotic, Biotic, Absorbent, Hydrophobic

Lesson 1: (1- 90 minute class)

- Ask the students, "Has anyone heard of the oil spill in Lynchburg, VA? Does anyone know what the Exxon oil spill was?"
- Show the impact/movement of an oil spill, Tracking the Oil Spill in the Gulf.
- Introduce group work/project: Talk about environmental engineering to the students. Discuss different tasks the environmental engineers are responsible for, such as: biotechnology, water treatment, wastewater treatment, hazardous waste management, etc. Instruct them that the focus will be on environmental problems.
- Discuss costs the environmental engineer and oil company owner have to consider.
- Brainstorm on different methods for cleaning up an oil spill- write on board. Group the methods as being organic or non-organic.
- Discuss methods they will use today: skimming, absorbing, and dispersal

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- Pass out and have the students form a hypothesis on the Oil Spill Cleanup Activity Worksheet.
- Provide groups of 2-3 students with the following: oil spill pan, oil, 2 graduated cylinders, string, spoon, absorbent pad, and dawn detergent ("dispersant").
- Instruct the students to fill the oil spill pan so it is ½ full. Then add 10ml of oil to pan, let set for 30 seconds, then use the skimmer-string-to remove the oil. They will skim the oil into the spoon and pour into a graduated cylinder. They will calculate how much oil is obtained and observe its effectiveness.
- Answer worksheet question on skimming.
- Give the groups a new oil spill pan. Instruct the students to fill the oil spill pan so it is ½ full again. Instruct the students to add 10ml of oil to pan, let set for 30 seconds, then use the absorbent cloth to try to absorb the oil.
- Answer the worksheet question on absorbing.
- Give the groups a new oil spill pan. Instruct the students to fill the oil spill pan so it is ½ full again. Instruct the students to add 10ml of oil to pan, let set for 30 seconds, and then place 2 drops of "dispersant" in the pan.
- Answer worksheet question on "dispersant".
- Clean up areas.
- Reflect over the students hypotheses

Lesson 2: (1-90 minute class)

- Put students back into their groups.
- Review the worksheet from lesson 1 with the class. Have groups examine and discuss the information gathered in lesson 1 by making two vertical bar charts on their worksheets.
- Have the students discuss their answers, and then defend their answers with the class.
- Collect completed worksheets and summarize the experiment.
- The teacher will introduce the problem: *There has been an oil spill in our water supply. The longer the oil sits in the water, the greater the environmental impact. Your team is responsible for helping the environmental engineers build an oil containment and clean-up system.*
- Provide a set of materials per group (suggestions in *supply* list).
- Explain that students must work as a team to design a system to clean-up after an oil spill. The spill will be a controlled with 20 ml of vegetable oil that is poured into water which is held in a container.
- Students will meet and develop a two tiered plan to first contain the oil and then to remove it. They can select from a range of everyday items provided to serve as their tools. Student teams will describe their plan in writing and with a drawing and then

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present their plan to the class. Plans may be adjusted after feedback from the presentation stage.

- Student groups next execute their engineered clean-up system step-by-step as described in their plan.
- Student clean-up systems will be scored on the following scale indicating how "clean" the water is after clean-up:

Water is completely clear of all oil	About a quarter of the oil remains	About half of the oil remains	About three quarters of the oil remains	No change, water is as oily as at the beginning of the challenge
0	1	2	3	4

- Pass out the Oil Spill Solutions worksheet.
- Provide each group with pans ½ full of water, materials to make a land area (sand, gravel), pompoms (land animals), shells (water animals), feathers, graduated cylinders, string, toothpicks, hay, aluminum foil, cotton balls, absorbent pads, oil mixed with cocoa powder
- Students will follow worksheet instructions and answer questions in their group
- Clean up.
- Discuss strategies that the students used and challenges they faced as acting like environmental engineers.

Lesson 3: (1 -90 minute class)

- Review over procedures the student used and answer any questions they have about their worksheets.
- Students will continue their group work to complete the following:
  - Finish the activity and answering questions.
  - Clean up any pans the students did not finish the previous day.
  - The students will pass in their worksheets.
- As they finish, pass out the “And now, the spill’s cost comes into focus” Worksheet and USA TODAY article.
- In their groups the students will read the article and answer questions about the costs of an oil spill.
- Discuss with the students that there are lots of costs an area has to endure during an oil spill.

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- Have the groups present one cost they had not considered and tell the impact of that costs.

Lesson 4: (1 -90 minute class)

- Students will work in groups to analysis and record the long-term impact and justification for species, and discuss with the classroom: What species were most affected and what ecosystems were affected?
- Collect worksheets.
- Discuss the interactions of biotic and abiotic factors. Tie in with the areas that were affected by the oil spill.
- Pass out Salt March Organisms Cards sheet, scissors, and worksheet. Have the students cut them and glue the food web on a sheet of paper.
- Review over the first, second, and third level consumers. Review over predator/prey relationships, and types of consumers.
- The students will discuss and answer their assessment questions in their groups.
- Have them look at their food web and identify what organisms were eaten by rat. Ask the students which organisms depend directly on the producers. Relate to what would happen to the organisms if there was an oil spill in this ecosystem.

Lesson 5: (1 -90 minute class)

- Pass back all worksheets and allow them to organize their information to present to the class.
- The students/groups will present their findings from all four days. Each sheet or activity they will summarize what they concluded.
  - The students can ask questions and compare their findings.
- Relate back to the Essential Questions:
  - How can you work together in groups and use teamwork to solve a problem since science is a social activity?
  - What are ways that human activities impact an ecosystem?
  - Can you develop an understanding of the interrelationship of science with technology, engineering and mathematics?
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Name: _____ Date: _____

Oil Spill Cleanup Activity – Oil Spill Worksheet

Hypothesis

Will skimming, using the absorbing pad, or dispersing the oil be the best method for cleanup? Explain why you think this:

_____

_____

_____

Oil Spill Cleanup

What volume percent of the liquid you skimmed into your test tube is oil? (show a ratio value if you have it) _____

How did you arrive at this answer? _____

_____

Prepare two vertical bar graphs: one to compare the effectiveness of oil spill clean up methods and another to compare the cost of each oil spill clean-up method based on the perspective of an environmental engineering *and* an oil company owner.

Assume you are the Environmental Engineer
(H = high, M = Medium, L = Low)

	Effectiveness (cleanliness)	Cost
Skimming:	_____	_____
Absorbing:	_____	_____
Dispersants:	_____	_____

Assume you are the Oil Company Owner
(H = high, M = Medium, L = Low)

	Effectiveness (cleanliness)	Cost
Skimming:	_____	_____
Absorbing:	_____	_____
Dispersants:	_____	_____

Oil Spill Solutions

Student Resource: What is an Oil Spill?

An oil spill is an accidental release of liquid petroleum hydrocarbons (usually during transportation of oil) into the environment. Oil spills usually refer to the release of oils into water, but of course an oil spill can take place on land as well. While spills can take place quickly, as when a ship sinks, or a leak occurs in a pipeline, the cleanup can be a long term project. And, the longer the oil sits in the water, the greater the impact on the environment.

◆ Impact on the Environment

Birds are one of the creatures impacted by oil spills. Oil can sink into and reduce the functionality of bird feathers. A bird's feathers provide insulation, so a bird exposed to oil will be exposed to temperatures they are not used to. It also makes it difficult for a bird to float or fly...so the bird will be more vulnerable to animals of prey, or the bird may not be able to move to find food or clean water. Birds try to clean themselves, and if they do they are likely to ingest some of the oil which can cause damage to internal organs. Most birds impacted by an oil spill die unless humans step in and help clean them. Many organizations work to save these animals. More information is at the "Oiled Wildlife Care Network" at the University of California, Davis (www.vetmed.ucdavis.edu/owcn) or the International Bird Rescue Research Center (www.ibrrc.org). Birds are not the only creatures put at risk by oil spills. Marine mammals such as seals and otters gain insulation benefits from their fur. As oil permeates the fur, they are potentially exposed to temperatures beyond their normal range. It is important to act quickly when a spill occurs to lessen the impact of the spill on the natural environment. Environmental engineers are often called upon to come up with planned solutions in advance of a spill, or to customize systems bases on a specific event.

◆ Engineering Trade-offs

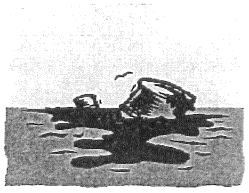
In order to reduce the chances of an oil spill, engineers have developed new ship designs with double -- and even triple hulls. The oil is stored in the most interior hull, so that if there was a leak, it would be captured in the next outer hull. Of course, these multiple hulled ships are more expensive to build and operate, so a company will have to weigh the advantages and disadvantages of ship engineering in order to come up with a plan that meets safety requirements, but also does not increase the cost of the shipped product more than the market can bear.

◆ Clean-up Methods

There are many types of cleaning methods used for spills, including:

- Bioremediation: using microorganisms or biological agents to break down or remove oil
- Dredging: some oils are actually denser than water, and would sink. These would require cleaning below the surface of the impacted water.
- Skimming: can be effective areas where the water is calm.
- Dispersion: materials such as some detergents can disperse oil into smaller clusters that may be easier to remove than larger areas. However, the detergents can sink deeper into the water than oil does, so it may cause harm deeper in the water while reducing negative environmental impact on the surface.
- Burning: controlled burning can often eliminate a large proportion of oil in water, but of course requires great care to avoid having the fire spread. The burning oil can also cause air pollution.

Oil Spill Solutions



Student Worksheet:
Engineer Your Own Oil Spill Solution

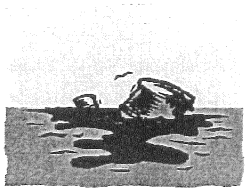
You are part of a team of engineers who have been given the challenge of first containing, and then cleaning up an oil spill. You will have many materials available to you, but will have to come up with a strategy to remove as much oil as possible.

◆ Planning Stage

Meet as a team and discuss the problem you need to solve. Then develop and agree on a plan for your containment system. Next develop a plan for cleaning up the oil you have contained. You may have to consider stages or steps you might take and determine which order you will execute different steps. You have been provided with many items you may use for your system. You don't need to use all the items, and should only use those that you think will work the best. Write a description of your containment and clean-up systems in the boxes below. Draw a sketch of what you plan to do. Be sure to indicate the materials you anticipate using. Present your design to the class. You may choose to revise your teams' plan after you receive feedback from class.

Containment System	Clean-up System
Materials Required:	Materials Required:

Oil Spill Solutions



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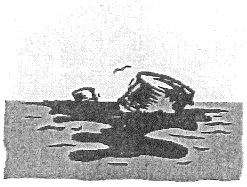


Student Evaluation Sheet

1. Did you succeed in removing all the oil from the "oil spill?" What was the score your team achieved?

2. If your system failed, what do you think went wrong?

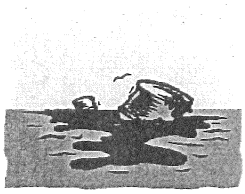
3. Describe a system another student team created that you thought worked well. What did you do differently?

4. How did your decisions on engineering trade-offs differ from that team? What goals or priorities for your system did you put above others?

5. Did you decide to revise your plan while actually doing the containment or clean-up? Why? How?

6. Why might a team of environmental engineers change their planned approach to an oil spill clean-up once they arrived on the site? Do you think it is common that professionals change their plans while on the job?

Oil Spill Solutions



Student Evaluation Form (continued):

7. If you had to do it all over again, how would your team have improved your containment system? Why?

8. If you had to do it all over again, how would your team have improved your clean-up system? Why?

9. Do you think that experience with prior oil spills would make a team of engineers more able to address the next unexpected one?

10. Now that you have learned about the different trade-offs engineers must factor into a product or system, if you were designing a new rail-based oil transportation system, what considerations would you have to balance in your new design (consider costs, environmental issues, public health, speed of transport)?

11. What other materials do you think would have helped speed up your containment or clean-up?

"And now, the spill's cost comes into focus"
Teacher's guide

Concepts

Environmental science, ecosystems, food chains, the Gulf oil spill

Objectives

Students will

- Predict how a complex ecosystem of related organisms will be impacted by the Gulf oil spill
- Justify their predictions based on what they know about the organisms and the effects of oil
- Compare their predictions with others' and attempt to synthesize the expected long-term effects of the spill

Prerequisite skills

The students will need to possess a basic understanding of :

- Ecosystems, including food webs
- Reproductive processes employed by various plants and animals

Standards

(From Project 2061)
D. Interdependence of Life

- 5D/H1: Ecosystems can be reasonably stable over hundreds or thousands of years. As any population grows, its size is limited by one or more environmental factors: availability of food, availability of nesting sites, or number of predators.
- 5D/H2: If a disturbance such as flood, fire, or the addition or loss of species occurs, the affected ecosystem may return to a system similar to the original one, or it may take a new direction, leading to a very different type of ecosystem. Changes in climate can produce very large changes in ecosystems.
- 5D/H3: Human beings are part of the earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.

Time to complete

This lesson could be completed in one or two 45-minute class periods, depending on how much time is given to students to research more information about the species discussed in this activity. The first extension activity could be completed in an additional day of class, while the second extension would be carried out over the course of the semester or school year.

Teaching suggestions

1. For this activity, students could work independently or as part of a group.
2. Students may be apprehensive to make predictions about something they know little about. Remind the students that environmental scientists also try to discern complex relationships sometimes with insufficient information.
3. Encourage students to have an open mind about how the oil spill may or may not impact each species. It is unlikely that all species will be effected the same way and improbable that every species will have a significant drop in population levels.

"And now, the spill's cost comes into focus"

Introduction

The Deepwater Horizon oil rig explosion and ensuing oil spill into the Gulf of Mexico was one of the worst environmental disasters in North America's history. Understanding the full impact of such a large oil spill on the environment is especially difficult because of the complex web of interactions that make up an ecosystem. In this lesson, we will explore the long-term ecological fallout from the oil spill, and we will try to predict how the Gulf of Mexico ecosystem will respond to the lingering effects of the spill and cleanup.

Materials needed (For extension activities only)

- Access to the internet
- Additional copies of recent USA TODAY newspapers

Discussion

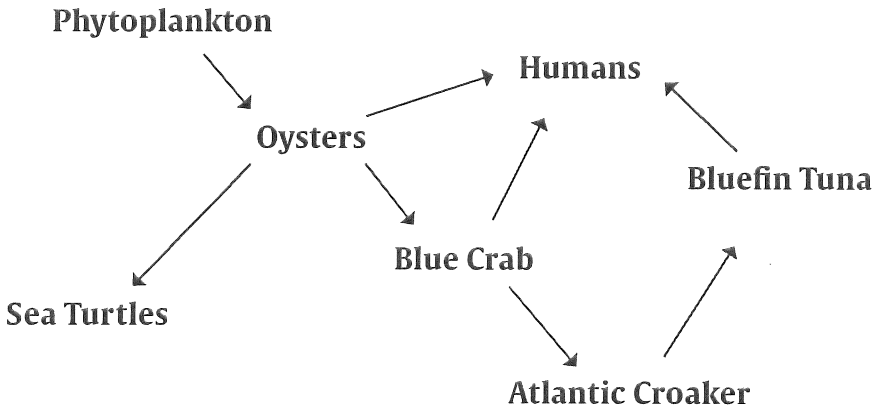
Begin by reading the article, *And now the spill's cost comes into focus*, then discuss the following questions:

1. When you think about the oil spill, what type of costs first come to mind: political, environmental, economic, or emotional? Which type of cost do you think will have the greatest effect on our country? Which type of cost do you think is the most important for us to address first?
2. What factors make environmental scientists think that the Gulf will recover in years instead of decades? Do you think that scientists can make accurate predictions about the recovery of the Gulf when it has never experienced an oil spill this large?
3. What surprising information did you learn about the emotional impact of an oil spill on the local fishing communities? Why do you think that the emotional impact lasts so long beyond the oil spill itself?

"And now, the spill's cost comes into focus"

Activity

Examine the food web below as well as the list of known factors related to oil spills. Using this information, information from the article, and any other resources at your disposal, try to predict the long-term impact (or lack of impact) that the oil spill exhibits on each of the seven species in the food web. For each species, also provide a justification for the prediction that you made using information from your research. Record your predictions and justifications in the table on the last page.



Known factors

- Excessive phytoplankton (enhanced by fertilizers leaked into the Gulf) reduces the amount of oxygen in the seawater and creates large "dead zones" where oxygen-consuming creatures cannot survive.
- Adult oysters breathe through over 50 gallons of water per day.
- Oyster larvae are neutrally buoyant and float through the water following chemical tracers to find other oyster beds.
- Humans are less likely to vacation in areas affected by an oil spill.
- Oxygen levels have been observed to decline in sea water exposed to oil spills.
- Tar balls (clumps of oil) sink where they can be eaten by bottom feeders such as crabs and oysters.
- Dispersants used to clean up the spill force the oil into tiny droplets that are suspended in the water.
- During spawning, which largely occurs in the Gulf, female bluefin tuna breathe much more rapidly.
- Oil and dispersants can impact the local density of water and change whether eggs, larvae, and plankton float or sink.
- Humans capture so many bluefin tuna that their numbers are in danger of dropping unsustainably low.
- Oil is toxic if consumed in larger quantities and can cause blindness, liver failure, and death in animals.
- Animals coated in oil can experience dangerous drops in body temperature that may be fatal.
- Fish are able to clear oil contaminants from their body much faster than crabs and oysters.
- Oil can disguise the scents that animals use to identify one another.

"And now, the spill's cost comes into focus"

Species	Long-term impact and justification
Phytoplankton	
Oysters	
Blue Crabs	
Sea Turtles	
Atlantic Croaker (small fish)	
Bluefin Tuna	
Humans	

Analysis

When you have completed the table, compare your results with a classmate's to see if you made similar conclusions. Make the case for your predictions and see if you can come to a consensus on the likeliest long-term effects on each species.

1. Which species would you conclude will be most affected by the oil spill in the long run? Why?
2. Which species do you think will be the least affected (or perhaps benefit) from the oil spill? Why?

Conclusion

Even environmental scientists who specialize in the Gulf of Mexico are not capable of predicting exactly what will happen to the ecosystem long after the oil spill. The complex interactions are simply too great. Environmental scientists will continue to wrestle with these questions and seek to learn more about how changes in the environment (whether natural or man-made) impact the diversity of life within the ecosystem. We, too, should wrestle with these questions and be ever mindful of the far-reaching and sometimes unpredictable impact that human activities have on the natural world.

Extensions

1. Visit http://oilspill.usatoday.com and explore the interactive map, which demonstrates the impact of the oil spill on the Gulf. Use the information in the Wildlife Habitat map to expand your collection of long-term impacts to include other species that are prevalent in the Gulf of Mexico. Make predictions of the oil spill's long-term effects on whales, shrimp, sharks, birds, and coral reefs.

2. Obtain recent issues of USA TODAY. Scan the newspapers for articles related to the Gulf oil spill. Cut-out the articles and categorize them as related to the long-term political, economic, environmental, or emotional impact of the oil spill. Keep tracking articles in the newspaper over the course of the school year to see which type of impact has had the most lasting effect on our country.

THE NATION'S NEWSPAPER

Special Reprint Edition

USA TODAY

NO. 1 IN THE USA

As seen in USA TODAY News

August 5, 2010

And now, the spill's cost comes into focus

As well is capped, the mark on the Gulf region will endure

By Rick Jervis
USA TODAY

NEW ORLEANS — Long after the cleanup crews and BP paychecks are gone, Gulf Coast fishermen will be dealing with dead oysters and a perception problem.

Salt marshes will struggle to regrow grasses raked by oil and digest stray pools of crude. Business owners will work to revive shuttered businesses and bruised economies in the wake of the Gulf of Mexico spill.

But the recovery is underway.

BP on Wednesday took a major step toward permanently capping the blown-out well and ending the 107-day disaster. Drilling mud forced down the well was pushing oil back into a reservoir 2.5 miles underwater for the first time since the Deepwater Horizon rig exploded April 20, killing 11 workers and unleashing the largest oil spill in U.S. history.

For many, Wednesday's news marked the beginning of the end of an ecological nightmare that saw more than 50 million gallons of crude escape into the Gulf — nearly five times the 11 million gallons that spilled from the Exxon Valdez tanker in Alaska in 1989, previously the nation's worst oil disaster.

In the Gulf, the footprint the spill leaves on the regional economy, the environment, political futures and the mental health of those closest to the disaster is likely to be felt for years to come.

A survey of 1,200 coastal residents by the National Center for Disaster Preparedness at Columbia University's Mailman School of Public Health found that more than one-third of children showed physical or mental effects of the spill, such as respiratory problems and depression, and nearly one-fourth of residents felt a need to relocate.

"There are a great deal of issues that are just beginning to get uncovered," says Irwin Redlener, the center's director and co-author of the survey.

BP is still working to clog the well for good. It may not be cemented and killed for a few more weeks. Increasingly, though, the broken wellhead appears to be lassoed under control.

Stopping oil from gushing into the Gulf had been the singular goal of BP engineers, Coast Guard officials and the thousands of fishers who were abruptly kept from their harvests this year. Now, there are lingering questions: How much longer will the fishers working on the cleanup be paid by BP? What effect will the nearly 2 million gallons of chemical dispersants sprayed on the spill have on fisheries? How will local tourism rebound?

"That we don't know and what we don't see are probably going to be the most determining factors for how soon we recover," says Rep. Charlie Melancon, a Louisiana Democrat who represents many of the affected areas.

The political cost

Disaster hurt Obama, but governors came out ahead

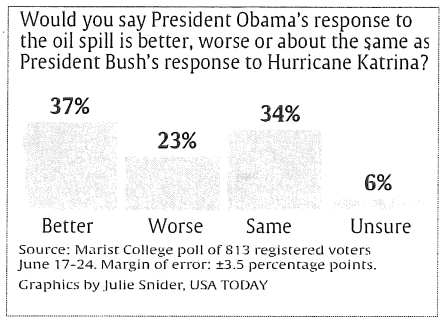
By Richard Wolf and John Fritze
USA TODAY

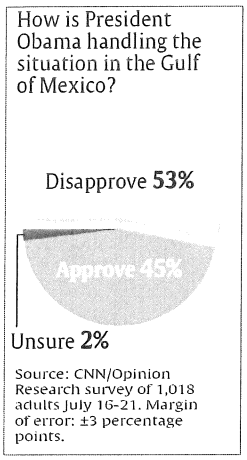
For politicians, the daily drip-drip-drip of bad news can be devastating. Yet the oil that gushed into the Gulf of Mexico for three months appears to have helped governors in the area. It hurt President Obama — but not as much as crises crippled his predecessors.

"People were blaming BP much more than they were blaming the government and Obama," says Andrew Kohut, president of the Pew Research Center. Even so, along with the economy and two wars, the spill "added to a sense of things not going well in the country."

Obama's handling of the disaster was popular at first, but as time wore on, not so much. Polls show a majority disapproved: 53% of those polled in June by USA TODAY/Gallup and the same figure in a CNN/Opinion Research survey last month. A majority, 51%, disapproved of his handling of the environment in a USA TODAY/Gallup Poll last week.

Gulf Coast governors fared better. In Florida, Gov. Charlie Crist's independent bid for the Senate picked up steam after he highlighted his opposition to offshore drilling.





In Louisiana, Republican Gov. Bobby Jindal won strong approval ratings after angrily denouncing the federal government's response.

"People appreciated that he was vocal in holding BP and the federal government responsible," says Edward Chervenak, a University of New Orleans p litical science professor. "Railing against the Obama administration is always good politics in Louisiana."

On a national level, Republicans such as Sen. James Inhofe of Oklahoma have compared Obama's actions to President George W. Bush's during Hurricane Katrina in 2005. In that case, the Federal Emergency Management Agency was seen as ineffective.

"I don't think it's going to hurt Obama the way Katrina hurt Bush," says Kenneth Green, an energy expert at the American Enterprise Institute. "We don't have an 'Oil Spill Response Administration.' If we did, there would probably have been a lot more blame."

The spill has given a boost to environmental causes, but that has not translated into congressional action.

Senators are preparing to leave Washington for the summer recess without acting on any response to the spill. Senate Majority Leader Harry Reid of Nevada says there wasn't even support to pass a scaled-back bill that would have raised liability caps on companies responsible for environmental catastrophes.

The announcement came days after Democratic leaders acknowledged that a broader energy proposal, intended to steer the country away from fossil fuels by targeting electric utility emissions, also would not get a vote in the Senate before the November elections.

"The oil spill has not ignited a groundswell in the Senate," says Sen. John Kerry, D-Mass., an architect of the legislation. He blames that on energy industry lobbying and the lengthy health care debate. But he says the spill won't be the last chance to focus public attention on energy.

"This issue is going to be much more intense, not less," he says. "It's unavoidable."

Sen. John Barrasso, R-Wyo., says Democrats were partly to blame for using the oil spill to "overreach" on a broad energy bill. "Anything that's going to raise energy costs for everyone is going to be rejected," he says. "People are focused on the economy."

The environmental cost

Rebound won't take decades, but many unknowns remain

By Dan Vergano
USA TODAY

Environmental scientists, such as biochemist Arne Jernelöv of Sweden's Institute for Futures, generally talk about the recovery from the Gulf of Mexico oil spill's worst effects as a matter of years, not decades. Blessed with a hothouse environment, fast-growing marshes may appear to shrug off oil in months or weeks while microbes chew up much of the oil on the surface.

A government report Wednesday said that only about a quarter of the spilled oil remains in the Gulf. Jane Lubchenco, administrator of the National Oceanic and Atmospheric Administration, said much of the oil has evaporated or naturally dispersed into the seawater; still more has been burned, skimmed, chemically dispersed or captured by the first containment cap, which leaked badly but still carried oil to waiting ships.

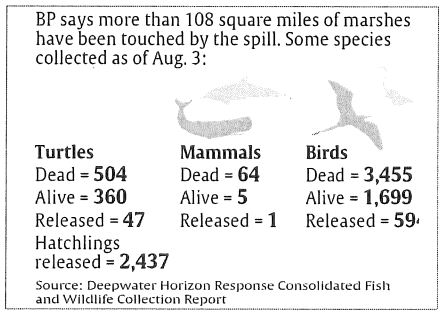
At the same time, many long-term unknowns— such as the toxicity of the spilled crude's ingredients to the Gulf's spawning sea life — cloud the crystal ball. What really will determine whether the Gulf recovers, once the oil slicks fade, the well is plugged and the TV cameras stop rolling, might be the sustained response.

" 'Out of sight, out of mind' — I worry about that," says environmental toxicologist Kim Anderson of Oregon State University in Corvallis. "I worry people will stop caring." In the worst case, people could unknowingly eat dioxin-rich seafood or swim in seawater filled with toxic chemicals.

The Gulf of Mexico was not the world's healthiest body of water even before the spill. Fertilizer-fueled algae blooms annually created an oxygen-deprived "dead zone," measured this year at 7,722 square-miles, as big as New Jersey.

The 1979 Ixtoc spill off Mexico's Yucatan coast provides the closest parallel to the Deepwater Horizon spill.

Ixtoc's oil was a light crude, thick with lighter gasoline-like compounds that quickly dissipated but were also toxic. Fish and octopus catches declined as much as 70% from some Texas ports, but lagoons stayed clear of oil because of fresh-water inflows. "Most things returned to normal within three to four years," says oceanographer Bob Gagosian of the Consortium for Ocean Leadership.



Environmental scientists see the unprecedented use of 1.84 million gallons of dispersants, much of it applied to the leak 5,000 feet deep, as saving the shore from the full effects of the spill while exposing unknowable numbers of creatures to potentially worse effects from dispersed oil droplets. "It was a bit of a giant crapshoot," says fish toxicologist Peter Hodson of Canada's Queens University. "Clearly, it was a risky move."

USA TODAY Special Reprint Edition USA TODAY News

The economic cost

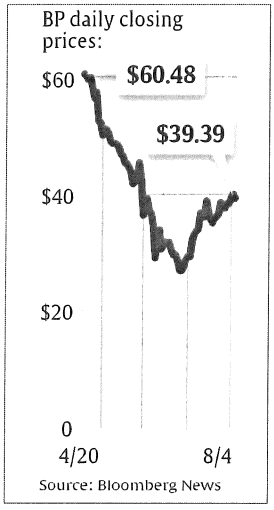
Lost jobs, declining incomes and a troubled oil industry

By Tim Watson
USA TODAY

The BP rig explosion set off a chain reaction of hardship that will be felt for a long time.

Exactly how great the cost — and whether the $20 billion BP has set aside for compensation is enough — is difficult to determine.

Moody's Analytics, an economics research firm, has estimated that almost $1.2 billion in economic output and 17,000 jobs will have been lost this year.



Calculations for losses over three years to the region's tourism industry alone could surpass the $20 billion BP has set aside, according to Oxford Economics, a consulting firm.

BP says it has paid $277 million to people and businesses making financial claims and put aside $100 million for rig workers sidelined by drilling moratoriums.

Some estimated effects of the spill:

▸ **Fishing.** The region's fish, shrimp, crab and shellfish sales are $177 million annually, Dunand Bradstreet says. Federal and state bans on fishing in one-third of the Gulf could affect at least 1,034 businesses. BP minimized some of suffering by hiring fishers and others for the cleanup.

But one in five people within 10 miles of the coast in Louisiana and Mississippi say their income fell, the National Center for Disaster Preparedness at Columbia University says. Restricted fishing has driven up restaurant prices — 30% on shrimp, 21% on fish and 18% on oysters, says Ralph Brennan of Louisiana, who runs 12 restaurants.

▸ **Tourism.** Oxford Economics says the spill may cost the tourism industry $7.6 billion to $22.7 billion over three years. Travelers have shied from the region. Welcomecenter registrations in Mississippi's Hancock and Jackson counties are down 19.4% and 35.3% respectively in the January-to-June period.

Estimates of economic loss in the Gulf Coast region vary widely:

Economy as a whole	Deep-water drilling industry	Tourism industry
$1.2 billion in economic output **17,000** jobs by year's end	**$2.1 billion** in economic activity **8,000** jobs as a result of a moratorium	**$7.6-$22.7 billion** over three years if tourism doesn't recover.
Source: Moody's Analytics	Source: Joseph Mason, Louisiana State University finance professor	Source: Oxford Economics

▸ **The oil industry.** Dun & Bradstreet calculates that 16,580 oil-related businesses and more than 150,000 workers could suffer from production and drilling moratoriums. Joseph Mason, a business professor at Louisiana State University, told Congress the moratorium on deep-water drilling will cost more than 8,000 jobs, $500 million in wages and more than $2.1 billion in economic activity this year.

The emotional cost

The leak may be plugged, but anxiety and uncertainty linger

By Rick Jervis
USA TODAY

SHELL BEACH, La. — Talk among fishermen at this BP staging point each morning is a good barometer of the local mood. Early in the crisis, shrimpers and oystermen recruited for cleanup work fretted that the leak would never stop. Then they worried they wouldn't get paid.

Today, fishermen here voice a fear that with the well nearly plugged, their steady BP paychecks may start disappearing.

"We don't know how long it will be before we get back to work fishing," says Donnie Campo, 46, an oysterman working for BP. "We look at what happened in Alaska and they're just starting to fish now."

The emotional rollercoaster coastal residents have ridden since the spill appears likely to continue even as the well is sealed.

Many of the fishermen of lower St. Bernard Parish find themselves in a dilemma: happy that the well may finally be clogged but worried that it means BP jobs may soon vanish. A boat captain could make $2,000 a day.

"As soon as these paychecks stop and you realize you can't do anything, you're going to watch that anxiety and stress go through the roof," says George Barisich, a shrimper and oyster fisherman who leads the Louisiana United Commercial Fisherman's Association.

Oil disasters often lead to spikes in depression, anxiety, divorce and post-traumatic stress, even years after the event is resolved, says Steve Picou, an environmental sociologist at the University of South Alabama.

After the Exxon Valdez spill in Prince William Sound, Alaska, fishing communities saw a rise in suicide, divorce and anxiety for six years after the spill, and symptoms lingered for another 12 years, he says.

"In this disaster, unlike a hurricane, people cannot be rescued and there's no way to inventory the damages," he says. "You have an unfolding conveyor belt of problems."

Unlike the Alaska spill, however, the Gulf already had scores of groups cre-

Mental health counselors sent by Catholic Charities have counseled 6,153 people since the start of the crisis. A survey of coastal residents found:

More than **40%** of those living near the coast had experienced direct exposure to spilled oil.

More than one-third of children had physical symptoms or mental health problems.

Source: National Center for Disaster Preparedness, Mailman School of Public Health, Columbia University

ated after Hurricane Katrina to help people recover from that disaster, Picou says. Many are shifting to helping residents deal with the spill.

Catholic Charities has opened five mental health centers across the Gulf and treated more than 6,000 people since the spill.

It sends counselors to docks and marinas to counsel fishermen. Larry Carbo, a Catholic Charities crisis counselor, says many he's spoken to have been drinking more or abusing their spouses. Others have confessed thoughts of suicide if they can't work soon.

Many fishermen lack a high school education and struggle with what they'll do if the oil is stopped but they can't fish, Carbo says.

"They want to believe it's going to work out," he says. "But there's a sense of, 'What's going to happen now?' "

Sal Sunseri says he is optimistic the Gulf can recover. It has been painful, though, to see his 134-year-old New Orleans family business, P&J Oyster Company, lose 70% of its sales and lay off 10 of 19 employees.

"My whole life has been turned around,"Sunseri says.

Oyster fishermen show some of the highest anxiety, Carbo says. Two freshwater diversions opened off the Mississippi River to repel the oil have killed off hundreds of young oysters, throwing future harvests into doubt.

Dave Casanova, a Shell Beach oysterman, says nearly two-thirds of his young oysters have died, pushing his earnings back two or three years. The mental strain of having to support a wife, four daughters and two grandchildren has been draining.

Casanova, 54, says he saves his BP pay for the day the company pulls out and the fishermen are left with dead oyster beds. He says he hopes other fishermen are doing so.

"The full effect of this spill is going to be felt much, much later."

A Salt Marsh Ecosystem

Strand	Biological Communities	
Topic	Investigating the impact of physical environment changes on food webs	
Primary SOL	LS.8	The student will investigate and understand interactions among populations in a biological community. Key concepts include a) the relationships among producers, consumers, and decomposers in food webs.
Related SOL	LS.1	The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which j) current applications are used to reinforce life science concepts.
	LS.5	The student will investigate and understand the basic physical and chemical processes of photosynthesis and its importance to plant and animal life. Key concepts include c) photosynthesis as the foundation of virtually all food webs.
	LS.7	The student will investigate and understand that interactions exist among members of a population. Key concepts include b) influence of behavior on a population.
	LS.10	The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic, change over time, and respond to daily, seasonal, and long-term changes in their environment. Key concepts include b) factors that increase or decrease population size.

Background Information

A salt marsh is a complicated ecosystem made up of different food chains that overlap to form a food web. Make sure students understand the biotic and abiotic factors of a salt marsh ecosystem. The data on the attached "Salt Marsh Organisms Cards" can be modified to add or substitute examples from your local ecosystem. Teacher should review basic knowledge of food chains and food webs as well as predator/prey relationships. First-, second-, and third-level consumers should be identified.

Materials

- Scissors
- Tape
- Yarn
- Copies of Salt Marsh Organisms Cards

Vocabulary

abiotic, biotic, carnivores, communities, consumers (first-, second-, and third-level), herbivores, omnivores, predator, prey, producers

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

1. Divide the class into groups of three or four students, and give each group a pack of the 15 cards, representing organisms of the salt marsh and sources of energy. Also, display the following questions on the board or chart paper:
   - What are the producers in this community?
   - What is the source of their energy?
   - Which three organisms are strictly herbivores?
   - Which two organisms are strictly carnivores?
   - Which three organisms are omnivores?
   - Which organisms are first-order consumers? Which are second-order? Which are third-order?
   - How would the predator-prey relationships be described?
   - How does the size of an animal determine its position in the food web?
2. Have students place the cards representing the producers of this community at the edge of their desk or table. Then, have students place the cards representing the grasshopper, snail, fish, and small crustaceans in a row above the plants and to connect each animal to its food source(s) with a piece of yarn. Have them tape the ends of each piece of yarn to a card. Next, place the hawk and the owl at the top edge of the desk and scatter the remaining organisms in the space between the herbivores and the hawk and owl. Again, have them use the yarn and tape to connect each of the organisms to all the other animals that will eat it, using the food list on each card to help determine the food each organism eats.
3. Ask students to identify the organisms in the food web which are eaten by the rat. Ask students which organisms depend directly on the marsh plants for part or all of their diet. Have students answer the questions listed above in step 1.
4. Have each team member hold one of the producer cards or the heron, hawk, or owl cards and carefully lift the food web off the table. It should be supported by the yarn attached to these five cards. Have students observe the web carefully, noting the connections.

Assessment

- **Questions**
  - What do you predict would happen to the food web if insecticides were to enter the salt marsh and kill the grasshoppers and snails?
  - Which animals would be affected by the loss of these foods?
  - What might these animals do to replace the lost food sources?
  - How might this affect their other food sources?
  - Which organism would be affected if pollution were to reduce the population of fish?
  - What is the basis of most every food web? Why are these organisms key to the other organisms' survival?
- **Journal/Writing Prompts**
  - Predict what might happen to this food web if the salt marsh were filled in to make room for a new housing development.

- **Other**
  - Have students create a food web from another ecosystem.

Extensions and Connections (for all students)

- Have students research other food chains. They may investigate how toxins travel through the food chain in the salt marsh. Why should all members of the larger watershed be concerned about a salt marsh that is hundreds of miles away. How do salt marshes benefit humans? Have students research other ways to control pests.

Strategies for Differentiation

- Have students construct a simple food web with the following organisms: grass, weeds, worm, grub, beetle, robin, starling, and cat. Have students identify the producers and first-, second-, and third-order consumers.
- Students can expand on the ecosystem food web by creating an energy pyramid that corresponds to the organisms listed.

Salt Marsh Organisms Cards

MOUSE ***eats*** grasshoppers snails marsh plants	**RAT** ***eats*** sparrows grasshoppers snails marsh plants	**OWL** ***eats*** rats sparrows ducks sandpipers
DUCK ***eats*** crustaceans marsh plants algae grasshoppers snails	**SANDPIPER** ***eats*** crustaceans algae	**SPARROW** ***eats*** crustaceans marsh plants grasshoppers snails
SMALL CRUSTACEAN ***eats*** algae	**FISH** ***eats*** crustaceans marsh plants algae	**HERON** ***eats*** fish
SALT WATER ALGAE ***energy source:*** sunlight CO_2 water	**SALT MARSH PLANTS** ***energy source:*** sunlight CO_2 water	**SNAIL** ***eats*** marsh plants algae
HAWK ***eats*** shrews mice rats	**SHREW** ***eats*** grasshoppers snails mice	**GRASSHOPPER** ***eats*** marsh plants

Salt Marsh Organisms Cards

MOUSE *eats* grasshoppers snails marsh plants	RAT *eats* sparrows grasshoppers snails marsh plants	OWL *eats* rats sparrows ducks sandpipers
DUCK *eats* crustaceans marsh plants algae grasshoppers snails	SANDPIPER *eats* crustaceans algae	SPARROW *eats* crustaceans marsh plants grasshoppers snails
SMALL CRUSTACEAN *eats* algae	FISH *eats* crustaceans marsh plants algae	HERON *eats* fish
SALT WATER ALGAE *energy source:* sunlight CO_2 water	SALT MARSH PLANTS *energy source:* sunlight CO_2 water	SNAIL *eats* marsh plants algae
HAWK *eats* shrews mice rats	SHREW *eats* grasshoppers snails mice	GRASSHOPPER *eats* marsh plants

1. What are the producers in this community?

2. What is the source of their energy?

3. Which three organisms are strictly herbivores?

4. Which two organisms are strictly carnivores?

5. Which three organisms are omnivores?

6. Which organisms are first-order consumers? Which are second-order? Which are third-order?

7. How would the predator-prey relationships be described?

8. How does the size of an animal determine its position in the food web?

1. What do you predict would happen to the food web if insecticides were to enter the salt marsh and kill the grasshoppers and snails?

2. Which animals would be affected by the loss of these foods?

3. What might these animals do to replace the lost food sources?

4. How might this affect their other food sources?

5. Which organism would be affected if pollution were to reduce the population of fish?

6. What is the basis of most every food web? Why are these organisms key to the other organisms' survival?

Extra Credit: (2 paragraphs minimum)
Predict what might happen to this food web if the salt marsh were filled in to make room for a new housing development.