Lecture outline

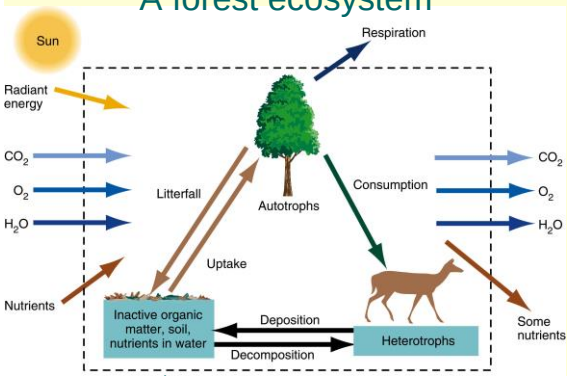
- Description of ecosystems
- Primary production (vs. biomass)
  - Controls on primary productivity
  - Food webs
- Secondary productivity
  - Energetic efficiencies
- Energy flow through ecosystems

What's an ecosystem?

- ??
- Coined by Tansley in 1935
- Focuses on energy flow and nutrient cycling
  - What's energy flow?
- Can *you* be considered an ecosystem?

Arthur Tansley

A forest ecosystem



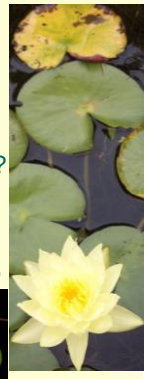
Energy and thermodynamics

- What is energy?
- 1st law: energy cannot be created or destroyed; it is transformed or moved
  - Eco. example?
- 2nd law: transfer of energy is accompanied by a loss of energy as waste; entropy, or disorder, is increased
  - Eco. example?
- Useful here because…

Biomass vs. Productivity

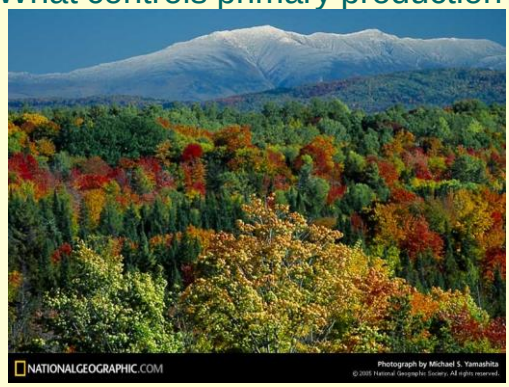
- energy/space vs. energy/space/time

Primary production



- *Energy produced by ?? (*mostly)
  - = autotrophic production
  - = carbon fixation
- Gross primary production (**GPP**) = ?
- Net primary production (**NPP**) = ?
- Is GPP or NPP a good measure of what is available to consumers (i.e., heterotrophs)?

What controls primary production?



Environmental controls of 1º production (1)

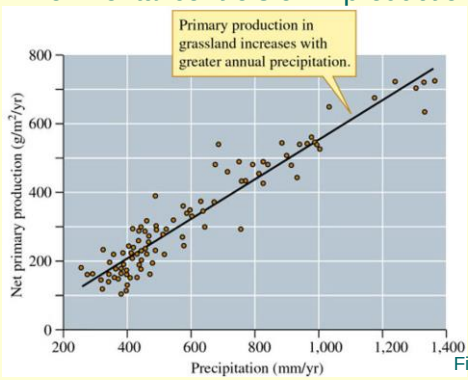


Fig. 18.3

Environmental controls of 1º production (2)

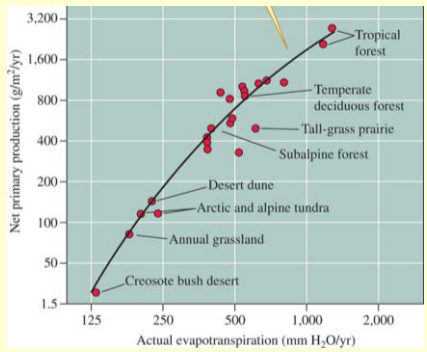
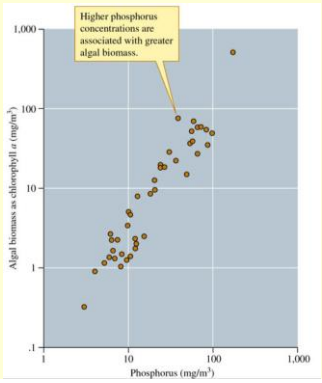
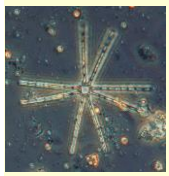


Fig. 18.2

Environmental controls of 1º production (3)

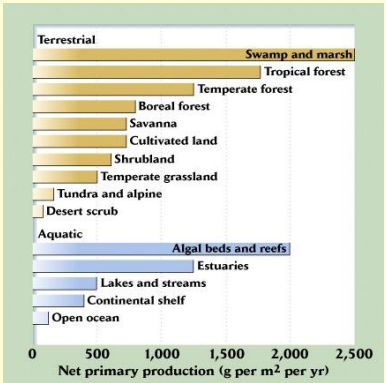




Lake phytoplankton

Fig. 18.6

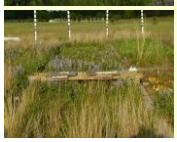
NPP by ecosystem



Environmental controls of 1° production (4)





- FACE experiments

Environmental controls of 1° production (5)

Human Appropriation of the Products of Photosynthesis

Nearly 40% of potential terrestrial net primary productivity is used directly, co-opted, or foregone because of human activities

Peter M. Vitousek, Paul R. Ehrlich, Anne H. Ehrlich, and Pamela A. Matson

BioScience 1986

Table 4. High calculation of net primary productivity (NPP) co-opted by humans: additions to Table 3 from processes that co-opt or degrade NPP.

Process	Amount (Pg)
Previous terrestrial total (Table 3)	40.6
Decreased NPP in agriculture	9.0
Conversion of forest to pasture	1.4
Desertification	4.5
Loss to human areas	2.6
Total terrestrial	58.1
Percent terrestrial co-opted or lost (58.1/149.8)	38.8
Percent terrestrial plus aquatic co-opted or lost [60.1/(149.8 + 92.4)]	24.8

Environmental controls of 1º production (6)

Trophic cascades

Stephen Carpenter
&
James Kitchell

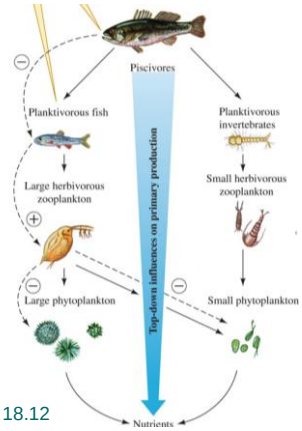
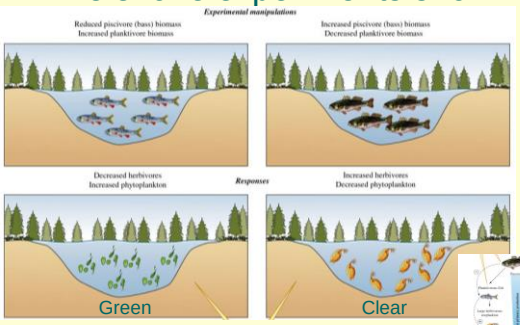


Fig. 18.12

Whole-lake experiments show…



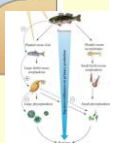


Fig. 18.14

Management implications?

A complementary approach

- What if abundance, biomass, and trophic levels are not enough to describe the importance of a species to a community or an ecosystem?

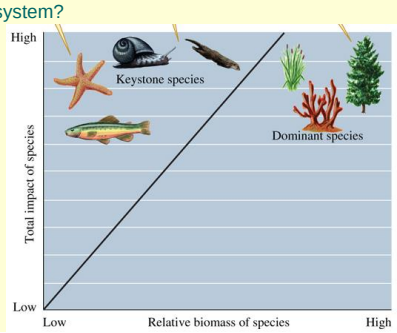


Fig. 17.17

Food web with *Pisaster*

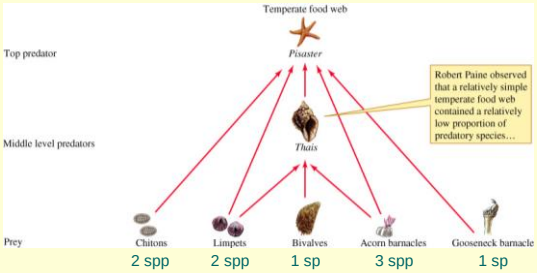


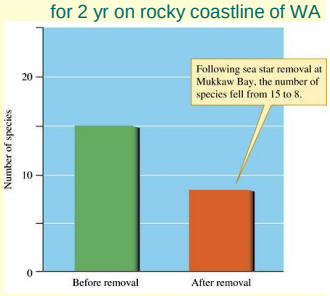
Fig. 17.9, top

Is *Pisaster* a keystone species?

- Explain these results

Removed sea stars each week for 2 yr on rocky coastline of WA

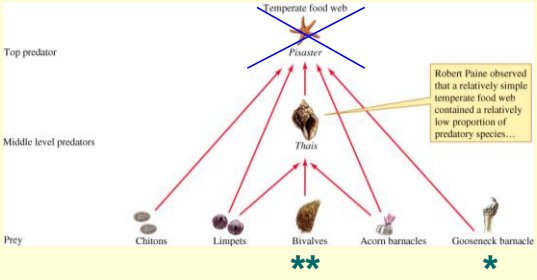
Robert Paine vs. *Pisaster*



Control plot *still* had 15 spp

Fig. 17.10, top

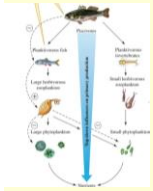
Food web withOUT *Pisaster*



Limiting resource?

Fig. 17.9, top

Bridging trophic cascades & food webs



- If we combine our understanding of food webs and the existence of trophic cascades, what do we learn?
- Two predictions:
  - Even number of trophic levels emphasizes roles of consumers
  - Odd number of trophic levels encourage "the world to be green."

HSS (1960)

- Bottom-up vs. top-down regulation

Secondary production

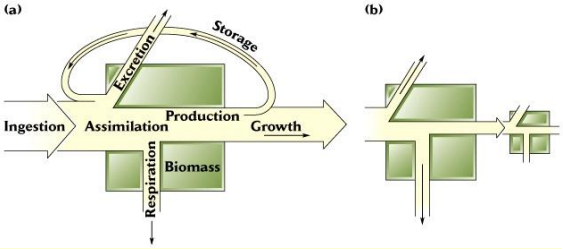
- Production by ?
- Practically speaking, it's all 'net' secondary production
- In one measurement, provides two important pieces of information:
  - individual growth
  - population survivorship

Secondary production (2)

- So, how do you make 2° production?
- P = C – R – (F + U)

Asian palm civet

Energy flow



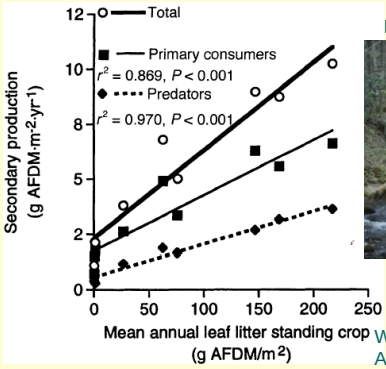
How efficient are these processes? (1)

- **Assimilation efficiency** =
  Food assimilated / food consumed
  - *Measures how effective the ingested food is made available for different bodily needs*
- Differs by type of food:
  - Leaf-eating insects: AE may be 10 – 20%
  - Predatory insects: AE may be 70% or more
- Differs by organism:
  - Broad averages
    - Endotherm: AE = 78%
    - Ectotherm: AE = 42%

How efficient are these processes (2)?

- **Net production efficiency** =
  Production / food assimilated
  - *Measures how effective the assimilated food is converted to new tissue and reproduction*
- Differs less by type of food:
  - Stream insects: NPE = 50%
- Differs by organism:
  - Broad averages
    - Endotherms: NPE = 2.5%
    - Ectotherms: NPE = 45%

Environmental controls of secondary production

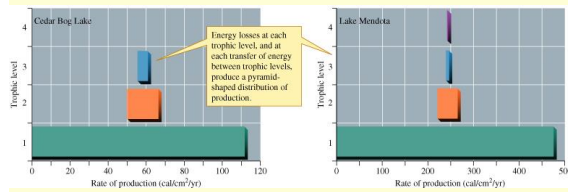


Headwater streams

Wallace et al. (1999)
Also see Fig. 18.22

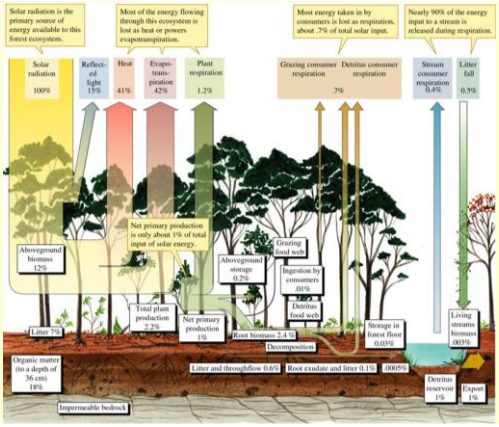
Trophic levels

Trophic or Ecological pyramids



Raymond Lindeman (1942)

Fig. 18.18



Putting it all together