Community Ecology

Evolution and species interactions

Dr. Brian M. Napoletano

University of Detroit Mercy
Department of Biology
Biology 1030

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Drought threatens way of life for Texas ranchers

`http://goo.gl/wkaqC`

- Most extreme drought in US history
- Already cost $5.2 billion in livestock and crop losses
- Wildfires have burned 3.7 million acres (roughly Connecticut)
- 80% of the state experiencing an “exceptional” drought
- Primary culprit is believed to be La Niña

Weather disasters keep costing U.S. billions this year

`http://goo.gl/P7biS`

> *But given the variety and violence of both short-term weather events and longer-term effects like a Southwestern drought that has lasted years, more scientists say climate itself seems to be shifting and weather extremes will become more common.*

Three simple ways to model trophic levels

1. Pyramid of numbers
2. Pyramid of biomass
3. Pyramid of energy

Pyramid of numbers

- Reflect the numbers of organisms required to sustain organisms at each trophic level
- Measures organisms' relative abundance
- Some groups of primary consumers consist of large numbers of smaller individuals, i.e. inverted pyramid

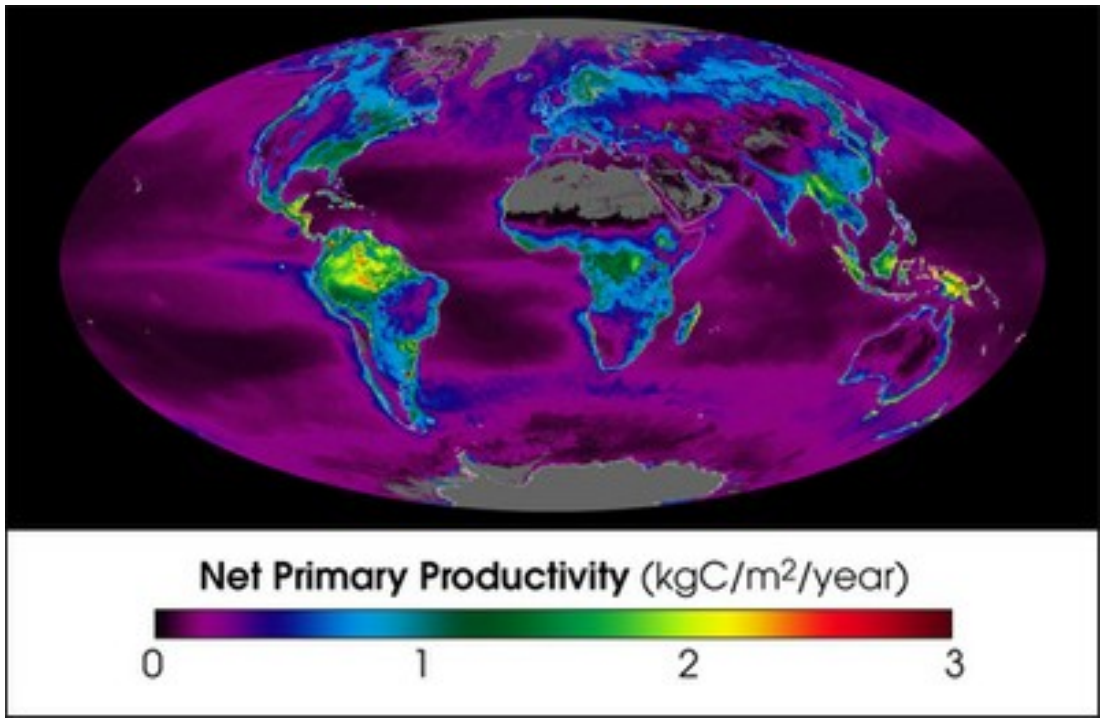
Pyramid of biomass

- Provide a standardized measure of flows between trophic levels
- Reflect the amount of energy fixed by different trophic levels at a particular point in time
- Comparative resource requirements of tertiary consumers become apparent, and can be standardized in units of, e.g., vegetation

Pyramid of energy

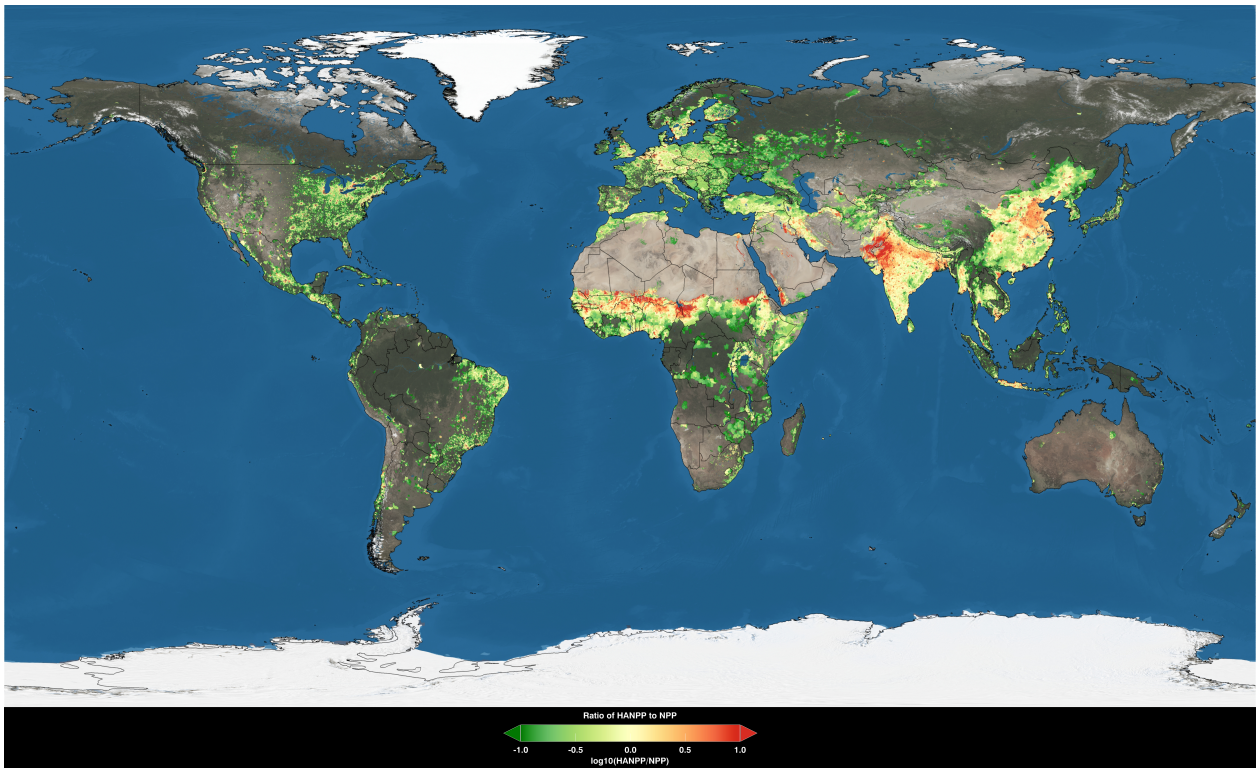
- Reflect actual energy flows between trophic levels
- Losses to entropy can also be measured, significance becomes apparent
- Can be used to compute energy budgets

Net Primary Productivity



$$\text{NPP} = \text{GPP} - \text{Plant Respiration} \quad (1)$$

Human Appropriation of Net Primary Productivity



See also: Vitousek et al. (1986); Imhoff et al. (2004); Haberl et al. (2007)

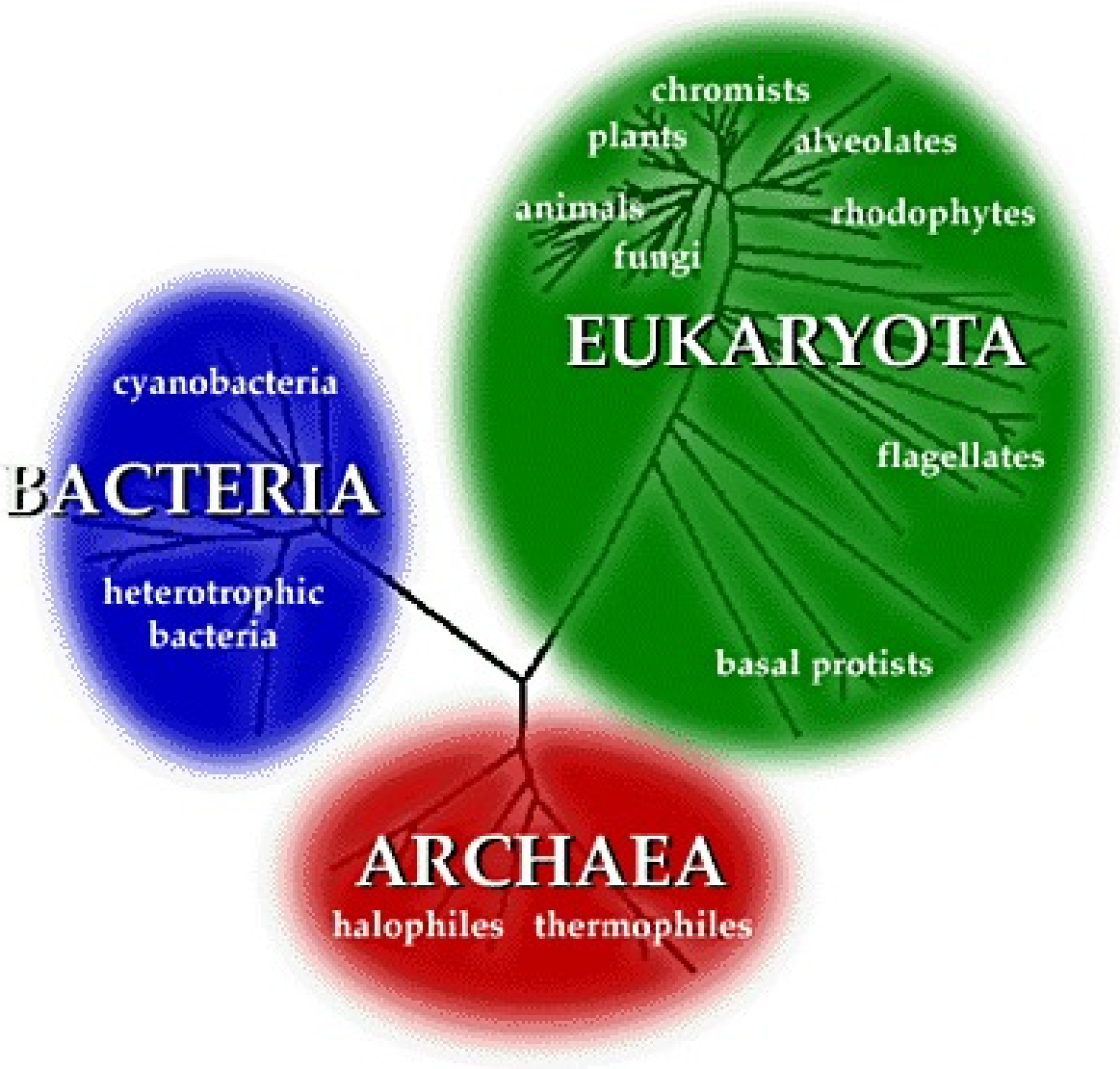
Natural selection

1. Above-replacement reproductive capacity
2. Heritability of key traits
3. Limits on population growth
4. Differential reproductive success

Modern synthesis

- The gene as the primary transmission mechanism
- Mutation as the primary source of variation
- Coevolution
  - *Mutual Aid* (Kropotkin, 1902)
  - May have been responsible for evolution of the cell (Margulis, 2000)
- Demographic stochasticity/ecological drift (Engen et al., 1998; Hubbell, 2001)

Three domains of life



Standard classification hierarchy

- Domain
- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species

Dreadful Kings Play Chess On Fancy Golden Stools

Ecological niche

- Multidimensional phase space defined by a species' resource requirements
- Condition actually constraining population size is the limiting factor (less than needed or more than tolerated)
- Niche that a species could theoretically occupy is its fundamental niche
- Actually occupied niche is the realized niche
- Are communities dominated by niche-assembly or dispersal-assembly rules?

Keystone species

- Species that significantly affects the rest of the community in disproportion to its relative abundance
- e.g. Wolves in Yellowstone Park, Sea Otter, Grizzly Bear, Beaver

Competition

- Interspecific vs. intraspecific competition
- Traditionally treated as the most important interaction, now recognized as one of many
- Competitive exclusion
  - Resource partitioning
  - Intermediate disturbance & non-equilibrium dynamics (Hutchinson, 1961; Huston, 1979; Tilman, 2007)

Mutualism

- Both species benefit from the interaction
- Removal of one species has detrimental effect on other
- e.g. mycorrhizae

Commensalism

- One species benefits, the other is unaffected
- Removal of beneficial species has detrimental effect on other, but not vice versa
- e.g. epiphytes on tropical trees

Parasitism

- One species benefits at the expense of another
- Removal of parasitic species has beneficial effect on host
- Loss of the host (prior to reproductive cycle) has detrimental effect on parasite
- Frequently not fatal, but can weaken host response to other stresses
- Parasites that trigger disease and death called pathogens
- e.g tapeworm, crown gall bacteria

Predation

- One species consumes the other (or most thereof)
- Capture prey through pursuit and ambush
- Consumers are predators

Evolutionary arms race

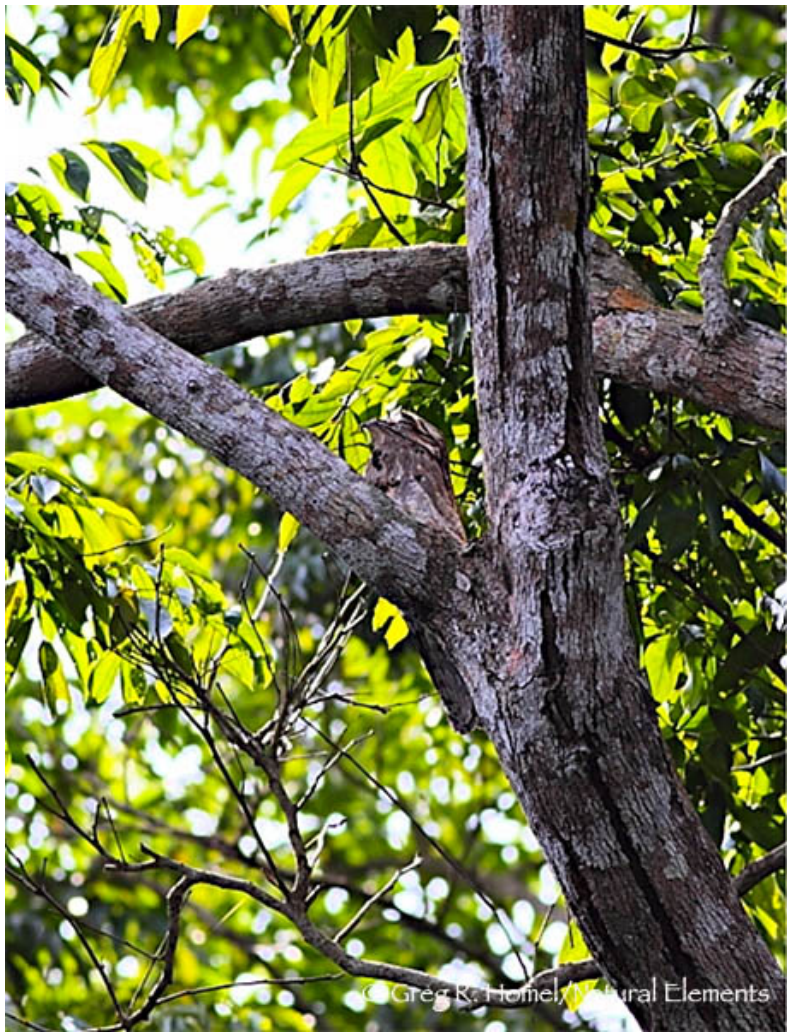
- Deterrence
  - Impose (or imply) cost on potential predator
  - Bright, bold coloration frequent
  - Mimicry by freeloaders
  - e.g. hornet, cacti, Monarch Butterfly
  - Predator adapts through physiological or behavioral changes
- Avoidance
  - Avoid detection by potential predator
  - Cryptic coloration frequent
  - e.g. Potoo, Walking Stick
  - Predator adapts through sensory or behavioral changes
- First predator to adapt gains competitive advantage

Asian Giant Hornet

Nopal(?) Cactus

Monarch Butterfly

Potoo



Walking Stick

Species richness

- Number of species in a community/ecosystem/habitat
- Structural complexity
- Ecotone/edge effects
- Disturbance regime
- Environmental stress
- Dispersal

Resilience and resistance

- Resistance is ability to withstand disturbances
- Resilience is ability to recover from disturbances
- Together, confer degree of community stability

Primary succession

- Occurs on non-vegetated or de-seeded land
- Undertaken by pioneer species

Secondary succession

- Occurs on de-vegetated or primary successional land
- Undertaken by non-pioneer (i.e. established) species

Succession

Questions to consider for Friday's discussion

- Do you think all aspects of ecosystems can be reduced to monetary values? If not, then what features cannot be monetarized? If so, then how would you address intangible aspects?
- Do you agree with the first author's (the one in favor of monetarization) assertion that distributional factors are unimportant? Why or why not?
- As the other author argues, are knowledge of many ecosystem services is incomplete. Can this fact be reconciled with the assumptions underlying the logic of monetarization? What about the fact that some services are not exchangeable?

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