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 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?

- Several different concepts
- Typological

What's a species?

- Morphological

What's a species?

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

- Genetic

Species definitions

- What's a conservation ecologist to do?

Special kinds of species

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

Fig. 3.5

Special kinds of species

- Keystone
- Ecosystem engineers
- Indicator
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Special kinds of species

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

“Rarity precedes extinction” (Darwin 1859)

Aren’t we all special?

Regardless of the name, how many?

<table>
<thead>
<tr>
<th>Category</th>
<th># described</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insects</td>
<td>751,000</td>
</tr>
<tr>
<td>All other animals</td>
<td>281,000</td>
</tr>
<tr>
<td>Bacteria and similar forms</td>
<td>4,800</td>
</tr>
<tr>
<td>Fungi</td>
<td>69,000</td>
</tr>
<tr>
<td>Algae</td>
<td>26,900</td>
</tr>
<tr>
<td>Protists (single-celled organisms with nuclei)</td>
<td>30,800</td>
</tr>
</tbody>
</table>

C of L
And, is that all? A realistic total #?

Some recent advances in detecting species

Describing biodiversity
- Alpha
- Beta
- Gamma

One famous extrapolation

How many species are there?

Do we need them all?
- Some competing hypotheses (plus null)

Alpha diversity ($\alpha$)
Beta diversity (\(\beta\))
- Describes…
- Many methods used to quantify
  - Whittaker’s Measure
    - \(S/\alpha - 1\)
    - Where \(S\) = all species across sites; \(\alpha\) = average # of species per site

\[\text{Miami of Ohio agroecosystem plots & mesocosms}\]

Gamma diversity (\(\gamma\))

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

\[\text{Laliberte et al. (2007)}\]

\(\alpha\) and \(\beta\) Diversity example

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Richness ((S))</th>
<th>Beta Diversity ((\beta))</th>
<th>Area Length ((L))</th>
<th>Elevation Change ((D))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Side</td>
<td>18.7 ± 1.6°</td>
<td>3.2 ± 0.9°</td>
<td>4.0 ± 0.6°</td>
<td>0.6 ± 0.2°</td>
</tr>
<tr>
<td>End</td>
<td>32.8 ± 2.2°</td>
<td>5.0 ± 0.9°</td>
<td>4.3 ± 0.5°</td>
<td>0.6 ± 0.1°</td>
</tr>
</tbody>
</table>

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”.

\[\text{Niches and competition}\]

\[\text{Gause’s law of competitive exclusion}\]

\[\text{Resource partitioning leads to…}\]
Species-area relationship

Mechanism?

Fig. 2.13

Species-area equation

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

Intermediate disturbance hypothesis

Mechanism?

Connell (1978)

Townsend et al. (1997)

Productivity

Mechanism?

Diversity in 30 freshwater ponds of Michigan


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

Geographic trends: An old stand-by

But, see Mackey & Currie (2001, Ecology)

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>

Hotspots
Biodiversity hotspots

- 25 hotspots; 1.4% of land cover of Earth
- Contains 44% vascular plants; 35% of 4 vertebrate groups
- 17,471 Google Scholar citations as of 2017

Myers et al. (2000)

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)

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)

War(?) and hotspots

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

Hanson et al. (2009)

Hotspots vs. NGO offices

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

Now what should we do?
- Would conserving 1.4% of the Earth's land be enough if the rest becomes degraded?
- One final point: “Although this [$500 million/yr] is 12.5 times the annual average of the $400 million spent on hotspots over the past decade, it is still only twice the cost of a single Pathfinder mission to Mars, which has been justified largely on biodiversity grounds (the search for extraterrestrial life).” Myers et al. (2000)