Lab: Shannon Diversity Index

**Purpose:**

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



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:**

1. State your null hypothesis here

| There is no correlation between the type of parking lot and the type of cars present in that lot. |
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**Materials:**

* vehicles parked at the school/neighborhood
* 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. Mr Jones 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 equation is:

H’ = - sum(pilnpi)

Where: H’ = Shannon Diversity Index

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

 where: *ni*= number of individuals in species “i”

*N*= total number of individuals of all species

lnpi = the natural log of pi

\*\**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 | ni | pi | ln(pi) | pi (ln(pi)) |
| Sedan (4-door or 2-door with regular trunk) | 1 | 10 | 0.17 | -1.79 | -0.30 |
| SUV (higher off ground, gate in back) | 2 | 10 | 0.17 | -1.79 | -0.30 |
| Van or Mini-Van (sliding doors with hatch in back) | 3 | 10 | 0.17 | -1.79 | -0.30 |
| Pick-Up Truck (cargo in back) | 4 | 10 | 0.17 | -1.79 | -0.30 |
| Station Wagon or Hatchback | 5 | 10 | 0.17 | -1.79 | -0.30 |
| Bikes or Motorcycles | 6 | 10 | 0.17 | -1.79 | -0.30 |
| **TOTAL** | S=6 | N=60 |  |  | -1.79 |

**Therefore H’=1.79**

Parking Lot B:

| Species of Car | Species Identifier Code | Number of Individuals in Parking Lot A |  |  |  |
| --- | --- | --- | --- | --- | --- |
| I | ni | pi | ln(pi) | pi (ln(pi)) |
| Sedan (4-door or 2-door with regular trunk) | 1 | 1 | 0.02 | -4.09 | -0.07 |
| SUV (higher off ground, gate in back) | 2 | 2 | 0.03 | -3.40 | -0.11 |
| Van or Mini-Van (sliding doors with hatch in back) | 3 | 25 | 0.42 | -0.88 | -0.36 |
| Pick-Up Truck (cargo in back) | 4 | 32 | 0.53 | -0.63 | -0.34 |
| Station Wagon or Hatchback | 5 | 0 | n/a | n/a | n/a |
| Bikes or Motorcycles | 6 | 0 | n/a | n/a | n/a |
| **TOTAL** | S=4 | 60 |  |  | -0.88 |

**Therefore H’= 0.88**

**Which parking lot above is more diverse?** Lot A (S=6, H’=1.8). 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’=0.88) and has low evenness, because the car species are unequally represented. Pick-up trucks are the most common species in Lot B, followed by Vans. This lot has a high degree of dominance by these two species (p3+p4=.95=95% of the individuals in this parking lot are Trucks and Vans).

| **Diversity Measurement** | **Community A (Lot A)** | **Community B (Lot B)** |
| --- | --- | --- |
| Species richness (S) | 6 species | 4 species |
| Evenness | High | Low |
| Shannon Diversity Index (H’) | 1.79 | 0.88 |
| Overall Diversity | High | Low |

Now collect data

**Student Parking Lot/Neighborhood Street(Lot/Community A)**

| Species of Car | Species Identifier Code | Number of Individuals in Parking Lot A |  |  |  |
| --- | --- | --- | --- | --- | --- |
| I | ni | pi | ln(pi) | pi (ln(pi)) |
| Sedan (4-door or 2-door with regular trunk) | 1 | 39 | 0.187 | -1.68 | -0.313 |
| SUV (higher off ground, gate in back) | 2 | 16 | 0.077 | -2.57 | -0.197 |
| Van or Mini-Van (sliding doors with hatch in back) | 3 | 4 | 0.019 | -3.96 | -0.076 |
| Pick-Up Truck (cargo in back) | 4 | 2 | 0.010 | -4.65 | -0.044 |
| Station Wagon or Hatchback | 5 | 11 | 0.053 | -2.94 | -0.155 |
| Bikes or Motorcycles | 6 | 127 | 0.656 | -0.42 | -0.277 |
| **TOTAL** | |  | 1 |  |  |

**H’ = 1.062**

**Faculty Parking Lot/Neighborhood Street (Lot/Community B)**

| Species of Car | Species Identifier Code | Number of Individuals in Parking Lot B |  |  |  |
| --- | --- | --- | --- | --- | --- |
| I | ni | pi | ln(pi) | pi (ln(pi)) |
| Sedan (4-door or 2-door with regular trunk) | 1 | 42 | 0.385 | -0.954 | -0.367 |
| SUV (higher off ground, gate in back) | 2 | 2 | 0.018 | -3.998 | -0.073 |
| Van or Mini-Van (sliding doors with hatch in back) | 3 | 2 | 0.018 | -3.998 | -0.073 |
| Pick-Up Truck (cargo in back) | 4 | 5 | 0.046 | -3.082 | -0.141 |
| Station Wagon or Hatchback | 5 | 40 | 0.367 | -1.003 | -0.368 |
| Bikes or Motorcycles | 6 | 1 | 0.165 | -1.801 | -0.297 |
| **TOTAL** | | 102 | 1 |  |  |

**H’ = 1.319**

**Fill in the following chart and use for your analysis:**

| **Diversity Measurement** | **Community A (Lot A)** | **Community B (Lot B)** |
| --- | --- | --- |
| Species richness (S) *(#)* | 6 | 6 |
| Evenness *(high/low)* | low | low |
| Shannon Diversity Index (H’) | 1.062 | 1.319 |
| Overall Diversity *(high/low)* | high | high |

**Analysis:** Remember to **provide data** to support your answer.

1. Compare the data related to the two communities. Evaluate this in light of your null hypothesis.

| Both of the communities have the same species richness, with 6 different species in both lots. Both also have a relatively high overall diversity. However, the student parking lot has significantly more SUVs and bikes than the faculty parking lot, and the faculty parking lot has significantly more station wagons and hatchbacks. In both lots, there are large numbers of sedans. The data disproves my null hypothesis, because there is are significant differences between the types of cars in the two types of parking lots. |
| --- |

1. Which species are more dominant in each community? Why do you think this is the case?

| Bicycles are most dominant in the student parking lot because students are encouraged to bike to school, and they typically live closer to the school than teachers. SUVs are also dominant in the student parking lot because students typically drive a family vehicle, which would likely be an SUV. Teachers typically drive hatchbacks and station wagons because they do not carpool as much as students, so they do not need many seats in their cars. This is also why sedans are popular for faculty and students. |
| --- |

1. Which group, if any, is more diverse? Why do you think this is the case?

| The faculty parking lot is more diverse, because it has a higher Shannon index. This is the case because teachers can select what types of cars to drive to school because they purchase the cars, whereas students are limited by the type of car their family vehicle is. |
| --- |

1. Would the Shannon 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.

| Yes, because the Shannon index takes into account the number of organisms in the fossil bed as well as the types of organisms. Although the number of organisms would be limited, the Shannon index would be a good measure of the diversity of the ecosystem. |
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