Ecosystem Services

1) Biodiversity

80% of people rely on natural medicinal products

Top 150 prescription drugs in the US:

118 from natural sources

74% from plants
18% from fungi
5% from bacteria
3% from vertebrates

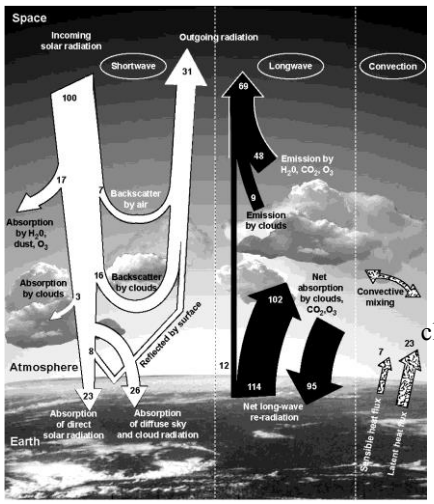
Ecosystem Services

2) Pollination

Over 100,000 animal species freely pollinate plants

bats
bees
flies
moths
beetles
birds
butterflies

One third of human food comes from plants pollinated by wild pollinators

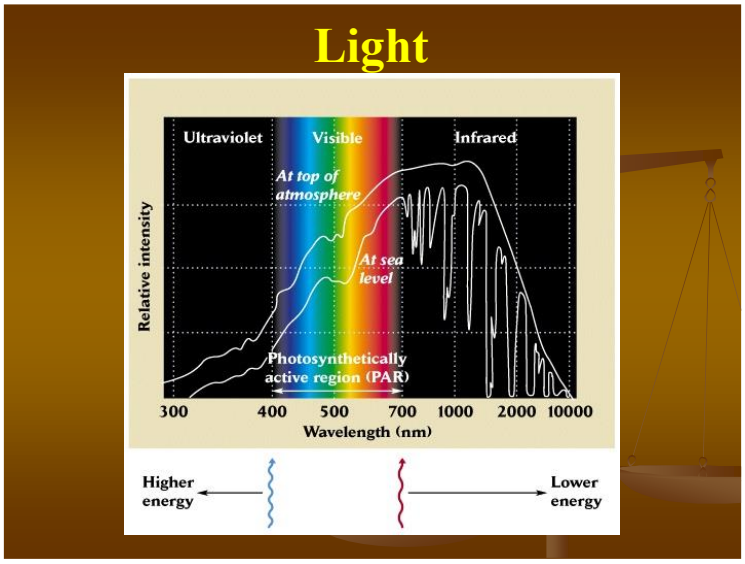


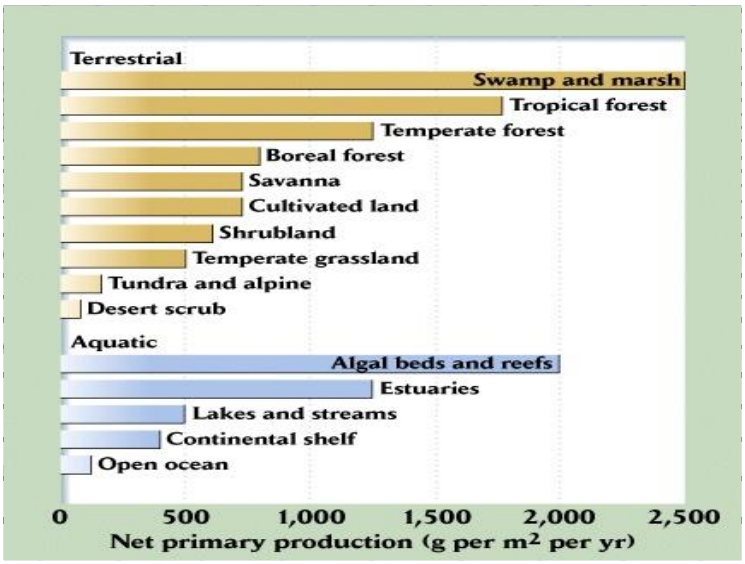
energy in =
energy out
343 Watts/m^2

31% reflected by clouds or surface

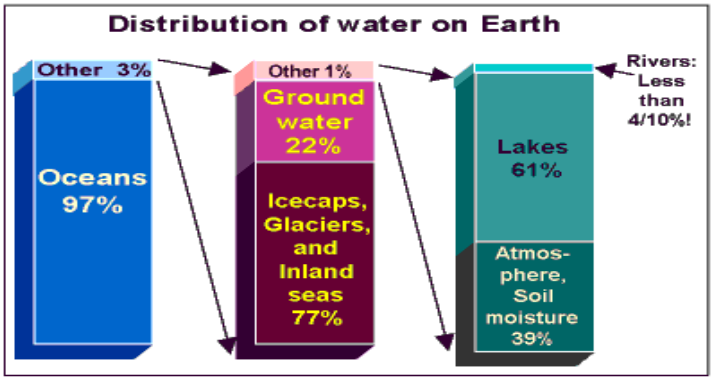
20% absorbed by clouds and atmosphere

49% absorbed by earth surface





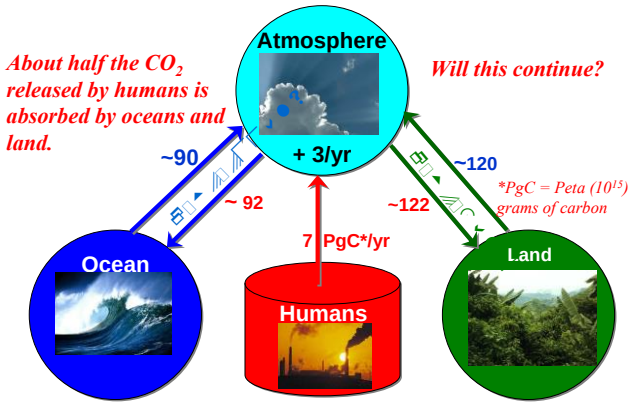
Water Storage in Oceans



Surface Runoff

- surface runoff gradually flows into gullies, streams, lakes, or rivers. Water in streams and rivers flows to the ocean, seeps into the ground, or evaporates back into the atmosphere.

The Global Carbon Cycle



Nitrogen fixation

I. Symbiotic nitrogen fixation

Conditions:

Inoculation with correct bacteria

Infection of the legume roots

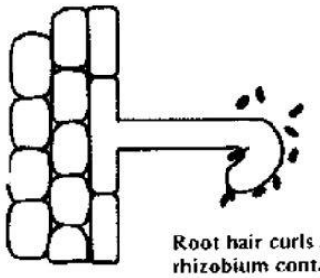
Nodulation

Legume feeds the bacteria

Bacterial provide fixed nitrogen

The nodulation process

2. **Root hairs curl**



Root hair curls after rhizobium contact stops cell growth.

Age structure and population growth

- When prereproductive age category is large, there is momentum towards growth
  - developing countries - 34% prereproductive
  - developed countries - 19% prereproductive
  - overall - 31%

Effects of Population Decline

- As percentage of 60+ aged people increases, population begins decline
- 60+population increase --> severe economic and social problems because 60+ consume
  - more medical care
  - Social Security
  - costly public services
- Labor shortages require automation & immigration

معادله رشد :

Equation for population growth is

$\Delta N/\Delta t = bN-dN$

Where N = population size, b is per capita birth rate and d is per capita death rate. $\Delta N/\Delta t$ is change in population N over a small time period t.

The per capita rate of population increase is symbolized by r.

r = (b-d) + (i-e).

r indicates whether a population is growing (r >0) or declining (r<0).

Exponential population growth (EPG)

Describes population growth in an idealized, unlimited environment.

During EPG the rate of reproduction is at its maximum.

The equation for exponential population growth is

$$\frac{dN}{dt} = r_{max}N$$

Logistic Population Growth

Exponential growth cannot be sustained for long in any population.

A more realistic population model limits growth by incorporating carrying capacity.

Carrying capacity (*K*) is the maximum population size the environment can support

Modeling density-dependent growth

The Logistic Equation (cont.)

The next part, $\left(\frac{K-N}{K}\right)$

As the population size approaches K…
actual growth rate slows down
stable equilibrium at N = K (or N=0)

The logistic growth equation includes *K*, the carrying capacity (number of organisms environment can support)

$$\frac{dN}{dt} = r_{max} N \frac{(K - N)}{K}$$

As population size (N) increases, the equation [(K-N)/K] becomes smaller which slows the population's growth rate.

Population growth models

exponential

$dN/dt = r * N$

$N_{(t)} = N_{(0)} * e^{r*t}$

r = birth - death

Factors that determine density: Births

Includes production of new individuals

Other terms

Fecundity - potential reproductive capacity

Fertility - based on # of offspring

Realized vs. potential fertility

Births usually reported as organisms produced per female per unit time (PER CAPITA)

Population Regulation

In a closed system (no immigration or emigration), populations increase until an EQUILIBRIUM is reached

Equilibrium is where:

Per capita birth rate = Per capita death rate Population is stable

Population regulation

- Density dependent
  - birth rate decreases with increasing population density
  - death rate increases with increasing population density
- Density independent
  - birth and death rates do not change with population density
- Inversely density dependent
  - birth rates increase with increasing population density
  - death rates decrease with increasing population density

Density independent population regulation

When the birth rate does not change as the population rises.

Populations decline only when members are killed off by natural disasters

e.g. forest fires, hurricanes, storms etc.

(NB. Death not due to "bad genes" death is due to "bad luck").

Density Dependent population regulation

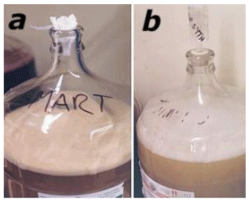
As population density increases birthrate declines and/or death rate increases.

eg. Competition for resources – nutrients, food.

Space: - "Territoriality"

Toxic waste

Organisms in closed systems can produce toxic waste which poisons their growth.



the fermentation

Intrinsic factors

High population densities can cause reduction in birth rates due to stress and antagonistic behaviors.