



## DEFINING AND MEASURING BIODIVERSITY

Greg Goldsmith, Integrative Biology, University of California Berkeley

**Grade Level:** 9-12

**Introduction:** Understanding and measuring biodiversity is no easy feat, especially when thousands of species are involved. Nevertheless, it is critical to have accurate measures for research and conservation. Students will consider the definitions of biodiversity and generate a method to accurately estimate the number of plant species growing epiphytically in the cloud forest canopy.

**Major Themes:** biodiversity, experimental design

**Connections to the National Science Standards:** Science as inquiry, Populations and ecosystems

**Time:** 1 hour (15 mins for introduction and handout reading, 10 mins for initial biodiversity count, 5 mins for discussion, 15 mins for standardization and recount, 15 mins for closing)

**Materials:** This plan is designed for use with the canopy panorama for the middle elevation forest site (#2). I recommend that students click on the “natural scene” button, which will facilitate better viewing for the purposes of the exercise.

**Objectives:** Students will be able to 1) define biodiversity and recognize the complexities of having a single definition and 2) gain a basic understanding of biodiversity sampling and the need for replication.

**Potential Misconceptions:** Students may have the following misconceptions:

1) Many students believe that biodiversity is simply a count of the number of organisms in a location. However, biodiversity has many definitions. For instance, it is often a measure of the number of different functions that organisms are performing in an ecosystem (i.e. number of herbivores, omnivores, predators, decomposers).

2) Biomass is the weight of living organisms. In contrast, biodiversity is a count of organisms, either from an absolute number or from a functional perspective. Students may confuse areas that appear to be more covered in epiphytes as having more biodiversity. This is not necessarily true, since biomass can increase, decrease, or stay constant even as biodiversity changes.



## PROCEDURE

**Opening:** Ask students to define biodiversity and write key ideas on the board. It may help to split the word into its components “bio” and “diversity,” so as to elicit the idea that diversity can encompass many different measures. Follow by asking students why measuring biodiversity is important. Tell students that they will first read a brief description of biodiversity and its measures, then practice biodiversity measurement using a canopy panorama (refer to handout page #1).

**Development:** Students will then read the handout, which asks them to navigate to the canopy of the panorama and derive an estimate of the number of plant species growing epiphytically in the canopy. Students should write their estimate in the appropriate space. Since time and resources for biodiversity estimates are limited, students should be limited to 10 minutes for this exercise.

Ask students to share their estimates and write them on the board. Estimates will likely vary widely; ask students to talk about how much of the canopy they counted and which plants they included (i.e. did students include mosses and lichens?), as potential sources of error in the different estimates.

Thereafter, ask students to form small groups and derive a standardized estimate of biodiversity. Stress the idea of using independent samples (replication) in order to derive an accurate estimate (via averaging) when the entire area cannot be measured. Note that the estimate of canopy biodiversity is limited to conclusions about the canopy of this tree and that making an estimate about the canopy in this forest would involve independent samples in a large number of trees.

Students can either standardize their biodiversity sampling technique to a class-wide technique, or work within groups to re-analyze the panorama and generate new estimates. Final estimates can be shared on the board. Techniques and findings can be discussed as necessary.

**Closing:** Working alone or in small groups, ask students to consider the following prompts (refer to handout page #2):

- 1) What is a working definition of biodiversity, as measured in this exercise and how does it differ from other definitions?
- 2) What are the primary components to achieving an accurate estimate of biodiversity?
- 3) How does one decide what to count and what not to count?
- 4) How would including the number of each individual species occurring in a sample (i.e. species density) have changed the process and how might this additional information prove valuable?

**Suggested Student Assessment:** Ask students to consider a scenario in which they must provide advice on measuring biodiversity to a conservation organization deciding between the purchase and preservation of two different forests (refer to handout page #3). Students advice will vary, but should emphasize different measures of biodiversity (i.e. numeric and functional) and discuss



the need for replication in order to derive an accurate estimate. Students may also identify more specific techniques for successful estimation.

**Vocabulary:** biodiversity, replication, species richness

**Extending the Lesson:** Bring your students outside and challenge them to create an appropriate sampling design for measuring some aspect of diversity. You may want to provide them with basic tools (i.e. tape measures, meter sticks, string). This can be done in any small piece of woods behind a school or even in an urban environment (i.e. insects or moss). For an advanced group, try the exercise with birds and discuss the challenges of measuring a moving animal as compared to a rooted plant.