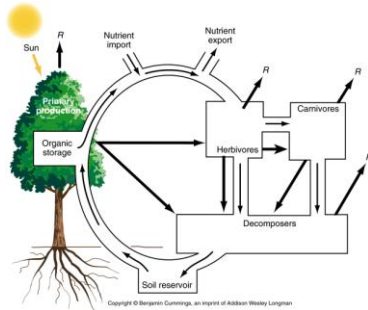


Cycling of Nutrients and Materials: Biogeochemistry

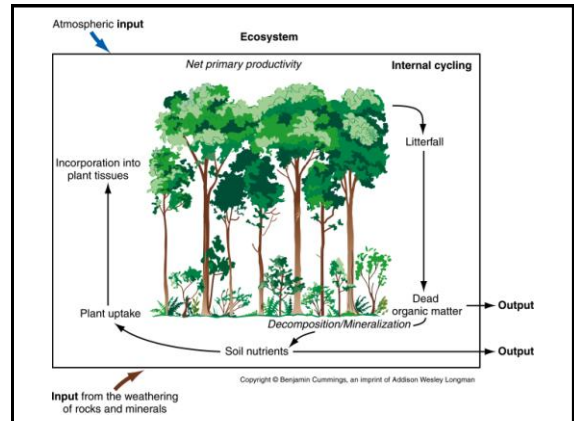


Nutrient Cycling

- Nutrients move through the ecosystem in **biogeochemical cycles**
 - "Bio" = living things
 - "Geo" = rocks, air, water
 - "Chemical" = chemical interactions
- Two general **types** (based on nutrient source)
 - **Gaseous** → atmosphere & ocean
 - **Sedimentary** → Earth's crust (soil and rocks)

Model of Nutrient Cycles

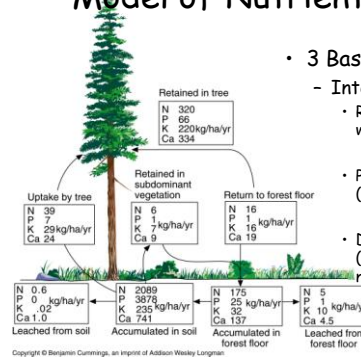
- 3 Basic components:
 - Inputs
 - Internal cycling
 - Outputs



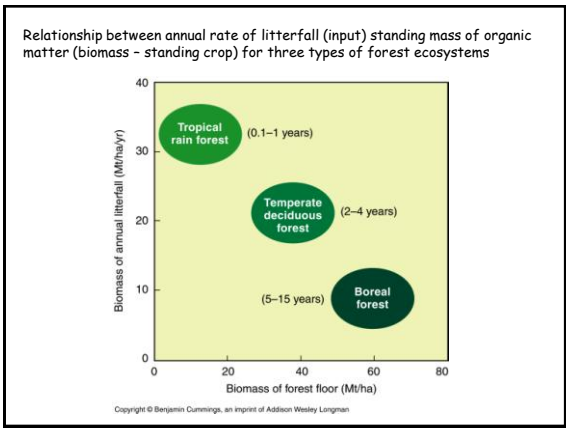
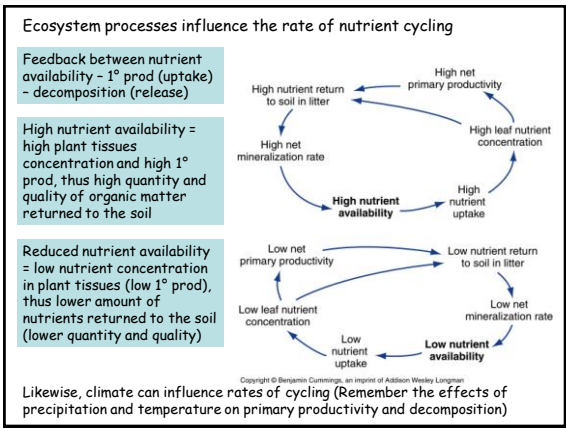
Model of Nutrient Cycles

- 3 Basic components:
 - Inputs:
 - Atmosphere - gaseous
 - Soil - sedimentary
 - Supplementary
 - Precipitation (wetfall)
 - Dryfall (air and dust)
 - Throughfall and stemflow

Model of Nutrient Cycles

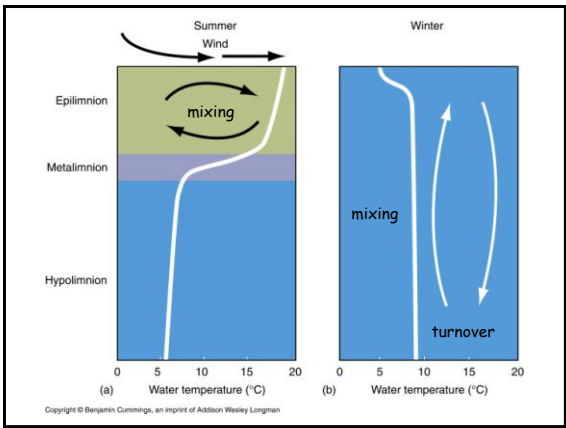
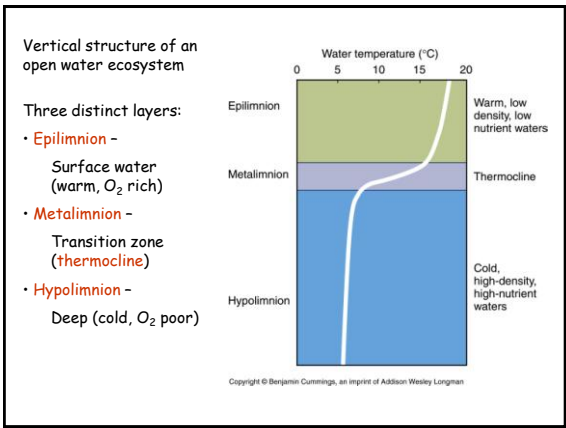
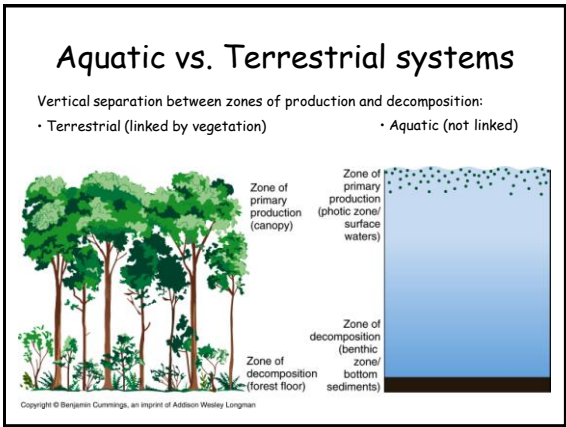


- 3 Basic components:
 - Internal cycling
 - Recycling of nutrients within the ecosystem
 - Primary production (nutrient uptake)
 - Decomposition (mineralization and nutrient release)

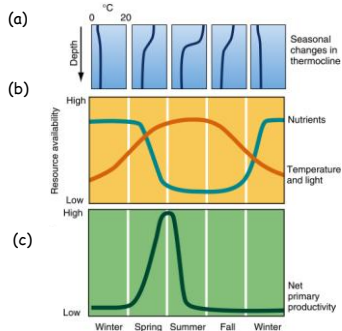


Model of Nutrient Cycles

- 3 Basic components:
 - Outputs
 - Export of nutrients from ecosystems represent a loss that must be offset by inputs or else net declines will occur
 - Exports vary with each biogeochemical cycle
 - Carbon is exported as CO₂ via respiration
 - Organic matter can be exported from watersheds through surface flow (streams and rivers)
 - Consumers remove materials (food) → transported and returned as feces to other systems
 - Materials removed as harvest (i.e., logging, fishing, ag., etc.)
 - Can affect ecosystem processes



Seasonal dynamics of the (a) thermocline and associated changes in (b) the availability of light and nutrients, and (c) net 1° productivity

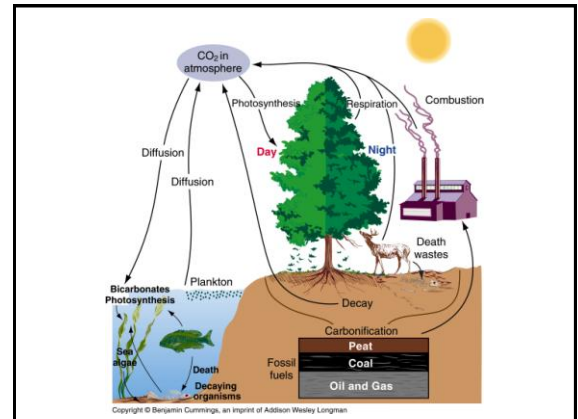


Major Biogeochemical Cycles

- Carbon Cycle
- Nitrogen Cycle
- Sulfur Cycle
- Phosphorus Cycle

Major Biogeochemical Cycles

- Carbon Cycle
 - Inseparably tied to energy flow
 - Carbon (CO_2) is fixed into organic compounds (photosynthesis), passes through the food chain and is eventually returned to the atmosphere (respiration)
 - Annual and diurnal fluctuations in CO_2



Major Biogeochemical Cycles

- Nitrogen Cycle (4 processes)
 - **Fixation** → converts gaseous N_2 to ammonia (NH_3 ; biological) and nitrates (high energy fixation)
 - **Biological fixation** → ~90% of fixed N; N-fixing bacteria in legumes (mutualism - *Rhizobium*), or free-living (i.e., cyanobacteria - blue-green algae)
 - **High energy fixation** → lightning, come to earth as rain water (nitric acid (H_2NO_3))
 - Once made available, N can be utilized (uptake)

Major Biogeochemical Cycles

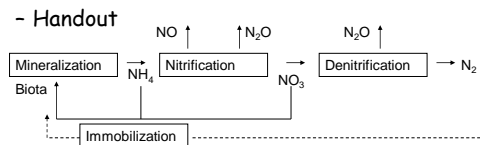
- Nitrogen Cycle (4 processes)
 - **Mineralization (Ammonification)** → major step; proteins in dead plant matter and animal matter are broken down by bacteria and fungi to amino acids
 - Ammonium absorbed by plant roots (passed through food chain) or dissolved in water and part is bound in soil and sediments

Major Biogeochemical Cycles

- Nitrogen Cycle (4 processes)
 - **Nitrification** → biological process in which ammonia is oxidized to nitrite (NO_2) and nitrate (NO_3)
 - *Nitrosomonas* bacteria → NO_2
 - *Nitrobacter* bacteria → NO_3
 - Nitrates then absorbed by plants and incorporated into organic matter

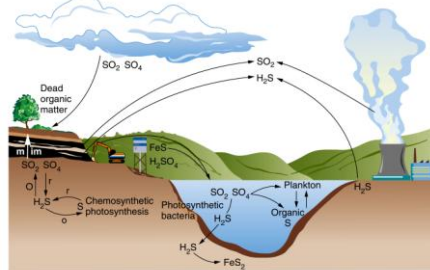
Major Biogeochemical Cycles

- Nitrogen Cycle (4 processes)
 - **Denitrification** → nitrates are reduced to gaseous nitrogen by certain organisms (fungi and bacteria) to obtain oxygen



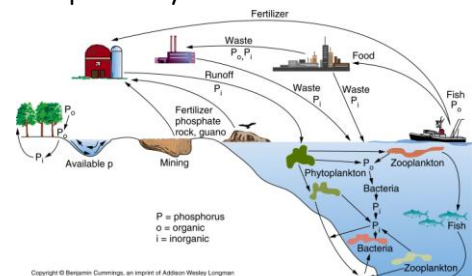
Major Biogeochemical Cycles

- Sulfur Cycle



Major Biogeochemical Cycles

- Phosphorus Cycle



Linkages: Biogeochemical Cycles

- All the major biogeochemical cycles are linked
 - Nutrients (cycled) are components of living organisms
 - Constituents of organic matter
 - Relationships involved in plant processes (carbon uptake and growth) have an important influence on the cycling of nutrients in ecosystems