

## Lecture 3 – Primary Productivity

### READINGS FOR NEXT LECTURE:

- Krebs. Pages 97-102: "Light as a Limiting Factor."
- Broad, WJ. 2003. Deep under the sea, boiling founts of life itself. *NY Times*. 9/9 (H,W)
- Field, CB *et al.* 1998. Primary production of the biosphere: Integrating terrestrial and oceanic components. *Science*. **281**:237-240. (H,W)
- Noble IR and R Dirzo. 1997. Forests as human-dominated ecosystems. *Science*. **277**:522-525.

### Questions for today:

How do energy and carbon move through ecosystems?  
How do terrestrial and aquatic ecosystems vary?  
What limits their productivity?

### Outline:

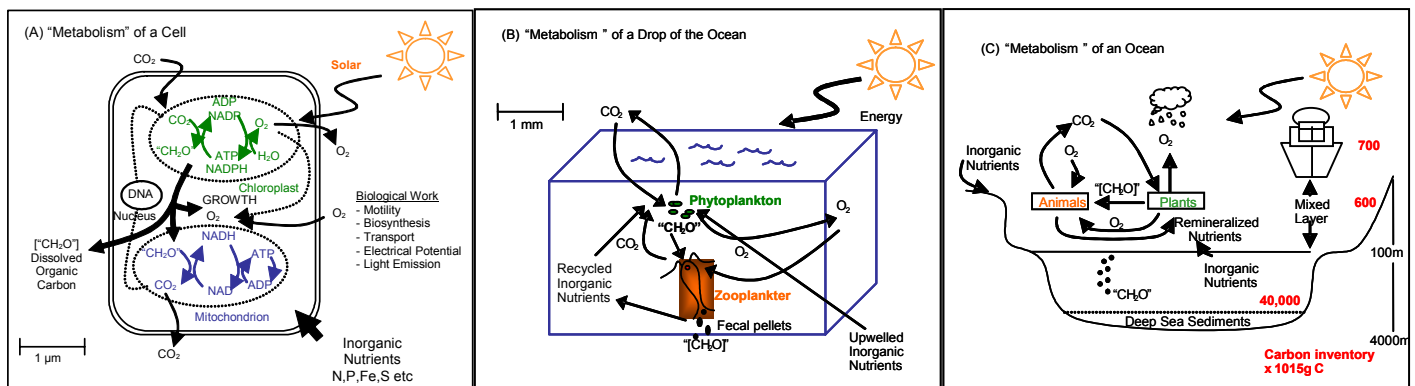
- I. Scale
- II. Definitions
  - A. Terms to describe productivity
  - B. Residence times and turnover rate
- III. Distribution on the Earth
- IV. Terrestrial Productivity
  - A. Limiting factors
  - B. Measurement

### MOVIE NIGHT:

Monday 9/15 @ 7:30pm

"Cane Toads"

### I. Scale



## II. Definitions

### A. Terms to describe Productivity

**gross primary productivity (GPP)** = rate of conversion of CO<sub>2</sub> to organic carbon per unit surface area

Units: g C m<sup>-2</sup> year<sup>-1</sup>, or Kcal m<sup>-2</sup> year<sup>-1</sup>

**gross primary production** has units of g C year<sup>-1</sup> for a lake, forest, field, etc.

**respiration by autotrophs (R<sub>A</sub>)** = how much energy or carbon is used for plant metabolism

**net primary production (NPP)** = GPP – R<sub>A</sub> = how much energy or carbon is stored as biomass

**respiration by heterotrophs (R<sub>H</sub>)** = how much energy or carbon is used for heterotroph metabolism

**net community production (NCP)** = GPP – R<sub>A</sub> – R<sub>H</sub> = NPP – R<sub>H</sub>

**photosynthetic efficiency (PE)** = 100\*(incident radiation converted to NPP)/(total incident radiation)

n.b. We're using energy and (reduced) carbon interchangeably. Conversion: 39 kJ per g C

### B. Residence times and turnover rates

f = flux (mass/area/time). use GPP (how much is entering the system)

M = mass (biomass/area)

**Mean residence time (MRT)** = M/f = (g/m<sup>2</sup>) / (g/m<sup>2</sup>/year) = years

**Fractional turnover (k)** = 1 / MRT \* 100 = % turning over each year

### Study Questions:

1. What is the difference between net and gross primary productivity? What is the difference between net community productivity and net primary productivity? How would you measure these difference?
2. What regulates primary productivity in terrestrial? How is this reflected in the global distribution of primary production?
3. What is the turnover rate in a forest? What does it signify? How is it measured?
4. What is functionally and physiologically similar about phytoplankton and trees? What is different?
5. How will increases in atmospheric CO<sub>2</sub> affect global productivity?
6. Discuss the principles behind remote sensing to terrestrial productivity. What limits the quality of the data?
7. Describe 2 strategies plants have developed to deal with low water availability.
8. According to Noble and Dirzo, human domination of forests extends beyond plantations and actively managed lands. In what other ways do humans alter forest ecosystems, and how do the authors recommend minimizing the detrimental impacts?