Announcements

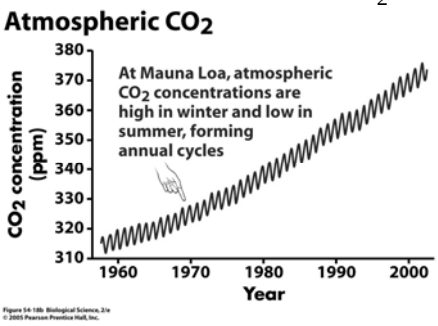
- Extra credit due Friday by 4 pm – my office or box
- Review session: Tues. 12/7, 3:30-5 p.m., room TBA

Ecosystem Ecology

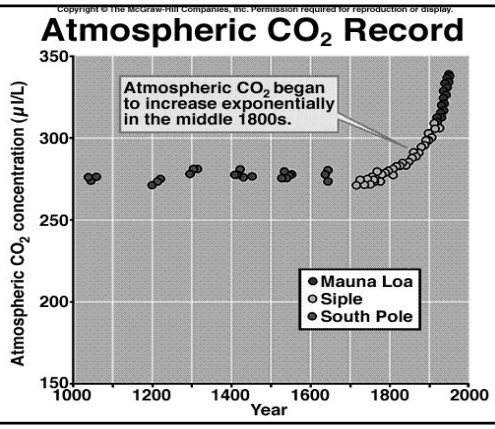
Reading: Chapter 54

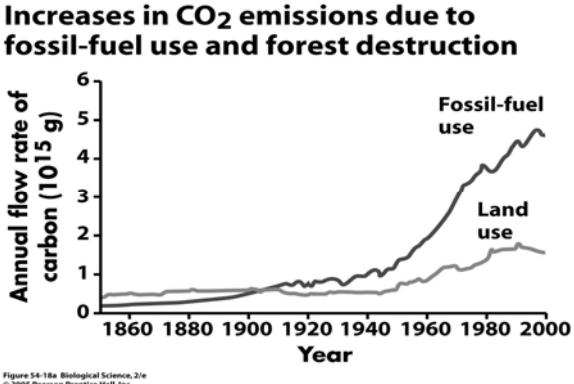
I. Intro – elevated CO_2 and global warming
II. What is ecosystem ecology?
  A. Components
  B. Basic Principles
    1. Element cycling
    2. Energy flow
III. Biogeochemical cycling
  A. Carbon cycle
  B. Limits to primary production
IV. Energy flow and Secondary Production

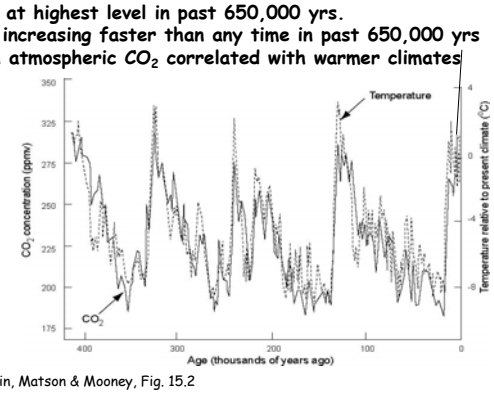
I. Intro - Elevated CO_2



What do you want to know about this data?

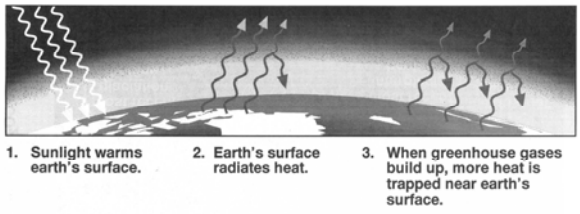






Chapin, Matson & Mooney, Fig. 15.2

Consequences?
Enhanced greenhouse effect



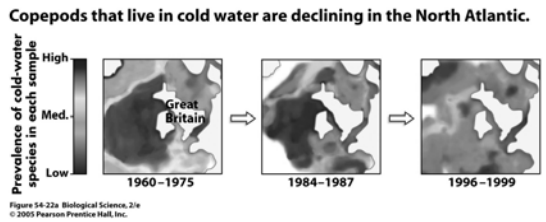
Starr&Taggart Fig. 37.12

Consequences?

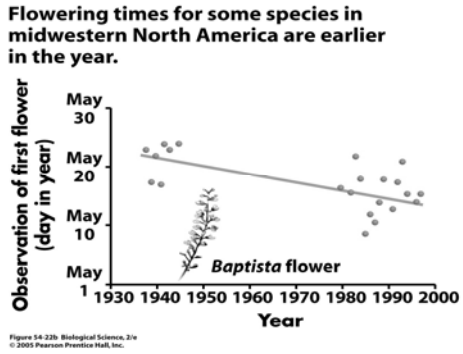
1. Increased average/extreme temperature
2. Increased sea level (melting of glaciers and icecaps, thermal expansion of oceans)
3. Changing precipitation patterns
4. Increasing intensity of storms (?)

Indirect Consequences

1. Changes in species distributions



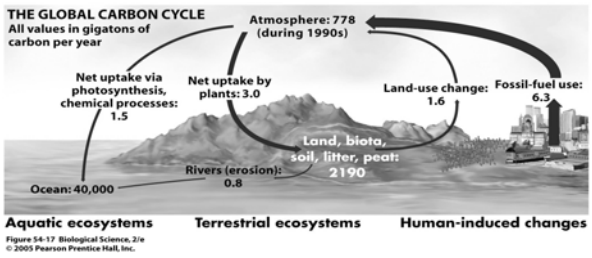
2. Changes in phenology



Questions?

Where's all the CO_2 going?
Can it be taken up by natural ecosystems?

CO_2 budget
Release: 7.9 Gt
Atmos: 3.0 Gt
Oceans: 2.0 Gt



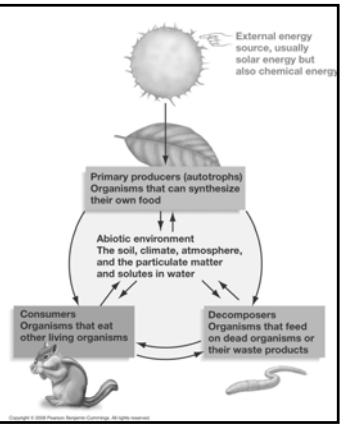
Question:

Is fertilizing the oceans a viable strategy for reducing global warming?

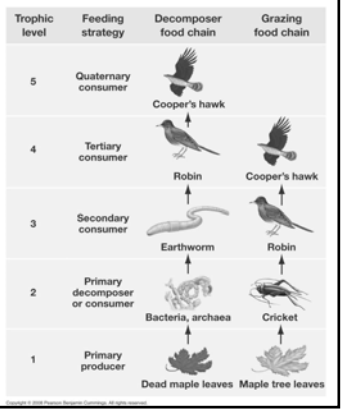
II. What is ecosystem ecology?

Ecosystem components

Primary producers
Consumers
Decomposers
Abiotic environment



Food chains track energy and matter flow within ecosystems

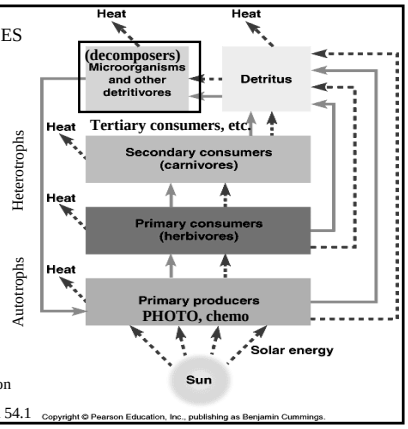


B. ECOSYSTEM PRINCIPLES
1- Energy flow
2- Chemical cycling

ENERGY- Cannot be recycled, flows through ecosystems, from an external source, enters as light exits as heat.

MATTER- Cycles within ecosystems.

Energy flow and chemical cycling described by grouping species in a community into trophic levels according to main source of nutrition and energy



C&R 54.1

Food webs

Detrital food web

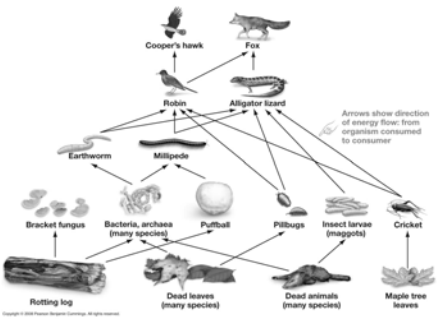
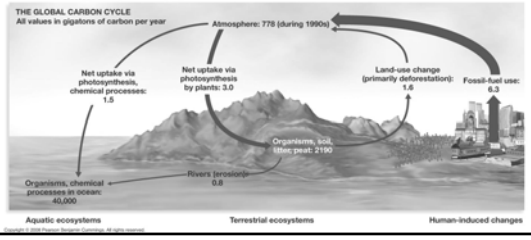


Fig. 54.6

III. Biogeochemical cycling

A. Carbon cycle

1. What is it?



ENERGY FLOW

PRIMARY PRODUCTION

ENERGY AVAILABLE TO ECOSYSTEM

Primary Production:
Amount of light energy converted to chemical energy (organic compounds) by an ecosystem's autotrophs in a given period of time.

The extent of photosynthetic production sets the spending limit for the energy budget of the entire ecosystem.

Of the visible light reaching photosynthetic organisms only ~1% is converted to chemical energy.

Gross Primary Production (GPP) = Total Primary Production

Some used as fuel for plant cellular respiration.
Net Primary Production (NPP) = GPP – R_p
Only NPP is available to consumers.

Net Ecosystem Production (NEP) = NPP – R_{het}

Secondary Production = change in biomass of consumers

Primary Production can be expressed as:
Energy per unit area per unit time (J / m^2 / yr).

Biomass (dry weight) of organic molecule per unit area per unit time (g C / m^2 / yr).

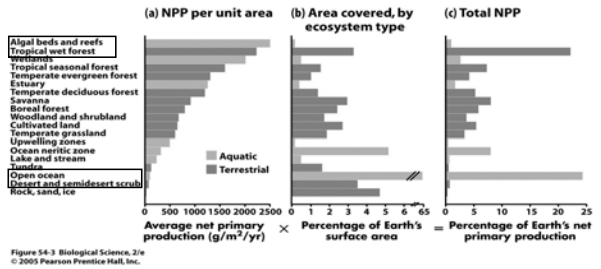


Figure 54-3 Biological Science, 2/e
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B. Controls on Primary production

Liebig's law of the minimum: the resource that is in greatest demand relative to supply will limit productivity.

Terrestrial ecosystems:

- Temperature, moisture, and nutrients most limit primary production.
- At large scales, climate (water and temperature) determines primary production
  - biomes
  - seasonal shifts

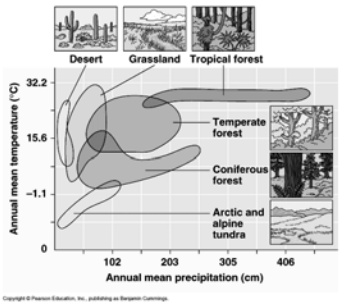

Fig. 50.10

Annual NPP

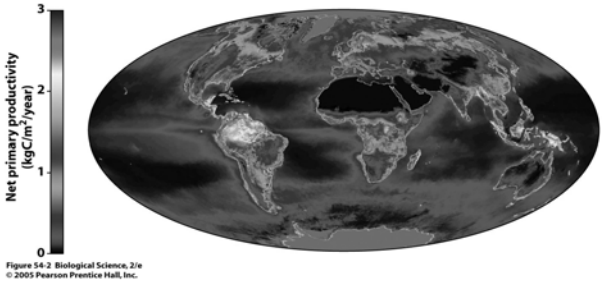

Figure 54-2 Biological Science, 2/e
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Terrestrial ecosystems: temperature, moisture and nutrients most limit primary production.

At small scales, soil nutrients determine primary production.

Salt marsh, Hudson Bay

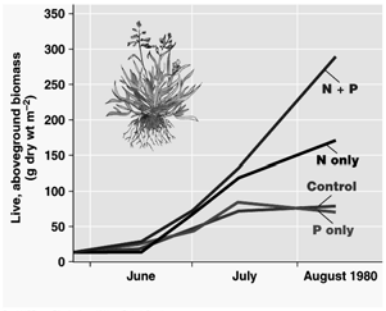

Fig. 54.9

Aquatic ecosystems: Light and nutrients most limit primary production

Within the photic zone the factor that most often limits primary production is a nutrient such as nitrogen or phosphorus, or a micronutrient such as iron.
Exception: upwelling regions.

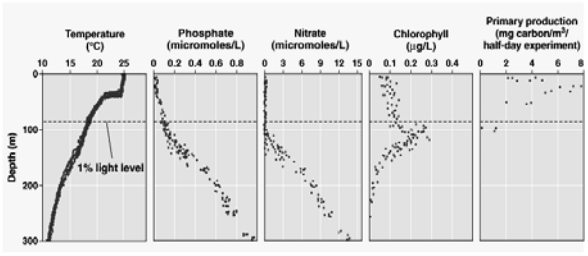

Fig. 54.5

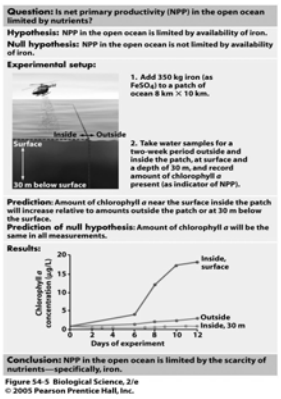

Figure 54-5 Biological Science, 2/e
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What limits productivity in the open oceans?

"Give me half a tanker of iron and I'll give you the next ice age."

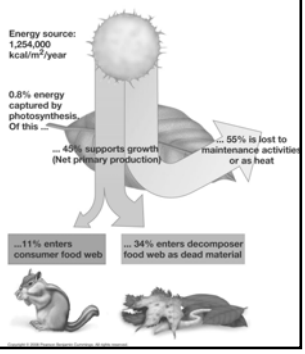
John Martin
Oceanographer

IV. Energy flow and secondary production

B. Secondary Production

Amount of chemical energy in consumer's food converted to new chemical energy in a given period of time.

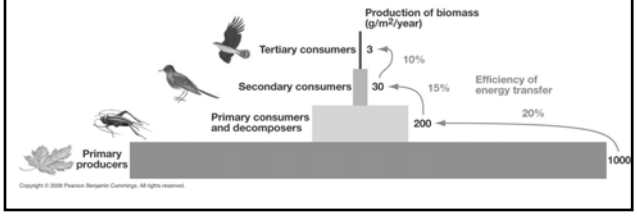
Amount determined by net primary production and by efficiency of energy transfer between trophic levels, which is usually 5- 20%.



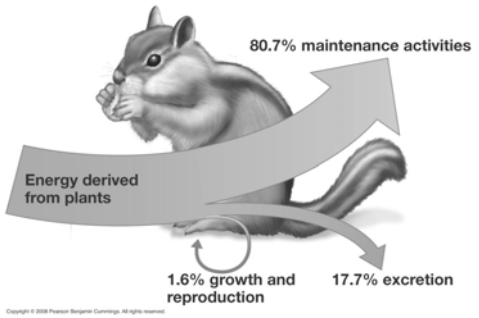
Trophic efficiency

Percentage of production transferred from one trophic level to the next.
Includes:
- production efficiency (amount of biomass made per amount consumed)
- energy not consumed in lower trophic level;

-Values are 5-20%, thus 80-95% of energy is lost.
- This loss is multiplied in each trophic level, forming an energy pyramid.



Most consumer energy is lost to respiration



Trophic pyramids - consequences for human carrying capacity

Eating meat is a relatively inefficient way of tapping photosynthetic production.

One can feed more people more efficiently if we all consumed plant material, thus bypassing one trophic level.

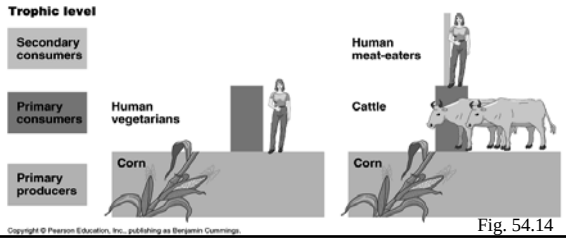


Fig. 54.14

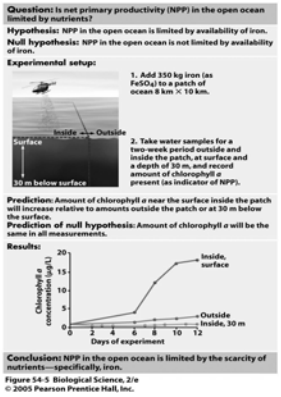


Figure 54-5 Biological Science, 2/e
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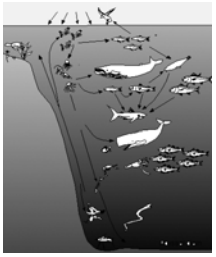
- Net carbon sequestration depends on both C uptake through primary production AND C release through respiration.
- What's that called?



The End