Nutrient Cycling and Disturbance

Introduction to Nutrient Cycling

Ecosystem – consists of the community and the abiotic factors in the environment (biotic + abiotic).

Trophic structure of a community can be viewed as a food chain: the sequence of organisms in which one organism feeds on the preceding one.

Algae ⇒ Zooplankton ⇒ Minnow ⇒ Bass ⇒ Osprey

A trophic level refers to the position in the food chain.
Food webs are more realistic.

Biomass -- the total mass or amount of living material.

Primary Productivity -- the amount of organic matter produced; generally in reference to plants.

Measured as Kcal/m^2/y (Kilo calories per square meter per year) or g/ m^2/y

Can study energy and nutrient flow through the biotic community and abiotic environment.

Energy loss through an ecosystem

On average, a 90% loss in energy between trophic levels.

The loss of energy leads to a substantial reduction in biomass between trophic levels.

--can depict as a pyramid (of numbers, biomass, or energy)

Biogeochemical cycles – the movement of nonliving (abiotic) physical matter through an ecosystem.

Carbon cycle

Carbon found in living organisms (e.g., sugars, fats, proteins).

Carbon found in the atmosphere as carbon dioxide gas.

More rapid cycling:

Carbon dioxide used by plants to produce sugars (photosynthesis).

Sugars used by heterotrophs--give off carbon dioxide.

Slower cycling of carbon:
Deposition of fossil fuels:
1. Natural gas
2. Oil
3. Coal (Plants)

Cycled through by:
1. Chemical weathering
2. Physical weathering
3. Combustion

Reduction in photosynthesis + increase in combustion = increased atmospheric CO_2 levels. Increased CO_2 can lead to global warming.

Phosphorous cycle

Phosphorous is released from Earth rocks via weathering.

Phosphorous compounds enter soil or water and can be absorbed by producers.

Re-released into water or sediments when organisms are decomposed or eliminate wastes.

Input of phosphorous (via fertilizers, mining activities, some detergents) + runoff into aquatic systems contributes to **eutrophication**.

Nitrogen cycle

Nitrogen is essential for all living organisms.

Comprises ca. 79% of the air

Atmospheric nitrogen (N_2) can not be used by most living organisms.

Five steps:
1. Nitrogen fixation
   a. Conversion of atmospheric N_2 to ammonia NH_3.
   b. Nitrogen fixing bacteria use the enzyme nitrogenase.
   c. *Rhizobium*, very common, forms nodules on legumes (symbiotic).

2. Nitrification
   a. Conversion of NH_3 (ammonia) to NO_2 (nitrite).
      Accomplished by bacteria, e.g., *Nitrosomonas* and *Nitrococcus*.
   b. Conversion of nitrite (NO_2) to nitrate (NO_3).
      Accomplished by bacteria, e.g., *Nitrobacter*.

3. Assimilation
Plants uptake ammonia and nitrate through the roots.
{Note: plant litter may also serve as source of nitrogen.}

4. Ammonification
Heterotrophs use the nitrate and convert it back to ammonia.

Can now go back to step 2, nitrification.

5. Denitrification
Bacteria that convert NO_3 to N_2
Only anaerobic bacteria.

Aerobic – with oxygen, oxygen present.
Anaerobic – oxygen free, devoid of oxygen (anaerobe).

Effects of Disturbance on Nutrient Cycling

Disturbances such as fire, grazing, can alter the nitrogen cycle and other nutrient cycles.

Fire
Short-term responses
released some stored N

exposes soil

Long-term responses
may variously effect N mineralization

can alter dynamics of N cycle

Grazing

Its effects are less studied than fire effects.

Short-term responses
Can increase N and P concentrations in plant shoots.

Long-term responses
Can result in overall greater plant species diversity.