Ecosystems and the Biosphere Outline

Ecosystems

- Processes in an ecosystem
  - Production, respiration, decomposition
- How energy and nutrients move through an ecosystem

Biosphere

- Biogeochemical Cycles
- Gaia Hypothesis

Ecosystem Ecology

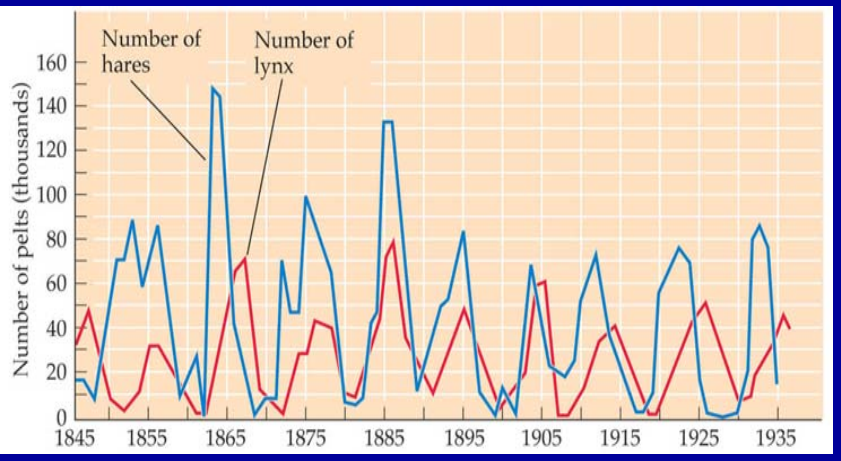
Ecosystems overview:

Ecosystem: all the **organisms** living in an area

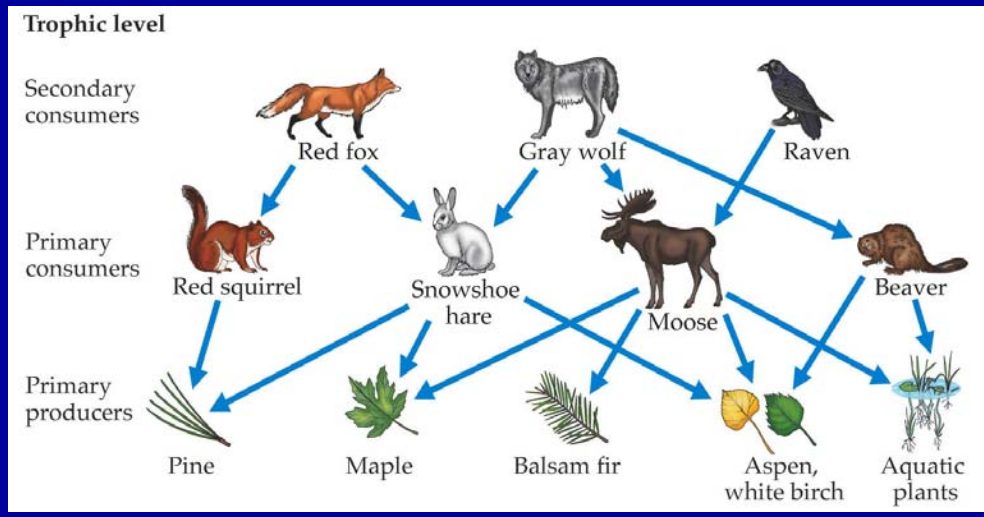
As well as all the **abiotic factors** or **physical environment** with which they interact

Biotic Components:

Pop dynamics



Trophic dynamics



Abiotic Components: the nonliving components the physical and chemical environment of the biota

Sunlight

Water/moisture

Temperature

Soil or water chemistry

Precipitation

Ecosystem dynamics includes energy flow and chemical cycling

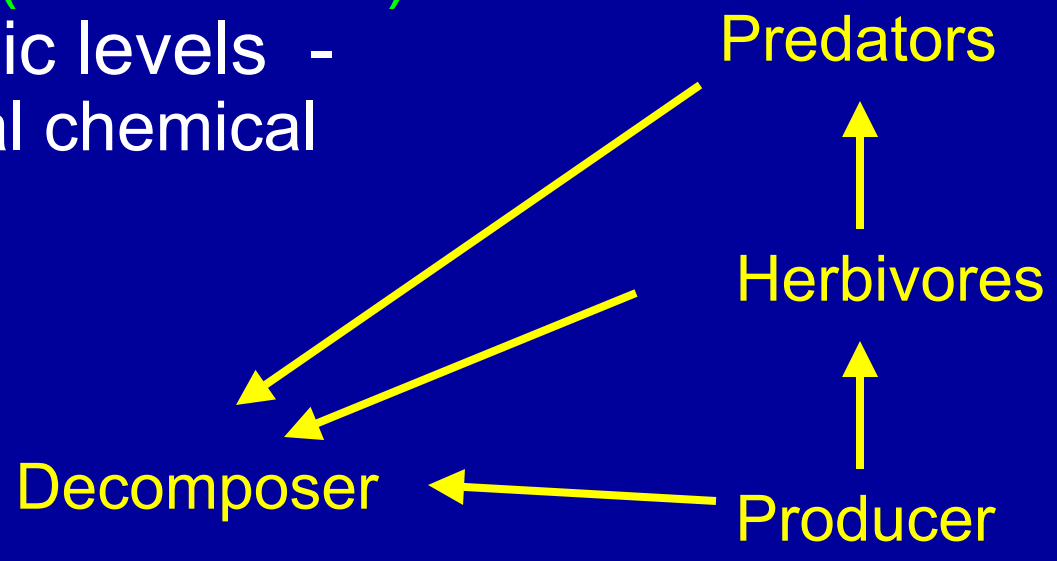
- Transformers of energy and processors of matter

- Energy flow in an ecosystem obeys the laws of thermodynamics….

Trophic relationships in ecosystems

Energy and nutrients move through trophic levels

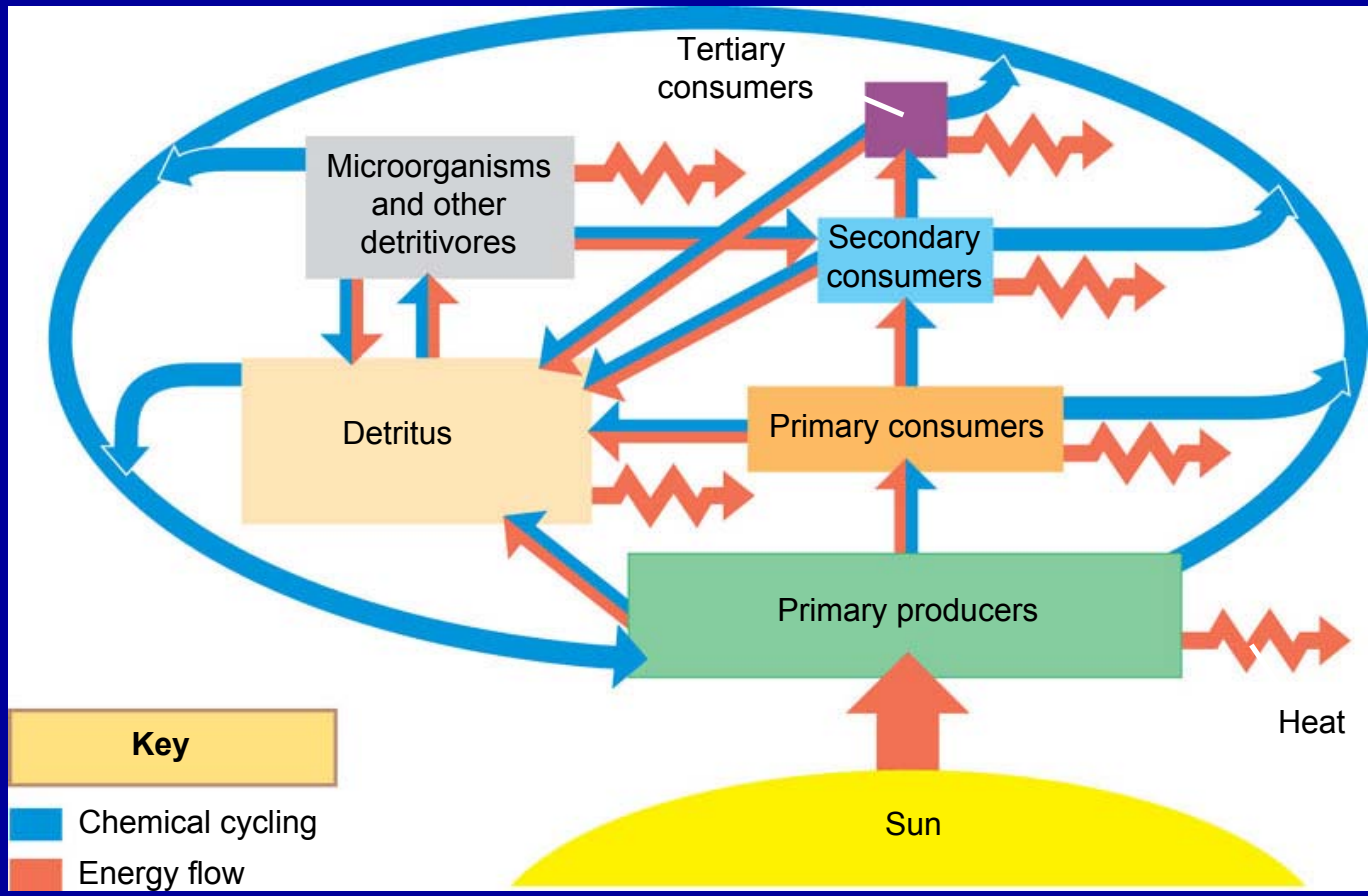
- Primary producers (autotrophs)
- Consumers (herbivores and predators)
- Decomposers (detritivores) connects trophic levels - recycle essential chemical elements



Trophic relationships in ecosystems

Energy flows through an ecosystem

– Entering as light and exiting as heat



See Fig 55.3, web activity 55.2

Energy Flow is Controlled by the Laws of Thermodynamics

1st Law?

Conservation of Energy:

- Energy is neither created nor destroyed

- The primary source of energy that ecosystems use is sunlight
- The first law implies the only energy available for growth in the ecosystem is what is photosynthesized

Physical and chemical factors limit primary production in ecosystems

- **Primary production**
  - the amount of light energy converted to chemical energy by autotrophs during a given time period

- So - the extent of photosynthetic production sets the spending limit for the energy budget of the entire ecosystem

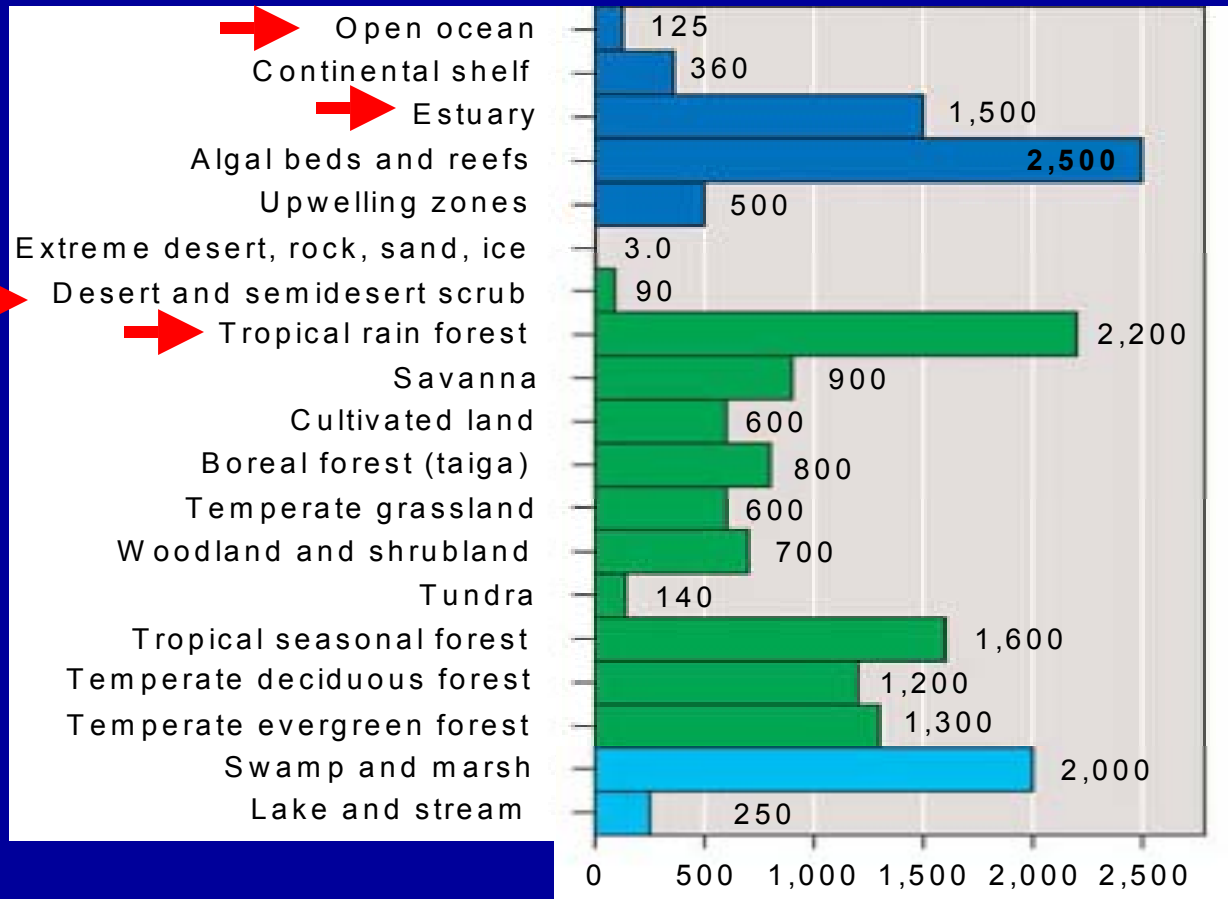
Gross and Net Primary Production

- **Gross Primary Production (GPP) - t**otal primary production in an ecosystem
  - All the energy produced by Photosynthesis
- Some energy is stored in the growing plants, some is respired
- **Net primary production (NPP)**
  - GPP minus the energy used by the primary producers (respiration)
  - The energy stored in biomass

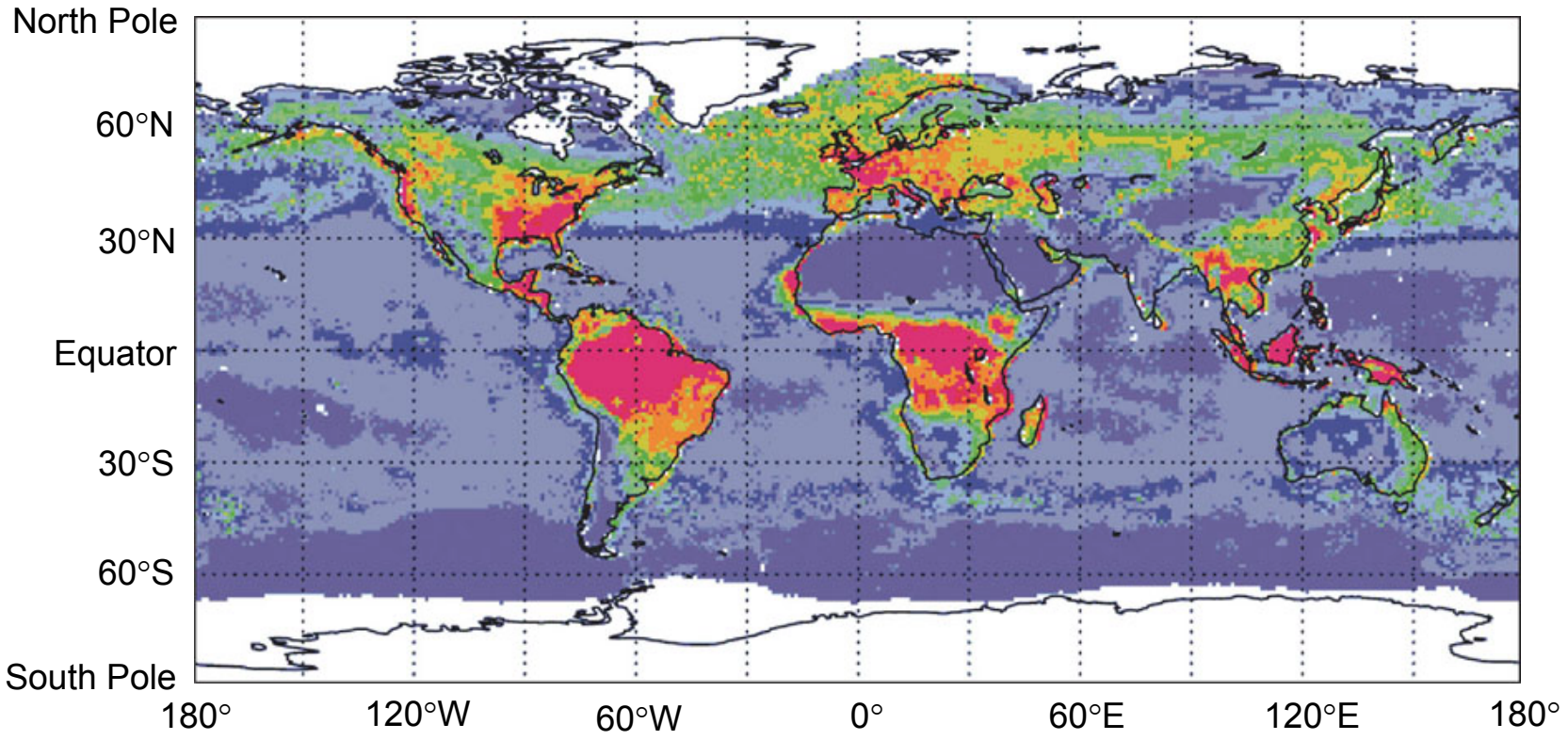
- **Only NPP is available to consumers**

Gross and Net Primary Production

Different ecosystems vary considerably in their net primary production



Overall, terrestrial ecosystems contribute about two-thirds of global NPP and marine ecosystems about one-third



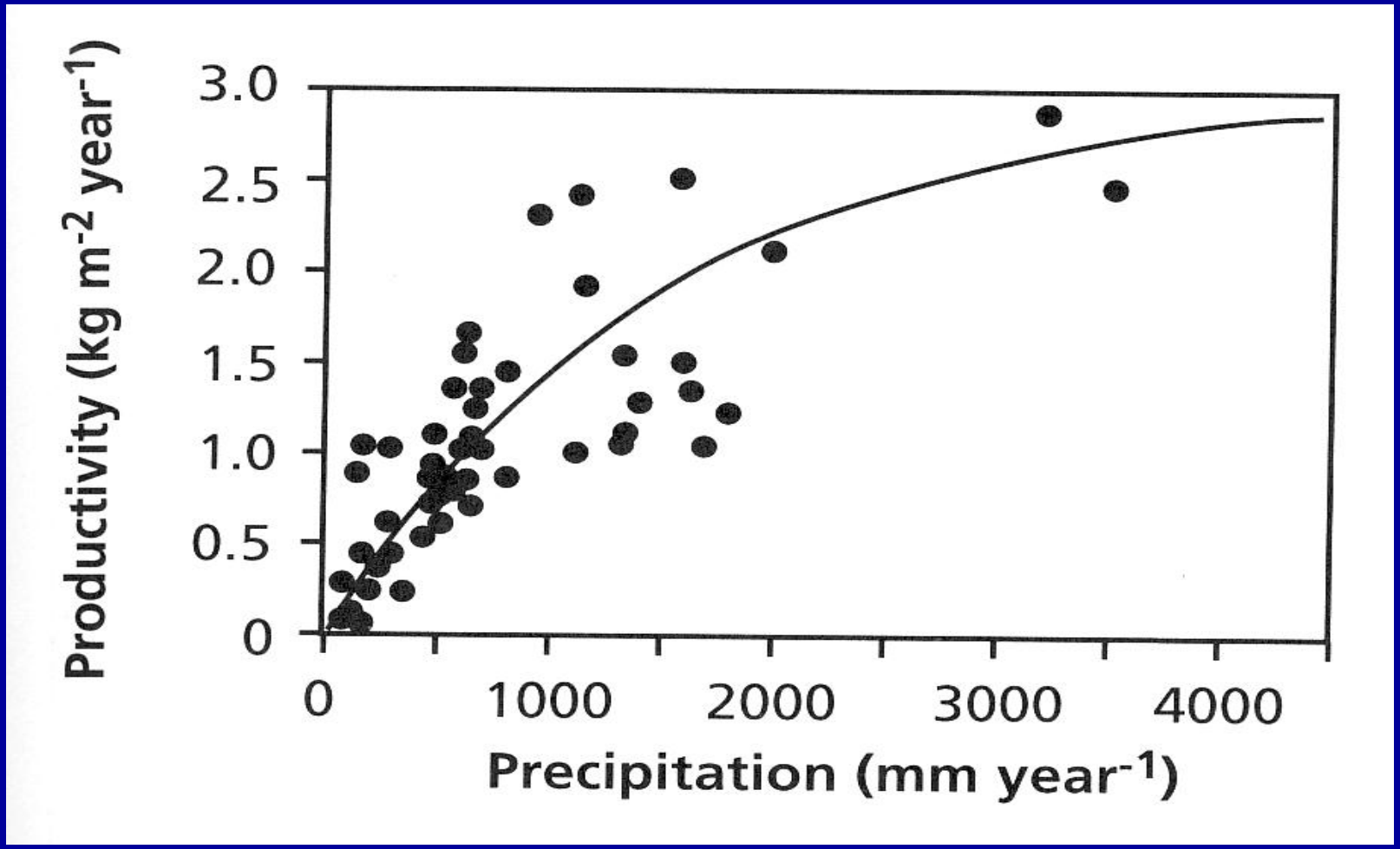
Primary Production in Terrestrial Ecosystems

- **Climatic factors** such as temperature and moisture, affect primary production

- Temperature effects – enzyme activity
- Wet and dry climates have different primary productivity

Primary Production in Terrestrial Ecosystems

NPP is related to precipitation



Energy Flow is Controlled by the Laws of Thermodynamics

2nd Law?

Entropy:

- Transfers of energy are not 100% efficient

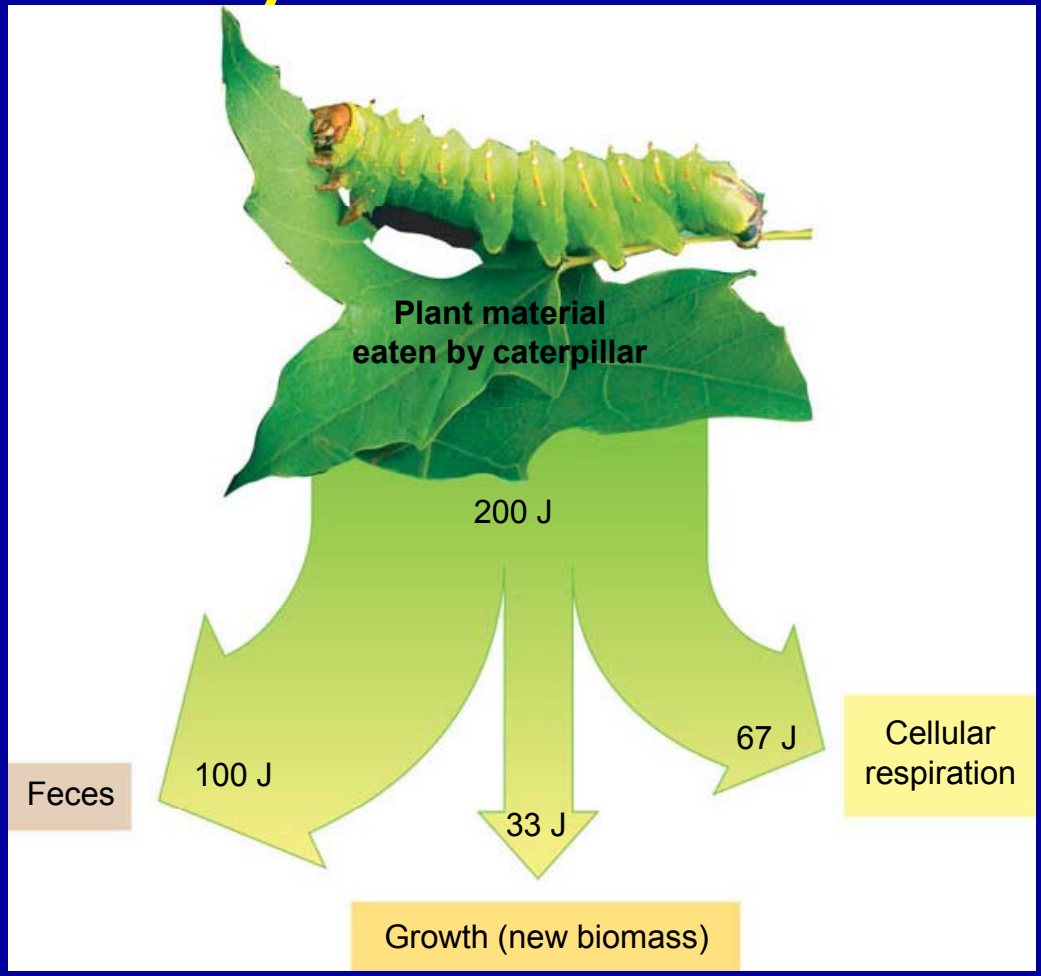
- Much energy in food is lost as heat
- As energy flows from organism to organism – the amount of energy available for growth, maintenance, etc. decreases

Energy transfer between trophic levels is usually less than 20% efficient

Secondary production: amount of chemical energy in a consumers' food that is converted to their own new biomass

Production Efficiency

About 15% of the energy in the leaf is used for secondary production



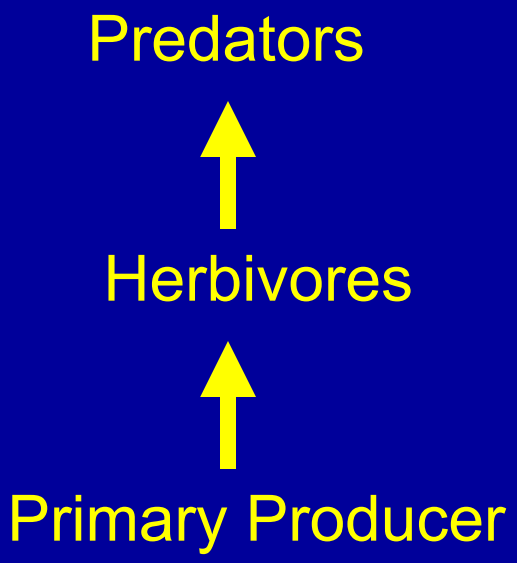
The production efficiency of an organism is the fraction of energy stored in food that is not used for respiration

Trophic Efficiency and Ecological Pyramids

Trophic efficiency

- Percent of production transferred from one trophic level to the next
- Usually ranges from 5% to 20%

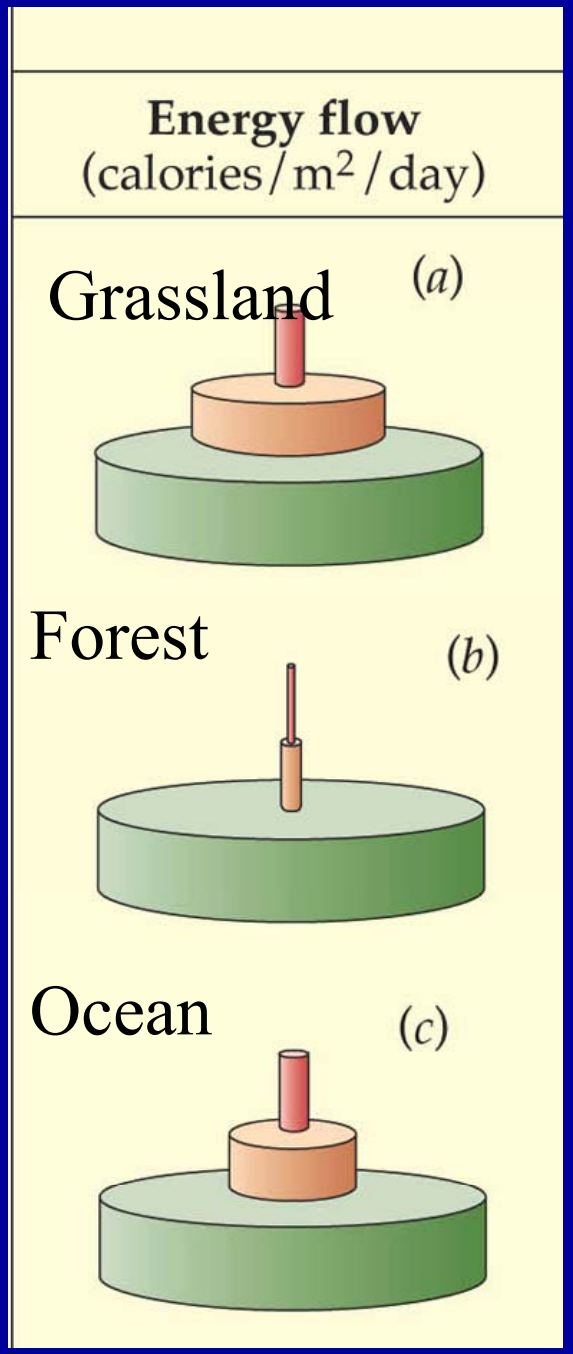
- Predictions?



Pyramids of Energy

- This loss of energy with each transfer in a food chain
  - Can be represented by a pyramid of net production

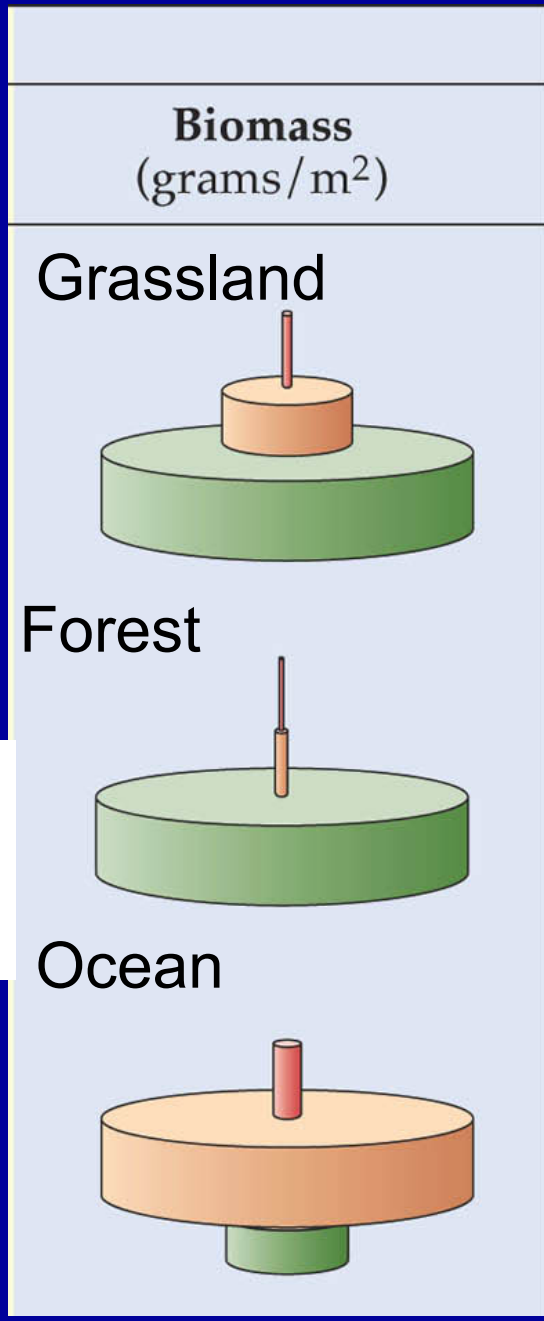
Fig 55.8



Pyramids of Biomass

One important ecological consequence of low trophic efficiencies

- Sharp decrease at higher trophic levels



Inversion →

Biological and geochemical processes move nutrients between organic and inorganic parts of the ecosystem

Biogeochemical cycles

The total amount of energy that plants assimilate by photosynthesis is called

a. Gross primary production
b. Net primary production
c. A pyramid of energy
d. Succession

Pop Quiz

- One one side: 4-digit code
- One other: Name, and:

- What are the 2 main factors that govern which biome is located in a particular place?

Biosphere?

The part of Earth where life occurs and which biotic processes alter or transform

Biosphere Ecology
Biogeochemical Cycles

- **Biogeochemical (nutrient) cycles:**

  movement of chemical elements through organisms and the physical environment

- Physical environment had four compartments:

  oceans fresh waters

  atmosphere land

Biogeochemical Cycles

- Driven by organism interactions, physical processes, chemical processes
- Strongly interrelated
- Humans have altered all biogeochemical cycles

The Carbon Cycle

- Most C in organisms comes from CO_2 How?
- Photosynthesis removes carbon from the atmosphere
- Heterotrophs get C from?

- Respiration returns carbon to the atmosphere

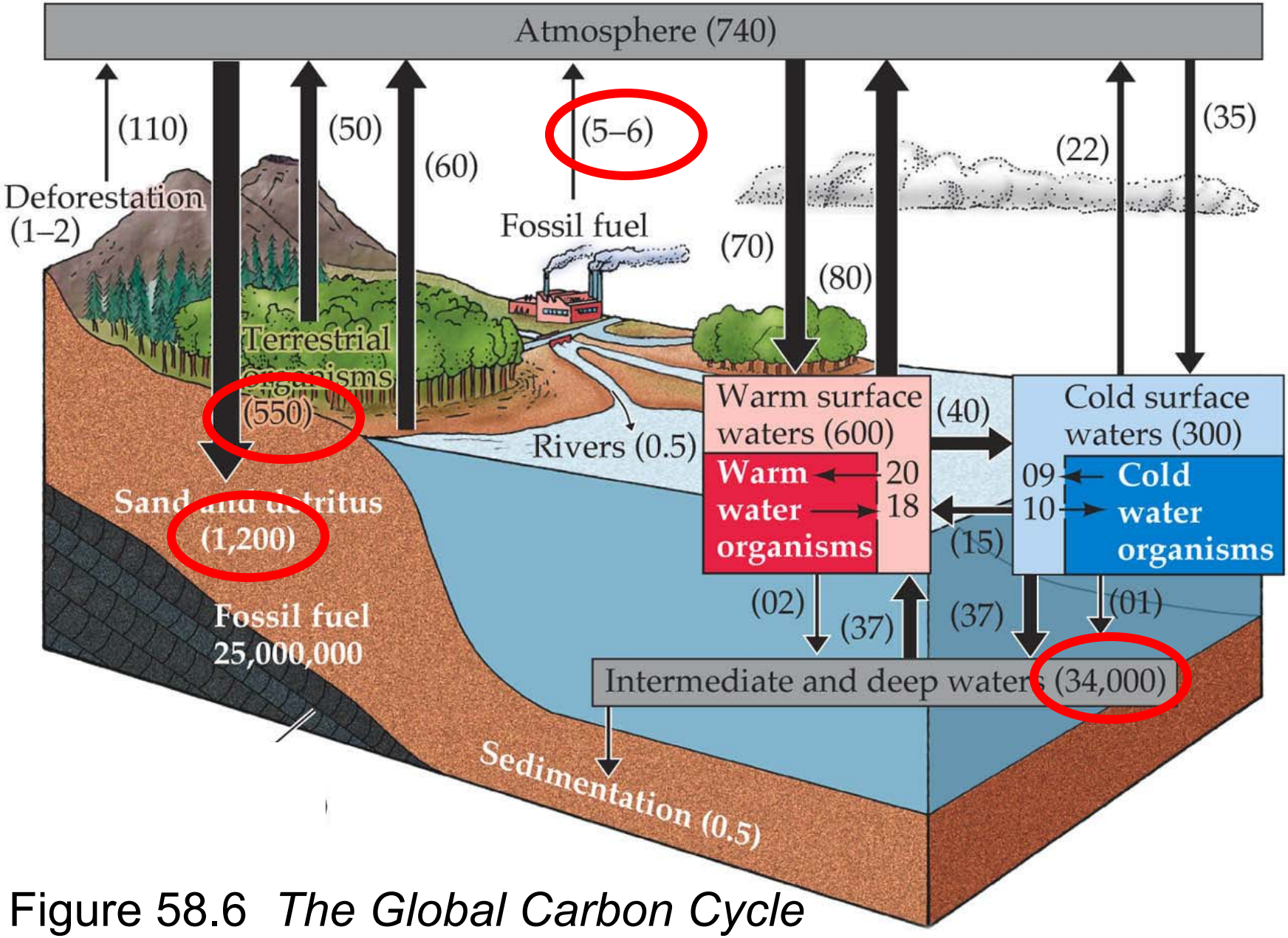
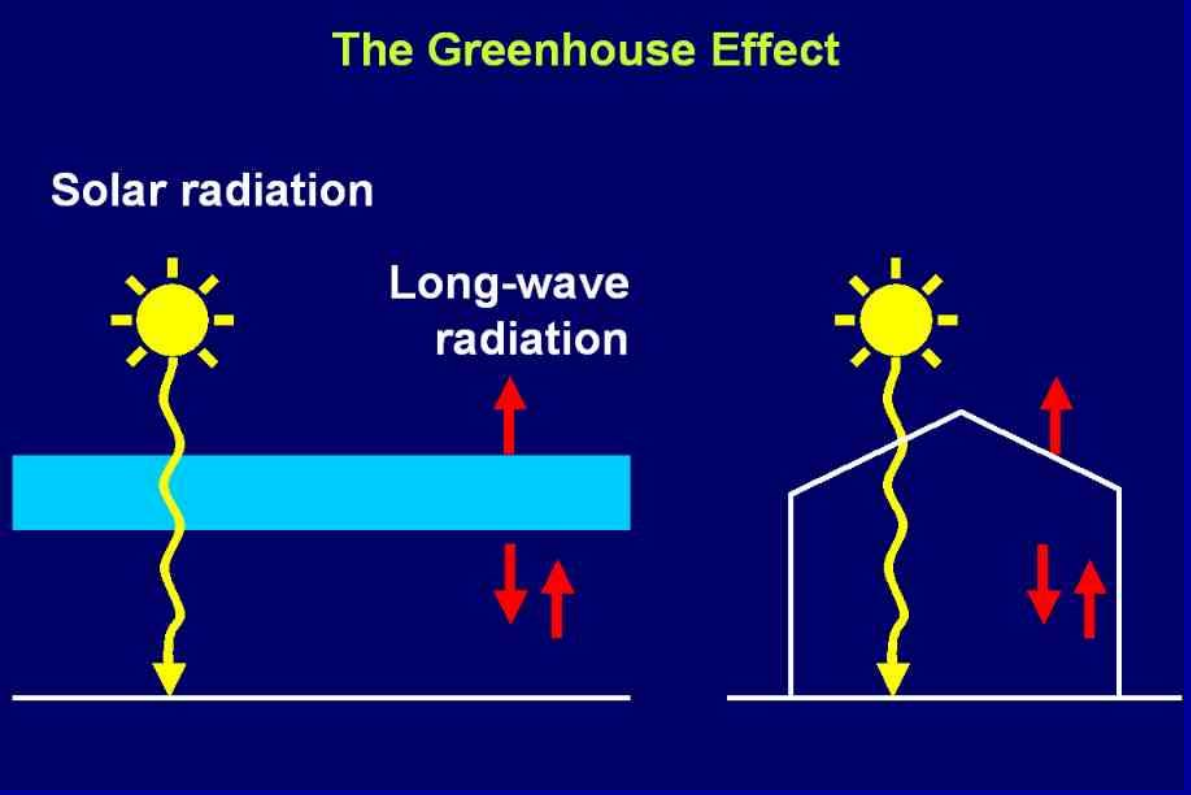


Figure 58.6 *The Global Carbon Cycle*

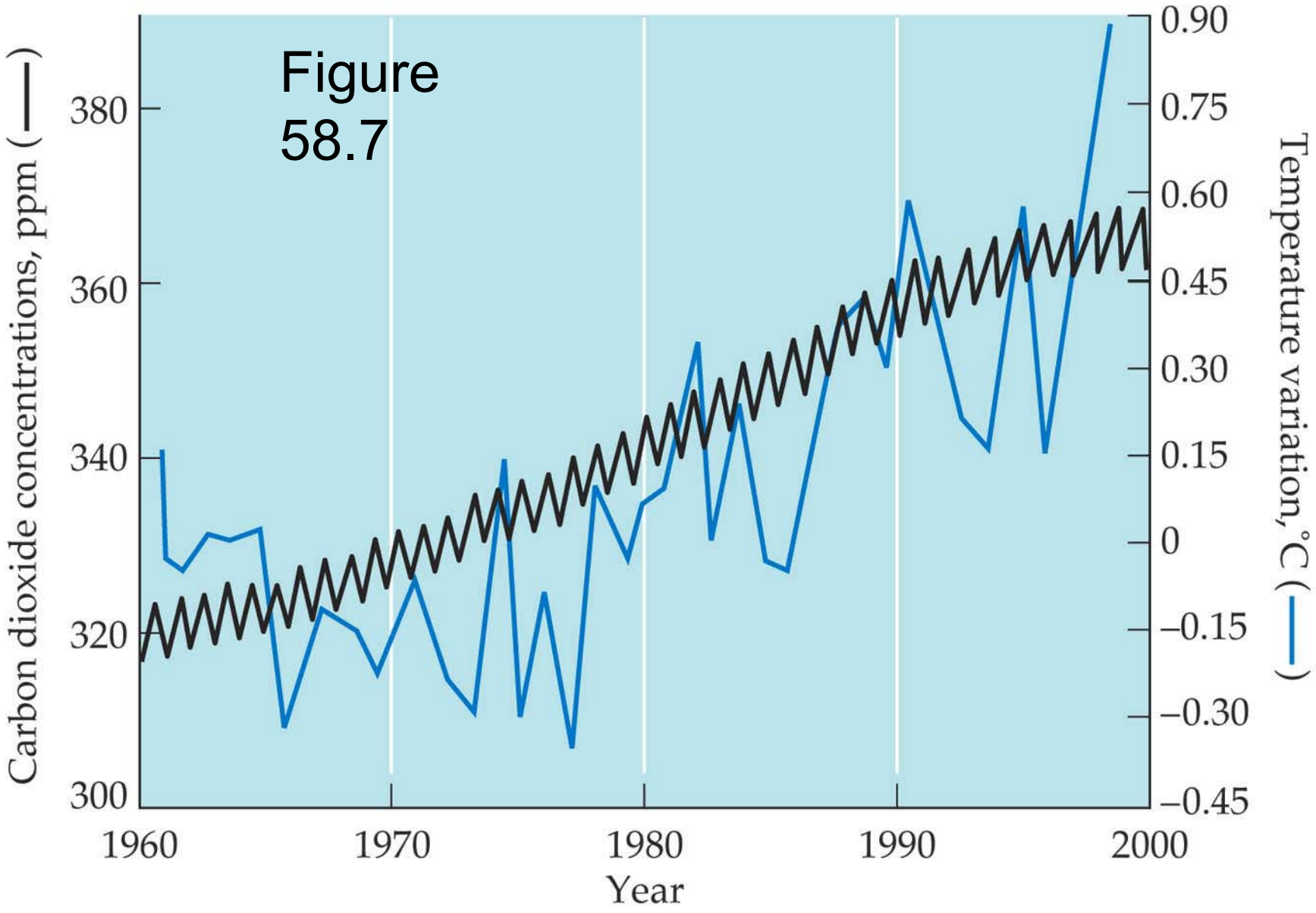
The Carbon Cycle

- Most stored in the **oceans**.
- On land – most C is in the soil (detritus)
- **Fossil fuels -** C was converted to such as oil, natural gas, coal, and peat.
- Burning of these fossil fuels (and wood) releases C to the atmosphere



Greenhouse gases (water vapor, CO_2, and O_3 etc.) trap heat that Earth radiates back to space.

Without an atmosphere, the average surface temperature of Earth would be about –18°C, rather than its actual +17°C.



LIFE: THE SCIENCE OF BIOLOGY, Seventh Edition, Figure 58.7 Atmospheric Carbon Dioxide Concentrations Are Increasing

Temp normally fluctuates

Humans are forcing climate change