Community Structure and Species Diversity

**Background:**

The number of species in a biological community is termed **species richness, N.** For example tropical rain forests have higher species richness than temperate forests.

Species diversity takes into account species abundances as well. A community is said to have a high species diversity if many equally, or nearly equally, abundant species are present. On the other hand, if a community is composed of very few species, or if only a few species are abundant, then species diversity is low.

*Ex: If a community had 100 individuals distributed among 10 species, the maximum possible diversity would be 10 species with 10 individuals each. The minimum diversity would be 91 individuals belonging to one species and only 1 individual in each of the other 9 species.*

The most commonly used measure of species diversity is the **Shannon diversity index, H,** is related to the concept on “uncertainty.” In a community of low diversity, we can be relatively certain of the identity of a species chosen at random. In a highly diverse community, however, it is difficult to predict the identity of a randomly picked individual. Thus high diversity is associated with high uncertainty and low diversity with low uncertainty.

The Shannon diversity index is:

**H = -∑pi (log pi) where pi = fi/n**

pi = the proportion of the total number of individuals occurring in species i

fi = the total number (or frequency) of individuals of species i

n = the total number of individuals of all species

An equivalent formula that doesn’t require proportions is:

**H = [n log n – (∑ fi log fi)] / n**

The value of H is affected not only by the relative abundance of species, but also by the number of species. The maximum possible diversity for a data set with k categories (or species) is:

**Hmax = log k**

Therefore, it is often useful to calculate **J**, the evenness measure.

**J = H**

 **Hmax**

Example #1:

|  |  |  |
| --- | --- | --- |
| Species **(i)** | Total number of each species **(fi)** | fi log fi |
| Vines | 5 | 3.495 |
| Leaves | 5 | 3.495 |
| Branches | 5 | 3.495 |
|  | Total **(n)**: 15 | **(∑ fi log fi) =** 3.494+3.495+3.495 =10.485 |

H = [n log n – (∑ fi log fi)] / n **Hmax = log 3 = .477**

H= [15 log 15 – (10.485)] /15

H= [17.641-10.485] /15 **J = (H/Hmax) = .477/.477 = 1**

**H = .477**

Example #2:

|  |  |  |
| --- | --- | --- |
| Species **(i)** | Total number of each species **(fi)** | fi log fi |
| Vines | 1 | 0 |
| Leaves | 1 | 0 |
| Branches | 18 | 22.595 |
|  | Total **(n)**: 20 | **(∑ fi log fi) =0+0+22.595** = 22.595 |

H = [n log n – (∑ fi log fi)] / n **Hmax = log 3 = .477**

H= [20 log 20 – (22.595)] /20

H= [26.021 – 22.595] /20 **J = (H/Hmax) = .171/.477 = .358**

**H = .171**

*\*\*Example 1 has the maximum possible diversity; while example 2 shows less diversity*

**Problems:** Write out the equations and **Show your work**! Box your answers. (Attach a separate sheet if needed)

1. The following frequency distribution of tree species was observed:

|  |  |
| --- | --- |
| Species **(i)** | Total number of each species **(fi)** |
| White oak | 44 |
| Red oak | 3 |
| Hickory | 28 |
| Black walnut | 12 |
| Basswood | 2 |
| Slippery Elm | 8 |

1. Use the Shannon index to calculate the tree species diversity
2. Compute the maximum diversity possible for this tree community
3. Calculate the evenness measure for this community
4. The frequency distribution of organisms in a salt marsh was counted:

|  |  |
| --- | --- |
| Species **(i)** | Total number of each species **(fi)** |
| Wolf spiders | 82 |
| Dwarf spiders | 51 |
| Dragonflies | 32 |
| Grasshoppers | 9 |
| Pill bugs | 3 |

1. Use the Shannon index to calculate the species diversity
2. Compute the maximum diversity possible for this community
3. Calculate the evenness measure for this community