Name____ Lab Section__________________

Objectives:

- Gain an understanding of the concept of biodiversity.
- Introduce you to basic skills in sampling and measuring biodiversity in a natural environment.
- Make ecological connections among the organisms observed.

Background material may be found in

- Chapter: 37
- Chapter: 38

Biology: Concepts & Connections,2 nd custom ed.

Introduction

Biodiversity is the term used to describe the variety of life on earth. It includes all the different species (e.g. microorganisms, plants, animals) as well as the genetic variety within those species and all the ecosystems (e.g. coral reefs, forests, deserts) in which they live. Biodiversity also refers to the number or abundance of different species living in a particular area.

Biodiversity is the foundation of ecosystem services to which human well-being is intimately linked. It provides us with an array of foods and materials, and it contributes to the economy. Without a diversity of pollinators, plants, and soils, our supermarkets would have a lot less produce. Most medical discoveries to cure diseases and lengthen life spans were made because of research into plant and animal biology and genetics. Biodiversity is an important part of **ecosystem services** that make life livable on Earth. These services include everything from cleaning water and absorbing chemicals, which wetlands do, to providing oxygen for us to breathe.

In today's lab, we are going to assess the diversity of living organisms found in a natural setting on campus. You are going to sample and count the organisms in an area and use that information to: 1) calculate the biodiversity of the community; 2) evaluate the trophic structure of the community and construct a food chain; and 3) make hypotheses about specific interactions – predation, competition, mutualism – among the species observed.

Procedure and Data Collection

1) Quadrat sampling
   - Measure a 2.5 meter^2 quadrat within the sampling area, making sure not to overlap with another group's quadrat.
   - Using the key to identifying plants, identify each different species present within the quadrat. Record the name of each species and the number of individuals in Table 14.1.
   - When you finished IDing your plants, spend another 5-10 minutes surveying the area for other species such as insects and birds. Identify those species and record them on Table 14.1.

2) Leaf litter sampling
   - Using a trowel, scoop some leaf litter into a large mesh sifter (labeled sift #1). Be careful not to dig down into the soil, but make sure you get under the wood chips. You want to get whatever is living in the material resting on top of the soil.
   - Shake the sifter over its cup to separate the critters from the litter. This is **sift #1**. Look through what **remains in the large sifter**. Identify and record anything you find in the large sifter. Once you have completely looked through the contents remaining in the large sifter, you can dump it back on the ground.
   - Put the contents of sift #1 into your bucket and bring everything up to the lab room.
   - Using forceps, probes and small scoops, search through the material from sift #1, looking for organisms. As you find things, remove them and place them in a separate bowl.
   - After you have thoroughly searched through the contents of sift #1, dump the remaining material into the fine mesh sifter (labeled sift #2) and sift again. This is **sift #2**. Put 1-2 tablespoons of the sifted material from sift #2 into a clean grid petri dish and distribute the material evenly over the bottom. Using the dissecting microscope, search through the sifted material looking for organisms.
   - Using the field guides, try to identify each species you find. Record the name of each species and the number of individuals in Table 1. If you cannot identify a species, refer to it as "Unknown A", "Unknown B", etc., and include a description or drawing.

Table 14.1: Organisms found during quadrat and leaf litter sampling.

Species/Name of Organism*	Sample type (quadrat or leaf litter)	Trophic Level[+] (P, H, C, D)	Number Found (n)	n(n-1)
Total number of species (R) =		**N = ∑ n =**		**∑ n(n-1) =**

* if unknown, use "Unknown A", "Unknown B", etc.

[+] P = producer (photosynthesizes); H = herbivore/primary consumer (eats producers); C = carnivore/secondary consumer (eats animals); D = detritivore (eats dead stuff)

Data Analyses

Calculating Biodiversity

Species diversity is a characteristic unique to the community level of biological organization. Higher species diversity is generally thought to indicate a more complex and healthier community because a greater variety of species allows for more species interactions (hence greater system stability), and indicates good environmental conditions. A uniform population of a single species adapted to a particular environment is more at risk if environmental changes occur. A more diverse population consisting of many species has a better chance of including individuals that might be able to adjust to changes in the environment. Therefore, the question of how many different species exist in a particular environment is central to understanding why it is important to promote and preserve species diversity.

Scientists use several different diversity measures to describe the species diversity within a community and to compare diversity among communities. The simplest way to measure biodiversity is to count the number of different species at a site or in a community. This number gives scientists a measurement of **species richness**.

Species Richness

This value is determined simply by counting the total number of species found in a community. This value is R in Table 14.1. **Record the species richness of your sample here.**

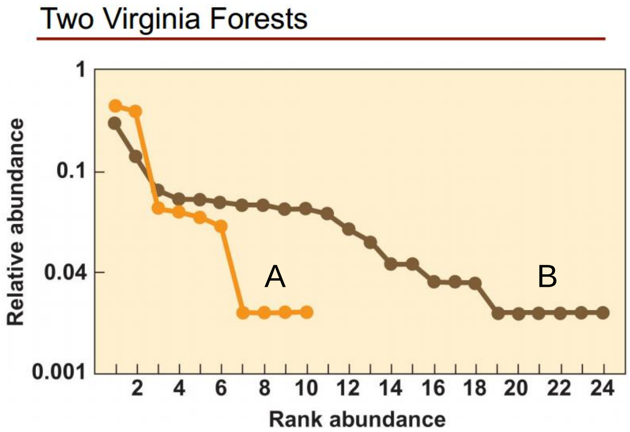
R = ___________________

By comparing species richness at two sites or communities, scientists learn something about biodiversity. But a simple survey of species richness does not necessarily give a complete picture of biodiversity in a community because it does not place any importance on **relative abundance** of each species. A community is said to have high species diversity if many nearly equally abundant species are present. ***If a community has only a few species or if only a few species are very abundant, then species diversity is low.***

Relative Abundance/Evenness

Rank-abundance curve

Relative abundance is best shown by creating a rank-abundance curve. This is done by plotting the proportion of each species' abundance vs. its rank (from most abundant to least abundant). The greater the slope of the resulting line, the less diverse (less "even") the sample, and the flatter the slope, the more diverse or "even" the sample. For example, rank-abundance curves were constructed using data from two forests in Virginia. You can see the line for forest "B" is flatter than that of forest "A" indicating that forest "B" is more "even" and diverse than forest "A".



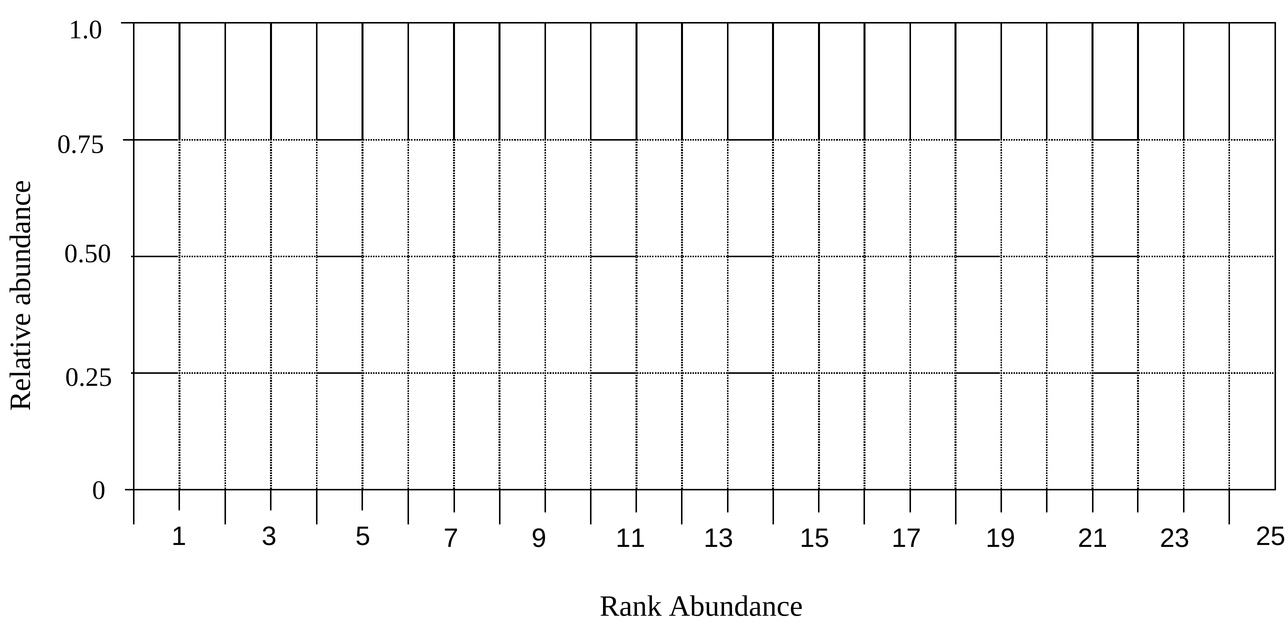
You are going to determine the evenness of your area by making a rank-abundance curve with your data.

1. Transcribe your data from Table 14.1, to Table 14.2, listing each species in order from most abundant to least abundant.
2. Calculate ∑ n by adding up the total number of individuals you found. This value is N.
3. Calculate the relative abundance of each species by dividing the number of individuals of each species (n) by N (∑ n). Put this value in the last column on Table 14.2.
4. Plot the relative abundance vs the rank abundance of each species on Figure 14.1.

Table 14.2: Rank abundance

Rank	Species/Name of Organism	Number Found (n)	Relative abundance ($n/\sum n$)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
	$N = \sum n =$		

Figure 14.1: Rank Abundance Curve



Examine your rank-abundance curve to determine how “even” your area is. A line with a relatively flat slope indicates your area is more even and more diverse. A line with a steep slope indicates your area is less even and less diverse.

What does your plotted curve tell you about the diversity of your area?

Simpson’s Index of Diversity

The Simpson’s Index of Diversity is one method for estimating diversity that takes into account both species richness and the relative abundance (evenness) of each species. This index will range from 0 to 1, where a value closer to 0 indicates less diversity and a value closer to 1 indicates more diversity.

To calculate this index, use the numbers from Table 14.1 (page 2) and Table 14.2 (page 4) and plug into the formula:

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

This value is the number from the lightly shaded area at the bottom of Table 14.1.

N is the number from the lightly shaded area at the bottom of Table 14.2.

D = ―――――――― =

Simpson’s Index of Diversity = 1 – D

=

What does this value tell you about the diversity of your area?

Comparison between a Terrestrial and Marine Community

Lastly, we are going to use the values you calculated in lab 13 (a marine community) to compare with the diversity of the terrestrial community. **Transcribe the values for R and 1- D from tables 13.4, 13.6, 14.3 and 14.5 to table 14.3**. In addition, using a pen or pencil of a different color **replot the data from table 13.4 onto figure 14.1** (the rank-abundance curve).

Table 14.3: Diversity measures for a terrestrial and marine community.

	Terrestrial Community	**Marine Community**
Species Richness (R)		
Simpson's Index of Diversity (1 – D)		

Looking at species richness, the rank-abundance curve and Simpson's Index of Diversity, do the two different communities have similar levels of biodiversity?

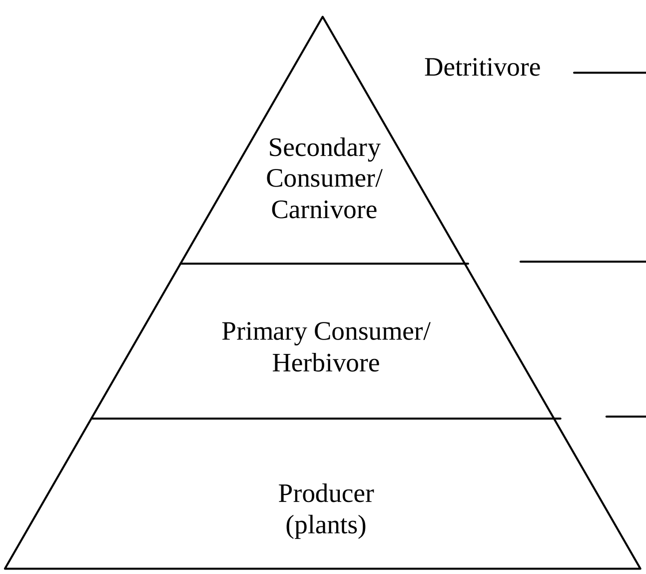
If not, which one is higher? Develop an hypothesis explaining why.

Trophic Structure

Once you have listed all the organisms from the sampling area, examine them with respect to what you think each different species eats and what level they are in the trophic structure (e.g. producer, primary consumer [herbivore], secondary consumer [carnivore], decomposer [detritivore]). In Table 14.1 assign each species to the trophic level in which you think it belongs and choose 2 or 3 species you think it might eat.

Examine your data and develop a food web for this community. Your food web should consist of at least four (4) trophic levels and have at least 2 species in each level. Write your food web in the space below.

Detritivore ______________________



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Each species in an ecosystem, no matter how small, interacts with other species. These interactions are critical to the proper function of the ecosystem. If you remove one species, it is very likely to affect another, which can affect another, and so on.

There are many types of interactions that occur among members of an ecosystem. A few of them are:
1) **predation** (+/-) – when one organism eats another

2) **competition** (-/-) – when two different species try to use the same resource at the same time

3) **mutualism** (+/+) – when two different species interact so that both benefit

Using the species you found, generate a hypothesis for each interaction, explaining which species are involved and what their role is.

Predation: What species do you think eats what other species? Which is the predator and which is the prey?

Competition: What species do you think might use the same resource, and what is that resource?

Mutualism: What species do you think work together to the benefit of both? Explain what each species does and how they help and are helped by the other species.

LABORATORY NOTES