

## SPECIES BIODIVERSITY LAB

**Purpose:** To understand the importance of biodiversity, calculate the indices of the Simpson's Index, and quantify the biodiversity of a sample.

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*Time: 40 minutes*

### BACKGROUND:

Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species.

Before looking at Simpson's Diversity Index in more detail, it is important to understand the basic concepts. Biological diversity can be quantified in many different ways. The two main factors taken into account when measuring diversity are **richness** and **evenness**. Richness is a measure of the number of different kinds of organisms present in a particular area. For example, species richness is the number of different species present. However, diversity depends not only on richness, but also on evenness. Evenness compares the similarity of the population size of each of the species present.

**Richness** - The number of species per sample is a measure of richness. The more species present in a sample, the 'richer' the sample.

Species richness as a measure on its own takes no account of the number of individuals of each species present. It gives as much weight to those species which have very few individuals as to those which have many individuals. Thus, one daisy has as much influence on the richness of an area as 1000 buttercups.

**Evenness** - Evenness is a measure of the relative abundance of the different species that make up the richness of an area.

To give an example, we might have sampled two different fields for wildflowers. The sample from the first field consists of 300 daisies, 335 dandelions and 365 buttercups. The sample from the second field comprises 20 daisies, 49 dandelions and 931 buttercups (see the table below). Both samples have the same richness (3 species) and the same total number of individuals (1000). However, the first sample has more evenness than the second. This is because the total number of individuals in the sample is quite evenly distributed between the three species. In the second sample, most of the individuals are buttercups, with only a few daisies and dandelions present. Sample 2 is therefore considered to be less diverse than sample 1.

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Flower Species	Individuals in Sample #1	Individuals in Sample #2
Daisy	300	20
Dandelion	335	49
Buttercup	365	931
<b>Total</b>	<b>1000</b>	<b>1000</b>

*A community dominated by one or two species is considered to be less diverse than one in which several different species have a similar abundance.*

As species richness and evenness increase, diversity increases. Simpson's Diversity Index is a measure of diversity which takes into account both richness and evenness.

**Simpson's Index (D)** measures the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species). There are two versions of the formula for calculating **D**. In this class we will use the following

$$D_s = \frac{\sum n_i(n_i - 1)}{N(N - 1)}$$

Where  $n_i$  is the number of each individual species,  $N$  is the total number of individuals, and  $D$  ranges between 0 and 1. With this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of  $D$ , the lower the diversity.

To calculate Simpson's Index for a particular area, the area must first be sampled. The number of individuals of each species present in the samples must be noted. For example, the diversity of the ground flora in a woodland, might be tested by sampling random quadrates. The number of plant species within each quadrant, as well as the number of individuals of each species is noted. There is no necessity to be able to identify all the species, provided they can be distinguished from each other.

As an example, let us work out the value of **D** for a single quadrat sample of ground vegetation in a woodland. Of course, sampling only one quadrat would not give you a reliable estimate of the diversity of the ground flora in the wood. Several samples would have to be taken and the data pooled to give a better estimate of overall diversity.

Species	Abundance ( $n_i$ )
Woodrush	2
Holly Seedlings	8
Bramble	1
Willow	1
Sedge	3
Totals	15

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Then to solve for Simpson's Index

$$D_s = \frac{\sum n_i(n_i - 1)}{N(N - 1)}$$

$$D_s = \frac{2(1) + 8(7) + 1(0) + 1(0) + 3(2)}{15(14)}$$

$$D_s = \frac{2 + 56 + 0 + 0 + 6}{210} = \frac{64}{210} = 0.3$$

So Simpson's Index = 0.3

## Pre-lab Questions

Species	Sample 1	Sample 2	Sample 3
1	10	20	100
2	10	20	1
3	10	10	1
4	10	10	1
5	10	2	1

1. Why would we want to rate the amount of biodiversity in a location?
2. Examine the charts below and calculate the diversity indices for the three samples.

Sample 1 = \_\_\_\_\_      Sample 2 = \_\_\_\_\_      Sample 3 = \_\_\_\_\_

3. Use the results from the previous question to describe the biodiversity of each sample.

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## Procedure

1. Using a small net, take a bottom sample from the simulated waterbody. Empty the sample and inventory the different "species" and the abundance of each species in the sample.

### Site 1

"Species"	Number

### Site 2

"Species"	Number

### Site 3

"Species"	Number

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Site 4

"Species"	Number

2. Use the data to calculate the Simpson diversity index for each sample.

Site	Simpson Diversity Index
Site 1	
Site 2	
Site 3	
Site 4	

- Which site had the greatest amount of biodiversity?
- Which site had the least?
- Which "species" were present and abundant at every site?
- Which "species" were only found at certain sites?
- Why do you think some species were not found at all sites? What could have caused their disappearance from the site?
- What were some problems or errors associated with the simulation?