Lab 12. Matter in Ecosystems: How Healthy Are Your Local Ecosystems?

Introduction

Ecosystems include all the living and nonliving things in a certain area. All living things in an ecosystem are called *biotic factors*. Biotic factors include the plants and animals in the ecosystem, as well as smaller organisms such as bacteria and fungi. All nonliving things in an ecosystem are referred to as *abiotic factors*. Abiotic factors include the water, soil, rocks, and air found in the ecosystem. Chemicals found in the ecosystem are also abiotic factors.

Water or air in an ecosystem is made up of many different chemicals. They include chemicals that are important for humans and animals to survive, such as the oxygen (O_2) we breathe and water molecules (H_2O). The air also contains other gases that other organisms use, such as carbon dioxide (CO_2) used by plants and nitrogen gas (N_2) used by bacteria. As living things use these chemicals for getting energy to survive, they will also release other chemicals that have similar elements, such as urea ($CO(NH_2)_2$) and phosphates (PO_4^{3-}). All of this activity means that different chemicals move between living and nonliving parts of an ecosystem.

The patterns of movement of matter through the living and nonliving parts of an ecosystem are known as *biogeochemical cycles*. The "bio" aspects of these cycles involve living things, and the "geo" aspects of these cycles involve nonliving things. All aspects of these cycles involve chemicals that are different forms of matter. The way scientists understand these cycles is based on a fundamental scientific law, the *law of conservation of matter*. This law tells us that as matter moves through an ecosystem, it will not be created or destroyed. The matter in an ecosystem simply changes forms as it is converted from one type of chemical to another.

Humans also add chemicals into different ecosystems. In many cases, these chemicals are used to help humans get what they need from the ecosystem. An example of this is fertilizer. Farmers use fertilizer containing nitrogen- and phosphorus-based chemicals to help crops grow. Chemicals that are added to an ecosystem can benefit some organisms while also harming others.

Keeping natural cycles in balance helps keep ecosystems healthy. One way scientists figure out how healthy ecosystems are is through testing living and nonliving parts of them. It is a little more difficult to test living organisms in an ecosystem than it is to test nonliving parts of an ecosystem. Scientists will often test soil and water and other nonliving parts of an ecosystem, to understand how different chemicals are moving through an ecosystem. Using this information, scientists can determine if there is too much or too little of a certain chemical in an ecosystem. Looking at the levels of different chemicals helps them figure out how healthy the ecosystem is. The amounts of similar chemicals in different locations (water or soil) can show how matter is moving through an ecosystem.

Your Task

Conduct an investigation of ecosystems where you live and how healthy they are. Look at ecosystems that include both soil and water sources.

The guiding question of this investigation is, **How healthy are your local ecosystems?**

Materials

You may use any of the following materials during your investigation:

Consumables	Equipment
• Samples of soil from three locations in your area • Samples of water from three locations in your area	• Soil quality test kit (nitrogen, oxygenation, phosphorus, pH) • Water quality test kit (pH, nitrates, phosphates, dissolved O_2, turbidity) • Sanitized indirectly vented chemical-splash goggles

	• Chemical-resistant apron • Gloves • Lab 12 Reference Sheet

Safety Precautions

Follow all normal lab safety rules. In addition, take the following safety precautions:

1. Put on sanitized indirectly vented chemical-splash goggles and laboratory apron and gloves before starting the lab activity.
2. Handle all glassware with care to avoid breakage. Sharp glass edges can cut skin!
3. Review the important information on chemicals on the safety data sheet, and use caution when handling chemicals.
4. Wash hands with soap and water after completing the lab activity.

Investigation Proposal Required? ☐ Yes ☐ No

Getting Started

To answer the guiding question, you will need to analyze water and soil samples taken from local ecosystems and use background information about chemical cycling in ecosystems. To accomplish this task, you must first determine what type of data you need to collect, how you will collect it, and how you will analyze it. To determine *what type of data you need to collec*t, think about the following questions:

- What type of information do I need to collect from the Lab 12 Reference Sheet?
- What type of tests do I need to determine the quality of the water and soil samples? (*Hint:* Be sure to follow all directions given in the water and soil test kits.)
- What type of measurements or observations will you need to record during your investigation?

To determine *how you will collect your data*, think about the following questions:

- What will serve as a control (or comparison) condition?
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?
- How will you keep track of the data you collect and how will you organize the data?

To determine *how you will analyze your data*, think about the following questions:

- What type of calculations will you need to make?
- What type of graph could you create to help make sense of your data?

Connections to Crosscutting Concepts, the Nature of Science, and the Nature of Scientific Inquiry

As you work through your investigation, be sure to think about

- how energy and matter flow into, out of, within, and through a system;
- how changes to different parts of ecosystems affect their stability;
- how observations and inferences are different but related to each other; and
- the difference between data collected in an investigation and evidence created in an investigation.

Initial Argument

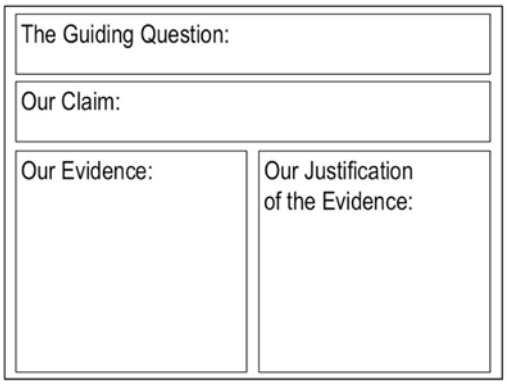
Once your group has finished collecting and analyzing your data, you will need to develop an initial argument. Your argument must include a claim, evidence to support your claim, and a justification of the evidence. The claim is your group's answer to the guiding question. The evidence is an analysis and interpretation of your data. Finally, the justification of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L12.1.

Argumentation Session

The argumentation session allows all of the groups to share their arguments. One member of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations one at a time to listen to and critique the arguments developed by their classmates. This is similar to how scientists present their arguments to other scientists at conferences. If you are responsible for critiquing your classmates' arguments, your goal is to look for mistakes so these mistakes can be fixed and they can make their argument better. The argumentation session is also a good time to think about ways you can make your initial argument better. Scientists must share and critique arguments like this to develop new ideas.

FIGURE L12.1

Argument presentation on a whiteboard



To critique an argument, you might need more information than what is included on the whiteboard. You will therefore need to ask the presenter lots of questions. Here are some good questions to ask:

- What did your group do to collect the data? Why do you think that way is the best way to do it?
- What did your group do to analyze the data? Why did your group decide to analyze it that way?
- What other ways of analyzing and interpreting the data did your group talk about?
- What did your group do to make sure that these calculations are correct?
- Why did your group decide to present your evidence in that way?
- What other claims did your group discuss before you decided on that one? Why did your group abandon those other ideas?
- How sure are you that your group's claim is accurate? What could you do to be more certain?

Once the argumentation session is complete, you will have a chance to meet with your group and revise your original argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the most valid or acceptable answer to the research question!

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections that provide answers to the following questions:

1. What question were you trying to answer and why?
2. What did you do during your investigation and why did you conduct your investigation in this way?
3. What is your argument?

Your report should answer these questions in two pages or less. The report must be typed and any diagrams, figures, or tables should be embedded into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid!