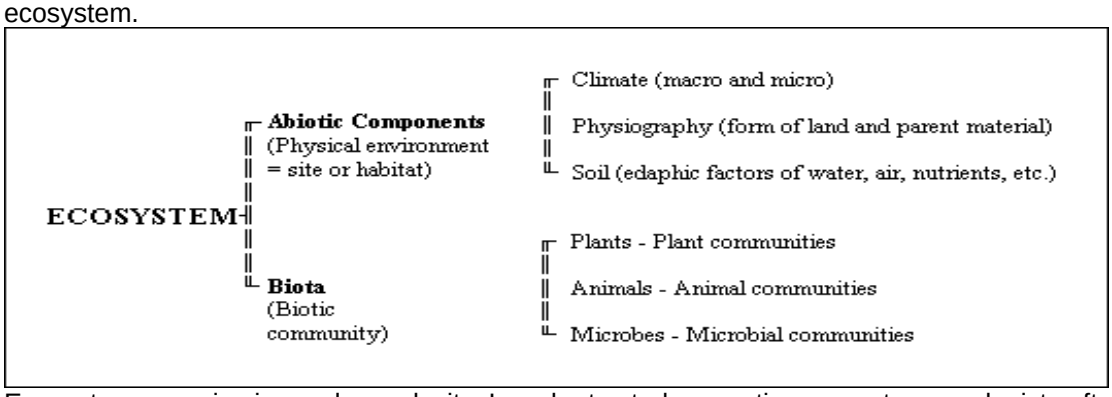
1.0 Relationships exist between living things and their environments

1.1 Defining an Ecosystem and Learning about Basic Needs

Ecology is the study of the relationship between living organisms and their environment. An ecologist is someone who studies those relationships. An ecosystem is a place, such as a rotting log, a forest, or even a schoolyard, where interactions between living and non-living things occur. All living organisms and non-living parts within this place are interacting all the time and adjustments must occur if the organisms are to survive. Living organisms make up the biotic components of the ecosystem, while non-living things make up the abiotic parts of the same ecosystem.

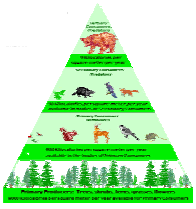


Ecosystems vary in size and complexity. In order to study an entire ecosystem, ecologists often study only a small aspect of an ecosystem and then work with other ecologists to piece together the overall picture of how the ecosystem functions.

- ***The World Within An Ecosystem***

Species within an ecosystem refers to those living things that can reproduce and have young that can also reproduce. When there are a number of individuals of the same species within an ecosystem the group is called a **population**. All the populations of the many different species that live and interact together in the same ecosystem is referred to as **community**.

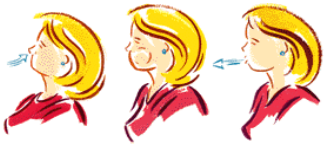
- ***The Needs of Living Things***



Living things need food.

Living things need a suitable habitat.

Living things need water.



Living things exchange gases.

Living things are always interacting with each other and with the non-living things in their environment.

1.2 Interactions among Living Things

- ***Symbiotic Relationships***

When two species live closely together in a relationship that lasts over time symbiosis occurs. There are three forms of symbiosis:

- **Mutualism**

Mutualism occurs when there is a relationship between two different organisms, in which each partner benefits from the relationship. Examples include:

Mutualism between plants and their herbivores .

3-way Mutualism between an ant, a butterfly caterpillar, and an acacia plant

- **Parasitism**

Parasitism occurs when there is a relationship between two different organisms, in which one partner benefits from the relationship, while the other parner is harmed. Typically, the partner that benefits (the **parasite**), lives on or in the other organism (the **host**), and feeds on it. Examples include:

Aphid mummy - the result of parasitism

A *Kalahari barking gecko* is crucified by a *Shrik*. They store them as a cache for a later meal.

- **Commensalism**

Commensalisms occurs when there is a relationship between two different organisms, in which one partner benefits from the relationship, while the other neither benefits, nor is harmed. Examples include:

Anemonefishes dwell among the tentacles of *Tropical Sea Anemones*

Insects and Flowers

Both partners apparently benefit from the relationship,

- ***Adaptating To The Environment***

Living things are adapted, so they ***'fit'*** into their surroundings, to ensure survival. An **adaptation** is an **inherited** characteristic that helps an organism survive and reproduce in its environment. Sometimes adaptations are **learned** during the organism's lifetime.

1.3 Human Impacts on Ecosystems

Symbiotic relationships are only a few ways that organisms interact with one another within an ecosystem. Other interactions may involve the physical changing of the ecosystem by the organisms living in it and interacting with parts of it. **Natural Resources** are the materials and products found in nature that people use to meet their basic needs. The impact that people have on the use of resources can be very small, or can be huge, and can lead to positive or negative consequences. The needs of all living things now have to be met with the available natural resources. How we are able to satisfy these needs with minimal conflict will determine how resourceful we can be.

- ***Declining Beaver Population***

When a family of beavers makes a dam, the stream below the dam dries up, killing the water organisms that need the water to survive. Above the dam, a pond changes the habitat and limits the kinds of organisms that can survive there. For every action in an ecosystem there is a resulting effect and reaction which will change the make-up of the ecosystem in some way. The decline in the beaver population in Yoho National Park has been as a result of improved firefighting equipment and fire-monitoring techniques. Young Aspen trees (the beavers preferred source of food and shelter) are scarce and the other trees in the forest are growing too large for the beavers to use effectively.

- ***Dealing With our Garbage***

The ways people interact with the environment has changed over time. Machines and advanced technologies have caused a higher impact than in the past. All of the needs people had in the past were satisfied by the natural resources they were able to find in the environment around them. Nowadays, resources are transported throughout the world, as the demand gets higher. Lifestyle changes over time have increased the pressure on different environments and the ecosystems we live in.

Needs are basic to survival, whereas, **' wants '** are things that just make survival more comfortable or enjoyable. Each time a need or a want is satisfied, natural resources or energy are used up. This impacts the environment we live in. Transporting food from all around the world, just so we can have the luxury of choice impacts other regions as well, because those regions had to clear land, use fuel (energy) and through the industrial processes caused pollutants to enter the air. When our 'want' demands conflict with the health of our ecosystems, we need to begin making some more responsible choices. The needs of wildlife can be negatively impacted by the wants of people. When this happens we need to decide whether our want is more important than their need.

- ***The Garbage Solutions***

The production of wastes on our planet is increasing. The storage or disposal of these wastes - until they can be returned naturally back to the environment is a major problem. Waste disposal techniques include recycling, composting, incinerating, and hazardous waste operations. **Sanitary landfills** are similar to landfills, where waste is spread over a large area and then covered with soil to encourage the natural decomposition of the waste. To prevent and control leaking of hazardous products from the sanitary landfills, a clay liner and a system of drainage pipes is put into place.

2.0 The flow of energy and the cycling of matter can be traced and interpreted in ecosystems.

2.1 Ecosystems Have interactions among Predators, Consumers and Decomposers

- ***You And Other Animals Are Food Consumers***

All of the organisms within an ecosystem have different roles. These roles are called **niches**. Organisms can have more than one niche and knowing the niches of an organism can help to explain why they act and interact the way they do. To determine an organism's niche, you need to identify what it eats, where it lives and how it interacts with the other organisms in the same ecosystem. Niches include:

- ***Producers*** - produce food energy for themselves and others
- ***Consumers*** - consume the food made by the producers
- ***Herbivores*** - eat producers (plant eating niche)
- ***Carnivores*** - eat other consumers (meat eating niche)
- ***Predators*** - eat *prey*
- ***Omnivores*** - eat both producers and consumers

- ***Food Consumers Depend On Food Producers***

The Process of Photosynthesis

The raw materials needed by plants to produce their own food -with the energy from the Sun - are water and carbon dioxide. The products produced are food (sugars) and oxygen, which is released back into the atmosphere. The food making process is called photosynthesis.

The Importance of Photosynthesis

Light Energy + Carbon Dioxide + Water → Food (Sugars and Starches) + Oxygen

This is important for 2 reasons: the sun's energy can be converted into a for you can use and oxygen is made available for you to breathe.

Oxygen Is For More Than Just Breathing

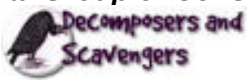
Plants need oxygen as well. All living things are able to release the energy that is stored in food through the process of cellular respiration.

Food (Sugars & Starches) + Oxygen → Carbon Dioxide + Water + **Energy** (used by living things)

A Vital Interaction

The products of one chemical reaction (photosynthesis) are used by the other chemical reaction (cellular respiration)

A Special Group of Consumers:



Scavengers are organisms that feed on dead or decaying plant or animal matter. They usually don't kill their own food.

Magpies, crows and wolverines are examples.

Decomposers are different from scavengers because they do not actually eat dead material. They grow on or in the dead or waste matter, absorbing the nutrients directly into their cells, which are then recycled back into the environment.

Bacteria and Fungi are examples.

Decomposers can be Helpful or Harmful

Helpful		***Harmful***	
Baker's yeast	- produce a by-product that makes dough rise	**Candida albicans**	-cause a disease called thrush
E. coli (found in your large intestine)	-break down nutrients in food to make vitamins you need to stay healthy	E Coli bacteria 0157-H7	- produce toxic chemicals that result in food poisoning
Nitrogen-fixing nodules	- home to bacteria which make nitrogen available to the plant		

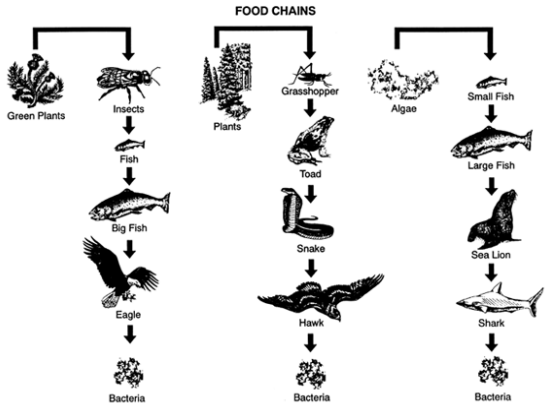
Decomposers Are Essential To All Ecosystems

Their actions make them the 'clean-up crew' and mean that plants will always have the nutrients they need to maintain life. They are the **bridge** between the biotic and abiotic parts of an ecosystem.

2.2 Food Chains Demonstrate the Flow of Energy in Ecosystems

- ***Food Chains***

A food chain is a model that shows how energy stored in food passes from organism to organism. It starts with the original food source -a producer.

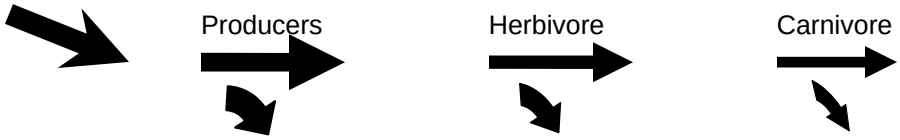


Energy flow is the movement of energy, starting with the sun, and passing from one organism to another.

As energy flows from one organism to another a food chain is established. Food chains usually involve more than three organisms.

- ***Energy Flow In Ecosystems***

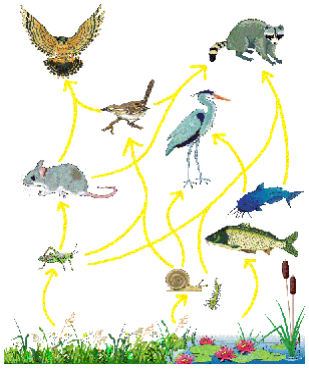
Ecosystems get energy originally from the Sun through the process of **photosynthesis**. Light energy is used by plants to make food, which contains the chemical energy that plants use for their life functions. 90% of this energy is used by the plant and the remaining 10% is available to the herbivore that eats the plant. The herbivore uses 90% of this energy to maintain life functions and provides the remaining 10% to the carnivore. Most of the energy is used to maintain body heat, which escapes into the environment and cannot be used. The flow of energy is one way.

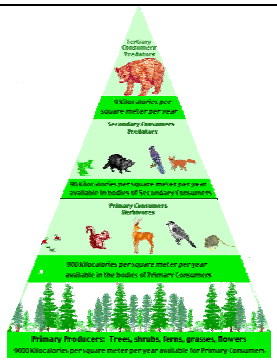


'Waste Energy' – body heat escaping into the environment

2.3 Food Webs

A ***Food Web*** is a combination of many different food chains, showing the interrelationships between and among many different producers and consumers in an ecosystem.
A ***Food Pyramid*** is a model representing the numbers of organisms consumed at each successive level of the pyramid. The size of the level indicates the number of organisms at that level. There are always more animals being eaten than are eating.





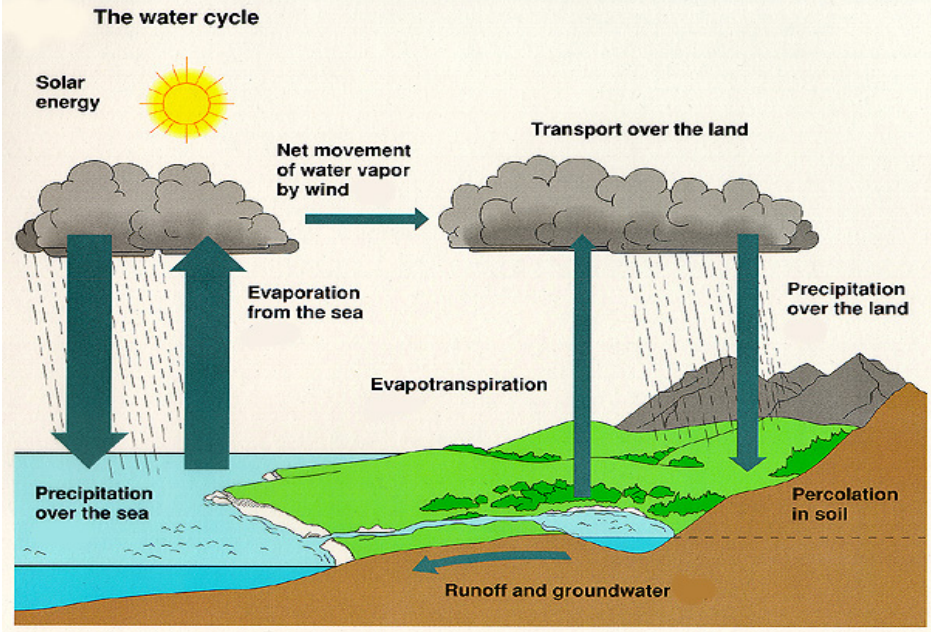
To find out how much energy is being transferred from one level of the pyramid to the other, b**iomass** needs to be calculated. **Biomass** is the total of all the organisms in the ecosystem. As you move up the pyramid, there is less biomass. The most biomass is found at the base, where the producers are.

2.4 Matter Cycles in Ecosystems

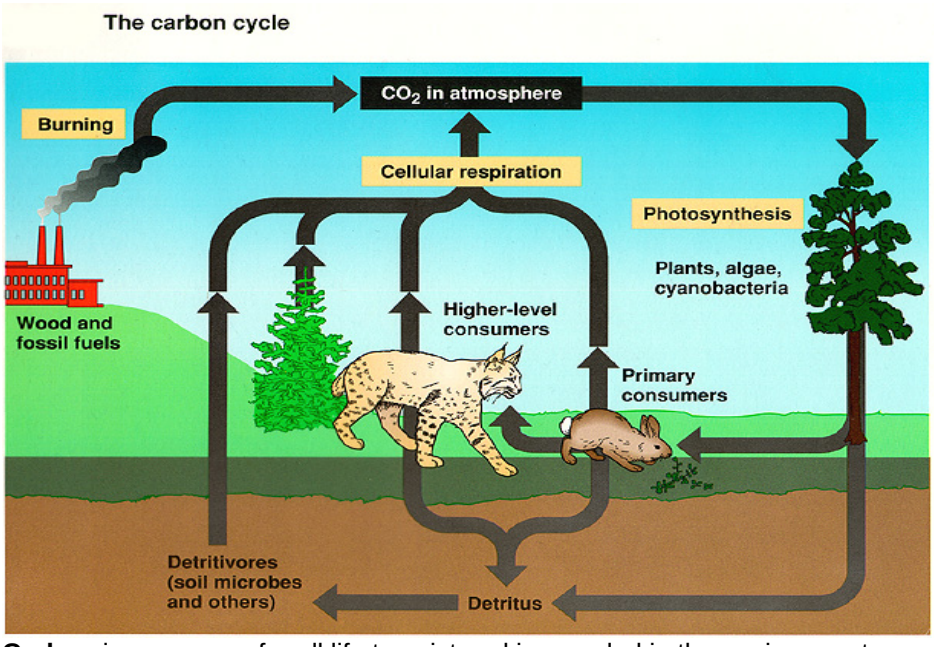
When organisms breathe, the gases are recycled in the air and used by other organisms. When organisms die, the nutrients they are composed of are recycled back into the environment and used as well.

- ***Water and Carbon Cycles***

All living things require water to survive and this water is also recycled over and over again.



The water cycle (as illustrated) contains 4 processes: evaporation and transpiration – move water from the Earth to the atmosphere, condensation and precipitation return the water to Earth.



Carbon is necessary for all life to exist and is recycled in the environment.

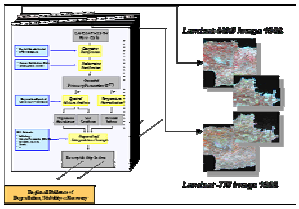
3.0 Changes can be observed and monitored in ecosystems

3.1 Investigating the Distribution of Living things in an Ecosystem

- ***Distribution of Living Things***

Ecosystem monitoring (also called - *environmental monitoring*) is a way to check the condition - health - of an ecosystem by comparing results of investigations done at different times. Monitoring helps scientists understand impacts of disturbances and changes - sudden and gradual - in order to try to reverse or reduce the impact. Biotic and abiotic factors are monitored.

Ecosystem Monitoring Types

Physical, uses satellites to track changes in the landscape over time.	**Environmental** tracks changes in climate, temperature and weather patterns.	**Chemical**, assesses the quality of air, soil and water	**Biological**, tracks the changes in organisms or populations of organisms
			

Environmental monitoring usually begins after a disturbance has taken place. It can also begin before a disturbance occurs. A key part of the monitoring program is to provide the evidence on which environmental decisions can be made to maintain the balance between human needs and the needs of other organisms in the environment. **Continuous monitoring** gives us the scientific data we need to make informed decisions about how we affect the environment over time.

Long-Term Monitoring Programs
Amphibians are very sensitive to environmental change, which makes them an indicator species. By using this indicator species, scientists all over the word can study the effects of pesticides, acid rain, loss of habitat and introduction of non-native species on these amphibians. http://www.biology-online.org/4/6_monitoring_populations_2.htm
http://www.earth.nasa.gov/outreach/biodiversity/paper1.html

Monitoring programs may be **qualitative**, **semi-quantitative**, or **quantitative**. Monitoring involves the use of **indicators**, **indicator species** or **indicator communities**. The presence or absence of the indicator or of an indicator species or indicator community reflects environmental conditions.
Dichotomous Key (**Identification Key for Alberta Amphibians**)
http://www3.gov.ab.ca/srd/fw/amphib/identify.html

Baseline Data gives scientists a starting point to compare changes in the environment. Scientists to monitor change use permanent plots, or study areas. The report that provides the data that has been collected - identifying how a certain activity will affect the environment - is called an **Environmental Impact Assessment**.

Quadrant Sampling is a technique used to study a large are. The quadrant is selected and the species is counted in the quadrant. The number of quadrants in the area provides the multiplier to estimate the **Quadrant sampling** is one way that ecologists estimate the distribution of different populations of species in an ecosystem. Studying the sample is called **quadrant analysis**.

3.2 Interactions and Changes Occur in Ecosystems

In any ecosystem a balance between living populations must exist if these populations are to be maintained. Setting a forest on fire (*a controlled burn*) is often necessary to maintain a balance in the ecosystem. These fires get rid of small trees, leaves, needles and other debris that settles on the forest floor. The new growth after a fire becomes food for elk, deer and other animals that need these nutrients from the forest floor.

A **wetland** ecosystem is also important. Drainage of wetlands to provide land for farming and housing put the populations that used these ecosystems, as their habitat, were at risk of extinction. Pollution also destroyed many wetland areas. The importance these wetlands to the overall diversity of living things has meant that many wetlands are now protected by law.

- ***All Things Change***

Bioinvasion

When species that are not native to a particular area are introduced they tend to take over and multiply quickly – taking necessary food or nutrients away from the native species. The native species suffer as a result and many have been **extirpated** (extinct in a specific area).
The species that is introduced may have no natural predators and will overtake the area (using up the food supply) so that other organisms cannot survive.

Introducing a species not natural to a particular area can cause more problems than what it solves.

This happened when **zebra mussels**

were introduced into the Great Lakes. It has become a major problem.

Purple loosestrife – sometimes called the "***beautiful killer'***

– was introduced into North America has taken over valuable wetland habitat, pushing out native species.

Competition

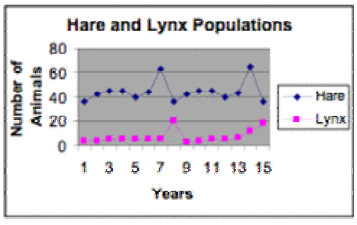
All living things compete for food, water and habitat. Because there is only so much to go around many species cannot survive because they are fewer in numbers and have more predators that other species.
Examples of birds that have multiplied very quickly and compete for food with many native birds.

House sparrows

European Starlings

Predation

Predation occurs when one animal hunts other animals for food. The organisms that are hunted are called **prey**. The hunters are called **predators**. The predator and prey populations increase and decrease as they numbers change. When prey population increases, the predator population will also increase. When the prey population decreases, the predator population also decreases.



Weather

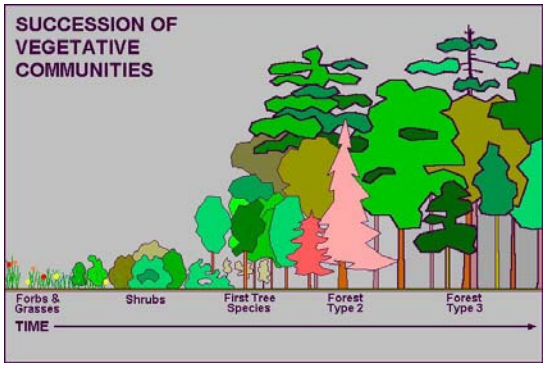
Weather can also affect ecosystems. Temperature, and he amount of precipitation will affect the growth of plants (the producers) positively or negatively. Natural disasters can also impact the populations of producers.

3.3 Succession: How Ecosystems Change over Time

The gradual process by which some species within an ecosystem replaces other species is called **succession**.

Primary succession is the gradual growth of organisms in an area that was previously bare – like a rocky slope. Organisms to first appear (called **primary species**) are those that can cling to the rock and grow, such as mosses and lichens. These organisms break down the rock and died. Other organisms use the nutrients to begin to grow.

Before **After**

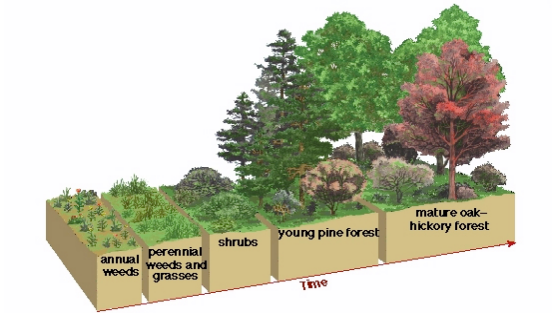


Examples of areas in which a community has never lived before would be:

- new lava or rock from a volcano that makes a new island or a new landscape
- a sand bar that arises from shifting sands in the ocean
- exposure of igneous rock surfaces by a land slide
- a meteor makes a depression that fills with rainwater or fresh water from underground streams.

A **climax community** is a stable community with a lot of diversity and is not easily replaced by other communities.

Secondary Succession The gradual growth of organisms in an area after a disturbance, such as a fire, or when a large tree falls, is known as **secondary succession**.



Before **After**

Examples of secondary succession include:

- A farmer's field
- a vacant city lot
- a newly forested area
- a strip mine.

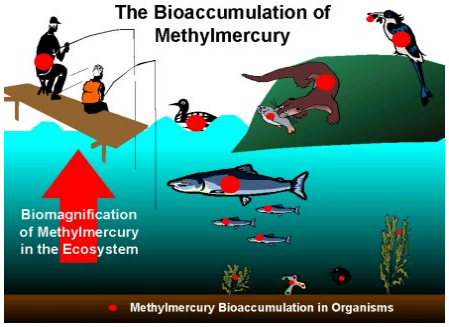
4.0 Maintaining sustainable environments requires knowledge, decisions and actions.

4.1 There are Intended and Unintended Consequences of Human Activities within Ecosystems

- ***Human Impact On Ecosystems: Chemical Use***

Mosquito populations in Borneo were causing malaria among the Dyak people. The World Health Organization used the pesticide DDT to kill off the mosquito population. However the DDT also killed a species of parasitic wasp that ate a certain species of caterpillar. This species of caterpillar began eating the material roofs of houses were made of and the roofs began falling on people's heads. DDT also affected small bugs that were food for the geckos. The geckos began to move slowly and the cats, which normally ate rats, switched to the slower moving geckos. The cats eventually died of the DDT magnified in their food supply and the rat population increased. The rats were infested with fleas that carried a bacteria causing typhus malaria – a much worse form of the original malaria.

Bioaccumulation is the process in which a substance builds up in a living organism from the surrounding air or water, or through the consumption of organisms that already have the substance that is being accumulated. It will vary for different species and will depend on sources of contamination, as well as water quality and temperature. It provides increasing levels harmful to species higher up the food chain, because of "**biomagnification**", where substances like mercury will increase in concentration from microorganisms, to fish, to fish eating predators like otters and loons, and to humans.



The accumulated mercury is shown by the red dots.
Source: Communication Canada

- ***Human Impact On Ecosystems: Too Little Too Late?***

Many species in North America and in Canada specifically are in danger of **extinction**. If a species becomes extinct, it can no longer be found anywhere in the world. Sometimes the organism is only lost in a large region. If this occurs, the species is **extirpated**. If a particular species is in danger of becoming extinct, or extirpated, it is placed on the **endangered species list**. The classification of species whose numbers are declining is **threatened**. There are special protection programs and laws made to protect endangered species.
Canada's Endangered Species http://raysweb.net/specialplaces/pages/canada-es.html
Alberta's Endangered Species http://www3.gov.ab.ca/srd/fw/escc/aeslist.html

- ***Famous Potatoes***

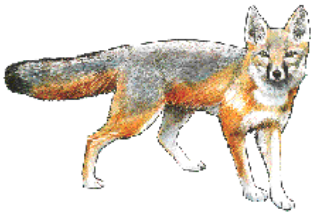
The small town of Pemberton, British Columbia is home to world-famous potatoes. These potatoes are virtually free of virus and disease because only locally cultured and laboratory-inspected seeds are used to grow them.

4.2 Information from Scientific Investigations Can Assist Environmental Decision-Making

- ***The Saving of the Peregrine Falcon***

[*Find out more*] Peregrine Falcon

Knowing what effects you are having on the environment (or will likely have) will help you make decisions. The use of **DDT** (a chemical pesticide) was found to have a negative effect on **Peregrine Falcons**. It wasn't until the species was almost lost completely that something was done. DDT was banned and recovery programs were put in place to restore the numbers of peregrine falcons.



[Find out more] Swift Foxes

Swift foxes were accidentally poisoned because certain predators were seen as 'pests' or 'unnecessary' animals.
When the Swift foxes used the poison instead, the species almost became extinct. Natural control is necessary in any ecosystem. If this natural control is upset, the impact can have ripple effects, which were never anticipated.

Captive breeding programs are used to help threatened species recover.
Sustainable Resources Development (Alberta Government)
You can also get additional information on other species that are threatened in ALBERTA..
Find out also about Canada's most Endangered Species – the Vancouver Island Marmot. – and what they are trying to do to save it.

4.3 There are Limitations to Scientific and Technological Knowledge

Science and technology cannot always solve the environmental problems we face. The mystery of the missing GOLDEN TOAD of Costa Rice is one such example. Scientists have theories, but no conclusive evidence has been found to support one as the primary cause of the problem.
The top 4 theories include:
climate change, pollution, disease and the thinning of the ozone layer.

- ***The Walk That No Wolf Would Take***

Overpasses and Underpasses - to help wildlife cross the highways more safely have been built in Banff National Park. There are many reasons that determine the suitability of a crossing structure to a particular species. Grizzlies are influenced by the distance the structure is from Banff. Elk are influenced the structure's length. Wolves and cougars choose underpasses near drains. When humans used the underpasses or overpasses, the effectiveness of the structures was reduced.

Wildlife Crossing Structures – Monitoring by Parks Canada

4.4 Using Evidence from many Sources Can Help Analyze a Local Problem

- ***Ecological Footprint***

The ecological footprint was developed to help people understand why they need to find a sustainable way of life. To calculate your **ecological footprint**, you need to determine the total area of land that you use and water needed to supply all of the energy and materials that you use, as well as absorb all of the waste that you produce. **Materials** that are included are: food, water, supplies to build shelter and raw materials needed to produce the manufactured products you use. **Energy** includes: electricity, natural gas, as well as all the energy needed to produce, and transport all of the manufactured products you use.

- ***Comparing Ecological Footprints***

We depend on the environment and we are part of the environment. **Sustainability** means that the resources from the environment can be replaced as quickly as they are used. Are we putting back what we take out, or, are we using up all the resources before they can be replaced? The amount of land available on Earth to support each person living is 1.7 ha. The average ecological footprint per person worldwide is 2.2 ha. The average Canadian ecological footprint is 7.7 ha. We are using more than we should!

Sustainability **Large Ecological Footprint**




The ecological footprint of average Canadians is very large, because they are using many more resources and creating much more waste than is sustainable.

- ***Factors That Can Reduce Your Ecological Footprint***

Ways to reduce ecological footprint include:

1. Be aware of the products you consume in a typical day

2. Reduce the energy you use

3. Reduce the number of products you buy

4. Reduce the amount of garbage you produce

Reduce, Reuse, Recycle