**BIODIVERSITY INDICES**

An Introduction to Understanding Community Structure

**Introduction**

Species diversity is a way to measure and evaluate community structure. It can be used to compare a community at different times during its development, or it can be used to compare two different communities at the same time. A community is said to have a high diversity if many equally or nearly equally abundant species are present. A community’s diversity is low if it is comprised of very few species or if only a few species are abundant. For example, if a community has 100 organisms distributed among 10 species then the maximum diversity would occur when there are 10 individuals in each of the 10 genera. The minimum diversity would occur if one species had 91 individuals and the remaining species had only one individual in each of the other 9 species.

**Meaning of Diversity Measurement**

High diversity indicates a highly complex community, a greater diversity of species allows for a greater amount of species interactions. Predation, energy transfer (food webs), and competition are all more complex and varied in a community where there is more interaction. Some ecologists are studying diversity as a measure of community stability (the ability to resist change) while others see diversity as a measure of community maturity. As communities mature, they become more complex and stable. These positions are still under intense study.

**Measuring Diversity**

We will be studying three parameters that are often calculated for an ecosystem under study. The observer needs to understand what each value contributes to their understanding of the ecosystem. The three parameters are: ***Species richness***, ***Simpson’s Index***, and ***Shannon’s Diversity Index***.

1. ***Species Richness*** (symbol = s)

The simplest measure of diversity is species richness. It is a measure of the number of species found in the community. You just walk through a habitat and count the number of different species in the study area.

1. ***Simpson’s Index of Dominance*** (symbol = D)

This index is a measure of both the richness and proportion (percentage) of each species. It is the measure of the chance that if two organisms are randomly taken from the environment they will be members of different species. It is therefore, a measure of dominance. 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. A small value of D (close to zero) implies a clumping of individuals in a few species and a large value of D (close to one) implies a more uniform distribution of individuals among the species. Or said another way: "Simpson index. Ranges from zero (one species dominates the community completely) to one (all species are equally present)."

1. ***Shannon-Wiener Diversity Index*** (symbol = H)

The Shannon-Wiener Index measures the order within a community. It is characterized by the number of individuals observed for each species in the ecosystem. It is often used when we wish to study a random sample from a larger community. As the value of the index increases there is less order in the community. A small value would indicate more order in the community. Or said another way: "The Shannon-Wiener diversity index takes into account the number of individuals as well as number of species. A value of zero represents a community with only a single species. A higher number is achieved by a community with many species, each with few individuals."

**Calculations**

The formulas given below are not important for you to remember. They are here so interested students may see how the values are generated. For each equation below, N = the total number of individuals in the community, n= the number of individuals in each of the different groups studied, i = individual species; fi = total number of each species.

The Species Richness (s):

**Count the number of different species**

The Simpson index (D):

**D = 1 – [∑ n(n-1)/N(N-1)]**

The Shannon-Wiener Index (H):

**H = [n log n – ∑ (fi log fi)]/ n**

**Practice Example**

Below are data to help you practice the two formulas given above. Use your calculator to determine the Simpson index (D) and Shannon-Wiener index (H). You are not asked to memorize the formulas, just be able to apply them to any situation. Be sure that you understand what each value (D and H) means when we compare the two data sets.

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| --- | --- | --- | --- | --- |
| **Community A** | |  | **Community B** | |
| **Species** | **Number** |  | **Species** | **Number** |
| Pig | 10 |  | Chickens | 95 |
| Cow | 11 |  | Pig | 1 |
| Goat | 9 |  | Cow | 1 |
| Horse | 8 |  | Goat | 1 |
| Sheep | 12 |  | Horse | 1 |
|  |  |  | Sheep | 1 |

1. Compare the species richness (s) of each community.

2. Compare the communities based upon dominance (Simpson Scale). Which is more diverse?

3. Compare the communities based upon order/complexity (Shannon-Wiener). Which is more diverse?