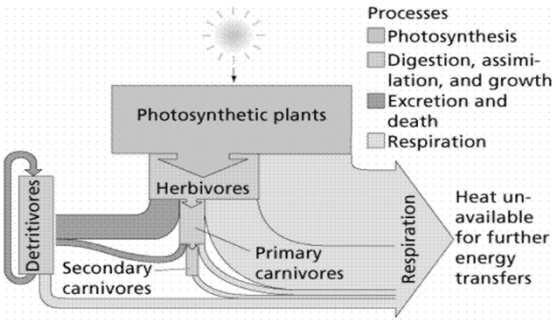
Ecosystems: Matter and Energy



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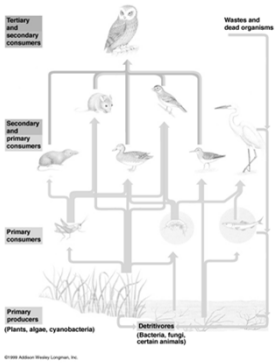
Food Chains and Food Webs

Food Chain
- linear flow chart of who eats whom

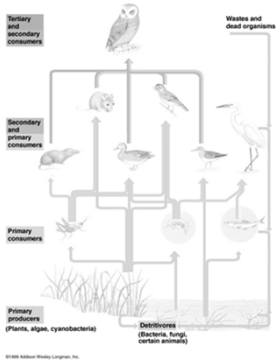
grass --> zebra --> lion --> vulture

Food Webs
- expanded, more complete



Ecosystems

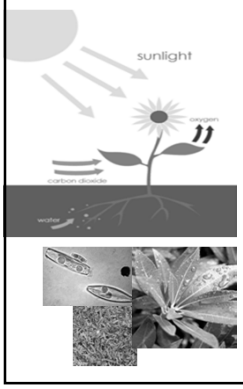
Trophic Levels
- Primary producers
  + autotrophs (plants, protists, cyanobacteria, chemosynthetic bacteria)
- Primary consumers
  + herbivores
- Secondary consumers
  + primary carnivores
- Tertiary consumers
  + secondary carnivores
- Detritivores
  + decomposers (fungi, bacteria, earthworms, insects, scavengers)



An ecosystem is dependent on the base of the pyramid, which is measured by…..

PRODUCTIVITY

Primary Production made by Primary Producers



Gross primary productivity is the *total* amount of energy that producers convert to chemical energy in organic molecules per unit of time.

Then the plant must use some energy to supports its own processes with cellular respiration such as growth, opening and closing it's stomata, etc.

What is left over *in that same amount of time* is **net primary productivity** which is the energy available to be used by another organism.

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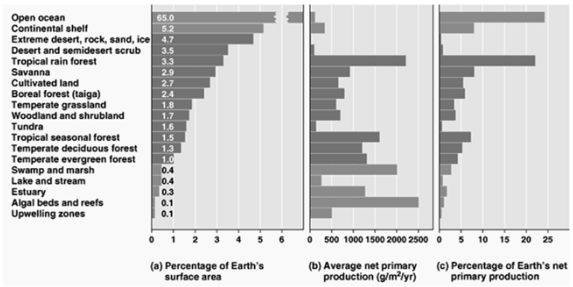
- Primary Productivity- Rate at which organic matter is produced from photosynthesis (kcal/m2/yr) RATE!!!
- Gross Primary productivity (GPP)= Total rate of photosynthesis
- Net Primary Productivity= Gross Primary – Energy Needs of Plant NPP=GPP-Rs

Figure 54.3 Primary production of different ecosystems



Experimental Data

Station Number	Dissolved Oxygen (mg O_2/L)	pH	Temp (°C)
1	4.2	6.8	21.0
2	7.8	8.2	24.7
3	8.4	8.6	29.3
4	6.5	7.0	23.9
5	7.0	7.2	24.2
6	6.7	6.9	24.2
7	6.9	7.1	25.5
8	5.6	7.4	24.6
9	5.6	7.3	28.1
10	9.9	6.2	25.1
11	11.2	9.2	25.8
12	4.9	8.2	22.1
13	7.2	8.0	32.4
14	3.6	7.4	16.2

The following data was collected from 14 different rivers in Virginia.

Use the Station 1 data to calculate the Primary Productivity of a water sample. Report your answer in units of mg Carbon fixed/Liter

The needed conversion factors are found on the student formula sheet

Primary Productivity Calculation
mg O_2/L x 0.698 = mL O_2/L
mL O_2/L x 0.536 = mg carbon fixed/L

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Answers to Previous Slides

Station Number	Dissolved Oxygen (mg O_2/L)	Carbon Fixed (mg/L)
1	4.2	1.6
2	7.8	2.9
3	8.4	3.1
4	6.5	2.4
5	7.0	2.6
6	6.7	2.5
7	6.9	2.6
8	5.6	2.1
9	5.6	2.1
10	9.9	3.7
11	11.2	4.2
12	4.9	1.8
13	7.2	2.7
14	3.6	1.3

Station 1

4.2 mg O_2/L × 0.698 = 2.9 mL O_2/L

2.9 mL O_2/L × 0.526= 1.6 mg Carbon fixed/L

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Visualizing Matter & Energy

There are a variety of diagrams that help us visualize how energy, biomass, matter, and even number of organisms interact in a particular community or ecosystem. It is important that you look carefully at the diagrams and understand what it says about that ecosystem in terms of matter and/or energy.

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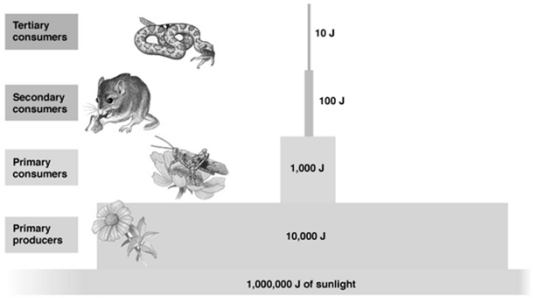
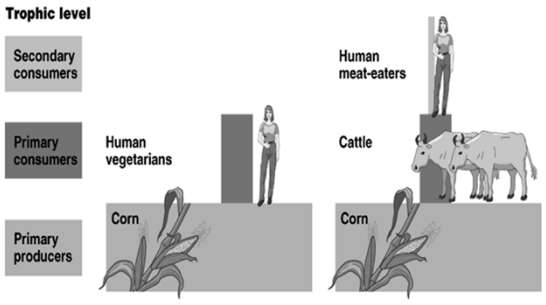
Pyramid of Energy



Trophic Level Human Population



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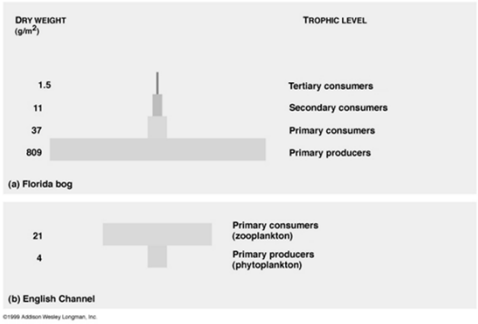
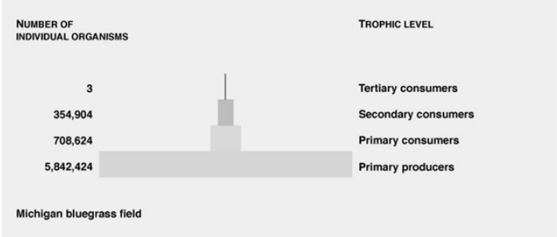
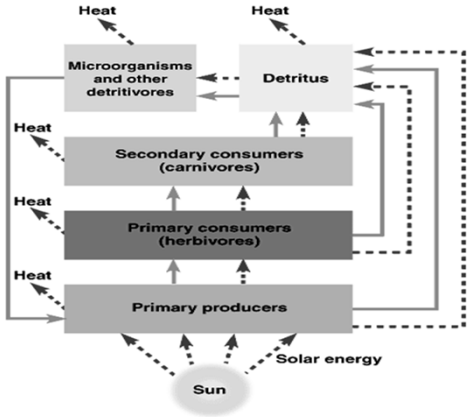
Pyramid of Biomass

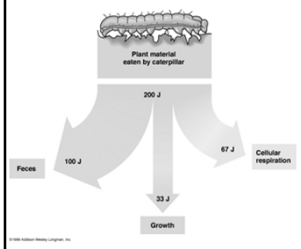


Pyramid of Numbers





Ecological Efficiency



Ecological Efficiency

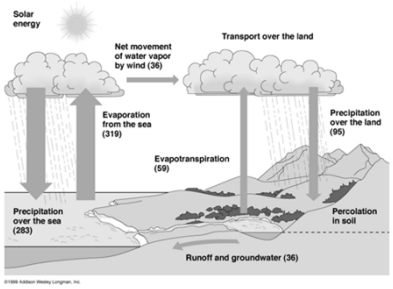
- proportion of energy represented at one trophic level that is transferred to the next
  - average efficiency=10%
    - only 10% of productivity is transferred to next level
    - remaining 90% is consumed by metabolism

Biogeochemical Cycles

Biogeochemical Cycles

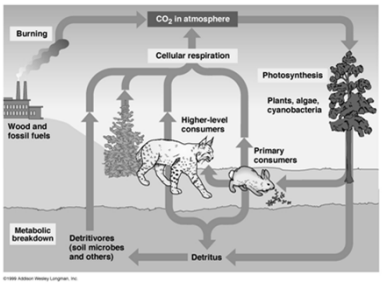
- flow of essential elements from the environment to living things and back to the environment
  - reservoirs
    - major storage locations
  - assimilation
    - processes through which element incorporates into terrestrial plants and animals
  - release
    - processes through which element returns to the environment

Hydrologic Cycle (water cycle)



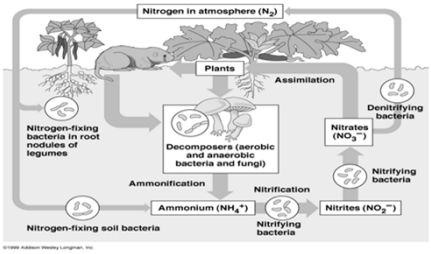
Reservoirs: oceans, air, groundwater, glaciers
Assimilation: plants absorb from soil; animals eat/drink
Release: plants transpire; animals/plants decompose

Carbon Cycle



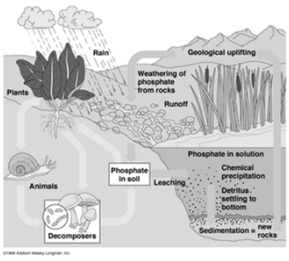
Reservoirs: atmosphere (CO_2), fossil fuels, peat, cellulose
Assimilation: plants via photosynthesis; consumers
Release: respiration and decomposition; burn fossil fuels

Nitrogen Cycle

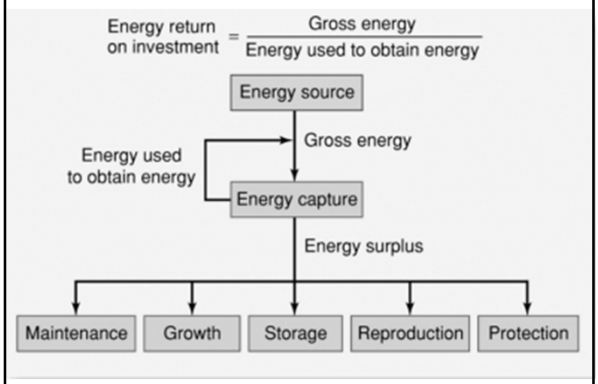


Reservoirs: atmosphere (N_2); soil (ammonium, ammonia, nitrite, nitrate)
Assimilation: plants absorb from soil; animals consume plants/animals
Release: denitrifying and detrivorous bacteria; animal excretion

Phosphorous Cycle



Reservoirs: rocks
Assimilation: plants absorb from soil (phosphate); consumers
Release: decomposition; excretion in waste products



http://www.theenergylibrary.com/files/images/Energy_Al

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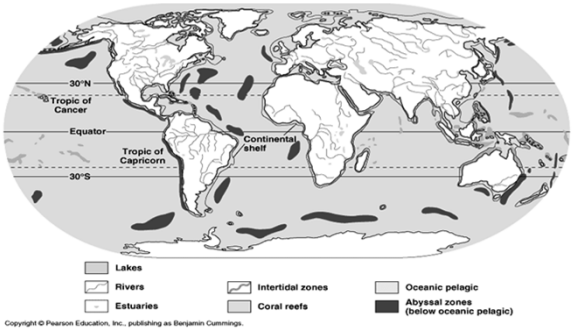
Biomes

Biome

- region of biosphere characteristized by vegetation and adaptations of organisms inhabiting the environment
  - + *Tropical rain forest* (high temp., heavy rainfall)
  - + *Savannahs* (grassland with scattered trees)
    - tropical, but receive less rainfall than rain forest
  - + *Temperate grasslands* (North American prairie)
    - receive less water/lower temp. than savannahs
  - + *Temperate deciduous forests* (warm summer/cold winters)
  - + *Deserts* (hot and dry)
  - + *Taigas* (coniferous forests)
    - precipitation in the form of snow
  - + *Tundras* (Lambau Field)
    - permafrost
  - + *Fresh water biomes* (ponds, lakes, streams, rivers)
  - + *Marine biomes* (estuaries, intertidal zones, continental shelves, coral reefs, pelagic oceans)

Aquatic Biome Distribution



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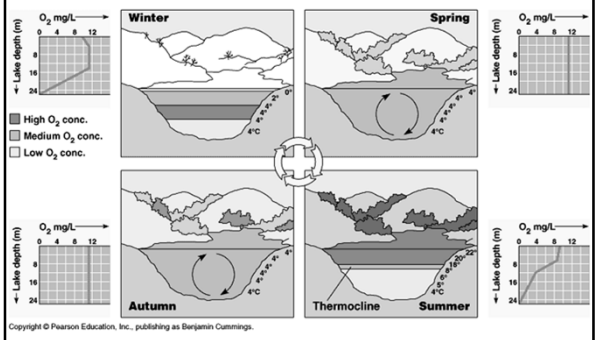
Lake Stratification



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Freshwater

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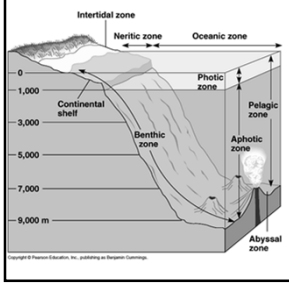
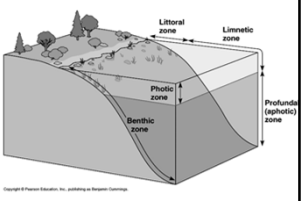
Zonation

Marine Zonation





Lake Zonation

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Wetlands & Estuaries

Transitional Zones between freshwater and marine. This water tends to be a mix of both depending on its geographic location. The water is often referred to as brackish

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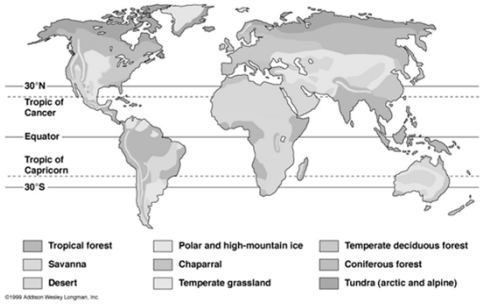

Tropical Rain Forest

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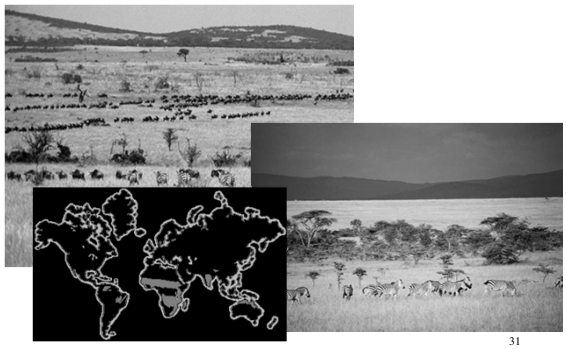
Savanna



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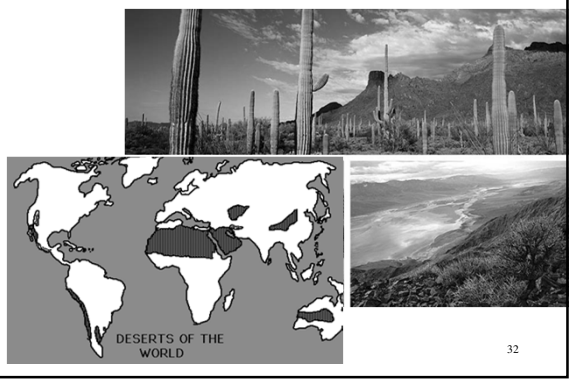
Desert



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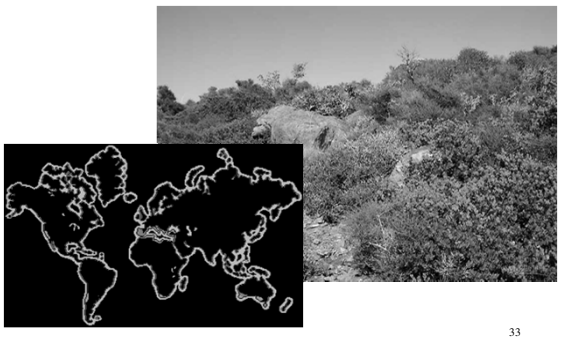
Chaparral- also called Scrubland



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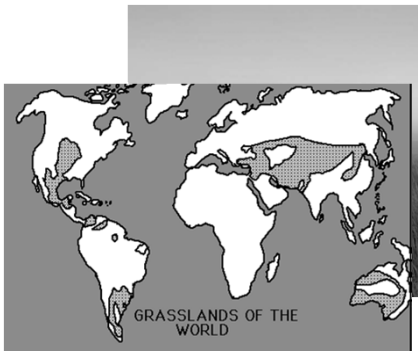
Temperate Grasslands



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Temperate Forest

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Taiga

Taiga: Also called Coniferous or Boreal Forest

1. precipitation usually snow
2. conifers like spruce, fir, hemlock
3. soil acidic and forms slowly

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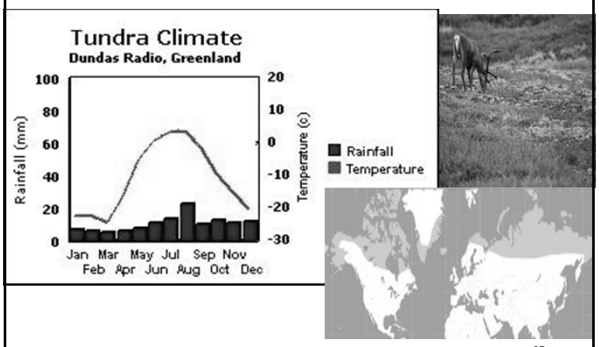
Tundra



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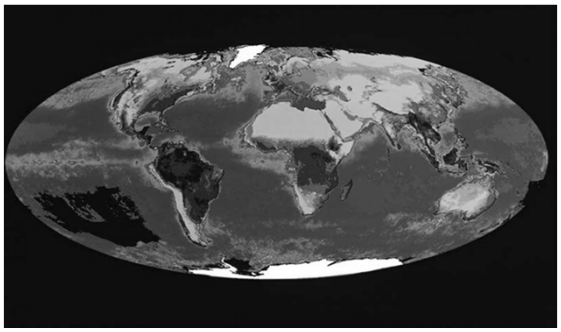
Biosphere



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What happens when a cycle is out of balance?

Cycles can have an anthropogenic (man-made) or a non-anthropogenic (natural phenomena) impact that causes a cycle to become unbalanced. Additionally, this may just be the natural state of that ecosystem as a consequence of the availability of nutrients.

Two examples involving imbalanced freshwater habitats include:

- Oligotrophic waters- low primary productivity
- Eutrophic waters- high primary productivity

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Oligotrophic Lake

Eutrophic

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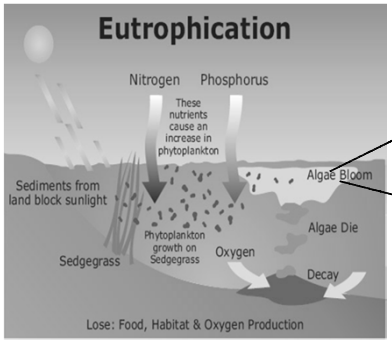
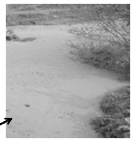
Eutrophication- The Algal Bloom





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Animal Behavior

Ethology

- the study of animal behavior
- nature versus nurture… both?
  - + kinds of animal behavior
    - - Innate Behavior
      - + *instinct*
      - + *fixed action patterns* or FAP (Niko Tinbergen)
      - + *imprinting** (Konrad Lorenz)
    - - Learned Behavior
      - + *associative learning*
        - - classical conditioning (Ivan Pavlov)
        - - operant conditioning (B.F. Skinner)
      - + *habituation*
      - + *observational learning*
      - + *insight*

Animal Movement

Kinesis
- *undirected* change in speed of movement in response to stimulus
  + speed up in unfavorable; slow down in favorable
    - light, touch, air temp., etc.
  + Avon bug in the bathroom tub

Taxis
- *directed* movement in response to stimulus
  + toward/away from stimulus
    - phototaxis, chemotaxis
  + mosquitos and CO2

Migration
- long-distance, seasonal movement
  + availability of food, degradation of environment
    - whales, birds, elks, insects, bats

Communication in Animals

Why do animals communicate? How do animals communicate?

Chemical
- pheromones
  + *releaser pheromones* cause immediate/specific behavioral changes
  + *primer pheromones* cause physiological changes
    - marking your territory

Visual
- *agonistic behavior*
  + displays of aggression
- *courtship behavior*
  + announce participants as non-threatening/potential mates

Auditory
- sounds
  + whales, crickets, birds

Tactile
- touching

Social Behavior

Agonistic Behavior
- aggression/submission
  + competition for food, mates, territory
  + ritualized; reduces injury/energy

Dominance Hierarchies
- power and status relationships among groups
  + minimize fighting for food/mates

Territoriality
- possession/defense of territory
  + insures adequate food/space

Altruistic Behavior
- unselfish behavior that appears to reduce fitness
  + increases *inclusive fitness*
    - ground squirrels