Ecological Components of Biodiversity

I. Measuring Biodiversity
II. Ecological components of Biodiversity
III. Patterns of Biodiversity
IV. Biodiversity Crisis

II. Measuring Biodiversity
A. Species richness
B. Alpha diversity
C. Beta diversity
D. Gamma diversity
E. Diversity Indices Shortcomings

A. Species richness [S]
- Number of different species
- Relative abundance of different species
- **Endemism** – species occurring in a restricted locality
- **Ecological distinctiveness** of different species, e.g., functional differentiation
- **Evolutionary distinctiveness** of different species

Endemics, generalists & specialists
- **Habitat generalists**
- **Habitat specialists**
- **Endemism and rarity**
Fundamental vs. Realized Niche

- Fundamental niche: Occupied range of conditions that an organism can tolerate and use for growth and reproduction.
- Realized niche: The portion of the fundamental niche that is actually utilized by the organism.

Competitive exclusion principle

B. alpha diversity

- # of species in a certain community, “the species richness of standard sample sites”
  - Heterogeneity (richness and relative abundance)
  - Evenness? [E]
  - Distribution pattern?
Diversity index = mathematical measure of species diversity in a community. Provides more information about community composition than simply species richness.

- Simpson Index - It takes into account the number of species present, as well as the relative abundance of each species. It represents the probability that two randomly selected individuals in the habitat belong to the same species.
  
  \[
  D = \frac{N(N-1)}{\sum n(n-1)}
  \]

  - \(1 - D\) the index represents the probability that two individuals randomly selected from a sample will belong to different species.

- Shannon Diversity Index – takes into account the proportional abundance of different species and the eveness.
  
  \[
  H' = -\sum p_i \ln(p_i)
  \]

  - Most widely used index in community ecology
  - The higher the number the greater the diversity

C. Beta diversity

- Diversity associated with changes in sample composition along an environmental gradient.
- Measures the rate of change in species composition across a landscape.
- \(S/\alpha - 1\)
- Can determine the following:
  - Are species sensitive to changing environmental conditions?
  - Are associations of species interdependent?
  - How does time/disturbance affect biodiversity at a particular site?

D. Gamma diversity

- # species in a large region, or on a continent
- Used to compare large areas that encompass diverse landscapes or a wide area
- Landscape scale where diversity also controlled by site-to-site variation in ecological controls, disturbance regime, habitat diversity, dispersal
E. Diversity Indices Shortcomings

- Richness & evenness can be inversely related
- Mathematical measures don’t correspond to ecological importance
- Habitat fragmentation increases diversity, "edge effect"

A. Ecology - review

Ecology & evolutionary biology are closely related sciences

- Ecologists describe how organisms respond to the environment and how organisms are distributed.
- Events that occur in the framework of ecological time (minutes, months, years) translate into effects over the longer scale of evolutionary time (decades, centuries, millennia, and longer). Ecology is the study of the interactions of organisms with other organisms and with the physical environment.

Limiting factors – determine whether an organism lives in an area

- Sometimes organisms do not occupy all of their potential range, but select particular habitats.
- Various biotic factors contribute to whether or not an organism will be found in a particular area.
- Each organism has an optimal range that it can survive.

- Oxygen – anaerobic, aerobic, aquatic
- Sunlight – light intensity, quality of light for photosynthesis, photoperiod
- Temperature – freezing/overheating, internal temperature affects metabolism
- Soil – structure, mineral composition, pH
- Water & Dissolved salts
- Climate
- Global Air movements
- Elevation
Climate, geology & geography impacts the geographic distribution of terrestrial biomes.

- **BIOME**
  - Global air patterns affect climate which determines types of vegetation present
  - Geology and climate determines soil type which also determines vegetation present
  - Geography affects biotic components as well...vertical stratification
    - mountains
    - canopy
Terrestrial Biomes

1) tropical forest
2) savanna
3) desert
4) chaparral
5) temperate grassland
6) temperate deciduous forest
7) tundra
8) polar and high-mountain ice

B. Functionality – the importance of biodiversity

- **Ecological Value:**
  - Biodiversity actually boosts ecosystem productivity & functionality where each species, no matter how small, all have an important role to play and that it is this combination that enables the ecosystem to possess the ability to prevent and recover from a variety of disasters.
  - Ecological components of biodiversity
    1) Functionality
    2) Productivity
Biodiversity is linked to productivity is linked to biodiversity…

- The more resources available (nutrients, plants or prey species) the more species are able to specialize
- The more energy available in a usable form for organisms, the more species the ecosystem can support

III. Patterns of Biodiversity:

Species-Area Relationship

- Direct relationship between species richness and area
- The number of species on an island is a constant power of the island’s area
  - Thus we can predict a decrease in species as the area or habitat decreases
Patterns of Biodiversity:

1) Global Patterns
- Species distribution affected by several factors:
  - Elevation, precipitation, climate, latitude affect species distributions
  - Tropical regions – most diverse

Spatial Patterns in Species Richness

Nature 2000 v. 405

earthworms
Lacustrine fishes

Patterns of Biodiversity cont.:

2) Regional Trends in Diversity

Biodiversity Hotspots =

http://www.biodiversityhotspots.org/xp/Hotspots/
Biodiversity Indicators:

VI. Biodiversity Crisis

- Rates of extinction v. speciation
Threatened animal species:

- Amphibians
- Invertebrates
- Fish
- Birds
- Mammals
- Reptiles

From the 2004 World Conservation Union Study:
http://www.iucnredlist.org/info/gallery2004

Already extinct:
- 352 Invertebrates
- 129 Fish
- 92 Reptiles
- 73 Mammals
- 34 Amphibians
- 86 Plants