Unit 1 Sustainable Ecosystems

BIG IDEAS

- Ecosystems are dynamic and have the ability to respond to change, within limits, while maintaining their ecological balance.
- People have the responsibility to regulate their impact on the sustainability of ecosystems in order to preserve them for future generations.

Sustainable Ecosystems: Overall Expectations

- **B1** assess the impact of human activities on the sustainability of terrestrial and/or aquatic ecosystems, and evaluate the effectiveness of courses of action intended to remedy or mitigate negative impacts;
- **B2** investigate factors related to human activity that affect terrestrial and aquatic ecosystems, and explain how they affect the sustainability of these ecosystems;
- **B3** demonstrate an understanding of the dynamic nature of ecosystems, particularly in terms of ecological balance and the impact of human activity on the sustainability of terrestrial and aquatic ecosystems.

Materials

Please see page XX for a list of the materials required for this unit and other units.

In this unit, students will learn how sustainable ecosystems endure and support the organisms that live within them. They will learn that human activities can alter the nutrient balance within an ecosystem. Students will use and define the terms "trophic level," "bioaccumulation," "cellular respiration," and "photosynthesis."

Students will also understand that populations become limited when resources are limited, and that each species occupies an ecological niche defined by abiotic and biotic components. They will investigate how humans have broadened their ecological niche and altered their ecosystems, to increase their carrying capacity. Students will use the terms *predation*, *competition*, *mutualism*, and *parasitism*.

Finally, students will explore biodiversity. Threats to biodiversity include habitat loss, introduction of alien species, overexploitation, and breaking the connectivity among ecosystems. Students will learn about bioremediation and bioaugmentation, and how restoration techniques can offset damage to an ecosystem.

English language learners may benefit from a preview of the key ideas and vocabulary of the unit, in which you develop a simple concept map relating all three chapter topics to the idea of sustainable ecosystems. Use the map to introduce and define the terms *cycle, chain, ecosystem, abiotic, biotic, sustainability, organism, population, species, biodiversity,* and *resources*, and return to the map throughout the unit to introduce and reinforce key terms and to help students connect new understandings to prior knowledge. Include examples and non-examples in the concept map.

Using the Unit Opener (Student textbook page 1)

- Check what students know and believe already about sustainable ecosystems using BLM 1–1, Unit 1 Anticipation Guide. Then, when you have completed the unit, check again and have students reflect on how and why their understandings and attitudes may have changed.
- ELL The forest ecosystem is very familiar to Canadian students but may be unfamiliar to English language learners. Discuss the names and characteristics of common forest animals and plants. This activity could be done in partners or small groups.
- DI Ask spatial learners to draw some of the animal warning road signs they have seen either in the local area or in their travels. For example, students may have seen a duck-crossing or turtle-crossing sign if they were near a marsh. Students can use chart paper, mini white boards, or the front board to sketch their signs.
- DI For the benefit of linguistic and interpersonal learners, arrange students into groups of five or six. Have each group construct a placemat spider map (see page 566 of the student textbook), then brainstorm other ways of protecting animals from being hit by cars on highways. Appoint one person in each group to ensure that everyone has a chance to participate.

Assessment OF Learning for Unit 1		
Activity	**Evidence of Learning**	**Interventions**
Unit Inquiry Project	[what you would expect to see if a student "gets it"—point form] <TO COME>	[what you might do if a student does not show the evidence–interventions, reference to BLMs, etc.] <TO COME>
Unit Issue Analysis Project	<TO COME>	<TO COME>

Get Ready (Student textbook pages 2 and 3)

Prerequisite Learning

Students would benefit from understanding

- the relationships among plants and animals in habitats and communities and be able to explain the cause-and-effect relationships that take place and affect the ecosystem. (questions 4, 5)
- how human activities affect habitats and communities. (question 5)
- how a food chain works. (question 3)
- that ecosystems are made of interacting biotic and abiotic components. (question 1)
- the roles of producers, consumers, herbivores, carnivores, and omnivores. (question 2)
- how matter is cycled. (question 4)

Prerequisite Skills

Students need to be able to

- communicate in writing, verbally, and using a variety of media with different audiences for a variety of purposes. (questions 6, 7, 9, and 11)
- interpret a variety of literary, graphic, and informational text. (questions 1, 9, and 10)
- proofread and edit work to correct errors and refine their expression. (questions 8 and 11)
- predict the meaning of unfamiliar words using a variety of cues. (questions 4 and 7)
- record and organize data using standard measurements in tables, graphs, or charts. (question 10)
- make predictions based on prior knowledge, and identify patterns in data. (questions 7 and 9)
- represent the steps and results of an experimental procedure. (questions 8, 9, and 10)
- state a conclusion based on information gathered. (question 7)

Students can review some of these skills using BLM 1–2, Skills for Unit 1.

Assessment FOR Learning

Tool	Evidence of Learning	Interventions
Get Ready Concept Check	Students catergorize and organize components of an ecosystem and their relationships.	Have students create a concept map based on the image on page 2 of the student textbook. Students should label part of the image as biotic or abiotic. Students should link and label the images further using the statements from question 2 and the terms from question 4. For question 3, English language learners could draw a food chain from an ecosystem that is more familiar to them.
Inquiry Check	Students read the given passage and extract information to analyze and predict outcomes. Students write a step-by-step procedure that includes data collection.	Have students deconstruct sample procedures from the textbook by looking at the number of steps, particularly how data collection is described for each procedure. As a class, model a template for writing a procedure and then have students write and peer-edit their own procedures for the inquiry check. English language learners could write and edit with a partner.
Numeracy and Literacy Check	Students are able to rank the data accordingly, select an appropriate graph, and write at least 300 words in the appropriate tone for the mayor.	To rank and graph the data, students can use spreadsheet software. Check local radio station websites for news announcements. Provide students with examples of these announcements as samples of a suitable style. Have students work in groups of four to six. Ask them to pass their papers around the group, with each student adding one positive comment and one improvement on small sticky notes, to their classmates' papers. Students can then revise their own paper according to the suggestions.

Using Making a Difference (Student textbook pages 11, 77, 101)

Throughout the unit, students will encounter examples of situations where humans' choices affect the health and sustainability of a species or an ecosystem. In some cases—such as the ruby-throated hummingbird, American eel, or Dolly Varden—the species travel long distances and have specific requirements from at least two distinct ecosystems. There are simple choices we can make as consumers, which drastically affect the habitats of other species (for example, choosing a specific type of coffee or using cell phones).

Just as Yvonne Su, Allyson Parker, and Severn Cullis-Suzuki were able to make a difference, so can students from any high school. Students can be encouraged to create an action plan for their class or school with the intention of reducing their impact on a specific species or ecosystem. Plans might include improving the songbird habitat on the school grounds, or helping their parents choose shade-grown coffee or even learning to make coffee in the morning so Mom and Dad do not have to go to the drive-through. Their action plans could be part of the school's EcoSchool initiative. Encourage students to realize that even small changes can make a big difference.

Using Science at Work (Student textbook page 124)

The significance of songbird decline was so important to Dr. Stutchbury that she incorporated it into her career as an author and a university professor. Reasons for songbird decline include deforestation in South and Central America and the fragmentation of forested areas in the United States. As the North American human population spreads to rural areas, the predators and competitors (for example, jays, crows, feral cats, foxes, and raccoons) that favour suburban habitats increase.

Songbirds are an important indicator of environmental health, biodiversity, and sustainability. With our growing population, we still require timber for the construction of new houses, and very little wood in North America is harvested from plantations. The origins of most medications (approximately 80 percent) commonly prescribed in North America are natural compounds.

To introduce this feature, consider playing a recording of local songbirds in the classroom and displaying photographs of the birds.

An extension to the career study is suggested in question 4 on page 125. Ask students to put themselves in the shoes of a person working in a career that they are interested in pursuing. Direct students to include in their answer what this person (for example a forester, an urban planner) could do to increase and protect songbird habitat.

Introducing the Unit 1 Projects (Student textbook pages 126 and 127)

Discuss with students one of the reasons scientists study ecosystems—to learn how to protect them. Explain that the Unit 1 Projects will give students the chance to apply what they learn to investigate some threats that humans pose to ecosystems and how we can protect the ecosystems. Preview the Unit Projects with students. Then, looking at the chapter titles in Unit 1, ask students to predict some things they may learn about that would help them complete one of the projects. As students work in Unit 1, draw their attention to concepts that may be helpful in completing one of the projects. For example, understanding the phosphorus cycle, on page 18, can help students complete the Inquiry Project. The investigations at the end of each chapter have been designed to help students develop both understandings and skills that will be useful to them as they complete the Unit Project. Students can begin to plan their work on a Unit Project at any time after they begin the Unit.

Most English language learners will find the Inquiry Project "Pollutants and Aquatic Ecosystems" less linguistically demanding than "Protecting Ecosystems." Hold mini-conferences throughout the unit, to ensure understanding and to establish a timeline for completion of each task of the Inquiry Project. Peer support groups (homework clubs with older students) could also be used in this context. If possible, invite older students with the same first language to help your students.

Using the Case Studies

The suggestions below provide opportunities for students of multiple learning styles to engage in and explore issues. The strategies chosen support bodily-kinesthetic, spatial, and interpersonal learning styles. The strategies also serve as pre-reading strategies and scaffolds for English language learners.

Chapter 1 (Student textbook page 8)

- Ask students to examine the graphic on page 9 and explain how the eels change in appearance. Ask, "What part of the eels' life cycle takes place in the great lakes?" Record the answers on the chalkboard.
- Before reading the Case Study, provide students with an opportunity to explore their views through a brief Four Corners activity. Post each of the following perspectives in one corner of the classroom, read them aloud, and invite students to move to the corner that best reflects their own view. The perspectives are the following:

  1. All species deserve equal protection.
  2. Eels are a special fish species of the Great Lakes and deserve more attention than other species.
  3. Eels are water snakes that are not that important in the Great Lakes.
  4. We should not intervene to protect any species. We should let nature take its course.

The perspectives are printed ready for posting on BLM 1–3, Four Corners Activity. Have students read the Case Study, answer the questions, and then reflect on how their views on this issue have changed. You could repeat the Four Corners activity and allow students who changed their minds to explain why they chose a different corner this time.

- Provide students with BLM 1–4, Eel Life Cycle, for them to record information about the eel while they read.

Chapter 2 (Student textbook page 72)

- Before reading the Case Study, have students stand in a value line. One end of the line could be those students who would say, "I believe that we are doing enough to protect the bees," and the other end could be those students who would say, "I believe that we could do much more to protect the bees." Split the line in half and shift one side down so that there are now two lines of students, facing each other. The students in each facing pair must convince each other of their opinion, for one minute each.
- After reading the Case Study, either in pairs or groups of four, have students discuss any questions their group members have, then create a concept map for the disappearing honeybee, using BLM 1–5. The concept map should have 10 connections.

Chapter 3 (Student textbook page 106)

- Brainstorm with students a brief list of plants and animals that must survive harsh conditions over the winter. Discuss the various strategies that these species use to survive (bears hibernate, frogs tunnel into mud, humans have developed central heating, trees produce antifreeze, and some seeds require a freezing period to germinate).
- Have students work in groups to brainstorm a list of other species that have a life cycle that completes itself in two distinctly different ecosystems.
- Remind students of the survival strategies that were discussed prior to reading the Case Study. Ask students to explain the survival strategy that Dolly Varden use.
- Use a Venn diagram to help students understand the similarities and differences between traditional knowledge and scientific knowledge. Use BLM 1–6, Traditional Knowledge/Scientific Knowledge.

Chapter 1 Nutrient Cycles and Energy Flow

Materials

Please see the teaching notes for each activity for a list of the materials required. Please see page XX for a summary of the materials required in this chapter and other chapters.

Advance Preparation

- Order or purchase plant material, soil, and fertilizer ahead of time.
- Supplies needed include *Elodea,* radish, and pea seeds; fertilizer; soil; and foam cups.
- Activities 1-C and 1-D will take several weeks to complete, so have students start them early in the unit, no later than the second week.
- Students can review the Key Terms in Chapter 1 using BLM 1–7, Chapter 1 Key Terms.

In this chapter, students will learn that all life depends on recycled matter and that all matter is interconnected within an ecosystem. Students will also learn how human interaction can interfere with the sustainability of an ecosystem.

Using the Chapter Opener (Student textbook pages 4 and 5)

- At the chalkboard, brainstorm with students to create a word family web starting with the word *sustain*. (Once you have modelled this process, students will be able to develop similar webs for other concepts on their own or in small groups.) Words that might be used in the web include *sustenance, sustainable, sustained, sustainedly, sustainer,* and *sustainability.* Ensure that all students understand the meanings of each word on the web. *Sustain* has a dual meaning—to provide nourishment and to maintain. Within the context of this unit, both meanings are applicable.
- Work with students to compare and contrast the importance of a provincial park versus a World Heritage Site. Some of the objectives of a World Heritage Site include protecting the cultural and natural importance of an area to all humanity, and protecting an area that contains habitat for threatened species. Some of the objectives for provincial parks include protecting representative ecosystems, and providing opportunities for ecologically sustainable recreation.

Alternative Context

Tell students about two Canadian parks, and then ask students to compare them:

Algonquin Park was established in 1893 as a wildlife sanctuary and to protect the headwaters of rivers that were important for logging; it is one of Canada's oldest provincial parks. Since its creation, the park has been selectively logged, yet it still maintains a variety of wildlife including deer, wolves, and the largest population of moose in central Ontario. Algonquin Park is classified as a Natural Environment Park. The objectives of this type of park include protecting outstanding recreational landscapes, and providing high-quality educational experiences.

Even though the park supports moose, deer, wolves, and canoeists, it can be argued that the ongoing logging has frozen the ecosystem of the park in time, maintaining these optimal conditions without ever changing or evolving.

Woodland Caribou Park, on the other hand, is classified as a wilderness park. Wilderness parks are remote, and only accessible by boat or float plane. This type of park allows nature to exist freely and only promotes low impact recreation.

Ask students which of these two parks best fits the definition of sustainability.

Activity 1-1, How Disturbed Is Too Disturbed? (Student textbook page 5)

Pedagogical Purpose

This activity illustrates that a system can usually tolerate some disturbance, but after a certain point, the disturbance can cause the whole system to collapse.

Planning			
Materials	24 smooth rectangular building blocks, labelled with environmental disturbances:		
	Deforestation	Global climate change	Overfishing
	Disease, extinction	Habitat fragmentation	PCBs, DDT, excess nutrients in run-off
	Draining wetlands	Hurricane, tsunami, flood, ice storm	Pollution (air, water, light)
	Drought, desertification	Meteor strike	Volcanic eruption
	Exotic species	Nuclear bomb	Wildfire
Time	5 min to label the blocks 15 min to do the activity		

Background

Some environmental disturbances are natural, and others are caused by humans. In this activity, students treat all environmental disturbances equally. In many cases, natural disturbances such as fire are part of the ecosystem necessary to promote regeneration. However, forest fires can also threaten homes and communities. Students may want to develop their own opinions about whether humans should interfere with natural disturbances like forest fires.

Activity Notes and Troubleshooting

- It is important that students take turns, and remove the blocks smoothly and slowly.
- Inexpensive versions of this game can be found at some dollar stores.

DI Strategies

- DI For linguistic learners, as well as English language learners, this game can be modified by showing different words on some of the blocks. For example,
  - Show several biotic and abiotic components of an ecosystem on the blocks. Use different colours for biotic and abiotic components.
  - List Key Terms on the blocks. In order to remove a block, students must define the word. Create a list of definitions of Key Terms for students to refer to.
- ELL After the activity, print and discuss the words *balance* and *interdependence*. Challenge students to draw a sketch to illustrate the meaning of these words. Share these sketches with a partner. Add these words to the concept map started at the onset of the unit.

Study Toolkit

Study Toolkit

Strategy	Page Reference	Additional Support
Previewing Text Features	Students can skim or scan the headings and subheadings throughout Chapter 1, in order to predict what each section will be about prior to reading.	Refer students to the Study Toolkit Appendix, in particular the section Preparing for Reading: Identifying Text Features, on page 560 of the student textbook.
Comparing and Contrasting	After reading pages 28 and 29, students can use a Venn diagram to compare and contrast photosynthesis and cellular respiration.	Have students write sentences using these comparing words: X and Y are alike because... X and Y are not alike because...
Word Families	Students can draw a word family web to record the meanings of the Key Terms *lithosphere, biosphere, atmosphere,* and *hydrosphere* on page 13.	*Think Literacy: Cross Curricular Approaches, Grade 9 Science* available at STAO.ca, includes strategies to help students make connections among words. Refer students to the Study Toolkit section Word Study: Common Prefixes, Suffixes, and Base Words in Science, on page 562 of the student textbook. Work with English language learners to identify prefixes and suffixes that can help them understand important words throughout the chapter.

Section 1.1 Sustainability (Student textbook pages 7 to 20)

Sustainable Ecosystems: Specific Expectations

- **B1.2** evaluate the effectiveness of government initiatives in Canada, and/or the efforts of societal groups or non-governmental organizations, with respect to an environmental issue that affects the sustainability of terrestrial or aquatic ecosystems
- **B2.2** interpret qualitative and quantitative data from undisturbed and disturbed ecosystems, communicate the results graphically, and, extrapolating from the data, explain the importance of biodiversity for all sustainable ecosystems
- **B2.4** plan and conduct an investigation, involving both inquiry and research, into how a human activity affects water quality, and, extrapolating from the data and information gathered, explain the impact of this activity on the sustainability of aquatic ecosystems
- **B3.1** compare and contrast biotic and abiotic characteristics of sustainable and unsustainable terrestrial and aquatic ecosystems
- **B3.4** identify the earth's four spheres, and describe the relationship that must exist between these spheres if diversity and sustainability are to be maintained

In this section, students will learn about the impact of human activities on sustainable ecosystems. Students will be able to explain what makes an ecosystem sustainable. They will compare and contrast the characteristics of an unsustainable ecosystem. Students will be able to describe the relationship between Earth's four spheres and how cycling of water, carbon, nitrogen, and phosphorus links Earth's spheres.

Common Misconceptions

- Some students may believe that biotic components of an ecosystem are important to sustain life, but may not appreciate the importance of the abiotic components. You could talk with them about what they need to survive (for example, food, water, oxygen) and point out that many of these requirements are abiotic.
- Students may be somewhat familiar with the water cycle, but may believe that other components are static; that is, they do not move around in our environment. Point out, for example, that carbon naturally cycles into and out of the atmosphere. Its movement is not caused by humans, but our actions affect the rate at which it moves, and thus upset the balance.
- We can counterbalance our carbon emissions by carbon sequestering and with carbon taxes and carbon offsets. Encourage students to investigate the details of the different types of carbon offsets that are available, for example, where the project will be located, and how students can be assured that any projects they invest in will remain in place for a sufficient time period. For example, seedlings purchased as part of a carbon offset program may be destroyed in five years for a new shopping mall. Point out that instead of paying a "tax" for our indulgences, it may be more effective to make and demand better choices.

Background Knowledge

Easter Island was populated from the west by Polynesians. While the human population probably contributed to most of the deforestation, due to the island's fairly southerly latitude, it may also have been influenced by a climate change event called the Little Ice Age. It is often assumed that the population's drastic decline on Easter Island was due to starvation; however, the islanders were also the target of Peruvian slavers in the 1860s.

The west coast has a great variety of hummingbirds; in Ontario, we usually only see the ruby-throated hummingbird. Only the male has the distinct red throat; the female is iridescent green with a white throat. Occasionally a rufous hummingbird will stray east of the Rockies and may be seen in the fall. The male has an orange/red head and the female looks similar to the female ruby-throated hummingbird but with orange/red flanks. If you want to attract hummingbirds to your schoolyard, you need to put out a feeder in mid- to late April when they are returning. Be sure to have a lot of red flowers around.

Although many fungi have a symbiotic relationship with plants, not all fungi are beneficial to trees and plants. Beneficial fungi such as Basidiomycota, Ascomycota, and Zygamycota produce what are called mycorrhiza—fine hair-like strands that bond to the roots of plants, assisting them with water and nutrient uptake. Other fungi such as Armillaria are pathogens and cause root rot, among other symptoms. Armillaria can often be identified by mushrooms growing at the base of trees, usually with red or honey-coloured caps.

If you are going to a rock concert or another event, you may be asked to purchase carbon offsets to help counterbalance the band's carbon emissions from putting on an elaborate show and travelling around on tour. Carbon offsets may include investing in renewable energy production such as wind farms, or they may also include investing in forestry projects. Before spending money purchasing carbon offsets, it is wise to consider what they will be used for.

Living things depend on biotic and abiotic resources. A population will grow only as fast as its most limiting resource will allow. For example, algae in a pond may have access to a lot of water and sunlight, but limited access to phosphorus will slow down their growth. If phosphorus is dumped into the pond, the algae will grow until another resource limits their growth. Often this rapid growth upsets the balance of the ecosystem. An analogy for limited nutrients is a class barbecue. Imagine that you are going to host a barbecue for the entire class, and you are planning to serve cheeseburgers. There are 30 students in your class. You brought 31 frozen burgers, 25 burger buns, and 12 slices of cheese. Although there are more burgers than students, you can only serve 12 cheeseburgers because there are only 12 slices of cheese. The cheese is the limiting nutrient. Analogies of this sort are very beneficial to English language learners.

Literacy Support

Using the Text

- ELL The geography of North America may be very new to many English language learners. A large wall map of the world and of North America are essential teaching aids. Use these maps prior to reading this section to set the physical context for English language learners.

Before Reading

- Have students preview the text features, looking for headings and highlighted words. In pairs, have them predict what the main ideas of the section will be.
- ELL To help English language learners use the text features to navigate the textbook, have a scavenger hunt. Ask students to find a feature that
  - helps to understand the meaning of a word (boxes in the margin)
  - explains a diagram (a caption)
  - tells a big idea (a head or subhead)
  - summarizes important information (the section summary)

During Reading

- Have students create a personal glossary by making a three-column table, and listing new terms as they encounter them in the textbook, in the left column of their table. Students can write the definition for each term in the next column, and draw a diagram to represent the term in the third column. Tell them to pay attention to the Key Terms in sidebars and highlighted in the textbook, and to identify base words that will help them find the meanings of other words (for example, the base word *bio* means life, and can help define biology, biosphere, and so on). Students can continue to build this glossary as they work through the rest of the unit, and the rest of the course.
- ELL Instead of a glossary in chart form, English language learners can make flash cards with a picture on one side of the card and a definition on the other side. They can then use these cards to review new vocabulary.
- ELL To help English language learners relate to the concept of migration, discuss what migration has meant to them. Talk about how many families move to new locations for a variety of reasons. Listing the advantages that exist in Canada helps all students understand that humans migrate as well as animals often for similar reasons.

After Reading

- To consolidate their learning, have students create a word web or another graphic organizer to show the relationship between two key concepts they learned about in the section. They can use this graphic organizer as a starting point for the graphic organizer they develop in the Chapter Review.

Using the Images

- DI Before reading the passage on page 7, have students describe the image in Figure 1.1. You can prompt them with questions such as, "How large are the statues?" "What does the vegetation look like?" "How could the statues have been put in place?" Describing the image will help to engage spatial learners.
- K Connect to students' personal experience. For Figure 1.2, ask students to imagine they are holding a hummingbird in their hand and to describe how large the hummingbird is in comparison to their hand.
- DI Table 1.2 on page 12 shows an example of how students can set up their own glossaries, which spatial learners may find helpful.
- Have students complete BLM 1–11, The Nitrogen Cycle, to summarize the content of Figure 1.6. Then have students create their own diagram of the carbon cycle based on page 15 of the textbook.
- ELL Use BLM 1–12, The Phosphorus Cycle, based on Figure 1.8 to help students predict and explain what will happen in each stage based on what they already know. On BLM 1–12, students can record what they think is happening in the first column for each number in the phosphorus cycle diagram. They can then use the Think, Pair, Share strategy to refine their prediction and record that refined version in the next column, and in the third column verify what is actually happening, using the textbook.

Assessment For Learning

Tool	Evidence of Student Understanding	Interventions
Learning Check questions, pages 9, 19	Students • explain how the elements of an ecosystem interact • describe the process of eutrophication.	**Pass, Pass, Trade** To help students identify the cause-and-effect relationships involved in eutrophication, have them complete BLM 1–13, Cause and Effect.
Section 1.1 Review questions, page 20	Students describe the role nutrient cycles play in a balanced ecosystem, and what can cause ecosystems to become unbalanced.	**Play a game** Divide the class into teams of varying strengths and abilities. Each team must submit five questions similar to those in the review, with answers. Teams take turns choosing questions from other groups and answering them. Students can use notes for the Section Review to help them. Set a time limit for students to come up with an answer. Allow opportunities to "phone a friend."
• Activity 1-2, What Symbol Would You Choose? Create a Poster	Symbol meets the criteria listed, clearly represents one or more of today's issues, and increases awareness for the future.	Students may feel uncomfortable with their own artistic skills. Show them exemplars of varying artistic ability that all meet the criteria for the assignment and that would achieve the same level (3+ or 4). Allow students to use alternative media, such as computer drawing applications, or use mini white boards. The lack of permanence of mini white boards makes them less intimidating for students.

Instructional Strategies

- The Mystery of Easter Island is an engaging introduction to the idea of sustainability. After students have read about Easter Island, do a concept attainment activity for sustainability (see BLM 1–8, What Is Sustainable?). Give students a sample data set with examples of activities that do promote sustainable environments and activities that do not promote sustainable environments. Then give students several "testers," or examples, which they will have to decide for themselves where to place. A class discussion after this activity can help reveal that the answers are not always clear, but that there are several common factors to be considered in making each decision.
- Compare and contrast the biotic and abiotic components of the Canadian and Mexican ecosystems required to sustain the ruby-throated hummingbird population. This comparison can be done individually, in groups on white boards or chart paper, or as a discussion at the board.
- Have students do a jigsaw brainstorming activity before reading the Abiotic Characteristics of an Ecosystem section. Arrange students into five home groups. Within each group, have students choose a colour—blue, red, white, green, or black. Then have students gather into new groups of the same colour (all the greens together, for example). Assign each colour one characteristic (for example, white = light, red = oxygen, and so on). Have each new group brainstorm why their characteristic is important and its effects on sustainability. Each individual should record the information on a card. Then have students return to their home groups and combine the information from all the cards on a larger piece of paper to create a table summarizing all of the characteristics of an ecosystem. When this task is done, do some round-robin sharing, and then compare the groups' results to Table 1.2 in the textbook.
- DI Spatial learners could create a graphic organizer to take notes if desired.
- ELL If necessary, appoint a student in each group to scribe for English language learners so that they will have accurate notes to take back to their home group.
- DI Bodily-kinesthetic learners might enjoy acting out the different nutrient cycles. Divide the class into groups and assign each group one of the nutrient cycles. Each skit should emphasize at least five stages in the cycle and should address the human impact on the cycle. Students could choose to present in the form of a talk show, a series of tableaus, or a "wildlife" documentary (for example, The Carbon Hunter).
- As an alternative activity, students could create a passport. Give students a blank template for one of the cycles (BLM 1–9, The Water Cycle; BLM 1–10, The Carbon Cycle; and BLM 1–11, The Nitrogen Cycle). Create stations around the classroom where students can collect stamps or stickers to complete their passports. At each station, include directions to the station where students can find the next sticker or stamp. Different tour groups (Carbons, Nitrogens, or Phosphoruses) will follow slightly different routes in the classroom (or around the school). (DI: bodily-kinesthetic, spatial, intrapersonal)

Activity 1-2, What Symbol Would You Choose? (Student textbook page 11)

Pedagogical Purpose

One of the big ideas of this unit is that people are responsible for regulating their impact on the sustainability of ecosystems. The first step in this process is to increase public awareness. One simple and effective way to do this is to create a symbol to spark public interest. In this activity, students activate the understandings of environmental issues and human effects on the environment that they will build on in this unit to design such a symbol.

Planning		
Materials	1 sheet construction paper Coloured markers Scissors	Tape or glue Internet access Computer lab
Time	20 min in class: 10 min to create a symbol and 10 min to discuss	

- You may want to book a computer lab with Internet access.

Background

Successful symbols are simple and easily understood, with a clear connection to the idea for which they stand, for example, the World Wildlife Fund's panda. Students may all choose to represent a different environmental issue, and so may produce different symbols.

Activity Notes and Troubleshooting

- Give students a time limit, if the assignment is an opener for discussion. "You have 10 min; it does not have to be a masterpiece."
- Make sure the criteria for the symbols are clear:
  - one symbol for current environmental problems
  - one symbol for a future of increased environmental awareness
  - no words are to be used
- Assign some time (for example, a 10-min period or some time at the beginning of class the following day) for sharing ideas.
- Discuss how the questions are to be answered, in notebooks for homework or as a discussion.
- Instead of paper, use small letter-sized whiteboards (the kind students stick in their lockers), which are available at dollar stores. White boards suggest less permanence, reduce stress, and evoke greater participation.
- Some students may be more comfortable using a computer drawing application instead of drawing by hand.

DI Strategies

- DI This is predominantly a spatial activity. To incorporate interpersonal and bodily-kinesthetic learning styles, encourage sharing and discussing of the results.
- ELL English language learners may prefer to use the Internet to refer to familiar symbols from their own culture for inspiration and clarification. They may also need more examples of what a symbol is versus a logo. Encourage all students to not include words in their symbol, and to try to make their symbol universally meaningful to all cultures.

Answers

1. Students' designs may differ in colour or size, and may be biotic factors or abiotic factors.
2. Students' symbols might show a very one-sided relationship, such as a balance scale with one side much heavier than the other.

Learning Check Answers (Student textbook page 9)

1. They used trees to make wooden frames to move and erect the statues, and to burn wood. They also cleared forests for agriculture.
2. *Sustain* means to endure and to support.
3. Ruby-throated hummingbirds live part of the year in a tropical rain forest, then they stop in many ecosystems along the way as they migrate north in the spring. They spend the summer in meadows and wetlands in Canada.
4. Biotic parts could include people, pets, houseplants, crops, grass, insects, and bacteria.

Learning Check Answers (Student textbook page 19)

5. Eutrophication is a process in which nutrient levels in aquatic ecosystems increase, leading to an increase in the populations of primary producers.
6. Phosphorus was found to be the main cause of eutrophication.
7. fertilizer in run-off
8. In order to get the lawn looking healthy, you probably added fertilizer. The fertilizer improved the lawn, but it also leached into the pond, causing eutrophication and an algae bloom that depleted the oxygen and therefore killed the fish.

Section 1.1 Review Answers (Student textbook page 20)

Please also see BLM 1–14, Section 1.1 Review (Alternative Format).

1. a healthy environment that endures and supports a variety of organisms
2. Once the forest ecosystem on Easter Island was gone, all of the resources and processes associated with trees, such as lumber for building or fuel, and protection from erosion, also disappeared.
3. Students can describe any three of the following: water, light, oxygen, nutrients, and soil. Accept any reasonable response regarding the effect that human activity could have on the abiotic part.
4. Students' drawings should be similar to Figure 1.6. Bacteria convert nitrogen from the atmosphere into forms that other living things can use.
5. **a.** Humans can add excess phosphorus to aquatic ecosystems through fertilizer in run-off. Phosphorus is naturally a limiting nutrient. When excess phosphorus reaches an aquatic ecosystem, the ecosystem becomes eutrophic.
   b. Farmers could participate in the Environmental Farm Plan to help reduce fertilizer in run-off.
6. Answers will vary. Generally, scientific research in the areas of environmental toxins and nutrient pollution causing eutrophication led to changes in laws designed to counter the problems that science revealed.
7. Answers will vary. Sample answer: Farmers may use less fertilizer or not apply it right before it rains. Fertilizer companies could make changes to their product, which may make it less destructive to an ecosystem. Governments could help educate people on the dangers of excess nutrients and require farmers to follow rules that would reduce the amount of fertilizer in run-off or require fertilizer companies to reduce the harmful chemicals in their fertilizers. Consumers can support farmers who are actively working to reduce this problem by buying their products.
8. Phosphorous levels decreased from the late 1960s until the early 1980s. From 1985 to the late 1990s, phosphorous levels increased almost to their 1960s levels.

Section 1.2 The Biosphere and Energy

(Student textbook pages 21 to 27)

Sustainable Ecosystems: Specific Expectations

- **B2.1** use appropriate terminology related to sustainable ecosystems
- **B3.2** describe the complementary processes of cellular respiration and photosynthesis with respect to the flow of energy and the cycling of matter within ecosystems, and explain how human activities can disrupt the balance achieved by these processes

In this section, students will learn about the relationship of energy to the biosphere. Students will describe photosynthesis and the transfer of energy through trophic levels. Students will also learn how bioaccumulation of certain manufactured toxins have affected bird populations in local ecosystems.

Common Misconceptions

- Students may be under the impression that the boreal and temperate forests perform the majority of Earth's photosynthesis. In fact, together they contribute less than 20 percent, as shown in Figure 1.14 on student textbook page 23.
- Another misconception is that the amount of photosynthesis done by phytoplankton provides a buffer that regulates carbon dioxide (CO_2) consumption and oxygen (O_2) production on Earth. In reality, this system is at serious risk due to overfishing of large predator species such as tuna, marlin, and shark, which leads to an overpopulation of smaller species that directly feed on phytoplankton.
- Students may think that toxic chemicals have now been banned and are no longer in use. Although we often speak of DDT being banned in the 1970s, DDT was not banned in Canada at the same time as it was in the United States. Rather, it was phased out in the mid 1970s, registration for use was discontinued in 1985, and it was not until 1990 that the use of DDT became a violation of the pest control act. While PCB production was banned across North America in 1977, the use of PCBs is still being phased out. PCBs are still in use in many electrical applications, such as transformers and capacitors. There are many other toxins that bioaccumulate in our environment, which are not yet banned or are only minimally controlled, such as mercury.

Background Knowledge

We tend to focus on humans' ecological impact on the lives of organisms that we can see, such as birds. What is neither well studied nor understood is how the ecosystems of our oceans have a direct impact on humans.

It is estimated that shark populations have declined by almost 90 percent since the 1970s due to overfishing. Sharks are the top predator in the oceans so they directly control the populations of smaller fish species. Most shark species prey on smaller fish, which are direct consumers of phytoplankton. Therefore, as shark populations decrease, the populations of smaller fish increase, and the amount of photoplankton decreases sharply. The food chain that links sharks and photoplankton is very short, and the effects of any imbalance on oxygen and carbon dioxide levels are felt quickly.

DDT is still in production and in use today in some parts of the world. It is used to control insect-borne tropical diseases such as malaria. Its use to control the insects that carry the disease is very controversial, but it can be argued that DDT has helped to save millions of lives. DDT is fat soluble, so it can build up in fatty tissue, and it causes the thinning of eggshells in fish-eating birds. The mechanism of human toxicity is not as well understood, although severe overexposure will have adverse effects, most likely neurological.

The effect of PCBs on humans is more clearly understood than that of DDT. There have been more direct links drawn to reproductive and cognitive disorders, as well as cancer. It is interesting to note that although the production of PCBs has been banned, the use of PCBs has not yet been banned, likely because PCBs were used as coolant and lubricant in large transformers that are still in use. Other uses for PCBs have included plasticizers and pesticide extenders. The disposal of PCBs is extremely difficult. When incinerated, one of the byproducts is dioxin. Dioxin is one of the most toxic environmental contaminants known.

Mercury still seems to get more coverage in the media than DDT and PCBs, and students may ask about it. The use of mercury is regulated, but it is certainly not banned. You can still get dental fillings that have mercury in them, and mercury does enter the ecosystem naturally. By far, the large majority of mercury entering the food chain is from atmospheric mercury, the result of burning fossil fuels—coal in particular. The mercury then enters our waterways as rain and bioaccumulates in fish, including fish that is caught as food.

Literacy Support

Using the Text

- Preview the Key Terms with English language learners before reading. Discuss the meanings of the root words synthesis, accumulation, and mass. Draw students' attention to words they already know that share prefixes with each Key Term, for example, *photo*…, *bio*…). Then have students make connections to predict the meaning of each Key Term.

Before Reading

- To set students up to make connections to prior learning, use an Anticipation Guide for this section (see BLM 1–15, The Biosphere and Energy). Students are given a series of statements related to the section. Before reading the section, students indicate whether they agree or disagree with each statement. You could read each statement aloud for English language learners, and allow them sufficient time to process what you have said, ask questions, and record their answers. Arrange students in pairs to discuss which statements they agree with and why. Encourage English language learners to ask their parters for clarification about what is being read aloud, when needed.

During Reading

- Students should have their anticipation guide beside them as they read, to record corresponding page numbers from the textbook for each statement on the guide.
- Choose some confident readers to read parts of the section aloud for the class.
  - DI To enable less confident readers to participate, pre-assign some short passages for them to practise before reading aloud.
  - ELL Pause the reading at any time to direct students to record an important point, to discuss a point, to ensure that English language learners understand a complicated sentence or new term, or to re-direct the reading.

After Reading

- Have students make connections to prior learning by revising their agree/disagree ranking. Students should also correct or revise the statements with which they disagree. Students can share their revisions with their learning partner. Using mini-white boards, chart paper, or the chalkboard, have each pair of students share one of their revisions with the class.

Using the Images

- For some students, it is difficult to connect a graphic to an actual cross-section. For Figure 1.12, provide students with some actual views of a leaf cross-section, either by using an LCD projector or by setting up some pre-prepared slides or microviewers. Have students locate the labelled parts of the leaf cross-section in the view you provide.
- Have students reconstruct the bar graph from Figure 1.14 into two circle graphs, one showing the percentage of Earth's surface area, and one showing the percentage of Earth's photosynthesis. This task will allow students to internalize the data and practise their graphing skills. Then have students discuss why the data are displayed in the textbook as a bar graph. (It was important to compare surface area to photosynthesis production.)

- For Figure 1.15, have students construct their own pyramids with data supplied (See BLM 1–16, A Food Pyramid). This activity is designed to walk students through the process of constructing an Energy Pyramid. To reinforce the concept, students could complete BLM 1–17, Consumers and Producers, or BLM 1–18, Consumers and Producers (Alternative Version).
- Now that students have had practice constructing Energy Pyramids, have them construct an upside down pyramid based on the data in Figure 1.16 to illustrate bioaccumulation.
- To reinforce the effect of biomagnification on PCB concentration, students could complete the calculations on BLM 1–19, Understanding the Mathematics of Biomagnification.

Assessment For Learning

Tool	Evidence of Student Understanding	Interventions
• Learning Check questions, page 23	Students correctly describe the process of photosynthesis, including inputs, outputs, roles of the leaf parts, and how it benefits us.	To reinforce the elements in the process of photosynthesis, make several cards, each one with a term to be guessed at the top, and a short list of words students are not allowed to use when giving clues, below it. Tape a card to each student's back. Students must ask their classmates to give clues in order to guess their own word. This activity will be appealing to the bodily-kinesthetic and interpersonal learners, as well as helpful for English language learners. Students can complete supplemental worksheet BLM 1-20, Photosynthesis, to help them organize the inputs, outputs, and other important elements of the process.
Section 1.2 Review questions, page 27	Students • explain the process of photosynthesis (questions 1 and 2) and its importance (question 3). • describe how energy and contaminants move through trophic levels (questions 5, 6, and 8).	Create a series of at least 30 cloze (fill-in-the-blank) statements related to photosynthesis and bioaccumulation. Provide students with a blank bingo template and a list of all the potential answers to the cloze statements. Students will randomly fill in the bingo template with 24 answers and include a free space in the middle. When students are ready, choose one cloze statement at a time and read it aloud. The first student who has five answers in a row yells "bingo!" and has you check if he or she is a winner.

Instructional Strategies

- DI Provide spatial learners with actual photographs of leaf cross-sections and plant cells. You can use pre-prepared slides, microviewers, or images from the Internet. Students should then draw and label their own diagrams from the slides.
- Have students use model kits to balance the photosynthesis equation. Divide the class into groups of four and provide each group with 6 carbons, 12 hydrogens, and 18 oxygens.
- DI For the logical-mathematical students, make this a problem-solving activity. Have groups build a glucose molecule, $C_6H_{12}O_6$, and then ask them to determine how many CO_2 molecules and water molecules were required to make the glucose.
- DI For bodily-kinesthetic learners, play an abbreviated version of the "Predator Game." Use four different colours of tokens to represent four trophic levels. Designate approximately two thirds of the class primary producers, one quarter primary consumers, one sixth secondary consumers, and just one or two tertiary consumers. Give each primary producer 10 green tokens to represent the energy they store through photosynthesis.

- Have primary producers stand, and direct primary consumers to ask the primary producers for tokens. They may give all or some to each consumer. When all tokens have been transferred, invite primary consumers to trade the green tokens for white tokens, which represent the energy they gain by consuming plants, using a ratio of 5 green:1 white.
- Have primary consumers stand, and direct secondary consumers to ask them for their white tokens. When all tokens are transferred, invite secondary consumers to trade five white tokens for one red token, to represent the energy they gain by consuming animals.
- Finally, repeat the exchange with the one or two tertiary consumers asking secondary consumers for their tokens, then trading 5 for 1 blue token.
- Debrief the game by asking students to comment on what represented the energy transferred through trophic levels, and on what changed as the energy moved up from one level to the next.

- DI As an extension to this section, for bioaccumulation, have students do some supplemental research on the Internet, or provide students with some articles or websites you have found. Students can research DDT or PCBs to find out the history, and current locations, of their use. Once students have done some brief research, divide the class into groups of four and have students perform quick debates. An example resolution statement could be the following: Be it resolved that DDT should be banned globally.
  - In one style of academic debate, each group of four has two A's and two B's. The A's take the pro position, and the B's take con. Each side debates for a maximum time length of 2 min. English language learners may require some time to prepare the language they will need for this debate and should have the opportunity to rehearse.
  - Once both sides have had a turn, all the A's gather at one side of the room, and all the B's gather at the other side, to share information briefly.
  - Have the groups return to their tables, but rotate the B's around the room so each pair of A's is debating with a new pair of B's.
  - Repeat the debates, but this time the B's are pro and the A's are con.
  - This activity should appeal to the linguistic and interpersonal learners. You can incorporate a literacy component by asking students to write a short position paper or letter to the editor voicing their personal opinion after the debate has concluded. Provide English language learners with sentence starters to use as a scaffold for their writing. Be sure to offer ample practice to English laguage learners prior to having them present their positions to others.

Learning Check Answers (Student textbook page 23)

1. Chlorophyll is the pigment that gives leaves their green colour and it uses energy from the Sun to assemble sugar molecules from water and carbon dioxide in the process of photosynthesis. *Chloros* means green and *phyllon* means leaf.
2. carbon dioxide + water + light energy → sugar + oxygen
   Carbon dioxide comes from the atmosphere. Water comes from the soil. Light energy comes from the Sun.
3. Drawings should include details and labels of stomata. If stomata were damaged, gas exchange could not occur.
4. During the winter, we continue to be able to breathe oxygen, even though very little oxygen is being released in Canada from plants. About 30 percent of the world's photosynthesis occurs in tropical forests. Wind moves air around Earth, and it is likely that some of the oxygen we breathe in January in Canada has been generated by photosynthesis in tropical forests.

Section 1.2 Review Answers (Student textbook page 27)

Please also see BLM 1–21, Section 1.2 Review (Alternative Format).

1. In the process of photosynthesis, chlorophyll in plant leaves receives solar energy and uses it to assemble sugar molecules from water and carbon dioxide. Besides sugar, oxygen is also produced by photosynthesis.
2. The three chemical elements that are the building blocks of carbohydrates are carbon, oxygen, and hydrogen.
3. Students' answers will vary, but they should explain how the process of photosynthesis is crucial to life on Earth because it puts together carbon, hydrogen, and oxygen to make sugar, which is life's universal energy supply.
4. A producer is an organism that can make its own food. A consumer cannot make its own food. Consumers must eat other organisms to get the matter and energy they need to survive.
5. bunchgrass: 2543 energy units
   grasshopper: 254.3 energy units
   spotted frog: 25.43 energy units
   red-tailed hawk: 2.543 energy units
6. Most of the energy in organisms is used by them to function, some is lost as waste, and some is lost as heat. Therefore, most energy cannot get transferred to the next trophic level.
7. Bioaccumulation: the toxins do not harm the organism. Example: a monarch butterfly ingested toxins from the milkweed that it ate as a caterpillar. The toxins do not harm the butterfly, but the butterfly would be poisonous to eat.

   Biomagnification: the concentration of toxins increases as it moves from one trophic level to the next, so that the animals at higher levels contain many more toxins, and may be affected by them. Example: DDT affecting reproduction in fish-eating birds.

   Both: processes in which toxins are ingested more quickly than they are eliminated; result in accumulations of toxins.
8. I would expect the larger fish to have more chemicals in their tissues. The smaller fish may get some chemicals in their bodies by eating zooplankton. Since the larger fish eat the smaller fish, they probably have higher levels of toxins due to biomagnification.

Section 1.3 Extracting Energy from Biomass

(Student textbook pages 28 to 36)

In this section, students will describe the processes of cellular respiration and fermentation. Students will identify factors that have contributed to acid rain, and explain how acid rain has impacted the viability of selected ecosystems. They will also analyze and represent graphically the effectiveness of recycling programs in Ontario.

Common Misconceptions

- It was once common practice to remove plants from hospital rooms at night. It was thought that at night, the plants removed the oxygen from the room and produced carbon dioxide. During the day, plants were thought to add oxygen to the room because of photosynthesis. We now know that the amounts of oxygen and carbon dioxide produced by the plants are not sufficient to be of any harm or benefit to patients.
- We also now know that cellular respiration takes place both during the day and at night.
- The greenhouse effect and ozone depletion are often linked together. In fact, they are two entirely separate effects. Ozone depletion does not cause global warming, and the greenhouse effect does not cause ozone depletion. Ozone in the upper atmosphere contributes to the greenhouse effect, but the ozone produced by humans only becomes smog; it does not reach the upper atmosphere. Ozone depletion is caused by CFCs, chlorofluorocarbons, human-made refrigerants, and propellants.
- The common misconception about landfills is that they will slowly decompose all the garbage and eventually convert the garbage to soil and useable land. While landfills do slowly decompose some garbage, they are not giant compost sites, which is often the assumption. Landfills are intended for long-term garbage storage, while some of the garbage does break down and produce methane gas. Landfills are designed to "seal" in the waste by covering it in layers of soil, which slows the decomposition by cutting off oxygen.
- Landfills are designed to be land reclamation projects—a completed landfill is eventually turned into parkland or a golf course. Problems with leachate usually prevent landfills from having housing or office space built on them.
- Some people believe that landfills are an untapped source of methane that until now has been underutilized. There is also some concern that landfills will not produce significant amounts of methane due to recent green-bin diversion programs, as there may not be enough organic material to decompose. While landfills do produce some methane, they are not intended to function as a major energy source.
- Since Canada and the United States created an agreement in the 1980s to reduce acid-rain-causing emissions, we have experienced a significant decrease in acid rain. However, it is difficult to assess the effectiveness of acid-rain-reduction programs when many of the major plants and industries responsible for sulfur dioxide and nitrogen dioxide emissions shut down entirely. It is difficult to say whether the initiatives started in the 1980s or our economic climate has been responsible for the reduction in acid rain.

Sustainable Ecosystems: Specific Expectations

- **B1.2** evaluate the effectiveness of government initiatives in Canada, and/or the efforts of societal groups or non-governmental organizations, such as Aboriginal communities, environmental groups, or student organizations, with respect to an environmental issue that affects the sustainability of terrestrial or aquatic ecosystems
- **B2.3** plan and conduct an investigation, involving both inquiry and research, into how a human activity affects soil composition or soil fertility, and, extrapolating from the data and information gathered, explain the impact of this activity on the sustainability of terrestrial ecosystems
- **B3.5** identify various factors related to human activity that have an impact on ecosystems, and explain how these factors affect the equilibrium and survival of ecosystems

Background Knowledge

All plants and animals perform cellular respiration. Plants produce glucose from photosynthesis and animals acquire glucose from consuming plants and other animals. Energy is produced with the addition of oxygen, and the other product of cellular respiration includes carbon dioxide. To eliminate the carbon dioxide that we produce through cellular respiration, we exhale it through our lungs.

Greenhouse gasses include nitrous oxide (N_2O), methane (CH_4), oxygen (O_2), ozone (O_3), water vapour (H_2O), and carbon dioxide (CO_2). Sources for atmospheric carbon dioxide include decaying vegetation, volcanic eruptions, exhalations of animals, deforestation, and the burning of fossil fuels.

There has been extensive scientific debate over the use of biofuels as a supplement or replacement for fossil fuels. The reasoning behind the debate is that the growing plants will remove carbon dioxide before they are converted to fuel, which in effect counterbalances the carbon dioxide emissions when finally burned. Exactly how much arable land would be needed to produce biofuels is still not clear, and this question has generated the food vs. fuel debate. Many farmers who should be growing crops to feed their communities are often more willing to grow crops for biofuels, as they can make a larger profit doing so. It has been speculated that the increasing interest in biofuel production has led to a global food shortage. Nevertheless, there have been successful and balanced programs where the stems and stocks left over from a harvested crop are turned into biofuel.

Visit www.scienceontario.ca for more information about the Kyoto Protocol and Canada's Climate Change Plan. [To Come: http://www.ec.gc.ca/doc/ed-es/p_123/s1_eng.htm]

Landfills are essentially garbage-storage facilities. They are usually lined to prevent leachate from leaking into ground water. The leachate that develops in landfills contains many toxic organic compounds, many of which come from household products. Leachate is usually drained off the bottom of a landfill and pumped into a separate pond. The Fresh Kills Landfill on Staten Island is reported to be the largest human-made structure on Earth. The Fresh Kills Landfill is now closed and plans are underway to convert it into a municipal park.

Ontario regulations have made the collection of methane from new landfills mandatory.

Damage caused by acid rain costs millions of dollars per year. Some research suggests that acid rain may also be a contributing factor in asthma, Alzheimer's, and cancer.

Literacy Support

Using the Text

- ELL To preview the section with English language learners, return to the web you created at the beginning of this unit. Add ideas for Sections 1.1 and 1.2 to the web, and introduce the Key Terms for this section, describing how they relate to the concepts already on the web.

Before Reading

- To help students connect to prior knowledge, create a K-W-L chart for this section on the chalkboard.

Activity	What I **Know**	What I **Want** to Know	What I have **Learned**
Respiration Greenhouse effect Biomass and fuel Landfills Acid rain			

  - Work with students to fill in the first two columns of their charts, showing what they already know about each topic and what they want to learn.

During Reading

- Students should fill in the last column for themselves, showing what they have learned from the textbook. Students may read the textbook alone or aloud in a group. For some subsections, you may decide to present the information that is in the textbook to the class yourself.
- ELL Provide English language learners with sticky notes. They can use them to indicate words or ideas that they do not understand as they read. Later, discuss these with the students.

After Reading

- Have students identify items about which they wanted to know, but to which they did not find answers in the textbook, and items about which they thought they knew, but that changed after reading the textbook.
- Students should compare charts with a partner and try to help each other find the answers to the things about which each student wanted to know.
- Have each pair share with the class one thing they learned, and one thing they still want to learn.

Using the Images

- Referring to Figure 1.19, direct students to create their own graphic organizer for photosynthesis and respiration. The graphic organizer could take the form of a concept map. Have students connect the following concepts and terms: carbon dioxide, green plants, decay, fossil fuel, glucose, animals, oxygen, and water. The words they should use along the connecting lines would include combustion, respiration, and photosynthesis.
- For Figure 1.21, ask students to describe the correlation between carbon dioxide concentration and global temperature. Have students use BLM 1–22, Carbon Dioxide and Temperature, to predict what the values will be in the following 10 and 20 years.
- Ask students to create their own table similar to Table 1.3, which includes actions they could take at home and at school to reduce carbon dioxide in the atmosphere. Their tables should follow the same format as Table 1.3 with a description in the middle column and an accompanying picture in the right column.
- For Figure 1.24, set up a demonstration on the lab bench. Include items similar to those listed in Figure 1.24 and arrange them in order. Display small amounts of each substance in beakers and test each one with universal pH paper, or invite a student to do some of the testing. Ensure that protective gloves are worn, and that nothing is spilled or splashed.

Assessment For Learning		
Tool	**Evidence of Student Understanding**	**Interventions**
Learning Check questions, page 31	Answers include an accurate description of respiration, a link from the Sun to all energy on Earth, and some effective ideas to reduce carbon dioxide emissions.	Form a value line in the classroom. At one end is "I understand the questions completely" and at the other end is "I do not understand any of the questions." Direct students to form a single-file line, with no bunching. When students have placed themselves along the line, fold the line in the middle, so that each student is facing another, as a pair. Now have the pairs explain their questions and answers to each other.
Section 1.3 Review questions, page 36	Answers show an understanding of how plants capture energy from the Sun, and how organisms use the energy through respiration, fermentation, or combustion. They also include evidence of the relationship between fossil fuel combustion, greenhouse gases, and acid rain.	Students can complete the flowchart on BLM 1-24, Extracting Energy from Plants to help them understand the sequence of events related to extracting energy and the environmental effects of combustion.
Activity 1-3, Recycling in Ontario	The *x*- and *y*-axes are labelled correctly. Students have chosen an appropriate scale for the *x*-axis for all the data to fit. Students have chosen to draw two bar graphs using a different colour for each material. Students' descriptions of trends are based on their graphs and include some speculation about why recycling may be increasing or decreasing.	Have students work in pairs or groups of four to complete the graphs on graphing chart paper. They must agree on every decision the group makes, including how to label the axes, what scale to use, and how high each bar should be. Alternatively, have students work in a computer lab and complete the graphs using a spreadsheet. Students who are unsure of the most effective ways to display the data can try different types of graphs. The software should also take care of scaling the axes for them.

Instructional Strategies

- Ask students to recall "reverse engineering" photosynthesis, which they did in Section 1.2 using model kits. Arrange students into groups of four and have them construct all of the molecules for respiration: 1 glucose ($C_6H_{12}O_6$), 6 oxygen (O_2), 6 carbon dioxide (CO_2), and 6 water (H_2O). Each group will need one symbol or token representing an arrow and another symbol representing energy. This activity should appeal to bodily-kinesthetic and spatial learners. Ensure that students with these learning styles are distributed among the groups.
- DI To engage logical-mathematical thinking, have students arrange the balanced equation for cellular respiration on their table. In their notebooks, each student should write down the equation. Under the equation in their notebooks, students should create a table to summarize the number of atoms on each side of the equation.

Number of Atoms	Left Side	Right Side
Carbon		
Hydrogen		
Oxygen		

- DI To engage interpersonal and linguistic thinking, ask students to reflect on movies or documentaries they have seen, or articles they have read recently about the environment or global warming. Allow a few minutes for discussion. Then ask students to create a T-chart in their notebooks with the following title: Myths and Facts about the Greenhouse Effect. (This chart could be created on chart paper or the chalkboard). One column of the chart will be for the myths and the other will be for the facts. Have students record as many points as they can for each column, and then ask them to trade papers with a partner. The partners can add information or make corrections to the charts. Trade the papers one more time. Once papers have been

traded twice, students should return all papers to their original creators. Have students share some of the results with the class.

- DI As an extension, have linguistic learners create an editorial on alternative fuels. Tell students that an editorial states a point of view, and then supports it. Show them a couple of examples from a local newspaper or magazine. Students should compare and contrast two different fuels and their ability to reduce carbon emissions. Students should also comment on the social and economical impacts that the alternative fuels could have. Suggested topics could include biofuel, clean coal, landfill methane, and hydrogen fuel cells. They can use a copy of BLM 1–23, Alternative Fuels as a template.
- Conduct a classroom debate about fermentation, methane, and landfills. Allow students some time to do research on the Internet. English language learners could conduct research in their first language. Each student should complete a graphic organizer to prepare for the debate on this topic: Be it resolved that the province should discontinue the use of landfills for waste management. Allow students to choose their own graphic organizer such as a Venn diagram, concept map, or T-chart. Conduct a brief and informal debate after students have completed their graphic organizers. This activity should appeal to the naturalistic, linguistic, and interpersonal learners.
- ELL Assign Learning Check questions that require less language output to English language learners. For example, question 3 requires students to list, which is easier than explaining or describing. Question 4 is more open-ended and will allow students to share the necessary content knowledge without requiring specific language.
- DI As an extension, have students do some independent research on how scrubbers work to reduce the amount of acid rain caused by industries. Ask students to complete a hand-drawn and labelled diagram showing how scrubbers work. Alternatively, bodily-kinesthetic and spatial learners may prefer to build a model.

Activity 1-3, Recycling in Ontario (Student textbook page 32)

Pedagogical Purpose

Graphing allows students to internalize the information and see relationships in it. By examining and manipulating the data, students find the information more meaningful.

Planning	
Materials	Graph paper Coloured pencils Ruler Computer lab with spreadsheet software (optional)
Time	20 min

Background

Students should notice that the amount of newspaper recycled had decreased. The amount recycled depends on many factors, such as that more people rely on alternative sources for their daily news, and that fewer people are buying newspapers.

Activity Notes and Troubleshooting

- Students can work independently.
- Students may have difficulty scaling the *y*-axis. Have them look at the greatest number that they will need to graph. For the first graph, the greatest number is 479 473, so the scale should go to 500 000.
- The graphs are intended to be bar graphs with three or four bars for each year—one bar for each material.
- Students can compare bar heights for the same material to identify trends or draw a line from the top centre of each bar to create a line graph.

DI Strategies

- DI This activity could be completed in a group using markers and chart-sized graph paper. Have students work in groups of four, and have one pair of students work on the first graph, and the other pair work on the second graph.
- ELL Some English language learners may need to see a sample bar graph before they begin. Refer to Figure 1.27. Discuss what the labels should be on the bar graph that they create, how many bars there might be, and so on.
- DI Students with weak mathematical or small-motor skills may be more comfortable using the computer to create the graphs. You may still have to walk them through setting up and labelling the axes by modelling the process, perhaps by using a projector.
- DI If students are using a computer, it will be easy for them to change the graphs from line to bar for comparison.

Answers

1. Students should notice that the trend for newspapers, tires, and electronic waste decreased. The data trend for glass, and aluminum and copper, increased and then decreased slightly. The recycling trend for cardboard and plastic increased.
2. Perhaps fewer people purchase newspapers. Instead they rely on the Internet and television for news. There has not been a recent surge in computer technology to cause people any need to upgrade. More people may be purchasing winter tires, causing both sets of tires to last longer because they are only used for half the year. Fewer products that are packaged in glass are available in the grocery store. Manufacturers may be switching to plastic packaging to save transportation costs.
3. The government could pass legislation making it mandatory for all communities to provide recycling pick-up for all residences. The government could also pass legislation for all apartment buildings to provide recycling bins for its tenants.

Learning Check Answers (Student textbook page 31)

1. Cellular respiration is a process in which oxygen and sugar are consumed and energy and carbon dioxide are produced.
2. The greenhouse effect occurs because greenhouse gases trap heat within Earth's atmosphere. This effect keeps Earth considerably warmer than it otherwise would be, allowing life to flourish.
3. Answers will vary, but should include the idea of ways to reduce the use of fossil fuels, such as carpooling, walking or biking instead of driving in a car, or turning off lights when you leave the room.
4. The energy used to operate a pen or a keyboard comes from the food we eat. That food includes energy-containing carbohydrates made by plants as well as additional energy sources in meals that include meat. Plants used photosynthesis to convert solar energy into the high-energy molecules of carbohydrates. Energy sources from meals that include meat came from animals' consumption of plants (or other animals that ate plants). The following example is the simplest route to show how the energy we use to operate a pen or a keyboard is traced back to the Sun:

   solar energy from the Sun → carbohydrate energy in the plant → energy available from the body to operate a pen or a keyboard

Section 1.3 Review Answers (Student textbook page 36)

Please also see BLM 1-25, Section 1.3 Review (Alternative Format).

1. Two processes that organisms use for energy extraction are fermentation and cellular respiration.
2. Oxygen is necessary for the aerobic breakdown of sugars.
3. Students' diagrams should be similar to Figure 1.22 on page 32 of the student textbook.
4. Humans have released much of the carbon dioxide that had been converted to biomass by ancient plants in the last 200 years or so (which seems sudden compared to the millions of years it took to make the carbon dioxide), by burning fossil fuels.
5. Nitrogen oxide and sulfur dioxide are released from burning fossil fuels and form acids that make precipitation acidic.
6. Since the pH of water in an acidic lake is between 4.0 and 5.0, none of these organisms would be able to survive.
7. Answers will vary and this question could lead to a debate. Presumably, students will recognize that they often make purchases based on price (and perhaps quality), but that as consumers, there may be other considerations based on environmental values.
8. Commuting by car uses fossil fuels that still produce oxides that tend to make precipitation acidic. This acidic precipitation can kill trees by interfering with their uptake of nutrients.

Plan Your Own Investigation 1-A, Fertilizers and Algae Growth

(Student textbook page 37)

Pedagogical Purpose

Students will plan and conduct their own investigation into the effects of fertilizer on algae growth, with your support and direction. In this investigation, students will manipulate variables and describe the changes they have observed. This is students' first chance to develop important skills related to the investigation. They will build on the skills they develop here in other investigations and in the Unit Projects.

Planning		
Materials	Balance 50 mL graduated cylinder Five 250 mL beakers Algae culture (enough for 5 samples) Distilled water Marker BLM 1–26, Plan Your Own Investigation 1-A, Fertilizers and Algae Growth (optional) BLM XX, Data Table (optional)	Scoop Small funnel Liquid fertilizer that contains nitrogen and phosphorus (enough for 5 samples) 5 adhesive labels
Time	25–30 min for students to write a plan, set up a data table, and have the plan checked by you 10–15 min for each student or group to set up beakers with algae and fertilizer 1 week to monitor the experiment. It would be advisable to start the activity on a Monday.	
Safety	• Fertilizer can burn sensitive skin, so instruct students not to touch the fertilizer, or provide gloves for students to use.	

Background

This lab is intended to model the process of eutrophication. Nutrient levels in lakes and ponds increase from agricultural run-off, increasing the algae growth. The excess algae use much of the oxygen needed for other plants and animals in that ecosystem, causing them to die.

Activity Notes and Troubleshooting

- If this is the first unit of the year, order the fertilizer and algae early.
- If your school has a pond nearby, you may be able to collect algae from it.
- Read the investigation together. Have students identify the parts of this investigation that are different from activities within the sections. (There is more analysis and communication, there is a central question or hypothesis, and there is a chance to extend the investigation.)
- Designate a space in the classroom where students can leave their experiment and return to check on it.
- If students decide to apply the fertilizer over several days, set aside time each day for students to monitor their experiment.
- If the experiment is running over several days, set aside the equipment and materials for students to measure out their fertilizer as they need it.
- Make sure students understand the difference between dependent and independent variables, before they write their plans.

- As you review students' plans, ensure that they include the following:
  - a control beaker (algae with no fertilizer)
  - a plan for regular observations
  - several different amounts of fertilizer
  - a plan to observe and describe the amount of algae present (perhaps describing colour or opacity)
- If there is a limited supply of beakers, purchase some clear disposable plastic cups, which can be washed and reused.

DI Strategies

- DI Intrapersonal learners can become overwhelmed when the whole class is out of their seats doing activities. As students set up their experiments, allow a limited number of groups to set up at a time. Have only one person from each group monitor the experiment each day. This person can be a different group member each day.
- ELL English language learners may have trouble distinguishing between independent and dependent variables. Use an example to illustrate the concept with something students will be familiar with, such as food or drink items.
  - For example, a student is purchasing juice bottles for herself and her friends. She purchases 5 bottles for $1.50 each, and the total cost is $7.50. The independent variable is the number of drinks purchased, and the dependent variable is the total cost—it *depends* on the number of drinks bought.
- ELL To ensure English language learners understand the instructions, have the class suggest simple verbs to replace the directions in the investigation. For example, *brainstorm* could be *list*, *carry out* could be *do*, and *analyze* could be *look at the parts*.

Answers

1. The independent variable was the amount of fertilizer added. The dependent variable was the algae growth.
2. Students should notice different amounts of algae growing in each beaker.
3. **a.** The number of producers would increase, except for deeper plants because the algae would decrease the amount of light reaching them.
   b. Consumers of algae would increase for a short time until the oxygen levels became too low to support them.
   c. The decomposer population would increase as plants and animals start to die off from the lack of oxygen.
4. Improvements might include the use of a control, and measuring the oxygen content in the water.
5. After brief research, students should record in their notebooks why potassium is added to fertilizer and be able to answer this question in class. (Among other uses, it helps with the movement of starches, the formation of proteins, efficient water use, and efficient use of nitrogen.) On a test, students could be asked to design an investigation to determine the effects of potassium on plant growth and/or the ecosystem.

Inquiry Investigation 1-B, The Chemistry of Photosynthesis

(Student textbook pages 38 and 39)

Pedagogical Purpose

In the investigation, students examine the change in pH of a system to provide evidence of photosynthesis.

Planning	
Materials	250 mL beaker Bromothymol solution 2 test tubes with stoppers 1 sheet black paper 2 freshwater plant sprigs (*Elodea* or a similar species) BLM 1–27, Inquiry Investigation 1-B, The Chemistry of Photosynthesis (optional) Water Drinking straw Test-tube rack Masking tape
Time	15 min for students to set up plants and test tubes Unless a strong light source is used, it will take more than one period to see a colour change.
Safety	• Students should be cautious to not get the indicator solution on their hands, as it could make them quite ill. • Students should only blow into the test tube; if they ingest the indicator solution, they will become extremely ill. • Students should wear goggles and aprons to avoid splashing in their eyes and spilling on their clothes.

Background

Bromothymol solution is yellow when the pH is below 7, indicating an acidic solution, and blue when the pH is above 7. Students' breath forms a weak acidic solution. The evidence of photosynthesis occurs when the plants use the carbon dioxide in the water, moving the pH back to 7 and changing the indicator back to blue.

Activity Notes and Troubleshooting

- *Elodea* can be ordered from a local aquarium store. Because the demand for *Elodea* is seasonal, call the aquarium store well ahead of time to order it.
- *Hornwort* will work as well as *Elodea,* and it is a more durable plant.
- Depending on the availability of plant material, this activity should be done in groups or possibly as a demonstration.
- A very strong light source is needed; use a grow light on a plant stand. If a grow light is not available, this activity may take a full day.
- Large test tubes are preferred to accommodate the plants. Larger test tubes can be supported by an Erlenmeyer flask.
- Any indicator that changes around pH 7 will work, including phenolphthalein and bromocresol purple.

DI Strategies

- DI Some students may wonder where these plants are used outside of the classroom. They are used most often in aquariums and backyard ponds to help oxygenate the water.
- ELL Appoint a confident reader to work with each English language learner. English language learners may wish to prepare a timeline, a poster, or another product instead of a report in Extend Your Inquiry and Research Skills.
- DI When students use straws, they are usually drinking. Demonstrate blowing bubbles with the straw, only touching your mouth to the dry end so as not to have any contact with the solution.

Answers

1. The gas added was carbon dioxide.
2. The gas created weak carbonic acid when mixed with the water. Acidic conditions change the colour of the blue indicator to yellow (when bromothymol solution is used).
3. In the uncovered test tube, students should have observed the indicator solution change back to blue. In the covered test tube, the indicator solution should have remained yellow.
4. In the uncovered test tube, the plant was able to perform photosynthesis and use the carbon dioxide in the water, therefore, changing the pH. In the covered test tube, the plant was unable to perform photosynthesis.
5. The control was the test tube covered with black paper.
6. Students' sketches should indicate carbon dioxide being exhaled by humans, absorbed by the water, and then consumed by the plant during photosynthesis. The sketch could also include the plant expelling carbon dioxide into the water during cellular respiration.
7. An extension of this lab could be to investigate how much light exposure the plant needs to consume the carbon dioxide. Students could cover several test tubes containing plants and expose each one to different amounts of light. Students should be able to clearly write out the procedure, and be given enough time to conduct their inquiry, if possible.
8. Students will require time to research in the library and on the Internet. They should be able to produce a one-page report on one of the scientists listed.

Inquiry Investigation 1-C, Soil-water Acidity and Plant Growth

(Student textbook pages 40 and 41)

Pedagogical Purpose

This inquiry allows students to investigate how human activity affects soil fertility. In this case, students are investigating the effects on plants of different acidity levels, resulting from acid rain.

Planning	
Materials	5 small plastic or paper cups Marker Tray Ruler Pencil 500 mL potting soil 50 mL graduated cylinder 5 stoppered Erlenmeyer flasks, containing water with pH levels of 3, 4, 5, 6, and 7 5 Seeds (such as beans, radish, or Brassica) Grow light (optional) BLM 1–28, Inquiry Investigation 1-C, Soil-water Acidity and Plant Growth (optional) BLM XX, Data Table (optional)
Time	1–2 h of preparation by the teacher 15 min for students to plant and water the seeds, and to place the cups on the trays 2–4 weeks to complete the investigation 5 min each day to water, and to record growth
Safety	• Students must wear safety goggles and acid-resistant gloves. A lab apron is also recommended to protect clothing. • Acid solutions should be stored in a fume hood or acid cabinet when not in use. • Always pour acid into water, instead of the reverse.

Background

While acid rain contains sulfuric acid, it is will be easier for teachers to control the pH of their solutions using hydrochloric acid or acetic acid. Acid solutions should be stored in a fume hood or acid cabinet when not in use. Always pour acid into water, instead of the reverse.

Activity Notes and Troubleshooting

- Start this activity early in the unit, preferably in the first or second week, in order to allow enough time for students to observe growth.
- Order seeds early, and purchase potting soil that has not been augmented with fertilizer.
- Prepare enough pH solution for students to water daily for at least two weeks, possibly three weeks. Each group will require approximately 150 mL of each solution.
- To prepare pH solutions, start with a solution of pH 3. Each subsequent pH is a dilution by a factor of 10. Use hydrochloric acid or acetic acid to prepare the solutions (they are monoprotic acids). A concentration of 0.001 mol/L will result in a pH of 3, 0.0001 mol/L will result in a pH of 4, and 0.00 001 mol/L will result in a pH of 5. Continue in this fashion until all of the solutions are prepared, and test each solution with a pH meter or indicator paper before dispensing. Clearly label, date, and initial the prepared solutions. If you prepare 2.5 L of pH 3, then you can use 250 mL of that solution to create 2.5 L of pH 4, and use 250 mL of the pH 4 solution to create 2.5 L of pH 5 solution, and so on.

- Take care in preparing the acid solutions. Wear proper safety equipment including goggles, acid-resistant gloves, and a lab coat. Always pour acid into water. If you are unsure how to dilute stock solutions, ask your department's chemistry teacher for assistance.
- Set aside an area of the classroom for students to conduct the lab; a plant stand with grow lights may be required.
- Have students work in pairs or groups, depending on the space and resources available.
- The procedure for preparing the plants is straightforward. Have a student read each step aloud as you demonstrate the step to the class.
- Radishes grow very quickly and provide the best results. If radishes are unavailable, black oil sunflower seed (from birdseed) will grow fairly quickly.
- Some plants will die prematurely. It may be acceptable for groups to merge or share data if this happens. Students will need enough data to analyze and make predictions.
- To conserve space in the classroom, save garden centre cell packs from your own gardening for students to start their plants in. Students can label the plants with craft sticks.
- It will be safe for students to take home plants grown in pH 6 or 7.

DI Strategies

- DI Some students will become upset when their plants die, especially if they die prematurely or fail to germinate at all. You should have your own set of plants as backup, or allow groups to merge to ensure enough data are collected.

Answers

1. Answers will vary depending on results.
2. Radishes prefer a pH of 6.5 or higher for optimal growth. Students should have recorded the best results for pH 7, but may have seen good results for pH 6 as well.
3. Students' statements should reflect their results, and will most likely state that lower pH inhibits the growth of radishes. Please note that some plants prefer slightly acidic soils, including some types of berries.
4. Students' results should support the hypothesis that plants will grow best in neutral soil and not grow as well in soils with more acidity. If their results do not support their hypothesis, they must have hypothesized a different relationship, for example, that more acidity would lead to greater growth, or that more acidity would have no effect.
5. Students could collect rain in the schoolyard and at their home and bring it into the classroom to test with universal pH paper. They should record the pH from several different rain events over a month. Ask, "Does the pH change on different days?" "What could be an explanation for your area?"
6. Students could conduct research in the library and on the Internet to identify the effects of rocks in neutralizing acid rain. Students could write a one-page report or fact sheet summarizing their findings.

Plan Your Own Investigation 1-D, Can a Plant Have Too Much Fertilizer? (Student textbook page 42)

Pedagogical Purpose

Based on what students have learned in this chapter, they should be able to make some predictions about the effects of fertilizer on plant growth. This activity provides an opportunity for students to design their own investigation, with teacher support, to support or refute their predictions.

Planning	
Materials	5 green pea seeds 750 mL soil Marker 3–5 large cups Garden trawl Water Fertilizer that contains nitrogen (enough for 3–5) Soil test kits for nitrogen BLM 1–29, Plan Your Own Investigation 1-D, Can a Plant Have Too Much Fertilizer? (optional)
Time	15 min to create the data table and have a plan approved by you 20 min to plant the seeds 10 min to prepare the fertilizer 5 min daily to monitor the plants 2–4 weeks to collect the data
Safety	• Fertilizer can burn sensitive skin. Students should wear goggles and gloves when handling fertilizer.

Background

Fertilizer run-off from our lawns and farms is the major contributor to eutrophication. However, without fertilizer, we would not be able to grow enough food to support the current population of our planet. Plants will thrive within a range of fertilizer concentrations. Too little and they will not get enough nutrients. Too much and they will be damaged by the chemicals in it.

Activity Notes and Troubleshooting

- Teachers should start this activity early in the unit so students have enough time to collect the data and analyze them.
- Purchase soil that has not been augmented with fertilizer.
- Set aside an area in the classroom for students to conduct the experiment and monitor it.
- You may want to start the seeds under a damp towel first; then students can plant the seeds that have germinated.
- Remind students that they should have a control as part of their plan.
- Students have a tendency to over-fertilize all of their specimens at the beginning, and then have no results at all. Read the directions on the fertilizer and the seed packages to determine the recommended amount. Have students try more than, and less than, this amount.

DI Strategies

- ELL Write the terms *dependent variable, independent variable,* and *control* on the chalkboard. Discuss the meaning of each term, and record a definition or example beside each one.
- DI Students have a tendency to take plant mortality too seriously. If their plants die prematurely, students take this death as a personal failure. Allow enough time for students to start over if their plants die too early to collect enough data.
- DI Allow groups to merge or share data if some plants die early.

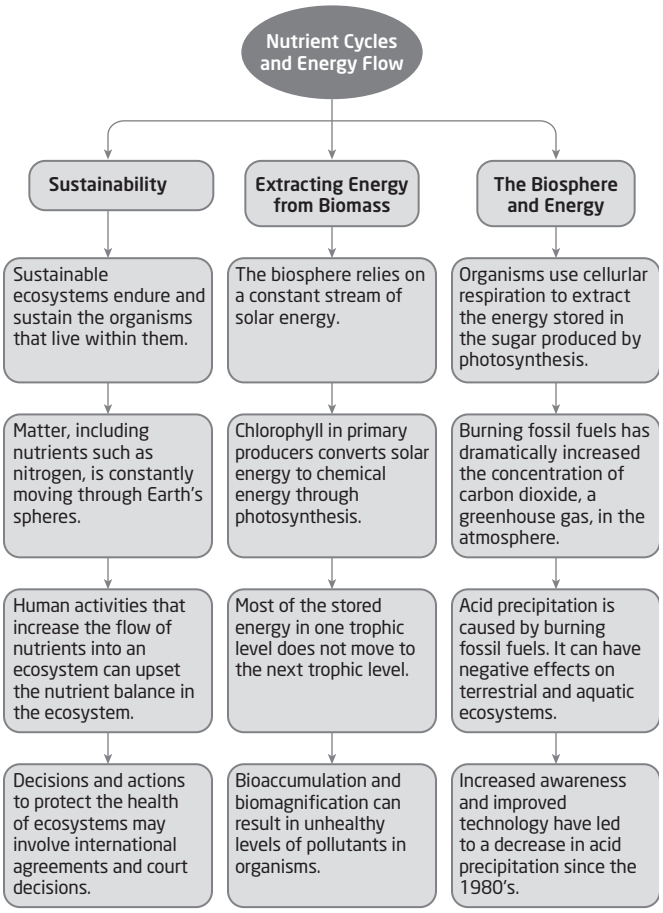
Answers

1. Answers will vary depending on students' results.
2. Too much fertilizer will have the opposite effect of what was intended. The fertilizer could run off and cause damage to surrounding gardens and ecosystems.
3. The trees could experience an unseasonable burst in growth; however, if too much fertilizer ran off, the roots could be burned and the tree would die.
4. Students should be able to write the procedure for an investigation using compost instead of fertilizer. Students may also want to compare compost to fertilizer. Conducting this investigation may not be practical for all students, as they may not have composters at home. All students should be able to write a procedure for this type of inquiry, however.

Chapter Review (Student textbook pages 44 and 45)

Please also see BLM 1–30, Chapter 1 Review (Alternative Format).

Make Your Own Summary



Reviewing Key Terms

1. biosphere
2. eutrophication
3. ecosystem
4. photosynthesis
5. trophic level
6. cellular respiration
7. greenhouse effect

Knowledge and Understanding

8. Interacting parts of a biological community and its environment are called an ecosystem.
9. A sustainable ecosystem endures and supports, which means it maintains the same condition for a long period of time and supports various different organisms.
10. Aquatic ecosystems are responsible for 30 percent of the world's photosynthesis to produce oxygen. Animals in terrestrial ecosystems depend on this oxygen to survive.
11. Organisms, such as plants, which can make their own food, are called primary producers. They are at the first trophic level within the biosphere, are the only organisms that can produce sugar to store the Sun's energy, and are therefore important for all other organisms to survive.
12. Step 1: the Sun
    Step 2: evaporation
    Step 3: condensation
    Step 4: precipitation
    Step 5: run-off
    Arrows should follow a cycle through Steps 2, 3, 4, 5, and 2 again.
13. The Industrial Revolution resulted in an increase in the burning of fossil fuels—such as coal, petroleum, and natural gas—as a source of energy. Burning these fossil fuels adds carbon dioxide to the atmosphere.
14. Fossil fuels are decomposed plant and animal matter. The energy stored in fossil fuels comes from the photosynthesis that the plants underwent when they were alive.
15. Cellular respiration takes place when oxygen is present; fermentation takes place where oxygen is not present.
16. **a.** Three examples of greenhouse gases are water vapour, carbon dioxide, and methane.
    b. Greenhouse gases increase the temperature of the atmosphere by trapping heat. Earth would be much colder without greenhouse gases in the atmosphere. The increased burning of fossil fuels in the last few centuries has released a lot of carbon dioxide in the atmosphere, and many scientists believe that this increase has led to problems such as global warming.
17. **a.** The Kyoto Protocol is an agreement signed by over 180 countries to reduce greenhouse gas emissions. Countries are encouraged to reduce emissions or to plant trees in non-forested areas to remove carbon dioxide from the atmosphere.
    b. Through government initiatives, countries can reduce carbon dioxide in the atmosphere by reducing gas emissions, planting trees, protecting existing forests, and recycling.

Thinking and Investigating

18. Students' examples will vary. Example: The Brock West Landfill Site in Pickering, Ontario, collects and uses methane gas to generate electricity.

19. Students' answers will vary but might include the following: using some form of vehicle transportation to get to school (petroleum); using electricity at school for lights, heat, air conditioning (coal, oil, and gas); and using any manufactured product like cell phones, food packaging, and so on (coal, oil, and gas to make products). Instead, students might walk, cycle, or carpool to school; turn off lights in rooms that they are not using; turn down the heat (and wear heavier clothing) or turn down the air conditioning (and wear lighter clothing); and try to buy naturally-made products or products that have less packaging.

20. To reduce the emissions of sulfur dioxide and nitrogen oxide, individuals can ensure their cars meet the motor-vehicle emissions tests. Students may also mention that they can walk, cycle, carpool, or take public transit; they can travel by air as little as possible; and they can buy products that were produced locally.

Communication

21. Students' diagrams should be similar to Figure 1.6 in the student textbook. Their diagrams should show that nitrogen is converted to usable forms, such as ammonium and nitrate, which are absorbed by plants. Organisms then eat the plants and use the nitrogen in their bodies. Excess nitrate and ammonium enter the lithosphere and become part of rocks. It does not return to the atmosphere for many centuries. Students should also show that fertilizer is a human factor that alters the balance of nutrients.

22. Students' e-mails will vary but should include the idea that trees and plants absorb carbon dioxide from the atmosphere and produce oxygen, so protecting forests and planting new trees is important.

23. first trophic level: Phytoplankton are primary producers.
second trophic level: Zooplankton are primary consumers.
third trophic level: Crabs are secondary consumers.
fourth trophic level: Sea otters are tertiary consumers.

24. Students' diagrams should be similar to Figure 1.3 in the student textbook, including placing the biosphere all around everything.

25.

Reaction	Photosynthesis	Cellular respiration
Organisms in Which Reaction Occurs	Plants, algae, and some bacteria	Plants, animals, fungi, other organisms
Reactants	Carbon dioxide, light	Oxygen, sugar
Products	Oxygen, sugar	Carbon dioxide, water
Is Energy Absorbed or Released?	Absorbed	Released

26. It does not matter where in the atmosphere the gases are released. Nitrogen oxide and sulfur dioxide combine with water in the atmosphere, producing nitric acid and sulfuric acid. The acids can travel far in the wind and will eventually fall back down to Earth's surface in the form of precipitation.

27. The greenhouse effect is produced by greenhouse gases warming Earth by trapping energy. The enhanced greenhouse effect is produced by humans adding too many greenhouse gases to the atmosphere, possibly resulting in global warming.

Application

28. An animal living far away from an area sprayed with DDT might get DDT in its body through the processes of bioaccumulation and biomagnification. It might eat contaminated birds or fish that travel great distances.

29. If a pesticide is stored in the body of an organism and remains toxic for many years, it can be passed on to other organisms for years to come. Instead, it would be better if pesticides were easy to break down and dispose of.

30. Eating a plate of rice and vegetables would make you a primary consumer, because primary consumers are herbivores and eat only plants. Eating a hamburger would make you a secondary consumer, since you would be eating part of a cow, which is a primary consumer.

Unit 1 Projects

Inquiry Project
Pollutants and Aquatic Ecosystems (Student textbook page 126)

Pedagogical Purpose

This investigation allows students to study the impact that humans can have on the sustainability of an ecosystem. The pollutants in this investigation are common substances resulting from the choices average people make for their homes and lifestyles.

This project is an opportunity for students to demonstrate the understandings and skills they have developed in this unit.

Planning	
Materials	Salt 100 mL beef or chicken broth 50 mL plant food 100 mL vinegar 50 mL dish detergent 50 mL paint thinner Seven 2 L soft drink bottles, or large jars, per group Aquatic plants and organisms for each ecojar BLM 1–31, Inquiry Project: Pollutants and Aquatic Ecosystems (optional) BLM XX, Data Table (optional) • Purchase the aquatic supplies ahead of time. • Ask students to bring in 2 L soft drink bottles for several days berforehand, until you have enough.
Time	• 15–20 min to create the plan and data table • 5–10 min to prepare each ecojar • 10 min to apply the treatments to each jar • 3–5 days to record the effects on each jar • 1 period to prepare the presentation, and 1 period for all students to present their findings.
Safety	Students should wear goggles.

Background

The choices we make every day to maintain our lifestyle can have direct impacts on the environment. We salt roads and driveways in the winter, and the salt collects in storm-water retention ponds. Car exhaust and coal-burning power plants contribute to acid rain. Fertilizer and animal waste from our lawns as well as from farmland produce run-off. Many household chemicals are intentionally and accidentally poured down the drain, or washed down the driveway. When we think of pollution, we often consider industry before we think of our own actions and choices.

Activity Notes and Troubleshooting

- Students should plan out the investigation several days before starting. They should also come up with their own list of materials so you know what to acquire for them.
- You may want students to conduct this investigation on their own and purchase their own supplies. To be equitable, supply some of the basic materials to get each ecojar started, such as plants and other organisms.
- Often, students want to put fish or tadpoles in their ecojars. This activity is discouraged, and may contravene local board policy, as the investigation will harm and probably kill the animals, and will be extremely upsetting to some students.

- Decide on the type of audience to which students will present their findings, and let them know. For example, will students be presenting to members of their community, or to members of their class? Students' presentations should be tailored to their audience.
- The assessment criteria are printed in the student textbook. Make sure students understand what is required of them, are aware of the assessment criteria, and refer to the list as they conduct their investigation and plan their presentation.

DI Strategies

- DI Bodily-kinesthetic and spatial learners may prefer to use chart paper or to draw their own overheads, as opposed to preparing a computer presentation.
- DI Intrapersonal learners and English language learners may feel uncomfortable presenting their findings to the class. Provide the option of presenting to a smaller group, or allow them to submit their presentation electronically by recording it at home.
- DI Another option is to have students who are uncomfortable presenting in front of a large group come in after school or at lunch to present.

Rubric

<CATCH: to come}

Please also see BLM 1-32, Pollutants and Aquatic Ecosystems Rubric.

An Issue to Analyze
Protecting Ecosystems (Student textbook page 127)

Pedagogical Purpose

In the process of becoming scientifically literate, students are asked to draw on their scientific knowledge and skills to assist them in making personal choices. Scientifically literate students are able to actively participate in and contribute to their neighbourhoods and communities. Being scientifically literate is part of being a good citizen. For this issue, students are asked, "What could you do, as a member of this community?"

This analysis is an opportunity for students to demonstrate the understandings and skills that they have developed in this unit.

Planning	
Materials	Local newspapers and maps
Time	• 2 weeks (in and out of class) for research • 1 or 2 periods for presentations

- Book a computer lab.
- Book a library period.
- Contact a local environmental group to see if they have resources that students might use.

Background

Over 30 years ago, a small group of concerned citizens started a campaign that resulted in the creation of one of the largest urban wilderness parks in North America. The creation of Rouge Park by the Ontario government in 1995 was the result of many years of public campaigning. Concerned citizens established the Save the Rouge Valley Society (SRVS) in 1975, and they tirelessly campaigned for the creation of Rouge Park. Thousands of citizens wrote letters and attended public meetings. Members of the SRVS went even further to demonstrate their dedication to the park by establishing a volunteer organization in 1989 called 10 000 Trees for the Rouge, which co-ordinates community tree planting events every spring to help maintain and rehabilitate park habitats and ecosystems. Rouge Park now connects the Oak Ridges Moraine greenbelt to Lake Ontario. Rouge Park is an example of how citizens' involvement can have positive and lasting results.

Activity Notes and Troubleshooting

- Students may not be aware of their local natural ecosystems. Local maps and news articles may help them identify a local ecosystem to investigate.
- Approve students' ecosystem choices to be sure they are appropriate before students begin significant research. In some cases, you may have to assist students in identifying these areas. Sources of information might include the local public library and local environmental groups.
- Consider planning a trip to a local conservation area or outdoor education centre.
- With students, decide on the audience they are targeting before they create the vehicle to communicate their findings.
- Provide students with a rubric for the assessment criteria at the beginning of the assignment.

DI Strategies

- DI By using a generic rubric, you allow students to choose the medium that best suits their particular ecosystem, audience, and preferred learning style.
- DI Be flexible in allowing students to speak about areas they are most familiar with. For example, a student may want to address an area near his cottage or his grandparents' home. You may decide to specify that the ecosystem must be from within Ontario, or within Canada.
- ELL English language learners may find an activity that is so locally targeted problematic. They should be allowed some flexibility. If they are very familiar with an ecosystem within their country of origin, they may wish to address this area.

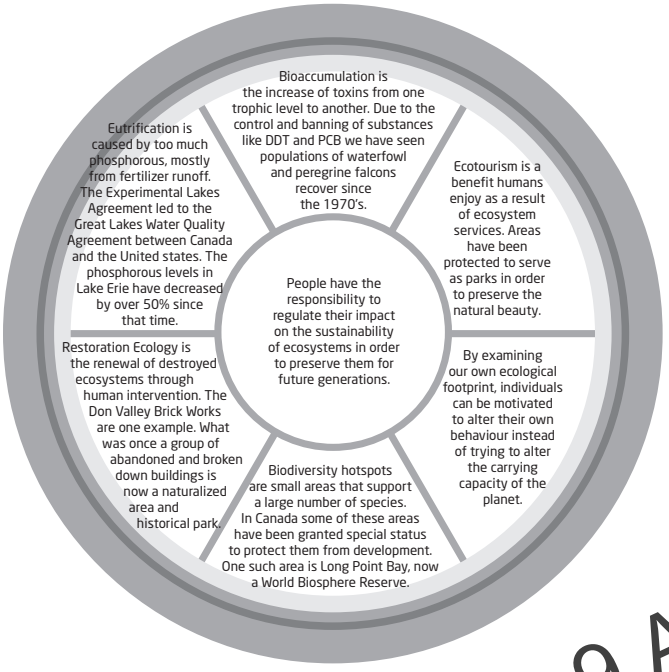
Rubric

<CATCH: to come>

Please also see BLM 1-32, Pollutants and Aquatic Ecosystems Rubric.

Unit 1 Review (Student textbook page 128 to 131)

Connect to the Big Ideas



Knowledge and Understanding

1. d.

2. d.

3. a.

4. c.

5. a.

6. phosphorus

7. Carbon dioxide has been increasing in the atmosphere because we have been burning fossil fuels that release carbon dioxide.

8. This example might be considered predation (bird preying on insect parasite) or mutualism (bird benefits by getting food, and large animal benefits by being rid of parasites).

9. Urban sprawl is a form of development where houses and business are built outside the core of the city, expanding the city. These areas often have few services available, making them car-centric, as people need to drive somewhere for work, shopping, recreation, and so on.

10. Organisms can be very small; they can be located in places that we cannot access easily (for example, the ocean floor); they can have different life stages; they can look similar but actually be different.

11. Any three of the following: Carolinian Canada of southern Ontario, Leitrim Wetlands near Ottawa, Long Point in Lake Erie, the Georgian Bay Biosphere Reserve

12. In the water cycle, water continually cycles through the hydrosphere, atmosphere, lithosphere, and biosphere through the process of evaporation, condensation, and precipitation. In the phosphorus cycle, phosphorus moves through the hydrosphere, biosphere, and lithosphere. It is carried from the lithosphere (soil) to the hydrosphere (lakes and rivers) by water run-off.

13. Plants are sometimes grown at a contaminated site to accumulate the poisons in their tissues, which cleans many of the poisons out of the soil.

14. Burning fossil fuels, such as gasoline in a car, increases the amount of carbon dioxide in the atmosphere, which travels with weather systems, and has a negative impact on ecosystems far away.

15. Some energy in tertiary consumers is transferred to a decomposer. Most is moved back to the abiotic components of the ecosystem.

Thinking and Investigation

16. The ruby-throated hummingbird and the monarch butterfly migrate long distances every year, so they are dependent on many ecosystems along their migratory routes for food and shelter. Since these organisms rely on many ecosystems, maintaining connectivity among ecosystems allows them to survive, and also allows the organisms that depend on them to survive.

17. a. In the first graph, the number of bacteria is increasing. In the second graph, the number of bacteria increased and then levelled off.

b. first graph

c. second graph

d. yes, second graph

18. The carrying capacity is approximately 1.6 million. In real life, populations can exceed the carrying capacity, but then they will run out of food. Once they number less than the carrying capacity, their predators will run out of food and begin to die, allowing the population to grow to exceed the carrying capacity again.

19. They harvest and hide seeds, some of which grow into new trees; stored seeds are a food source for other seed-eaters; squirrels are prey for larger predators like owls; squirrels make nests that are later used by other small mammals; squirrels scold predators, warning other animals.

20. Acid precipitation causes forest soils to lose nutrients, and it also increases the amount of aluminum in soil, which interferes with the uptake of nutrients by trees. Some species cannot survive these changes. Acid precipitation also affects aquatic ecosystems because it can lower the pH of water, causing problems for fish, amphibians, and other organisms that live in the water. Some aquatic organisms are very sensitive to a drop in pH.

21. Canadians use more electricity; consume more oil; and have more highways, which probably indicates more vehicle use.

22. Answers will vary, but should include questions about chemicals and alien species that the ship may be carrying, and possibly also questions about where the ship has been.

Communication

23. The greenhouse effect is the process in which greenhouse gases in the atmosphere—such as water vapour, carbon dioxide, and methane—prevent heat from leaving the atmosphere, therefore increasing the temperature of the atmosphere. Without greenhouse gases, Earth's temperatures would be much colder than they are.

24. Answers may include symbols for biodiversity, communities, environmental groups, traditional ecological knowledge, and stewardship. Alternatively, symbols may represent five different rich ecosystems, for example, aquatic, tundra, prairie, forest, and wetland.

25. Flowcharts should show many of these connections:

- Prairie dogs → "dog towns" (burrow system) → poisoned, trapped, shot → soil poor, drier, plant diversity drops
- prairie dogs → "dog towns" → prairie rattlesnake, black-footed ferrets use the burrows and eat the prairie dogs → population reduced
- captive breeding in zoos → trained for wild → re-introduced → population rescued

Application

26. Questions might include the kinds and quantities of chemicals that were used; the likelihood of run-off; where and how the pesticide will be used and disposed of, what animals might come into contact with it, and how quickly it will decompose.

27. Answers should include an appreciation of the importance and difficulties of sustaining several ecosystems far apart and in different countries.

28. Students should include a rationale for their course of action, including risks and benefits; for example, using birds of prey to control the gull population does not introduce poisons into the environment, but birds of prey may eradicate other populations, and upset the balance in the ecosystem.

29. Answers will vary, but sustainable activities use resources more efficiently by using only what can be regrown. Unsustainable activities will eventually use up the resource.

30. property in public ownership, proximity of industry that might imperil the restored wetland, proximity of residential development, size, links to other wild areas, suitable topography

31. It might cause you to spend more funding on foxsnakes because we have a greater responsibility for the global population, and they have a smaller range overall.

Literacy Test Prep

32. b.

33. b.

34. d.

35. b.

36. CO_2: Burning fossil fuels releases carbon dioxide into the atmosphere. It is believed that increased carbon dioxide is causing global warming.

vehicles driven: Vehicle emissions contribute to acid precipitation.

paper used: Cutting down trees to produce paper leads to erosion, a loss of habitat, and less photosynthesis.

gasoline used: Gasoline is a fossil fuel that when burned, releases carbon dioxide into the atmosphere.

fresh water used: Water sources can dry out during long, hot periods with no rain. Chemicals from industries can contaminate water.

Sustainable practices may vary, but should address the issues listed above.