Diversity

31 October 2011

Readings:
Pueyo Y, Alados CL, Feina-Brindel C (eds) and use of plant community structure for the assessment of plant species diversity. JOURNAL OF ARID ENVIRONMENTS 64 (4): 698 - 712 MAR 2006

Plant communities

• Have a physical structure and attribute – most of the class to date.
• Have species of various abundances

Species Diversity

• Very popular among ecologists.
• Emphasis on biodiversity and conservation.
• Sometimes this has involved genetic and ecosystem diversity as well but we will concentrate on species.

Why is diversity important?

• Conserving the most diverse types is an efficient conservation strategy.
• It seems to be a metric of the health of a community.
• Communities with lots of species are more resistant to invasion and more resilient to disturbance.

Terms

• Species Richness
• Diversity
  – Simpson’s index
  – Shannon-Weiner index
  – Brillouin index
• Species Abundance

Species Richness

• Simplest
• Number of species per unit area.
• If the area is the whole region of interest and the species are surveyed to include all the growing seasons, then this is a *flora*.
• Usually use a sampling approach and count species in a number of quadrats.
Species Richness

- Not as informative as often desired
- Species richness is the same for both sites.

<table>
<thead>
<tr>
<th>Site one</th>
<th>Site two</th>
</tr>
</thead>
<tbody>
<tr>
<td>90% spp A</td>
<td>25% spp A</td>
</tr>
<tr>
<td>8% spp B</td>
<td>25% spp B</td>
</tr>
<tr>
<td>1% spp C</td>
<td>25% spp C</td>
</tr>
<tr>
<td>1% spp D</td>
<td>25% spp D</td>
</tr>
</tbody>
</table>

Indices

- Fixes the species richness problem by adding the abundance into the mix.
- More than 50 indices have been described in the literature. New ones are being developed every day.

Shannon-Weiner index

- A widely used diversity index is the **Shannon index**. It is calculated from the proportional abundances \( p_i \) of each species (abundance of the species / total abundances, noted here as \( p_i = \frac{n_i}{N} \)) as:

\[
H = - \sum_{i=1}^{S} p_i \ln(p_i)
\]

Indices

Evenness (also called the Pielou index)

- For a fixed species richness, the most even distribution will be where each species has the same abundance, and thus a proportional abundance of \( 1/S \). The maximum value of \( H \) for fixed species richness is therefore \( \ln(S) \).

Comparing the obtained \( H \) with the maximum possible \( H \) for the same species richness can be used as an expression of the evenness of the community as:

\[
J = \frac{H}{\ln(S)}
\]

Indices

http://www.worldagroforestry.org/sites/rsu/resources/biodiversity/analysistypes/diversityindices.asp
**Simpson index**

- The **Simpson index** or concentration index is another diversity index calculated from species proportions. Its formula is:
  \[ D = \sum_{i=1}^{S} p_i^2 \]
- The index describes the chance that two species sampled at random and with replacement from a community will be the same species.

**Brillouin index**

- When a subsample is taken from an area, the **Brillouin index** provides a better estimate of the Shannon index for the survey area (for samples of the same size). It also corresponds to situations of sampling without replacement, whereas the Shannon index is appropriate for sampling with replacement. This index is calculated as:
  \[ H_B = \frac{\ln(M) - \sum_{i=1}^{S} \ln(n_i)}{N} \]
- In practical situations, the Shannon and Brillouin indices will have values that are very similar.

**Picking an index**

- Each index has its own strengths and weaknesses. Picking an index has to do with the question, the site, and the sampling;
- Typically people use two or three together (often Simpson and Shannon);
- There is typically little relationship between the indices;

**Functional group richness**

- WSPG
- CSPG
- WSAG
- CSAG
- CSPF
- Etc.
- Warm-season
- Cool-season
- Annual
- Perennial
- Grass
- Forb
- Shrub
- Tree
- Cacti
- Invader
- N-fixer
- Etc.