Primary focus of course to date: response of organismal groups to increased CO_2 levels or warming

Remainder of course focuses on responses of ecosystems to climate change:

- High levels of complexity. Why?
- How can we effectively study such complex problems?
- Is this a problem worth studying (spending your tax dollars)?

Students in Bio 325 (Fungal Biology) studying the role of fungi in an oak-hickory forest at CERA →

Thinking about organisms functioning within ecosystems?

Individuals of a particular species (genotypes)

Populations (interbreeding genotypes of a particular species)

Communities (of interacting species)

Ecosystems (communities interacting with abiotic variables)

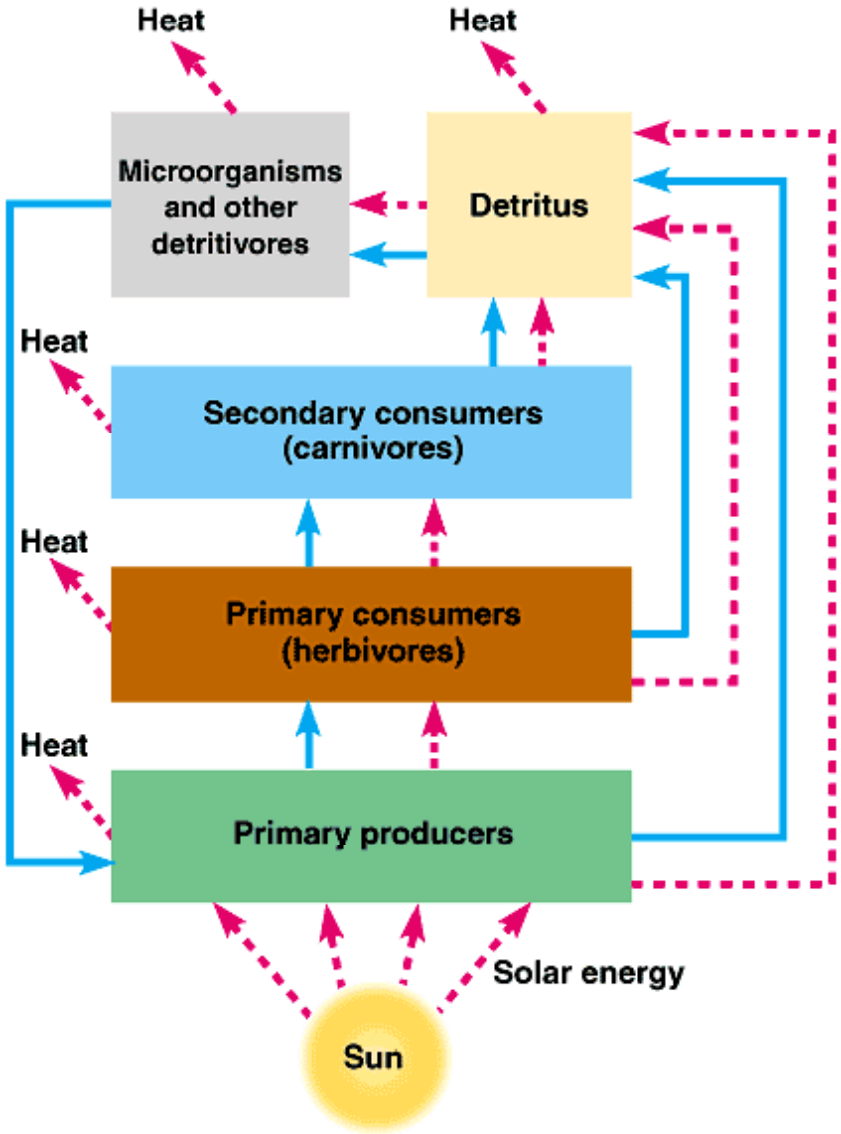
- commonly addressed in terms of energy flow and nutrient cycling

How can we conceptualize energy flow and nutrient cycling in ecosystems?

- **trophic dynamics** (feeding relationships)

  – defined by Lindeman (1942) in

"The trophic dynamic aspect of ecology".



1. Energy flow through ecosystems
2. Nutrient cycling within ecosystems

Energy flow through ecosystems –

- what's relevant to our study of the effects of climate change? 3 questions:

1. What ultimately determines an ecosystem's energy budget?

Primary production

Some terms to know:

Gross primary production (GPP): amount of light energy converted to chemical energy by photosynthesis

Net primary production (NPP): GPP – plant respiration

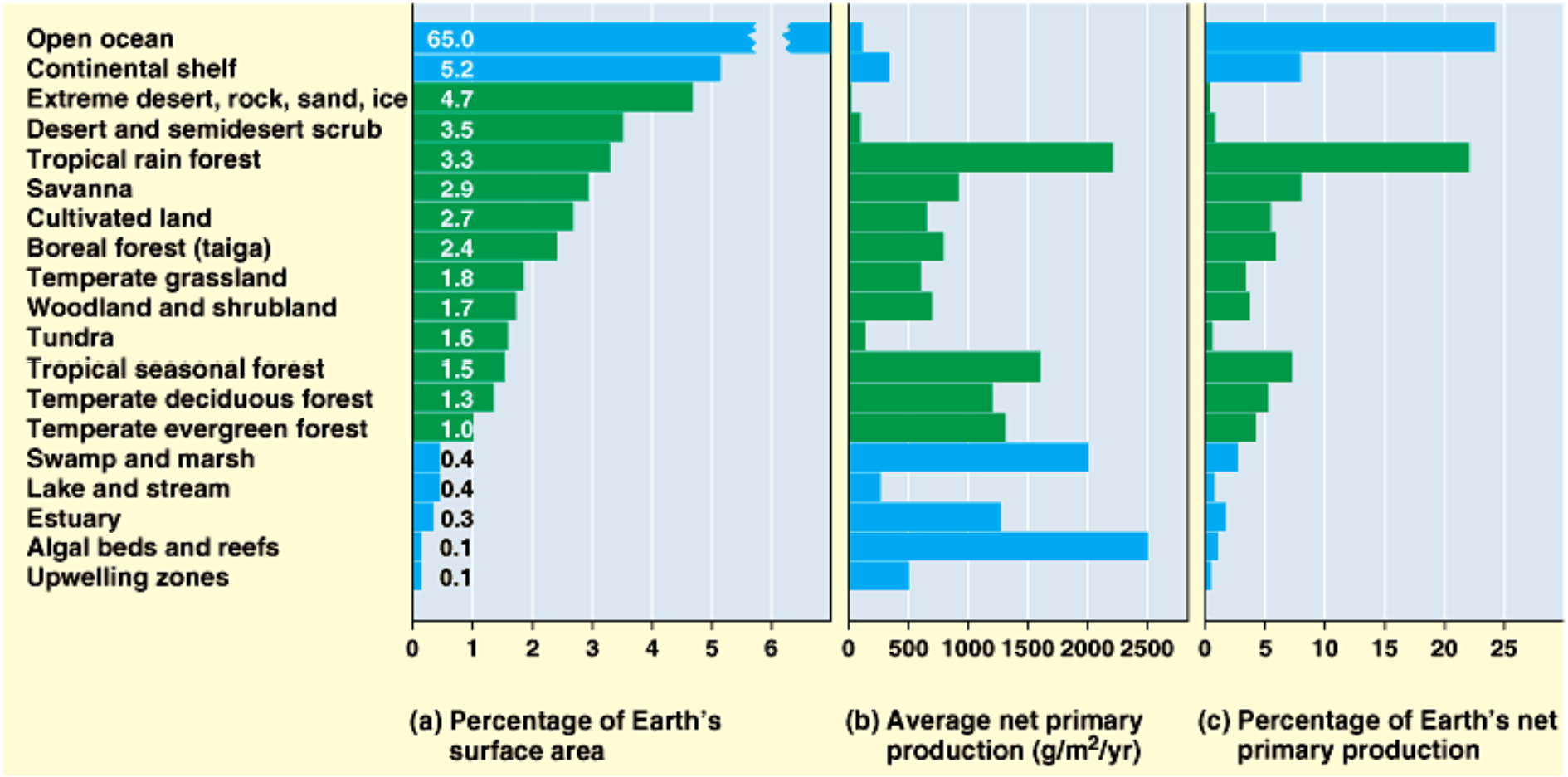
($J/m^2/year$)

Biomass (a more common expression of NPP): NPP added each year ($g/m^2/year$)

Standing crop: total biomass of primary producers

Which ecosystems are most productive?

Which ecosystems contribute the greatest proportion of NPP?



2. What abiotic factors determine levels of primary production in ecosystems?

i.e. what abiotic factors limit growth of plants?

Terrestrial environments:

Water availability (precipitation)

Temperature (soil and/or air)

Limiting essential nutrients: typically N and P

Aquatic environments:

Light

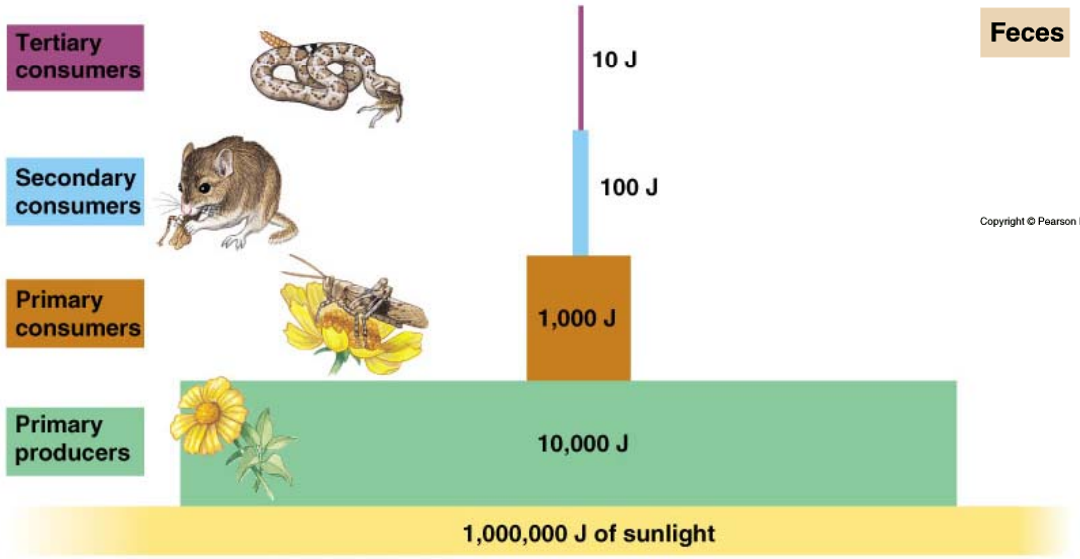
Limiting essential nutrients: typically N and P

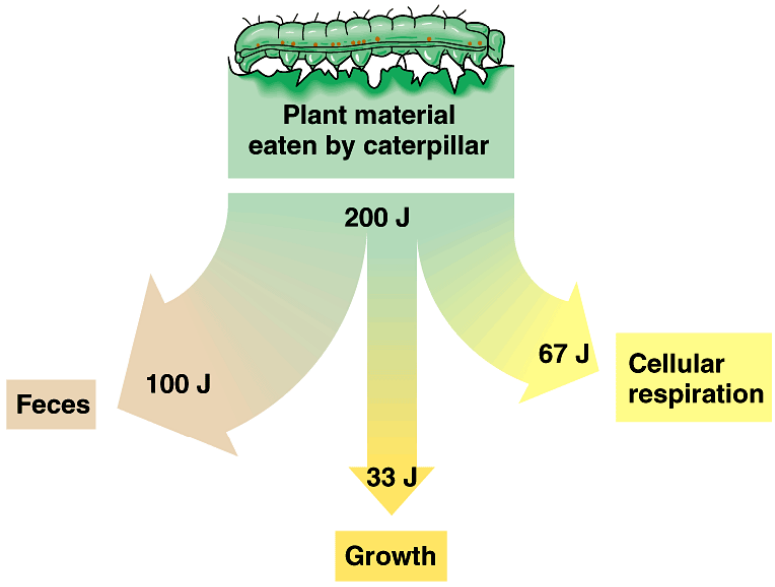
Temperature

3. What determines the number of trophic levels in an ecosystem?

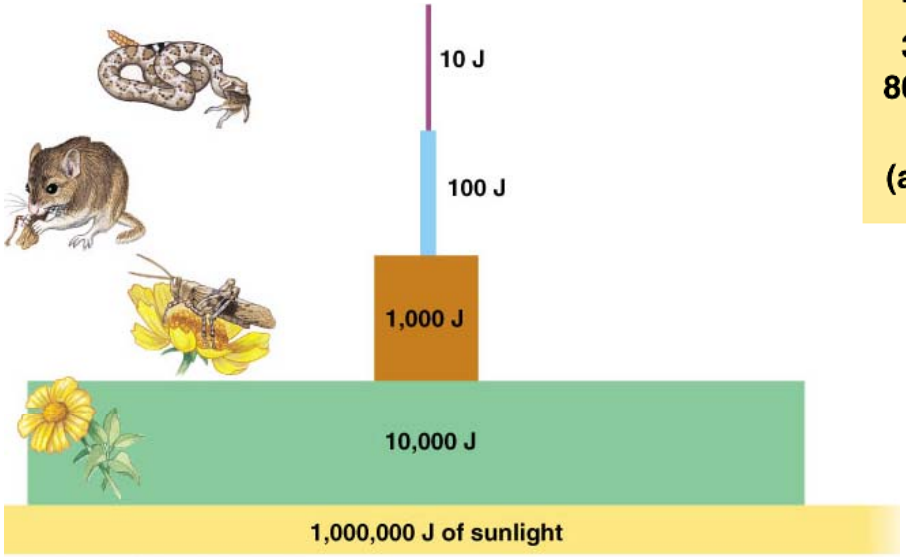
- NPP

- efficiency of consumers (<20%)

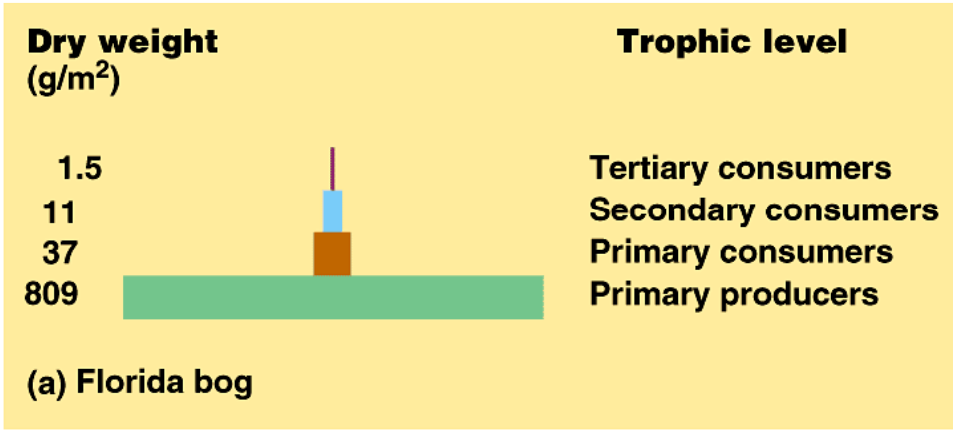




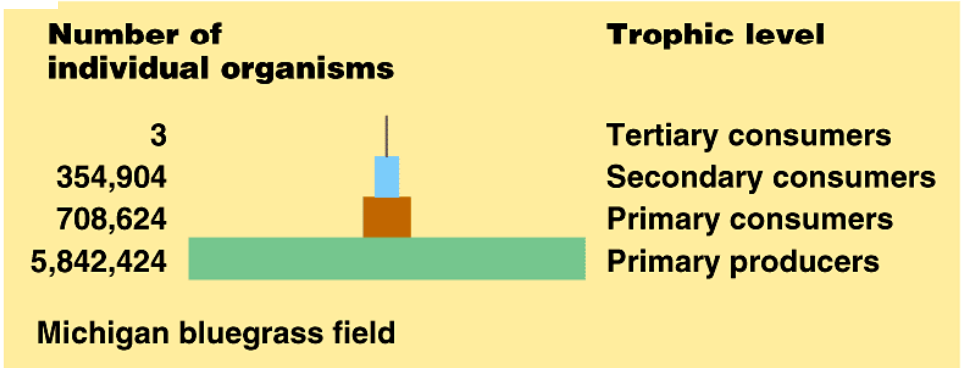
Three different ways to think about trophic dynamics:



ucation, Inc., publishing as Benjamin Cummings.



Pyramids of production, biomass and numbers



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Predicting the influence of wolf-provided carrion on scavenger community dynamics under climate change scenarios

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Abstract

Climate change poses an immediate threat to the persistence and distribution of many species, yet our ability to forecast changes in species composition is hindered by poor understanding of the extent to which higher trophic-level interactions may buffer or exacerbate the adverse effects of warming. We incorporated species-specific consumption data from 240 wolf-killed elk carcasses from Yellowstone National Park into stochastic simulation models to link trends in the El Niño Southern Oscillation (ENSO) to food procurement by a guild of scavengers as a function of gray wolf reintroduction. We find that a shift in ENSO towards the El Niño (warming) phase of the cycle coincident with increasing global temperatures reduces carrion for scavengers, particularly those with strong seasonal patterns in resource use such as grizzly bears. Wolves alleviate these warming-induced food shortages by rendering control over this crucial resource to biotic rather than abiotic factors. Ecosystems with intact top predators are likely to exhibit stronger biotic regulation and should be more resistant to climate change than ecosystems lacking them.

Key words: *Canis lupus*, climate change, El Niño, ENSO, global warming, kleptoparasitism, stability, trophic, Yellowstone

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