



### Bean Biodiversity:

Healthy ecosystems, such as a salt marsh, temperate forest, and tropical rainforests, are complex webs of living and nonliving elements. An important Measure of an ecosystem's health is its biodiversity. The term "biodiversity" itself is defined in diverse ways. It may be "all living things within a given geographical area and the interrelationships among them (Audesirk & Audesirk 1996). E.O. Wilson - a brilliant man with a lot to say about diversity calls it "all of the variety of life - from the different genes at the same chromosome position within populations, up through different species of organisms, on up to different aggregations of species in ecosystems. Familiarity with the term has increased in the last couple of decades as extinction rates, driven by human activities, have reached a crisis level.

For our purposes we will define and use this biodiversity definition. "Biodiversity is the variety of life that occurs within an ecosystem (commit this to memory)". A population is "a group of one species that live in a particular geographic area (Campbell's, 1996)". Although it is important to view life at all structural levels, many ecologists use the "species" level of taxa (short for taxonomy) to determine the biodiversity of the system being studied. Two simple methods for describing the biodiversity are richness and abundance. Richness is defined as "the number of unique taxa (species / organisms) present". It does not give you an indication of how the population (# of each species) is distributed. In other words, a system with 100 grackles, 1 red-wing blackbird, and 1 American crow has the same biodiversity (richness value 3) as a system with 34 grackles, 34 red-wing blackbird, and 34 American crow. Abundance (sometimes called "relative abundance") is "the number of individuals present in each taxonomic group relative to the total number of individuals" (# of individuals in each taxonomic group, population / total # of individuals from all taxonomic groups being studied X 100). It is expressed in percent. For example: # of red wing blackbirds / total # of birds in the study area X 100. Okay, lets practice.

**You are Bean Counters** (actually, you are ecologists studying the biodiversity in the ecosystem defined by the volume of a coffee can called "bean world")

### **Materials**

Cup / Beaker (This captures a sample from the ecosystems you will observe.)  
A sample of organisms from one of the ecosystems (can A, can B, can C, or can D)  
Pencil  
Graph Paper  
The ability to count beyond 10 without your fingers

### **Procedure**

1. Pour (capture) beans (~100) from ecosystem (can)
2. Record the can: A, B, C, or D, you took beans from (return beans to the same can when you are done counting).
3. Record the type of beans / unique taxa and the number of individuals in each taxonomic group in table 1.
4. Calculate the total number of individuals (beans) in the community
5. What is the richness for your community?
6. Calculate the relative abundance of each taxonomic group  
 $\frac{\text{\# of individuals in each taxonomic group}}{\text{Total \# of individuals in the community}} \times 100$  or  
 $\frac{\text{\# of individuals for each type of bean}}{\text{Total \# of beans}} \times 100$
7. **Graph relative abundance**
8. Return beans to correct can (to live happily ever after)
9. Repeat process with another community (coffee can)
10. Answer questions

**Bean Table 1**

Bean Community (Circle one) A, B, C, D

Taxa/ species / bean description	# of Beans	Relative Abundance
Total # of Beans		
Richness		

**Bean Table 2**

Bean Community (Circle one) A, B, C, D

Taxa/ species / bean description	# of Beans	Relative Abundance
Total # of Beans		
Richness		

## Questions

1. Which community has the greatest richness?
2. Which bean taxa has the greatest relative abundance in each community?
3. Which bean taxa is most likely to become extinct? Why? (okay, we all know the beans are safe in the coffee can - pretend they are subject to the forces of natural selection and the negative consequences of human activities)
4. Which community has the greatest biodiversity? Use richness, abundance to support your answer.
5. Urbanization is the process by which humans occupy and modify ecosystems. It is a matter of degrees, with densely populated areas (such as Broadway in Revere) representing one end of the spectrum and wilderness areas representing the other. How does urbanization effect habitat quality and quantity?

## Teacher Guide for Bean Biodiversity Activity

Overview and rationale:

Students will learn two methods (richness and abundance) for measuring and expressing the biodiversity of an ecosystem. The skills will be used to ascertain the health of actual ecosystems explored as part of a class field study component.

- Students will measure the richness and abundance of a model ecosystem (can of beans)
- Students will graph data for model ecosystems
- Students will use findings to answer questions about model ecosystems.

Materials:

- Coffee cans or similar container
- Cups (beakers may be substituted)
- A large assortment of dried beans (Dark kidney beans, light kidney beans, navy beans, dried yellow peas, dried green peas etc)
- Copies of activity; include enough data sheets for the number of ecosystems (cans of beans) you want students to study.

Teacher time & preparation: (~1 hour)

- Purchase beans (supermarket)
- Label each can (A, B, C, D...)
- Distribute beans. Creating ecosystems with the same richness but different levels of abundance will force students to justify answers (why one ecosystem has greater biodiversity than another)

Example:

Can A Richness 10 – uneven abundance

Can B Richness 10 – even abundance

Can C Richness 4 – uneven abundance

Can D Richness 4 – even abundance

Time:

Allot ~1 hour for introduction and data collection / analysis.

Potential issues:

- How many beans/peas should be put in each cup? Amount varies with time, objectives, and how much you like/dislike the student(s).
- Students may want to count split peas as half. Decide how peas are to be counted before starting.
- Similar shaped and colored beans (Ex. Light and dark kidney beans) create good discussions about “species” Is it normal variation within a species or a separate species? Again, having this discussion before students begin counting will prevent issues later in the activity.
- Students may notice that species occupy different trophic levels and therefore some variation in abundance is to be expected and is not a measure of a less healthy ecosystem. Scientists generally group species by order and trophic levels to get a better measure of biodiversity evenness.

Extension / Follow-up:

- Data can be used to introduce Frequency and Biodiversity indices (Shannon-Weiner or Weaver Biodiversity Index)
- Take students to a field site to study biodiversity. Birds are generally easy to study. Insect traps (pit traps) can be set up on school campus. Aquatic macroinvertebrates can be collected using kick nets, leaf-litter bags. Minnow traps can be used to collect organisms.
- Bird biodiversity activity
- Virtual Ecology Web based activities such as <http://faculty.etsu.edu/jonestc/Virtualecology.htm>