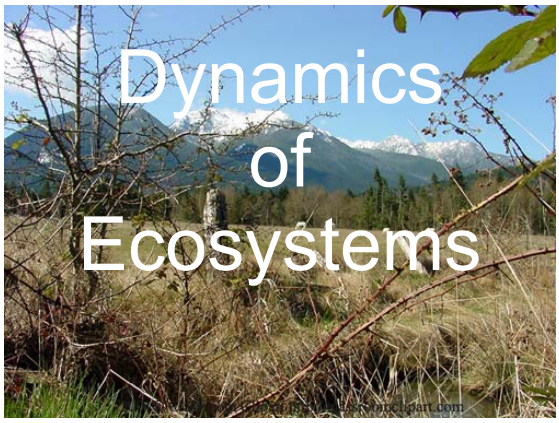


Ecology

- the study of relationships between living organisms and between organisms and their environment

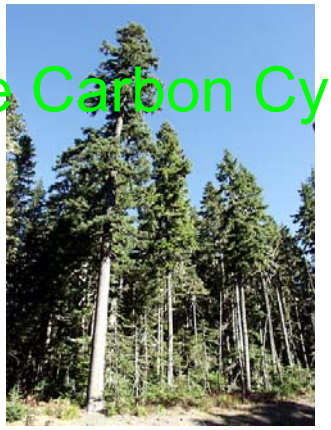
Definitions

- Species
  - a group of organisms that can interbreed and produce fertile offspring
- Habitat
  - the environment in which a species normally lives or the location of a living organism
- Population
  - a group of organisms of the same species who live in the same area at the same time

- Community
  - a group of populations living and interacting with each other in an area
- Ecosystem
  - a community and its abiotic environment
- Abiotic
  - non-living components of the environment
    - light, heat, minerals, air, water
- Biotic
  - living components of the environment

- All organisms in an ecosystem have a specific roll or trophic level
  - Autotroph (Producer)
    - Convert radiant energy into chemical energy using photosysthesis
  - Heterotroph (Consumer)
    - Cannot produce their own food
    - Get energy by eating other plants or animals
  - Detritivore
    - Ingests non-living matter (dead leaves, carcasses)
  - Saprotroph (Decomposer)
    - lives on or in non-living organic matter, secreting digestive enzymes into and absorbing the products of digestion

The Carbon Cycle



Carbon

- Carbon is such a crucial element to living organisms that it is part of the basic of the definition of a living thing

- Carbon is found in one of four 'pools'
  - Biosphere
    - All living organisms
  - Hydrosphere
    - Water
  - Atmosphere
    - carbon dioxide
  - Lithosphere
    - Rocks/Sediments as carbonates, fossil fuels
- Carbon is moved between these four pools by a variety of processes

Photosynthesis

- Occurs in all plants
- Converts carbon dioxide and water to carbohydrates (sugar) and oxygen
- $6CO_2 + 6 H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$

Cellular Respiration

- Converts oxygen to carbon dioxide
- Carried out by all living cells
- $6O_2 + C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O$ + energy

Feeding

- One organism eats another
- The carbon of one organism is ingested by another

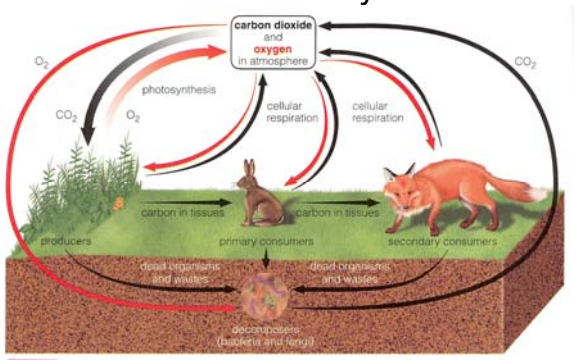
Fossilization

- Carbon as organic molecules becomes trapped in sediment as coal, gas and oil

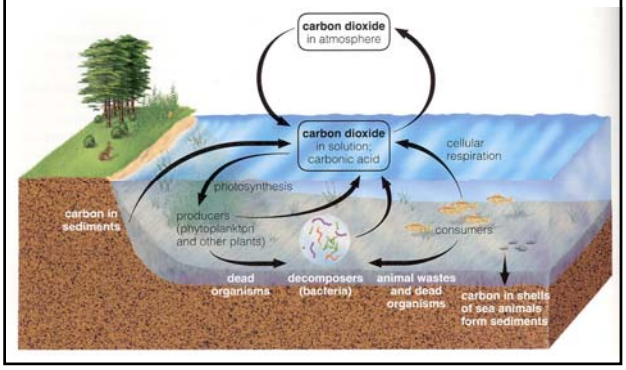
Combustion

- Burning of any biotic organism

Carbon Cycle for a Terrestrial Ecosystem



Carbon Cycle for a Water Ecosystem



The Nitrogen Cycle

Nitrogen Fixation

- Plants use Nitrogen (N), Phosphorus (P), and potassium (K) for growth.
- These elements are found in plant fertilizer.
- How do plants get Nitrogen if they are not given fertilizer?
  - From the atmosphere.
  - The Earth's atmosphere is 80% Nitrogen
- But....

- Most plants cannot absorb nitrogen directly from the air.
- The nitrogen must first be “fixed” :
  - Pulled from the air and bonded to other elements to make new compounds
- This process is called **nitrogen fixation**.
- For example, nitrogen can combine with hydrogen to form ammonium (NH_4^+) or oxygen to form nitrate (NO_3^-)

- Plants absorb the nitrogen compounds through their roots
- Animals can obtain nitrogen only by eating plants or other animals.

- In nature, the job of nitrogen fixation is carried out by a few species of nitrogen-fixing bacteria that live in the nodules (rounded swellings) on the roots of legumes (beans, peas, alfalfa, clover)

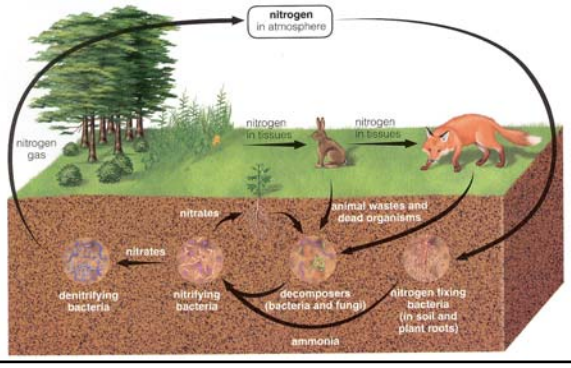
- Once Nitrogen has been fixed it enters the soil and water where it becomes available for living organisms to use.
- Nitrogen compounds that enter plants move through food chains and return to the soil and water through dead organisms and waste materials
- These compounds can re-enter plants without being converted to Nitrogen gas.

Nitrification

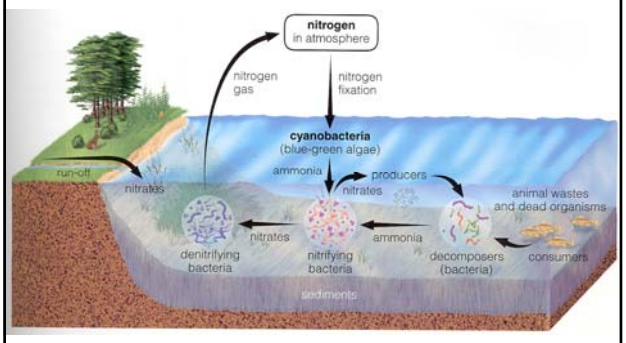
- Decomposers, such as bacteria, break down the waste and dead materials producing ammonia.
- Ammonia is used directly by some plants as a source of nitrogen.
- Ammonia is also converted into nitrates by nitrifying bacteria in a process called **nitrification**.

- The nitrates in the soil or water may be converted back into nitrogen gas by denitrifying bacteria.
- This process is called **denitrification**.

Nitrogen Cycle in a Terrestrial Ecosystem



Nitrogen Cycle in an Aquatic Ecosystem



Disturbing the Cycles

- Some factors may disturb the carbon and nitrogen cycles
  - Overuse of fertilizers and herbicides
  - Combustion of fossil fuels
  - Deforestation
  - Human and animal waste mismanagement
  - Volcanic activity
  - Forest fires

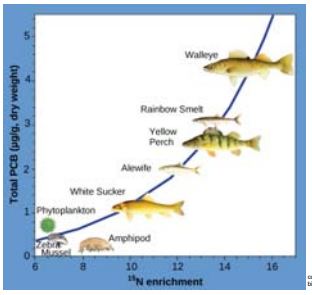
How Pollutants Move Through the Various Trophic Levels in an Ecosystem

Bioaccumulation

- increase in concentration of a pollutant from the environment in the first organism in a food chain
  - the pollutant is stored in the organism rather than being expelled as waste

Biomagnification

- increase in concentration of a pollutant from one link in a food chain to another



courses.lumenlearning.com/boundless-biology/chapter/energy-flow-through-ecosystems/

- For bioaccumulation and biomagnification to occur, the pollutant must be:
  - Long-lived
    - stays in the environment more than 15 years before it breaks down
  - Mobile
    - if it stays in one place it can be easily contained
  - Soluble in fats
    - it is absorbed and retained by animals
  - Biologically active
    - it affects biological organisms

DDT (dichloro, diphenyl trichloroethane)

- DDT has a “half-life” of 15 years
  - If there is 100kg, then after 15 years 50kg remains
  - After 30 years 25kg remains
  - After 90 years 1.56kg remains
- DDT is fat soluble and is stored in the bodies of organisms
- DDT has low toxicity in humans, but kills insects

Other Substances that can Bioaccumulate and Biomagnify

- PCBs (polychlorinated biphenyls)
  - Uses:
    - coolant in transformers
    - sealing and caulking compounds
    - inks and paint additives
  - Problems:
    - severe form of acne (chloracne), swelling of the upper eyelids, discoloring of the nails and skin, numbness in the arms and/or legs, weakness, muscle spasms, chronic bronchitis, and problems related to the nervous system

- PAH (polynuclear aromatic hydrocarbons)
  - Uses:
    - component of petroleum products
  - Problems:
    - possible carcinogen

- Heavy metals (mercury, copper, cadmium, chromium, lead, nickel, zinc, tin)
  - Uses:
    - mercury from gold mining
    - many from metal processing
  - Problems:
    - may affect nervous system
    - may affect reproduction

- Cyanide
  - Uses:
    - leaching gold from ore
  - Problems:
    - toxic

- Selenium
  - Uses:
    - plays a key role in metabolism
  - Problems:
    - liver, kidney and heart problems
    - at high enough levels it is toxic