Ecosystem

- A community of different species interacting with one another and with their non-living environment of matter and energy.

What sustains this life?

- Sun-(one-way flow of high-quality, usable energy from the sun starting the food chain, powering the cycles.)
- Biogeochemical Cycles-(cycling of types of matter or nutrients, water, carbon-oxygen, nitrogen, minerals.)
- Gravity-(allows for the plants atmosphere (biosphere)and movement of nutrients through the cycles)

Components of an Ecosystem

- **Biotic**-living *(plants, animals, other living things)*
- **Abiotic**-nonliving *(water, air, nutrients, solar energy, temperature, precipitation, wind, latitude, altitude, salinity, level of oxygen)*

Biotic parts of an Ecosystem

- **Producers:** Autotrophs, self-feeders, make their food from compounds obtained from their environment through photosynthesis or chemosynthesis.
  Land-Plants Water-Phytoplankton.
- **Consumers:** Heterotrophs, other-feeders, get their organic nutrients by feeding on the tissue of producers or other consumers.

Consumers

- **Primary Consumers or Herbivores-** Feed directly on producers.
- **Secondary Consumers or Carnivores-** Feed on Primary Consumers.
- **Tertiary Consumer-** Feed only on other Carnivores.
- **Omnivores:** Feed on Plants and Animals.
- **Scavengers:** Feed on Dead Organisms.

Detritivores

Live off of detritus (parts of dead organisms and wastes of living organisms)

Decomposers: recycle organic matter by breaking down detritus to get nutrients. They release the resulting simpler organic compounds into the soil where they are taken up by producers. (bacteria, fungi)

Detritus Feeders: extract nutrients from partly decomposed organic matter. (earthworms, termites)

Energy Flow in Ecosystems

- ***Food Chain-*** determines how energy moves from one organism to another.
- ***Trophic Level-*** a feeding level in a food chain based upon producer/consumer and what it eats/decomposes.

Food Chain Trophic Levels

- First Trophic Level-
  Producers: Energy from the Sun
- Second Trophic Level-
  Primary Consumers
- Third Trophic Level-
  Secondary Consumers
- Fourth Trophic Level-
  Tertiary Consumers

Keep in Mind

Detritivores processes detritus from all trophic levels.

Some animals feed at several trophic levels,
thus the organism in most ecosystems form a
FOOD WEB

Ecological Pyramids

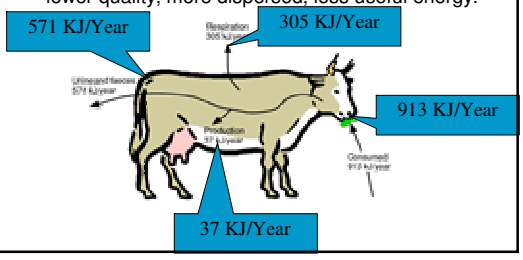
- *Pyramid of Numbers*- a graphic display of the estimation of organisms at each trophic level.
- *Pyramid of Biomass*- a graphic display of the estimation of the biomass (organic matter, chemical energy) of organisms at each trophic level.

Ecological Pyramids

- *Pyramid of Energy Flow*- a graphic display that shows the cumulative loss of usable energy in a food chain.
  (80-95%)
- *Pyramids of Energy/Biomass always have a pyramidal shape because of the automatic degradation of energy quality required by the Second Law of Thermodynamics.*

Second Law of Energy or Thermodynamics

In any conversion of heat energy to useful work, some of the initial energy input is always degraded to a lower quality, more dispersed, less useful energy.



Second Law of Energy or Thermodynamics in ecosystems

- *In a food chain or web, biomass is transferred from one trophic level to another, with some usable energy degraded and lost to the environment as low-quality heat.*
- *The more steps in a food chain or web, the greater the cumulative loss of usable energy.*

Energy Flow and the Impact on Ecosystems

- The Earth could support more people if they eat at lower trophic levels by consuming grains directly.

Example: Rice → Humans

Instead of eating meat eaters:

Rice → Steer → Humans

Energy Flow and the Impact on Ecosystems

- The large loss in energy between successive trophic levels also explains why food chains and webs rarely have more than four or five trophic levels.
- It also explains why top carnivores such as eagles, tigers and sharks are few in numbers and are usually the first to suffer when the ecosystems that support them are disrupted.

Changes in Abiotic Factors

- **Range of Tolerance or Optimum Range**: range of chemical and physical conditions that must be maintained for populations of a particular species to stay alive, grow, develop, and function normally.
  - Most organisms are least tolerant during their juvenile or reproductive stages of their life cycles.
  - Highly tolerant species can live in a variety of habitats with widely different conditions.

Changes in Abiotic Factors

- **Acclimation:** The ability of an organism to adjust their tolerance range to a gradual change in physical or chemical conditions.
- **Threshold Effect/Tolerance Limit:** the point at which an organism can't acclimate.
- **Limiting Factor :** (too much or too little). The factor that prevents the growth of a population.

Limiting Factors:

- Space: Established territories for breeding/living
- Food: Abundance or scarcity
- Climate and Weather: Adaptations
- Cover: Safety from predators
- Disease: Rate of spreading
- Shade: Sun's Energy or Harm
- Invasive Species: competition for resources
- Human Activity:

The Biogeochemical or Matter Cycles of Ecosystems

- **Matter**: Anything that has mass and takes up space.
  - –It is never created or destroyed just changed from one form to another.
  - –Some is gained or lost from or to outer space but not usually.

- –Wind or water can move matter from one ecosystem to another.
- –The flow of matter between the environment and organisms is essential to the survival of an ecosystem.
- –Matter is recycled through an ecosystem. Gravity and the Sun's Energy allow this to happen.

The Biogeochemical Cycles

- The Carbon-Oxygen Cycle
- The Nitrogen Cycle
- The Mineral Cycle
- The Hydrologic (water) Cycle

The Hydrologic/Water Cycle

- Evaporation
- Transpiration
- Osmosis
- Condensation
- Precipitation
- Runoff
- Infiltration
- Groundwater/Aquifer
- Seepage

The Carbon-Oxygen Cycle

- Producers use CO_2 from the atmosphere in the process of **photosynthesis**.
- Light energy + CO_2 + H_2O = Organic Compounds (sugars, proteins, oils, starches)
- Plants give off O_2 as a waste product.

The Carbon-Oxygen Cycle

- Consumers and most cells use O_2 in the process of **respiration**.
- O_2 breaks down the organic compounds and CO_2 is released.

The Carbon-Oxygen Cycle

- During **combustion** compounds containing carbon combine with oxygen from the atmosphere and CO_2 is released.
- During **decomposition** decomposers use oxygen to break down carbon compounds in dead matter and CO2 is returned to the atmosphere.

The Carbon-Oxygen Cycle

- Therefore CO_2 is released into the atmosphere by **Respiration, Combustion and Decomposition** and is taken out by **Photosynthesis.**
- And O_2 is released into the atmosphere by **Photosynthesis** and taken out by **Respiration, Decomposition and Combustion.**

The Nitrogen Cycle

- Plants and animals need nitrogen to make proteins.
- The air is 78% Nitrogen (N_2) but plants and animals can't use nitrogen (N_2) in this form.
- Bacteria known as nitrogen "fixers" can change Nitrogen Gas (N_2) into Nitrogen fertilizers (NO_3^-) or ammonium ions (NH_4^+) that plants can use.

The Nitrogen Cycle

- Another Symbiotic Relationship: The plants provide food and water for the bacteria and the bacteria convert nitrogen gas (N_2) to fertilizer for the plant.

The Nitrogen Cycle

- Animals get the nitrogen they need by eating the plants or eating other plant-eating animals.
- Other Bacteria (**decomposers**) break down the nitrogen compounds (proteins) in dead matter and animal wastes and recycle it back into the soil and atmosphere.

The Nitrogen Cycle

- **Lightening** causes nitrogen and oxygen to combine in the atmosphere.
- This compound is then dissolved in the rain and is carried to the soil where bacteria convert it into fertilizer.

The Nitrogen Cycle

- Farmers also **add fertilizers** to their crops.
- The high temperatures of **Combustion** cause nitrogen and oxygen to chemically combine creating Nitrogen Oxides (NO_x) which are released into the atmosphere where they mix with other gases to form Acid Rain.

The Mineral Cycle

- Most minerals (calcium, phosphorus) are stored in rocks.
- They are released from rocks by physical and chemical means.

The Mineral Cycle

- Physical means include erosion by water and wind, weathering by water and changes in temperature, the action of plants roots, soil leaching and mining.
- Chemical weathering occurs when acid rain or chemicals in plants roots dissolves the minerals in rocks.

The Mineral Cycle

- Trees absorb most of the minerals.
- Sometimes humans can remove minerals from an ecosystem forever.
- The mineral cycle never enters the atmosphere.

Ecological Succession

The series of changes (species) that occur in an ecosystem with the passing of time.

- **Both Natural and Human Disturbance can effect the rate and kind of succession.**

Natural (Time, Fires, Volcanoes, Melting Glaciers, Droughts, Floods)

Human Disturbance (Deforestation, Clearing for Agriculture, Fires, Dams)

Ecological Succession

We are going to look at the following three examples

- Ponds
- Kettle Lakes
- Forests

Ecological Succession of A Pond

- Pioneer Stage
- Submerged Plant Stage
- Emerging Plant Stage
- Marsh Stage
- Swamp Stage
- Climax Community: Bog, Grassland or Forest

Pioneer Stage

- Sandy or Muddy Bottom
- Species that depend on a "bare bottom" (Algae, protozoa, bacteria, larvae, crustaceans)
- Death and decay of organisms start to form a layer of "humus" on the bottom.

Submerged Plant Stage

- Humus allows for larger algae, gill-breathing snails, fish and small aquatic weeds to grow.

Emerging Plant Stage

- Larger plants (cattails, bulrushes, water lilies) provide stems for organisms that need to come to the top for Oxygen
- New species of larvae and crustaceans, lung breathing snails.

As years pass, the pond is filled with plants, waste products and dead organisms---when there are no longer large areas of open water the pond becomes a Marsh

Marsh

- Truly aquatic animals die
- Frogs, salamanders, crayfish, leeches
- Marshes becomes drier as the organic matter continues to build up

Swamp

- Small trees invade, soil becomes deposited
- Climax Community: The final stage in succession….marsh or swamp becomes a grassland or forest or bog.

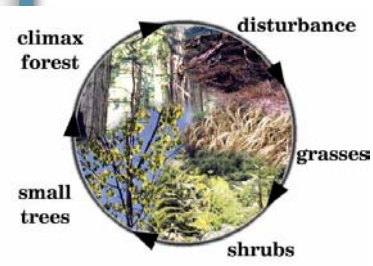
BOG

- In a pond that does not have good water flow and is acidic a bog will be the ***climax community***
- Moss will grow with a small amount of oxygen in an acidic environment.
- It will float like a green mat and eventually the part that sinks will begin to decay. The highly acidic water will prevent a large amount of decay.
- This partly decayed moss is called **peat**. It may become many feet thick and certain shrubs can grow on it.

Ecological Succession of a Kettle Lake

- When large masses of ice called Glaciers melt, Kettle Lakes are formed.
- The Glaciers contain rocky debris and when they melt this debris acts like a dam creating a Kettle lake.
- Kettle lakes are low in oxygen, lack flowing water and become very acidic.
- Most organisms can not live in a Kettle Lake.

Ecological Succession of Land



- Disturbances can include:
  - Fire
  - Volcano
  - Upstream Dam
  - Deforestation

EXTRA CREDIT:

- Found out about the ecological succession that happened after
  - Mt. St. Helens erupted.
  - The fires at Yellowstone

Forests

- America—only 10% of virgin forest ecosystems remain
- Penn's Woods

  There were 29 million acres of virgin forest when William Penn founded PA. Now only 649-acres remain in a place called ***Woodburne Forest and Wildlife Sanctuary*** owned by the Nature Conservatory

Penn's Woods

- Woods were cleared for farming and logging.
- Today the State owns and manages 2 million acres.

Old Growth Forests

- 250 year-old trees
- Multilevel canopy- young trees provide food for animal species
- Standing dead tress and fallen logs called snags provide cover and shade and nurse young seedlings trees.
- 1 Massive tree supports 1,500 species of invertebrates
- Biodiversity determines stability of forest.
- The National Forest Mgt Act of 1976 called for mgt plans for all National Forests

Clear Cutting Vs Selective Cutting

- Clear Cutting: removes all timber regardless of size and condition
- Selective Cutting: removes individual or small groups of trees.
- Identify pros and cons for environment and logging industry