

---

## Upsetting the Stability

---

### Overview and Objectives

Using their two model ecosystems as examples, students in this lesson are introduced to the concept of “stable” and “disturbed” ecosystems. After identifying systems that have become disrupted through natural causes, students read about disturbances caused by human activity. Identifying human-made pollutants and analyzing which of these pollutants can be used in a classroom pollution experiment sets the stage for students to plan their own pollution experiments in Lesson 10.

- Students observe, describe, and compare stable and disturbed ecocolumns.
- Students become familiar with pH paper.
- Students identify and discuss some natural causes that can disturb an ecosystem.
- Students read and write about human-made disturbing forces, or pollutants.
- Students reflect on their own learning through a self-assessment.

### Background

The students’ ecocolumns probably are flourishing right now, providing examples of stable ecosystems. The plants and algae should be producing enough food for all inhabitants. The water should be clear and odorless, the soil dark brown, and the animals thriving.

But natural events may have occurred to disturb a system or two, and you can take advantage of these to lead into today’s discussion. For example, if multiple births have occurred in a system, the food supply may be running low. If a death has occurred (particularly in the water) the build-up of bacteria may cause a foul smell and discoloration.

As in the students’ ecocolumns, disturbing forces occur naturally in the larger world. In nature, ecosystems change in response to these forces in an unending process.

Unfortunately, most disturbing forces today are human-made. One type is a **pollutant**; that is, anything that can harm living organisms when too much of it is released into the ecosystem. Pesticides, fertilizers, nuclear waste, garbage, and exhaust fumes are all pollutants that can upset the stability of ecosystems on land, in the air, and in the water. **Pollution** is the condition that results when pollutants interact with the environment.

Figure 8-1

Natural disasters



The reading selections in this lesson will give students background information about three common pollutants: acid rain, road salt, and fertilizer. In this lesson, you will divide your class into six groups and assign one pollutant and its accompanying reading selection to every two groups. Students in each group will be asked to read about only one pollutant to prepare for Lesson 9's presentation on that pollutant. They will learn about the other two pollutants from the other groups' presentations. Then, in Lesson 9, students will read about all three pollutants, since they will need this information for Lesson 11's pollution experiments and for Lesson 15 when they study the Chesapeake Bay.

One of the pollutants students will read about is acid rain. To help prepare for the reading selection on acid rain, students will now use pH paper to test for the presence or absence of acid. The pH scale was devised by a Danish biochemist, Soren Sorensen, in 1909. The pH is the value of a solution's **acidity** or **basicity** (or **alkalinity**) in terms of the relative amounts of hydrogen ions ( $H^+$ ) and

hydroxide ions (OH<sup>-</sup>). The initials “pH” represent two French words, *pouvoir hydrogene*, which mean “hydrogen power.”

The pH scale’s values range from 0 to 14. **Acidic** solutions have pH values below 7, with the most acidic solutions having a pH value near 0. **Basic**, or **alkaline**, solutions have pH values above 7, with the most basic solutions having a pH value near 14. The pH of a **neutral** solution—a solution that is neither acidic nor basic—is 7. To test the pH of vinegar in this lesson, and of the ecocolumns in Lesson 11, students will use an indicator—pH paper—that changes color as the pH changes. This pH paper has a color range from yellow (most acidic) to green (least acidic). Testing vinegar for pH shows students what happens to the paper in the presence of extreme acidity and prepares them for analyzing acidity results when they test the ecocolumns in Lessons 11 and 12.

**Note:** Although we often refer to acid rain as a pollutant, it is, strictly speaking, a by-product of two pollutants: sulfur dioxide and nitrogen oxide. You may want to review the reading selections at the end of this unit now and clarify these points with your students.

## Materials

*For each student*

- 1 science notebook
- 1 copy of **Student Self-Assessment** (blackline master on pgs. 198–199)
- 2 strips of pH paper

*For every two students*

- 1 ecocolumn
- 1 dropper

*For the class*

- Vinegar
- Water
- 15 cups, 30 ml (1 oz)
- 2 droppers
- 1 sheet of newsprint or transparency film
- Markers

## Preparation

1. Scan the ecocolumns to identify any that have become disturbed naturally.
2. Try to add supplemental materials to the learning center to provide more information on pollution problems.
3. Obtain materials to record student ideas. Title the sheet “Pollution Caused by Humans.”
4. Plan how you will divide your class into six groups—two per pollutant. Keep student pairs together in each group, since they will be using their own ecocolumns (with animals) in upcoming lessons as well.
5. Cut the pH paper into 5-cm (2-in) strips.
6. Make a copy of the **Student Self-Assessment** (blackline master on pgs. 198–199) for each student.

## Procedure

1. Invite the class to share notebook entries from Lesson 7. Ask students if they have any new ideas about how one of their ecosystems might affect the other.
2. Encourage students to talk about those ecosystems that have become naturally disturbed in some way (for example, births, deaths, plants that died or were eaten). Challenge them to explain what happened and what the consequences to the ecosystem were.

**Note:** If no births or deaths have occurred, ask students to imagine the situation and its consequences.

3. Discuss other natural disruptive forces on earth (for example, volcanoes, earthquakes, lightning, and fire). If any students did Extension 1 from Lesson 7, let them share their ideas on how a natural disaster can affect an ecosystem they know well.
4. Explain that natural disasters account for only a part of ecological disruption. Unfortunately, humans are responsible for the rest: we release pollutants into the environment. State that one definition of **pollutant** is “anything that can harm living organisms when too much of it is released into an ecosystem.” Ask students to jot in their science notebooks a quick list of the ways humans pollute. Help the students understand that the term “pollution” is the condition that results when pollutants interact with the environment.
5. Show students the sheet you have prepared, “Pollution Made by Humans.” Ask them to share their lists with the class. Record all ideas. When students offer duplicate ideas, put a check next to the first one to acknowledge all contributions.
6. Now review the class list and ask students to speculate on which of the ways humans pollute could be duplicated in a class ecosystem to study. Explain that any pollutant used in the study must fulfill two criteria:
  - It has to be fairly common and easily obtainable.
  - It cannot be toxic to people in small doses.
7. Ask students how vinegar, fertilizer, and salt could be used to simulate three common pollutants.
8. Let students know that vinegar is similar to one pollutant, acid rain, in that both are acidic. Distribute two strips of pH paper to each student. Distribute two 30-ml cups to each group of four students. Use one dropper to put a few drops of water in one of the cups. Then use a second dropper to place a few drops of vinegar in the second cup. Let students determine what happens when the pH paper is dipped in each liquid.
9. Discuss results. Which liquid represents the pH of acid rain? Using the chart on the pH paper dispenser, discuss how the resulting colors represent different levels of acidity.

## Final Activities

1. Divide your class into six groups. Let students know that each group will read about one of three common pollutants and will plan a presentation on that pollutant (see the reading selections beginning on pg. 48 of the Student Activity Book and pg. 112 of this guide).
2. Help the groups decide which one of the three pollutants they will read about. Be sure that two groups are assigned to each pollutant.

3. Let your students decide how they will make their presentations in Lesson 9. For example, an entire group can make a presentation to the class, or students can meet in teams of three, with one representative from each group.
4. Assign the appropriate reading selection to each group.
5. Give students time to read, take notes, and prepare for the presentations in Lesson 9.
6. Remind students to continue their daily observations and recordkeeping.
7. Explain to students that since they have worked through half of the unit, it is a good time to reflect on their own work. Distribute the **Student Self-Assessment**.
8. Have students complete the Self-Assessment and place it in their notebooks. Let students know that they will revisit this again at the end of the unit.



**Management Tip:** If the water becomes stagnant, you may find it necessary to have students use the dropper to aerate the aquaria periodically.

### Extension

#### SOCIAL STUDIES

If possible, reserve a space on your bulletin board for current articles on pollution problems. Encourage students to contribute to it.

### Assessment

If you review the **Student Self-Assessments** now, you will be able to judge whether a student views his or her work as adequate or whether a student is having difficulty working with a partner. You may want to discuss these issues with certain students and make any necessary changes or suggestions before Lesson 9.

## Reading Selection

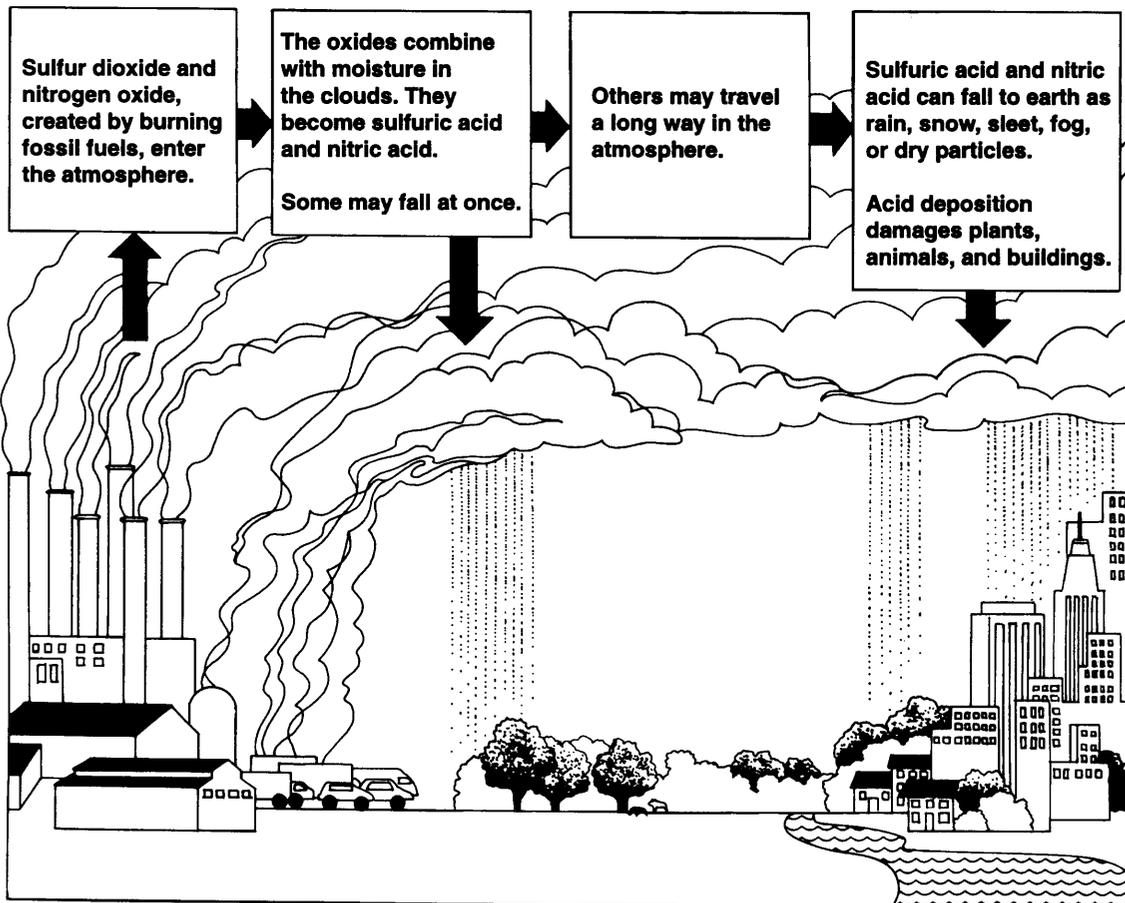
## The Story behind Acid Rain

There is a lot of talk these days about acid rain. Do you know what acid rain is? Do you know if humans are involved in causing it?

The problem begins when we burn coal, oil, and gas, which are called **fossil fuels**. We burn these fuels in our cars, homes, or factories. Burning fuels release sulfur and nitrogen, which chemically combine with oxygen in the air. In this new combined form, the chemicals are known as **sulfur dioxide** and **nitrogen oxide**. Sulfur dioxide and nitrogen oxide are harmful to the environment and are called **pollutants**. (A pollutant is anything that can harm living organisms when too much of it is released into an ecosystem.) Both of those pollutants escape through

smokestacks, chimneys, and tailpipes and climb skyward as the fuel burns. Over 20 million tons of each of these two pollutants move into the atmosphere each year.

Sometimes these pollutants fall to the earth with dry particles, such as dust. Other times these pollutants become trapped by moisture in the clouds. When these pollutants chemically combine with water, they form new chemicals called **acids**. As you can see in the illustration, these acids (**sulfuric acid** and **nitric acid**) fall to earth in rain, snow, sleet, hail, or fog. This is polluted rain, called **acid rain** or **acid deposition**. Acid deposition can damage plants, animals, and buildings.



*How acid rain is formed*



Clams, crayfish, snails, and mayflies are in trouble at pH 6. The eggs and larvae of aquatic creatures seem even more sensitive to low pH. Fewer eggs hatch, and fewer creatures grow to adults.

It's not easy for experts to measure acid rain's effects on terrestrial ecosystems. But it seems that too much acid in the soil may harm plants' root systems. Acid rain also seems to damage the leaves of sensitive trees.

Acid rain seems to change the soil, too. Acid releases certain chemicals (like aluminum) that normally stay locked up in the soil. These chemicals can poison some plants.

### **What Can We Do to Help?**

Do you remember that when we burn fossil fuels, we generate the pollutants that form acid rain? The energy in fossil fuels heats, cools, and lights our homes. It also runs our vehicles, cooks our food, and runs our machinery. We aren't going to stop doing these things altogether. But we can each try to cut down. Every time we walk or bike instead of driving, or turn down the heat, or shut off extra lights, we help prevent pollution.

## Reading Selection

## Crops and Cows—What's the Problem?

Farming, or **agriculture**, produces the fruits, vegetables, and grains we need to survive. But the fertilizer used to grow these crops also pollutes our water systems. How can this be? Chemical fertilizers run off from fields. And animal manure runs off from barnyards and feedlots. Both are washed into ponds, streams, rivers, oceans, and even the water that runs underground.

water system. So the body of water and the plants in it become too “well fed.”

Overfed plants can grow so quickly that they choke waterways. When overfed, algae also reproduce rapidly. (This is called an **algae bloom**, which turns the water a bright green.) When the plants use up the nutrients in the water, they die and rot. When bacteria feed on this dead material, they use up

valuable oxygen.

Manure is rich in nutrients, too. It also carries bacteria with it. In the water, these bacteria have a population explosion. This increase in bacteria takes away oxygen from the water. Sometimes, the bacteria use up so much oxygen that the plants and animals in the water suffocate and die.

**What Can We Do?**

We want to keep growing good crops. And many farmers need to keep raising cattle. So we will need to find solutions for the



*Agricultural runoff*

**How Can a Fertilizer Pollute?**

These **fertilizers** are rich in nutrients, especially nitrogen, phosphorus, and potassium. That's how they help crops grow. But if you think of a pollutant as anything that can harm living organisms when too much of it is released into the ecosystem, then fertilizers can be pollutants, too. Excess fertilizer can provide too many nutrients in a

runoff problem. Many experts are researching ways to keep pollutants out of the water. They're trying to find out exactly how much fertilizer to spread on the soil for each type of crop. That way we won't use any more than we need. And the extra fertilizer won't wash into the water. Other scientists are experimenting with ways to recycle manure cheaply. What are your ideas?

## Reading Selection

## When Salt Isn't Safe

Have you ever ridden in a car in a snowstorm? Then you probably know that the roads can get awfully slippery. And that makes driving dangerous. In parts of the country where winters are fierce, the highway departments spread a mixture of sand and **road salt** on the roads. The sand helps tires get a grip. And the salt melts ice.

We want people who travel on these icy roads to be safe. But we are also concerned about the damage salt does. When spring comes and the snow and ice melt, salt dissolves in the water. Then passing cars wash or spray the salty water out to the roadside.

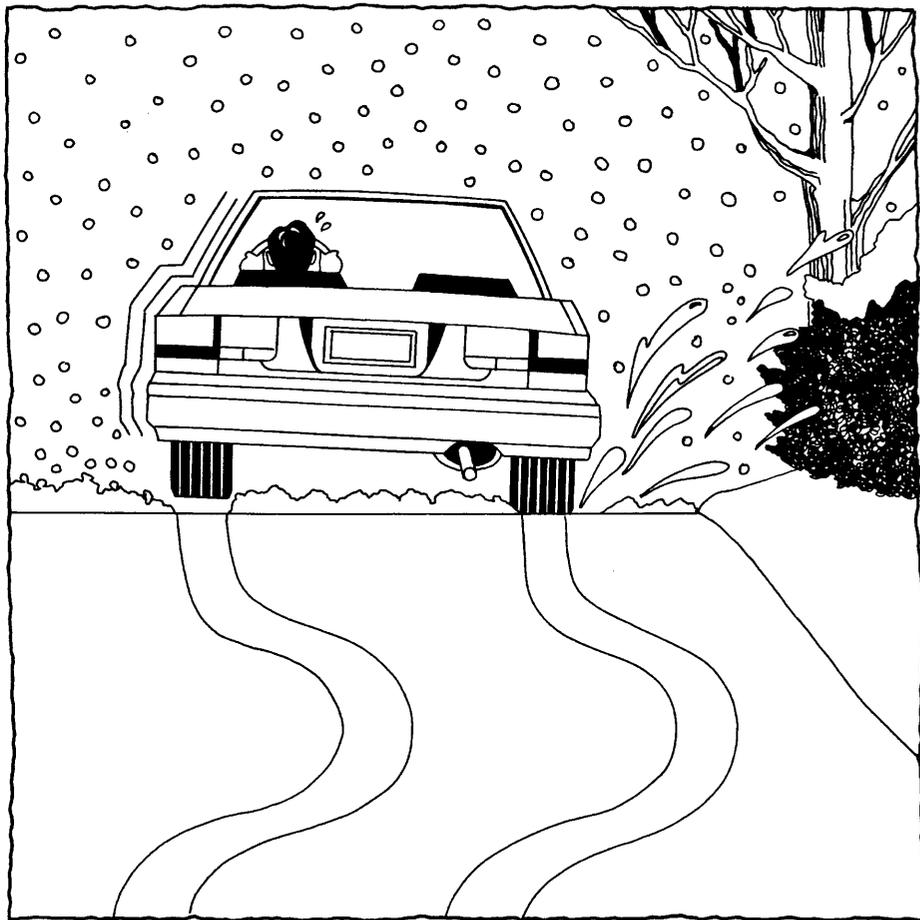
At the roadside, salt coats the bark of trees and soaks down into their roots. It "burns" the tops of tender new plants just coming out of the soil. Salt also covers plants that roadside animals such as rabbits and woodchucks depend on for food and shelter. It goes down through the soil to the water system below ground. Eventually, it runs into other bodies of water.

When salt enters a body of water such as a stream or a lake, it can cause harm there, too. Both plants and animals are sensitive to salt in different degrees. Take the egg and larval stages of many aquatic animals, for instance. Even the slightest increase in salt can kill them.

Is there a solution? We know that there are other chemicals that can melt ice just as well as salt does. However, these chemicals are more expensive. And while officials want the roads to be safe, they must consider costs when they make their decisions.

**It's a Trade-off**

Some areas have started using less harmful, but more expensive, chemicals. But many other areas are still dumping tons of salt on the roads every winter. If you were an official, what would you do?



*Salt helps melt the ice and lets tires grip the road, but it can be harmful, too.*