UNIT 1
Sustainable Ecosystems and Human Activity

- **Topic 1.1**: What are ecosystems, and why do we care about them?
- **Topic 1.2**: How do interactions supply energy to ecosystems?
- **Topic 1.3**: How do interactions in ecosystems cycle matter?
- **Topic 1.4**: What natural factors limit the growth of ecosystems?
- **Topic 1.5**: How do human activities affect ecosystems?
- **Topic 1.6**: How can our actions promote sustainable ecosystems?

Topic 1.1 What are ecosystems, and why do we care about them? (Pages 8-17)

Key Concepts

- Ecosystems are about connections.
- Ecosystems are made up of biotic (alive) and abiotic (not alive) parts that interact.
- Interactions between terrestrial (land) ecosystems and aquatic (water) ecosystems keep all ecosystems healthy.

Life is Everywhere

Living things are found almost everywhere on planet Earth!

Each living thing makes its home somewhere.

Many organisms even make your body their home.

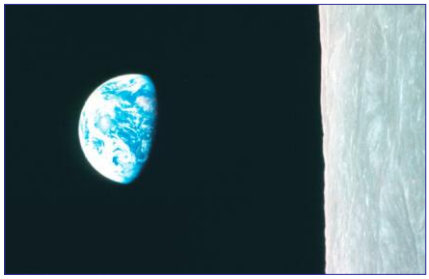
What different ecosystems can you identify in the picture on the left?

Ecosystems are Everywhere

Living things make their homes in the places they do because these places provide them with what they need to survive.

What different ecosystems can you identify in the picture on the left?

Ecosystems are about connections.



A trip to the moon gave astronauts a very special view of Earth, a view of an Earth where everything is connected.

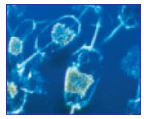
Studying the Connections

Ecology is a branch of science that studies the relationships between living things and the environment.

Ecosystems can be very large or very small. It all depends on the types and numbers of connections an **ecologist** wants to study.

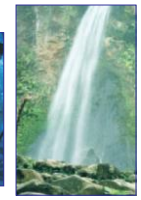
Ecosystems are made up of biotic and abiotic parts that interact.

All **living** things in an ecosystem are the **biotic** parts of the ecosystem. They include micro-organisms, plants, and animals.



Ecosystems are made up of biotic and abiotic parts that interact.

The **non-living** parts of an ecosystem are described as being **abiotic**. Examples of abiotic things include the soil, the water, sunlight, temperature, and air in an ecosystem.



Interacting Biotic and Abiotic Parts

To function and stay healthy, the biotic parts of an ecosystem interact with each other as well as with the abiotic parts.

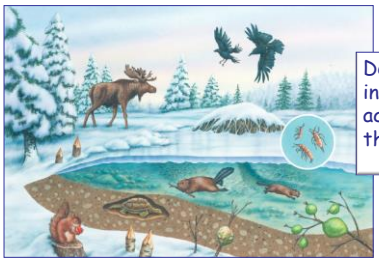
An **ecosystem** is a system that is made up of all of the interacting **biotic** and **abiotic** parts of a certain place.

Name the interacting biotic and abiotic parts in a beaver pond ecosystem.

Interactions between terrestrial and aquatic ecosystems keep all ecosystems healthy.

A **terrestrial ecosystem** is an ecosystem that is based mostly or totally on land.

An **aquatic ecosystem** is an ecosystem that is based mostly or totally in water.



Describe interactions in the terrestrial and aquatic ecosystems in the image on the left.

Interactions within and between ecosystems sustain life.

Terrestrial and aquatic ecosystems are closely linked.

Interactions keep biotic and abiotic parts of all ecosystems balanced. This keeps all ecosystems healthy.

Human activities can upset this balance.

Topic 1.1 Review

Key Concepts to be reviewed:

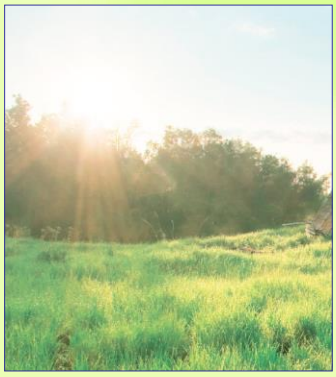
- *Ecosystems are about connections.*
- *Ecosystems are made up of biotic (alive) and abiotic (not alive) parts that interact.*
- *Interactions between terrestrial ecosystems and aquatic ecosystems help keep all ecosystems healthy.*

Topic 1.2 How do interactions supply energy to ecosystems? (Pages 18-27)

Key Concepts

- Photosynthesis stores energy, and cellular respiration releases energy.
- Producers transfer energy to consumers through food chains and food webs.
- Interactions are needed to provide a constant flow of energy for living things.

The Sun's Energy Sustains All Life



The energy that you depend on to sustain your life is stored in the food you eat. And that energy originally came from the Sun.

The Sun's Energy Sustains All Life

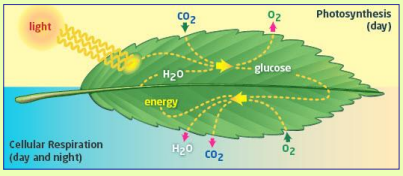
How do the adult cow and the calf depend on energy that originally came from the Sun?

How are foods that you have eaten lately related to energy that came from the Sun?

Photosynthesis stores energy, and cellular respiration releases energy.

Photosynthesis is a process that occurs in the cells of plants, algae, and some bacteria that converts light energy from the Sun into stored chemical energy.

Cellular respiration is a process that occurs in the cells of most organisms that converts the energy stored in chemical compounds into usable energy.



Photosynthesis

	Photosynthesis
1. What is it?	A series of chemical changes in which green plants capture the Sun's light energy and transform it into chemical energy that is stored in energy-rich food compounds such as sugars
2. Which living things use it?	Only green plants and certain kinds of single-celled organisms
3. How is energy changed?	Light energy is changed to chemical energy.
4. What substances does it use?	• carbon dioxide • water
5. What substances does it produce?	• glucose and other sugars • oxygen
6. How can it be represented?	light energy + carbon dioxide + water ⟶ glucose + oxygen 
7. Why is it important?	1. Photosynthesis transforms the Sun's energy into a form that living things can use to survive. 2. Photosynthesis produces the oxygen that most living things need to survive.

Cellular Respiration

Cellular Respiration	
A series of chemical changes that let living things release the energy stored in energy-rich food compounds such as sugars to fuel all life functions	1. What is it?
Nearly all living things on Earth	2. Which living things use it?
Chemical energy is changed to other forms of energy such as kinetic (motion) energy and heat.	3. How is energy changed?
• glucose and other sugars • oxygen	4. What substances does it use?
• carbon dioxide • water	5. What substances does it produce?
glucose + oxygen ⟶ carbon dioxide + water vapour + usable energy 	6. How can it be represented?
1. Cellular respiration releases the energy that living things use to survive. 2. Cellular respiration produces the carbon dioxide that green plants need to carry out photosynthesis.	7. Why is it important?

Comparing Photosynthesis and Cellular Respiration

Photosynthesis:

- Stores energy
- Uses carbon dioxide and water
- Produces glucose and oxygen

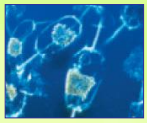
Cellular Respiration:

- Releases energy
- Uses glucose and oxygen
- Produces carbon dioxide and water

Producers transfer energy to consumers through food chains and food webs.

Producers are any living thing that gets the energy it needs by making its own food.





They use photosynthesis to do this. Only **green plants** and **some kinds of single-celled living things** can carry out photosynthesis.

Producers transfer energy to consumers through food chains and food webs.

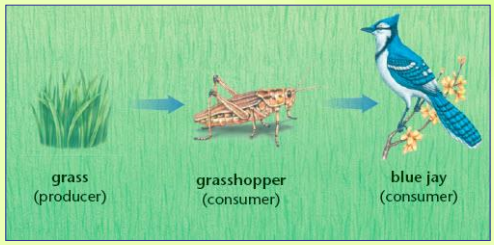
Consumers are any living thing that gets the energy it needs by eating producers or other consumers.



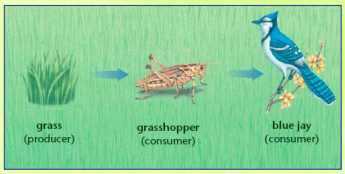
Animals and most other kinds of living things are consumers.

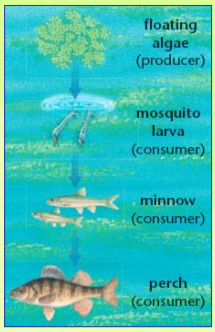
Food Chains Chart the Flow of Energy

A **food chain** is a model that describes how the energy that is stored in food is transferred from one living thing to another.



Food Chains Chart the Flow of Energy

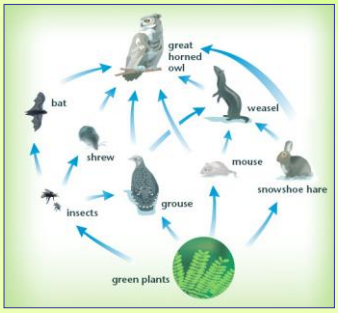




- The flow of energy always goes from a producer to a consumer, and then onto one or more other consumers.
- The path of energy always follows the path of a straight line.

Food Webs Map Many Food Chains

A **food web** is a model that describes how energy in an ecosystem is transferred through two or more food chains.



Identify four food chains in the food web pictured on the left.

Interactions are needed for a constant flow of energy for living things.

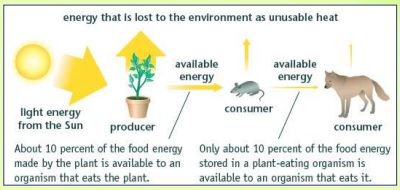
Most food chains have three or four links. There are limits to the length of a food chain because less energy is transferred as you move higher up the food chain.

At each step in a food chain energy is lost:

- to support life functions of the organism
- as heat to the environment
- as waste (urine and faeces) to the environment

Losses as resources move through a system

The images on the right show how water and energy can be lost as they move through a system.



Topic 1.2 Review

Key Concepts to be reviewed:

- *Photosynthesis stores energy and cellular respiration releases energy.*
- *Producers transfer energy to consumers through food chains and food webs.*
- *Interactions are needed to provide a constant flow of energy for living things.*

Topic 1.3 How do interactions in ecosystems cycle matter?

(Pages 28-39)

Key Concepts

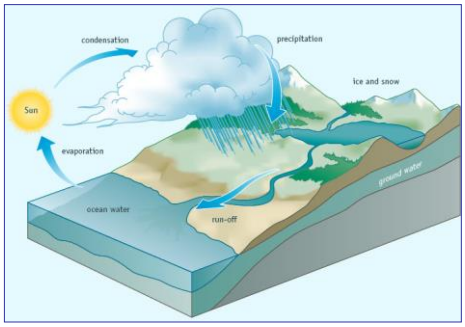
- Abiotic and biotic interactions cycle matter in terrestrial and aquatic ecosystems.
- Photosynthesis and cellular respiration cycle carbon and oxygen in ecosystems.
- Human activities can affect ecosystems by affecting nutrient cycles.

Cycles are Everywhere

Cycles are links of changes whose endings lead back to where they began. Calendars, the life stages of organisms, product life cycles, and successive changes in substances in nature (like water) are all examples of cycles.

The life cycle of an aluminum can is shown to the left.

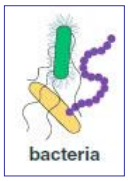
The Water Cycle



Why is the water cycle (shown above) a cycle?

Abiotic and biotic interactions cycle matter in terrestrial and aquatic ecosystems.

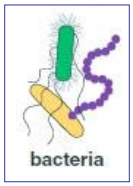
Decomposers are organisms that obtain energy by consuming dead plant and animal matter.



Examples of decomposers include insects in soil and earthworms, fungi (moulds, mushrooms), and certain kinds of bacteria.

Abiotic and biotic interactions cycle matter in terrestrial and aquatic ecosystems.

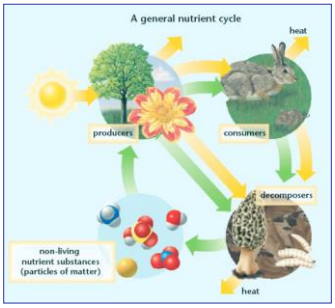
As decomposers digest waste materials, substances in the wastes enter the soil, water, and air as **nutrients**.



A **nutrient** is any substance that a living thing needs to sustain life.

Interactions and Nutrient Cycles

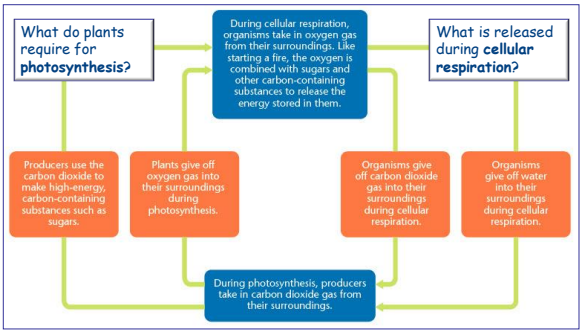
A **nutrient cycle** is the pattern of continual use and re-use of a nutrient.



Examine the nutrient cycle on the left and try to determine the pathway followed by **energy** and **matter** in the cycle.

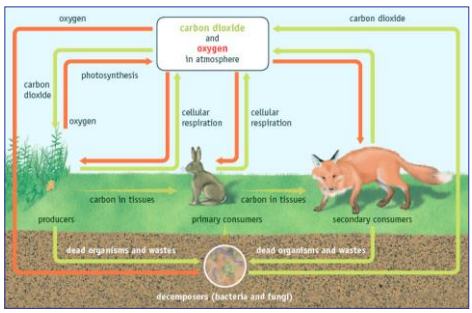
Where in the cycle do **photosynthesis** and **cellular respiration** take place?

Photosynthesis and cellular respiration cycle carbon and oxygen in ecosystems.



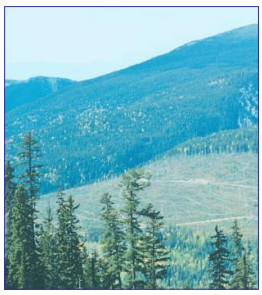
Cycling Oxygen and Carbon

Examine the pathways followed by **carbon** and **oxygen** as they are cycled through an ecosystem.



Human activities can affect ecosystems by affecting nutrient cycles.

The amount of carbon dioxide used by photosynthesis and given off by cellular respiration is roughly balanced.



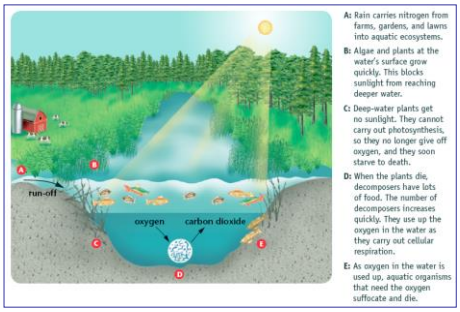
The tree is an organism that removes carbon dioxide from the atmosphere. The numbers of trees have been rapidly reduced by logging.

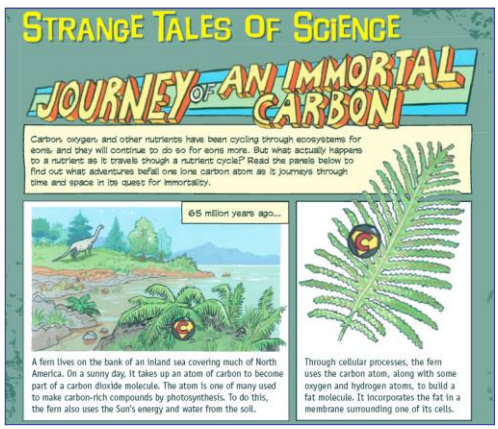
Human activities can affect ecosystems by affecting nutrient cycles.

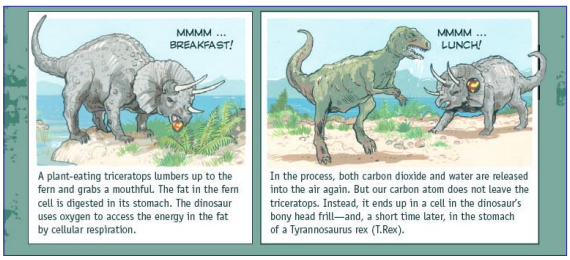
Humans add additional carbon dioxide to the atmosphere by burning fossil fuels and wood. The excess carbon dioxide added to the atmosphere is contributing to climate change.

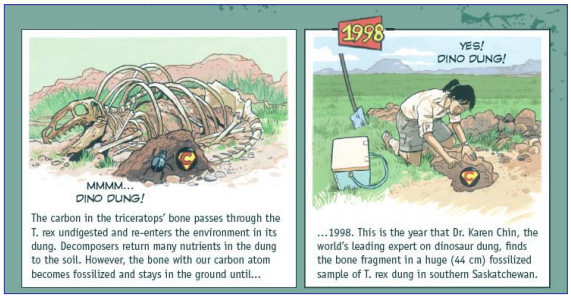
Human Activities and the Nitrogen Cycle

Nitrogen that enters waterways can cause rapid algae growth that eventually harms fish populations.



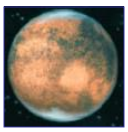






Recycling on Mars

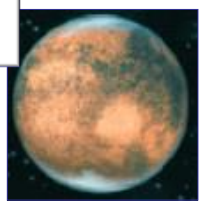
In order to live on Mars, humans would have to construct ecosystems that could sustain life for long periods of time.



A Mars colony would have to recycle and reuse all its materials. This includes water, carbon, oxygen, and nitrogen.

Recycling on Mars

Using your understanding of **ecosystems**, **photosynthesis**, **cellular respiration**, and **cycles**, suggest why humans may or may not be able to colonize Mars.



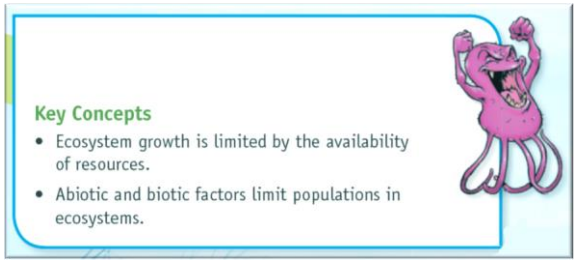
Topic 1.3 Review

Key Concepts to be reviewed:

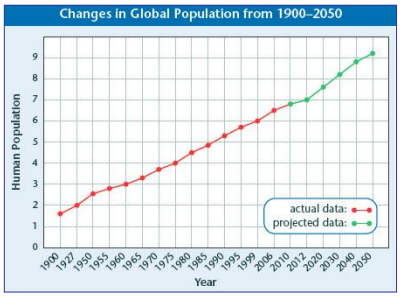
- *Abiotic and biotic interactions cycle matter in terrestrial and aquatic ecosystems.*
- *Photosynthesis and cellular respiration cycle carbon and oxygen in ecosystems.*
- *Human activities can affect ecosystems by affecting nutrient cycles.*

Topic 1.4 What natural factors limit the growth of ecosystems?

(Pages 40-9)

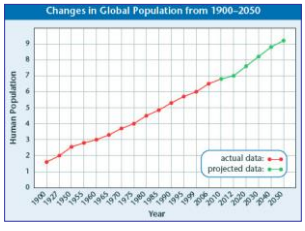


What natural factors limit the growth of ecosystems?



Earth's human population is increasing very rapidly.

What natural factors limit the growth of ecosystems?



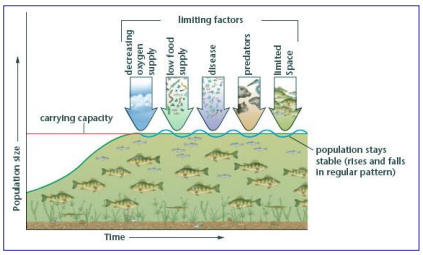
Name three resources that humans need.

What happens to these resources as the human population grows?

Do you think there is a limit on the size of the human population? Explain why or why not.

Ecosystem growth is limited by the availability of resources.

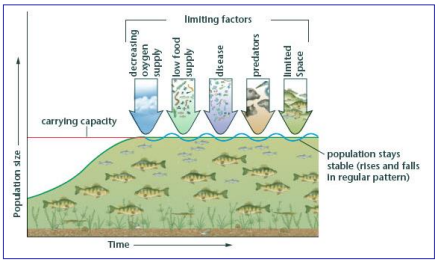
A **population** is all of the individuals of a species that live in a certain place at a certain time.



What population is represented in the diagram on the left?

Carrying Capacity

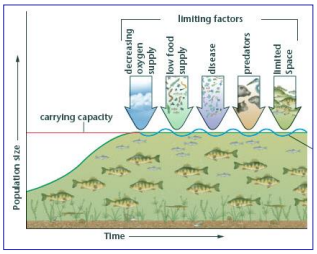
The **carrying capacity** of an ecosystem is the largest population size that it can sustain.



Does the carrying capacity shown above ever change?

Limiting Factors Can Play Different Roles in Different Ecosystems

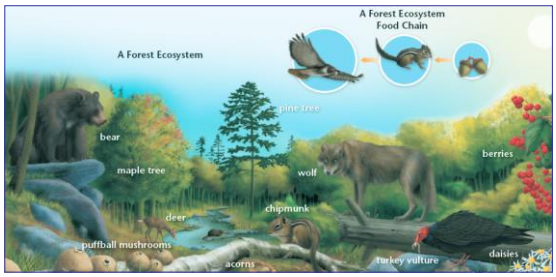
Limiting factors are factors that limit the size of a population.



How and/or why do you think any of the limiting factors shown on the left would affect the population of fish?

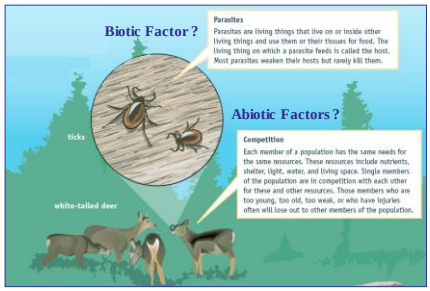
Abiotic and biotic factors limit populations in ecosystems.

The factors that affect the carrying capacity of an ecosystem can be non-living (**abiotic**) or living (**abiotic**).



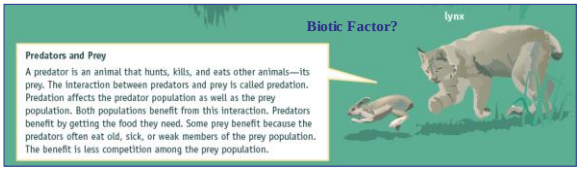
Parasites and Competition

Can you name a parasite and the animal it affects?



What would animals compete for in an ecosystem?

Predators and Prey

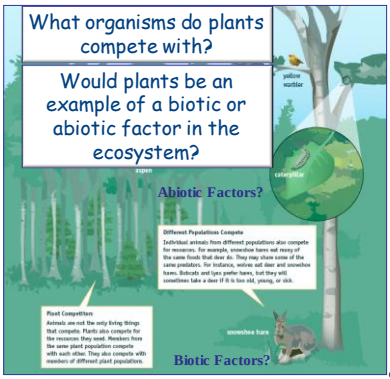


Name examples of animals that interact as predator and prey.

Plants and Competition

What organisms do plants compete with?

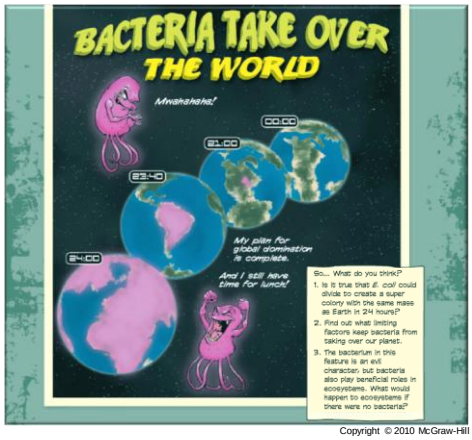
Would plants be an example of a biotic or abiotic factor in the ecosystem?



Name several different populations that compete with each other.

STRANGE TALES OF SCIENCE

Limiting factors limit the size to which a population can grow. Consider a population of bacteria, known as a colony. Bacteria grow by doubling: one bacterium becomes two, two become four, four become eight, and so on. If there were no limiting factors to keep its growth in check, a bacterial population could get very large, very quickly. How large? How quickly? *E. coli* bacteria divide once every 20 minutes. Without limiting factors, it would take a single *E. coli* bacterium (one cell) exactly 24 hours to create a super colony with the same mass as planet Earth!

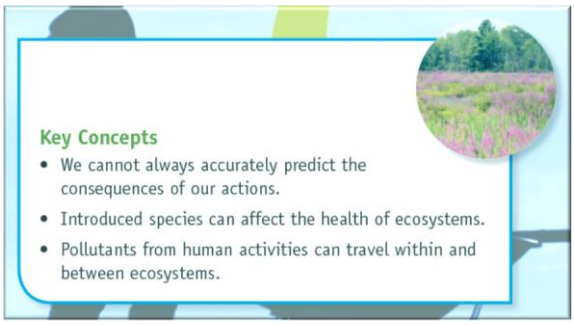


Topic 1.4 Review

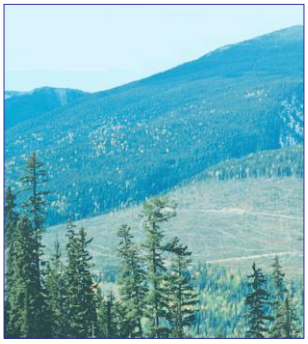
Key Concepts to be reviewed:

- *Ecosystem growth is limited by the availability of resources.*
- *Abiotic and biotic factors limit populations in ecosystems.*

Topic 1.5 How do human activities affect ecosystems? (Pages 50-61)



How do human activities affect ecosystems?



Why do you think human populations have a greater impact on ecosystems than most other living things?

How do human activities affect ecosystems?

How could clear cutting the forest affect the other organisms that live there? List some of the ways they would be affected.

We cannot always accurately predict the consequences of our actions.

Human activities always cause changes to ecosystems.

The changes caused by human activities always have consequences for the biotic and abiotic parts of ecosystems.

Human Activities and Their Consequences

Human Activity	Possible Abiotic and Biotic Consequences
 Construction of roads and buildings	• Surface soil is removed, killing soil organisms and plants that were rooted in the soil. • The shape or slope of the land is changed, resulting in different patterns for drainage of rainwater. • Farmland that is taken over to build roads and buildings can no longer be used to grow crops and livestock.
 Dam-building	• The courses of rivers and streams are changed so that water will flow to the specific place chosen for the dam. • Land is flooded to create lakes in places where none existed before. • Huge numbers of living things are killed. • Huge numbers of living things are displaced and must find new places to live. (This includes humans, too.)

Human Activities and Their Consequences

 Manufacturing and consumption of goods	• Soil and plant life are removed to make space to build factories and landfill sites for the solid wastes that the factories produce. • Factories consume energy to make products. • Production process creates wastes that can enter and pollute air, water, and soil. • Stores that sell goods consume energy to operate. • The packaging, transportation, and consumption of goods generate wastes that must be disposed of. • Disposal and recycling of wastes consumes energy.

How many other human activities can you think of that affect ecosystems?

Introduced species can affect the health of ecosystems.

An **introduced species** is any species that has been introduced into and lives in an ecosystem where it is not found naturally.

Starlings are an introduced species

Introduced species thrive because there are few limiting factors to keep their populations from growing too large.

Introduced Species Can Affect Species Diversity

Species diversity refers to the number and variety of different species of living things in an area.

Purple Loosestrife taking over a meadow

Introduced species can be deadly to the native species in an ecosystem.

When the population of an introduced species increases rapidly, it can take over an ecosystem. A multi-species ecosystem could eventually change to one that consists almost entirely of the introduced species. Would this be a bad thing?

Introduced Species Can Affect Species Diversity

The species shown on the left represent some of Ontario's most destructive introduced species.

Have you seen any of these species in or around the area in which you live?

Pollutants from human activities can travel within and beyond ecosystems.

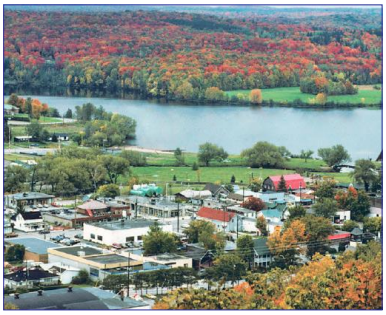
Watersheds are areas of land (either natural or human-made or both) that drain into a body of water.

Watersheds provide:

- water people use for drinking, cooking, and washing
- water used by other living things for drinking, washing, and cooling off
- places to live
- irrigation for farmland
- water for use by industries for cooling and cleaning equipment
- recreation areas for swimming, boating, snowmobiling, relaxing
- beauty

Pollutants from human activities can travel within and beyond ecosystems.

All watersheds connect terrestrial and aquatic ecosystems.

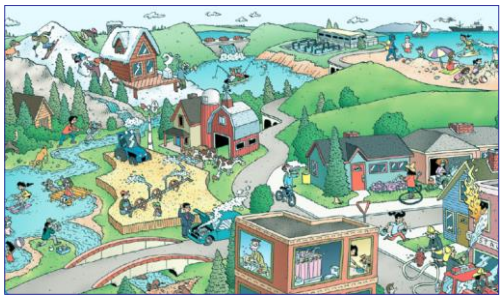


What we do on the land or in the water can affect the land or water around us.

Which of your activities might affect your watershed?

A Watershed Mind Map

In what ways is the watershed pictured below being used?



In what other ways could this watershed be used?

Topic 1.5 Review

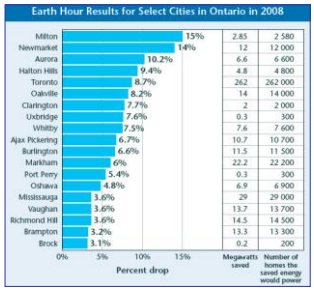
Key Concepts to be reviewed:

- *We cannot always accurately predict the consequences of our actions.*
- *Introduced species can affect the health of ecosystems.*
- *Pollutants from human activities can travel within and between ecosystems.*

Topic 1.6 How can our actions promote sustainable ecosystems?

(Pages 62-77)

How can our actions promote sustainable ecosystems?



During **Earth Hour** people were asked to shut off their lights for one hour in order to show how much electrical energy usage could be reduced.

Did you participate in Earth Hour? How? Or why not?

We must understand and commit to sustainability.

Sustainability is maintaining an ecosystem so present populations can get the resources they need without risking the ability of future generations to get the resources they will need.

We must understand and commit to sustainability.

Sustainability helps ensure that populations stay within the carrying capacity of their ecosystem.

What actions can humans take to promote sustainability?

Reflecting on Responsibilities

We acknowledge one another, female and male. We give greetings and thanks that we have this opportunity to spend some time together.

We turn our minds to our ancestors and our Elders. You are the carriers of knowledge, of our history.

We acknowledge the adults among us. You represent the bridge between the past and the future.

We also acknowledge our youth and children. It is to you that we will pass on the responsibilities we now carry. Soon, you will take our place in facing the challenges of life. Soon, you will carry the burden of your people. Do not forget the ways of the past as you move toward the future. Remember that we are to walk softly on our sacred Mother, the Earth, for we walk on the faces of the unborn, those who have yet to rise and take up the challenges of existence.

We must consider the effects our actions will have on their ability to live a good life.

What message is the passage on the left trying to communicate to humans?

Why is this message important?

We must understand the link between biodiversity and sustainability.

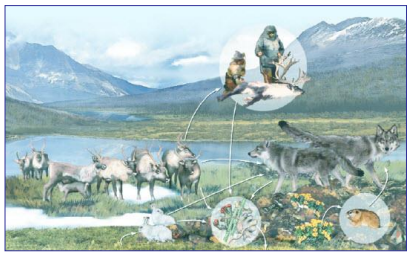
There are at least 2 million species (kinds) of organisms on Earth. These are just the species we know about. Some scientists estimate there could be as many as 100 million more species yet to be discovered. There is truly a great diversity of species of living things on Earth.

Now think about ecosystems. An ecosystem's size and the number of populations it supports is limited only by the abiotic and biotic parts of that ecosystem. Any ecosystem may contain tens, hundreds, thousands, and more smaller ecosystems. There is truly a great diversity of ecosystems on Earth.

There is a word that describes the great diversity of Earth's species and the great diversity of Earth's ecosystems at the same time. That word is biodiversity. **Biodiversity** is all of the diversity of species that live in an ecosystem, plus all of the diversity of ecosystems within and beyond that ecosystem. So biodiversity is all the different kinds of living things in a certain place, as well as all the different kinds of places within that place and elsewhere.

We must understand the link between biodiversity and sustainability.

Biodiversity is all the diversity of species that live in an ecosystem, as well as all the diversity of ecosystems within and beyond that ecosystem.



How many different species can you see in the ecosystem on the left?

We must understand the link between biodiversity and sustainability.

A sustainable ecosystem must maintain a balance between its diverse living and non-living parts.

Describe the interactions between living and non-living things in the ecosystem on the left.

Equilibrium is a state of balance in an ecosystem.

Looking For the Links

Compare the **abiotic** components of the two ecosystems.

Compare the **biotic** components of the two ecosystems.

Which of the two ecosystems is more diverse? Why?

Our actions can maintain or rebuild sustainable ecosystems.

Although the actions of humans often harm ecosystems, humans also have the power to heal ecosystems. The following images show ways in which humans can help.

Protecting Wetlands

A healthy wetland is a hotbed of biodiversity. Alfred Bog in southern Ontario is one such place. Thanks to the efforts of concerned citizens and government officials, more than 70 percent of this wetland is managed as a nature reserve, keeping it safe from mining and other activities that would harm it.

Our actions can maintain or rebuild sustainable ecosystems.

Re-introduction of Species

Elk were once native to Ontario, but by the late 1800s, these majestic animals were gone as a consequence of growing human settlements and over-hunting. Efforts to restore elk to Ontario have been in place since the mid-1990s. Four populations are now re-established in the areas of Sudbury, Bancroft/North Hastings, Lake of the Woods, and the north shore of Lake Huron.

Our actions can maintain or rebuild sustainable ecosystems.

Biocontrol

This beetle, originally from Europe, is one of the species of insects used in the fight against purple loosestrife. Use of living things to control introduced species is called biocontrol. This can be effective in reducing the population size of an introduced species. However, it rarely can remove the invader entirely.

Our actions can maintain or rebuild sustainable ecosystems.

Habitats for Birds

Farmers and home-owners in rural areas, as well as in cities, often set up special boxes to provide places for birds to establish nests. People who love and respect birds and their role in ecosystems put up nest boxes to make up for the trees that have been logged to clear space or provide timber for various products.

Our actions can maintain or rebuild sustainable ecosystems.

Smart Growth

Urban sprawl happens as cities with growing populations increase their size by spreading into natural areas and farmland. A strategy called smart growth helps by concentrating growth in the centre of a city, rather than in outlying areas. Homes and businesses intermingle, while green spaces are preserved. Smart growth also enhances public transit, which reduces traffic pollution.

You can choose actions that benefit ecosystems now and for the future.

Change in society starts with change in individuals. Each one of us has tools and gifts that can help us bring about change.

Consumers

Consumers have power. What choices do you make about the products you will and will not buy? What reasons lie behind, or motivate, your choices?

You can choose actions that benefit ecosystems now and for the future.

Volunteers

Volunteers inspire by their commitment and example. Where do you, or can you, volunteer your time? Who benefits from your willingness to share a part of yourself?

You can choose actions that benefit ecosystems now and for the future.

Citizens

Citizens have responsibility. In what ways are you a citizen of your community? Your province? Your country? Your planet? What responsibilities do you have as a citizen?

Case Study: Securing a Bright Future For Songbirds

Topic 1.6 Review

Key Concepts to be reviewed:

- *We must understand and commit to sustainability.*
- *We must understand the link between biodiversity and sustainability.*
- *Our actions can maintain or rebuild sustainable ecosystems.*
- *You can choose actions that benefit ecosystems now and for the future.*