Name:_____ **Period:**_____

Ecology: Intro. to Math in AP Bio!

Goal: Review Simpson diversity index in ecology while introducing mathematical modeling and application in AP biology.
It's more math than freshman bio, which makes it more fun!

1) Warm-up: The language of math

Term	Symbol	What do you need to do (5 words or less)
Difference		
Per (x per y)		
total		
	∑	

2) Read background activity #1: Modeling and Measuring Ecosystem Biodiversity

OBJECTIVES: After you complete this activity you will be able to

- Describe the structure of a community according to its species composition and diversity
- Use the Simpson Diversity Index to determine the degree of species composition and diversity
- Describe the relationship between ecosystem diversity and its resilience to changes in the environment
- Explain how the addition or removal of any component of an ecosystem will affect its overall short-term and long-term structure

INTRODUCTION

Did you ever wonder why some environments had dozens of different organisms that lived there, while others seemed to be inhabited by only a few kinds of organisms? The biodiversity of an ecosystem acts as an indicator of overall ecosystem health, and can tell you a lot about that ecosystem. There are several different methods that can be employed to measure ecosystem biodiversity. One such measure is the Simpson's Diversity Index.

Biodiversity will increase naturally as **succession** occurs in an ecosystem--as an ecosystem ages and reaches its climax community, the number of species occupying various niches increases which can act as an indicator of ecosystem stability. There are two factors that comprise biodiversity: species richness and species evenness. **Species richness** refers to the number of varied species that occupy an ecosystem, while **species evenness** refers to the number of each species that occupies an ecosystem. The diagram below provides a visual explanation for these concepts:

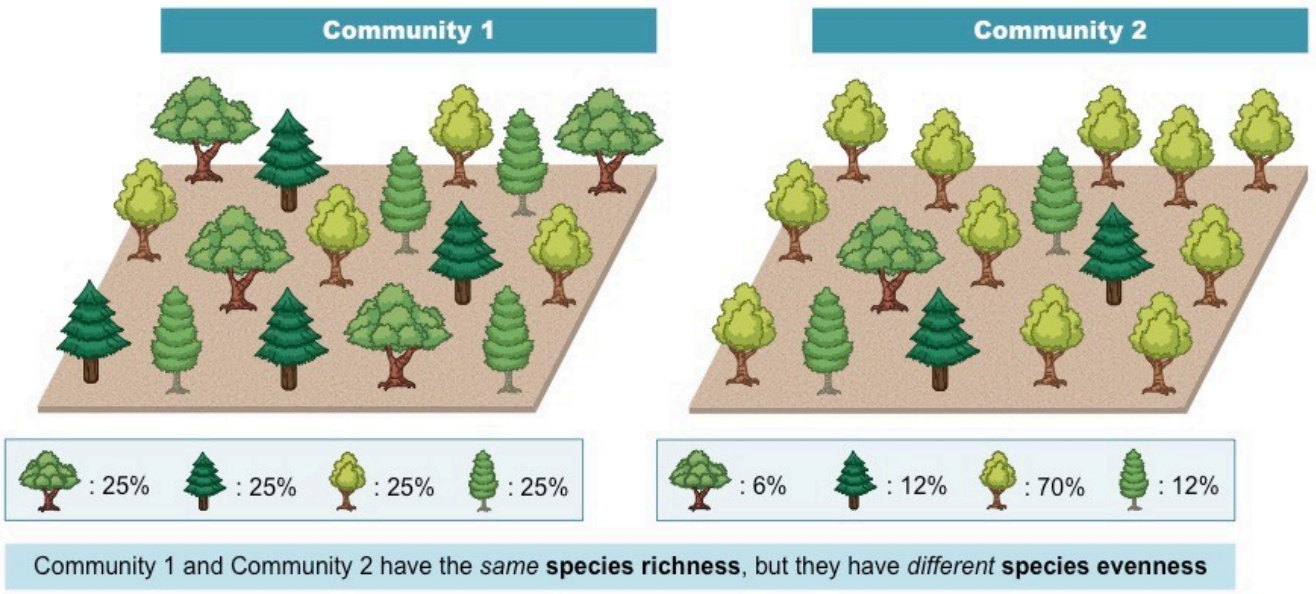


Image source: https://ib.bioninja.com.au/_Media/biodiversity_med.jpeg

Ecosystems such as old-growth forests and rainforests tend to be quite complex in their biodiversity and are stable. However, not all ecosystems have the same level of biodiversity. Humans have altered many ecosystems to reduce their complexity and diversity by converting previously unused forests into cropland, for example. The conversion of forests into croplands reduces biodiversity by creating **monocultures** (all the same species), which presents several problems. Nature's tendency to increase biodiversity through succession is something humans battle in an attempt to maintain these monocultures. This is often done with the use of pesticides and herbicides which kill off undesirable species, but that also tends to create other problems when these substances are used to make it easy to harvest a crop for human use.

The Simpson's Diversity Index is used to determine how biodiverse an area is. The formula we will use looks like this:

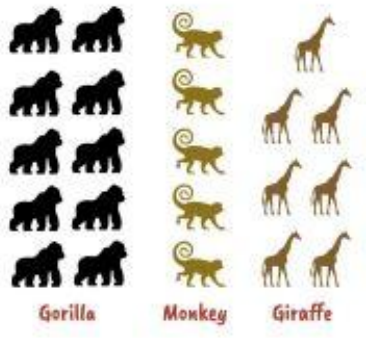
$$Diversity\ Index\ =\ 1\ -\ \Sigma\left(\frac{n}{N)}\right)^2$$

Where n = the total number of organisms of a particular species
N = total number of organisms of all species

The index has values of 0 to 1. A large index value indicates a higher degree of biodiversity and a stable ecosystem with many niches and little competition, while a lower value indicates a lower degree of biodiversity which may indicate an ecosystem with a few dominant species and a greater degree of competition.

In this activity, you'll determine the Simpson's Diversity Index for a model ecosystem, and then compare it to others in the class. You'll then be asked to consider factors that might contribute to the index value for your particular ecosystem, and why. Finally, as a class, you'll use the index value you calculate for each of the ecosystems you analyze to determine which ecosystems are worth rescuing from disaster or human intervention.

3) Practice: Together - Calculate the Simpson diversity index for ecosystem A



		∑	
		1- ∑	

a) Concept check: Ecosystem B has a Simpson diversity index of 0.73. Which ecosystem would you predict to be more resistant to change? Explain your answer.

4) Individual/Partner Practice

MATERIALS

Ecosystem bag with "species" inside	Graph paper	Calculator	Patience for counting 😊

PROCEDURE

1. Get a labeled ecosystem bag from the supply area. There are several different kinds: lawn, agriculture, rainforest, desert, coniferous/deciduous forest, and grassland.
2. Carefully pour out the "species" from the bag onto your work surface and begin sorting them out by species type. Note the number of different species present in your ecosystem. Please keep your species separate from those of other lab groups!
3. On a separate sheet of paper, you will want to create a data chart where you will record the information you will gather from the ecosystems you have selected. Think carefully about what information you will need in order to calculate the Diversity Index for your ecosystem before you make your data chart.
4. Now count the number of each species in your bag and record this information in the data chart you have created.
5. Carefully return the "species" back to the bag and return the bag to the supply area.

ANALYSIS

Now that you've collected data about your ecosystem, use the Simpson's Diversity Index to determine the level of biodiversity your selected ecosystem has. Remember the formula is:

$$Diversity\ Index\ =\ 1\ -\ \Sigma\left(\frac{n}{N}\right)^2$$

Once you have calculated the diversity index for your ecosystem, compare your value to the others in class. Record that information here:

Ecosystem	**Simpson's Diversity Index**
Tropical Rainforest	
Agriculture	
Lawn	
Grassland	
Forest (deciduous/coniferous)	
Desert	

Use this information to produce a graph comparing the biodiversity indices of each ecosystem to one another. Which ecosystem(s) would you invest time and resources into conserving, and why?

4) REFLECTION QUESTIONS

1. When you compared the biodiversity indices to one another, what did you notice?

2. Describe factors that could contribute to a biodiversity index changing over time. Why would these things change this index?

3. If a natural disaster were to strike an ecosystem that had a high species richness and evenness, how would the ecosystem be affected? What if the ecosystem had low species richness and evenness?

4. Describe how human intervention can change biodiversity in positive ways.