Grade Level: 6-8
Time Estimate: 3-5 days

OCEAN POLLUTION / INSTRUCTOR INFO

Summary

This lesson includes vocabulary, content, and problem solving activities to help students learn about water pollution and ways to prevent it. This program includes a chemistry activity that allows the students to test water quality in their own environment.

Part 1. Sources of Pollution
Part 2. Types of Water Pollution
Part 3. Impacts of Water Pollution on Marine Life
Part 4. Preventing Pollution
Activity 1. Preventing Pollution Challenge
Activity 2. Testing Water Quality

Goals & Objectives

The students will:

- learn about different types of pollution;
- identify different causes of pollution;
- be able to explain impacts of pollution on marine wildlife;
- and describe ways to prevent pollution.

// STANDARDS

This lesson aligns with the following TEKS:
Grade 6 Science: 1A, 1B, 2A, 2B, 2C, 2D, 2E, 3A, 4A, 4B, 5A
Grade 7 Science: 1A, 1B, 2A, 2B, 2C, 2D, 2E, 3A, 4A, 4B
Grade 8 Science: 1A, 1B, 2A, 2B, 2C, 2D, 2E

This lesson aligns with the following Next Generation Science Standards:

Framework

1. Asking questions and defining problems
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communication information

Helpful Tips

1) The content in this lesson is based on the conservation work of OCEARCH™ and the Global Shark Tracker™. Spend a few minutes getting familiar with the website and the tracker if you have not done so already. The Global Shark Tracker™ is also available as an app for iPhone and Android.
2) This lesson plan is designed to be adaptable to suit your specific needs. Use the entire lesson plan or just parts of it. This material can be expanded to be an entire unit or condensed for just one day in the classroom.
3) Vocabulary words will be underlined as they first appear in the lesson plan. A complete list of vocabulary words is included as well.
4) Answers to questions and prompts for discussions will appear in *italics*.
5) Optional activities and content (side notes) will appear in a box. Use these to enhance your lesson and adapt it to suit your needs!
6) Have questions for OCEARCH Expedition Leader, Chris Fischer? Email info@OCEARCH.org to schedule a Skype session and let your students/child talk directly to Chris and the OCEARCH crew!
7) Email all questions about this lesson to info@OCEARCH.org.

Vocabulary

Algae – Aquatic plantlike organisms ranging from microscopic, unicellular diatoms to giant kelp, a large brown alga that may grow up to 50 meters in length.
Bioaccumulation – The buildup of substances, such as toxic chemicals, in organisms. The concentration of such substances increases as they are passed up the food chain.
Currents – Continuous and directed movement of water from one place to another. Currents are influenced by water temperature, salinity, and wind.

Dead Zone – Area of water with low oxygen content where wildlife cannot survive.
Decompose – The process by which deceased plants and animals are broken down into simpler forms of matter.
Environment – The biotic (living) and abiotic (non-living) surroundings of an organism.
Eutrophication – An aquatic ecosystem's response to excess artificial or natural substances mainly from fertilizers and industrial chemicals.
Gyre – A giant circular oceanic surface current.
Hypoxic – A deficiency of oxygen.
Microorganism – A microscopic organism, such as a bacterium, virus, or protozoan.
Nitrogen Cycle – The process by which nitrogen is converted between its various forms, moving from the atmosphere to plants and animals, to the soil, then either back to the atmosphere or to plants again.
Non- Point Source Pollution – Pollution that originates from more than one source.
Organism – An individual living thing.
Point-Source Pollution – Pollution that originates from a single source, such as an oil spill.
Pollution – Introduction of chemicals or other contaminants into the environment that causes a negative impact.
Trans-Boundary Pollution – Pollution that originates in one country, but travels by water or air to another country causing damage to the environment.

Grade Level: 6-8
Time Estimate: 5-15 mins

OCEAN POLLUTION / PRE-LESSON ASSESSMENT

Use the following true/false and multiple choice questions as an introduction/warm-up to the lesson topics. You can do this in a verbal or written format, as a game, individually, or as a whole class! A handout is provided if you wish to hand the questions out in a quiz format.

The questions do not need to be graded. They are intended to give the students an idea of what they will be learning and to see what they already know.

1) True or False In a process called eutrophication, excess amounts of nitrogen in an aquatic ecosystem can cause algae blooms which deplete oxygen levels in the water.
Answer: *True*

2) True or False Oil spills are a form of nutrients pollution.
Answer: *False*

3) True or False An area of water where oxygen has been depleted is called a dead zone.
Answer: *True*

4) _____ explains how chemicals and other toxins enter the food chain and become more concentrated as they are passed from animal to animal.
   a. pollution
   b. bioaccumulation
   c. dead zones
   d. decomposition

Answer: *b*

5) What percentage of the atmosphere is made up of nitrogen?
   a. 5%
   b. 10%
   c. 21%
   d. 78%

Answer: *d*

6) What type of pollution can affect an environment hundreds of miles away?
   a. distant pollution
   b. international pollution
   c. trans-boundary pollution
   d. none of the above

Answer: *c*

Name: _____ Date: _____

Ocean Pollution

Select the correct answer(s) to each of the following questions.

1) True or False In a process called eutrophication, excess amounts of nitrogen in an aquatic ecosystem can cause algae blooms which deplete oxygen levels in the water.

2) True or False Oil spills are a form of nutrients pollution.

3) True or False An area of water where oxygen has been depleted is called a dead zone.

4) _____ explains how chemicals and other toxins enter the food chain and become more concentrated as they are passed from animal to animal.

a. pollution
b. bioaccumulation
c. dead zones
d. decomposition

5) What percentage of the atmosphere is made up of nitrogen?

a. 5%
b. 10%
c. 21%
d. 78%

6) What type of pollution can affect an environment hundreds of miles away?

a. distant pollution
b. international pollution
c. trans-boundary pollution
d. none of the above

Grade Level: 6-8

OCEARCH
EDUCATE INSPIRE ENABLE

OCEAN POLLUTION / LESSON PLAN

INTRODUCTION **3-5 mins**

Pollution occurs when an environment is contaminated, or dirtied, by waste, chemicals, trash, and other harmful substances. There are three main forms of pollution: air, land and water. This lesson will focus on water pollution and more specifically, ocean pollution.

The world's oceans are facing many threats due to pollution. Pollution comes in many forms including algae blooms, pesticides, fertilizers, and litter. How do these pollutants get into the oceans and how do they affect our oceans and marine wildlife? In this lesson, students will learn about the different types of pollutants threatening the health and biodiversity of our oceans. Students will also learn how they can prevent pollution and preserve natural resources.

Part 1. Sources of Pollution (10 – 15 minutes)

Water pollution is the contamination of bodies of water such as lakes, rivers, oceans, and groundwater, often by human activities. Sometimes, water pollution can occur through natural causes like algae blooms, animal waste, volcanic eruptions, and floods. However, a lot of water pollution is the result of humans, such as sewage, pesticides, fertilizers, and trash.

Water pollution can originate from a number of sources. If the pollution comes from a single source, such as an oil spill, it is called point-source pollution. If the pollution comes from more than one source, such as toxic chemicals from runoff, it is called non-point source pollution.

Most types of pollution affect the immediate area surrounding the source. But sometimes the pollution may affect environment hundreds of miles away such as nuclear waste. This is called trans-boundary pollution.

Part 2. Types of Water Pollution (15 – 20 minutes)

There are many types of water pollution since water itself comes from many sources.

Surface Water Pollution

Surface water is the natural water found on Earth's surface such as rivers, lakes, lagoons, and oceans. When hazardous substances come directly into contact with surface water, it mixes or dissolves. This is called surface water pollution.

Nutrients Pollution

Some wastewater, fertilizers, and sewage contain high levels of nutrients. After getting washed away by rain, they end up in large bodies of water. The extra nutrients cause algae to grow. This makes the water undrinkable and unsafe for animals to live in. This is because the excess algae use up all the oxygen in the water.

Oxygen Depleting Pollution

Any body of water is home to microorganisms, both aerobic (requires oxygen) and anaerobic (do not require oxygen). When too much biodegradable matter ends up in the water, it allows these microorganisms to thrive. Just like algae, they end up depleting the oxygen in the water.

Eventually, the aerobic organisms die due to the lack of oxygen. In turn, the anaerobic continue to thrive, producing harmful wastes such as ammonia and sulfides.

Groundwater Pollution

The pesticides and chemicals used in agriculture are eventually washed from the soil or pushed deep into the ground by rainwater. Water found deep underground collects these harmful chemicals in high concentrations. This means when we dig wells for drinking water, the water needs to be checked for harmful water pollution.

Microbiological Pollution

Not everyone around the world has access to clean drinking water. In America, our drinking water is filtered and treated to remove natural pollution caused by microorganisms like bacteria and viruses. In excess, this type of pollution (though natural) can cause animals who live in the water to get sick and die. It can also cause serious illnesses to humans who drink that water.

Suspended Matter Pollution

Not all substances dissolve easily into water. These substances are called particulate matter and are suspended in the water column. Eventually, the suspended particulate matter settles to the bottom of the body of water. If the matter is toxic and harmful, it can harm and kill aquatic life.

Chemical Pollution

Many industries, including agriculture, use chemicals on the land that eventually end up in our oceans. These chemicals are usually poisonous to aquatic life. The United States government has issued laws

to regulate how companies dispose of harmful chemicals in order to protect the environment. However, it is often difficult to enforce these laws.

Oil spills are a form of chemical pollution and typically occur when a ship ruptures or when an oil platform malfunctions. Once in contact with ocean water, the leaking oil can spread for many miles, sticking to wildlife and sometimes washing up onto beaches. It can take decades for an environment to recover from an oil spill.

In-Class Demonstration

Oil and Water

(Optional; 10 – 15 minutes)

Materials – Vegetable oil, fresh water, food coloring, two identical containers with flat mouths, towel, and a playing card.

Many substances dissolve into water, but oil certainly does not! That is why oil spills float on the surface of the water, creating a layer of toxic pollution. Why do water and oil not mix? And why does oil always float on the surface of the water? The following experiment answers these questions!

1. Fill one of the identical containers to the brim with vegetable oil.
2. In the other container, add a few drops of food coloring. The color is completely up to you.
3. Fill the remainder of the container with food coloring with fresh water.
4. Place the playing card over the mouth of the container filled with vegetable oil.
5. Working over the towel, carefully turn the container with the vegetable oil upside-down and line it up with the water-filled container.

In-Class Demonstration (continued)

Oil and Water

What does this experiment demonstrate about water and oil?

1. **Water and oil do not mix.**

The molecules of water will not mix with the molecules of oil due to their polarity. This basically means that oil molecules are more attracted to each other than they are to water molecules. This is why they will not break and mix with the water molecules. However, try adding dish soap to a mixture of water and oil. The soap molecules are attracted to both water and oil, which finally mix the two together – but not completely! The soap, water, and oil form something called an emulsion. Basically, the soap causes the water and oil to disperse throughout the mixture into microscopic droplets. So while they are still separate from one another, to the human eye it looks as though they are mixed together. You might see every day when washing greasy dishes. Your dish soap takes the oil from leftover food off the dishes and into the water.

2. **Oil floats on top of water.**

Oil floats on the surface because water has a higher density. Density is a measurement of how solid an object is – how tightly packed together the object's molecules are. Density is not dependent on size. For example, marshmallows have a low density and pebbles of the same size have a high density. If you fill identical containers, one with marshmallows and the other with rocks, the container with pebbles will feel much heavier. This is because the molecules that make up the pebbles have more mass and are packed more closely together. This is exactly why oil always floats on top of water!

Bioaccumulation

As previously discussed, many industries, including agriculture, use chemicals on the land that eventually end up in our oceans. Bioaccumulation explains how chemicals and other toxins enter the food chain and become more concentrated as they are passed from animal to animal. The figure below shows how the concentration of a harmful toxin, like DDT, increases as it is passed along up the food chain. DDT (**d**ichloro**d**iphenyl**t**richloroethane) is a colorless, odorless, chlorinated insecticide used heavily in U.S. agriculture during the 1950s. Scientists recorded drastic population decreases in various marine species due to the widespread use of DDT. The chemical was banned in 1972 due to its negative impacts on wildlife.

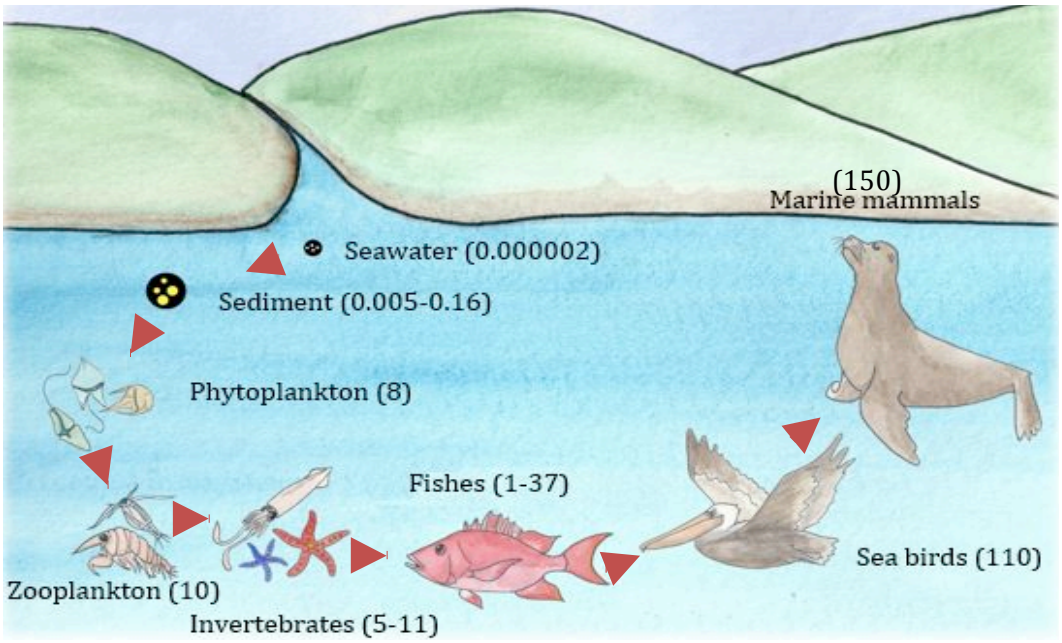

Figure 1. Bioaccumulation of chemicals in marine wildlife (milligrams per kilogram).
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

After being washed into the ocean, the chemical mixes with the water and sediment where it is then taken up by phytoplankton. By now, the concentration of the chemical has increased from 0.000002 mg/kg to 8 mg/kg! The chemical is passed up the food chain until it reaches the apex predators. The concentration of the chemical is so high at this level because apex predators have no natural predators. So the chemical continues to accumulate inside the animal's tissue at dangerously high amounts.

The Nitrogen Cycle

Nitrogen is the most abundant element in Earth's atmosphere. Approximately 78% of the air we breathe is comprised of this important element. All living things need nitrogen to survive. However, nitrogen in its gaseous form is almost entirely unusable to living organisms, leading to a scarcity of usable nitrogen in many ecosystems. The nitrogen cycle is the process by which atmospheric nitrogen is converted into various forms so organisms can use it to produce amino acids and proteins. The steps of the nitrogen cycle include:

1. Nitrogen Fixation – Most fixation is completed by specialized bacteria living in soil who consume atmospheric nitrogen and use it to produce ammonia.
2. Nitrification – The same bacteria then converts the ammonia into other organic compounds, such as nitrates.
3. Assimilation – Plants can now absorb the nitrates from the soil into their roots. The nitrates are used to produce amino acids and proteins. Nitrates are passed up the food chain as herbivores consume plants and carnivores consume herbivores.
4. Denitrification – Bacteria use nitrogen from animal waste for respiration. The result is nitrogen gas that re-enters the atmosphere. The nitrogen cycle then re-starts from here.
5. Ammonification – When a plant or animal dies, decomposing organisms, such as fungi and bacteria, convert the nitrogen back to ammonia so it can also re-enter the nitrogen cycle.

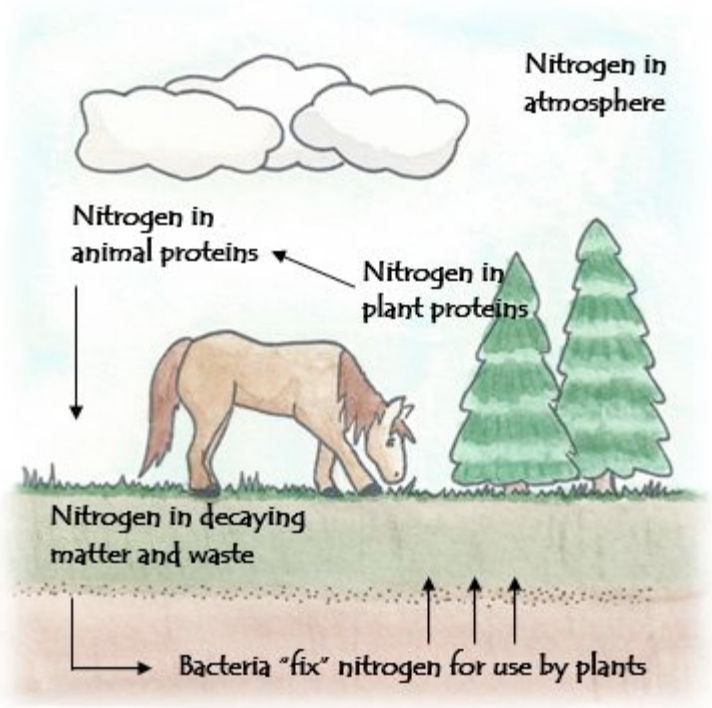

Figure 2. The Nitrogen Cycle
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

The amount of nitrogen passing through the nitrogen cycle in an ecosystem can affect crucial biological processes, such as primary production and decomposition. Chemical pollution from fertilizers, vehicle emissions, and industrial plant waste can dramatically alter the nitrogen cycle, thus weakening the environment and damaging plants and animals.

Excess amounts of nitrogen in the ocean can result in a large algal bloom which ultimately depletes oxygen levels in the water (Figure 3). In a process called eutrophication, nutrients (nitrogen) enrich the water allowing the algae to grow. If there is an excessive amount of nutrients, the algae can grow more rapidly than animals can consume them. The algae eventually die and begin to decompose – a process that consumes oxygen and produces carbon dioxide. The water eventually becomes devoid of oxygen causing animals to die or leave the area. This oxygen depleted area is called a hypoxic area or dead zone.

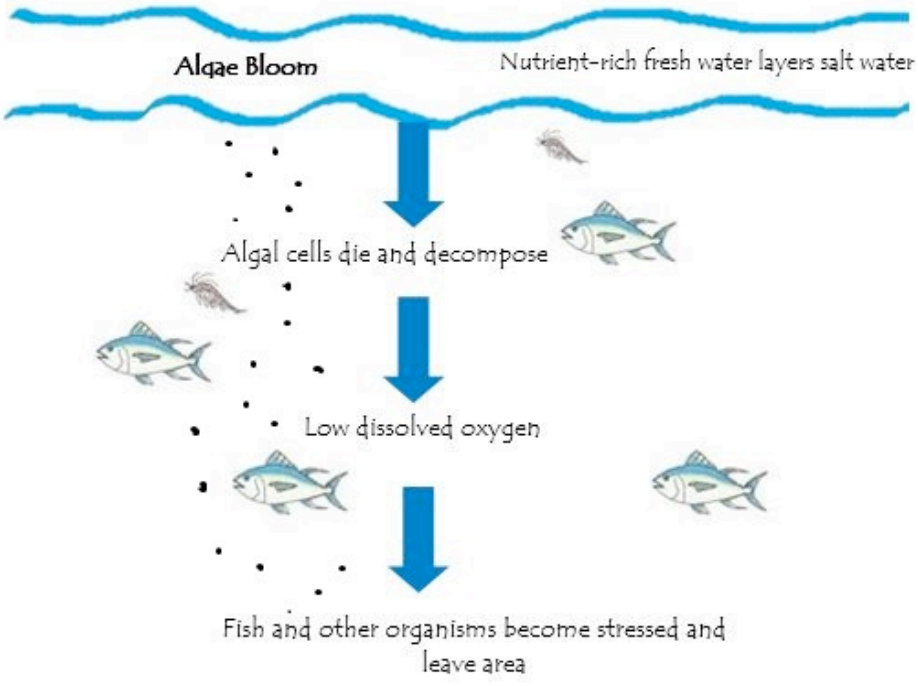

Figure 3. Algae Blooms
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

The largest dead zone is located at the mouth of the Mississippi River where it empties into the Gulf of Mexico. This dead zone spans approximately 7,000 square miles of water and is largely caused by nutrient enrichment from agricultural and industrial practices along the Mississippi River.

Did you know?

Approximately 80% of trash in the oceans comes from human activities. And an estimated 1.4 billion pounds of trash in dumped into the ocean every year! Wind and ocean currents carry this trash into the center of gyres, which are giant circular oceanic surface currents (Figure1).

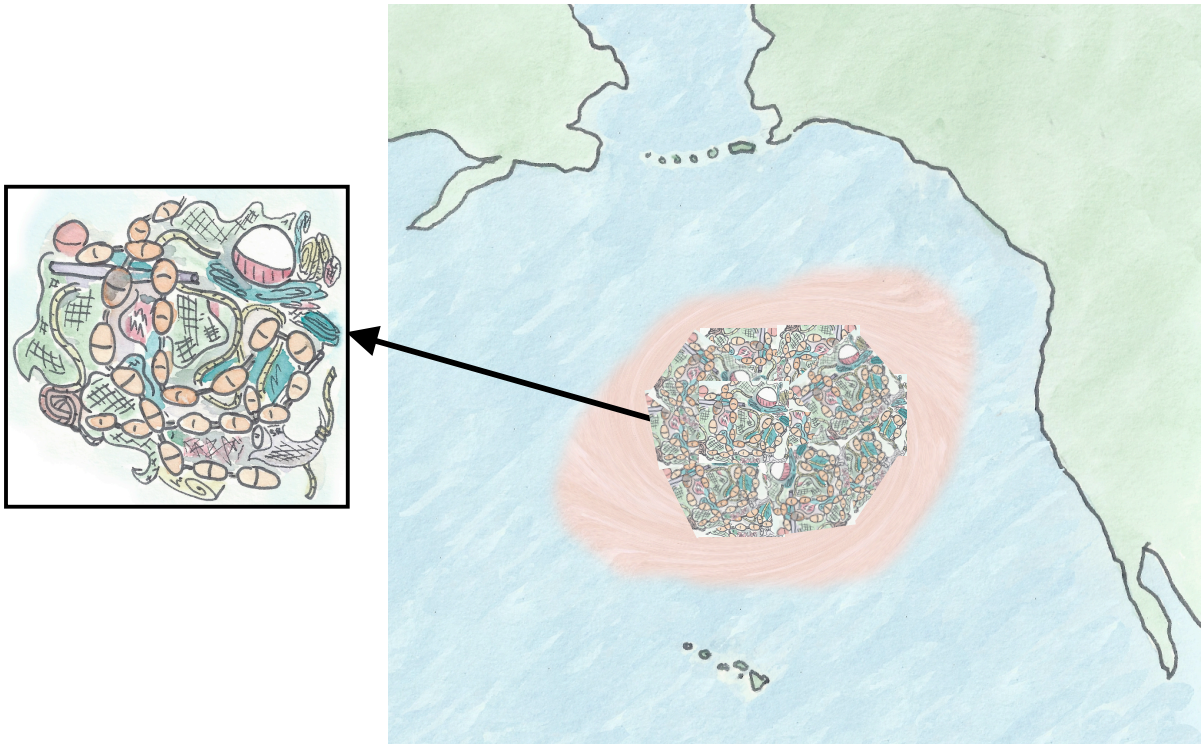

Figure 1. Massive amounts of trash collect in the center of the north Pacific gyre, located of the west coast of the United States.
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

The circular motion of the gyres keeps the trash towards the center, where energy is low and the area is very calm and stable. Therefore, the trash builds up and gets bigger and bigger over time. As the trash begins to break down it creates a "soup-like" mixture that circulates within the gyre. The north Pacific garbage patch in the Pacific Ocean is so large, it is currently the size of Texas! Due to the large quantity of trash collected in the north Pacific gyre, it is often referred to as the Great Pacific Garbage Patch.

Part 3. Preventing Pollution (15 – 20 minutes)

Students: Preventing ocean pollution is something that everyone including governments, researchers, educators, and students should be involved with. There are many things even you can do to help! Learning about the issue and sharing your knowledge is the greatest and most important thing you can do.

Now that you are aware of the issue, brainstorm ways that you and your classmates can help prevent ocean pollution. Consider the following in your discussion:

1. The various sources of pollution.
    a. Point Source Pollution
    b. Non-Point Source Pollution
    c. Trans-Boundary Pollution
2. The different types of pollution.
    a. Surface Water Pollution
    b. Nutrients Pollution
    c. Oxygen Depleting Pollution
    d. Groundwater Pollution
    e. Microbiological Pollution
    f. Suspended Matter Pollution
    g. Chemical Pollution

Ocean Pollution

ACTIVITY 1. Preventing Pollution Challenge

(3 weeks; mostly take-home)

Introduction

This activity provides an excellent opportunity for students to develop a plan to reduce pollution in their own home and follow it for two weeks! Students should record their observations before and after the project and present it to the class. An example project would be tracking the number of trash items the family throws away that could otherwise be recycled for one week. Then for week two, recycle those items for one week and record the amount of trash thrown away. This is a great opportunity for students to graph the before and after observations. They may be surprised by the results! Another example could be recording the types of household cleaners in the home and investigate other options, such as eco-friendly cleaners. With adult supervision, students could even make their own cleaners with water and vinegar. Students could then compare the two cleaners (store-bought non-eco-friendly versus store bought eco-friendly or homemade eco-friendly cleaner). Another example could be as simple as riding a bike to school or a friend's house instead of having a parent drive? How many miles of driving do they save in a week?

Materials

- Internet access
- Poster board or Microsoft PowerPoint
- Graphing paper or Microsoft Excel
- Markers, pens, pencils
- Journal or paper to record observations

Instructions

1. This activity is designed to be fun and creative!
2. Have the students brainstorm and come up with their own ideas of how they can help reduce pollution in their own homes or neighborhoods. This should be an individual project.
3. Have the students explain their project in advance by completing the worksheet provided.
4. Once planned, students will carry out their experiment at home. This process will take two weeks.
5. During the first and second week, students will record observations in their journal.
6. During week three, students will organize their project and create a presentation to present to the whole class.

Activity 1. Preventing Pollution Challenge

Name: _____

Date: _____

Answer the following questions before you start your experiment:

1. What is the purpose of your project?

2. What will you measure or what activity will you do the first week of your experiment?

3. What will you measure or what activity will you do the second week of your experiment?

4. What is your hypothesis (if applicable)?

5. What supplies are needed to conduct your experiment?

6. What is your procedure? How will you conduct the experiment?

7. How will you measure and present your results? For example, will you use a graph or table? Will you use Microsoft PowerPoint or a poster?

Week 1:

Record your findings in a journal.

Week 2:

Make a change to prevent pollution and record your findings in a journal.

Week 3:

Prepare your presentation. Create tables when necessary. Create graphs with graphing paper or with Microsoft Excel when needed. For your presentation, include the purpose, what you did the first week and the second week, procedure, hypothesis, results, and conclusion.

Will you continue with your efforts in maintaining a healthier environment?

Ocean Pollution

ACTIVITY 2. Testing Water Quality

(1 hour – 3 hours; some things can be assigned as homework to decrease time in classroom)

Introduction

In this activity, students will test the water quality of local bodies of water and compare to clean, treated water. In doing so, students will be able to determine how human activity has affected their local environment. Factors such as acidity (pH), ammonia, and nitrate concentrations will be measured and considered.

Because students will be testing the quality of their local water source(s), they should have a better understanding of the importance of water health and safety. In addition, students will improve their ability to approach problems and questions scientifically. And by developing their ability to reason through problems, they are becoming critical thinkers.

Materials

- Clean, empty test tubes or bottles with lids (e.g. recycled plastic water bottles)
- Freshwater test kit (can be purchased at a pet or aquarium store)
- Protective safety equipment (e.g. goggles, gloves, aprons)
- Writing utensil
- Data table (use one provided or have students create their own)
- Graphing paper

Instructions

1. As a class, the students should discuss local bodies of water near their school and/or homes. Is it a river, a stream, a pond, or a lake? What types of plants and animals live in or around that body of water? How do humans use that body of water? And what types of human activities may have an effect on the water quality and overall health of that body of water?
2. Discuss the benefits of having a healthy body of water (recreation, drinking, economic, food, aesthetic, culture, etc.).
3. Identify the types of pollutants that may be found in this body of water and the effects it could have on the environment.
4. Research to gain background knowledge. Since students will be testing for pH, ammonia, and nitrates, students should find out about these factors and what the ideal levels are for aquatic life.

5. Collect water samples in plastic bottles or test tubes. Some things to keep in mind:
    a. Teachers may collect samples in advance for the students. Otherwise, students can collect the samples at home with parental supervision or together as a class if the sampling location is near the school.

b. If sampling from a river or stream, samples should be taken from multiple points along the body of water.
c. If not sampling from a river (e.g. a pond or lake) samples should be taken from multiple points around the body of water.
d. Take at least two samples from the body of water.
e. Be sure to label the samples!

6. In the classroom, set up lab stations to test each sample. Stations should include the test kits, instructions (typically provided with the test kits, but may be typed up), and protective safety equipment.
7. Before testing their samples, students should construct a table that they will use to record their results in. A sample table is provided below.
8. Test each sample of water for pH, ammonia, and nitrates using the instructions provided in the test kits. Students should also test a sample of clean, treated water (tap or bottled). This is the controlled variable.
9. Display the results in a bar graph and analyze the data. How do the pH, ammonia, and nitrate levels compare to that of the clean, treated water?
10. Discuss the outcome of the water quality test. Do the samples from the local body of water appear to be contaminated with pollutants? High or low pH indicates a possibility of industrial chemical contamination. High ammonia levels may indicate acid rain, agricultural chemicals, and animal waste (from farms). High nitrate levels may indicate agricultural activities, human waste, or industrial pollution.
11. Review the benefits of having a healthy body of water to both humans and the environment.
12. Students should create a poster, brochure, skit, or slide show presentation showing what they have learned about water quality, the results of their test, and how to protect the local water source.

Activity 2. Testing Water Quality

Name: _____

Date: _____

Water sample location: _____

1. Record the results for each sample of water in the table below.

Water Sample Name	Acidity (pH)	Ammonia Content (ppm)	Nitrate Content (ppm)
Clean Water			

2. Use your data to create bra graphs – one each for pH, ammonia, and nitrates – on graphing paper.

3. How do the pH, ammonia, and nitrate levels of your water samples compare to that of the clean water?

4. What factors, if any, might be affecting the water quality of your samples?

5. Create a poster, brochure, skit, or slide show presentation showing what you have learned about water quality, the results of your test, and how to protect the local water source.