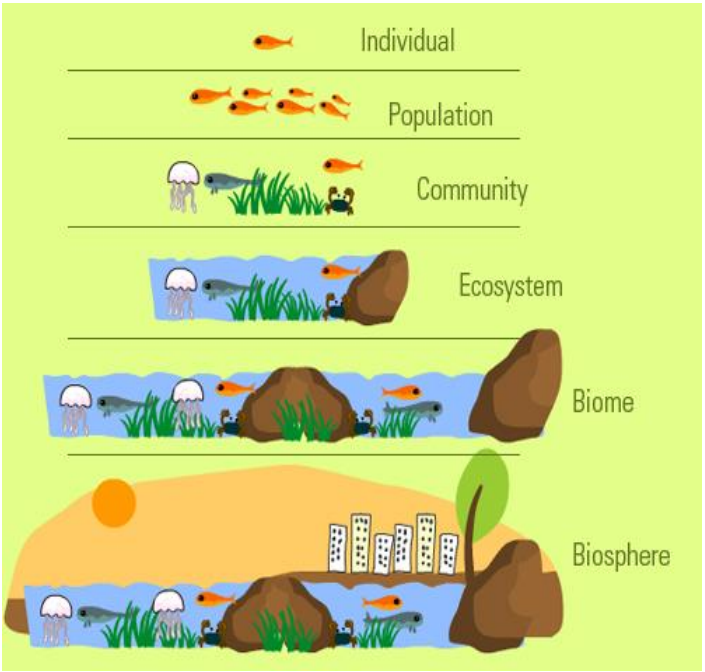
Unit 9 – Ecology

Ecology- the study of the **interactions of living things** with each other and their physical environment.

How are things organized? **Ecologists** *study nature* on different levels from a local to a global scale. Take a look



- **Organism**- an **individual** living thing, such as an alligator.
- **Population**- a group of the **same species** that lives in one area, such as all the alligators that live in a swamp.
- **Community**- a group of **different species** that live together in one area, such as groups of alligators, turtles, birds, fish, and plants that live together in the Florida Everglades.
- **Ecosystem**- ecosystem includes **all of the organisms** as well as the climate, soil, water, rocks, and other **nonliving (abiotic)** things in a given area.
- **Biome-** a collection of **different ecosystems that share similar climate conditions**, and are characterized by the plant communities that thrive there.
  - **Biosphere**- the part of the earth's crust, waters, and atmosphere that supports **life**.

Biotic vs. Abiotic

All the **living things** that directly or indirectly affect the environment

The **non-living factors** that effect a population, which can become limiting factors that determine types of organisms that can live in that area

Carrying Capacity

The **maximum number of organisms** the resources of an area can support.

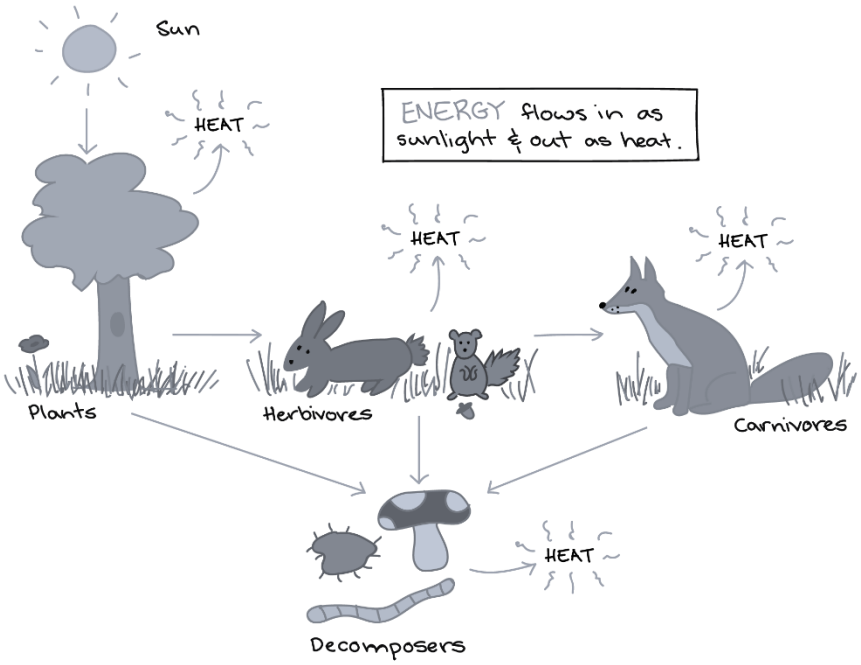
The carrying capacity of the environment is **limited** by the available abiotic and biotic **resources.**

Biodiversity- the assortment, or **variety, of living things in an ecosystem**. An area with a high level of biodiversity, such as a rain forest, has a large assortment of different species living near one another.

Increased **biodiversity** = increased **stability** of an ecosystem

Energy in Ecosystems

All organisms must have a **source of energy** in order to survive. However, not all organisms obtain their energy by eating other organisms.



Producers are organisms that get their energy from nonliving resources, meaning they **make their own food**. Producers are also called **autotrophs.**

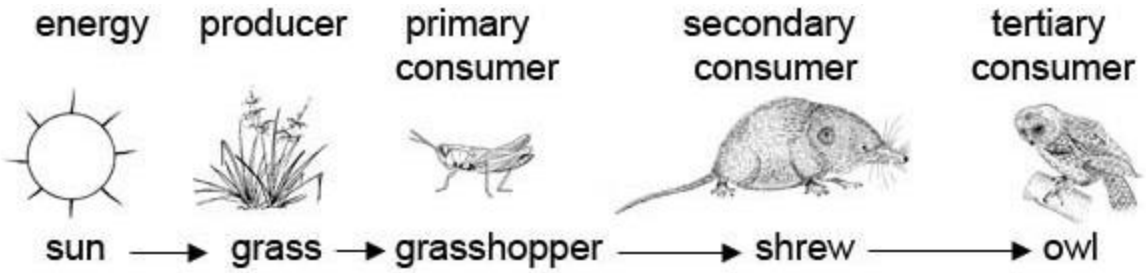
Consumers are organisms that get their energy **by eating other living or once-living resources**, such as plants and animals. Consumers are also **heterotrophs.**

Consumers can be **herbivores** (plants only), **carnivores** (meat only), or **omnivores** (plants and meat)

Decomposers- **break down** organic matter into simpler compounds. Fungi, for example, are decomposers. Decomposers are **important to the stability of an ecosystem** because they return vital nutrients back into the environment.

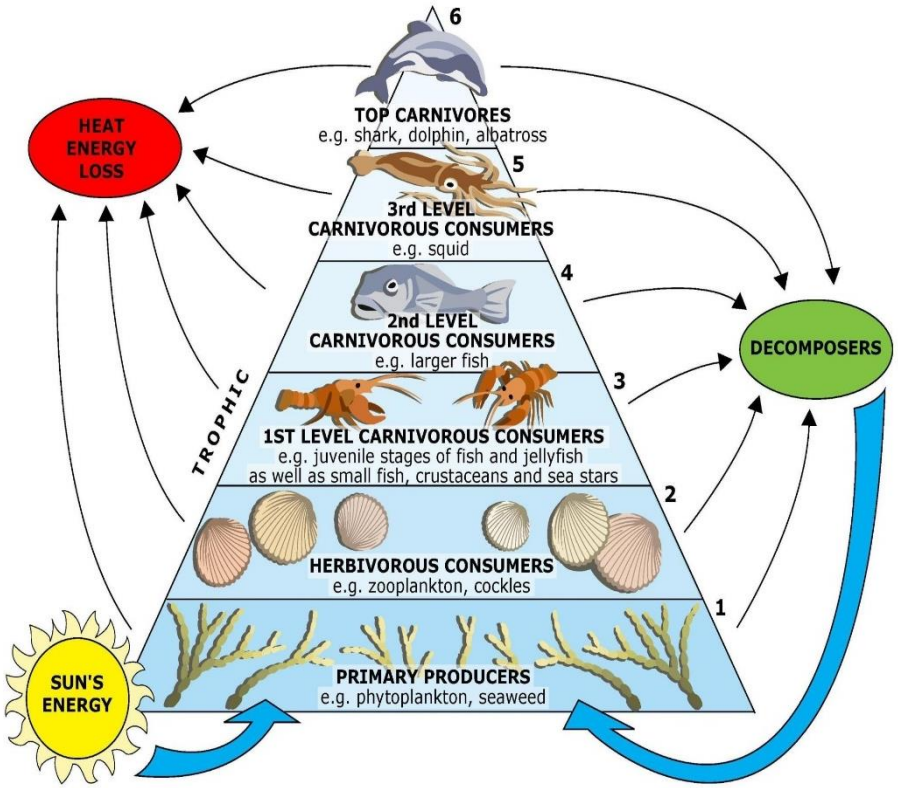
Food Chains and Food Webs

The simplest way to look at **energy flow** in an ecosystem is through a food chain. A **food chain** is a sequence that *links species* by their **feeding relationships.**



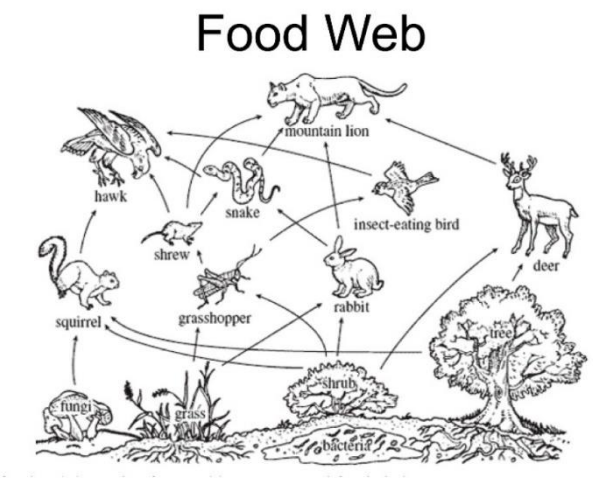
Note: the arrow always points **toward the organism doing the feeding**
For example, in the food chain shown, grasshoppers feed on grass.

Trophic levels
(AKA **energy pyramids**)
Trophic levels are the **levels of nourishment in a food chain**. For example, the producer–herbivore–carnivore chain has three trophic levels. **Carnivores** are at the highest trophic level. **Herbivores** are at the second trophic level. **Producers** are at the first, or bottom, trophic level. *Energy flows up the food chain* from the lowest trophic level to the highest.

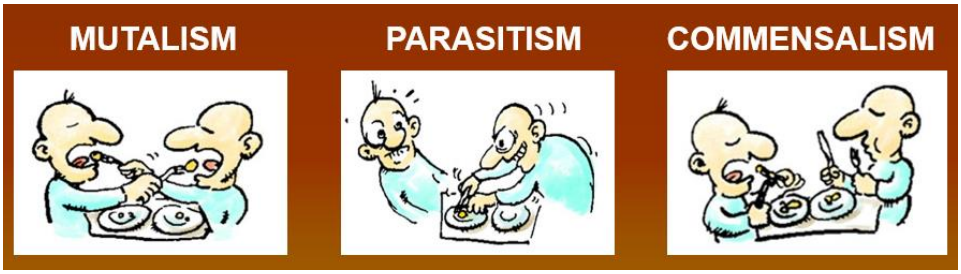


Check out the marine trophic energy pyramid shown ↑ Generally, only about **10 percent** of the **energy** at one level is available to the next level.
Why??
It is used for **metabolic processes** or given off to the environment as **heat**.

Food Webs

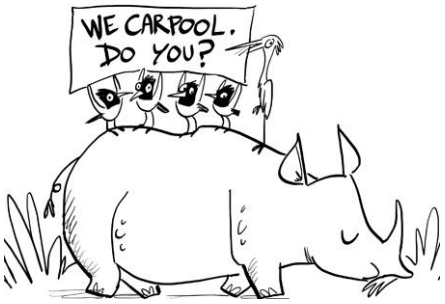


A food web is a model that shows the **complex network of feeding relationships** and the flow of energy within and sometimes beyond an ecosystem.
The stability of any food web depends on the **presence of producers**, as they form the **base** of the food web.
An organism may have multiple feeding relationships within a food web (**generalists**).



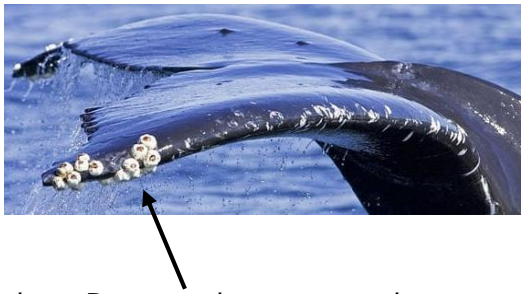
Symbiotic Relationships
Symbiosis: living together with another organism in close association

Mutualism: both organisms benefit. Both organisms **use each other** for a variety of reasons, which could include getting **nutrients** or protection.
Ex) The *oxpecker* is a bird that lives on a rhino or a zebra. The *oxpecker* eats parasites off the larger animal, providing food for the bird and fewer parasites for the larger animal. The *oxpecker* will also make a shrill noise when there is danger.



Parasitism: the parasite benefits at the expense of the host.
Ex) Fleas or ticks that live on dogs and cats are parasites. They are living off of the blood of the host animal.

Commensalism is a type of relationship where **one of the organisms benefits** greatly from the symbiosis. The other is *not helped but is not harmed.*



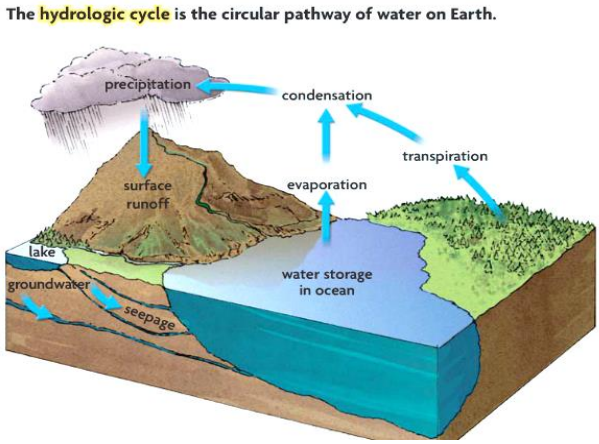
Ex) *Barnacles* are a crustacean that attach to whales. *Barnacles* cannot move on their own, so they use the whale to move around and find food.

Cycling of Matter

In addition to organism interaction with one another and the environment, **matter cycles in and out of an ecosystem** as well.

Matter changes form, but it **does not disappear**. It can be used over and over again in a continuous cycle.

The **water cycle** is a common example:
the water cycle, is the **circular pathway of water** on Earth from the atmosphere, to the surface, below ground, and back

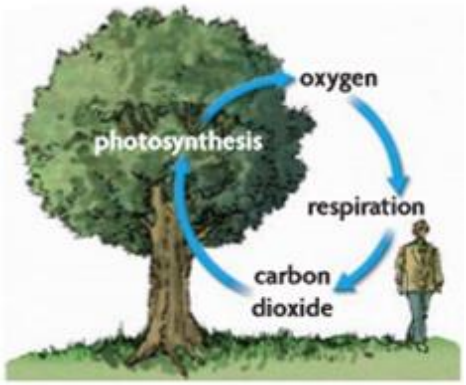


includes processes such as:

- **runoff**
- **evaporation**
- **condensation**
- **transpiration**
- **precipitation**

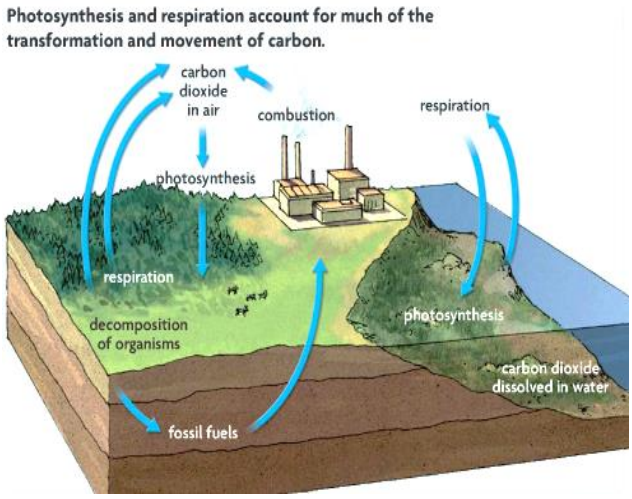
Elements essential for life also cycle through ecosystems, such as **oxygen**, **carbon**, **phosphorus**, and **nitrogen**. All of these elements cycle through ecosystems, just as water does.

The diagram shown of the **oxygen cycle**, illustrates how oxygen flows into the atmosphere as a byproduct of **photosynthesis**. Organisms take in this oxygen and release it as carbon dioxide through **respiration**.



The Carbon Cycle

Carbon is the building block of life. It is an essential component of **carbohydrates, proteins, fats,** and all the other organic molecules. Carbon continually flows from the environment to living organisms and back again in the carbon cycle.



Photosynthesis and respiration account for much of the transformation and movement of carbon.

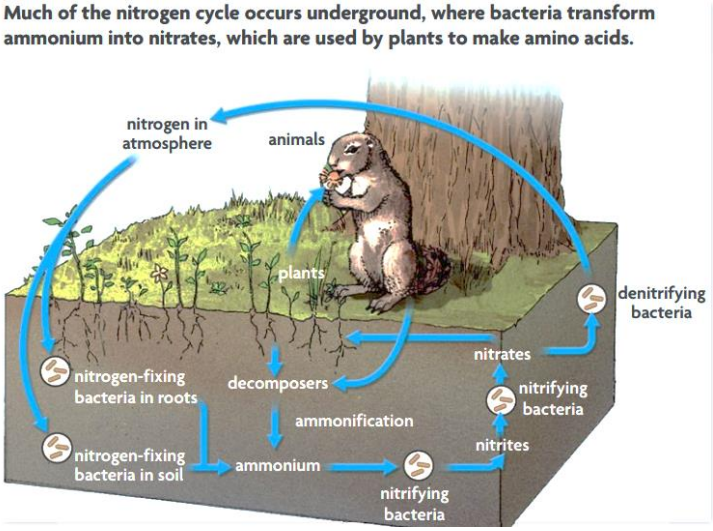
Carbon exists in the abiotic world in several forms:

- Carbon dioxide (CO2) gas in the **atmosphere**
- **Bicarbonate** (HCO3 –) dissolved in water or found in rocks (limestone)
- **Fossil fuels**
- **Dead organic matter** in the soil

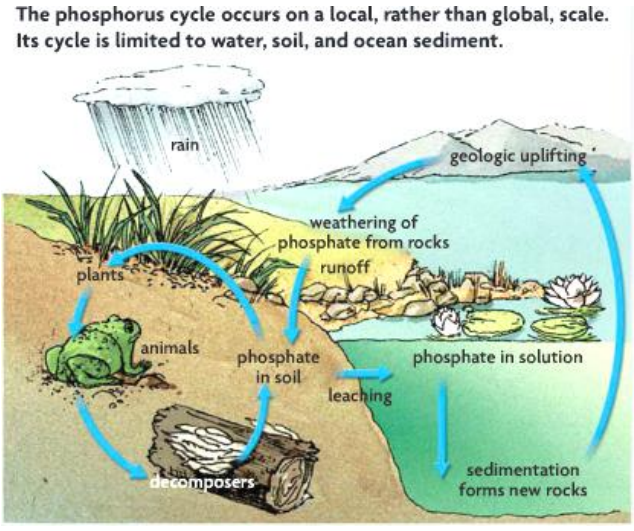
The Nitrogen Cycle

About **78 percent** of Earth's atmosphere is made of **nitrogen gas**. Most organisms can use nitrogen only in the form of ions such as ammonium (NH4 +) or nitrate (NO3 –).

Certain types of **bacteria** convert gaseous nitrogen into ammonia (NH3) through a process called **nitrogen fixation.** Nitrates released by soil bacteria are taken up by plants, which convert them into organic compounds such as **amino acids and proteins**.



Much of the nitrogen cycle occurs underground, where bacteria transform ammonium into nitrates, which are used by plants to make amino acids.



The phosphorus cycle occurs on a local, rather than global, scale. Its cycle is limited to water, soil, and ocean sediment.

The Phosphorus Cycle

Unlike the other cycles, the **phosphorus cycle** does not include an atmospheric portion. Instead, most of the cycle **takes place at and below ground level.** Phosphorus moves from producers to consumers through the food web. Phosphorus is a **limiting factor** for the growth of plants.

Interactions in an Ecosystem

What is the difference between a habitat and a niche?

A **habitat** can be described as **all of the biotic and abiotic factors** in the area where an organism lives. Ex) Lion in the African Savannah has a habitat that consists of all the living things, grasses, water, air, etc.

Each species interacts with its environment in a different way. Within an ecosystem, each species has an **ecological niche** or role. An ecological niche is composed of all of the physical, chemical, and biological factors that a species needs to survive, stay healthy, and reproduce.

You can think of a **habitat as where a species lives** and a **niche as how it lives** within its habitat.

Many species can **share similar habitats** and they may use some of the same resources. Notice in the example, bees and butterflies use the same flowers but have a different niche.

If they **occupied the same niche**, they would be in **competition for resources**.

Another way species interact with one another is through **predation**. Predation is the process by which one organism **captures and feeds upon another organism.**

An organism's role in the environment is just one of many factors that can impact overall **population density.** Population density is a measurement of the number of individuals living in a defined space.

We use this formula to calculate →

$$\frac{\#\text{ of individuals}}{\text{area (units}^2\text{)}} = \text{population density}$$

Factors affecting population growth:

Changes in a population's size are determined by immigration, births, emigration, and deaths.

Immigration is the movement of individuals into a population from another population.

Births increase the number of individuals in a population.

Emigration is the movement of individuals out of a population and into another population.

The size of a population decreases when individuals **die.**

Population growth is a function of the environment. **The rate of growth for a population is directly determined by the amount of resources available**.

The environment determines how many individuals of the species can be supported based on natural cycles and species diversity. An environment, therefore, has a carrying capacity for each species living in it. The **carrying capacity of an environment is the maximum number of individuals of a particular species that the environment can normally and consistently support.**

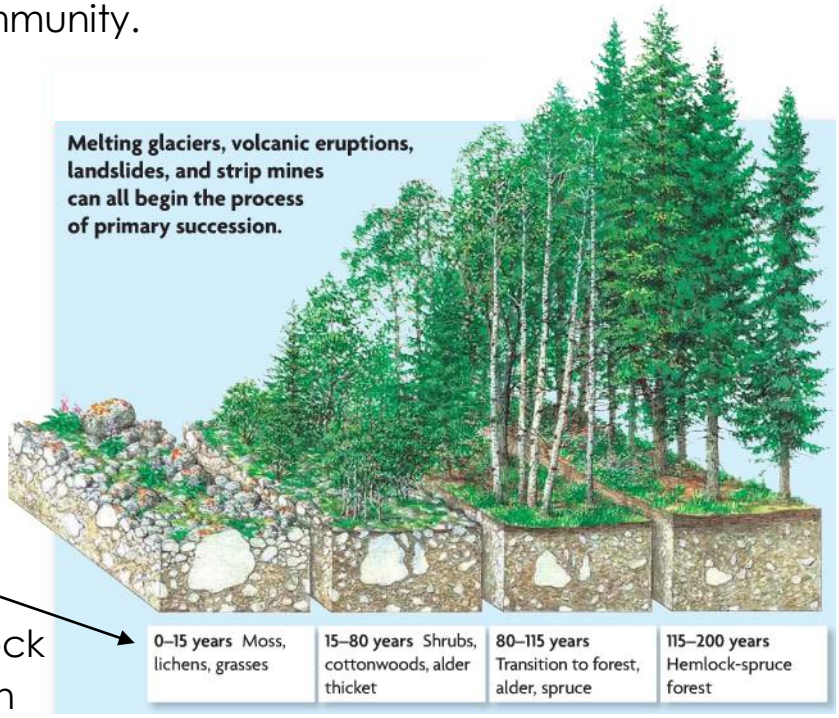
The factor that has the greatest effect in keeping down the size of a population is called the **limiting factor.** Examples of limiting factors include:

- **Competition**
- **Predation**
- **Disease**
- **Resource Availability**

Ecological Sucession

If an ecosystem experiences a **catastrophe** and begins to **regrow**, the space re-forms itself through a process known as succession. **Succession** is the sequence of biotic changes that regenerate a damaged community or create a new community.

Primary succession establishment of an ecosystem in an area that was previously **uninhabited.**

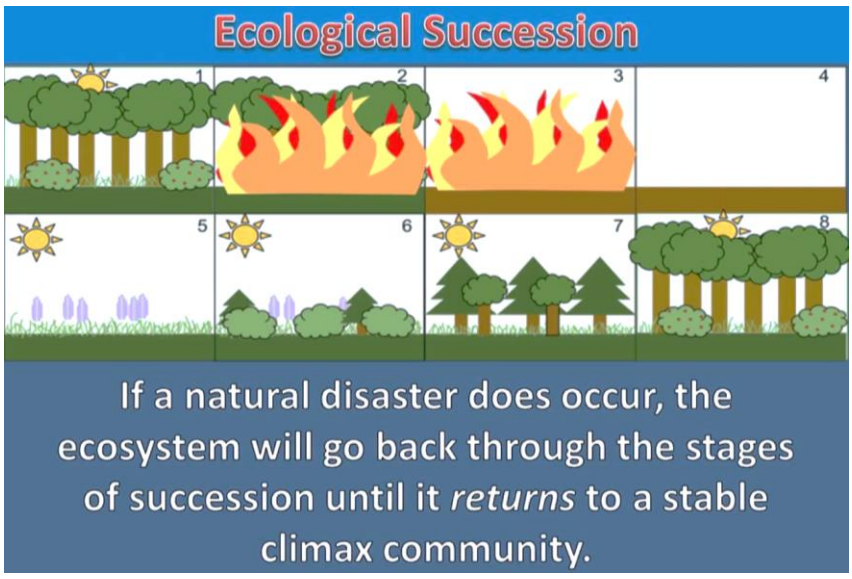


The first organisms that live in an **uninhabited area** are called **pioneer species**.

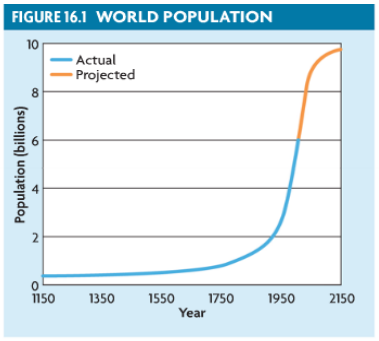
Here's how it works:

1- Glacier retreats exposing rock
2- Lichen/moss spores blown in By the wind
3- Over time seeds are blown in to the area, small flowers & shrubs grow
4- Soil grows thicker, small trees begin to take root
5- Larger trees take root

Disturbances such as a fire or hurricane, halts the progress of succession or destroys an established community. **Secondary** succession, is the **reestablishment** of a damaged ecosystem.



Human Impact



Source: United Nations, World Population Prospects, Population Reference Bureau

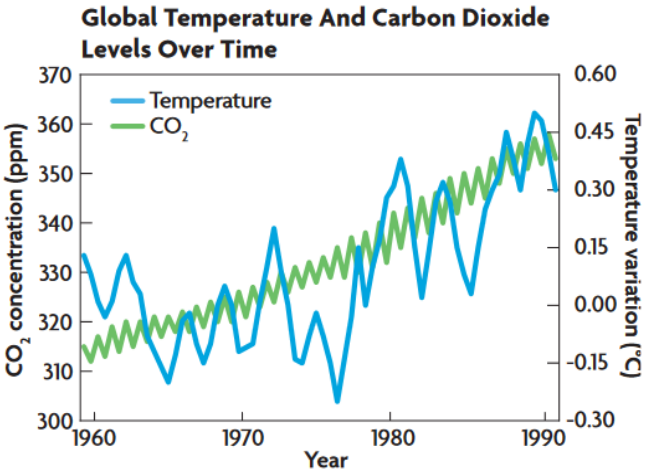
Population Growth- Human population **continues to grow** which exerts pressure on Earth's natural resources. Use of **non-renewable** resources (coal, gas, etc.) can lead to depletion and greater **pollution**.

Pollution is any **undesirable factor** that is added to the *air, water, or soil.*

Examples of Types of Pollution

Smog
air pollution caused by the interaction of sunlight with pollutants produced by fossil fuel emissions

Acid Rain
Precipitation produced when pollutants in the water cycle cause rain **pH** to drop below normal levels



Source: University of California, Scripps Institute of Oceanography/ Hadley Centre for Climate Prediction and Research

Air pollution is changing Earth's biosphere. Scientists have found that **changes in Earth's temperature** correspond with fluctuations in global **carbon dioxide** levels.

This causes what is known as the "**Greenhouse Effect**." Water vapor, carbon dioxide, and methane are gases that absorb radiant energy and contribute to **global warming**.

Preserving biodiversity is important to the future of the biosphere. A **decrease** in an ecosystem's biodiversity will have a ripple effect through the **entire ecosystem**. Medical and technological **advancements** come from nature.