TD 01: Ecological Indices for Measuring Biodiversity

Natural biodiversity refers to the total variety of life forms on Earth, from genetic diversity to ecosystem diversity. To estimate it, several measurement parameters must be used. The assessment of biodiversity is based on phylogenetic or functional aspects, which are particularly relevant in conservation biology. Among these indices, the most important and commonly used in ecology are:

1- Species richness (S):

The most common index used in biodiversity studies is species richness (S), which represents the number of species present in a given area. A simple inventory can provide an idea of all the categories of species present in an environment.

2- Specific abundance (A):

This refers to the number of individuals for each species identified in a given environment. Relative abundance (Ar) expresses the percentage of an individual species in relation to the total number of individuals in the community:

$$Ar = A(i) \times 100 / A(total)$$

3- Species evenness (J):

Evenness (J) refers to how evenly individuals are distributed among the different species. In other words, it provides information about the relative abundance of species and their regularity within the population. Its value approaches 1 when the number of individuals per species in a community is nearly the same.

$$J = H' / Hmax$$

$$Hmax = Log2 (S)$$

- **H'**: Specific diversity
- **S**: Number of species forming the community
- **Log_2**: Log base 2 or binary logarithm

4- Simpson's index (D):

Also called the *dominance index*, it combines species richness and evenness. It represents the probability that two individuals randomly selected from a sample belong to the same species.

$$D = \Sigma\, ni\,(ni-1) / N(N-1)$$

- **n_i**: Number of individuals of a given species
- **N**: Total number of individuals

5- Shannon-Weaver index (H'):

This index expresses the specific diversity of a community, quantifies the heterogeneity of biodiversity within an environment, and helps observe population changes over time. The higher the Shannon-Weaver index (H') value, the greater the diversity.

$$H' = -\sum (ni/N) \times Ln (ni/N)$$

Where:

- **S**: Total number of species
- $\mathbf{n_i/N}$: Proportional abundance or percentage importance of the species
- $\mathbf{n_i}$: Number of individuals of a species in the sample
- **N**: Total number of individuals of all species in the sample
- **Ln**: Natural logarithm

Table 01. Shannon Index (H') and Ecological Diversity of a Natural Environment

Shannon Index (H')	Environmental Quality
0 – 2.5	Poorly diversified environment (dominant species)
2.6 – 3.9	Moderately diversified environment (species-rich environment)
4 – 5	Highly diversified environment (isotropic environment)

Exercise 01:

The following table shows the abundance values of five different species during the four seasons of the year.

1. Calculate the Shannon-Weaver diversity index (H') for each season.
2. Calculate the annual Shannon-Weaver index (H').
3. Determine the ecological quality of the environment.

Table 02. Abundance of five different species during four different seasons

Species	Autumn	Winter	Spring	Summer
E1	**3**	**13**	**6**	**2**
E2	**3**	**20**	**20**	**5**
E3	**2**	**3**	**3**	**4**
E4	**0**	**4**	**1**	**2**
E5	**1**	**2**	**0**	**1**