# Science 1206

## UNIT 1

## Life Science - Sustainability of Ecosystems

# SUSTAINABILITY OF ECOSYSTEMS

## Topic 1: Introduction to Ecology

# Biosphere

**Biosphere** includes all places on the planet where living organisms can survive. The **Biosphere** is referred to as a layer of life, ( Discuss and orange) it start at the lowest depth of the ocean to the highest point in the atmosphere

# Ecology

**Ecology:**

**The scientific study of the interactions between organisms and their environment**

The scope of ecology is extremely large and due to this the study of ecology may be approached on a number of different levels, from the very specific to the very broad. The approach taken depends upon the information sought after by an individual.

# Newfoundland Fishery

- How people of their time thought about the taking of natural resources.
- Were people concerned with the amount of resources that were taken?
- Did they consider that their activity had any affect on the ecosystem?
- Did they believe that the resources were limitless?
- Do they think the same way about the
- taking of natural resources today?
- If not, what caused them to change their values, ideas and beliefs regarding the exploitation of natural resources?

# Sustainability and Changing Paradigms

Our past ancestors stood on the face of this Earth with the belief that it was a tremendously large and flat world. The Earth, in their view, was the center of the universe. People believed humans were totally unrelated to other animal life here on Earth; that humans were placed on this earth to Rule over and make use of the boundless resources, put here for the sole benefit of humans. Water, land, air, minerals, forests, fish, and all other resources, both renewable and non-renewable, were all considered to be endless supply.

# Paradigms and paradigm shifts

- **The way that humans view the world is known as a paradigm.**

"The earth and all things on it exist for the sole benefit of humans" was an old world paradigm.

Today it is clearly understood by most people that the early views were wrong. The  old paradigms have been replaced by new paradigms.

**Changes in paradigms are known as paradigm shifts.**

- Humans no longer regard the Earth as the centre of the universe.

- Humans now recognize that the Earth is a sphere rather than flat.

- We are the caretakers of this world and we must take responsibility for its sustainability. These are all examples of paradigm shifts.

The paradigms of modern man differ from the paradigms of our forefathers

# Earth – Closed System

- From outer  space it is easy to recognize that the earth is for the most part, a **closed system**. The materials that make up the biosphere are not limitless as was once believed. These materials are recycled.

Even the life forms found on Earth are made of the same materials that are found in the land, water, and air. These materials too are recycled. It is only in recent times that humans have had the opportunity to view the Earth in this way. Perhaps this view is one of the reasons why modern man has shifted his paradigms regarding the Earth and its resources

# What is sustainability?

- **The ability to maintain without changing or losing the ability to survive. This represents a new paradigm shift.**

- *e.g. As humans, we hope that the earth and world can maintain what we need so that both the present and future generations on this earth will be able to survive.*

**Forests:** If we were to cut down all the trees in the world, what would happen? Would we be able to sustain life?

# Test yourself

1. What is sustainability?

2. Explain why each of the following is or is not a sustainable practice.

   a. Taking oil from the grand banks of Newfoundland.
   b. Establishing an open pit diamond mine in the far north (tundra).
   c. Replanting trees in a forest clear-cut.
   d. Catching more fish each year than are reproduced.

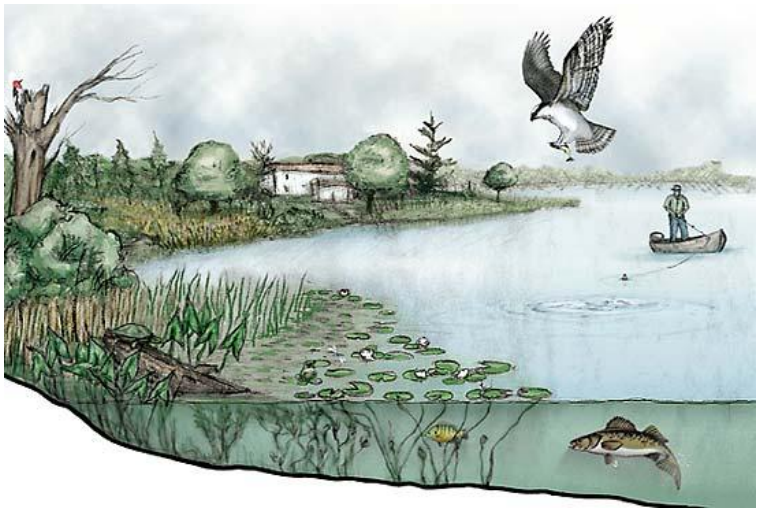
3. Describe one example of an early paradigm and explain why it has changed over time.

4. What conditions must be met in order for Canada to maintain a sustainable fishery?

# Ecosystem.

- **Ecosystem** refers the network of interactions that links the living and the non-living things in an environment.

Ecosystem includes



• the many species living in an environment

•the relationships among those species

•the relationships between the species and the non-living environment.

**Note: An Ecosystem can be studied by breaking it into two parts:**

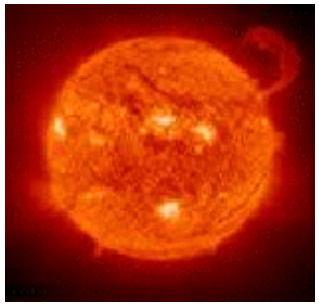
# 1. BIOTIC FACTORS

- **Biotic factors** refers to living or dead parts of the environment.

- Examples:  plants, animals, and micro-organisms.

# 2. ABIOTIC FACTORS

- **A biotic refers** to the non-living parts of the environment. .
- Examples. air, water, soil, sunlight, temperature and landscape.



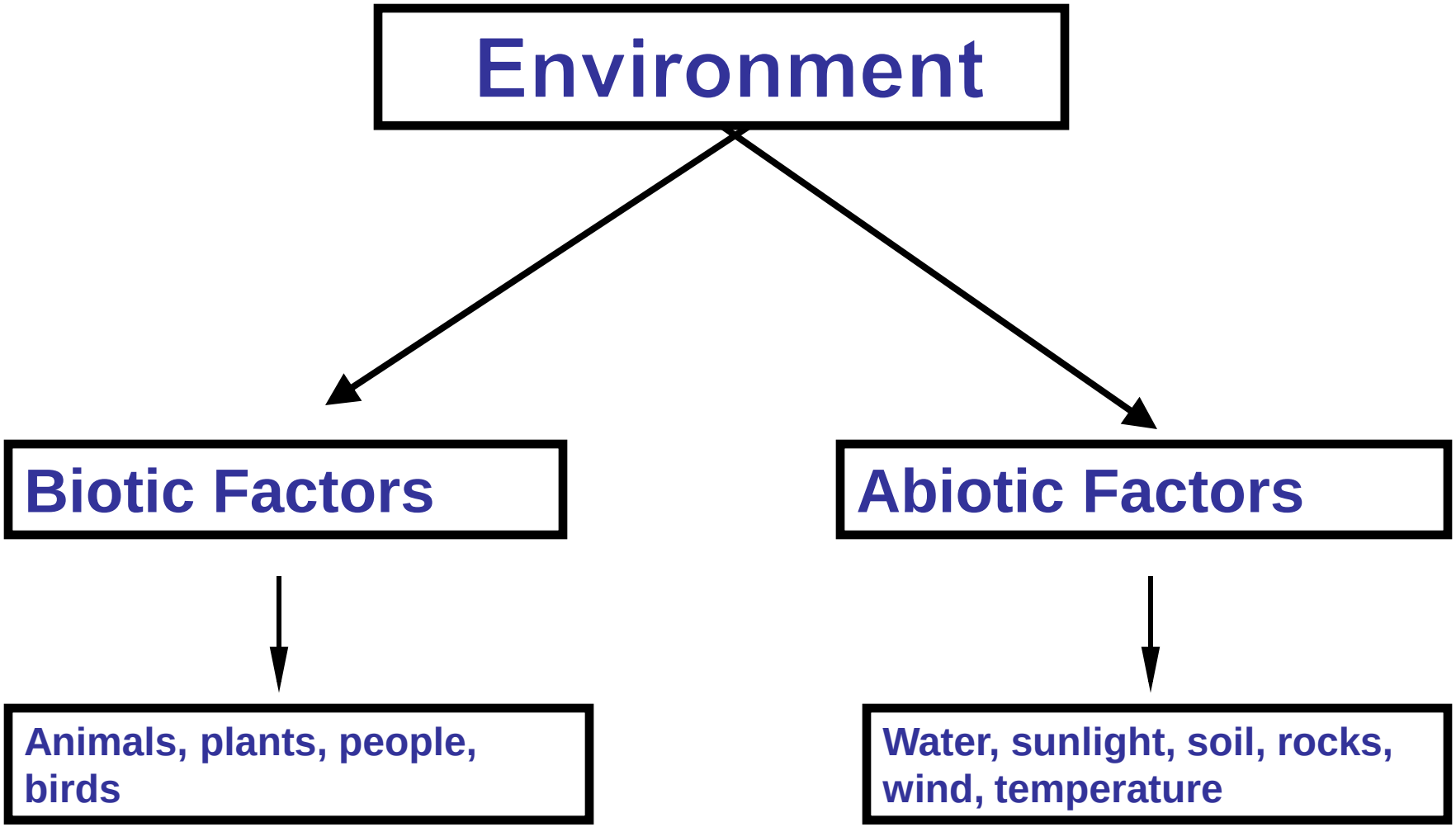
# Biotic & Abiotic Factors

**Place each item in the correct location in the chart:**

**Rotting Tree**
**Dead Bird**
**Fish**
**Sunlight**
**Bone**
**Air**
**Temperature**
**Rocks**
**Maple Tree**

| Biotic | Abiotic |
| --- | --- |
| | |

# Biotic vs Abiotic Factors



# Educational Film

- The role of abiotic factors.

# Symbiotic Relationships

**Symbiosis refers to a relationship between two species that may benefit one or both partners. They depend on the other for:**

1) **Food**
2) **Shelter**
3) **Protection**
4) **Transportation**

**There are three different types of symbiotic relationship:**

# 1. Commensalism

- **Commensalism is a relationship in which one species benefits and the other neither benefits nor is harmed. (free loader).**

**Examples:**

-**Clown can live safely among the tentacles of sea anemones**

**- Sea worm that lives in a sea shell with a hermit crab**

**- Robin and a Bush**

# 2. Mutualism

- **Mutualism is a relationship between two organisms in which both benefit is called Mutualism (The equity relationship**

**Examples**

**- a fungus and an alga live closely together to form a lichen**

**- Ants that live in thorny plants**

**- Butterfly and Flower**

# 3. Parasitism

- **Parasitism is a relationship in which one species benefits and the other is harmed, although not usually killed. The partner that benefits is called the parasite, and the other partner is called the host.**

**Examples**

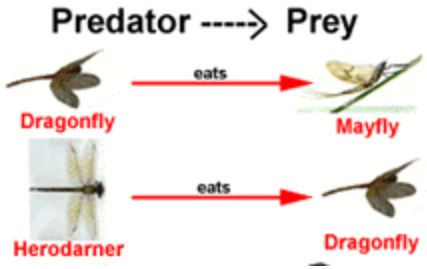
**- lice, live and feed on the body of their host**

**- People and Tapeworms**

**- mistletoe is a parasite that grows on trees**

# 4. Predation

- **Predator** is an animal that hunts and seizes other animals for food
- **Prey** is an organism that is hunted and eaten by the predator.




**Predator-Prey relationships are necessary to stabilize all the species in a specific area. This is called the balance of nature.**

# Worksheet #1

# SUSTAINABILITY OF ECOSYSTEMS

## Topic 2:
## HABITAT, NICHE AND COMPETION

# Habitat

- **Habitat** ------ The physical environment in which a species lives.( Ex: wetlands for ducks, barrens/ tundra for caribou )

# HABITATS

- .

- eg *Arctic Canada* is the habitat of the polar bear.

# MEASURING POPULATIONS

- **Population: members of a species, living in the same area. (Number of people in  Green's harbour)**

- **Community:  interacting populations of two or more species that live together in the same area. Cats, dogs, human's in green's harbor).**

# Species

**Species: a group of organisms that can naturally breed to produce fertile offspring. (Example. Human)**

# Population

- **Population** are members of the same species, living in the same ecosystem or habitat
- Ex: moose on the Avalon Pen.

northern cod stock

# Community

- **Community** the collection of all populations of all species

  - Ex: forest:
  - > all birds, all rodents, moose, rabbits, foxes

  - lake:
  - trout, eels, tadpoles, mosquito larvae, algae

# ECOLOGICAL NICHE

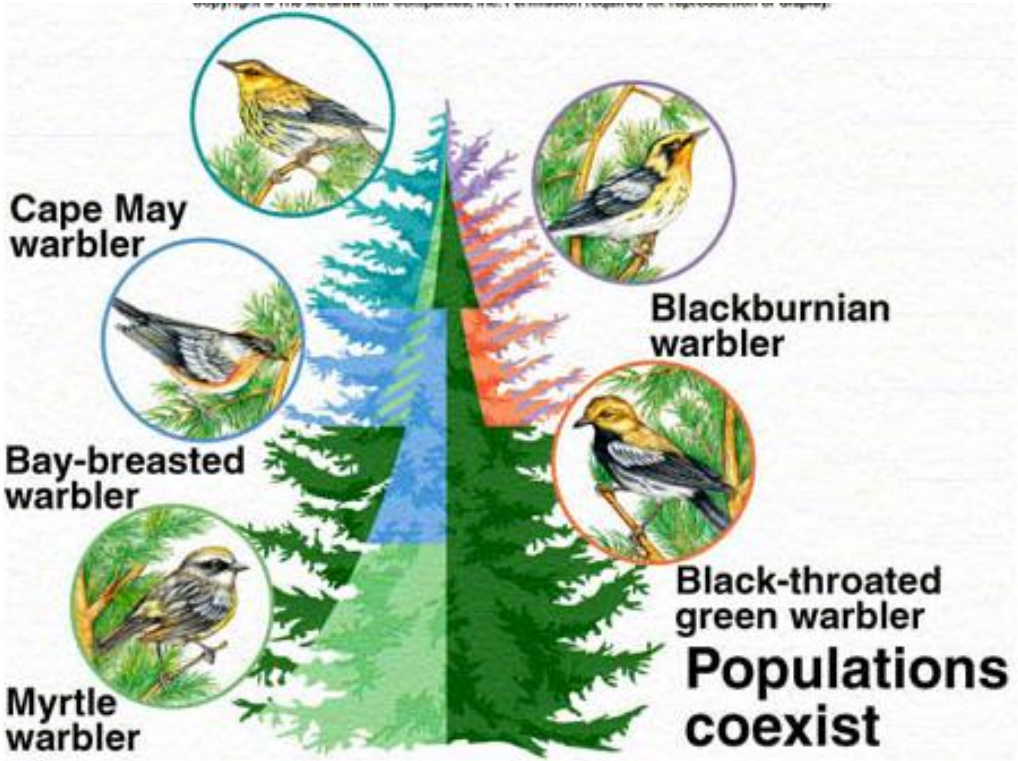
- **In nature, each species plays a particular part in the ecosystem it shares with other organisms. Some are producers, some are consumers, some are decomposers, some are parasites, and so on.**

**Ecological Niche refers to the jobs, or roles of an organism make up. Every type of organism has its own niche and no two niches in the same ecosystem are exactly the same.**

## A complete description of an organism's ecological niche includes:

**Where and when it mates**
**When it feeds / where it feeds**
**What it eats**
**What eats it**
**How it competes etc**

**To provide a description of a ecological niche, consider what would happen if the organism was removed from its habitat**




**The American Warblers split up their niches within spruce trees. In other words, each species of bird hunts insects in a different part of the tree and nests at a separate time from other warblers. These data indicate that by reducing niche overlap, species are able to coexist within a community. Such a scenario results in a decrease in competition between species within a community.**

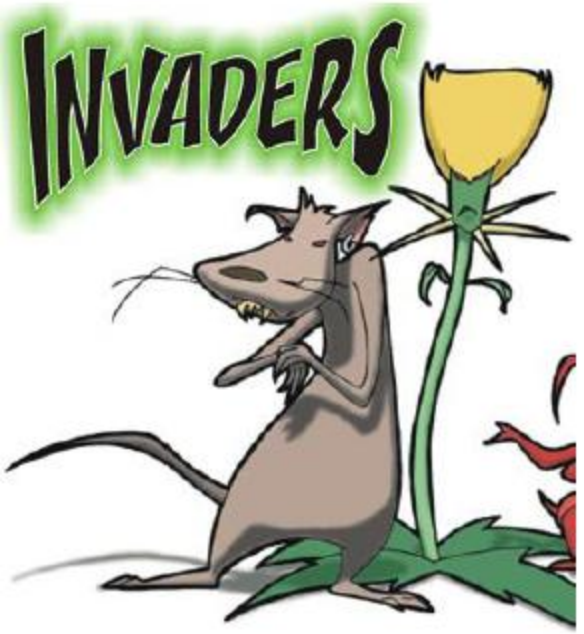
# Competitive Exclusion Principle

- Competitive Exclusion Principle suggests that no two organisms can occupy the exact same ecological niche. If this were so, one organism would out compete the other and displace it from this niche. Thus, most niches have a minimal overlap there by reducing the extent of the competition.

# Introduction of New Species

**Exotic species – introduced outside its native range (generally implies human involvement)**

**Invasive species – spreading rapidly in numbers and in space**



# Competition

**There are two types of competition:**

1. **Intraspecific:** competition between members of the same species. This allows for "survival of the fittest". The result is a healthier overall population.

Atlantic Male salmon will compete with other males for mates during the spawning season. The strongest will be successful, ensuring the fittest genes will be passed on. This demonstrates **intraspecific competition.**

## 2. **Interspecific:** competition between members of two different species

Competition from other species may cause an organism to either **adapt** or **die**. During poor conditions, the more adaptive species has the best chance of survival.

Both the lynx and the red fox prey on the snowshoe hare; this fight for food resources exhibits **interspecific competition.**

Note: Competition is a **biotic factor.**

# Keystone Species

**keystone species is one considered so important to the stability of the ecosystem, that if there was a decline in that species, the community would not be able to maintain its stability and may even collapse.**

**The snowshoe hare in Newfoundland.**

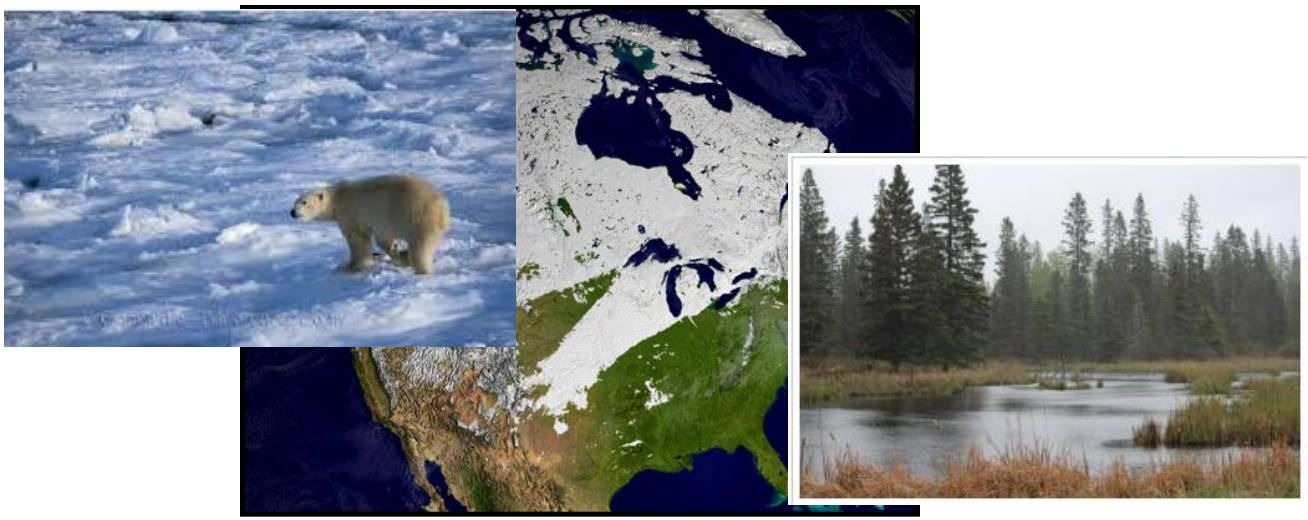
# Worksheet #2

# SUSTAINABILITY OF ECOSYSTEMS

## Topic 3:
## BIODIVERSITY AND SPECIES AT RISK

# Biodiversity

- the number of species in an ecosystem
- every organism in an ecosystem is connected to all other organisms



- reduction in biodiversity (ie: extinction of ONE species) will affect many other species and may cause the ecosystem to collapse

# LOSS OF BIODIVERSITY

**Extinction is one of the main causes for the reduction in Biodiversity**

**<u>Causes of Extinction can be classified as:</u>**

1) **Natural Factors : Ex. competition from an invasive species, climate change**

2) **Human Activities: Ex. Over hunting, logging, pollution**

**Natural factors usually occur at a slower rate and therefore cause a low extinction rate. Human activities occur at a faster rate and cause higher extinction rates. Human activities are mostly responsible for the present extinction rates.**

# Consequences of Biodiversity Loss

- Loss of food
- Decrease in biomass
- Collapse of food web
- Loss of keystone species
- Reduction of ecosystem efficiency and community productivity
- Loss of medicinal supplies
- Increased vulnerability of species to disease and predation


WILDLIFE IN DANGER
THE MOST
THREATENED SPECIES
1
2
3
4
5
6
7
8
9
10
That's one more creature we can remove from the endangered species list.
It's become extinct.
Chris Madden
www.chrismadden.co.uk

| Classification | Description | Example |
|---|---|---|
| Extinct | A species no longer found anywhere | Great Auk<br>Newfoundland Wolf<br>Labrador Duck |
| Extirpated | A species no longer existing in the wild in Canada, but occurring elsewhere or no longer existing in one part of its normal range in Canada but still exists in others | Atlantic Walrus (Northwest Atlantic population) |
| Endangered | A species facing imminent extirpation or extinction | Ivory Gulls<br>Newfoundland pine Martin<br>Wolverine ( Labrador)<br>Beluga Whale ( Labrador)<br>Barrens Willow |
| Threaten | Any species that is likely to become endangered if factors that make it vulnerable are not reversed | Piping Plover<br>Peregrine Falcon<br>Woodland Caribou<br>Porsild's Bryum |
| Vulnerable | A species that is not in imminent danger of extinction, but is at risk because of low or declining numbers at the fringe of its range, or in some restricted area. | Atlantic cod<br>Harlequin Duck<br>Boreal Felt Lichen<br>Short-eared Owl<br>Mountain Fern |

# 1. Extinct

- A species no longer found anywhere.
- At the rate of 80 species per year.
- It is caused by climate change and the pressure of competition (adapt or die).

# Example of an extinct species:

## The great auk

**The Great Auk has been extinct since 1844.**

**The Great Auk, black and white, hugely beaked and shaped rather like a Penguin, could hardly be confused with any living bird. Its upright stance separates it from the vast majority of birds,**

**its enormous**

**beak marks it**

**out from any**

**Penguin.**

# 2. Endangered

- A species that is close to extinction in all parts of Canada or in a significantly large location.

# Example of an endangered species: Whooping crane

The number one cause of death of adult cranes is collisions with power lines during migration.

Conservation efforts since 1938 have resulted in a slow increase. Including those in captivity, there are now 320 whooping cranes in the world.

# 3. Extirpated

- Any species that no longer exists in one part of Canada, but can be found in others.

# Example of an extirpated species:

## grizzly bear

No longer found in Manitoba and Saskatchewan, but still found in the mountains of Alberta and B.C.


# 4. Threatened

- Any species that is likely to become endangered if factors that make it vulnerable get reversed

# Example of a threatened species:

## Wood Bison

Wood Bison are the largest native land animals in North America. In 1940 pure Wood Bison were thought to be extinct. In 1957 a herd of about 200 Wood Bison was discovered by Federal Wildlife officers in the remote north west part of Wood Buffalo National Park.

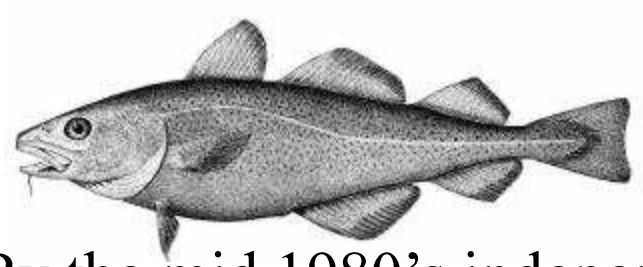
Today the Wood Bison have been downgraded from "endangered" to a "threatened" species in Canada.

# 5. Vulnerable

- Any species that is at risk because of low or declining numbers at the fringe of its range or in some restricted area.

# Example of a vulnerable species:

## Atlantic Cod



Since the 1500's the cod fish has been sought off the Newfoundland coast. At first they were caught by hooks and lines, but since the 1600s to the present they have been caught by nets.

By the mid 1980's independent studies were showing that the cod stocks were declining and the ages of the fish being caught were decreasing at an alarming rate. Many environmental problems have been associated with the drop in cod numbers. A change in ocean currents in the North Atlantic is responsible for a two degree drop in water temperature. Since cod have a very narrow range in which their roe (eggs) can survive, these temperature changes have destroyed their reproductive cycle. Other factors that may be harming the cod stocks include an explosion in the seal population off the coast of Greenland and the increased melting rate of the Greenland glaciers.

# Worksheet #3

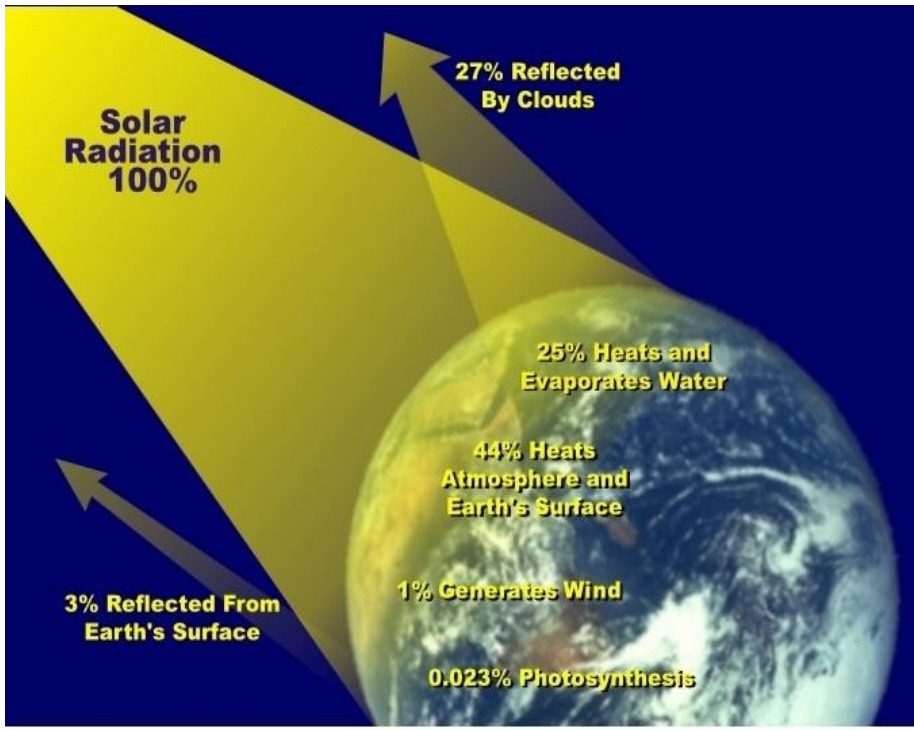
# SUSTAINABILITY OF ECOSYSTEMS

## Topic 4:
## PART 1: ENERGY FLOW THROUGH AN ECOSYSTEM

# Energy flow

- **A major factor involved in the reflection of sunlight off the Earth's surface is the Albedo effect. Albedo is a measurement of the percentage of light that an object reflects. The higher the albedo, the greater the object's ability to reflect sunlight.**

- **For the Earth, the higher its overall albedo, the less energy will be absorbed and available for maintaining global temperatures.**

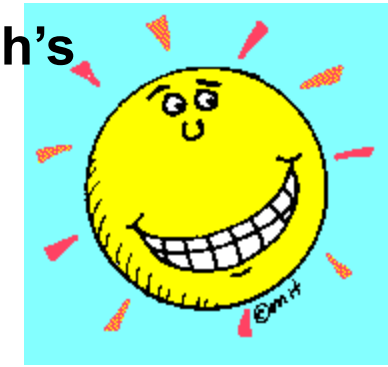


# Energy flow.

- **The source of energy for Earth is the sun**

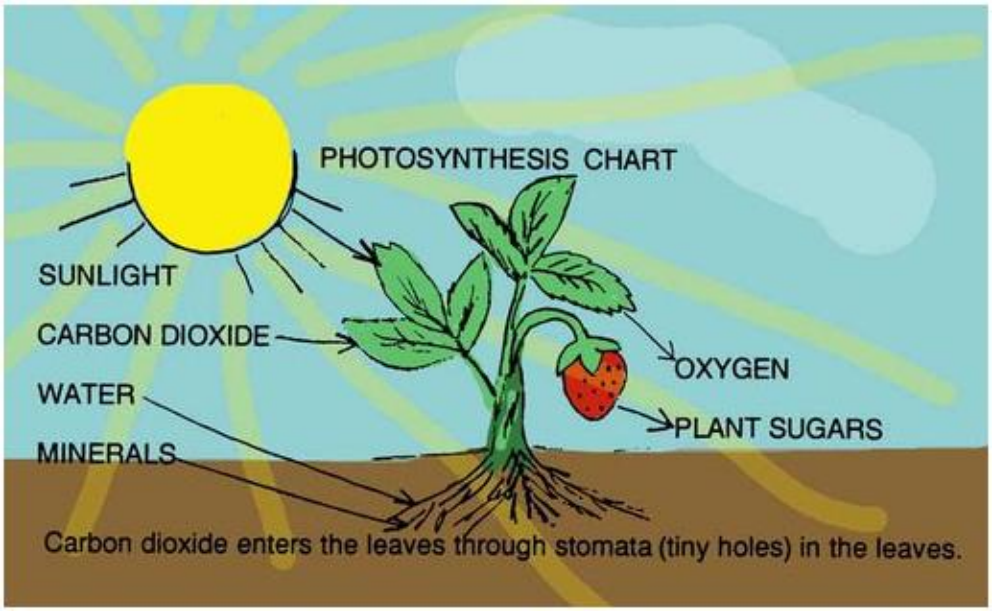
**All energy produced by the sun does NOT reach the Earth's surface.**

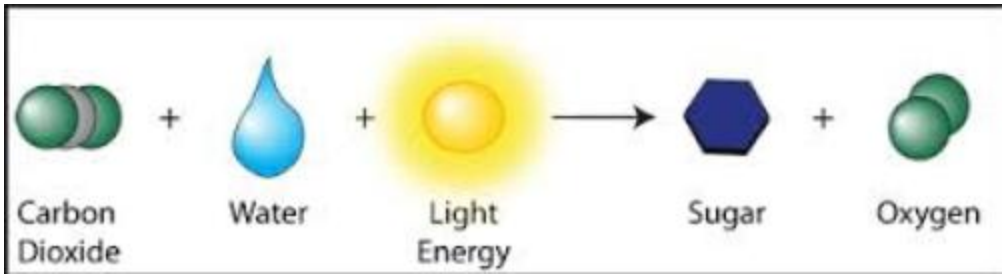
- **30% is reflected by clouds or surface**
- **44% heats atmosphere/land**
- **25% heats water/evaporation**
- **1% generates wind**
- **0.023% is used for photosynthesis**



- **It is a one-way flow. Energy enters food chains through the process of photosynthesis carried out by primary producers.**

# Producers and Photosynthesis



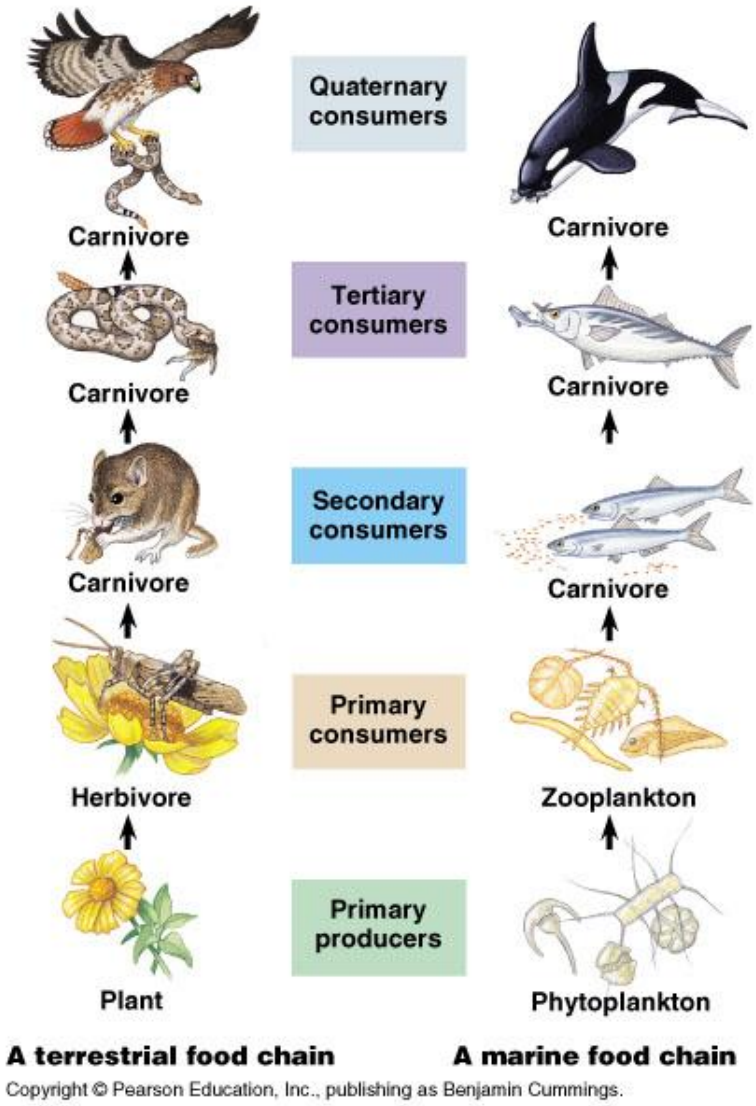
**Relationships Within Ecosystems** include:

**Food Chain**
step-by-step sequence of organisms that feed upon each other.

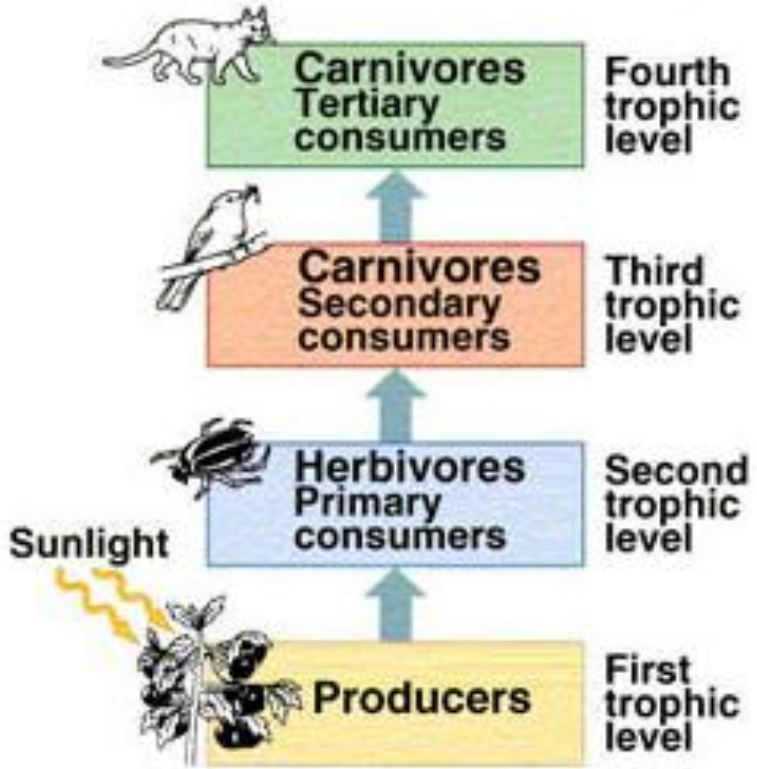
It indicates the flow of:

⇒Energy
⇒Nutrients
⇒ Pesticides

- **Food chains are divided into "Trophic Levels". This refers to the divisions of species in an ecosystem on the basis of their feeding relationships.**



# Ecosystem energy flow



# The major trophic levels are:

1. **Primary producers**:

**These consist of *autotrophs*. These organisms have the ability to manufacture their own food from simple inorganic substances.**

**Most primary producers are photosynthetic organisms that use light energy to synthesize (make) sugars and other organic compounds.**

# Note: Consumers

- **All other organisms in an ecosystem are *consumers*, collectively referred to as *heterotrophs*, that directly or indirectly depend on the photosynthetic output of producers.**

- 1. **Primary consumers**:
  ***Herbivores*** which eat producers.

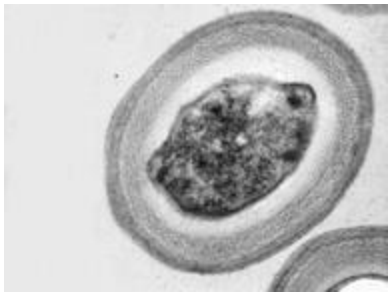
- 2. **Secondary consumers**:
  Carnivores that eat herbivores.

- 3. **Tertiary consumers**:
  Carnivores that eat other carnivores.

4. ***Decomposers*** **constitute another major group of consumers, often referred to as *saprobes*. They derive their energy from "detritus", which is organic waste such as feces or fallen leaves and the remains of dead organisms from all trophic levels.**

- **Decomposers are of critical importance in all ecosystems. They ensure the return of basic minerals to the soil so the future generations of primary producers may have access to them for the purpose of photosynthesis.**




# NOTE:

***Carnivores*** may be divided into a number of different subdivisions:

***A. Omnivore***:

Carnivores which eat both plant and animal material.

***B. Predators***:

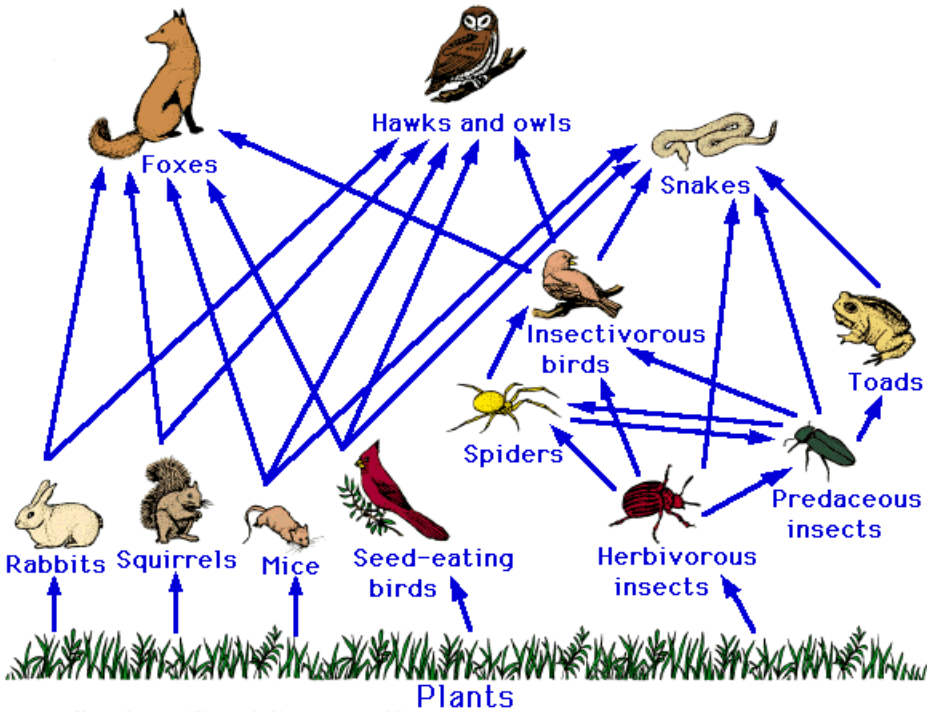
Carnivores that capture and eat prey.

***C. Scavengers***:

Consumers that feed on dead organisms.

# Food Web

- **<u>Food Web:</u>** a series of interconnected food chains, showing many feeding relationships among organisms.



# Summary:

| | | |
|---|---|---|
| **Primary Producer:** | plant/ algae | autotrophs |
| **Primary consumer:** | herbivores | heterotrophs |
| **Secondary consumer:** | primary carnivore | |
| **Tertiary consumer:** | top carnivore | |

Usually no more than 5 links in a food chain. Why?

| | |
|---|---|
| **Detritivores:** | consume litter, debris, and dung |
| **Scavengers:** | clean-up dead carcasses |
| **Decomposers:** | microorganisms that complete final breakdown of organic matter |

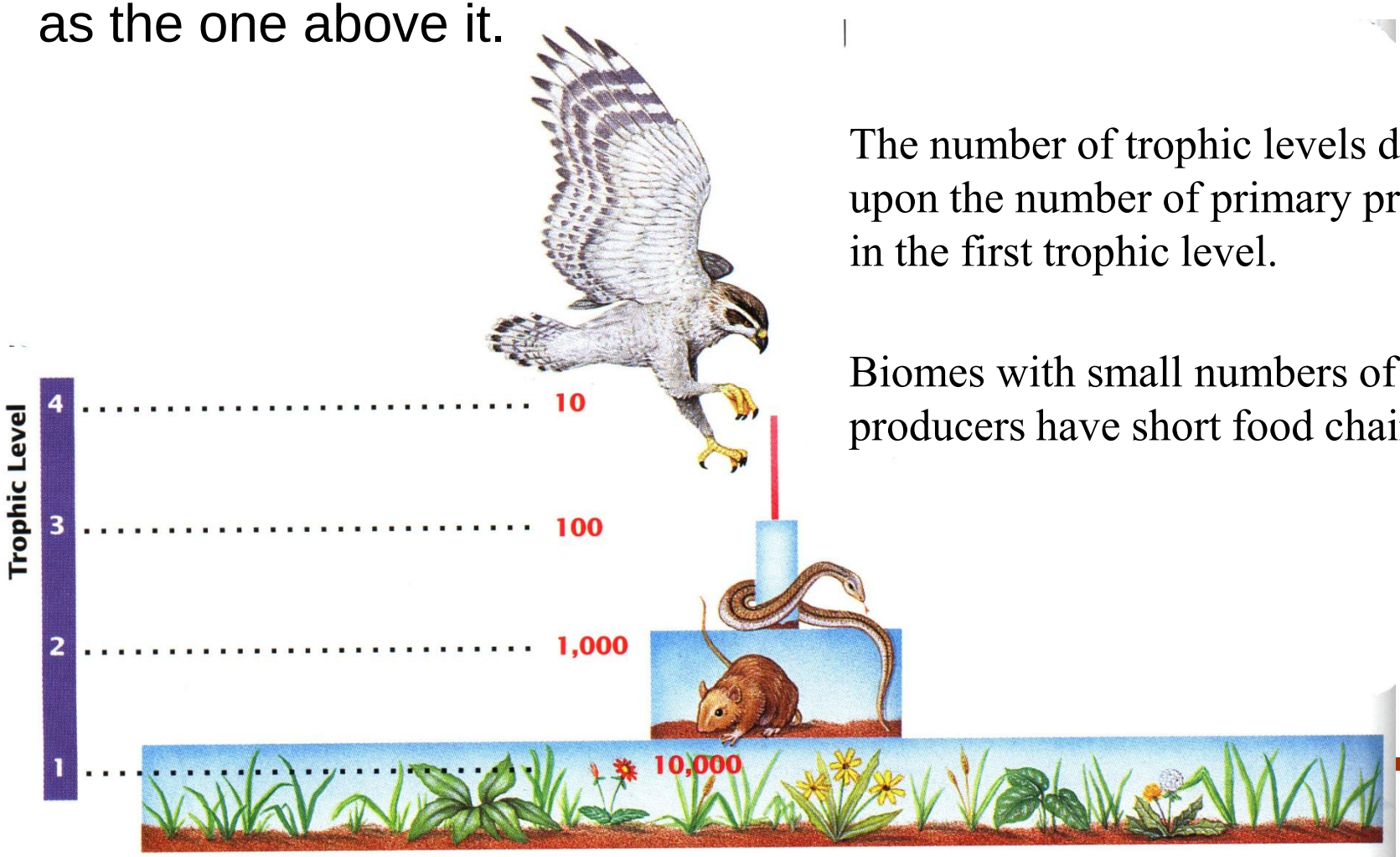
# Worksheet #4

# Introduction to Ecology

## Topic 5:
## PART 2: ENERGY FLOW THROUGH AN ECOSYSTEM

# Energy and the Food Chain

If **10%** of the energy can be transferred from one trophic level to the one above it, each trophic level must have **10x** the energy as the one above it.




The number of trophic levels depends upon the number of primary producers in the first trophic level.

Biomes with small numbers of primary producers have short food chains

# The major sources of energy loss from food chains are:

- 1. Lower order consumers die before being consumed by higher order consumers.
- 2. Each consumer uses some energy it has received for its own needs before being consumed by a higher order consumer.
- 3. Not every part of a lower consumer is consumed by a higher order consumer.
- 4. Not every part of a lower order consumer is always digested by a higher order consumer.

# Pyramids And Tropic Levels

Graphs called pyramids are often used to represent food chains. There are three difference types of pyramids:

## 1. Pyramid of Energy:

Trophic levels are stacked in blocks with primary producers forming the foundation of the pyramid. The size of each block is proportional to the amount of energy at that level.

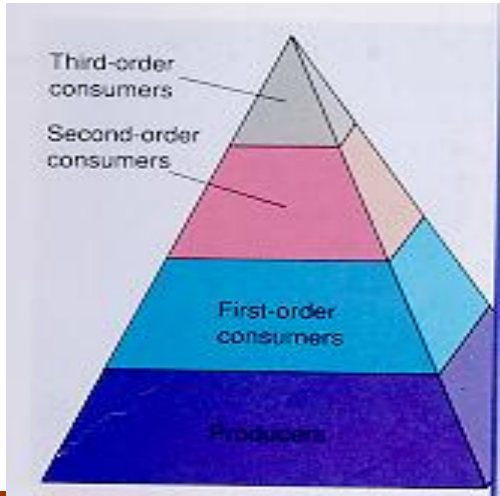
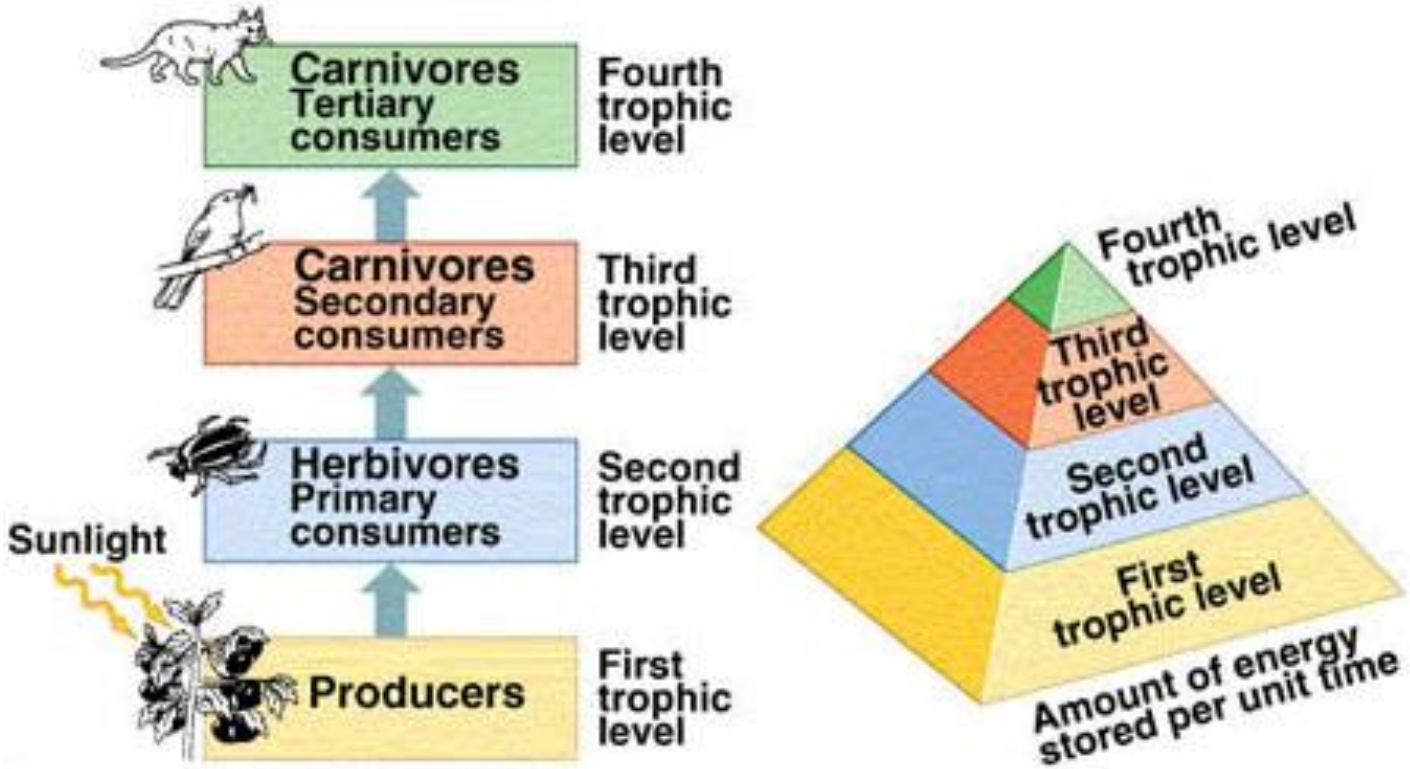
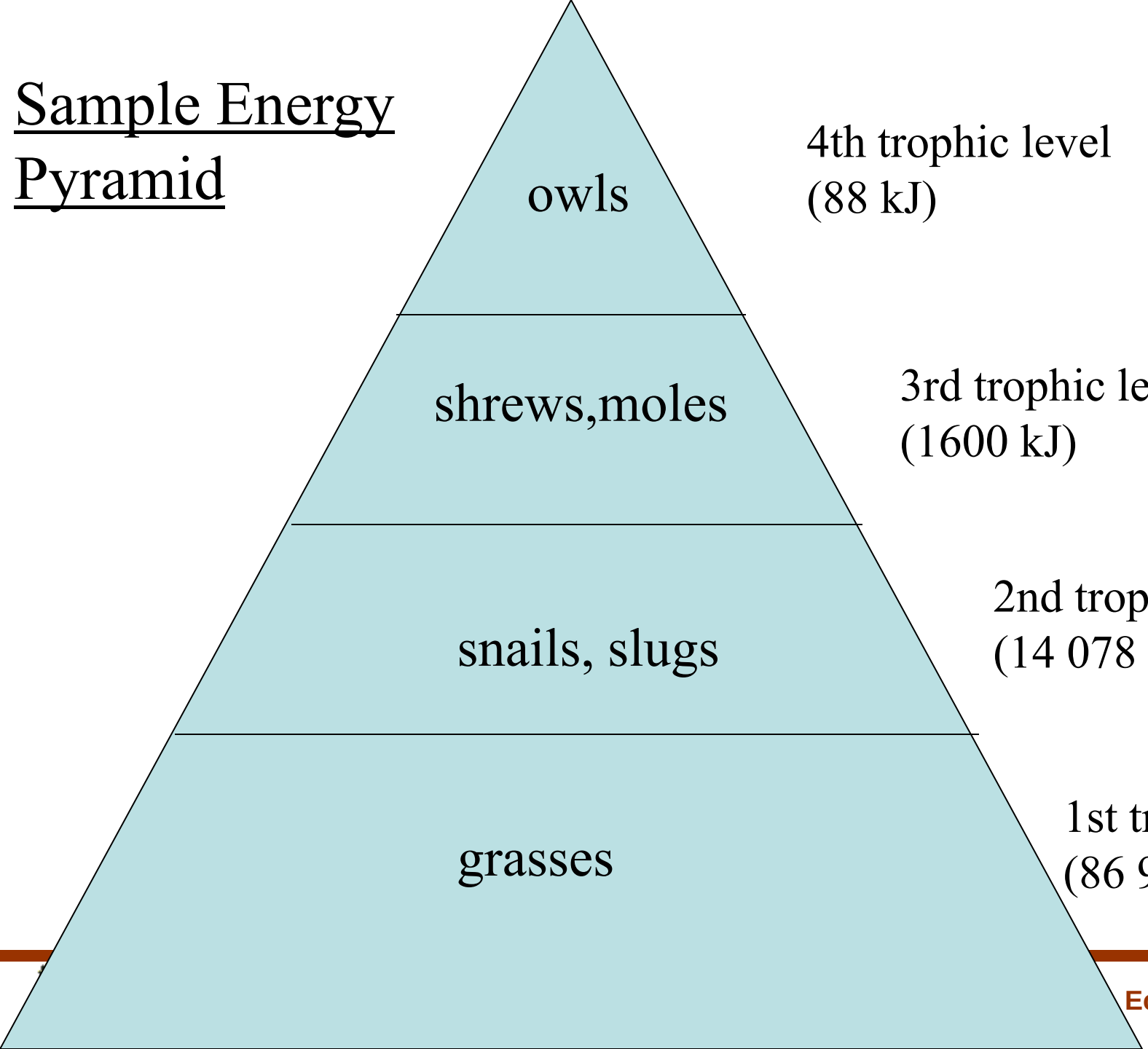



**Figure 48-6** In an energy pyramid, there are fewer organisms at the top than at the bottom.

# Ecosystem energy flow



# Sample Energy Pyramid




4th trophic level
(88 kJ)

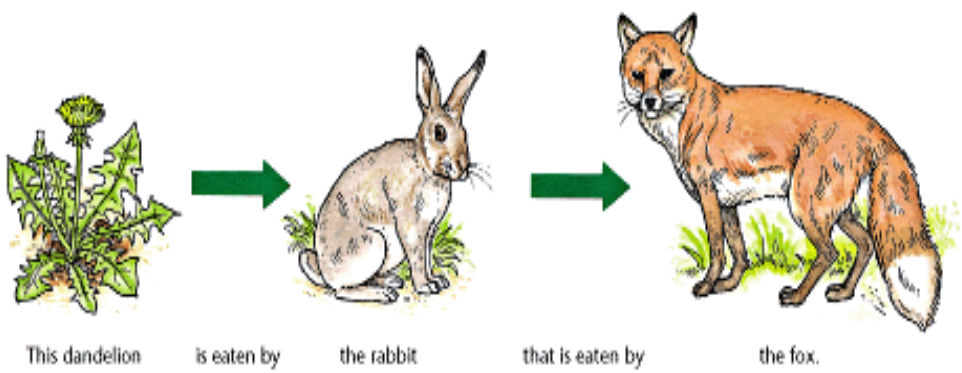
3rd trophic level
(1600 kJ)

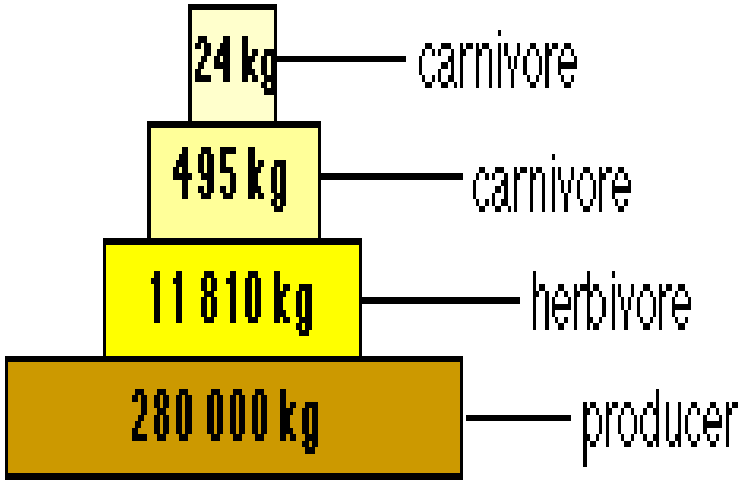
2nd trophic level
(14 078 kJ)

1st trophic level
(86 986 kJ)

## 2. Pyramid of Biomass:

Each tier represents the standing biomass (total dry weight of all organisms) in a trophic level. Biomass pyramids generally narrow sharply from primary producers at the base to top-level carnivores at the apex because energy transfers between trophic levels are so inefficient.

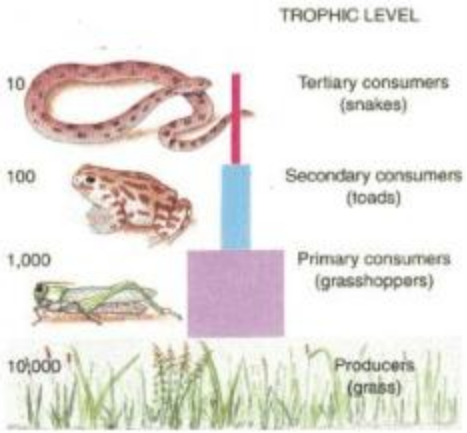


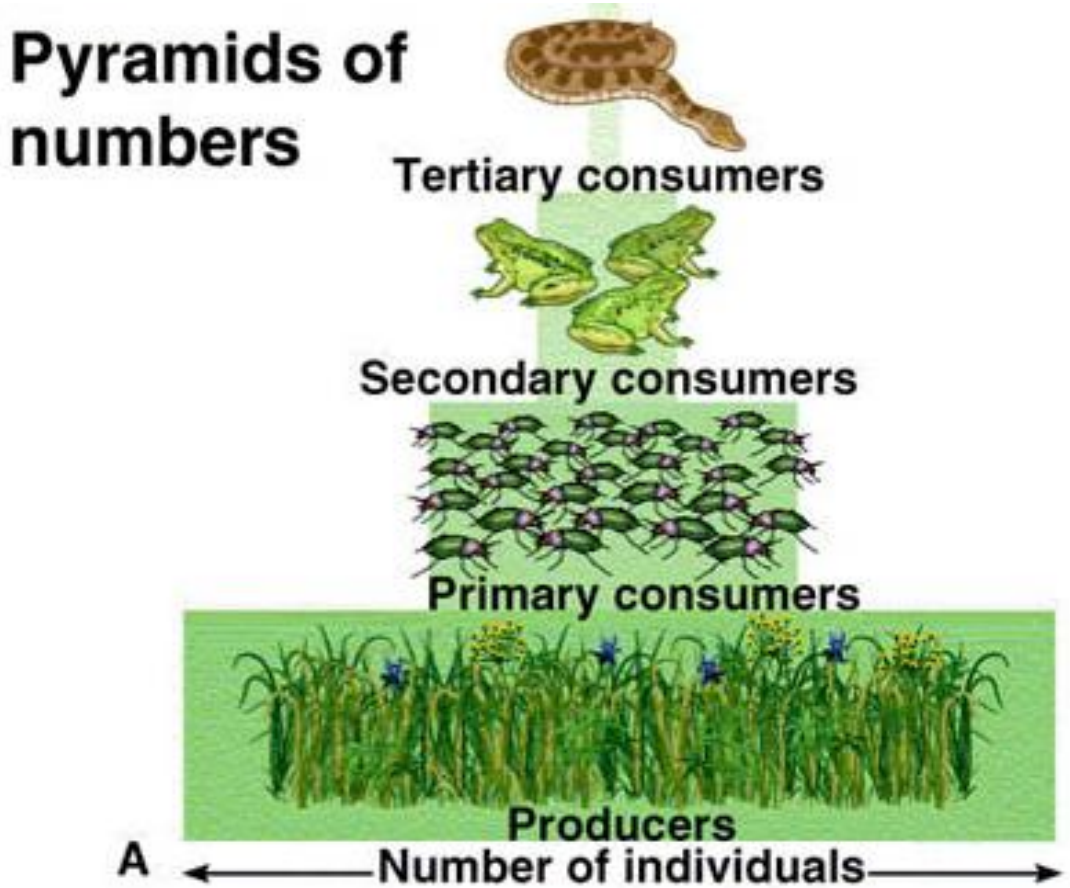



## 3. Pyramid of Numbers:

The size of each tier is proportional to the number of individual organisms present in each trophic level. Like biomass pyramids, numbers pyramids usually narrow sharply from primary producers at the base to top level carnivores at the apex.

Populations of top level predators are typically very small, and the animals may be widely spaced within their habitats. As a result, predators are highly susceptible to extinction.




Pyramids of numbers
Tertiary consumers
Secondary consumers
Primary consumers
Producers
A
Number of individuals

# Activit

– Read 1.11 "Following Energy Movement in Ecosystems" on pages 34 - 39. Answer questions 1 - 14 from "Understanding Concepts" on page 39.

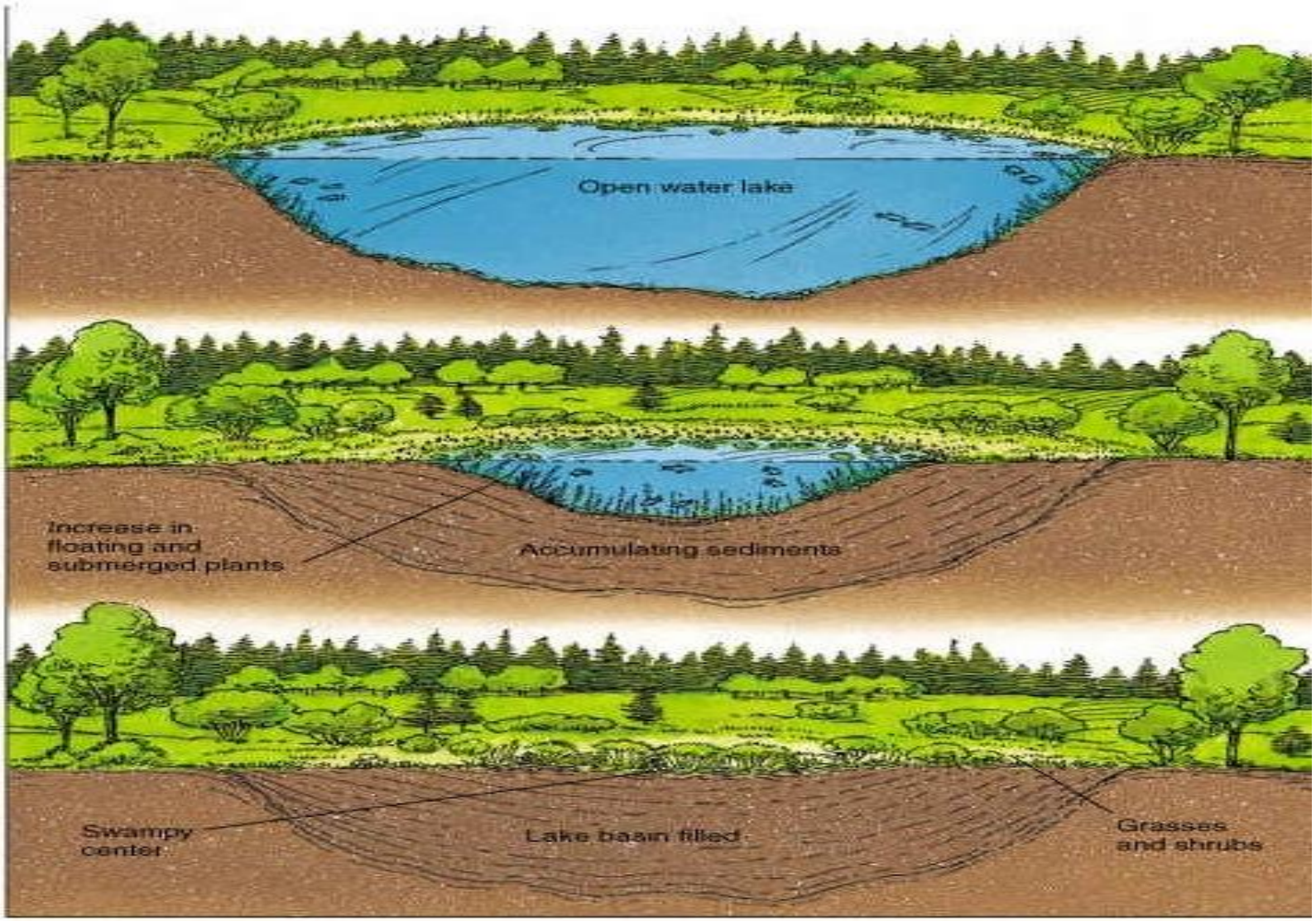
# Worksheet #5

# STUDENT ACTIVITY

- LABORATORY #1
  - Sustainability of Ecosystems

# Introduction to Ecology

## Topic 8:
## ECOLOGICAL SUCCESSION

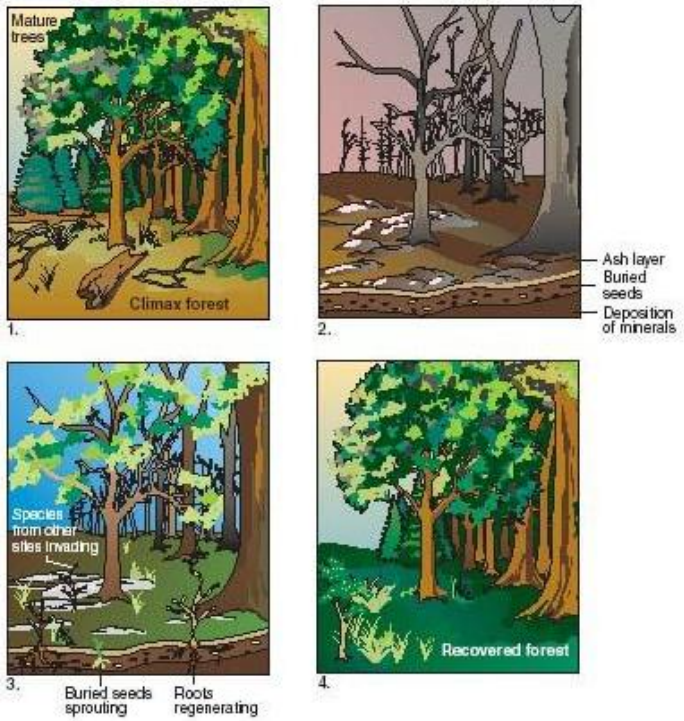



Caption

(a) What begins as a lake gradually fills with organic and inorganic sediments, which successively shrink the area of the pond. A bog forms, then a marshy area, and finally a meadow completes the successional stages. (b) Aquatic succession in a mountain lake. [Photo by Bobbé Christopherson.]

# Ecological Succession

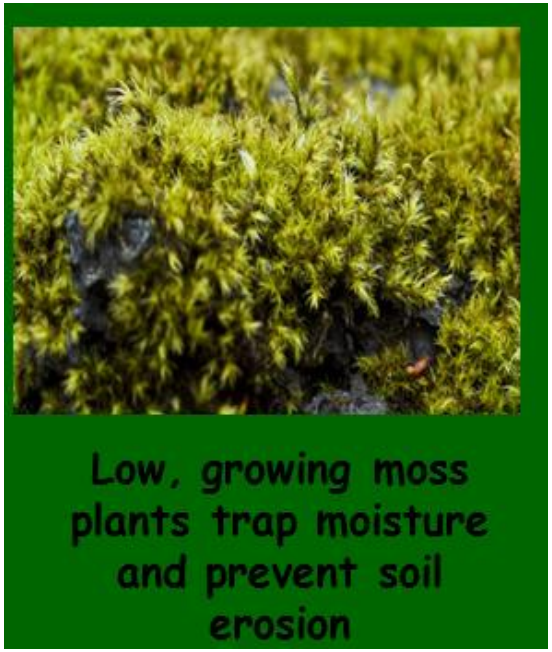
**Ecological Succession- Refers to the series of changes that every community undergoes over long periods of time**



# What is the process of succession?

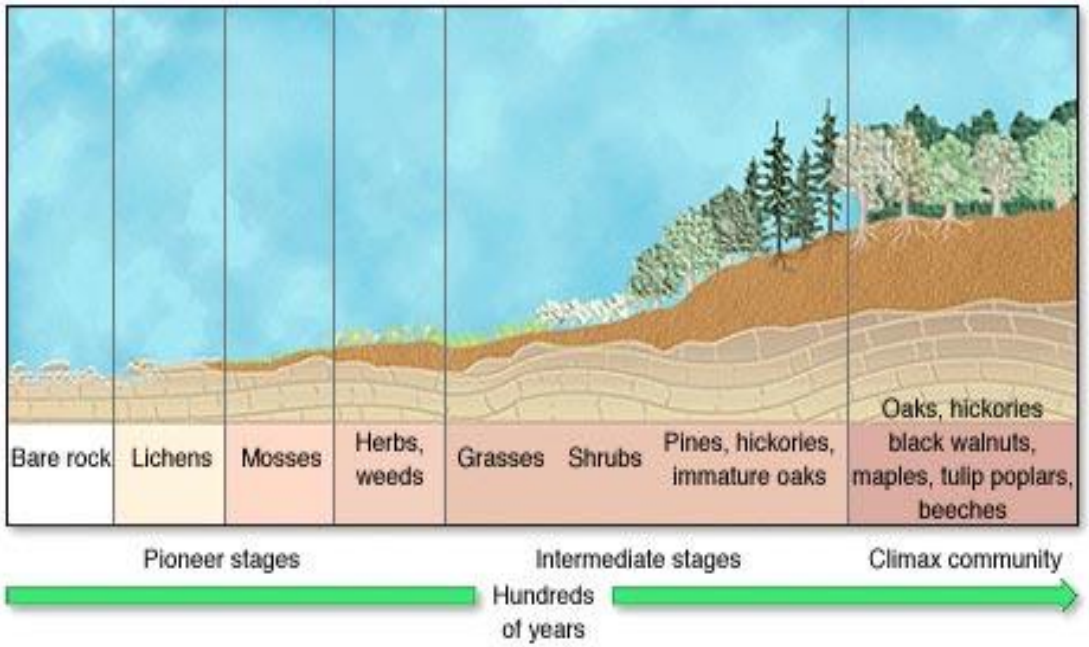
**Pioneering Plants and Animals (the first organisms to appear in succession) appear in an area, forming a primitive community.**

Lichens break down rock to form soil.



Low, growing moss plants trap moisture and prevent soil erosion

**A climax community is the final stage in succession. A stable group of plants and animals that is the end result of the succession process.**




**Does not always mean big trees**

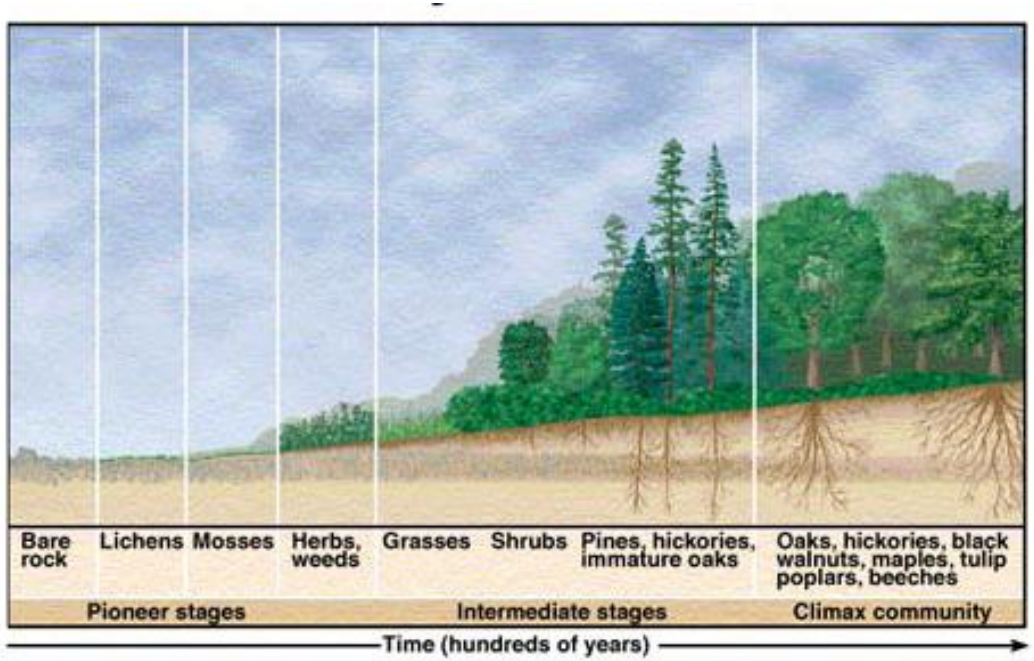
- **Grasses in prairies**
- **Cacti in deserts**

**Abiotic factors determine the type of climax community that will become established**

# These are Climax Communities

# Two Types of Ecological Succession:

**1) Primary Succession: A sequence of changes that begin in an area where there is no soil or other forms of life. (For example, bare rocks that eventually become a coniferous forest).**



# Primary Succession

- Insects, small birds, and mammals have begun to move in
- What was once bare rock now supports a variety of life


http://p2-raw.greenpeace.org

**2. Secondary Succession:** a sequence of changes that begin with soil already there because of an existing community that has been destroyed by such things as fire, clear cutting or volcano

# Disturbances will start the process of succession again

Forest fires

Volcanoes

Avalanche

Deforestation

# Secondary Succession

- Insects, small birds, and mammals have begun to move in
- What was once bare rock now supports a variety of life


http://p2-raw.greenpeace.org

# A summary of changes that occur during succession:

- Pioneer species colonize a bare or disturbed site. Soil building.
- Changes in the physical environment occur (e.g., light, moisture).
- New species of plants displace existing plants because their seedlings are better able to become established in the changed environment.
- Newly arriving species alter the physical conditions, often in ways that enable other species to become established.
- Animals come in with or after the plants they need to survive.
- Eventually a climax community that is more or less stable will become established and have the ability to reproduce itself.
- Disturbances will start the process of succession again.

# Web sites

- http://www.hww.ca/hww.asp?id=5&pid=0

# Activit

- Read 1.10 "Energy in Ecosystems" on pages 32 - 33. Answer questions 1 - 5 from "Understanding concepts" on page 33.
- Activity 2: