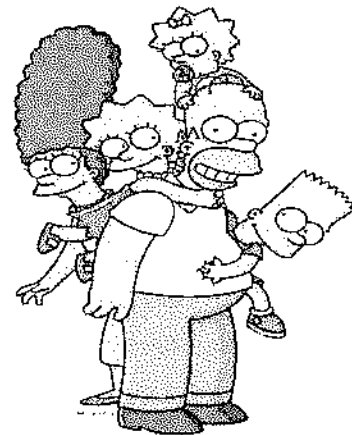# SIMPSON'S INDEX LAB

INTRODUCTION

Biodiversity is defined as the total number of species living in an ecosystem. At present about 1.5 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.

The Simpson's Diversity Index is calculated as follows:

$$D = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

D = Diversity
Σ = Sum of
N = total number of individuals
n = numbers of each different species (relative abundance of each species)

Simpson's Diversity Index takes into account the number of species present, as well as the abundance of each species. The value of this index starts with 0 as the lowest possible figure. When using the Simpsons Index, the number you will calculate should be a value between zero and one with $0 < D < 1$. Values near zero indicate a less diverse (homogeneous) ecosystem and values near one indicate a highly diverse ecosystem (heterogeneous). *The LOWER the value, the LOWER the diversity.*

A high value of D suggests a stable and ancient site and a low value of D could suggest pollution, recent colonization or agricultural management (disturbance of some sort). The index is normally used in studies of vegetation but can also be applied to comparisons of animals (or even all species) diversity.

## Example of all calculations relating to Community Diversity

Species	Number (n)	n(n-1)	Putting the figures into the formula for Simpson's Diversity Index:
Beetles	2	2	
Spiders	20	380	*Simpson's Diversity Index:*
True-bugs	3	6	
Caterpillars/Sawflies	3	6	
Total (N)	28	Σ n(n-1) = 394	

Species Richness = 4
(4 different species present)

$$D = 1 - \frac{\sum n(n-1)}{N(N-1)}$$

$$D = 1 - \left[\frac{2(2-1) + 20(20-1) + 3(3-1) + 3(3-1)}{28(28-1)} \right]$$

Relative Species Evenness: Low
(20 vs 2 vs 3 vs 3)

$$D = 1 - \left[\frac{2 + 380 + 6 + 6}{756} \right] = 1 - \left[\frac{394}{756} \right]$$

$$D = 1 - 0.52 = .48$$

Relative Level of Species Dominance: High
(One species dominates (spiders) with 20 individuals)

0 = Very Low Diversity
1 = Very High Diversity

PRE-LAB QUESTIONS:

1. Use Simpson's Diversity Index to determine which of the following 5 communities is most diverse.
   - Community 1 contains 20 species with 5 individuals in the first species, and 1 individual in each of the remaining species.
   - Community 2 contains 5 species, but there are 20 individuals in each species.
   - Community 3 contains 2 species, with 50 individuals in each species.
   - Community 4 contains 2 species, with 99 individuals in one and 1 individual in the other.
   - Community 5 contains 10 species, with 91 individuals in one and 1 individual in the other 9 species.

2. Describe how species evenness compares among the five communities outlined in question 1. How does species evenness affect species diversity? Explain.

PROCEDURE:

1. *Individually* read the background material

2. *Individually* complete the Pre-lab questions

3. Partner off with someone in the class.

4. Prepare a data table that will assist in the data collection process. Remember that a well-designed data table can help this process immensely.

5. Each group of 3 will then partner up with two other groups (9 total people).

6. Each group is responsible sampling a parking lot (Physics, LA, Senior) community. Hopefully there will not be much immigration or emigration (cars coming and going) during our sampling time. But, if you do notice some, use your best judgment.

7. Each group of 3 will randomly choose a section of the parking lot to sample (50 cars). The 50 cars in your sample MUST BE adjacent to each other, not interspersed Throughout the lot. No individual car may be skipped.

8. Your "species" will be based on the make of the automobile (e.g. Dodge, Honda, Chevy, etc.). If you are having difficulty classifying a "species", you must come to a decision as a team.

9. When complete, you will come together into your larger group and share the data collected from each lot with one another.

10. Individually calculate the Simpson's Diversity Index for each parking lot. It is YOUR responsibility to organize the data into a chart and do all of the calculations on your OWN. You may do calculations by hand or use a spreadsheet. You must provide an example of each calculation in your lab write-up.

11. Individually determine the Species Richness, Relative Species Evenness, and Relative Level of Species Dominance for each lot. These, along with the Diversity calculations, will be included in the Data Processing/Presentation section of your lab write up.
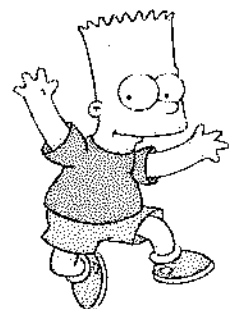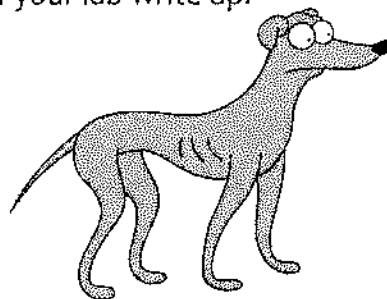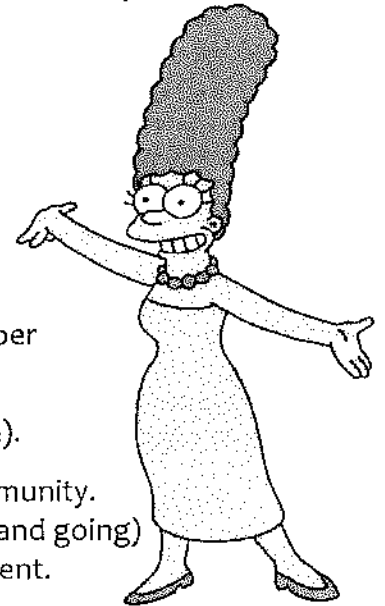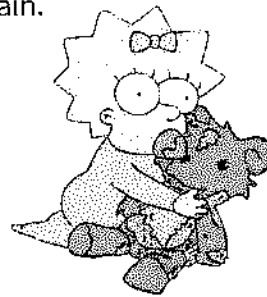
HYPOTHESIS (Which parking lot will have higher biodiversity? If.. then..) : _____

_____ | 5 |

PRE-LAB QUESTIONS: (SHOW your work)

	WORK	ANSWER
Community #1		
Community #2		
Community #3		
Community #4		
Community #5		

| 5 |

2. Describe how species evenness compares among the five communities outlined in question 1.

Community #1 is more or less diverse than community #2:   more / less

Community #2 is more or less diverse than community #3:   more / less

Community #3 is more or less diverse than community #4:   more / less

Community #4 is more or less diverse than community #5:   more / less

Community #5 is more or less diverse than community #1:   more / less

| 2 |

3. How does species evenness affect species diversity?   *Relationship (circle): inverse / direct*

Explain: _____

_____

_____ | 3 |

_____

DATA COLLECTION & CALCULATIONS:
STAPLE YOUR RAW DATA FOR EACH OF THE PARKING LOT COMMUNITIES TO THIS LAB

*YOU MUST INCLUDE YOUR WORK FOR CALCULATING THE SIMPSONS INDEX
FOR EACH PARKING LOT ON THIS ATTACHED SHEET!*

| 5 |

DATA PROCESSING/PRESENTATION:

	Bohrer Park Lot	Front Lot
Simpson's Index		
Species Richness		
Relative Evenness		
Relative Level of Species Dominance		

6

ANALYSIS:

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?

_____

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2

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

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3. Various human disturbances can cause diversity to change. Based on your data, if all two communities were similar in species composition, which one would you conclude has most likely experienced some sort of human disturbance? Explain.

_____

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4

_____

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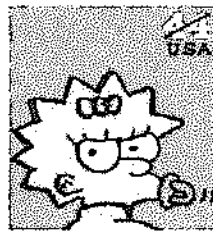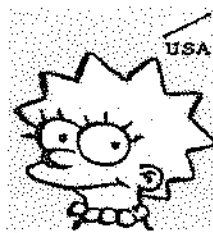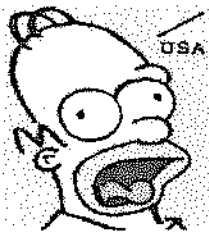
Because: _____

_____

_____

_____

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_____

| 2 |

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

_____

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_____

_____

| 2 |

CONCLUSION/EVALUATION:

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

_____

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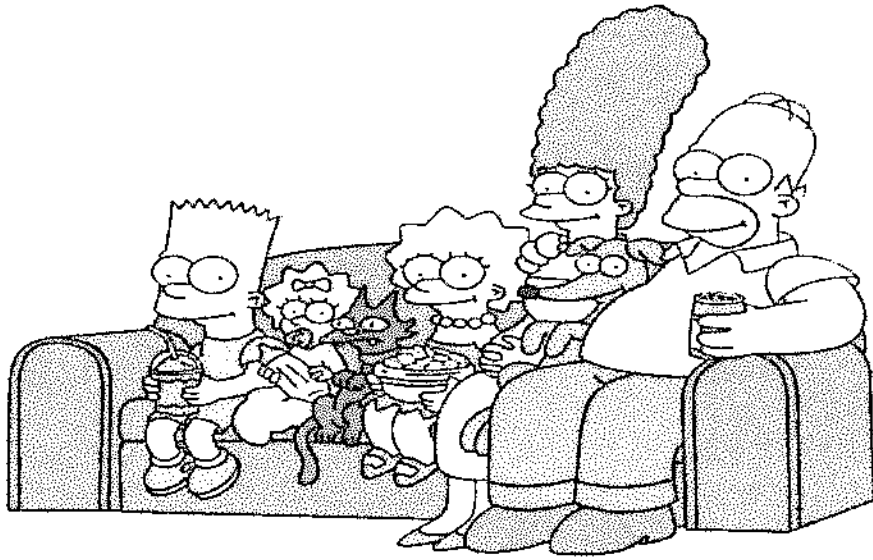
_____

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| 4 |

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7. Thoroughly discuss the opportunities for error in your methods/calculations/conclusions.

_____

_____

_____

_____ | 3 |

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_____

8. How could this lab be changed to make it better for future APES classes?

_____

_____

_____

_____ | 2 |

_____

_____

Simpson's Index - AP

Name:_____

LAB Rubric

GRADE: _____/50

☐ **1. Abstract** (5 pts)
Brief summary of the purpose, basic procedure, findings

☐ **2. Hypothesis & Explanation** (5 pts)

☐ **3. Pre-Lab Questions** (5 pts)
(2 pts)- Which community is most diverse? Provide calculations
(3 pts)- Describe how evenness compares in the three communities. How does evenness affect diversity? Explain.

☐ **4. Data Collection** (5 pts)
Rewrite your results (units included)
Raw data for all 3 lots included

☐ **5. Data Processing/Presentation** (5 pts)
Species richness for each lot
Simpson's Diversity Index for each lot
Relative Evenness for each lot
Relative level of species dominance

☐ **6. Analysis** (15 pts)
9. 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?
10. Which parking lot community is most diverse? Support your conclusion with experimental data.
11. If all "communities" were similar in make-up, which one would you conclude has most likely experienced some sort of human disturbance? Explain.
12. Did any species dominate in any "community"? If so, explain.
13. Explain how immigration and emigration can affect species diversity and richness.

☐ **7. Conclusion/Evaluation** (10 pts)
- Summarize your overall conclusions.
- *NO NEW INFORMATION IN YOUR CONCLUSION*
- Thoroughly discuss the opportunities for error in your methods/calculations/conclusions.
- How could this lab be changed in the future?

OVERALL LAB COMMENTS: