

Name(s) _____
Mods _____ Date _____

AP Environmental Science



Lab: Shannon-Weiner Diversity Index

Purpose:

- To employ the concept of the null hypothesis in a scientific experiment.
- To determine the Shannon-Weiner Diversity Index for two groups of “species.”
- To compare and analyze the two samples using the Shannon-Weiner method.

Background:

A central theme in ecology is **biodiversity**, which often serves as a measure of the overall health of an ecosystem. Declining biodiversity can indicate that the ecosystem is undergoing some type of environmental stress. Further study may then help to pinpoint that stress.

There are many methods that ecologists use to calculate species diversity. The Shannon-Weiner Diversity Index is a common way of showing that diversity involves not only numbers of different species, but also how well each of these species is represented in different “habitats.” The Shannon-Weiner value “H” can range from no diversity at 0.0 (think of a Christmas Tree farm) to a maximum diversity of 4.0 (think of a rainforest). These values have no real meaning by themselves, but can be used to compare two communities or the same community at different times. A large value of H indicates that if you randomly pick in your test area, the odds are the second individual will be different from the first. In this investigation your group will collect data from the vehicles in the student and faculty areas of parking at the school.

$$H' = - \sum_{i=1}^S [p_i \times (\ln(p_i))]$$

You need to begin with a good hypothesis. This statement needs to show cause and effect between two aspects of the situation being investigated. The standard hypothesis is an “if...then” statement that connects the two aspects being discussed. Experiments of this nature attempt to agree or disagree with the hypothesis. For this lab we will employ a second type of hypothesis, called the **null hypothesis**. This is a statement that there is **no relationship** between the two aspects of the situation under consideration. Experiments of this format are designed to disprove the null hypothesis. Theoretically in science it is easier to disprove something than it is to prove something. The null hypothesis is often the reverse of what the experimenter actually believes; it is put forward to allow the data to contradict it.

Prelab Questions:

1. State your null hypothesis here:

Materials:

- vehicles parked at the school
- calculator with natural log function

Procedure:

Your team of four people will be divided into two people who will count the vehicles in the faculty area of parking and two who will count the vehicles in the student area of parking. Miss Clark will explain where these areas are located. Fill in one chart completely for each site.

Results: see data tables. Fill them in using the calculations below:

Calculations:

The Shannon-Weiner equation is:

$$H' = - \sum(p_i \ln p_i)$$

Where: H' = Shannon-Weiner Diversity Index

p_i = the ratio of the number of organisms of a species to the total number of organisms

$$p_i = \frac{n_i}{N} \quad \text{where: } n_i = \text{number of individuals in species "i"}$$

N = total number of individuals of all species

$\ln p_i$ = the natural log of p_i

***Note there is a negative sign before the sum sign, which means that your answers will always be positive.*

Example Data Set

Parking Lot A:

Species of Car	Species Identifier Code	Number of Individuals in Parking Lot A			
	I	n _i	p _i	ln(p _i)	p _i (ln(p _i))
Sedan (4-door or 2-door with regular trunk)	1	10	0.17	-1.77196	-0.30123
SUV (higher off ground, gate in back)	2	10	0.17	-1.77196	-0.30123
Van or Mini-Van (sliding doors with hatch in back)	3	10	0.17	-1.77196	-0.30123
Pick-Up Truck (cargo in back)	4	10	0.17	-1.77196	-0.30123
Station Wagon or Hatchback	5	10	0.17	-1.77196	-0.30123
Bikes or Motorcycles	6	10	0.17	-1.77196	-0.30123
TOTAL	S=6	N=60	1		-1.8074

Therefore $H' = 1.8074$

Parking Lot B:

Species of Car	Species Identifier Code	Number of Individuals in Parking Lot B			
	I	n _i	p _i	ln(p _i)	p _i (ln(p _i))
Sedan (4-door or 2-door with regular trunk)	1	1	0.02	-4.09434	-0.06824
SUV (higher off ground, gate in back)	2	2	0.03	-3.4012	-0.11337
Van or Mini-Van (sliding doors with hatch in back)	3	25	0.42	-0.87547	-0.36478
Pick-Up Truck (cargo in back)	4	32	0.53	-0.62861	-0.33526
Station Wagon or Hatchback	5	0	0	0	0
Bikes or Motorcycles	6	0	0	0	0
TOTAL	S=4	N=60	1		-0.88165

Therefore $H' = 0.88165$

- **Which parking lot above is more diverse?** Lot A (S=6, $H' = 1.8074$). The car species are equally represented in this lot. We say that this parking lot (community) has a high degree of evenness. Lot B is less diverse based on our indexes (S=4, $H' = 0.88165$) and has low evenness, because the car species are unequally represented. Chevy Cavaliers are the most common species in Lot B, followed by Toyota Corollas. This lot has a high degree of dominance by these two species ($p_3 + p_4 = .95 = 95\%$ of the individuals in this parking lot are Chevy's and Toyotas).

Diversity Measurement	Community A (Lot A)	Community B (Lot B)
Species richness (S)	6 species	4 species
Evenness	High	Low
Dominance	Low	High
Overall Diversity	High	Low
Shannon Diversity Index (H')	1.8074	0.88165

Now collect data. You may want to group similar vehicles like “Ford pick-up trucks” or “Chevy sedans” into a single species. **Sample at least 100 cars in each lot.**

Student Parking Lot (Lot/Community A)

Species of Car	Species Identifier Code I	Number of Individuals in Parking Lot A n_i	p_i	$\ln(p_i)$	$p_i (\ln(p_i))$
Sedan (4-door or 2-door with regular trunk)	1				
SUV (higher off ground, gate in back)	2				
Van or Mini-Van (sliding doors with hatch in back)	3				
Pick-Up Truck (cargo in back)	4				
Station Wagon or Hatchback	5				
Bikes or Motorcycles	6				
TOTAL					

Faculty Parking Lot (Lot/Community B)

Species of Car	Species Identifier Code I	Number of Individuals in Parking Lot B n_i	p_i	$\ln(p_i)$	$p_i (\ln(p_i))$
Sedan (4-door or 2-door with regular trunk)	1				
SUV (higher off ground, gate in back)	2				
Van or Mini-Van (sliding doors with hatch in back)	3				
Pick-Up Truck (cargo in back)	4				
Station Wagon or Hatchback	5				
Bikes or Motorcycles	6				
TOTAL					

Fill in the following chart and use for your analysis:

Diversity Measurement	Community A (Lot A)	Community B (Lot B)
Species richness (S)		
Evenness		
Dominance		
Overall Diversity		
Shannon Diversity Index (H')		

Analysis: Remember to **provide data** to support your answer in order to earn full credit.

1. Compare the two indices. Evaluate this in light of your null hypothesis.
2. Which species are more dominant in each community? Why do you think this is the case?
3. Which group, if any, is more diverse? Why do you think this is the case?
4. Would the Shannon-Weiner Index be a good comparison for evaluating dinosaur and plant diversity in a fossil bed 150 million years old and one that is 90 million years old? Explain.