

# Shannon-Wiener Diversity Index

## Introduction Questions:

1. What is biodiversity?
2. Explain how the biodiversity of an ecosystem relates to the health of that ecosystem.
3. Explain why biodiversity is important to the human population.

## Background:

Measuring diversity has been of historical significance and due to the obvious declines in habitat diversity this data is still valuable. The Shannon-Wiener diversity index is one measure that we will use to try to draw information from samples in the field. Historically, the index has been used to measure the effects of habitat quality such as effects of pollution effluents. Recently, this index has fallen out of favor because it doesn't take into account habitat specific parameters required by specific species. Newer indices have incorporated such parameters and are termed, appropriately enough, Habitat Suitability Indices (HSI).

Though the results of the Shannon-Wiener index needs to be used with caution, it still provides a good learning tool for comparing two distinct habitats. It combines two quantifiable measures: the species richness (# species within the community) and species equitability (how even are the numbers of individual species). For example, if we have a sample of 100 fish containing only 2 species, this sample is equitable if there are 50 of each species. Conversely, if there were 99 of 1 species and 1 of the other, there would be no equability. In this second example, if we were to sample 1 individual, it likely would be of the first species. If the community was equitable (first example), we'd have a 50/50 chance of sampling the first species.

## Sample Calculations:

The Shannon-Wiener Diversity Index,  $H$ , is calculated using the following equation:

$$H = -\sum P_i(\ln P_i) \text{ where } P_i \text{ is the proportion of each species in the sample.}$$

Species	# found	$P_i$	$\ln(P_i)$	$P_i \ln(P_i)$
1	84	0.3281	-1.1144	-.03656
2	4	0.0156	-4.1589	-0.0650
3	91	0.3555	-1.0343	-0.3677
4	34	0.1328	-2.0188	-0.2681
5	43	0.1680	-1.7840	-0.2997
Total	256	1.0000		-1.3661

In the example above  $H = 1.3661$

Given a very large sample size, with more than 5 species, the S-W index values ( $H$ ) can range of 0 to ~4.6 using the natural log ( $\ln$ ). A value near 0 would indicate that every species in the sample is the same. A value near 4.6 would indicate that the number of individuals are evenly distributed between all the species. Values in the middle are ambiguous which is an obvious flaw of this index and, thus, care should be taken when using this index.

For the AP Exam you should be able to calculate the Shannon-Wiener Index for a given sample.

## Part 1: Example Communities

Complete the tables for the following populations and make a conclusion about the diversity for each community.

### Community #1

Species	# found	$P_i$	$\ln(P_i)$	$P_i \ln(P_i)$
1	40			
2	40			
3	40			
4	40			
5	40			
Total				

### Community #2

Species	# found	$P_i$	$\ln(P_i)$	$P_i \ln(P_i)$
1	1			
2	1			
3	196			
4	1			
5	1			
Total				

### Community #3

Species	# found	$P_i$	$\ln(P_i)$	$P_i \ln(P_i)$
1	0			
2	200			
3	0			
4	0			
5	0			
Total				

## Part 2: Campus Cars Biodiversity Index:

1. Count the number and variety of cars in your groups' portion of the parking lot.
2. Get summaries cars in three specific groups:
  - a. Front of the Building
  - b. Back of the Building
  - c. All cars in entire parking lot
3. Calculate the biodiversity indices of all three groups.
4. After calculating  $H$ , calculate the species evenness  $E$  [ $E=H/\ln(S)$ ], of each location.

## Discussion Questions:

1. Explain the variation in the Biodiversity between the front and back parking lots.
2. Which  $H$  value tells us that there is greater biodiversity? Why might this sample be so diverse?
3. Which parking lot had a great species evenness? Speculate why.