AMP IT UP

Advanced Manufacturing & Prototyping Integrated to Unlock Potential

8TH GRADE SCIENCE

Experimental Design

OCEAN BLIZZARD

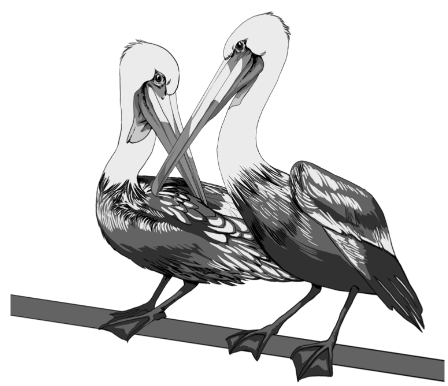
Marine Snow Challenge

8EDS

SECTION 1 – HOW DOES OIL GET TO THE BOTTOM OF THE OCEAN?

1.1 INTRODUCTION

Oil spills in the ocean are a very serious pollution problem. Every year 52 million gallons of oil are released into the world's oceans through oil spills and off shore drilling. In 2010, the Gulf of Mexico suffered one of the worst oil spills in United States' history. This oil spill was named the Deepwater Horizon oil spill and occurred after the explosion of an oil rig called the Macondo Well. Pictures of oil floating on ocean water and covering wild animals that live in the Gulf were broadcast worldwide.



Discuss these questions as a class:

1. Why is oil so hard to clean up?
2. Why are oil spills so disasterous to the environment?
3. What is the dark mess in the picture above on the left? Why is it floating on top of the water?

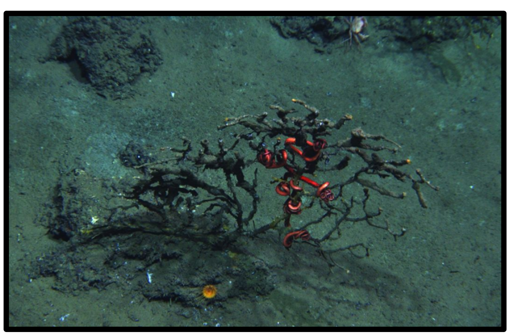
Using what you know about oil and water, make a prediction about what will happen when the two substances are combined in a graduated cylinder. Write down your **prediction** on Row 1 of your **Student Sheet #1 – Predict, Observe, Explain.** After your teacher completes a demonstration of this first Event, fill in the **Observe** and **Explain** columns.

1.2 ADD TO YOUR UNDERSTANDING

When oil is spilled into the ocean, it naturally stays on top of the water. Oil molecules are more attracted to one another than to water molecules. Therefore, oil does not dissolve in water. However, oil spilled into an environment like the Gulf of Mexico does not just stay in one place. Oil from the Deepwater Horizon Spill was transported by winds, currents, and tides. It ended up contaminating 16,000 miles of coastline. Cleanup crews expected the oil to move in a certain way, and tracked the movement so they could focus their cleanup efforts in the right locations. However, one research team, the ECOGIG team, found lots of oil where no one expected: at the bottom of the ocean.

The ECOGIG team is a group of scientists from different universities, led by the University of Georgia and Georgia Tech, who are researching the long-term effects of oil spills on deepwater ecosystems in the Gulf of Mexico. The ECOGIG group brings together oceanographers, marine biologists, and chemists from universities all over the United States and world to study this problem. Dr. Annalisa Bracco, a professor in the School of Earth and Atmospheric Sciences at Georgia Tech, is one of the lead scientists in the ECOGIG group. She studies and models how materials circulate and mix in the ocean. You will read more about Dr. Bracco's work throughout this challenge.

When the ECOGIG scientists investigated the very sensitive deep sea coral ecosystem, they discovered a dark substance called "Floc" covering much of the coral, as shown in the picture below.



Floc is made up of clumps of particles containing substantial amounts of oil. The ECOGIG scientists hypothesized that the floc might cause severe damage to the deep sea environment, and they set out to study it. However, since the oil in the floc appeared to be the same oil that had been released from the Deepwater Horizon spill, they had another mystery to solve: **How did this oil end up at the bottom of the ocean?**

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Dr. Uta Passow is an ECOGIG Oceanographer at the University of California, Santa Barbara, who is originally from Germany. She does research on a phenomena called ***Marine Snow***. Marine Snow can be thought of as the “dust bunnies” of the ocean—clumps of algae and other particles that start at the ocean’s surface and eventually sink to the bottom. Animals on the ocean floor then eat the marine snow as food. Most marine snow is composed of decaying organisms and their waste.

There is always marine snow in the ocean, but Dr. Passow noticed a significant increase in the size and amount of the snow after the Deep Horizon Oil Spill. She wondered whether this was how the oil was moving to the bottom of the ocean. She also wondered the effect oil-saturated food would have on deep sea animals.

Watch the video to learn more about Dr. Passow’s discovery.

Watch ***ECOGIG Marine Snow*** video #1

Discuss these questions as a class:

1. Why is marine snow important for deep sea ecosystems?
2. What made Dr. Passow and the ECOGIG team realize that oil and marine snow might be connected?
3. What happens when fish eat marine snow in the Gulf?
4. Why is collaboration important in science?

1.3 YOUR ECOGIG CHALLENGE

You and your group members are graduate students with the ECOGIG research project. You are trying to determine how and why certain materials clump and fall to the ocean floor as marine snow. In particular, what causes oil (which normally floats on water) to sink to the bottom? **Specifically, your challenge is to create a model of marine snow that provides consistent and reliable results and that you can communicate to other people.** Having this model will help you to determine how some of the oil from DeepWater Horizon reached the deep sea corals.

1.4 MODELING MARINE SNOW

Predict, Observe, Explain

To understand how oil can sink to the bottom of the ocean, it is important to investigate what types of objects sink or float in water. Your teacher will perform a short demonstration dropping different objects in a tank of water. Follow the procedure below to complete the activity.

Procedure:

1. Read each Event list on your **Student Sheet #1 – Predict, Observe, Explain**.
2. Look at the materials presented by your teacher.
3. Make a prediction of whether each item will sink or float based on your prior knowledge.
4. Observe each event demonstration and write your observation of whether the object sank or floated.
5. Write a simple explanation of why you believe each object sank or floated. What characteristics of the materials do you think were important?

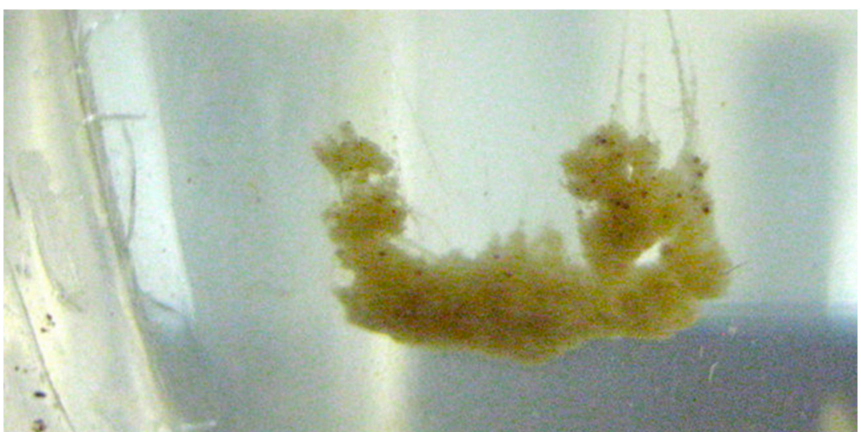
SECTION 2 – INVESTIGATE AN OIL SPILL

2.1 PLAN AN INVESTIGATION

In this investigation you will create a model of marine snow. Your team will develop and use a model because:

1. You cannot create a real oil spill to observe marine snow events, as you would cause more damage to the sensitive ecosystem.
2. You can test procedures for much less cost and time in the lab compared to doing field work in the ocean.

Scientists frequently use models to substitute for actual events, processes, and situations. This allows them to safely investigate dangerous or difficult events and understand better how things work. The ECOGIG team uses models in their labs. In this photo, they modeled the composition of marine snow and examined its falling patterns in a tank of water.



Discuss this question as a class:

1. What are some other models that scientists use to investigate real-life situations?

In developing your model, you will use:

- 1000 ml of water to represent the ocean or a body of water
- A wood cork to represent the oil
- Washers to represent the algae and plankton that compose marine snow
- A paper clip to represent the glue that binds the marine snow together

Your challenge is to:

- Determine the minimum **number** of washers it will take to sink your cork
- Determine the minimum **mass** of washers it will take to sink your cork

Develop your experimental procedure:

1. Spend 5-6 minutes discussing and creating a procedure to determine the minimum number or mass of washers needed to sink two different corks.
    a. Include the materials listed to the right in your procedure.
    b. Include two different types of corks.
    c. The 1000ml beaker is to assist you as you empty water from the 1000ml graduated cylinder.
2. Write your procedure on ***Investigation Sheet 1***.
3. Raise your hand for your teacher to check that you have recorded your procedure and are ready to begin your investigation.

MATERIALS

- Two corks (may be different shapes/sizes)
- Washers
- Paper Clip
- 1000ml Graduated cylinder
- 1000ml Beaker
- Water (1000 ml)
- Mass Balance
- Paper Towels
- *Investigation Sheet 1*

2.2 CARRY OUT YOUR INVESTIGATION

You will have 15 minutes to run your procedure with both corks. You have everything you need to complete your procedure.

Procedure:

1. Follow the procedure that your group created for Cork #1.
2. After the first cork sinks, pour your water from the graduated cylinder to the beaker and remove your cork and washers.
3. Count the washers and put this number on your data sheet.
4. Use the mass balance to mass the washers and write this number on your data table.
5. Use the mass balance to mass the washers, cork, and paperclip and write this number on your data table.
6. Pour the water from the beaker back into the graduated cylinder and repeat this process with Cork #2.

2.3 COMMUNICATE YOUR RESULTS

Each group will report to the class the results of their investigation. Your teacher will record the outcomes on a graph known as a histogram, and you will record them on your own histogram on the ***Results Graph 1*** student sheet. For this investigation, create two separate histograms; one for the number of washers and another one for the mass of washers. Each group will share two data points for each histogram—one for each cork.

Procedure:

1. Each group should report their results for the number of washers needed to sink each cork.
2. As each group reports out, chart those trials on your ***Results Graph 1*** student sheet by placing an "X" on the graph for each data point.
3. Repeat this procedure for the histogram for the mass of the washers, in grams. Chart the results on **Results Graph 2**.

2.4 ANALYZE THE DATA

Procedure:

1. Look at the histograms that were created from the class data.
2. Answer the following discussion questions as a class. Have your written procedure available as your answer the questions.

Discuss these questions as a class:

1. Did your group have any difficulties while following your procedure? Describe each one.
2. How similar are the results of the numbers of washers of different groups?
3. How similar are the results of the mass of the washers of different groups?
4. What did the distribution, or spread, of data on the histogram look like?
5. Were the results of the mass of the washer or the number of washers more spread out? Why do you think that occurred?
6. What do you think this says about how reliable the class's data are?
7. What could the class do to get results that are more similar (consistent)?
8. Do you think the ECOGIG research team would trust your class data for using this procedure to model marine snow?

SECTION 3 – REDESIGN YOUR INVESTIGATION

3.1 ADD TO YOUR UNDERSTANDING: TRUSTWORTHY INVESTIGATIONS

Each team of students in your class is trying to answer the same challenge – how to determine the number and mass of washers required to sink a cork. Every group used the same units of measurement—i.e. number and grams. Every group had the same type of materials.

Discuss these questions as a class:

1. Did all groups get the same test results? Why, or why not?
2. How could the experiment be changed to get more consistent results?

When scientists and engineers carry out investigations, they try hard to use ***consistent procedures*** so they can collect trustworthy data that can be used to determine trends and draw conclusions. **Consistency** refers to using the same procedure each time when collecting data. That does not mean that scientists never change their procedures. They might refine their procedures to make them work better or more precisely. However, when comparing data points, it is very important that the data points you are comparing were collected in exactly the same way.

Scientists communicate and analyze data through graphs and statistical analysis**.** When there is a wide spread of data in the graph, the data is said to have a large amount of **variation**. Sometimes this variation is a real result of a good experiment. However, a lot of variation can also signal that the procedures used were not consistent, or **standardized**. A standardized procedure means that the experiment was done the same way every time.

Scientists often share their procedures and data with other scientists. An important part of science is having more than one scientific team do the experiment to show that the results can be repeated, or **replicated**. This collaboration helps reveal patterns within the data and helps identify possible errors in the experiments. But for a second scientist to replicate the experiment, he or she needs to have a very accurate procedure that explains exactly how the experiment was done.

Creating Accurate Procedures

Creating a good procedure requires that you identify and describe every step in the procedure, so it can be run the same way each time. It also requires identifying possible **sources of error** in the procedure, so people trying to replicate your experiment know what to be careful about as they run it. Sources of error might be things like different people using a stop-watch in slightly different ways so they get different results for the same trial or using a measuring tool in different ways.

KEY TERMS

Variation: a change or difference in condition

Error: a measure of the estimated difference between the observed or calculated value of a quantity and its true value

Variables

In the first investigation, each group used different corks (different volumes, shapes, and masses), different sized washers, and different combinations of attachment. These are examples of ***variables***. By changing variables between groups and trials, you are likely to have inconsistent results.

KEY TERMS

Variable: any part of the procedure that could change

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Independent and Dependent Variables

In your first investigation, you determined both the mass of washers and the number of washers it took to sink the cork. The number and mass of washers are **independent variables**. Whether the cork sank or floated is the **dependent variable** as it is the variable being tested and depends on the number and mass of washers attached to the cork. In every experiment you will have an independent variable that you are testing and a dependent variable that you are measuring.

KEY TERMS

Independent Variable: The variable that is changed or manipulated in an investigation

Dependent Variable: The variable that is tested or measured in an investigation (depends on the independent variable)

3.2 CREATING A STANDARDIZED PROCEDURE

As a class, discuss the different procedures you used to determine the number and mass of washers needed to sink the cork. What are different sources of variation? How can the class limit the variations in procedure?

In the first investigation, the graph that showed the number of washers needed to sink the cork probably revealed a large amount of variation. Determining the number of washers needed to sink the cork, instead of the mass, can cause inconsistent results. This is because the washers are of different sizes and have different masses. In the second investigation, you will measure **just one independent variable:** <u>the mass of the washers</u>**.** Although you will continue to use different size washers to sink the cork, you will control for that variable by only recording the mass of the washers.

Procedure:

1. Your teacher will make a list of the procedural differences you noticed during your first investigation.
2. As a class, discuss changes that could make your procedure more consistent and identify sources of error.
3. As a class, revise the procedure to standardize the procedural details. Your teacher will record and display the new procedure as the class designs it.

4. After the class has decided on the procedure, each group should review, discuss the new procedure, and record the new procedure on ***Investigation Sheet 2***.
5. Raise your hand for your teacher to come by to make sure that you have recorded your procedure and are ready to run the investigation again.

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Discuss these questions as a class:

1. What are three or four key differences between your previous procedure and the new class procedure?
2. What are you now controlling better in the new procedure?
3. What effect do you think this new procedure will have on the range of results across groups?
4. What are your predictions for the mass of the washers to sink the corks?
5. What could the class do to produce a procedure to achieve consistent results?

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SECTION 4 –MARINE SNOW CHALLENGE WITH A NEW PROCEDURE

4.1 CARRY OUT YOUR NEW INVESTIGATION

Now that you have a new procedure, your class should be able to produce more reliable results. Your class will now collect another set of data and produce a new histogram.

MATERIALS

- One cork
- Washers
- Paper Clip
- 1000ml Graduated cylinder
- 1000ml Beaker
- Water (1000 ml)
- Mass Balance
- Paper Towels
- ***Investigation Sheet 2***

Procedure:

1. Follow your new procedure using the materials listed to complete two trials.
2. Record your results on ***Investigation Sheet 2***.

Be prepared to share your results with your class and teacher. You will have 15 minutes to perform your investigation and collect your data.

4.2 COMMUNICATE YOUR RESULTS

Procedure:

1. Once all groups finish collecting data, each group will share their results.
2. Each student will plot the results on ***Results Graph 3*** as the teacher creates another histogram on the board. Each group should report any problems they had completing the procedure. **Remember you will only be recording the mass of the washers for these trials**.

4.3 ANALYZE THE DATA

After your class has created the histogram, think about and discuss how the new, more standardized procedure demonstrates how the class can more effectively determine the mass of the washers that would sink the cork.

Discuss these questions as a class:

1. How do the results from this investigation compare to the first trial's results?
2. Did all groups get results similar to yours? Do you trust these results more? Why or why not?
3. Did your procedure produce consistent results and meet the goals of the challenge?

One more time?

You might find that the range of results is still too large for you to trust. If so, return to your procedure. Discuss how to better standardize the steps and process, and record a new procedure. Afterward, as a class, plot these new results on another histogram to see if you are getting more reliable data and a more efficient design because of a better procedure.

Controlled Variables

In your second investigation, every group should have used the same type of cork and same method of attachment. These are now examples of ***controlled variables***. Controlled variables stay the same each time the procedure is run. The data should be more accurate and clustered closer together on the histogram.

KEY TERMS

Controlled variable: An element that is not change throughout an experiment

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4.4 ADD TO YOUR UNDERSTANDING: DENSITY

Your class has created a model of how oil, which like a cork floats on water, can sink to the bottom of the ocean. When you increased the mass of the cork by adding washers, the cork sank. Oil acts in the same way. Oil can be a sticky substance and when the oil comes in contact with junk in the water, it can stick to it. In the ocean, the oil sticks to marine materials like decaying matter and waste products from animals. The clumps that result have a higher **density** than the oil. Density is the relationship between the mass of the substance and how much space it takes up, or **volume**. The clumps can even have a higher density than water. In those cases, the clumps become marine snow and sink.

In your ***Predict, Observe, Explain*** activity from ***Section One***, objects that were of the same volume might have had different results. This was due to the density of the object.

KEY TERMS

Volume: the amount of space an object occupies

Density: the relationship between the mass of the substance and the volume

4.5 ANSWER THE CHALLENGE: Write a Lab Proposal

As a graduate student with the ECOGIG research project, your initial challenge was to create an easily understood model of marine snow that provides consistent and reliable results. You created the model by developing and documenting a precise procedure for everyone to use. In that procedure you identified and discussed:

- variables and controls
- tools needed to gather data
- measurements to be collected and recorded
- sources of error

To complete the challenge, you need to communicate your model to the other researchers on your project in the form of a lab proposal.

You will write your Lab Proposal on ***Student Sheet #7: Marine Snow Lab Proposal***. Your lab proposal needs to include the following information:

- Your final procedure (the procedure from the second investigation with any changes needed to obtain more reliable data).
- A list of the different variables that you needed to control.
- A list of all the sources of error that you identified.
- Your evidence that the procedure produces reliable data.

SECTION 5 –RESEARCH CONNECTIONS

5.1 ECOGIG SCIENCE

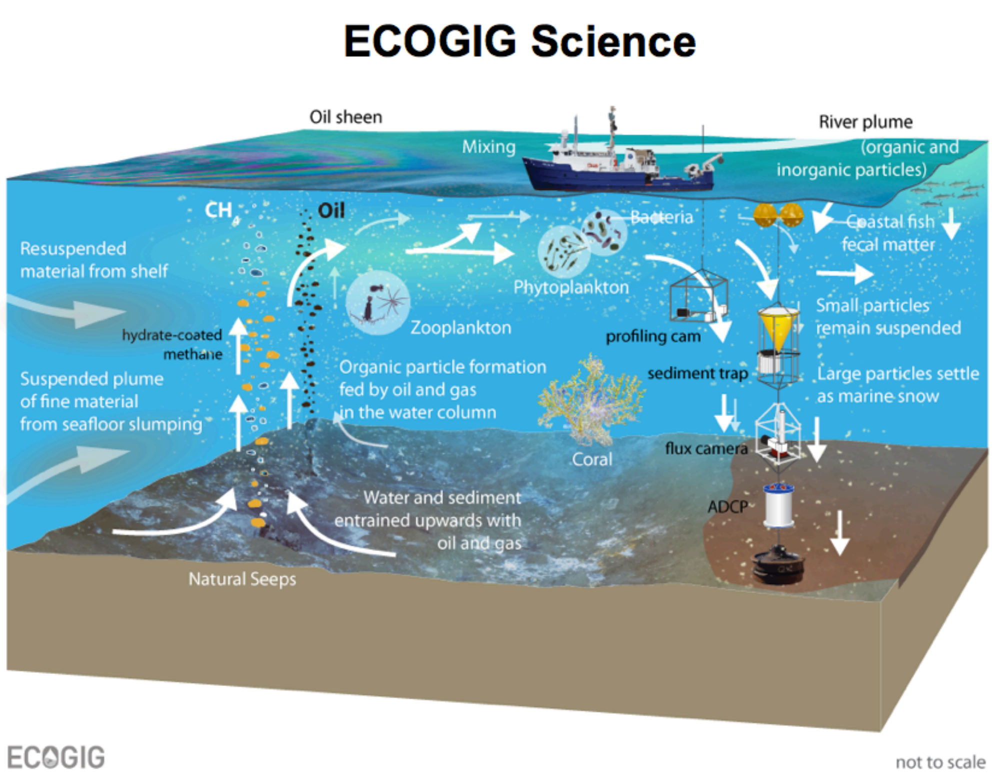
The ECOGIG research team understands the importance of conducting good science investigations. When they first saw pictures of what looked like an oily substance covering the corals at the bottom of the ocean, they did not immediately conclude it was oil from the Deepwater Horizon explosion. They knew they needed to conduct additional investigations and collect more data. They used a multicorer (pictured below) to sample sediment from the seafloor and brought the samples into the laboratory. The lab experiments determined that there was oil on the seafloor. The ECOGIG team hypothesized that the oil could have come from the surface and tested the oil to see if it had the same chemical composition as the oil from Deep Sea Horizon spill. It did. This, coupled with other data, confirmed that the surface oil had sunk to the seafloor.

Sample of multicorer sediments samples from the seafloor after Deepwater Horizon

A zoomed in image of the oily floc in the sediment on the seafloor.

Modeling Oil Movement

Dr. Annalisa Bracco creates models of how materials move around in the Gulf of Mexico. In particular, she investigates where the oil went from the Deepwater Horizon Spill. She studies both how the oil moved vertically (down towards the ocean floor) and horizontally (across the ocean). Dr. Bracco has discovered that just because there is oil on the surface in one particular location, it does not mean there is also oil on bottom of the ocean in that location. Often oil on the bottom of the ocean was originally on the surface at a very distant location. In order to make predictions about where on the seafloor oil might be located, Dr. Bracco uses models that include ocean currents and evidence about how quickly different materials sink. These models, and good procedures like the one you developed, play an important role in her scientific research.



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