INTRODUCTION

Biodiversity is defined as the total number of species living in an ecosystem. At present about 1.8 million species have been named, but this figure is not certain. It is impossible to know how many species actually exist because we have not explored every part of the biosphere yet. Most species are also less than 1mm long so they are easily overlooked. Human actions such as over exploitation, islandisation, habitat destruction, introduction of alien species as well as pollution have all contributed to a decrease in local and global biodiversity.

There are several reasons why we should want to maintain a high biodiversity on Earth. High biodiversity is an indication of the health of an ecosystem and if an ecosystem comes under stress from over exploitation or pollution, it will show low diversity. Once diversity is lost from an ecosystem it can't recover easily because species need to migrate back in from neighboring ecosystems or if the organism has become extinct, it is lost forever.

In order to measure biodiversity, scientists must take two factors into consideration: species richness and the relative abundance (evenness) of each species. **Species richness** is a measure of the number of different kinds of organisms present in a particular area. **Evenness** compares the similarity of the population size of each of the species present.

Ecology In Your Backyard

- **Calculate the Shannon diversity index and "species" richness for cars in a parking lot.** Diversity indices are typically used to measure species diversity in nature, but, just for fun, you could calculate a "diversity index" for cars in a parking lot!
- The calculations of species diversity, evenness, and richness are the same (see equations and example data set below).
- This kind of inter-community comparison is done by ecologists attempting to assess the impacts of human development or pollution. When pollution is present or a human disturbance has occurred in an ecological community, diversity is typically low.
- **Example of calculating species diversity in two parking lot "communities":**
- Count the number of individuals of different "species" of cars in each parking lot "community".
- The number of "species" or car types in each lot = S
- First, calculate **relative abundance (p_i)** for each "species" in each "community" (i.e., the proportion of the "community" represented by each "species" i):

$$p_i = \frac{n_i}{N}$$

Where:

n_i = number of "individuals" in "species" i,

and

N = total number of "individuals" of all "species"

- Next calculate the **Shannon Diversity Index** :

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

- The summation sign $\sum_{i=1}^{S}[\ ]$ means that you should perform the operations inside the [ ] for each "species" i, starting with "species" i = 1. Add the result inside the [ ] for the first "species" to the result inside the [ ] for the next "species", and so on , and stop when you get to the last "species", i = S.

- Note that there is a negative sign before the summation sign (Σ), which means that your answers will always be positive, because the quantity $\sum_{i=1}^{S}\left[p_i \times \left(\ln(p_i)\right)\right]$ will always be negative.

- Here's an example data set:

"Species" of Cars	"Species" identifier code I	Number of "individuals" in Parking lot A n_i	p_i	$\ln(p_i)$	$p_i (\ln(p_i))$
Chrysler Lebaron	1	10	0.17	-1.7719	-0.3012
Dodge Minivan	2	10	0.17	-1.7719	-0.3012
Toyota Corolla	3	10	0.17	-1.7719	-0.3012
Chevy Cavalier	4	10	0.17	-1.7719	-0.3012
Nissan Pickup	5	10	0.17	-1.7719	-0.3012
Ford Taurus	6	10	0.17	-1.7719	-0.3012
TOTAL	**S= 6**	**N = 60**	**1.00**		**H' = 1.8074**

"Species" of Cars*	"Species" identifier code i	Number of "individuals" in Parking lot B n_i	p_i	$\ln(p_i)$	$p_i (\ln(p_i))$
Chrysler Lebaron	1	1	0.02	-3.9120	-0.0782
Dodge Minivan	2	2	0.03	-3.5066	-0.1052
Toyota Corolla	3	25	0.42	-0.8675	-0.3644
Chevy Cavalier	4	32	0.53	-0.6348	-0.3364
Nissan Pickup	5	0	0.00	0	0
Ford Taurus	6	0	0.00	0	0
TOTAL	**S= 4**	**60**	**1.00**		**H' = 0.8842**

* Note: Do not worry if the car "species" list differs somewhat between "communities"

- **Which parking lot "community" above is most diverse?** Lot A (S= 6, H' = 1.8074). The car "species" are equally represented in this lot. We say that this "community" has a high degree of **evenness.** Lot B is less diverse based on our indexes (S= 4, H'= 0.8842) 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" ($p_3 + p_4 = 0.95$, or 95 % of the individuals in this community are Chevys and Toyotas).

Diversity Measurement	Community A	Community B
Species richness (S)	6 species	4 species
Evenness	High	Low
Dominance	Low	High
Overall diversity	High	Low
Shannon Diversity Index (H')	1.8074	0.8842

- **Now, collect your data outside in a real parking lot!**
- Choose a safe parking lot, preferably one without much immigration and emigration (cars coming and going) and record the number of cars by "species", i.e., their manufacturer (e.g., Ford, Chevrolet, Toyota, or Ferrari).

- Diversity indices are used for comparative purposes, so compare your parking lot with another parking lot, for example, a faculty vs. a student parking lot, or compare the same parking lot at different times. Which car "species" is the most common, or dominant "species", in each lot?
- If you compared the student lot to a car dealer's lot, which one would show the greatest diversity in types of cars? The car dealer's lot would be characterized as a low diversity "community", while the student lot would have more "species" of cars, and would thus be considered high diversity.
- *If the campus police look at you suspiciously, show them your data.*
- Remember to count the number of "individual" cars in each "species" and enter that number in the third column on the data sheets that follow.
- Use a calculator with a ln (natural log) function to calculate the remaining two columns, and add up the negative values in the last column. Multiply the sum by -1 and you have calculated H'.
- You may want to group similar vehicles like "Ford pick-up trucks" or "Chevy sedans" into a single "species".
- Do not worry if the car "species" list differs somewhat between "communities".
- Sample at least 100 cars in each of the lots you survey.

"Species" of Cars in Lot A	**"Species" identifier i**	**Number of "individuals" n_i**	p_i	$\ln(p_i)$	$p_i(\ln(p_i))$
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
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	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
TOTAL					

"Species" of Cars in Lot B	"Species" identifier i	Number of "individuals" n_i	p_i	$\ln(p_i)$	$p_i (\ln(p_i))$
	1				
	2				
	3				
	4				
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
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	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				
	26				
	27				
	28				
	29				
	30				
TOTAL					

<u>ANALYSIS:</u> (Answer the following questions in your Scientific Composition Notebook)

1.) Discuss the ecosystem metaphor: Why have we used cars rather than counting actual species in a real ecosystem? How do the cars in the parking lot represent species in an ecological community?

2.) Which of the two communities is most diverse? Support your conclusion with experimental data.

3.) Various human disturbances can cause diversity to change. Based on your data, which community would you conclude has most likely experienced some sort of human disturbance? Explain.

4.) Did any species dominate in either community? If so, explain what might cause this dominance (be sure to relate it to environmental dominance). *Dominate Species*:

5.) Explain how immigration and emigration can affect species diversity and richness.

<u>CONCLUSION/EVALUATION:</u>

Summarize your overall conclusions. **REMEMBER: NO NEW INFO IN THE CONCLUSION & ADDRESS YOUR HYPOTHESIS!**