

Name:

Date:

## Student Handout 1A: How to Calculate Biodiversity

Diversity Indices:

- A) A diversity index is a mathematical measure of species diversity in a given community.
- B) Based on the species richness (the number of species present) and species abundance (the number of individuals per species).
- C) The more species you have, the more diverse the area, right?
- D) However, there are two types of indices, dominance indices and information statistic indices.
- E) The equations for the two indices we will study are:

$$\text{Shannon Index (H)} = - \sum_{i=1}^s p_i \ln p_i$$

$$\text{Simpson Index (D)} = \frac{1}{\sum_{i=1}^s p_i^2}$$

The Shannon index is an information statistic index, which means it assumes all species are represented in a sample and that they are randomly sampled. Can you point out any problems in these assumptions?

In the Shannon index, **p** is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), **ln** is the natural log, **Σ** is the sum of the calculations, and **s** is the number of species.

The Simpson index is a dominance index because it gives more weight to common or dominant species. In this case, a few rare species with only a few representatives will not affect the diversity. Can you point out any problems in these assumptions?

In the Simpson index, **p** is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), **Σ** is still the sum of the calculations, and **s** is the number of species.

Let's look at an example. Area 1 was sampled and the following specimens were collected.

order	description	number of individuals (n)	n/N	$p_i$	$p_i^2$	$\ln p_i$	$p_i \ln p_i$
Orthoptera (grasshopper)	green with red legs	6	6/27	0.222	0.049	-1.505	-0.334
Orthoptera (grasshopper)	brown with a yellow stripe	5	5/27	0.185	0.034	-1.687	-0.312
Lepidoptera (butterfly)	large, blue	1	1/27	0.037	0.001	-3.297	-0.122
Lepidoptera (butterfly)	small, blue	3	3/27	0.111	0.012	-2.198	-0.244
Coleoptera (beetle)	red & blue	12	12/27	0.444	0.198	-0.812	-0.360

$s$  (number of species) = 5

$N$  (total number of individuals) = 27

$\Sigma$  (sum) of  $p_i^2$  ( $n/N$ )<sup>2</sup> = 0.294

$\Sigma$  (sum) of  $p_i \ln p_i$  = -1.372

$H$  =  $-(-0.334 + -0.312 + -0.122 + -0.244 + -0.360)$  = **1.372**

$D$  =  $1 / (0.049 + 0.034 + 0.001 + 0.012 + 0.198)$  =  $1 / 0.294$  = **3.4**

These are the specimens collected from Area 2.

order	description	number of individuals (n)	n/N	$p_i$	$p_i^2$	$\ln p_i$	$p_i \ln p_i$
Hymenoptera (wasp)	black	12	12/91	0.132	0.017	-2.025	-0.267
Hymenoptera (wasp)	purple	21	21/91	0.231	0.053	-1.465	-0.338
Hymenoptera (bee)	striped	5	5/91	0.055	0.003	-2.900	-0.160
Orthoptera (grasshopper)	green with red legs	25	25/91	0.245	0.060	-1.406	-0.345
Orthoptera (grasshopper)	brown with a yellow stripe	2	2/91	0.022	0.0004	-3.817	-0.084
Lepidoptera (butterfly)	large, blue	17	17/91	0.187	0.035	-1.677	-0.314
Lepidoptera (butterfly)	small, blue	9	9/91	0.099	0.010	-2.313	-0.229

$s$  (number of species) = 7

$N$  (total number of individuals) = 91

$\Sigma$  (sum) of  $p_i^2$   $(n/N)^2 = 0.179$

$\Sigma$  (sum) of  $p_i \ln p_i = -1.736$

$H = -(-0.267 + -0.338 + -0.160 + -0.345 + -0.084 + -0.314 + -0.229) = 1.736$

$D = 1/(0.017 + 0.053 + 0.003 + 0.060 + 0.00004 + 0.035 + 0.010) = 5.59$

Which area is more diverse? The bigger number is more diverse.

## Community Similarity

- A) Calculating community similarities (what the communities have in common in terms of species) helps us determine if we are comparing apples to apples and oranges to oranges.
- B) There are many indices that do this, we will use Sorenson's coefficient.
- C) Sorenson's coefficient gives a value between 0 and 1, the closer the value is to 1, the more the communities have in common.
  - a. Complete community overlap is equal to 1; complete community dissimilarity is equal to 0.
- D) The equation is:

$$\text{Sorenson's Coefficient (CC)} = \frac{2C}{S1 + S2}$$

Where C is the number of species the two communities have in common, S1 is the total number of species found in community 1, and S2 is the total number of species found in community 2.

### Example 1:

There are 20 species found in community 1 and 25 in community 2. Between them, they have 5 species in common. The calculation would be:

$$\text{Sorenson's Coefficient (CC)} = \frac{2 * 5}{20 + 25} = 10/45 = 0.222$$

According to Sorenson's coefficient, these communities do not have much overlap or similarity.

### Example 2:

There are 15 species found in community 1 and 25 in community 2. Between them, they have 12 species in common. The calculation would be:

$$\text{Sorenson's Coefficient (CC)} = \frac{2 * 12}{15 + 25} = 24/40 = 0.6$$

According to Sorenson's coefficient, these communities have quite a bit of overlap or similarity.