The Web of Life

Ecology and Ecosystems

Advanced Regents Living Environment

What is a Species?

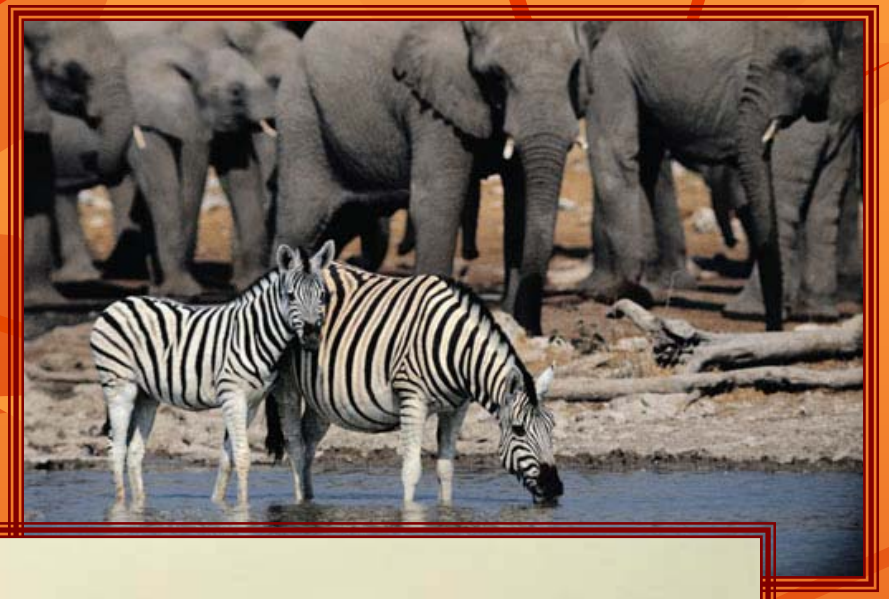
- A ***species*** is a group of organisms that share the most common characteristics and are capable of reproducing fertile offspring.

Population

- A *population* is comprised of all the members of a single species in a given location.

Community

- A *community* is made up of all the interacting populations in a given location.

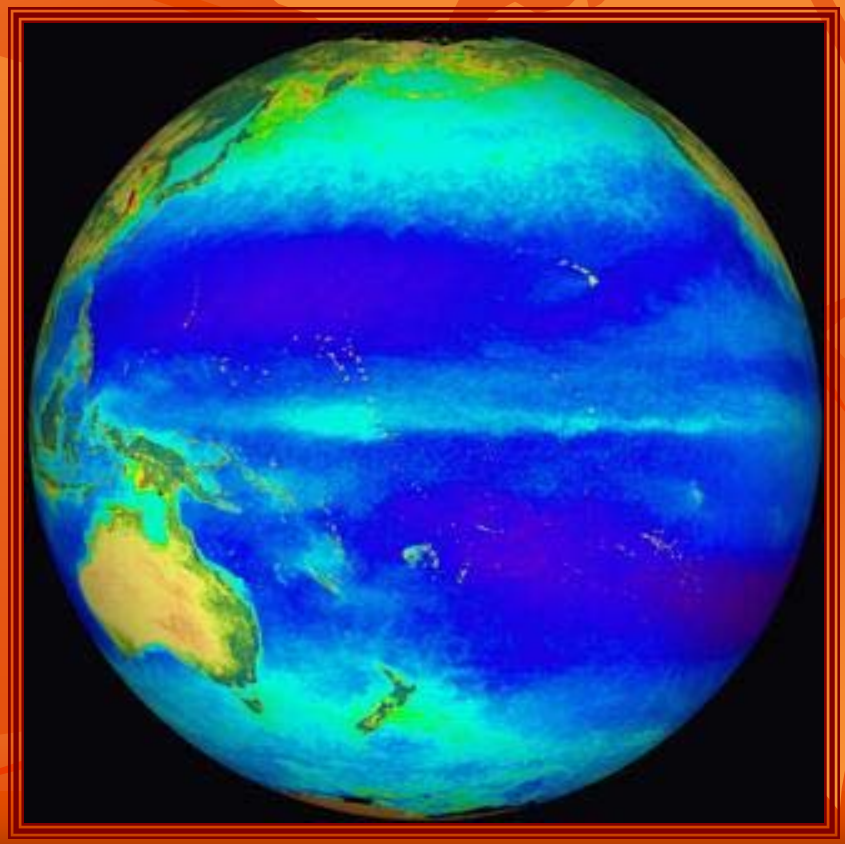


Ecosystem

- **An *ecosystem* is comprised of the community and the physical environment in which they live.**

Biosphere

- The ***biosphere*** **is made up of all the ecosystems that exist on Earth.**
- **Essentially the biosphere is the zone of life on Earth.**
- **It includes the living and nonliving parts of ecosystems.**

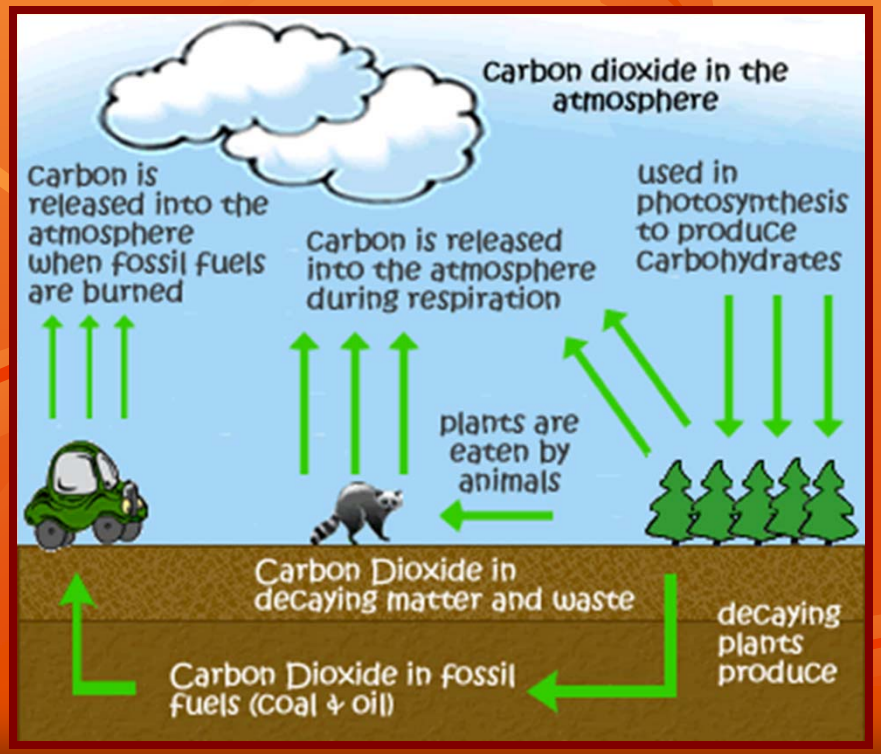


Characteristics of an Ecosystem

- **Species within an ecosystem compete for limited resources.**
- **Community members interact within and among their species.**
- **There also is an interdependence between the community and the physical environment.**

Survivial of an Ecosystem

- **Ecosystems are *stable* and self-sustaining if:**
  - ✓**there is a constant source of energy**



  - ✓**There is a cycling of materials between the community members and the physical environment**

Ecosystem: Abiotic Factors

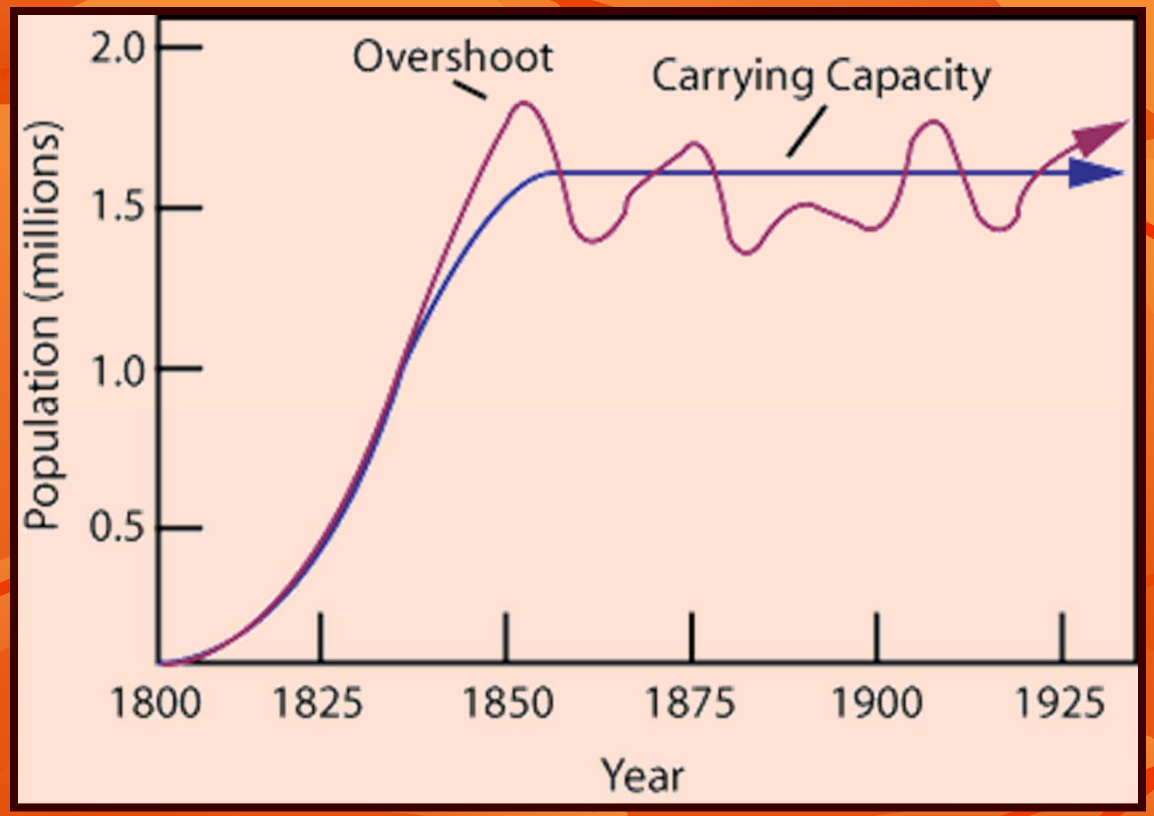
- ***Abiotic factors*** are the non-living parts of the ecosystem.
- Such factors include:
  - ✓ ***Substratum:*** **soil and rock**
    - ***-pH:*** **acid rain can make soil pH too low for plant growth**
    - ***--texture of soil and clay content:*** **determines the quantity of water the soil can hold**
    - ***--minerals*** **such as nitrates & phosphates determine what vegetation can grow in a given area**
    - ***--humus quality:*** **determined by the amount of decaying plant and animal life in the soil**
  - ✓ ***Sunlight:*** **serves as the ultimate source of energy most living organisms**
  - ✓ ***Water:*** **essential to all life and a major component of all living organisms**
  - ✓ ***Salinity:*** **the relative saltiness of a given body of water**
  - ✓ ***Oxygen Supply***
  - ✓ ***Temperature***

Properties of Populations

- ***Size:*** **the total number of individuals in a population. Limited by:**
  - ✓ ***number of births & number of deaths***
  - ✓ ***immigration & emigration***
- ***Density:*** **number of individuals per unit area or volume. Difficult to count the number of organisms in a given area.**
  - ✓ ***Mark and recapture:*** **organisms are captured, tagged, and released. The process is repeated at a later date, and the density of the population is then calculated by mathematical formula.**

Carrying Capacity of an Ecosystem

- ***Carrying Capacity:*** **the maximum number of organisms a ecosystem can support.**



Initial *exponential growth* followed by overproduction too large for the environment to sustain. In an effort to maintain *dynamic equilibrium* with the environment, the population fluctuates around the *carrying capacity*.

Competition Limits Population Size

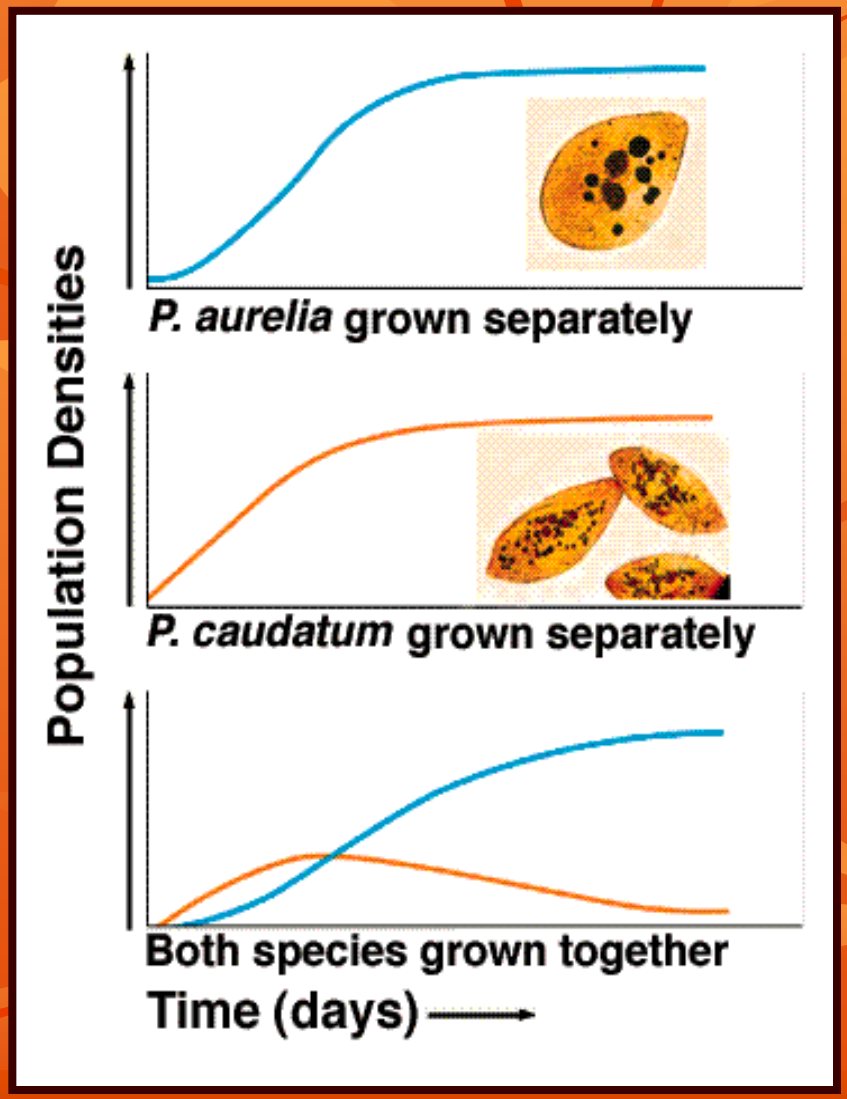
- In any ecosystem, resources such as oxygen, carbon dioxide, water, nutrients, space, and sunlight are limited in supply.
- Since resources are finite, organisms must compete with one another for survival.

Intraspecies Competition

Interspecies Competition

Competition and Niche

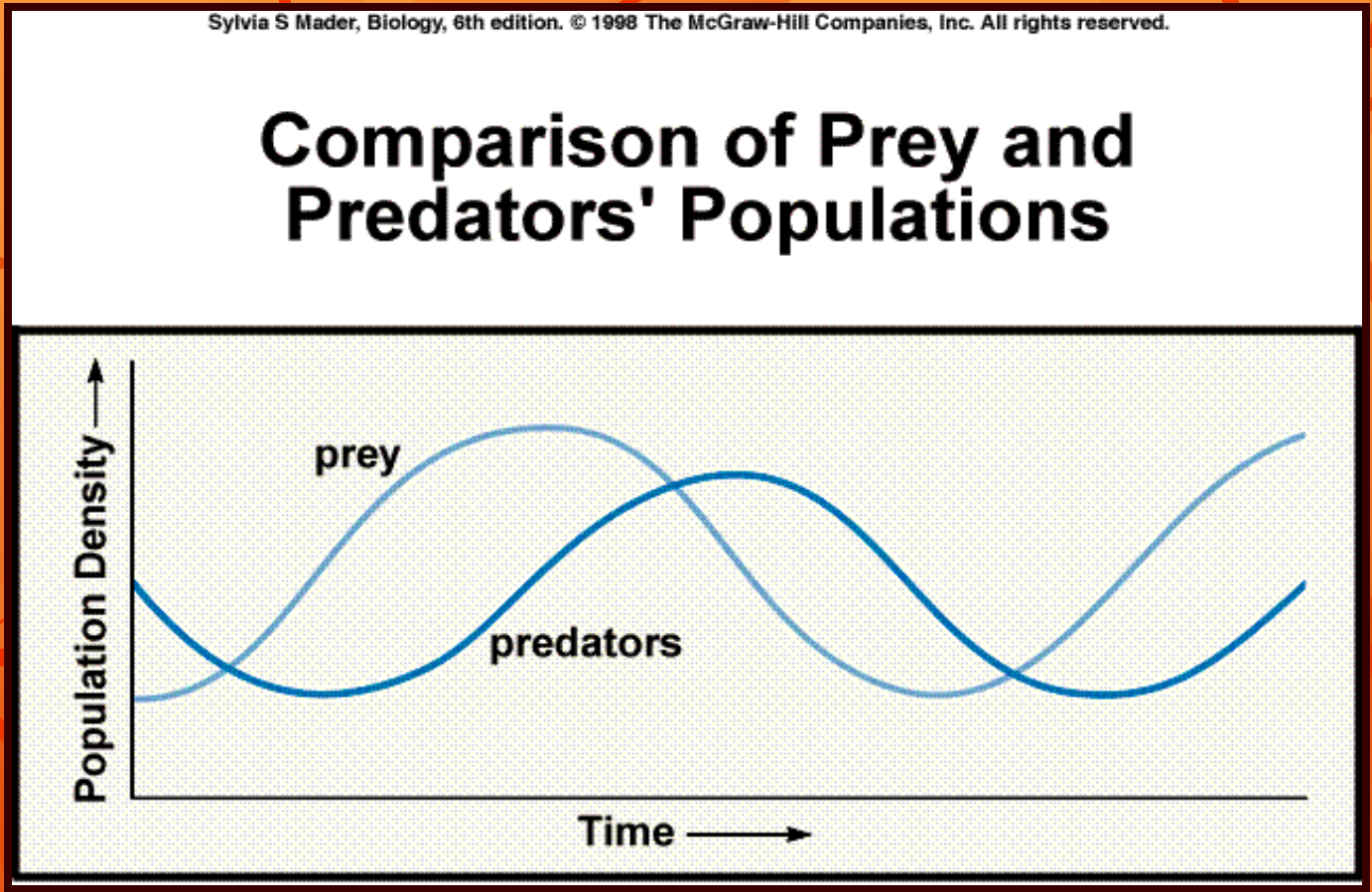
- ***Niche:*** **the role of the organism in its environment (the way it relates to and uses the environment in which it lives).**
- ***Competitive Exclusion Principle:*** **Two species cannot co-exist together if they share the same niche.**



Limiting Population Size

- **Other factors that limit the size of a given population include:**
  - ✓ ***abiotic factors*** **such as temperature range, intensity of light, mineral availability, water, type of rock/soil, pH of soil.**
  - ✓ **One of the most important biotic factors that limits the size of a population is the *relationship between predator and prey*.**
  - ✓ ***Predators kill their prey, reducing their numbers. When there are too few prey, predators begin to die off. With few predators to feed on them, the prey begin to repopulate.***

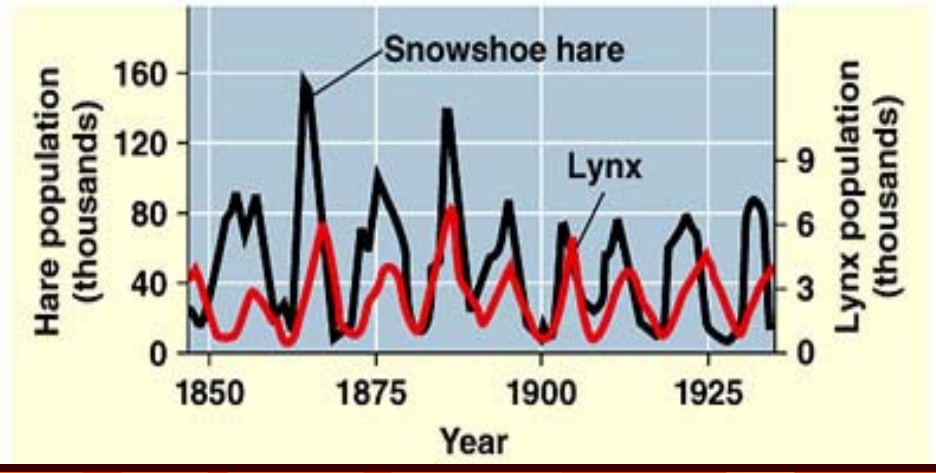
Predator/Prey Relationship



Prey populations peak before predator populations so there is enough food to support the increase in predators.

Lynx and the Snowshoe Rabbit

- For over 300 years, the Hudson Bay Company has been involved in the fur trade in Canada.
- Detailed company records list the number of snowshoe hare and lynx pelts collected by hunters and trappers every year since the late 1700s.
- The data they collected demonstrates a cyclical pattern of population changes between the showshoe hare and lynx populations.



Predation and Adaptation

- **Many plants and animals have defenses against predation.**
- **Plants have evolved spines, thorns, and chemical poisons such as strychnine, mescaline, morphine, and nicotine to fend off attack by animals.**
- **Some animals have *ACTIVE* defenses such as hiding, fleeing, or defending themselves. These defenses are costly in terms of energy.**
- ***Passive* defenses such as camouflage to fend off predators without a large expenditure of energy.**

Aposematic Coloration

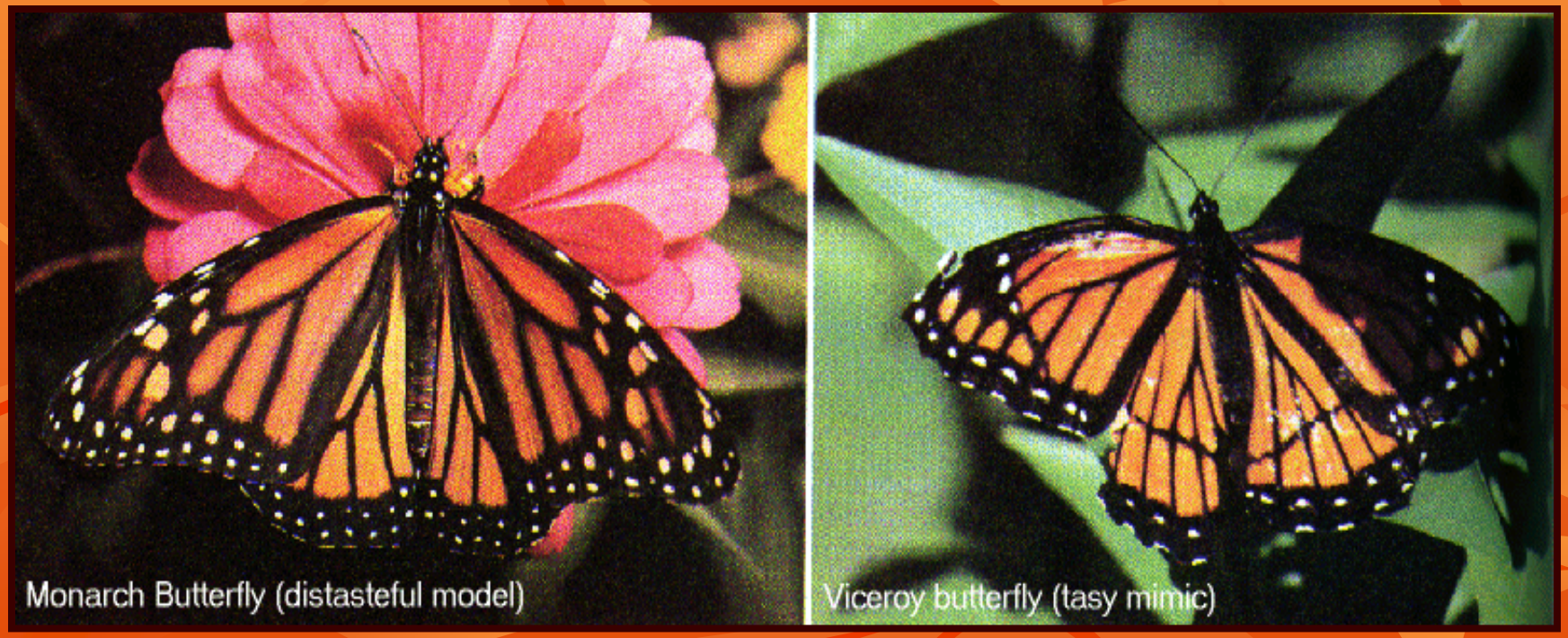
- **The very bright coloration is a signal of special defenses and is a warning to would be predators to stay away.**

Regal Ring-Necked Snake

Poison Dart Frogs

Batesian Mimicry

- Otherwise known as copycat coloration, where one harmless animal mimics the coloration of another that is poisonous.



Mullerian Mimicry

- **Two or more poisonous species resemble each other and gain an advantage from their combined numbers.**
- **Predators learn quickly to avoid any prey with that coloration.**

***Helliconius* butterflies, tropics of the Western Hemisphere**

Symbiosis: Mutualism

- Both organisms benefit (+,+) from the association.
- Examples include nitrogen fixers and legumes, termites and protozoa, rhino and tick bird (oxpecker), crocodile and Egyptian plover (crocodile bird)

Symbiosis: Commensualism

- One organism benefits and the other is not helped or harmed (+.0). Eamples include barnacles on a whale, ramora fish and sharks, and orchids and tropical trees.

Symbiosis: Parasitism

- One organism, the parasite, benefits while the other organism, the host, is harmed (+,-).
- Examples include a tapeworm and humans, athlete's foot and humans, heartworm and dogs.

Community Structure

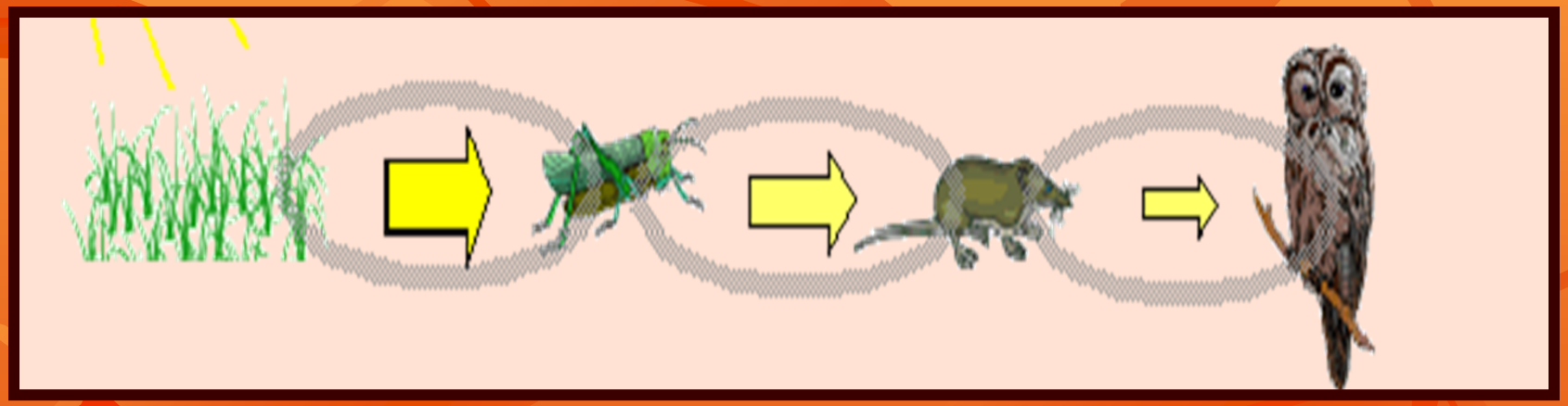
- ***Producers:*** **convert light energy (sun) into chemical bond energy of food. *Autotrophs are producers.***
  - ✓ **Producers are the FOUNDATION of any community, passing their energy to other organisms.**
  - ✓ ***Terrestrial Environments:*** **green plants and photosynthetic bacteria are producers (autotrophs)**
  - ✓ ***Aquatic Environments:*** **algae and phytoplankton are the producers**
- ***Consumers:*** **must obtain nutrients from the environment. *Heterotrophs are consumers.***
  - ✓ ***Herbivores:*** **plant eaters (primary consumers)**
  - ✓ ***Carnivores:*** **meat eaters (secondary or tertiary consumers)**
  - ✓ ***Omnivores:*** **eat both plants and meat (secondary or tertiary consumers)**

Community Structure (cont'd)

- ***Scavengers:*** **eat left over remains of dead organisms killed by other predators, helping to clean carcasses of their flesh.**
  - ✓ **Examples of scavengers include hyenas and vultures.**
- ***Organisms of Decay:*** **also known as saprophytes or decomposers (detrivores)**
  - ✓ **Decompose dead organisms and recycle materials such as carbon dioxide, nitrogen, phosphorous, and other inogranic compounds back into the environment.**
  - ✓ ***Bacteria and fungi*** **are the primary decomposers in most communities.**

Food Chains

- **Simply, food chains show what organisms eat.**
- **The arrows indicate the flow of energy through the food chain.**

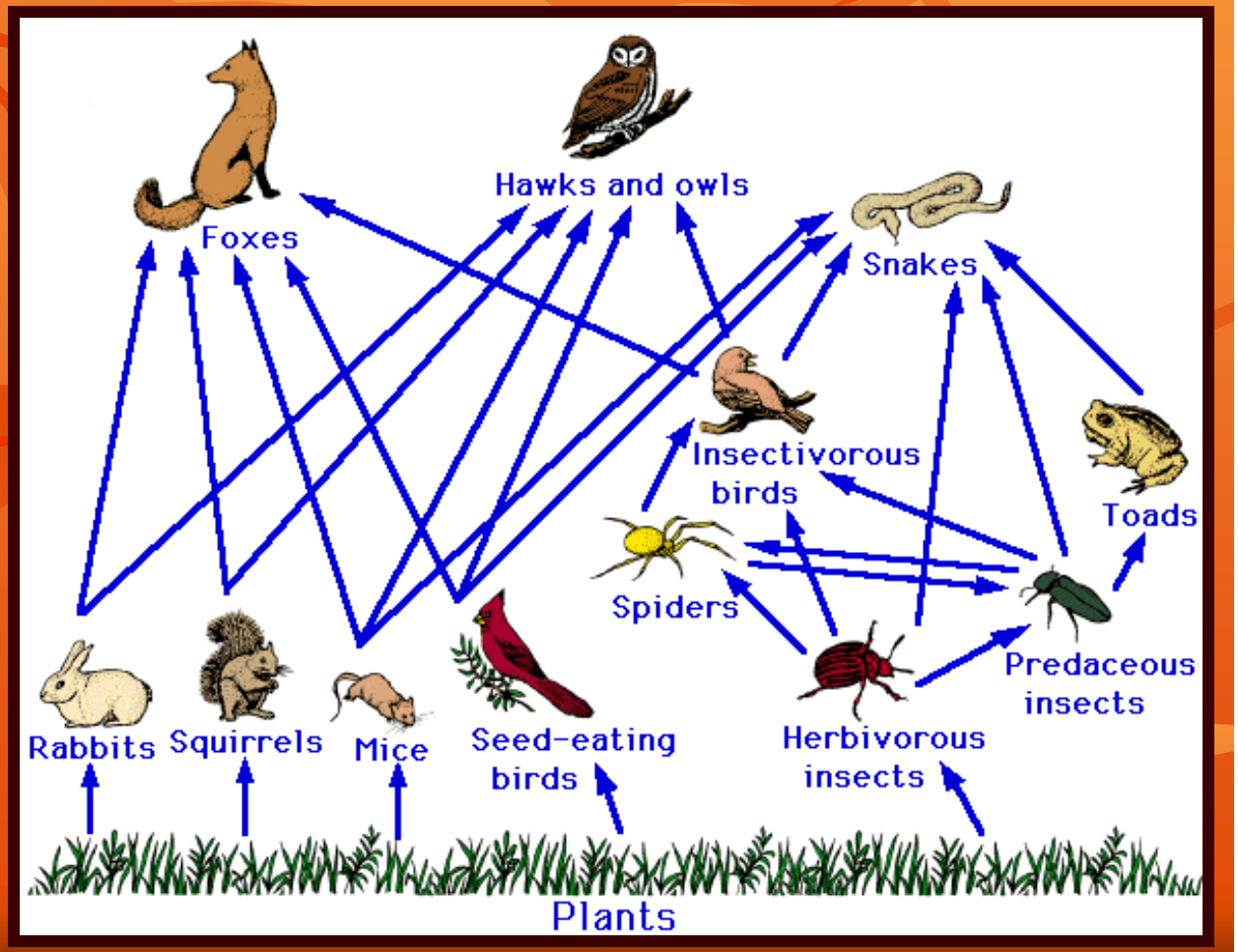


- **In this food chain, the grass, the producer, is being eaten by the grasshopper (herbivore and primary consumer), which is eaten by the shrew (carnivore and secondary consumer) , which is then eaten by the owl (carnivore and tertiary or third level consumer.**

Food Webs

- In stable ecosystems, most organisms have more than one kind of food source.
- *Food webs* help to maintain the stability of an ecosystem.

- If one population declines, organisms that feed on that declining population will then rely more heavily on other food sources until the declining population recovers.



Energy Flow through an Ecosystem

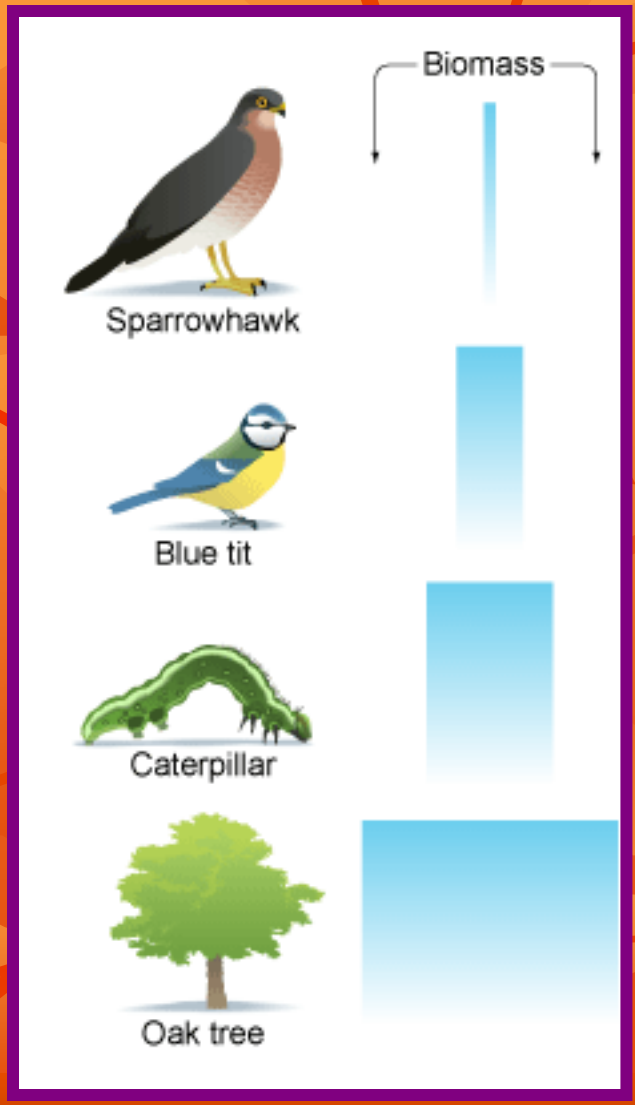
- **Much of the energy producers absorb from the sun is either used to "fuel" their metabolic life processes.**
- **As producers maintain their metabolic processes, some of the energy is converted to heat and lost to the environment.**
- **In fact, only 10% of the solar energy absorbed by producers is available to primary consumers for their life activities.**
- **As energy moves through the food chain, only 10% of the energy taken in by the primary consumers is available to the secondary consumers.**
- **Since most of the available stored energy is lost in a few steps, most food chains are usually very short.**

Pyramid of Energy

- **Food chains can be arranged into pyramids to illustrate the loss of energy at each consumer level (known as trophic levels).**

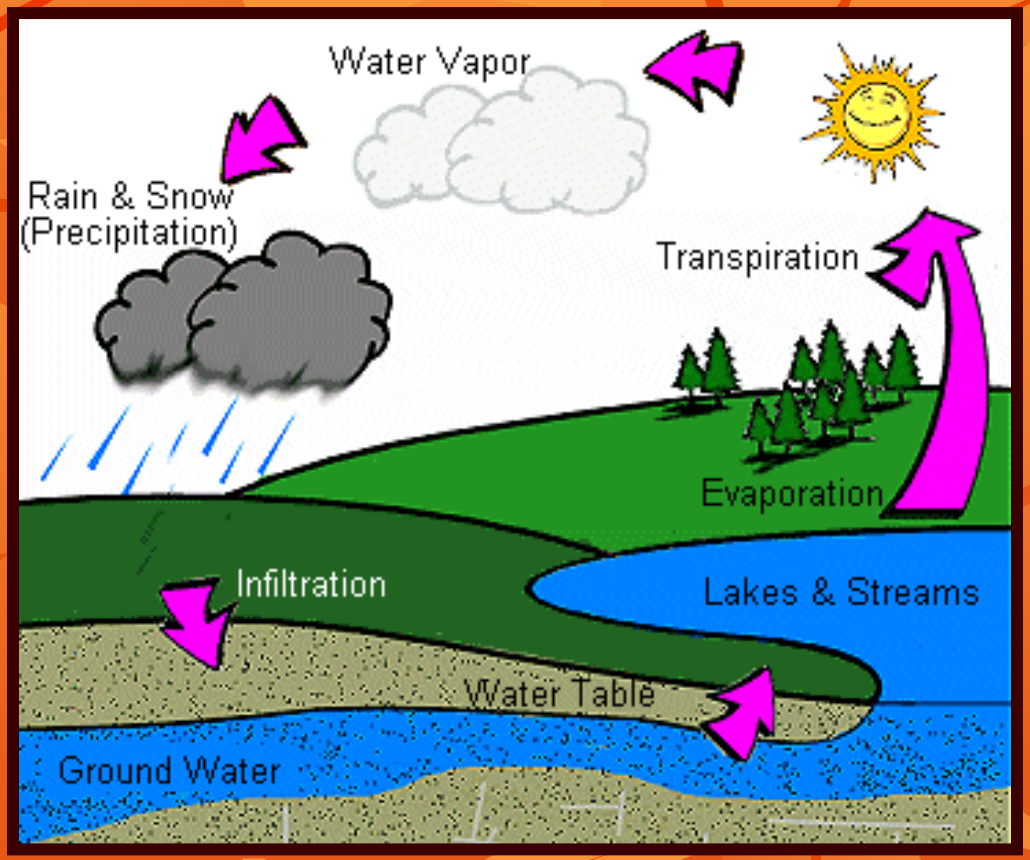
Pyramid of Biomass

- Each trophic level provides less energy to the level above it.
- Therefore, each succeeding level of the food chain has to have less mass than the level below it in order to survive.
- In other words, a large mass of producers is needed at the based of the pyramid to support a few connivers at the top of the pyramid.



Water Cycle

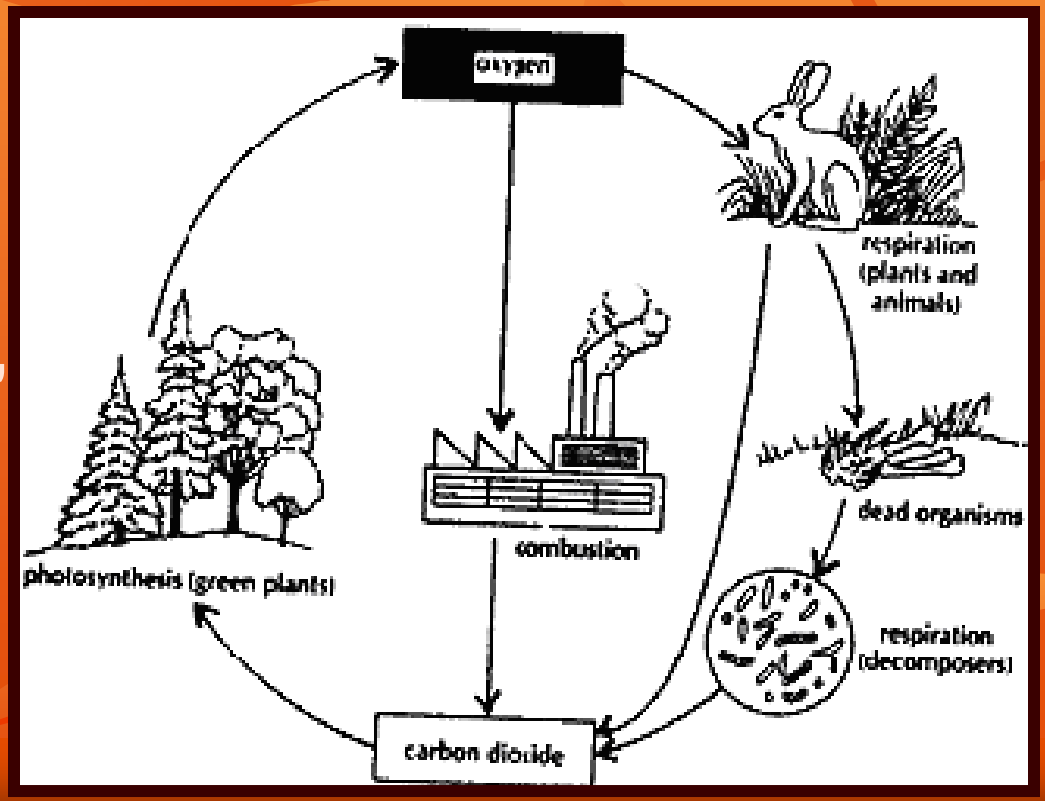
- ***Physical Changes***
  - ✓ Evaporation
  - ✓ Transpiration
  - ✓ condendation
- ***Chemical Changes***
  - ✓ photosynthesis
  - ✓ cellular respiration



When water falls on land, it will often infiltrate the soil and eventually enter a body of water through the process of percolation (the downward movement of water through saturated or nearly saturated water.

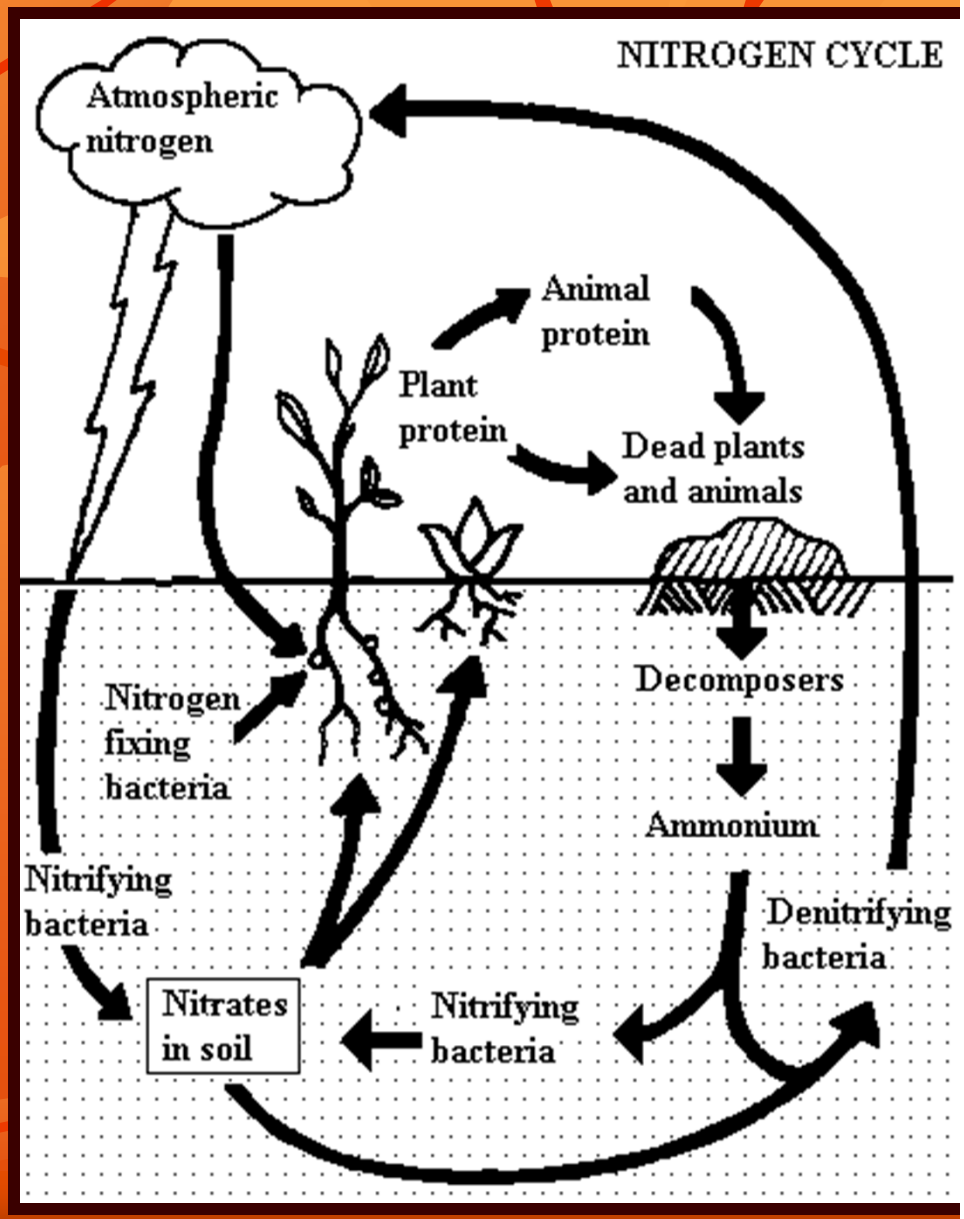
Carbon Oxygen Cycle

- ***Photosynthesis*** **releases oxygen to the environment which is used during** ***Respiration*****, releasing carbon dioxide to the atmosphere.**
- ***Oxygen*** **is also used during industrial and residential** ***Combustion*** **(burning of fuel) releasing** ***Carbon Dioxide*** **to the atmosphere.**
- ***Carbon Dioxide*** **is used by autotrophic organisms during** ***Photosynthesis*****.**
- **When living organisms die,** ***Decomposers*** **break down chemicals in the tissues, releasing** ***Carbon Dioxide*** **into the environment.**



Nitrogen Cycle

- Animals and plants die
- **Decomposers** (break down dead organisms, NH_3 into the soil
- **Nitrifying bacteria** in the soil converts **ammonia into nitrates.**
- **Denitrifying bacteria** in the soil takes some of the nitrates, breaks them down and **releases free nitrogen (N_2)** into the air.
- **Nitrogen fixing bacteria** found in the soil and in the nodules on the roots of legumes (peas, beans, clover, peanuts, soy) takes **free nitrogen from the air and converts it into nitrates** that plants can absorb and use to make proteins and DNA.



Biodiversity

- **The measure of the degree to which species vary within an ecosystem**
- **Can be subdivided into 3 different levels:**
  - ✓ **Genetic Diversity: deals with the variations among inherited biological traits (genes) of each species.**

    --important to the survival of a species
  - ✓ **Species Diversity: the greater the biodiversity of an ecosystem, the more stable the ecosystem is.**

    -- Serves as a barrier to the spread of disease.
  - ✓ **Ecosystem Diversity: deals with the variety of species in natural communities which are interdependent on one another.**

Threats to Biodiversity

- **Physical alteration of habit areas**
- **Introduction of alien species**
- **Exploitation for human consumption**
- **Air, water, and land pollution**
- **Continual increase in human population**
- **Wasteful consumption and management of limited resources.**

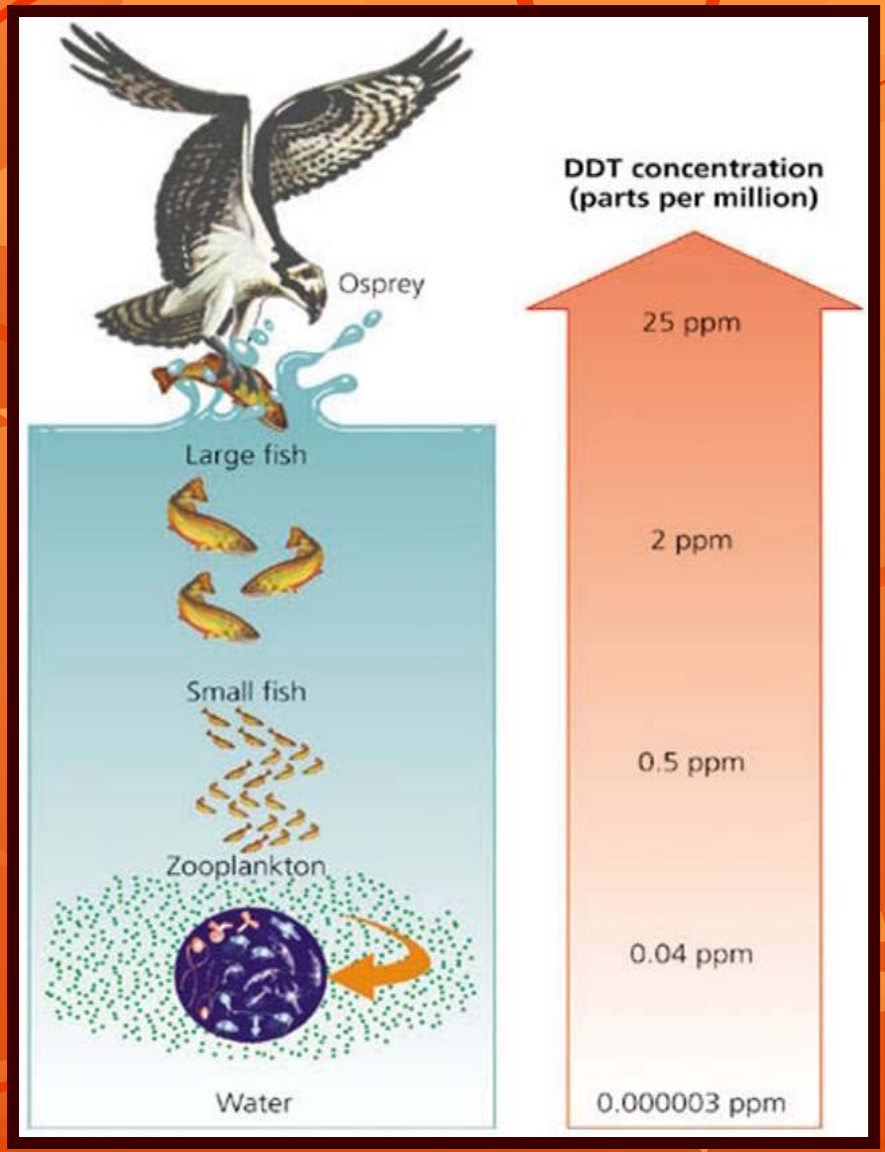
Why Should We Care?

- Maintenance of soil quality
- Maintenance of air quality
- Pest control
- Diversity of food resources
- Sources of Medicines

Biodiversity

Biomagnification

- **Biomagnification is the increase in concentration of a pollutant from one link in a food chain to another.**
- **Pesticides, fertilizers, and other pollutants enter aquatic ecosystems as a result of *RUNOFF.***
- **These pollutants pass up the food chain, becoming more concentrated at each trophic level.**
- **The top level consumer has the greatest concentration of pesticide, which can cause a variety of reproductive problems, resulting in a decrease in its population.**



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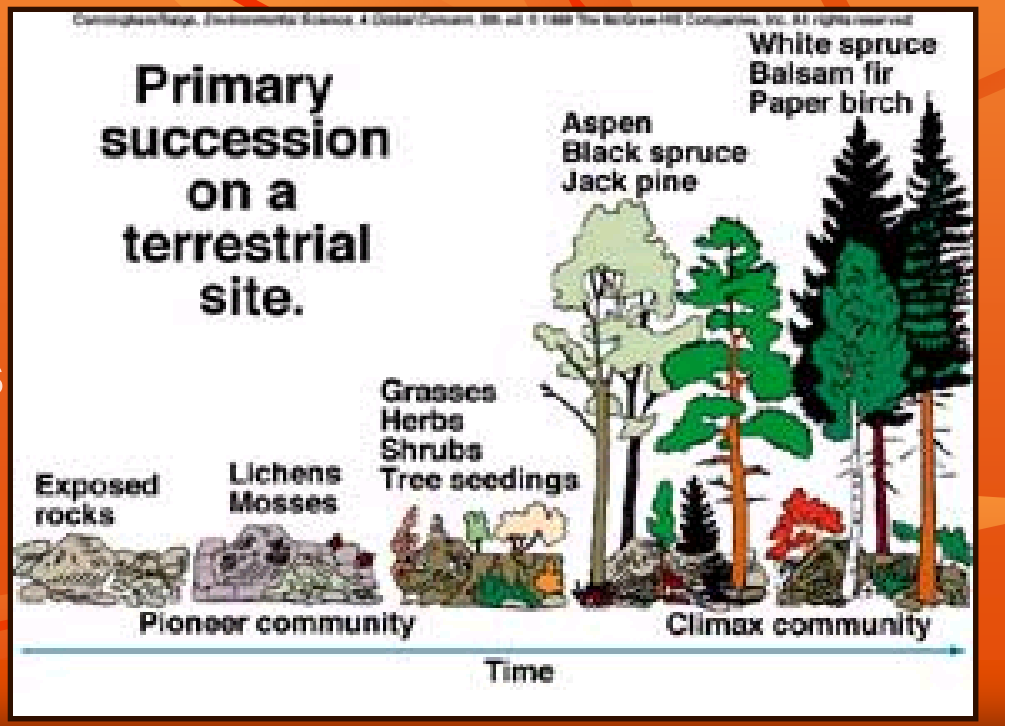
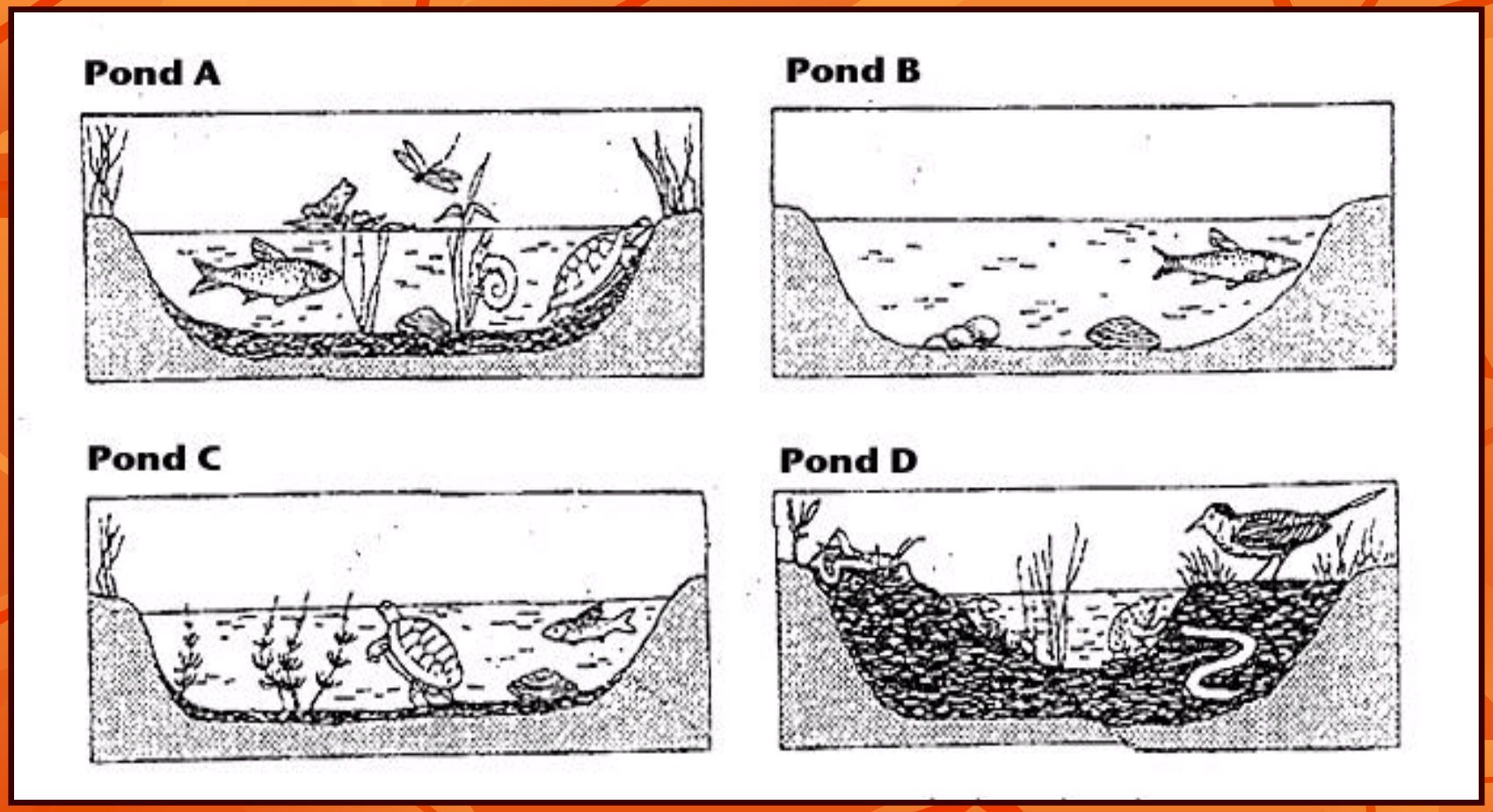
Ecological Succession

- Series of changes where one community is replaced by another until a stabile stage is reached.
- **Pioneer Organisms:** first organisms to populate a give area or location.
- **Climax Community:** self-perpetuating community in which populations remain stable and exist in balance with the environment .
- Producers determine what animals can live in a given location.
- Each communitymodifies its environment making it more favorable for another community to move in.



Freshwater Succession of a Pond



Secondary Succession