Get Ready for Unit 1

Sustainable Ecosystems

Answers for page 2

Multiple Choice

1. c

2. b

3. a

4. c

5. a

6. d

7. b

8. d

Answers for page 3

Written Answer

9. A population is a group of organisms of a single species that live in the same place at the same time. A community consists of all of the populations of different species that interact in a specific area or ecosystem.

10. Biotic components of an ecosystem include living things. Abiotic components of an ecosystem are non-living things, such as water, sunlight, and soil.

11. Primary producers, such as plants and trees, use light from the Sun during photosynthesis to generate energy. This energy is passed on to animals when the animals eat the plants. The energy is passed further up the food chain when plant-eating animals are eaten by other animals.

12. *Sample answer*: Three limiting factors are size of the area inhabited, access to water, and availability of food.

13. *Sample answer*: Instead of deforesting an area, which results in habitat loss, a lumber company removes a mixture of species and sizes of trees. Because the forest retains its biodiversity and its forest canopy, the remaining trees and undergrowth allow the forest to recover quickly.

14. a. *Sample answer*: Healthy river and lake ecosystems provide clean water for humans to drink and fish for humans to eat. **b.** *Sample answer*: When humans pollute the land, the pollutants enter the water and make it unsafe to drink. The pollutants also contaminate the fish that live in the water, which decreases the fish population and makes the fish unsafe to eat.

15. Answers will vary but may include fossil fuels, water, and soil.

16. About 40 plant species in Ontario are endangered.

Section 1.1 Review

Sustainability

Answers for page 4

Multiple Choice

1. e

2. a

3. e

4. b

5. b

6. b

7. e

8. e

Answers for page 5

9. b

10. a

11. a

12. c

13. d

14. d

15. d

16. a

Answers for page 6

Written Answer

17. An ecosystem includes all of the living things in an area and the non-living environment in which they live.

18. An ecosystem includes all of the living things in an area and the non-living environment in which they live. A sustainable ecosystem is an ecosystem that is capable of supporting a variety of organisms and is able to withstand changes to the living or non-living components of the ecosystem while returning to a state of equilibrium.

19. Both the quality and quantity of water in an ecosystem affect whether the ecosystem can maintain equilibrium and support a variety of organisms. If water sources dry out or become polluted, living things in the ecosystem may die or leave the area.

20. a. Biotic: C, D, E, F, G, H **b.** Abiotic: A, B, J, K

21. Nutrients are non-living parts of an ecosystem.

22. A river otter eats fish and crabs.

23. Predation occurs when one organism consumes another organism as food. Competition occurs when two or more organisms compete for the same resource, such as food.

24. Masses of mushrooms that live around the bases of trees help the trees absorb water and nutrients from the soil. In return, the mushrooms get food in the form of sugar that is produced by the trees.

Answers for page 7

25. a. predation **b.** competition **c.** symbiosis

26. The four main spheres that make up Earth are the atmosphere, the biosphere, the lithosphere, and the hydrosphere.

27. The salt water in the oceans and the fresh water on the continents form the hydrosphere. The layer of air above Earth's surface is the atmosphere.

28. Nitrogen and phosphorus move over land and enter aquatic ecosystems when rainwater runs off into lakes and oceans. Run-off is one way in which the water that falls as precipitation is returned to lakes and oceans.

29. Carbon dioxide, a gas, moves from the biosphere into the atmosphere and back again. Animals exhale carbon dioxide into the atmosphere and plants absorb it to use during photosynthesis. Carbon dioxide also moves back into the atmosphere when organisms die and their bodies decompose. Carbon enters the lithosphere when the remains of organisms are covered by sediment. After millions of years, these remains are converted into fossil fuels, such as coal, oil, and natural gas. Carbon dioxide is returned to the atmosphere when humans burn the fossil fuels for energy or through natural wildfires.

30. Fertilizer runs off from farmland into water, which causes algae to bloom. Submerged plants die due to reduced light, and then the algae and other plants die. Bacteria use oxygen during decomposition, which causes oxygen levels in the water to drop too low for fish to survive.

31. Scientists performed experiments to determine why Lake Erie was so eutrophic. They found that excess nutrients from fertilizers in run-off caused algal blooms, which led to low oxygen levels in the water. As a result of the work, Canada and the United States signed the Great Lakes Water Quality Agreement to reduce pollution and algal blooms.

32. Farmers volunteer to be part of a program in which particular environmental impacts of a family's farm are examined. Then they develop a plan to reduce some of these impacts, such as the amount of fertilizer in run-off.

Section 1.2 Review

The Biosphere and Energy

Answers for page 8

Multiple Choice

1. d

2. e

3. d

4. a

5. d

6. b

7. b

8. d

Answers for page 9

Written Answer

9. Energy is produced by nuclear reactions in the Sun.

10. These organisms use chlorophyll to convert sunlight into glucose.

11. Photosynthesis produces glucose, an energy supply that plants and the organisms that eat plants require for all of life's essential activities. Photosynthesis also continuously adds oxygen to the atmosphere and removes carbon dioxide from the atmosphere.

12. Herbivores are primary consumers. Carnivores are secondary consumers. Top carnivores are tertiary consumers. Plants are producers.

13. Biomass is lost because herbivores may not eat all the parts of a plant; for example, they may eat only the tops of the plants and leave the roots. Not everything that is eaten is digested; for example, fur may not be digested. Also, at every level, energy is lost as heat from the bodies of organisms. Because of the inefficiency of energy transfer among trophic levels, there are usually fewer carnivores than herbivores, and fewer herbivores than plants.

14. Approximately 90 percent of the energy is lost between one trophic level and the next in the food chain.

15. Bioaccumulation occurs when the body ingests toxins at a faster rate than it eliminates them. Biomagnification is the increase in the concentration of a toxin as it moves from one trophic level to the next in the food chain.

16. At high concentrations, DDT affects the reproduction of birds that contain the chemical. Exposure to PCBs also affects the reproduction of birds. When the substances were banned, the bird populations that had become endangered by these substances recovered.

Section 1.3 Review

Extracting Energy from Biomass

Answers for page 10

Multiple Choice

1. b

2. c

3. d

4. b

5. d

6. e

7. c

8. e

Answers for page 11

Written Answer

9. Gases in Earth's atmosphere prevent heat from leaving the atmosphere, which increases the temperature of the atmosphere.

10. Burning fossil fuels: burning biomass that was produced by photosynthesis millions of years ago. Cellular respiration: cells of organisms break down glucose. Both: consume oxygen, release energy, and produce carbon dioxide.

11. The burning of fossil fuels has increased the concentration of carbon dioxide in Earth's atmosphere, which has caused global warming.

12. The concentration of carbon dioxide in the atmosphere has increased. Before the Industrial Revolution, levels were less than 280 ppm. Since then, levels have increased to over 380 ppm.

13. In most cases, less energy is needed to make something from recycled materials than from new materials. Therefore, a smaller amount of fossil fuels is burned, and less carbon dioxide is released into the atmosphere.

14. Nitrogen oxide and sulfur dioxide are produced when fossil fuels are burned. When

these gases combine with water in the atmosphere, nitric acid and sulfuric acid are produced. These acids can travel great distances in the wind, eventually descending to Earth's surface in rain, sleet, or snow. The pH of the precipitation is lowered, and the precipitation becomes acidic.

15. Below the surface, a landfill ecosystem contains almost no oxygen. Bacteria in the landfill break down the glucose in the waste through the process of fermentation. However, the bacteria cannot extract all of the energy from the glucose. The energy they cannot extract gets re-assembled into a gas called methane.

16. *Sample answer*: Acid precipitation can cause forest soils to lose valuable nutrients, such as calcium. Acid precipitation can lower the pH of aquatic ecosystems, which can decrease survival for fish, amphibians, and other organisms that live in the water.

Chapter 1 Review

Nutrient Cycles and Energy Flow

Answers for page 12

Multiple Choice

1. e

2. a

3. d

4. b

5. a

6. c

7. e

8. d

Answers for page 13

Written Answer

9. In step 1, 423.7 units of energy are passed from the producer (which contains a total of 4237 units) to the primary consumer, because the primary consumer receives 10 percent of the energy that was in the previous step. In step 2, 42.37 units of energy are passed from the primary consumer to the secondary consumer, because the secondary consumer receives 10 percent of the energy that was in the previous step.

10. Bacteria in landfills generate methane through fermentation. Ontario landfills collect the methane gas formed at the landfill and burn it to produce electricity. This electricity is distributed to homes and businesses in the province.

11. Photosynthesis must occur during the daytime because sunlight is an essential part of the reaction that generates glucose. At night, because light is not necessary for cellular respiration, glucose can still be used to generate energy for the plant's life processes, such as growth.

12. If a producer absorbs a small amount of a substance that is toxic, that toxin will be passed to the primary consumer that eats the producer. If that primary consumer eats a lot of the contaminated producer, the consumer will begin to build up a higher concentration of the toxin in its body. If the population of primary consumers that contains the toxin is

hunted and consumed by a secondary consumer, an even higher concentration of the toxin will accumulate in the secondary consumer.

13. By understanding how human activities affect the ecosystem, government officials can understand how the construction of roads, buildings, and parks, and the generation of electricity, affect the local ecosystem. They can use this information to make decisions that support sustainability of the ecosystem.

14. Herbivores are animals that eat plants, carnivores are animals that eat other animals, and omnivores are animals that eat both plants and other animals.

15. During photosynthesis, plants use solar energy to assemble glucose molecules from water and carbon dioxide. During cellular respiration, the plant breaks down glucose, releasing chemical energy that can be used to perform life functions, such as growth.

16. Both types of organisms must obtain energy to survive. Producers convert sunlight into chemical energy. Consumers get chemical energy by eating producers.

Answers for page 14

17. Posters should show that the greenhouse effect is a natural process that results when certain gases in the atmosphere absorb heat. The enhanced greenhouse effect is an increase in the natural processes of the greenhouse effect that is caused by human activity, especially the burning of fossil fuels. Students may use diagrams or other illustrations to help explain these two effects.

18. Diagrams should show that glucose and oxygen are reactants and carbon dioxide and water are products in the process of cellular respiration. This process releases energy from glucose, making it available to body cells. Diagrams may show that the glucose originates from photosynthesis.

19. If water pH drops to 5.0, the number of mayflies will likely decrease. If the population of mayflies drops, fewer of the insects will be available for frogs to eat. As a result, the frog population will also decline.

20. Diagrams should show that when fossil fuels are burned, sulfur dioxide and nitrogen oxides are released into the atmosphere. These compounds combine with water in the air to form nitric and sulfuric acids. These acids cause the water in clouds to become acidic, and when that water falls to Earth as rain or snow, the precipitation is acidic.

21. Acid precipitation can lower the pH of the water. Some organisms are very sensitive to changes in pH. If the producers or primary consumers in the ecosystem are susceptible to changes in pH and begin to die, organisms higher in the food chain will be faced with a food shortage. Alternatively, if organisms in the middle of the food chain, such as secondary consumers, die from changes in pH, primary consumers may increase in

number. The increased population of primary consumers will put stress on the ability of producers in the ecosystem to support the new, larger population of primary consumers.

22. If a large quantity of fertilizer entered a lake or stream, the number of producers would likely increase because the fertilizer would provide nutrients to the producers. The number of consumers would likely rise initially, as more food became available to them. After a short time, however, the population of consumers would likely decline as the producers die and their decomposition uses oxygen that the consumers need to survive.

23. Answers may vary. Students should indicate that government controls on the use of fossil fuels, fertilizers, and pesticides can have a powerful effect on the health and sustainability of Canada's natural ecosystems.

24. Answers may vary. Students may mention that consuming food from conventional, commercial farms increases the amounts of both phosphorus and nitrogen in the ecosystem. They may also mention the use of some detergents. Examples of actions students can take include growing some of their own food, choosing organically grown food, switching detergents or using less detergent with each load of dishes or laundry.

Answers for page 15

25. Answers may vary but should demonstrate student understanding of the difference between biotic and abiotic components of an ecosystem.

26. Answers may vary but should demonstrate the differences between the two spheres. The lithosphere is the hard part that makes up Earth's surface. It contains the abiotic factors of soil and nutrients in soil. The word *lithosphere* comes from the Greek word for stone. The biosphere consists of the regions of Earth where living things exist. Living things are a biotic component.

27. Answers may vary. Posters should include a clear explanation of the initiative and have a list of actions that can be taken to support it.

28. *Sample answers*: **a.** phytoplankton, zooplankton, herring, cod **b.** grass, grasshopper, rat, snake, eagle **c.** berries, insects, raccoon

29. *Sample answer*: The ecologist could test the tissues of plants and fish in various parts of the wetland to see where else in the wetland the chemical has been absorbed by living things. The source would likely be near the highest concentrations of the chemical.

30. Biomagnification is occurring. At each trophic level, the concentration of the toxin increases.

31. Illustrations may vary but should demonstrate that cutting down trees results in habitat loss for many organisms, which can affect the sustainability of the ecosystem. Also, forests, especially rainforests, play an important role in adding oxygen to the

atmosphere and taking up carbon dioxide for photosynthesis. Creating an imbalance in these gases could affect the sustainability of the biosphere because many organisms need oxygen to undergo cellular respiration. As the concentration of carbon dioxide in the atmosphere increases, the greenhouse effect is enhanced. An increase in Earth's surface temperature is a change to an abiotic factor that could affect many organisms in the biosphere.

32. Pamphlets should explain that recycling reduces carbon dioxide emissions because less energy is needed to make something from recycled materials than from new materials. Materials that can be recycled include paper, glass, aluminum and other metals, and plastic. Statistics will vary but may include information on the amount of material recycled each year.

Section 2.1 Review

Populations and Resources

Answers for page 16

Multiple Choice

1. b

2. c

3. a

4. c

5. e

6. c

7. a

8. d

Answers for page 17

Written Answer

9. *Sample answer*: Exponential growth of a population may occur when resources are abundant, such as when an organism enters a new habitat, or when other population pressures, such as predation, decline.

10. No ecosystem has an unlimited supply of the resources that a population of organisms needs.

11. *Sample answers*: **a.** The labelled limiting factor is the availability and quality of water. **b.** The deer in the ecosystem require clean water to survive. If there is not enough water or if the water becomes polluted, the deer will get sick, die of thirst, or move to other areas where clean water is more plentiful.

12. When a population reaches its carrying capacity, and the environment cannot support more individuals, organisms begin to die. Over time, a balance develops between the number of individuals that are added to the population (by birth) and the number of individuals that leave or die. This balance is a state of equilibrium.

13. Urban sprawl is the growth of cities or urban areas as people build new homes and new businesses near the outer edge of a city.

14. a. In the 1800s, the fur trade led to a drastic reduction in the northern fur seal population. This decline prompted the first international treaty ever designed to conserve wildlife, which was signed in 1911. **b.** The fur seal population underwent exponential growth after it became protected, but eventually levelled out at the ecosystem's carrying capacity.

15. Intensification, in which new development occurs on land within the boundary of a city, reduces urban sprawl.

16. Negative effects of urban sprawl include more dependence on automobiles, decreased farmland as roads are built, and reduced carrying capacity for native organisms.

Section 2.2 Review

Interactions Among Species

Answers for page 18

Multiple Choice

1. b

2. a

3. a

4. d

5. d

Answers for page 19

6. a

7. d

8. b

9. b

10. b

11. b

12. d

13. c

14. c

Answers for page 20

Written Answer

17. An ecological niche is the way in which an organism occupies a position in an ecosystem, including all the necessary biotic and abiotic factors.

18. Biotic niche factors include the insects it eats, its competitors, and its predators.

19. Abiotic niche factors include the places it uses for roosting and hibernation, the time of night it hunts for food, and the temperature range it can tolerate.

20. In most bogs, the soil is nutrient-poor. The plants get nutrients by consuming insects.

21. They have a predator-prey interaction.

22. In bottom-up population regulation, the population growth and size are controlled by a shortage in food resources at a lower level of the food chain, such as plants or primary consumers. In top-down population regulation, the size of prey animal populations and producer populations are controlled by the population and behaviours of predators.

23. Answers may include any three of the following: space, food, water, and nutrients.

24. The more energy an organism spends competing for resources, the less energy it has for growth and reproduction. As a result, the reproduction rate of the population declines.

Answers for page 21

25. The ecosystem contains a limited amount of each resource. Individuals compete with one another to get the resources they need to survive and reproduce.

26. In a lake with just brook sticklebacks, these fish can be found feeding along the bottom, among the vegetation growing from the bottom, and in the shoreline waters above the vegetation. When brook sticklebacks share a lake with the nine-spine sticklebacks, however, the brook sticklebacks are only found at the bottom of the lake. The nine-spines are found in the water above the vegetation.

27. When there is no competition, a species can occupy a broad niche. When there is competition, however, the same species is forced into a narrower niche, or forced to behave differently in order to secure resources.

28. Symbiosis is an interaction between members of two species that live together in a close association.

29. Parasitism is a symbiotic relationship in which the niche of one species is dependent on a close association with a larger host organism.

30. For corals, an essential biotic factor is their symbiotic algal partner. The algae in the coral provide food for the coral. An essential abiotic factor is sea temperatures that do not become excessively warm. When water temperature rises, the algae leave the coral. As a result, the coral become white, and the decrease in photosynthesis results in less food for the coral, and the coral die.

31. White-tailed deer appear to be little affected by the brainworm. The minimal impact of the brainworm on its host allows the brainworm to complete its life cycle

successfully. Brainworms and white-tailed deer probably have an ancient relationship. This may be why deer are relatively immune to the damage.

32. The number of cases decreased.

Section 2.3 Review

Human Niches and Population

Answers for page 22

Multiple Choice

1. c

2. e

3. e

4. e

5. a

6. c

7. e

8. c

Answers for page 23

Written Answer

9. Humans use their brains to build complex tools, control external forms of energy, and expand the use of resources.

10. A deadly plague, or disease, caused a large drop in population around 1400.

11. The beginning of the Industrial Revolution and major scientific advancements have been followed by large population growths.

12. The human population is rapidly approaching its carrying capacity. Earth currently contains more than 6.7 billion people. Scientists project that Earth's carrying capacity for humans is probably less than 9 or 10 billion people.

13. An ecological footprint is a measure of the impact of an individual or a population on the environment in terms of energy consumption, land use, and waste production.

14. *Sample answer*: Sustainable use involves using resources at levels that continue forever. Unsustainable use involves using resources in a manner that leads to the decline in the function of an ecosystem. Both involve a way in which resources are used.

15. The average person in developed countries, which includes Canada, has a larger

ecological footprint than the average person in other parts of the world.

16. Consuming fewer resources would decrease a person's ecological footprint because using less resources means less fossil fuels will be burned.

Section 2.4 Review

Ecosystem Services

Answers for page 24

Multiple Choice

1. e

2. a

3. c

4. b

5. a

6. c

7. d

8. b

Answers for page 25

Written Answer

9. Ecosystem services include the provision of food and clean water, the cycling of nutrients, the conversion of atmospheric carbon into biomass, the pollination of crops and natural vegetation, the balance of processes such as growth and decomposition, and the provision of beauty and spirituality.

10. Trees remove huge amounts of water from the soil. This water leaves the trees and enters the atmosphere as water vapour, which forms clouds. The water falls as rain and helps reduce local temperatures. When large forested areas are cleared, the local annual precipitation drops and the climate gets hotter and drier.

11. Male pollen from one flower is carried to the female ovary of another flower by insects or other organisms. The pollen fertilizes the ovary and reproduction occurs.

12. The three decomposers in ecosystems are insects, bacteria, and fungi.

13. Step 1: When burying beetles find the body of a small animal, such as a mouse, they quickly dig soil out from under the body. Step 2: The body sinks below the surface and the beetles cover the body to help prevent flies from laying eggs. Step 3: The adult beetles lay eggs on the decaying body, then use the body to feed their growing larvae.

14. All aerial insectivores leave Canada for the winter and migrate great distances to other locations. Factors that affect the survival of the birds can come into play at any point along the route, which make it difficult to pinpoint specific events or resources that may be limiting the populations.

15. *Sample answer*: Biologists at Bird Studies Canada, an organization dedicated to the welfare of Canadian birds, have developed an international program that uses financial resources and expertise to foster stewardship and bird research in tropical regions of North and South America.

16. Two trips include: a boat trip to view whales, dolphins, and sea birds or a trip to watch birds fly back and forth between breeding grounds in Canada and wintering grounds farther south.

Chapter 2 Review

Populations and Sustainable Ecosystems

Answers for page 26

Multiple Choice

1. d

2. b

3. c

4. e

5. b

6. c

7. c

8. d

Answers for page 27

Written Answer

9. Removing trees decreases water absorption by the soil and results in higher amounts of run-off and soil erosion.

10. When an exponentially growing population reaches carrying capacity, resources become limited and scarce, and organisms begin to die. As a result, the population decreases in size.

11. Seed production is much higher in plants that are cross-pollinated by insects. If the population of the pollinating agent were to decline dramatically, the success of the cross-pollinated plants would decline dramatically as well.

12. The population experienced exponential growth. Exponential growth occurred because a population pressure (hunting) was removed.

13. Unsustainable use of resources could result in the reduction of the ecological niche available to humans.

14. Many songbirds that occupy Canadian woodlands during the summer spend time in

tropical ecosystems during the winter, including ecosystems in which coffee is grown. Coffee can be grown either in sunlight, in which case forests are cleared and a monoculture of coffee is planted, or in shade, in which forests are not cleared and the coffee is grown in natural landscapes that include the shade of overhanging trees. Clearing forests in order to grow the coffee in sunlight results in habitat loss for songbirds, which may affect their populations.

15. In most cases, a parasite harms its host in some way.

16. Three ecosystem services of forests include: providing resources for the logging industry, influencing climate, reducing erosion in watersheds, or providing habitat for thousands of species.

Answers for page 28

17. Initially, the population will grow, and it may grow exponentially, as it competes successfully for food and does not have natural predators. Over time, the other organisms in the ecosystem will adapt to compete better with the new species and predators will begin to hunt the new species. These factors will limit the number of individuals of the new species that survive, and the population of the new species will stabilize or decline.

18. Answers will vary but should include a stated hypothesis and an experimental design that has a control group and an experimental group. *Sample answer*: When the carrying capacity for space is reached, female mice will give birth to fewer mice per litter. I would include several groups in the experiment, including a control group. The independent variable would be the area squared per mouse. I would measure and record the number of mice per litter in each group.

19. Graphs should show a population at carrying capacity, then the population numbers decrease rapidly as time increases. Graphs should be labeled in the area of carrying capacity and in the area in which the population exceeded carrying capacity.

20. Because the number of nesting sites for the flying squirrels would decrease, competition for those sites would increase. The number of nesting sites would act as a limiting factor. As a result, the flying squirrel population would decrease.

21. Big brown bats live in caves and they are insectivores. Horned owls live in trees and they are carnivores. Owls eat organisms such as mice and lizards.

22. No two species can occupy the exact same ecological niche or provide the exact same services to their ecosystem because if they did, the two species would be in constant competition for every resource they need. Eventually one species would out-compete the other species.

23. Answers will vary but should include ecosystem services such as the beauty and recreational use of the area, the fact that the trees produce oxygen and take in carbon

dioxide from the atmosphere, and the role that the tree roots playing in helping to reduce erosion.

24. *Sample answer*: Their niches overlap in that both species are omnivorous, they both live in woodlands, and they both nest in holes in trees. Their niches are different in that brown-headed nuthatches forage for food on the bark of trees, whereas redheaded woodpeckers catch insects in the air, and drill into tree bark to find insects.

Answers for page 29

25. Students' graphs should show that in the short term, the populations of the prey organisms would increase rapidly. Eventually, the growth rates of the populations would slow, and the population sizes of these organisms would stabilize as the populations of remaining organisms competed for resources and developed new predator-prey relationships. The population would reach a new carrying capacity that is defined by the altered limiting factors of the changed ecosystem.

26. In mutualism, both organisms benefit from the relations. In most parasitic relationships, the parasite harms the host. Both are examples of symbiosis.

27. Ecosystems supply raw materials that can be used in artifacts or tools for spiritual practices. For example, trees can provide wood that can be carved into totem poles or altars.

28. Answers will vary. Students' presentations should identify a local ecosystem, the ecological services provided by that ecosystem, and how those ecological services benefit humans.

29. *Sample answer*: **a.** The size of the population grew until it reached a point at which it was slowed by limiting factors. **b.** Most likely, the population will remain the same or decline slightly because the population has reached the carrying capacity, the point at which the birth rate and death rate keeps the size of the population at an equilibrium.

30. Both species showed higher population numbers and a higher carrying capacity when grown alone. When they were cultured together, the *Paramecium aurelia* had lower population numbers but still stabilized after reaching carrying capacity. The *Paramecium caudatum* grew exponentially, but then population numbers were reduced to zero.

31. *Sample answer*: There was competition between the two species for resources. Two limiting factors were food and space. The *Paramecium aurelia* out-competed the *Paramecium caudatum.*

32. Posters may vary but should demonstrate that four ecosystem services such as recreation in the form of beaches and boating, food in the form of fish, seaweed, and shellfish, phytoplankton release oxygen into the atmosphere and take in carbon dioxide, and oceans are beautiful and are a source of inspiration to millions of people.

Section 3.1 Review

Measuring Biodiversity

Answers for page 30

Multiple Choice

1. e

2. b

3. d

4. d

5. b

6. e

7. e

8. e

Answers for page 31

Written Answer

9. Scientists estimate that the total number of species on Earth ranges between 5 million and 100 million species.

10. The methods used depend on the types of organisms ecologists are counting and on the environment. For example, the methods used to study organisms that live in oceans must differ from those used to study organisms that live in soil or in trees.

11. Because ecosystems are influenced by human activities, studying and recording biodiversity information allows land-use planners to know the location of different species, especially rare or sensitive ones.

12. Almost 5000 species of plants have been identified in Canada.

13. Peary caribou are found only in the Canadian Arctic and in Greenland.

14. A biodiversity hotspot is a place that has an exceptionally large number of species in a relatively small area.

15. Leitrim Wetlands is a biodiversity hotspot because it is home to more than 200 species of plants and 90 species of birds. This number of species is higher than what is found in most places in Canada.

16. Biodiversity is highest near the equator (at low latitudes) and lowest near the poles (at high latitudes).

Section 3.2 Review

Communities

Answers for page 32

Multiple Choice

1. a

2. b

3. a

4. d

5. b

6. b

7. b

8. a

Answers for page 33

Written Answer

9. There are many types of relationships among organisms in a community, such as symbiosis, competition, and predation. Species depend on these interactions, so it is important to preserve the biodiversity of communities in order to protect the individual species in that community.

10. Three categories of organisms that have an important impact on the functioning of an ecosystem are dominant species, keystone species, and ecosystem engineers.

11. Sea otters are a keystone species. They are not the most abundant species in the ecosystem, but they greatly affect the population numbers in an ecosystem.

12. Dominant species are so abundant that they have the largest amount of biomass of any community member. In a terrestrial ecosystem, producers have a higher biomass than consumers because producers form the base of the food chain and form the lowest trophic level.

13. Prairie dogs are a keystone species because when their populations were decreased through poison, trapping, and hunting, the wild prairie ecosystem suffered from lower

plant diversity, inefficient mixing and water penetration of the soil, insufficient nitrogen in the soil, and a reduction in the population of other animals.

14. By removing a species from its environment, scientists can ensure the safety of the organisms and increase the resources dedicated to the species. Once a population of an endangered species is large enough to survive in the wild, scientists can re-introduce the species into its natural habitat.

15. By building dams across streams and creeks, beavers create ponds that provide them with safety and a food supply of aquatic plants. Their tree-cutting activities also make small clearings in the forest. Many species of fish, birds, amphibians, and insects benefit from a beaver-pond ecosystem. What was once moving water becomes a calm refuge for juvenile fish, migrating birds, and aquatic insects.

16. Succession is the series of changes in an ecosystem that occurs over time following a disturbance. In the case of a beaver pond, the area changes from forest to flooded forest, then to sunny pond, and ultimately to an abandoned pond that becomes a beaver meadow.

Section 3.3 Review

Threats to Biodiversity

Answers for page 34

Multiple Choice

1. c

2. a

3. e

4. e

5. a

6. d

7. e

8. c

Answers for page 35

9. d

10. c

11. b

12. b

13. c

14. c

15. c

16. d

Answers for page 36

Written Answer

17. *Sample answer*: Humans can drastically alter the conditions of an ecosystem by draining wetlands, cutting down trees, and damming rivers.

18. Deforestation is the practice of clearing forests for logging or other human uses and never replanting them.

19. Deforestation caused the number of bird species in these provinces to decline from a maximum of 105 species to 67 species in only eight years.

20. Canada's boreal plains ecosystem is home to more birds than any other forest ecosystem in North America.

21. Most alien species are harmless or beneficial in their new environments, whereas invasive species upset the equilibrium of an ecosystem and cause problems for native species.

22. Scientists think they arrived in the ballast water of ships.

23. Ontario, Québec, and British Columbia have the most invasive plant species.

24. It could have arrived by accident due to human activities, such as the shipment of food or other goods.

Answers for page 37

25. The three ecosystems connected are a stream in the temperate rainforest, a marine ecosystem, and a terrestrial ecosystem in the temperate rainforest. Salmon connect the three ecosystems. Salmon hatch in freshwater streams throughout the temperate rainforest. They then migrate to the Pacific Ocean and pick up nutrients from the marine ecosystem. When the salmon return to the streams to reproduce, bears and other animals move the salmon from the stream beds far into the forest. When the remains of the salmon decay in the forest, nutrients from their bodies, including nitrogen, enter the soil.

26. Possible consequences include a reduction in the carrying capacity in the terrestrial ecosystem (due to a reduction in nutrients, which can be a limiting factor), and a reduction in the biodiversity of the temperate rainforest ecosystem (if nutrients are limited, some species may not be able to survive).

27. Possible answers: low population numbers or extinction

28. Extinction is caused by an imbalance in the rates at which individuals of a species are born and die. If, over a period of time, the death rate exceeds the birth rate, the organism will become extinct.

29. The two extinction patterns are background extinction (extinction of a species during a period when the ecosystem is changing gradually over time) and mass extinction (extinction of many species in a very short time as a result of a catastrophic change in the ecosystem).

30. Scientists think that the biodiversity crisis is caused by the actions of humans.

31. Large sections of Earth's forests have been cut down for timber or cleared for agricultural use.

32. Humans can improve the sustainability of Earth's ecosystems are decreasing human impact on ecosystems and restoring ecosystems that have already been altered.

Section 3.4

Restoration Ecology

Answers for page 38

Multiple Choice

1. d

2. c

3. c

4. c

5. b

6. b

7. c

8. a

Answers for page 39

Written Answer

9. Just as rivets hold an airplane wing together, species hold ecosystems together. There are some special "rivets" that ecosystems cannot afford to lose, such as the keystone species.

10. One major goal of restoration ecology is to produce a sustainable ecosystem where an existing ecosystem has been altered by human activity.

11. The red pines provided shade, under which many native tree species, such as sugar maple, beech, hickory, and ash, could grow.

12. Scientists used a fly called a parasitoid to try to control the spread of the gypsy moth, which escaped from a lab into the forest ecosystems of eastern North America. The fly kills the gypsy moth caterpillar by laying its eggs inside of it.

13. Scientists used chemicals to eliminate a population of rats that were introduced to Langara Island.

14. In bioremediation, scientists introduce living plants, bacteria, and fungi to absorb poisons. Then, the organisms are harvested, which removes the toxins from the environment. In bioaugmentation, scientists use organisms to add essential nutrients to depleted soil. Both are methods used by restoration ecologists.

15. Captive breeding programs can provide ecologists with large enough populations of keystone species to re-introduce into the natural environment. These keystone species help stabilize the functioning of the ecosystem and speed up recovery of altered ecosystems.

16. a. After approximately 14 days, 90% of the toxins were removed. **b.** All the toxins were removed after 31 days.

Chapter 3 Review

Biodiversity

Answers for page 40

Multiple Choice

1. a

2. d

3. c

4. d

5. a

6. a

7. b

8. b

Answers for page 41

Written Answer

9. Biodiversity is the number and variety of organisms found within a specific region.

10. For biodiversity to remain high, Earth must support a variety of ecosystems and those ecosystems must remain sustainable.

11. In canopy fogging, a low dose of insecticide is sprayed up into the top of a tree. When the insects fall, they are collected on a large screen, and scientists keep or observe some insects. In netting, fine mesh nets are used to capture birds and bats in terrestrial ecosystems and fish and other organisms in aquatic ecosystems. Once captured, the organisms are identified, measured, tested, tagged, and then released.

12. Scientists record the number and variety of living things on Earth so that they know the locations of different species and can protect or preserve rare or sensitive organisms and their ecosystems.

13. A dominant species plays an important role in an ecosystem. It is the foundation of the food chain, and it commonly provides shelter to many other species. If a dominant

species is removed from an ecosystem, the other species that depend on the dominant species for food or shelter may either die or leave the ecosystem.

14. The prairie dog is a keystone species in the ecosystem in which the black-footed ferret lives. The prairie dog digs burrows that the ferrets live in, and black-footed ferrets are predators of prairie dogs.

15. Habitat loss occurs when events, caused by natural disasters or human activities, alter a terrestrial or aquatic ecosystem so drastically that many species can no longer survive there. If the organisms cannot move somewhere else, or if no alternative habitat is available, species may not survive and biodiversity is threatened.

16. Succession is shown in the diagram.

Answers for page 42

17. Zebra mussels are ecosystem engineers. They change the ecosystem so dramatically that the species composition begins to change.

18. *Sample answer*: When people travel long distances, such as from one side of a continent to another or from one continent to another, seeds may be attached to their shoes or clothing. If the seeds reach a suitable habitat and germinate, this can lead to the establishment of an alien species in an ecosystem.

19. If humans practise stewardship, ecosystems will remain sustainable. If ecosystems remain sustainable, biodiversity will remain high and at healthy levels. If biodiversity remains healthy, it will encourage everyone to practise stewardship. If humans do not practise stewardship, ecosystems will not remain sustainable. If ecosystems are not sustainable, biodiversity will decrease. One solution to help slow the rate of decreasing biodiversity (or even reverse it) is to practise stewardship.

20. Students' pamphlets may include the following information: Although Carolinian Canada makes up only 1 percent of Canada's total landmass, it has a higher number of species than any other ecosystem in Canada. It is estimated to have 2200 plants, including endangered trees and orchids, as well as 40 percent of Canada's breeding birds. Biodiversity is the number and variety of organisms found in a specific region. A biodiversity hotspot is a place where there is an exceptionally large number of species in a relatively small area.

21. Answers may vary but should include steps in each process. **a.** Oil was spilled. Micro-organisms are released at the site of the spill. They break down the oil. Damage to the coastline may be reduced. **b.** The soil in a farm field is nutrient-poor. Clover is planted. Nitrogen levels in soil are replenished. Crops can be planted on the field again.

22. An ecosystem engineer alters the landscape in a way that makes it more suitable for other species.

23. Diagrams should show that in the kelp forest, otters are a keystone species that controls the population of sea urchins through predation. When fewer otters are around to eat the sea urchins, the sea urchins eat more kelp, which reduces the amount of energy for other primary consumers in the ecosystem.

24. The red-naped sapsucker is a keystone species. A keystone species is one that can greatly affect the population numbers of other species and the health of an ecosystem.

Answers for page 43

25. Answers will vary. Survey methods could include quadrat sampling or transect sampling. In either method, a certain area of the prairie will be sampled. The total area sampled should be recorded, along with the number of species found and, if possible, the number of individuals in each species. Multiple surveys, the locations of which are randomly determined, should be taken within the prairie so that a representative sample is measured.

26. *Bio* means life, the root word *remediation* means to remedy or to make correct. Bioremediation is the use of living organisms to remove toxins from an area. The root word *augmentation* means to improve or make better. Bioaugmentation is the use of living organisms to improve the quality of soil by adding essential nutrients back into the soil.

27. Between years 60 and 110, the forest is experiencing exponential growth. The forest must be undergoing succession as a result of a wildfire, landslide, or deforestation that removed most of the trees from the area.

28. *Sample answer*: Humans get practical, ethical, and spiritual benefits from practising stewardship. If stewardship is practised, they live in healthy, sustainable ecosystems that provide good food and clean water. They get the satisfaction of taking care of Earth and conserving it for future generations. They experience the beauty and spirituality of natural systems that have been unaffected by human activities.

29. If an area has high biodiversity, an argument could be made to leave it undisturbed or make sure any resources are extracted in a sustainable manner.

30. The populations of herbivores and small carnivores greatly increased because they were no longer being preyed upon by larger predators. They also had fewer competitors for food and other resources. However, the increase in herbivore populations may have reduced the biodiversity of plants on the islands because the herbivores were eating more plants as competition within and between species increased over time.

31. Governments need to understand how ecosystems are connected so they can decide which areas to protect to ensure that the maximum biodiversity is preserved.

32. Graphic organizers will vary but should include the following ecosystems services: Thousands of other organisms live in wetlands. Wetlands are a protected environment in which juvenile animals can grow and develop. Every spring and fall, migrating birds also use wetlands to feed and rest. The plants that grow in wetlands filter sediment and pollution from water.

Unit 1 Review

Sustainable Ecosystems

Answers for page 44

Written Answer

1. Many organisms depend on more than one ecosystem to survive. Migratory organisms, such as birds and monarch butterflies, move over a large distance throughout the year. As they migrate, they stop to drink water, eat nectar and insects, and rest. They are dependent on the many ecosystems along their migratory route for food and shelter.

2. Salmon provide *connectivity* among three ecosystems: an *aquatic ecosystem* in the temperate rainforest, a marine ecosystem in the Pacific Ocean, and a *terrestrial ecosystem* in the temperate rainforest. These ecosystems are connected because the salmon moves between the stream in the temperate rainforest, the Pacific Ocean, and back to the stream, transferring nutrients, particularly nitrogen, from the ocean to the stream. The *food chain* further connects the stream to the terrestrial ecosystems of the forest when bears and other animals eat the salmon, dragging the fish and leaving their remains on the forest floor. When the remains of the salmon decay in the forest, a natural part of any *nutrient cycle*, nutrients from their bodies, including nitrogen, enter the soil. Scientists think that the increase in nutrient availability, which can be a *limiting factor*, leads to an increase in *biodiversity* with the forest.

3. *Sample answer*: The areas that have the highest populations have the highest number of incidents, but the area that has the lowest population does not have the lowest number of incidents. Where there are more people driving, there are likely to be more incidents where animals attempt to cross the roadways. Areas with a lower human population may have higher animal populations, which could increase the number of incidents as well.

4. *Sample answer*: primary producer: grass, primary consumer: grasshopper (herbivore), secondary consumer: prairie dog (carnivore), tertiary consumer: hawk (carnivore), decomposer: bacteria

5. Concept maps should include all terms and appropriate phrases that link the terms together.

6. One method is biocontrol, which is the use of one species to control the population growth or spread of an undesirable species. Biocontrol sometimes backfires when native species are also attacked by the biocontrol species. A second method is using chemicals as poisons to remove unwanted pests; however, native species may also be susceptible to the toxic chemical.

7. Answers may vary. Most students will classify the relationship between domesticated dogs and humans as mutualism, since both species appear to benefit from the relationship.

8. The population of gypsy moths in 1981 was much smaller than the population had been in 1980. The gypsy moth caterpillars exceeded the carrying capacity of the food source. The availability of food acted as a limiting factor, and the population of gypsy moths declined.

Answers for page 45

9. Presentations should explain that if an ecosystem cannot remain sustainable, the carrying capacity of the populations within the ecosystem may decrease. This can further reduce the sustainability of the ecosystem and may lead to a decrease in biodiversity within the ecosystem, and possible the extinction of species.

10. *Sample answer*: Preserving ecosystems is a better strategy than preserving individual species. If the ecosystems are sustainable, the species that live in them will most likely survive and not be threatened with extinction. Although preserving an individual species is sometimes necessary, it is better to look at the big picture. The real issue is that the species is endangered because its ecosystem is not sustainable.

11. *Sample answer*: Lynx prey on snowshoe hares. As the population of snowshoe hares rises, the population of lynx also rises. As the population of snowshoe hares declines, the population of lynx also declines. This rise and fall appears to occur roughly every 10 years. However, the population of lynx lags slightly behind that of the hares, so the number of hares peaks and begins to decline while the number of lynx is still increasing.

12. Flowcharts should show that after organisms die, they decompose. In the process of decomposition, nitrogen is released from the organism's body and returned to the soil. The nitrogen is converted to nitrate by soil bacteria. Some of the nitrate is taken up by plants and some is returned to the atmosphere in the form of nitrogen gas.

13. Each organism in an ecosystem has a unique ecological niche and provides unique ecological services. These services are essential to the cycling of matter and energy, and to the health of the ecosystem and the planet.

14. This predator-prey relationship is regulated by both top-down and bottom-up forces, depending on the behaviour of the seals. If the seals remain in a large colony, the predators regulate the seal population, which is top-down regulation. If the seals leave the colony, thus limiting the population of predators (which is limited by the amount of food the predators can catch), the seals regulate the populations of sharks and killer whales, which is bottom-up regulation.

15. Conservation scientists could try to deter predators from staying in the area, or they could try to develop new areas that would be attractive to the seals as colony living space.

16. Answers may vary. Students should provide a scientifically accurate rationale for choosing either the keystone or dominant species.

Answers for page 46

Literacy Test Prep

Unexpected Predators

Multiple Choice

17. b

18. d

19. a

20. a

21. d

Written Answer

22. Students may draw a line that represents the cyclical rises and falls of the lemming population, along with a line that represents changes in the shorttail weasel population. Students could then draw in arrows with talking boxes at appropriate points along the cycles to explain why changes are taking place. Students may choose to draw a flowchart or a cyclical diagram as well.

Answers for page 47

Literacy Test Prep

Biomagnification of Mercury

Multiple Choice

23. d

24. a

25. d

26. c

27. c

Written Answer

28. Answers will vary but should include that mercury is toxic to living things at certain concentrations and that it biomagnifies in the tissues of living things.