**Richness, Abundance, Shannon-Wiener Diversity Index, and Evenness**

**Richness** (S) is the total number of species in a geographic area. Richness does not take into account the number of individuals, proportion, or distribution of each species.

1. Based on the species list below, what is the richness of this community?

*Species:* Deer, Deer, Deer, Deer, Deer, Badger, Elk, Elk, Elk, Squirrel, Squirrel, Squirrel, Squirrel, Wolf, Wolf, Red Fox, Sandhill Crane, Sandhill Crane, Sandhill Crane, Porcupine, Porcupine, Bald Eagle, Snowshoe Hare, Snowshoe Hare, Snowshoe Hare

**S = 10**

Richness alone misses an important component of species diversity: some species may be rare while others may be common. This is understood through the **abundance** (N) of each species. Note that we use ‘N’ to refer to the total number of individuals of all species, and ‘n’ to refer to the total number of individuals of a particular species.

The **Shannon-Wiener diversity index** (H) accounts for species abundance by calculating the proportion of individuals of each species compared to the total number of individuals in the community (pi).

For each j in 1:S, pi = nj / N and ln is the natural log. Importantly, we can think of pi as the relative proportion of the species j in the community.

Higher H values indicate higher diversity; values typically fall between 1.5 and 3.5.

1. Using the table below and the species list provided in question 1, calculate the different components of the Shannon-Wiener diversity index for each species to 3 decimal places.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *Species* | *Abundance (n)* | *pi* | *ln(pi)* | *pi \* ln(pi)* |
| Deer | 5 | 0.2 | -1.609 | -0.322 |
| Badger | 1 | 0.04 | -3.219 | -0.129 |
| Elk | 3 | 0.12 | -2.120 | -0.254 |
| Squirrel | 4 | 0.16 | -1.832 | -0.293 |
| Wolf | 2 | 0.08 | -2.526 | -0.202 |
| Red Fox | 1 | 0.04 | -3.219 | -0.129 |
| Sandhill Crane | 3 | 0.12 | -2.120 | -0.254 |
| Porcupine | 2 | 0.08 | -2.526 | -0.202 |
| Bald Eagle | 1 | 0.04 | -3.219 | -0.129 |
| Snowshoe Hare | 3 | 0.12 | -2.120 | -0.254 |
| **Total Abundance (N)** | 25 | 1 |  | -2.169 |

1. Calculate H according to the formula.

**H = 2.169**

**Shannon’s Evenness** (E), or relative abundance, is a metric that compares the abundances of each species. Areas where the abundance of each species are more evenly represented are considered more diverse than communities where a few species are very common and other species are very rare. Evenness values range from 0 to 1. Low values indicate that one or a few species dominate, while high values indicate that all of the species in a community have similar abundances.

H = Shannon-Wiener diversity index

Hmax = ln(S), signifying the highest possible diversity value

Note that this metric is also called Shannon’s evenness because it is the ratio of the Shannon index calculated from the real community and the maximum Shannon index for the community with the same richness

1. Use the richness value you calculated in question 1 to calculate Hmax

**Hmax = 2.302**

1. Calculate the evenness.

**EShannon = 2.169 / 2.302 = 0.942**

The effective number of species (ENS) is used to convert metrics like Shannon-Wiener into values with more intuitive units of the number of species (as opposed to its native units of ‘bits of information’).

As it applies to the Shannon-Wiener index, the effective number of species is the number of species in a hypothetical community which has the same Shannon-Wiener value as the community under investigation, but is composed of equally-abundant species.

Where H is the Shannon-Wiener value (exponentiated).

1. Calculate the effective number of species for the Shannon-Wiener index.

**ENSShannon = 8.750**