Biodiversity

The heart and soul of conservation ecology

What's biodiversity in the first place?

- Biological diversity
  - The variety of life in all its forms, and at all levels of organization.
  - The variety and relative abundance of species.
  - The genetic, taxonomic, and ecosystem variety in living organisms of a given area, environment, ecosystem, or the whole planet.
  - The structural and functional variety of life forms at genetic, population, species, community, and ecosystem levels.

What's a species?

- Several different concepts
- Typological

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What about just protecting species?

- How do you define a species?
- Isn't this obvious?
- Implications for ESA?
- What about the public?

What's a species?

- Morphological
- Biological
  - Mayr (1969)
What's a species?

**Genetic**

Genetic

Phylogenetic/Cladistic

- Synapomorphies

What's a species?

Species definitions

- What's a conservation ecologist to do?

Special kinds of species

- Keystone
- Ecosystem engineers
- Indicator
- Umbrella
- Flagship
- Vulnerable
- Economic

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http://evolution.berkeley.edu/evosite/evo/101/0History.shtml

Fig. 3.5
Special kinds of species

- Keystone
- Ecosystem engineers
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- Economic

“Rarity precedes extinction” (Darwin 1859)

Regardless of the name, how many?

<table>
<thead>
<tr>
<th>Domain/kingdom</th>
<th>Phylum</th>
<th>Number of described species</th>
<th>Number of estimated species</th>
<th>Percent described</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria</td>
<td>1,400</td>
<td>500,000</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Arthropoda</td>
<td>20,000</td>
<td>500,000</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>Plantae</td>
<td>200,000</td>
<td>500,000</td>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>Animalia</td>
<td>500,000</td>
<td>500,000</td>
<td>50</td>
<td>0.5</td>
</tr>
<tr>
<td>Fungi</td>
<td>10,000</td>
<td>500,000</td>
<td>10</td>
<td>0.5</td>
</tr>
</tbody>
</table>

And, is that all?

A realistic total #?
One famous extrapolation

How many species are there?

Some recent advances in detecting species

Alpha diversity (α)

Beta diversity (β)

Do we need them all?

Some competing hypotheses (plus null)

Describing biodiversity

Miami of Ohio agroecosystem plots & mesocosms
**α and β Diversity example**

Table 1. Characteristics of 36 transects established on the rims of six Carolinian bays at Luceo Ocean Bay Heritage Preserve. In each bay, two transects were established, one on a side rim and one on an end rim. Means are presented ± standard error, α = 8. Superscript letters indicate no significant (P > 0.05) differences between side and end transects.

<table>
<thead>
<tr>
<th>Position</th>
<th>Richness (N)</th>
<th>Beta Turner (day)</th>
<th>Area Length (HA)</th>
<th>Elevations Change (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side</td>
<td>16.7 ± 3.8</td>
<td>3.2 ± 0.8</td>
<td>4.0 ± 0.9</td>
<td>0.8 ± 0.2</td>
</tr>
<tr>
<td>End</td>
<td>21.8 ± 2.2</td>
<td>10 ± 0.3</td>
<td>4.3 ± 0.8</td>
<td>0.6 ± 0.1</td>
</tr>
</tbody>
</table>

Laliberte et al. (2007)

**Gamma diversity (γ)**

<table>
<thead>
<tr>
<th>Region 1</th>
<th>Alpha (species per mountain)</th>
<th>Gamma (species per region)</th>
<th>Beta (gamma/alpha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>7</td>
<td>1.2</td>
</tr>
<tr>
<td>Region 2</td>
<td>4</td>
<td>10</td>
<td>2.5</td>
</tr>
<tr>
<td>Region 3</td>
<td>3</td>
<td>9</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**Diversity indices**
- Combination of ________ and _____________
  - Examples: Shannon index, Simpson index
- Some issues
  - What do they really mean?
  - Describes an overall community, not ....

**Niches and competition**
- Gause’s law of competitive exclusion
- Resource partitioning leads to...

**Some explanations of biodiversity**
- Niches and competition
- Species area relationship
- Intermediate disturbance hypothesis
- Productivity

When the British biologist J. B. S. Haldane was asked by a group of theologians what one could conclude as to the nature of the Creator from a study of His creation, Haldane is said to have answered, “An inordinate fondness for beetles”.

**Species-area relationship**

**THE NONCONCEPT OF SPECIES DIVERSITY: A CRITIQUE AND ALTERNATIVE PARAMETERS**

STUART H. HUBBARD (1971)
Division of Biological Control, Department of Entomology, University of California, Riverside

Abstract. The recent literature on species diversity contains many semantic, conceptual, and idiosyncratic problems. It is suggested that, as a result of these problems, species diversity has become a meaningless concept, that the term be abandoned, and that ecologists take a more critical approach to species-member relations and rely less on information theoretic and other analogies. As multispecific collections of organisms possess numerous statistical proper-
Species-area equation

- ?
- But, ecologists often do what to the equation?
- $z$ often set to ______
- Implications for conservation?

Intermediate disturbance hypothesis

- Mechanism?
  - Connell (1978)

Productivity

Mechanism?

Diversity in 30 freshwater ponds of Michigan


But, see Adler et al. (2011, *Nature*)

Geographic trends: An old stand-by

Hotspots of diversity

- Are some places more important to protect?

<table>
<thead>
<tr>
<th>Taxa</th>
<th># of Species</th>
<th># Endemic</th>
<th>% Endemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plants</td>
<td>13,000</td>
<td>11,600</td>
<td>89.2</td>
</tr>
<tr>
<td>Mammals</td>
<td>155</td>
<td>144</td>
<td>92.9</td>
</tr>
<tr>
<td>Birds</td>
<td>310</td>
<td>181</td>
<td>58.4</td>
</tr>
<tr>
<td>Reptiles</td>
<td>384</td>
<td>367</td>
<td>95.6</td>
</tr>
<tr>
<td>Amphibs</td>
<td>230</td>
<td>229</td>
<td>99.6</td>
</tr>
<tr>
<td>Fishes</td>
<td>164</td>
<td>97</td>
<td>59.1</td>
</tr>
</tbody>
</table>

Biodiversity hotspots

- 25 hotspots; 1.4% of land cover of Earth
- Contains 44% vascular plants; 35% of 4 vertebrate groups

- 22,323 Google Scholar citations as of 2019

Myers et al. (2000)
Wait a minute. What about…

How global biodiversity hotspots may go unrecognized: lessons from the North American Coastal Plain

Table 1 (below) identifies eight sites where we sampled plants and mammals, including threatened taxa (and to what extent) near full species within the North American Coastal Plain. The eight sites are: (1) Offshore islands, Santa Cruz Island, California, (2) offshore islands, Santa Barbara Island, California, (3) coastal islands, Channel Islands, California, (4) coastal islands, Santa Cruz Island, California, (5) coastal islands, Santa Barbara Island, California, (6) coastal islands, Santa Cruz Island, California, (7) coastal islands, Santa Barbara Island, California, and (8) coastal islands, Santa Cruz Island, California. The full text of the study can be accessed on the journal’s website.

Lack of biodiversity in the highlighted areas is a concern for conservation efforts.

Cincotta et al. (2000)

Languages and hotspots

“A total of 3,202 languages, nearly half of those on Earth, currently are found in the 35 biodiversity hotspots.”

Gorenflo et al. (2012)

Humans and hotspots

- In 1995, 20% of humans (1.1 billion) live in the hotspots; growth rates there (1.8% per yr) are higher than world-wide average (1.3% per yr).

Cincotta et al. (2000)

War(?) and hotspots

- 80% of major armed conflicts between 1950 and 2000 took place in biodiversity hotspots.

Hanson et al. (2009)

Biodiversity coldspots?

- Kareiva & Marvier (2003, Amer. Sci.)
- If hotspots are so important, what about the rest—are they then coldspots?
- Any problems with hotspots?


Hotspots vs. NGO offices


Threatened mammal and bird genera
Now what should we do?

- The rest? Relative cost?