Grade Level: 3-5
Time Estimate: 2-4 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 Water 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;
- Describe ways to prevent pollution.

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.

// STANDARDS

STEM
This lesson plan aims to assist teachers in implementing a STEM-based program into their classroom while inspiring the next generation of explorers, scientists, and stewards of the ocean. Based on real science and the Global Shark Tracker™, "Ocean Pollution" is intended to promote environmental awareness and to prepare students for STEM careers.

This lesson aligns with the following TEKS:
Grade 3: 1A, 1B, 2A, 2B, 2C, 2D, 2F, 3A, 3D, 4A, 4B, 9B
Grade 4: 1A, 1B, 2A, 2B, 2C, 2D, 2F, 3A, 3D, 4A, 4B, 9B
Grade 5: 1A, 1B, 2A, 2B, 2C, 2D, 2F, 2G, 3A, 3D, 4A, 4B, 9A, 9B, 9C

This lesson aligns with the following Next Generation Science Standards:

4-ESS3-2 Earth and Human Activity

Science and Engineering Practice
Obtaining, Evaluating, and Communicating Information
• Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods. (4-ESS3-1)
• Obtain and combine information from books and other reliable media to explain phenomena. (4-ESS3-1)

Disciplinary Core Ideas
ESS3.A: Natural Resources
• Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. (4-ESS3-1)

5-ESS3-1 Earth and Human Activity

Science and Engineering Practice
Obtaining, Evaluating, and Communicating Information
• Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods. (5-ESS3-1)
• Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. (5-ESS3-1)

Crosscutting Concepts
Science Addresses Questions about the Natural and Material World
• Science findings are limited to questions that can be answered with empirical evidence. (5-ESS3-1)

Disciplinary Core Ideas
ESS3.C: Human Impacts on Earth Systems
• Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. (5-ESS3-1)

Grade Level: 3-5

OCEAN POLLUTION /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.

Gyre – A giant circular oceanic surface current.

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: 3-5
Time Estimate: 5-10 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
Too much pollution in an aquatic ecosystem can cause greatly decreased amounts of oxygen in the water.
Answer: True

2. True or False
An area of water where oxygen has been depleted is called a dead zone and is unsafe for many animals to live in.
Answer: True

3. _____ explains how toxins enter the food chain and become more concentrated as they are passed from plankton all the way to top predators.

- **a.** Pollution
- **b.** Bioaccumulation
- **c.** Oil Spills
- **d.** Algal Blooms

Answer: b

5. What percentage of the air we breathe is made up of nitrogen?

- ***a.*** 5%
- **b.** 100%
- **c.** 21%
- **d.** 78%

Answer: d

5. What type of pollution can affect an environment hundreds of miles away?

- ***a.*** Distant Pollution
- **b.** Point-Source Pollution
- **c.** Trans-Boundary Pollution
- **d.** None of the above.

Answer: c

Name: _____

Date: _____

PRE-LESSON ASSESSMENT: OCEAN POLLUTION

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

1) True or False

Too much pollution in an aquatic ecosystem can cause greatly decreased amounts of oxygen in the water.

2) True or False

An area of water where oxygen has been depleted is called a dead zone and is unsafe for many animals to live in.

3) _____ explains how toxins enter the food chain and become more concentrated as they are passed from plankton all the way to top predators.

a. pollution

b. bioaccumulation

c. oil spills

d. algae blooms

4) What percentage of the air we breathe is made up of nitrogen?

a. 5%

b. 100%

c. 21%

d. 78%

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

a. distance pollution

b. point-source pollution

c. trans-boundary pollution

d. none of the above

Grade Level: 3-5

OCEAN POLLUTION / LESSON PLAN

INTRODUCTION **3-5 mins**

Pollution occurs when an environment is contaminated, or dirtied, by waste, chemicals, trash, and other 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 pesticides, fertilizers, and litter. How do these pollutants get into the oceans and how do they affect our oceans and wildlife? In this lesson, students will learn about the different types of pollutants threatening the health of our oceans. Students will also learn how they can prevent pollution and preserve natural resources.

PART 1. SOURCES OF POLLUTION **10-15 mins**

Water pollution is the contamination of bodies of water such as lakes, rivers, oceans, and groundwater. 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. Sometimes, the pollution may affect an environment hundreds of miles away such as nuclear waste. This is called trans-boundary pollution.

PART 2. TYPES OF WATER POLLUTION **15-20 mins**

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

Nutrients Pollution
Pollution like fertilizers and sewage contain high levels of nutrients. After getting washed away by rain, this pollution ends up in large bodies of water. The extra nutrients cause too much algae to grow which will use up all the oxygen in the water. Areas without oxygen in the water because of nutrients pollution are called dead zones. The water in a dead zone is unsafe for many animals to live in.

Oxygen Depleting Pollution
Any body of water is home to microorganisms, like bacteria. 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, most microorganisms die due to the lack of oxygen. However, bacteria that do not need oxygen to survive will continue to grow and can produce toxic wastes such as ammonia.

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 bodies of water. These substances are called particulate matter and are suspended in the water. Eventually, the suspended particulate matter settles to the bottom of the body of water. If the matter is toxic, it can harm and kill aquatic life.

Chemical Pollution
Many industries, including agriculture, use chemicals 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 mins)

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

Introduction
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.
6. Slowly, and gently, remove the playing card. What happens? The oil and water remain in their respective containers.
7. Now repeat the process but this time, turn the water-filled container upside-down on top of the oil-filled container.
8. Carefully remove the card and watch what happens this time. The water and oil trade places! If you wait long enough, it will look almost exactly opposite of how it started.

In-Class Demonstration: Oil and Water (Cont.)

Conclusion and Discussion: 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. You might see this 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. 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!

PART 3. IMPACTS OF POLLUTION ON MARINE LIFE **45-60 mins**

How an environment and its wildlife are affected by pollution depends on the type of pollution, its concentration, and its location. But no matter what the type or source, water pollution tends to have the same general negative effects on marine life.

The main (and most obvious) impact of water pollution on marine wildlife is that pollution causes illness and death to organisms that depend on that body of water. For example, a plastic garbage bag will directly harm a sea turtle if it mistakes the bag for a jelly fish and swallows it. Animals are indirectly affected by water pollution by the transfer of toxic pollutants through biological processes like bioaccumulation.

Bioaccumulation

As previously discussed, many industries, including agriculture, use chemicals 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 increases as it is passed up the food chain.

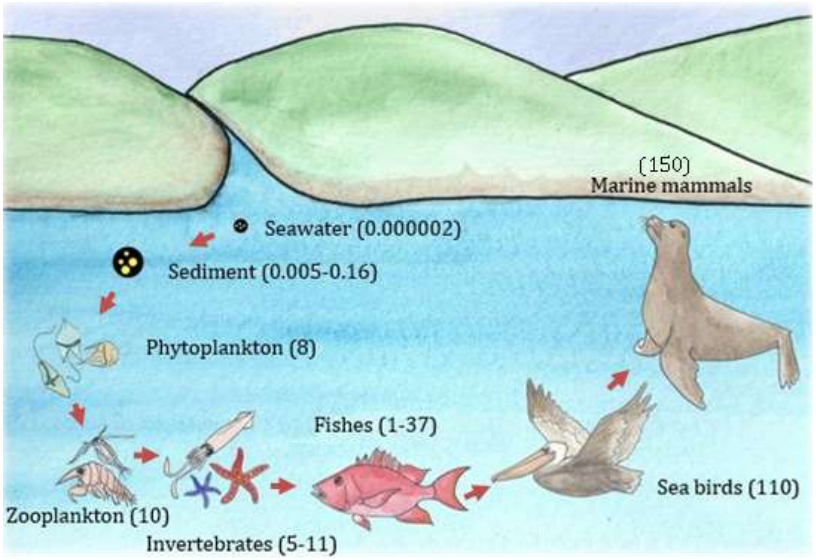


Figure 1. Bioaccumulation of Chemicals in Marine Wildlife (milligrams per kilogram).
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

After being washed into the ocean, the chemical mixes with the water and sediment where it is 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 top predators. The chemical continues to accumulate inside the top predators body in 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. The nitrogen cycle is the process by which nitrogen in the air is converted into various forms so organisms can use it. The steps of the nitrogen cycle include:

1. Bacteria living in soil consume nitrogen from the air and use it to produce ammonia.
2. The same bacteria convert the ammonia into other, more usable compounds, such as nitrates.
3. Plants can now absorb the nitrates from the soil into their roots and use it to grow. Nitrogen within the plants is then passed up the food chain as herbivores consume plants and carnivores consume herbivores.
4. Bacteria use nitrogen in decaying matter and animal waste which results in either nitrogen gas that returns to the air we breathe or ammonia which returns to step 2.
5. The nitrogen cycle then re-starts.

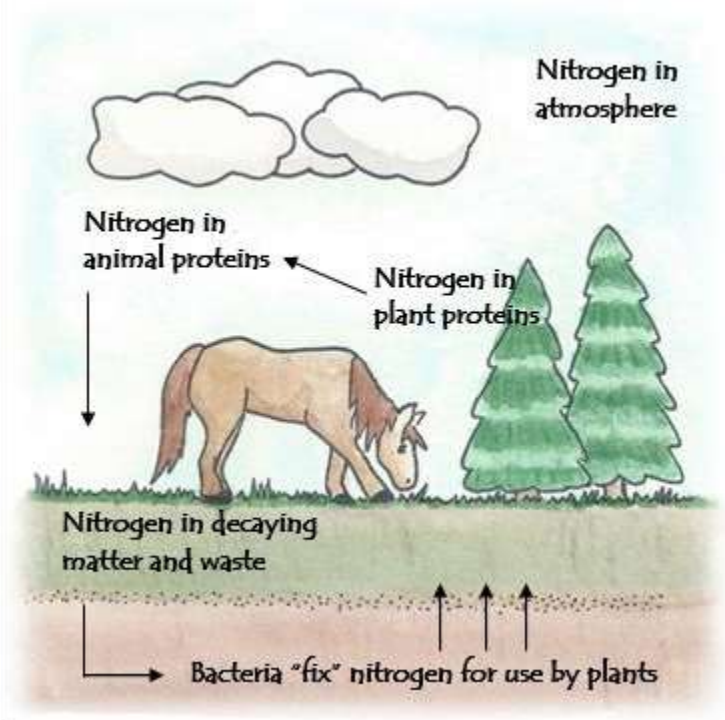


Figure 2. The Nitrogen Cycle
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

Chemical pollution from fertilizers, vehicle emissions, and industrial waste can negatively affect 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). If there is an excessive amount of nitrogen compounds in the water, algae can grow faster than animals can consume it. The excess algae die and begin to decompose, or break down consuming large amounts of oxygen. Areas without oxygen in the water are called dead zones. The water in a dead zone is unsafe for many animals to live in.

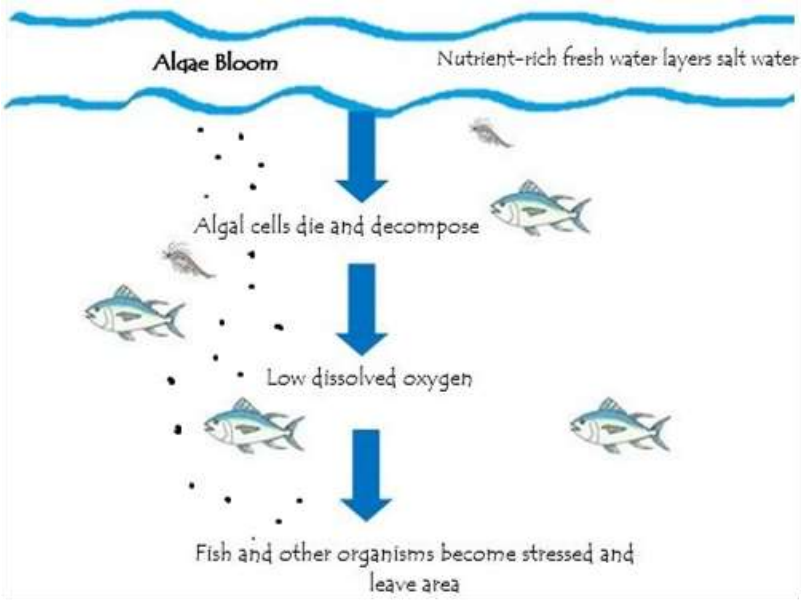


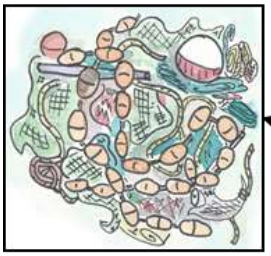
Figure 3. Algae Blooms
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

Where in the world would you find the largest dead zone?

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 caused by agricultural and industrial waste running down 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 is dumped into the ocean every year! Wind and ocean currents carry this trash into the center of gyres, which are giant circular oceanic currents at the surface of the water (Figure 4).



The circular motion of the gyres keeps the trash towards the center. 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.

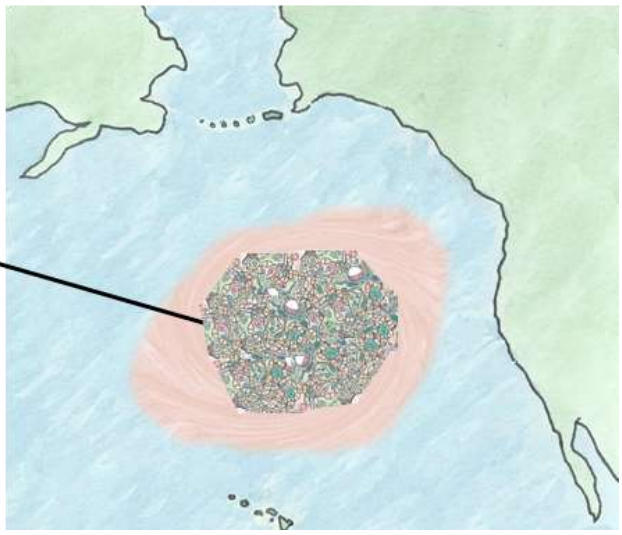


Figure 4. Massive amounts of trash collect in the center of the north Pacific gyre, located of the west coast of the United States.
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

PART 4. PREVENTING POLLUTION **15-20 MINS**

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. Nutrients Pollution

    b. Oxygen Depleting Pollution

    c. Microbiological Pollution

    d. Suspended Matter Pollution

    e. Chemical Pollution

Grade Level: 3-5
Time Estimate: 3 weeks; take-home or in-class

OCEARCH
EDUCATE INSPIRE ENABLE

OCEAN POLLUTION / ACTIVITY 1. PREVENTING POLLUTION

INTRODUCTION **3-5 mins**

This activity provides an excellent opportunity for students to develop a plan to reduce pollution in their own home or classroom 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 or class throws away that could otherwise be recycled for one week. Then for week two, recycle those items for one week and re-record the amount of trash thrown away. This is a great opportunity for students to create a simple graph before and after observations. They may be surprised by the results! 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

- Poster board
- Graphing paper
- 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, neighborhoods, or classroom. This should be an individual project but can be adapted for group work.

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 or in the classroom. 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.

Student handout provided on next page.

Name: _____

Date: _____

ACTIVITY 1. PREVENTING POLLUTION CHALLENGE

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 supplies are needed to conduct your experiment?

5. Where will you conduct the experiment?

6. How will you measure and present your results? For example, will you use a graph or table? Will you use 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 or graphs with graphing paper when needed. For your presentation, include the purpose, what you did the first week and the second week, procedure, results, and conclusion.

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

Grade Level: 3-5
Time Estimate: 1-3 hours

OCEAN POLLUTION / ACTIVITY 2. TESTING WATER QUALITY

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) and ammonia 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 testing 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)

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, etc.).

3. Identify types of pollutants that may be found in this body of water and what effects it could have on the environment.

4. Research to gain background knowledge. Since students will be testing for pH, and ammonia, students should find out about 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. Samples should be taken from multiple points around the body of water. Take at least two samples from the body of water.
   c. Be sure to label the samples!

INSTRUCTIONS (CONT.)

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 and ammonia 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 and analyze the data. How do the pH and ammonia 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).

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.

Student handout provided on next page.

Name: _____

Date: _____

ACTIVITY 2. TESTING WATER QUALITY

Water sample location: _____

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

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

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

3. What might be affecting the water quality of your samples?

4. 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.