Measuring Biodiversity

Biology/Env S 304

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Measuring Biodiversity

- Genetic Diversity
- Species Diversity
- Taxonomic Diversity
- Surveys
- Patterns in Time
- Patterns in Space
- Dimensionless Patterns

Measuring Biodiversity: Genetic Diversity

- Extremely important, but very time- and resource-intensive to measure accurately
- Focus tends to be on individual species
- Can't do this for fossils
- Of greatest utility in conservation and management of rare species
- Preservation of habitat for rare species often beneficial for other species

Measuring Biodiversity: Species Diversity

- Two main aspects: species richness and species abundance
- Species richness = the number of species in an area; often the only information available, depends on baseline taxonomic data
- Species abundance = relative commonness of species, or evenness; requires baseline ecological data

Measuring Biodiversity: Taxonomic Diversity

- Taxonomic diversity= richness of higher taxa (number of major lineages is a rough measure)
- Distinctness of evolving lineages is an important component of biodiversity (Species X is an example)
- Some assign a higher conservation value to ancient or very distinct lineages

Measuring Biodiversity: Surveys

- Ideally should combine both taxonomy and ecology
- Depends on floras (ID guides and descriptions for all plants in an area), faunas (= floras, but for animals), checklists, data from permanent plots, good natural history observations, satellite images, GIS data

Measuring Biodiversity: Surveys

- ATBI = All Taxa Biodiversity Inventory
- Some relatively large areas representing different habitats would be completely inventoried for all groups
- Analyses would reveal patterns of diversity, abundance, interactions, etc. and a baseline for assessment of biodiversity in other similar areas

Measuring Biodiversity: Patterns in Time

1) Increase in total diversity over evolutionary time

2) Succession

3) Seasonal variation

Measuring Biodiversity: 1) Increase in total diversity

- Life first evolved on Earth about 3.8 bya
- Eukaryotes appeared by 1.5-1.25 bya
- Bursts of diversification associated with new adaptations or opportunities
- Overall pattern is one of increasing diversity in evolutionary time, despite background extinctions and five mass extinction events

Measuring Biodiversity: 2) Succession

- Change after a disturbance; often species replace each other in a more or less orderly sequence
- Succession occurs in all natural communities
- Immigration and competitive displacement are fundamental processes in succession
- Creates both spatial and temporal patterns following disturbances

Measuring Biodiversity: 3) seasonal variation

- Annual cycles of diversity

- Migration, dormancy/hibernation, and endangered phenomena are included here

Measuring Biodiversity: 3) annual migrations

- Many birds, some insects migrate on an annual basis
- One study showed that up to 60% of the bird species in an Ohio forest were migratory
- In the tropics, birds will migrate seasonally up and down the mountains

Measuring Biodiversity: 3) dormancy/hibernation

- Many members of the biota disappear physiologically during the winter or drought periods
- In desert regions, annual plants exist as seeds until sufficient rain falls and then they complete their life cycles in weeks
- Lots of diversity is hidden this way

Measuring Biodiversity: 3) endangered phenomena

- Endangered phenomena = a spectacular aspect of the life history of an animal or plant species involving large numbers of individuals that is threatened with impoverishment or decline
- The species itself may not be endangered but the phenomenon is

Measuring Biodiversity: 3) endangered phenomena

- Examples include: ecological diversity associated with flooding rivers; the 17-year and 13-year cicada emergence events in North America; animal migrations; the existence of species in huge herds

Measuring Biodiversity: Patterns in Space

1) Species-Area Curve
2) Habitat Diversity
3) Latitudinal gradients
4) Areas of endemism
5) Disturbance

Measuring Biodiversity: 1) Species-Area Curve

- You will find more species if you sample a larger area
- Basic relationship remains even at different scales
- Curves may differ depending on islands vs. continents, areas with different histories
- One of the earliest-recognized relationships

Measuring Biodiversity: 2) habitat diversity

- The greater the habitat variety, the greater the species diversity
- Also, the more complex the community, the greater the species diversity
- Related to the Species-Area Curve and regional diversity

Measuring Biodiversity: 3) latitudinal gradients

- The inventory of species declines as you move away from the Equator, north or south
- More species in the tropics than in higher-latitude communities
- True for most groups; exceptions include brown algae, coniferous trees, salamanders, penguins, waterfowl
- Are analogous altitudinal and depth gradients

Measuring Biodiversity: 4) areas of endemism

- Endemic = found only in one geographic area or habitat
- Areas with a high proportion of unique species not found elsewhere are "hotspots" (areas of endemism)
- Nonrandomly distributed on Earth
- Islands often have a high proportion of endemic species (due to isolation)

Measuring Biodiversity: 4) areas of endemism

- Endemism in temperate regions is concentrated in areas of Mediterranean climate (California, South Africa, Chile)
- Patterns of endemism can vary greatly but are correlated among mammals, birds and reptiles
- Plants tend to speciate in smaller areas than vertebrates, however

Measuring Biodiversity: 5) disturbance

- Diversity peaks over intermediate disturbance levels
- Patches with very high or very low rates of disturbance will have lower diversity
- Many types of disturbance and different scales
- This pattern relies on small-scale disturbance (not mass extinctions)

Measuring Biodiversity: Dimensionless patterns

- These are patterns not rooted in space or time per se
- Examples include: reproductive rate, longevity, body mass/metabolism ratios
- Food Webs and Chains: animal diversity declines as trophic level increases, usually 3-4 trophic levels present, but 5 or 6 are rare
- Real webs tend to have relatively few omnivores