# Measuring Biodiversity: Student Handout

## INTRODUCTION

Snapshot Wisconsin is a volunteer-based wildlife monitoring project at the WDNR. Snapshot Wisconsin involves a statewide network of trail cameras used to capture images of wildlife year-round. Photos are hosted on a crowdsourcing platform, Zooniverse, where anyone can identify what animals appears on the trail cameras. Data collected from Snapshot Wisconsin cameras can be used to evaluate species ranges, population trends, and biodiversity.

Biodiversity refers to the variety of life. Biodiversity can be measured at various levels including genetic diversity, species diversity, or ecosystem diversity. Additionally, there are different measurements of biodiversity such as richness, Shannon diversity index, and evenness. In this activity, you will learn about different indices, or measurements, of biodiversity and use these measurements to analyze biodiversity across different Wisconsin ecoregions using real Snapshot Wisconsin data.

## PROCEDURES AND QUESTIONS

### Part 1: Introduction to Diversity Indices

Before measuring biodiversity using a large data set, like the trail camera data, you will be introduced to calculating richness, evenness, and the Shannon diversity index by hand using a small sample data set.

**Richness** (S) is the total number of species in an ecosystem. Richness does not take into account the number of individuals, proportion, or distribution of each species within the ecosystem.

1. Based on the species list below, what is the richness of this community?

Species: Deer, Deer, Deer, Deer, Deer, Badger, Elk, Elk, Elk, Squirrel, Squirrel, Squirrel, Squirrel, Wolf, Wolf, Red Fox, Sandhill Crane, Sandhill Crane, Sandhill Crane, Porcupine, Porcupine, Bald Eagle, Snowshoe Hare, Snowshoe Hare, Snowshoe Hare

S = _____

Richness alone misses an important component of species diversity: the abundance (number of individuals) of some species may be rare while others may be common. The **Shannon diversity index** (H) accounts for species abundance by calculating the proportion of individuals of each species compared to the total number of individuals in the community ($P_i$).

$H = -SUM (P_i * \ln(P_i))$
Where:
$P_i$ = species abundance/total abundance in the community
ln = natural log

Higher H values reflect more diverse ecosystems; values typically fall between the ranges of 1.5 and 3.5.

2. Using the table below, calculate the total abundance in the community and the $P_i$ value for each species. Next, calculate the natural log of Pi for each species ($\ln(P_i)$) and then multiply the two columns to calculate $P_i * \ln(P_i)$. Limit your numbers to 3 decimal places.

| Species | Abundance | $P_i$ | $\ln(P_i)$ | $Pi * \ln(P_i)$ |
|---|---|---|---|---|
| Deer | | | | |
| Badger | | | | |
| Elk | | | | |
| Squirrel | | | | |
| Wolf | | | | |
| Red Fox | | | | |
| Sandhill Crane | | | | |
| Porcupine | | | | |
| Bald Eagle | | | | |
| Snowshoe Hare | | | | |
| **Total Abundance** | | | | |

3. Calculate H by adding each of the values in the $P_i * \ln(P_i)$ column of the table above and taking the negative of that value.

H = _____

**Evenness** (E) is a measurement to compare the abundances of each species in the community. Communities where the abundance of each species are more evenly represented are considered more diverse than communities where a few species are very common and other species are very rare. Low values indicate that one or a few species dominate, and high values indicate that all of the species in a community have similar abundances. Evenness values range from 0 to 1, with 0 signifying low evenness and 1, complete evenness.

$E = H/H_{MAX}$
Where:
H = Shannon diversity index
$H_{MAX}$ = the highest possible diversity value for the community (calculated by ln(richness))

4. Use the richness value you calculated in question 1 to calculate $H_{MAX}$.

$H_{MAX}$ = ln(richness)) = _____

5. Use the Shannon diversity index value you calculated in question 3 and the $H_{MAX}$ value you calculated in question 4 to calculate E.

$E = H/H_{MAX}$ = _____

**Part 2: Diversity by Ecoregion**

Read through the Ecoregion Appendix to answer question 6 (this will be useful for the following sections as well!)

6. Read about the Northern Lakes and Forest and Southern Wisconsin Till Plains, two ecoregions of Wisconsin. Predict which has the greatest biodiversity? What information did you use to make that prediction?

**Part 3: Measuring Biodiversity using Snapshot Wisconsin Data**

View the Tutorial handout (either Google Sheets or Microsoft Excel depending on your class). Complete the steps in the tutorial before recording your answers. Limit your numbers to 3 decimal places.

7. Calculate the species **richness** for each ecoregion. Record the values below.

| Ecoregion | Richness |
|---|---|
| Northern Lakes and Forests | |
| Southern Wisconsin Till Plains | |

8. Which ecoregion has the greatest species richness? Propose an explanation for differences in species richness from one ecoregion to another.

9. Calculate the **Shannon diversity index** for the two ecoregions types. Record the values in the table below.

| Ecoregion | Shannon diversity index |
|---|---|
| Northern Lakes and Forests | |
| Southern Wisconsin Till Plains | |

10. Is there a relationship between the Shannon diversity index and the richness for each ecoregion? Explain your reasoning.

11. Calculate the **evenness** for each ecoregion. Record the values in the table below.

| Ecoregion | Evenness |
|---|---|
| Northern Lakes and Forests | |
| Southern Wisconsin Till Plains | |

12. Is there a relationship between the evenness and ecoregion? Explain your reasoning.

**Part 4: Interpreting Diversity Indices**

13. Based on the calculations you performed, which ecoregion has the overall greatest diversity? Use evidence from the data to support your claim.

14. Values for Shannon diversity index typically fall between the ranges of 1.5 and 3.5, did the analyzed data fall between these values? What could be a possible explanation?

15. What are some advantages of using trail camera data for calculating biodiversity? Disadvantages?

16. What additional information would be valuable for analyzing the diversity of the different ecoregions that can't be captured in trail camera photos?

17. In ecology, resilience is defined as the ability of an ecosystem to resist change or recover from a disturbance quickly. Which ecoregion do you predict would have the greatest resilience? What evidence supports this claim?

18. An ecological niche is the function of an organism in its environment, which includes the conditions under which it can live, what resources it uses, and how it reproduces. Use the concept of ecological niche to explain the difference in richness from the Northern Lakes and Forests and Southern Wisconsin Till Lands ecoregions.

19. Think about the human population in the Northern Lakes and Forests versus Southern Wisconsin Till Plains. How might human activities influence the biodiversity of these ecoregions?

20. How might biologists use the diversity indices you calculated to inform their restoration efforts?