SHANNON-WIENER DIVERSITY INDEX

Measurements of diversity have been of historical significance and their importance still remains today given the obvious declines in habitat quality in almost every ecological system. The Shannon-Wiener Diversity Index is one of the most widely used species diversity indices for examining overall community characteristics comparing two or more distinct habitats. It is derived from a function used in the field of information and has been adapted by ecologists to describe the average degree of uncertainty of predicting the species of an individual picked at random from the community. The uncertainty of occurrence increases both as the number of species increases and as the individuals are distributed more and more evenly among the species already present. When properly manipulated, it will result in a diversity value (H) ranging between 0 (indicating low community complexity) and 4 (indicating high community complexity).

The S-W index is a measure of the likelihood that the next individual will be the same species as the previous sample. It combines two quantifiable measures; 1. the species richness (the number of species in the community) and 2. species equitability (how even are the numbers of individuals of each species). For instance, say we have a sample of 100 fish containing only 2 species. We would say that the species are equitable if there were 50 of each species. Conversely, if there were 99 of 1 species and only 1 of the other, there would be no equitability. Given this second scenario, we would be pretty confident in our prediction that if we were to sample 1 more individual that it would be the same as the 99 in that sample. Conversely, in the previous scenario, we would have a 50/50 chance at predicting the next species sampled.

Sample Calculations for Shannon-Weiner Diversity Index

Lets say we have a sample of 256 individuals comprised of 5 species and record the frequency of each of the species. We can then calculate the proportion of each species in the sample (Pi).

Fish Species	Frequency	Pi	ln(Pi)	Pi*ln(Pi)
Species #1	84	0.3281	-1.1144	-0.3656
Species #2	4	0.0156	-4.1589	-0.0650
Species #3	91	0.3555	-1.0343	-0.3677
Species #4	34	0.1328	-2.0188	-0.2681
Species #5	43	0.1680	-1.7840	-0.2997
Sum=	**256**	**1**		**-1.3661**

ln(Pi) is the natural log of that proportion value for each species and the final column is the multiplication of the natural log value and the proportion.

The Shannon-Wiener Diversity Index, H, is then calculated using the equation,

$$H = -\sum_{i=1}^{s} Pi(\ln(Pi))$$

Inserting our data into this equation gives the following result,

$$H = -(-1.3661)$$

$$H = 1.36$$

Given a very large sample size with many species (many more than 5) the S-W Index values (H) can range from 0 to 7 using the natural log (versus log10). A value near 0 would indicate that every species in the sample is the same. Conversely, a value near 7 would indicate that the number of individuals are evenly distributed between the 5 species.

The following tables illustrate how the index indices changes as the relative number of each species change. In the first three examples, there are a total of 200 organisms. The number of organisms are equal in the first example. There is one dominant species in the second and third example.

1. **All the same**

Species Name	# Found	P_i	P_i^2	$P_i \ln[P_i]$	Measure	Value
Species 1	40	0.200	0.040	-0.322		
Species 2	40	0.200	0.040	-0.322		
Species 3	40	0.200	0.040	-0.322		
Species 4	40	0.200	0.040	-0.322		
Species 5	40	0.200	0.040	-0.322	**H**	1.609
Totals	200	1.000				

2. **One dominate species**

Species Name	# Found	P_i	P_i^2	$P_i \ln[P_i]$	Measure	Value
Species 1	1	0.005	0.000	-0.026		
Species 2	1	0.005	0.000	-0.026		
Species 3	196	0.980	0.961	-0.020		
Species 4	1	0.005	0.000	-0.026		
Species 5	1	0.005	0.000	-0.026	**H**	0.126
Totals	200	1.000				

3. **Only one species present**

Species Name	# Found	P_i	P_i^2	$P_i \ln[P_i]$	Measure	Value
Species 1	0	0.000	0.000	0.000		
Species 2	0	0.000	0.000	0.000		
Species 3	200	1.000	1.000	0.000		
Species 4	0	0.000	0.000	0.000		
Species 5	0	0.000	0.000	0.000	**H**	0.000
Totals	200	1.000				