Lecture 18 Productivity and Food Webs

March 16, 2005

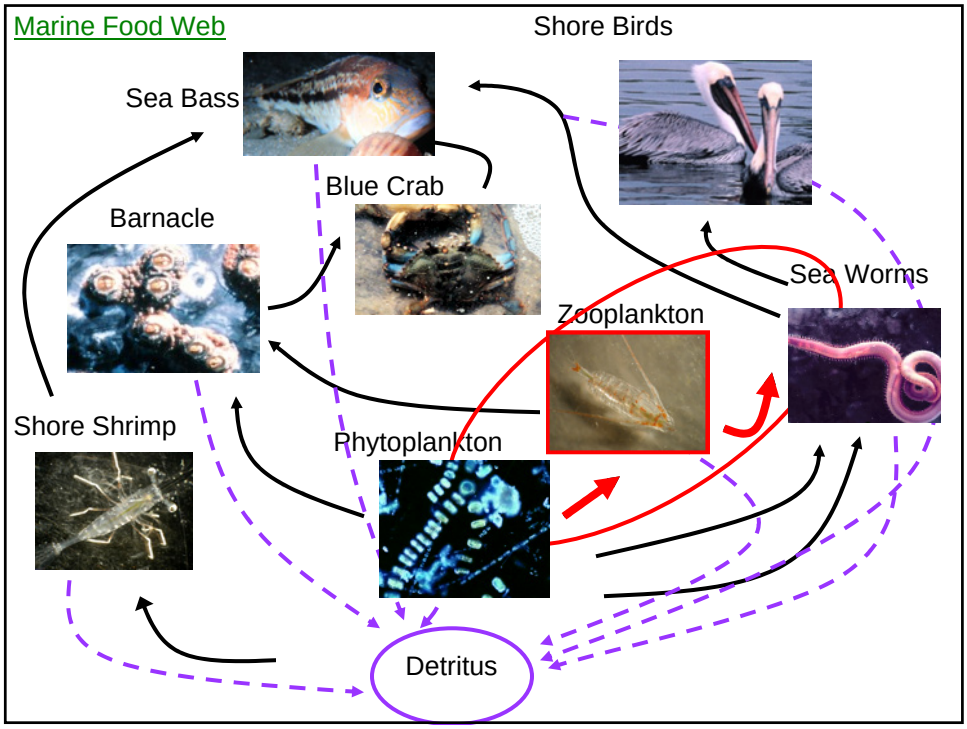
Photosynthesis and Respiration on ecosystem scales

- *Analysis of global productivity*
- *Energy flow through trophic levels and ecosystems*
- *Three weeks in the life of a food web (DVD)*

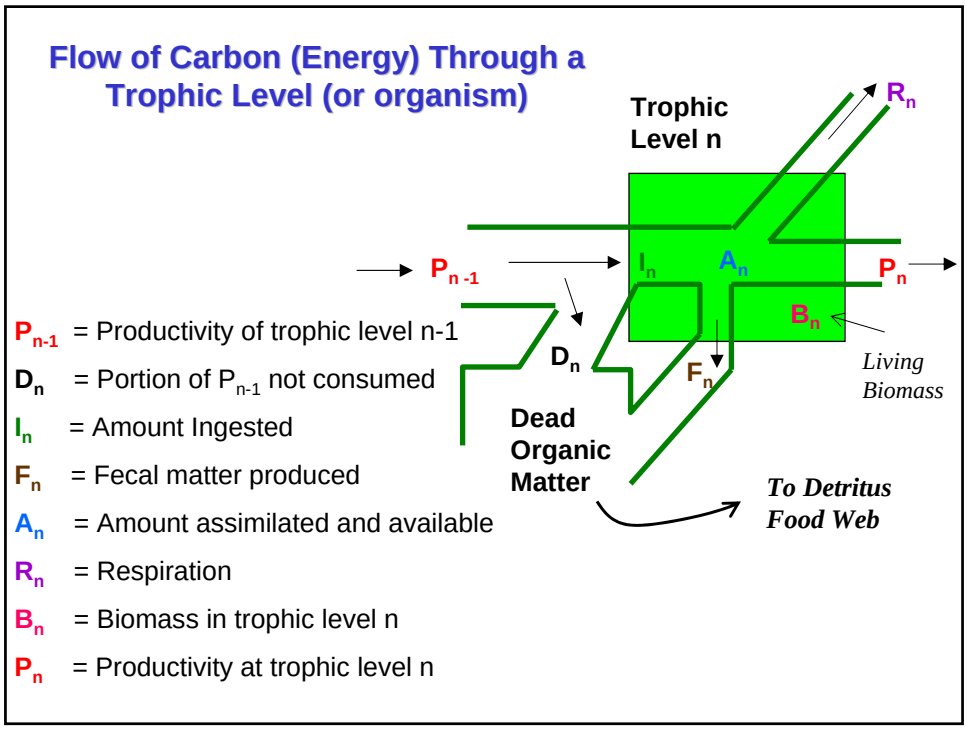
World Net Primary Productivity
(Rounded Estimates)

Ecosystem	NPP ($g\ m^{-2}\ y^{-1}$)	World NPP ($x10^{15}\ g\ y^{-1}$)	Biomass ($g\ m^{-2}$)	World Biomass ($x10^{15}\ g$)
Desert	50	2	720	15
Grassland, etc.	500	25	4000	125
Cultivated Land	1000	10	1000	14
Moist Forest	1000	40	30,000	900
Tropical Forest	2000	40	45,000	750
LAND TOTAL		**177**		**1804**
Estuaries	2000	4	1500	2.6
Continental Shelf	500	10	20	.3
Open Ocean	100	40	3	1.0
MARINE TOTAL		**54**		**3.9**

World NPP = NPP × ∑Area
World Biomass = Biomass × ∑Area



All photos taken from the National Oceanic and Atmospheric Administration at: http://www.noaa.gov/.



Ecological Efficiencies

Exploitation Efficiency (EE)

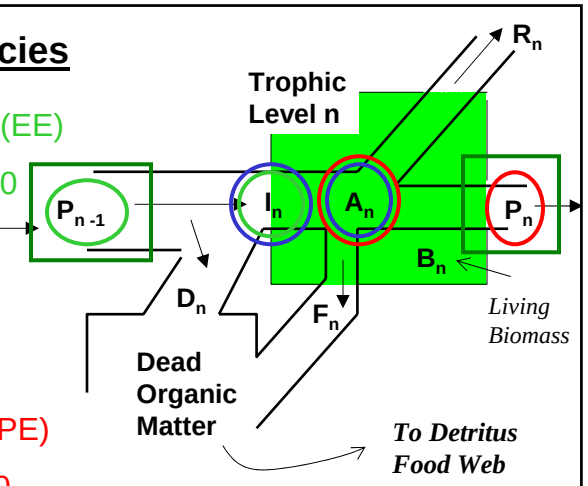
$EE = I_n / P_{n-1} \times 100$

Assimilation Efficiency (AE)

$AE = A_n / I_n \times 100$

Production Efficiency (PE)

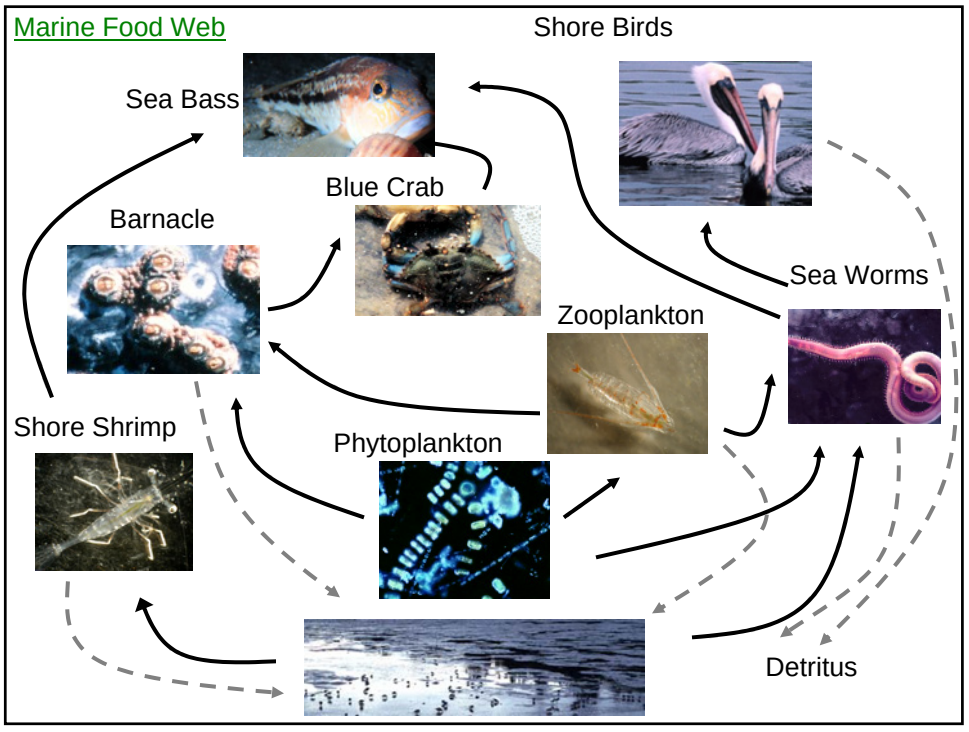
$PE = P_n / A_n \times 100$



Ecological Efficiency = (EE)(AE)(PE)

$= P_n / P_{n-1} \times 100$

$\approx$ 10 % to 20 %



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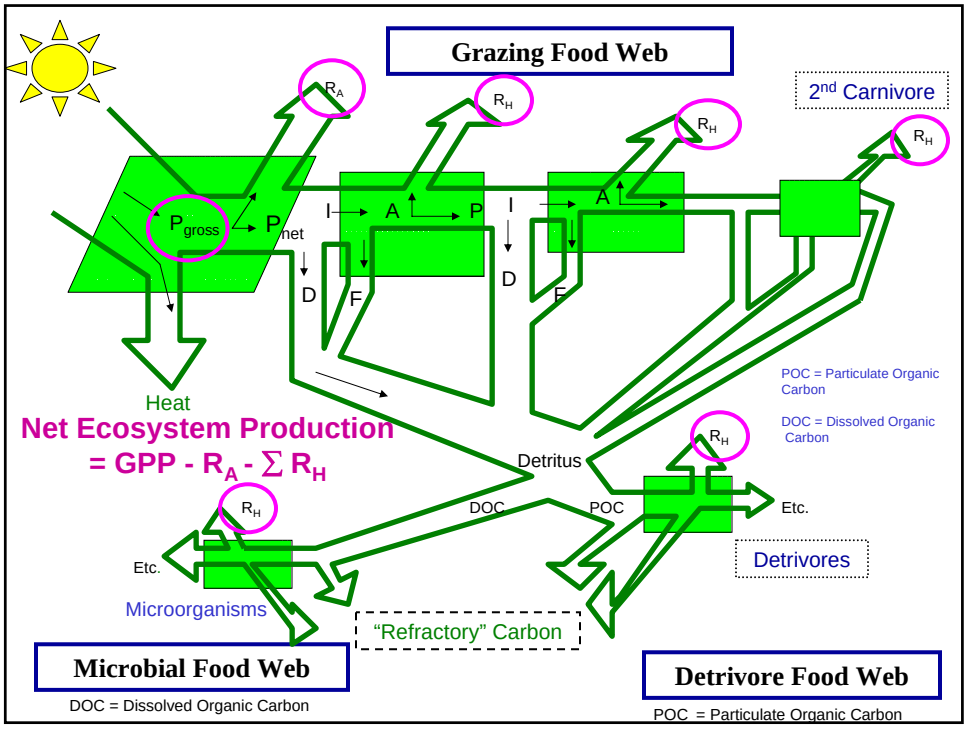
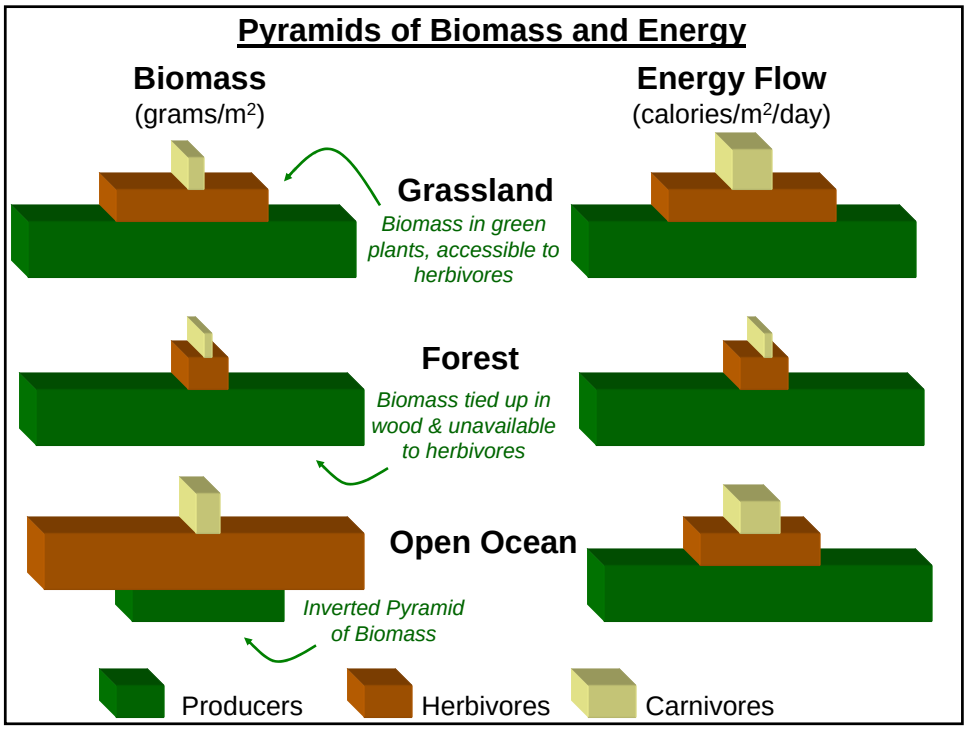

Grazing Food Web
2nd Carnivore
R_A
R_H
P_{gross}
P_{net}
I
A
P
D
F
Heat
Net Ecosystem Production
= GPP - R_A - ∑ R_H
POC = Particulate Organic Carbon
DOC = Dissolved Organic Carbon
Detritus
DOC
POC
Etc.
Detrivores
Microorganisms
"Refractory" Carbon
Microbial Food Web
Detrivore Food Web
DOC = Dissolved Organic Carbon
POC = Particulate Organic Carbon


Pyramids of Biomass and Energy
Biomass
(grams/m²)
Energy Flow
(calories/m²/day)
Grassland
Biomass in green plants, accessible to herbivores
Forest
Biomass tied up in wood & unavailable to herbivores
Open Ocean
Inverted Pyramid of Biomass
Producers
Herbivores
Carnivores

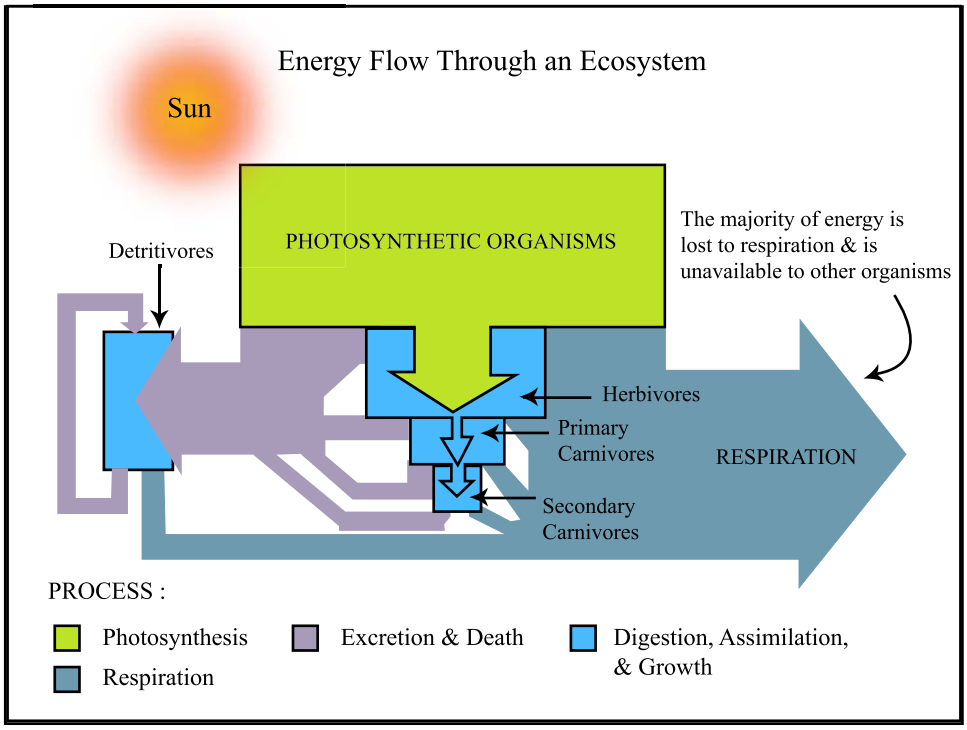


Figure by MIT OCW.

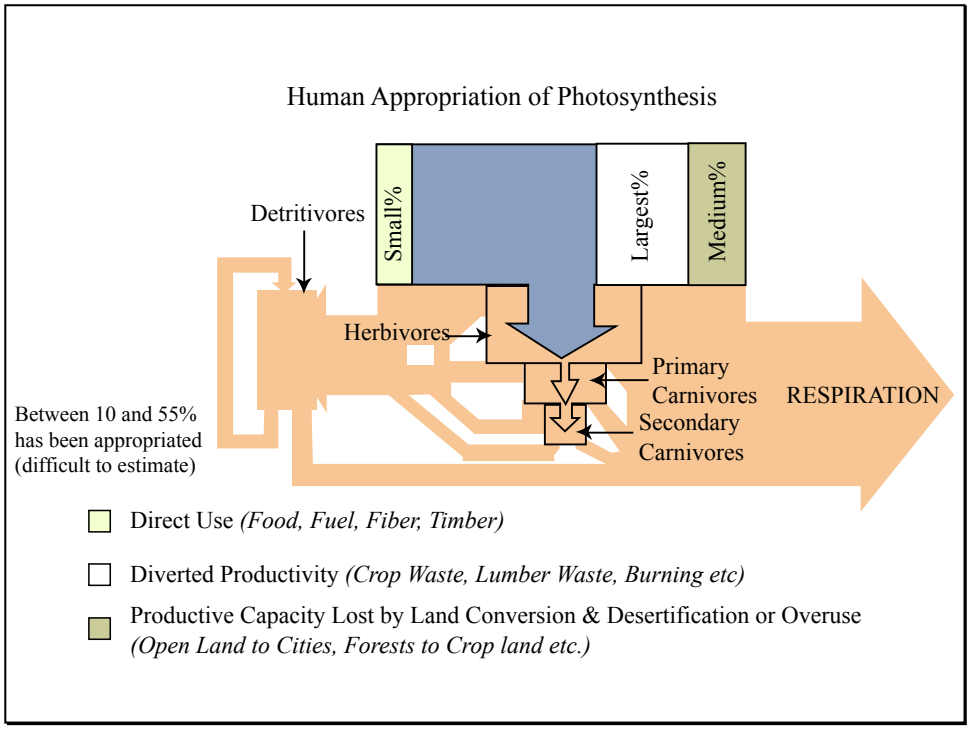


Figure by MIT OCW.

Blue Planet DVD
Three weeks in the life of a Marine Food Web

Think About:

- The massive amount of energy and carbon the phytoplankton must be processing to support such a diversity and biomass at higher trophic levels
- How the information in DNA could be controlling all of these complex processes