



## **Cabrillo Marine Aquarium Lesson Plan**

**Grade Level:** Fifth Grade

**Title:** Who Pollutes?

**Objective:** Students will: (1) be able to name at least a few types of pollutants that can get into storm drains; (2) observe how a bowl of clean water changes into dirty water as different pollutants are added to it; and (3) be able to describe solutions to the problem of pollution getting into our waterways that either individuals, cities, or lawmakers are doing.

**California Science Standards:** 5<sup>th</sup>: 3a, 3d

**Time to Complete:** 45 minutes

**Materials Provided by CMA Ocean Discovery Kits:** *Reading Handout: Who Pollutes? Story*, Labeled Film Canisters (22)

**Materials Provided by Teacher:** Large clear container, water to fill the container, contents of film canisters (*Helpful hint: use small amounts and dilute food coloring for the various colors needed, or mix a small amount of water and paint.*):

1. Construction site – dry soil
2. Trees – crumpled dry leaves
3. Homeowner – yellow water with small pieces of tissue
4. Cattle farm – brown water
5. Horses – brown water
6. Pesticides – baking soda
7. Fertilizer – baking soda
8. PCBs – yellow water
9. Cars – chocolate syrup
10. Exhaust – vinegar
11. Factory – cooking oil
12. Tune up – chocolate syrup and oil
13. Antifreeze – green water
14. Washing the car – soapy water
15. Mysterious liquid – red + green water
16. Garbage – small pieces of paper
17. Power plant – chocolate powder
18. Motorboat – chocolate syrup and oil
19. Picnickers – trash
20. Party – trash
21. Fishing – fishing line or dental floss

**Vocabulary:** pollution, storm drain, waterway, lawmakers, pesticides, fertilizers, PCBs, exhaust, antifreeze, power plant, water quality, prevent, contaminant

**Teacher Preparation:**

1. Fill each film canister about half-way with the contents that will represent that particular type of pollutant.
2. Make sure you close the film canister caps tightly so the contents don't leak.

**Lesson Outline:**

1. Review watersheds and the storm drain system pathway. Ask students "Where does polluted water and trash that gets into the ocean come from?" (Mostly, it comes from a variety of places inland.)
2. Set the scene for this story. Tell students that each of them is going to play the role of somebody who lives, works, or plays in the watersheds that drain into the bay.
3. Each student will receive a film canister with pollution inside. "We're going to tell the story of how these various pollutants get into the environment and drain down to the ocean. We're also going to see how we can help."
4. Set out a fishbowl or other clear container with one gallon of water in it. Have students sit where they can see the bowl of water.
5. Give each student a labeled film canister filled with its symbolic pollution (dirt, baking soda, etc.). See the materials list to fill the canisters. There are 22 total film canisters.
6. Tell the students to keep their container closed until it is their turn, do not shake their container (contents may leak), and do not reveal what they have to the other students.
7. Have them look at their canisters' label to see what they have. Circulate amongst the class to make sure everybody can name their item.
8. Begin to tell the pollution story. See the attached story. The container of water represents your nearest water body or the ocean.
9. Before you begin, have the students look at the container full of water. Ask the students if they would drink the water? Would they fish in it? Would they swim in it?
10. As you read the attached story out loud, have the students listen carefully to hear the word, or words, that are written on the label of their canister.
11. When they hear the word, pause the story. Have the student(s) take the lid off their canister, pour the contents in the container full of water (ocean or river), and hand you the empty canister.
12. Again ask the students if they would drink the water. Would they fish in it? Would they swim in it? Discuss the type of pollution that was just added to the clear container.
13. Continue to read the story, having students listen for their word, and following the steps above for each type of pollution.

14. Finish the story and then discuss some solutions that we can do in our everyday lives that will decrease the amount of pollution in our waterways. Discuss things that cities and lawmakers are doing to help solve the problem.

### **Lesson Extensions:**

1. Have students draw on a sheet of paper or make their own containers with a pollutant inside each of them. Have them write a paragraph describing each of their pollutants, where it comes from, how it can hurt the ocean, and what we can do to prevent that kind of pollution from entering the storm drain system. End the paragraph with other things that we can do to improve water quality and prevent pollution.
2. Ask students questions to assess their observations and knowledge as you proceed and after you finish doing the pollution story. Here are some possible questions:
  - What happens when pollutants get added to the water? How does it look/smell?
  - Which one do you think was the grossest pollutant and how did it affect the water?
  - How could we reduce the amount of pollution?
3. Discuss in more detail the Clean Water Act and how we can make a difference by appealing to lawmakers. Look into current measures that protect water quality. Tie in cause-and-effect relationships of “If – Then” sentences with the pollutants and what happens when they get into the environment.
4. For younger grades, you can remove some of the contaminants such as PCBs or mining. Concentrate on a few things with which we have the greatest impact, such as litter. Have students use whole body movements to act out their item or make a sound that correlates with their item, as they dump it into the container of water.

### **References:**

- Key to the Sea Curriculum Guide  
<http://www.healthebay.org/get-involved/ways-heal/classroom/key-sea>



## **Cabrillo Marine Aquarium Lesson Plan**

**Grade Level:** Eighth Grade

**Title:** Ocean Acidification Experiment

**Objective:** Students will test, observe, record and make conclusions on how acidity affects marine life.

**California Science Standards:** 8<sup>th</sup>: 5a, 5b, 5e, 6a, 9a-c

**Time to Complete:** 60 minutes

**Materials Provided by CMA Ocean Discovery Kits:** *Worksheet: Ocean Acidification Experiment Datasheet*, pH Probe, Shell Fragments, Marine Life Affected by Ocean Acidification Specimen Display

### **Materials Provided by Teacher:**

- small cups (5 per **group**)
- paper towels
- copies of datasheet (1 per **group**)
- graduated cylinder (1 per **group**)
- tap water
- lemon/lime juice or distilled vinegar
- baking soda solution (mix 15 teaspoons to 1 quart tap water)
- carbonated soda
- pH test strips or red cabbage juice pH testing solution (optional)
- eyedropper (optional)
- water from a local source such as a river, pond, ocean, rain, etc.(optional)

**Vocabulary:** Global warming, greenhouse gas, anthropogenic, ocean acidification, pH, carbonic acid, dissociation, carbonate, bicarbonate, fossil fuel

### **Teacher Preparation:**

**If you would like to use cabbage juice instead the pH probe**, prepare the solution as follows: (from *Cabbages and Chemistry*, Lawrence Hall of Science)

1. Chop and boil red cabbage.
2. Drain the liquid through a sieve to filter out the cabbage.
3. The liquid should be a red-purple-bluish color. This liquid is at about pH 7. (The exact color you get depends on the pH of the water.)
4. You can find color images for red cabbage pH indicator colors on-line, or use this scale:

Red Cabbage pH Indicator Colors	
pH	Color
2	Red
4	Purple
6	Violet
8	Blue
10	Blue-Green
12	Greenish Yellow

Setup the following materials for each group:

1. 4 or 5 cups per group (depending on whether or not you will be using water collected from a local waterway in your neighborhood)
2. Shell fragments (4 or 5 per group)
3. 1 graduated cylinder (if using)
4. paper towels

You could set-up a location in the classroom where students can measure out 25 mL of each solution (tap water, distilled vinegar, baking soda solution, carbonated beverage) and have students label cups appropriately on their own or distribute the cups already labeled and filled with solution.

**Lesson Outline:** Introduce “ocean acidification” to the students and how it could impact marine life. Students then observe what happens to the shells of marine organisms in different solutions of varying pH (acidic, neutral, basic).

**Lesson Procedures:**

1. Show students the specimens labeled Marine Life Affected by Ocean Acidification and ask them what all these creatures have in common.
2. Share with the students that one important thing all these ocean animals have in common is that they have shells made of calcium carbonate.
3. Explain to the students that we will be taking a closer look at the ocean and how a changing climate and changing ocean chemistry might affect life in the ocean.
4. Introduce the Ocean Acidification Experiment to the students, pass out datasheets and equipment to each group.
5. Have students make predictions about what they think will happen when they place the shell fragments into each of the solutions. Then have them place each of their shell fragments into the solution, one at a time, and record any initial observations they notice as they placed the chalk into the solution.
6. Let shell fragments sit for 10-15 minutes and record any observations throughout this time.

7. While waiting and observing the shell fragments, have students use the pH probe, dip a piece of pH paper, or add 1 dropper full of cabbage juice to each sample starting with the tap water.
8. Record the results on the datasheet.
9. Students should notice that each solution has a different pH. They also may have noticed that each solution produced a varying degree of fizz when the shell fragments were added (for example the vinegar should have produced the most “fizz” when a shell fragment was added).

### **Lesson Wrap-Up:**

1. Discuss with the class how a more acidic ocean could impact shelled organisms in the ocean.
2. Discuss what we can do about ocean acidification. Discuss with them that combating acidification requires reducing CO<sub>2</sub> emissions (from cars and factories), reducing carbon footprints, and improving the health of the oceans. Creating marine protected areas (or national parks for the ocean) and stopping destructive fishing practices would increase the ability of marine ecosystems to withstand acidification. For example, evidence suggests that coral reefs in protected ocean reserves are less affected by global threats such as ocean acidification. Overall, the same strategies needed to reduce carbon emissions on land can also help slow these changes in the ocean.

### **Lesson Extensions:**

1. This is a great way to visually show the change in acidity of water as CO<sub>2</sub> is dissolved in it. Using bromothymol blue as an indicator of the PH of water, simply use straws to blow into the water in a glass flask with a small opening. As you blow, the water turns from blue to green to yellow as the CO<sub>2</sub> from your breath dissolves in the water and makes it more acidic.
2. Watch Ocean acidification video from COSEE Now  
<http://coseenow.net/blog/2010/12/ocean-acidification/>

### **References:**

- COSEE NOW  
<http://coseenow.net/blog/2010/12/ocean-acidification/>



## Reading Handout: Who Pollutes? Story

The weather is changing; it's beginning to rain and soil from a nearby **construction site** is washing into the mountain river. As the storm gets worse, the wind through the **trees** blows leaves into the water. *Would you drink this water? Play in it? Is it safe for animals?*

High up in the mountains there is a **mining** operation and in the process of removing rocks from the earth, acids are produced that get into the river. Along the river in the mountains there is a house that has a septic tank to hold wastewater from the house. This **homeowner** doesn't know it, but here is a leak in the tank and untreated sewage is seeping into the river. Down the dirt road from the home there is a **cattle farm** that also has a lot of **horses**. The manure from these animals washes into the river with each rain. *Would you drink this water? Play in it? Is it safe for animals?*

On the edge of the river is a farm site. It uses chemical **pesticides** on crops to keep the bugs away. The farmer also uses **fertilizer** on the plants he grows. Every time it rains, some of the poisons wash into the river. Further down the river, there is an old military base. Harmful chemicals such as **PCBs** were used in the 1950's during experiments. Some of these chemicals are still in the soil, so when it floods they are washed into the river. *Would you drink this water? Play in it? Is it safe for animals?*

Downstream, the river runs through a city. People in the city drive to and from work every day. These **cars** leak small amounts of motor oil into the street, which runs down the storm drains and into the river with each rain. The **exhaust** from the cars goes into the air as a gas. These gases combine with the moisture in the air and come back down to earth in the water cycle. Some of the city people work in a **factory**, where smog from the smokestacks also adds to the air and water pollution. *Would you drink this water? Play in it? Is it safe for animals?*

At home, a father is teaching his daughter to **tune up** the family car. They pour the used motor oil and **antifreeze** down the storm drain. Across the street, the neighbors are **washing the car**. The soapy water runs down the curb and into the storm drain. Another family is cleaning out their garage. They find an old rusty can with some sort of **mysterious liquid** in it. They aren't sure what it is, but it looks dangerous. Not knowing how to properly dispose of it, they decide to get rid of it by pouring it down the storm drain. People in the neighborhood often throw their trash onto the ground, and this **garbage** gets blown into the storm drains, which empties into the ocean. *Would you drink this water? Play in it? Is it safe for animals?*

Near the mouth of the river, where the river empties into the ocean, there is a **power plant** that creates electricity by burning coal and fossil fuel. Again, emissions from the smokestack combine with other gases to create air and water pollution. The river flows into the ocean where some **motorboat** drivers are out having fun. As they zoom around, some oil from their engine leaks into the water. On the beach, there are some **picnickers** and some people having a **party** who leave their trash behind on the shore. This trash is blown and washed into the ocean. Nearby, there is a person **fishing** who gets their fishing wire tangled around a log in the water and the nylon line breaks off. *Why could this be a problem? Is the water safe for wildlife? Would it be safe to play in? But do you?*

