

# SCIENCE FOCUS 7

**Teaching Notes**

**for**

## Unit A

# INTERACTIONS
**and**
# ECOSYSTEMS



# Topic 1 - Interactions Within Ecosystems

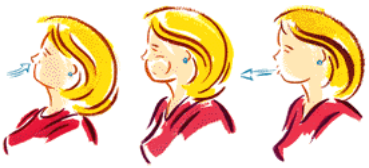
**Ecology** is the study of the relationship between living organisms and their environment. An **ecologist** is someone who studies those relationships.

## 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.

## Adaptations

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.

## Ecosystems

An **ecosystem** is the interactions between living and non-living things in a particular environment. An ecosystem is a place where these interactions occur, such as a rotting log, or a forest. All organisms and parts within this place are interacting all the time and adjustments must occur if the organism is to survive. Ecosystems vary in size and complexity. In order to study an entire ecosystem, scientists often study only a small aspect of an ecosystem and then work with other scientists to piece together the overall picture of how the ecosystem functions.

## Interactions in Ecosystems

### Symbiosis

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

**Notes for Interactions and Ecosystems**

## 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.

*Anemone fish (Clown Fish)* dwell among the tentacles of *Tropical Sea Anemones*
Both partners apparently benefit from the relationship,

## Parasitism

Parasitism occurs when there is a relationship between two different organisms, in which one partner benefits from the relationship, while the other partner 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 Shrik* crucifies *Kalahari barking gecko*.
They store them as a cache for a later meal.

## Commensalism

**Commensalism** 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:

Orchid plants grow high on the trunks of trees in the rainforest. The Orchid benefits with the water that is provided as it flows down the tree trunk from above.

The tree doesn't appear to be harmed or benefit from the relationship with the Orchid.

## 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. Like 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.

# Topic 2 – Human Impacts on Ecosystems

**Natural Resources** are the materials and products that are 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.

## People and Nature – A Changing Relationship

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.

## Gathering Food in Alberta: Then and Now

| Head-Smashed-In Buffalo Jump → | Prairie Settlers → | Cattle Feedlots |
|---|---|---|
|  |  |  |
| **Buffalo** were hunted by driving them to run off a cliff. The carcasses were then dragged to camps where they were processed into meat, hides, tools, and other necessary items. | Early settlers kept **mixed farms** (livestock and crops). The improvements in technology allowed them to stay in one place (instead of following the food supply around). This lifestyle had a larger impact on the environment because farmland and ranchland had to be modified, to support the crops and livestock. | A large area that has been fenced in to feed cattle for food is called a **feedlot**. Once the beef is slaughtered and processed, the products are transported all over the world. The impact of this activity is significant, because cattle waste can pollute the water system nearby, and the soil conditions can be negatively affected. |

All parts of the buffalo were used, with minimal impact on the environment.



## When Is a Need a Want?

**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**.

## No Simple Answers

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.
**[ Find out more ]** http://www.cws-scf.ec.gc.ca/hww-fap/hww-fap.cfm?ID_species=32&lang=e
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. ***Swift foxes*** were accidentally poisoned because certain predators were seen as ‘pests’ or ‘unnecessary’ animals.
**[ Find out more ]** http://www.cws-scf.ec.gc.ca/hww-fap/hww-fap.cfm?ID_species=75&lang=e
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.

# Topic 3 – Environmental Choices

## Your Ecological Footprint

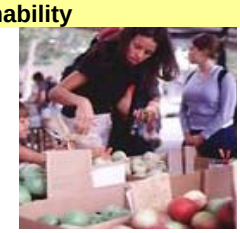
We depend on the environment and we are part of the environment. Sustainability means that the resources from the environment can be replaced as quickly as they are used. Are we putting back what we take out, or, are we using up all the resources before they can be replaced?

## Impact Here and There

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

**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.

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

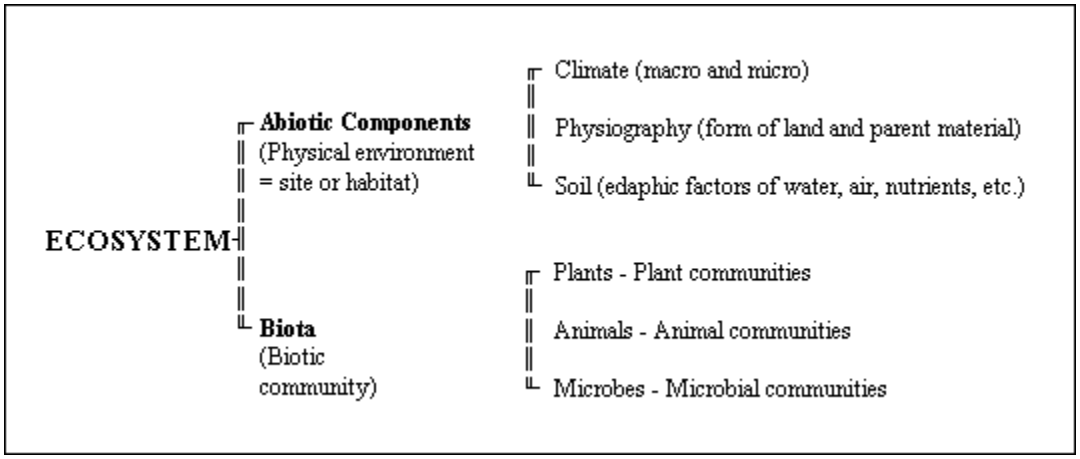
**Reduce, Reuse, Recycle**


**Making The Connection**

Better understanding the principle of sustainability will enable people to realize the impact their *wants and needs* have on the life of this fragile planet. The more knowledge we have about how our actions positively or negatively affect sustainability, the more often we will make choices that will sustain our natural resources.

# Topic 4 – How Organisms Interact

Living organisms make up the **biotic** components of the ecosystem, while non-living things make up the **abiotic** parts of the same ecosystem.




## The Roles of Organisms in an Ecosystem

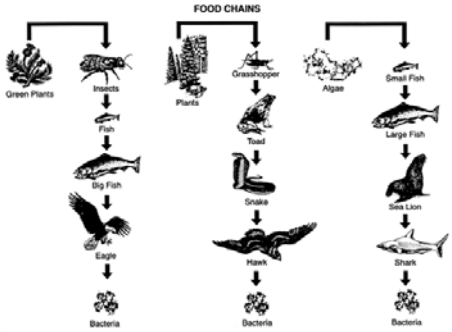
All of the organisms within an ecosystem have different roles. These roles are called **niches**. Organisms can have more than one niche and knowing the niches of an organism can help to explain why they act and interact the way they do. To determine an organism's niche, you need to identify **what it 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 Chains

A food chain is a model that shows how energy stored in food passes from organism to organism.



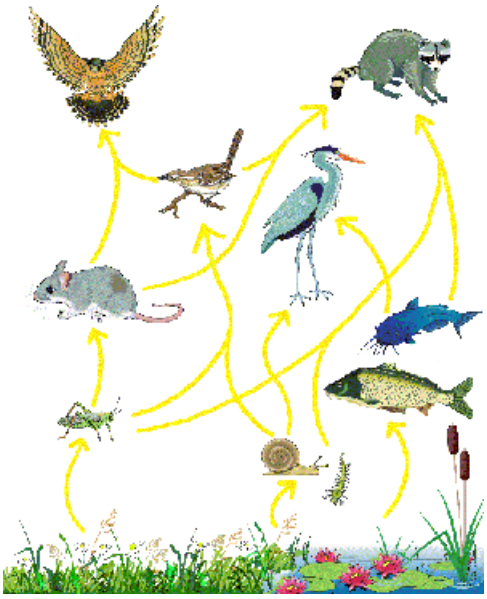

**Energy flow** is the movement of energy, starting with the sun, and passing from one organism to another.

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

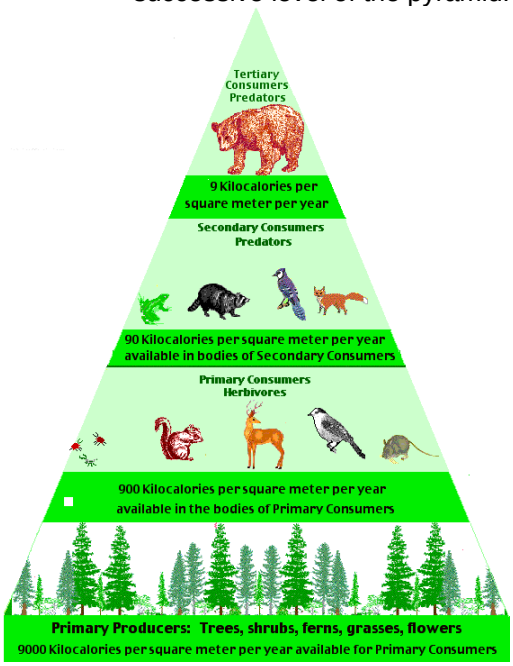


## Food Webs

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, which represents the number of organisms consumed at each successive level of the pyramid.




The size of each 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, Biomass 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.


## The Clean-Up Squads:

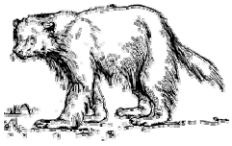
**Decomposers** are different from scavengers because they do not actually eat dead material. They grow on or in the dead or waste matter, absorbing the nutrients directly into their cells, which are then recycled back into the environment.

**Scavengers** are organisms that feed on dead or decaying plant or animal matter.

**Bacteria**

**Fungi**

**Wolverine**



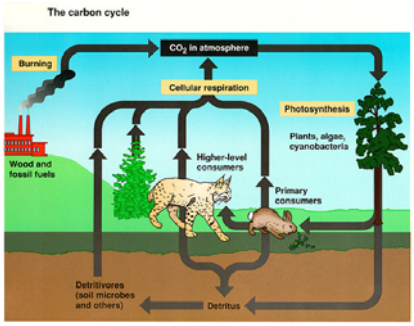
**Magpie**

# Topic 5 - Cycles in the Environment

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.

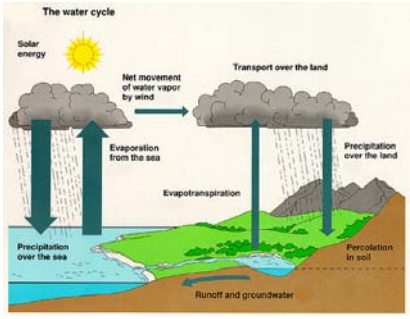
## The Carbon Cycle

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




## The Water Cycle

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.



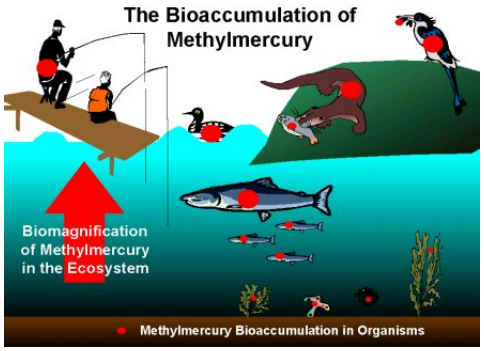

## Pollution in the Environment

**Pollution** occurs when a substance is added to the environment at such a fast rate that it cannot be broken down, stored or recycled in the air, land, or water in a non-damaging form. **Pollutants** are substances that cause pollution.

| *Type of Pollutant* | **Acid Rain (high pH level)** | **Carbon Dioxide** |
|---|---|---|
| ***Reason they are pollutants*** | Sulfur and Nitrogen at higher than normal levels in the air, which mix with water to produce acidic precipitation. | Burning of Fossil fuels puts higher than normal levels of CO2 into the atmosphere and the ozone layer (which protects us from radiation is being depleted. |

## The Movement of Pollution (accidental contamination of the air, water and ground – unsafe use)

**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*

# Topic 6 – Succession and Change in Ecosystems

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 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**

Examples of areas in which a community has never lived before would be a new lava or rock from a volcano that makes a new island or a new landscape, or sand bar that arises from shifting sands in the ocean, from exposure of igneous rock surfaces by a land slide, or if a meteor makes a depression that fills with rainwater or fresh water from underground streams.

**After**

## Secondary Succession

**Before**

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**.

**After**

## Changes Caused by Human Activity

Humans affect the environments around them in many ways, including activities and technologies such as: forestry, industrial processes, transportation, urban development, construction and farming. When an ecosystem is changed by human activity, there can be unexpected consequences. Some species thrive when change occurs (eg. Cowbirds), while some species suffer (eg. Warblers )

## Some Species Adapt Better Than Others

The **cowbirds** adapt to farmland easily, while others cannot.

The **coyote** has been able to adapt to the spread of urban areas, whereas other animals, such as the wolf have not.

## Pest Control

Pests that can affect human health and crops are a major problem. Besides controlling the pest population a pesticide can also damage other organisms that are not targeted. This occurs with a pesticide that is designed to kill **lygus bugs** (who damage canola crops). The pesticide will also kill bees. If the pesticide kills the pest predators, then the pest population may actually increase.

## Biological Control

Using their own natural enemies is another way to control pests. This method is known as biological control

## Introduced Species

Biological control can however cause other problems. 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.

This happened when ***zebra mussels*** were introduced into the Great Lakes. It has become a major problem. Introducing a species not natural to a particular area can cause more problems than what it solves.

***Purple loosestrife*** – sometimes called the "beautiful killer' – was introduced into North America has taken over valuable wetland habitat, pushing out native species.

## Species In Danger

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. 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

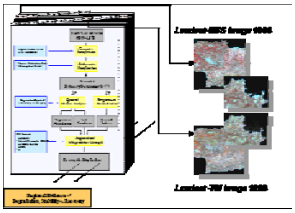
## How Can You Help?

Recovery programs are in place or being developed to assist the species with repopulating an area. Volunteering to help is a great way to get personally involved.
Learn More at Alberta Government Website
***Sustainable Resource Development*** http://www3.gov.ab.ca/srd/fw/wild/



# Topic 7 – Environmental Monitoring

**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 |
|  |  |   |  |

## When Do We Monitor?

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.
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***) **sf** p. 73
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 population of the species in the area. (see – **sf** p. 76-77)

### Using Science in Real Ecosystems

The **North River Basins Study** (1991) was designed to see what impact the development of natural resources would have on the ecosystems in the region. The analysis of the results indicated that industries were having a negative impact.