Bead of a Different Color

Calculating Biodiversity Index Using an Indoor Activity

An *UrbanWatch* Lesson Plan

Level: Grades 6–12 **Site: Classroom**

Time Format: One to two 50-minute periods

Background

Biological diversity is all around us. It's in the variety of habitats that surround us, the different kinds of plants and animals that we see, and the subtle differences among plants and animals of the same kind. There are three levels of biological diversity:

1. If we look out the window and see woodlands, wetlands, and grasslands, we are looking at a scene that has high ***ecosystem diversity.*** On the other hand, if we can only see croplands or housing developments, the ecosystem diversity is low.
2. Another level of diversity is ***species diversity.*** This diversity is displayed by the number of different plants and animals present. A forest with dozens of kinds of trees and hundreds of kinds of other plants is more diverse than a city park with turf and three kinds of trees.
3. The third level of diversity is the hardest to see. It is ***genetic diversity***. Within a single species of plant or animal, there is variation. Take a close look at two plants of the same species collected from different locations, and you may notice subtle differences in color, leaf shape or height.

We are going to focus on species diversity among plants. It's not hard to see that a prairie is more diverse than a lawn or that a woodland forest is more diverse than a city park. However, sometimes the differences are more subtle than that! How do scientists know that some places are more diverse? How do they know that diversity is declining on a worldwide basis?

In order for scientists around the world to calculate, compare and discuss diversity, they have created many tools. One method uses sampling techniques and the Diversity Index to assign numerical values to the biodiversity of a given habitat. The Diversity Index is a tool that scientists use to:

- Calculate the diversity of organisms in an ecosystem and establish baseline information about a site. Baseline information provides a point of reference so that changes to plant communities can be measured.
- Measure the health of an ecosystem or compare healthy and disturbed sites.
- Track changes in diversity at one location over time. Monitoring could help determine if the changes are due to succession, disturbance or invasion of a non-native species.
- Show the changes to vegetation at a site during and after an invasive species control project or evaluate the effectiveness of various control methods.

GPS Standards Addressed

S6CS1; S6CS2; S6SC3
S7CS1; S7CS2; S7SC3; S7L1, S7L3, S7L4; S7L5
S8CS1; S8CS2; S8SC3
M6D1; M6P5; M7A2; M7P3
SEV2; SEV3; SEV5; SB4, SB5, SCSh1-6; SCSh8

Focus

Life Science, Math, Biodiversity, Native/Invasive Species

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Objectives

1. Students will realize that scientists use sampling techniques to measure biodiversity.
2. Students will calculate the Diversity Index of plants (beads) along a transect line (in a bucket or other container).
3. Students will understand the importance of diversity indices in measuring the success of invasive species control methods.

Materials

- 100 beads of various colors in a container for each group (two to four students per group)
- Paper, pencils and writing surfaces

Optional Materials

- Calculators

Activity Introduction

Getting Ready

Prepare containers of beads for the warm-up activity. There should be 100 beads in each container. Try to vary both the number of different colors of beads and the number of each color. For example, the container representing a very diverse habitat could have equal numbers of 12 different colors of beads while the container representing the least diverse habitat could have only two different colors of beads with most of them one of the colors.

Doing the Activity

1. **Talk about sampling.** If you were a scientist assigned to measure the biodiversity of plants in a habitat, how would you do it? (Entertain all answers, but help students realize that rarely can scientists count EVERY plant in an area. Instead, they take samples using various sampling techniques and then perform calculations on samples.)
2. **Introduce random sampling and the Diversity Index.** Explain that the students are going to use random sampling and a Diversity Index to study the "populations" of various beads in a "habitat" or container. Explain that the students are going to randomly pick a sample of beads from the container.
3. **Get ready for the warm-up activity.** Divide into teams of two to four. Give each team a habitat with 100 beads. Each color of bead should represent a different "organism" in the habitat. Assign a letter to each bead color by writing a code on the board or asking students to record it in their lab books.
4. **Conduct the sampling.** Instruct students to randomly choose ten beads from their containers, one at a time. Using the letter symbols, they should record each bead as they remove it. Their results should look something like this: P B G G G W W G B B.
5. **Count the number of runs in the sample.** Group letters that are the same by drawing alternating lines above and/or below the letters. The results from above would look like this: P B G G G W W G B B. The number of runs is the number of groupings, or strings, of the same organism found consecutively in the sample. A run can consist of only one species at a time. This example has six runs.
6. **Count the number of individuals in the sample.** The example shows ten individual beads.
7. **Calculate the diversity index.** Use the following formula:
   Diversity Index = number or runs/total number of individuals = 6/10 = .6
8. **Discuss the results.** The Diversity Index is a measure of the biodiversity of a group of organisms in an area. The value of the diversity Index will vary between 0 (no diversity) and 1 (high diversity).
   - How did the Diversity Index values vary from group to group? Note that the variety of beads is not the same from container to container. In other words, some habitats are more diverse than others.
   - Which habitat is the most diverse? (Assume that the container with the highest Diversity Index is the most diverse.)

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Bead of a Different Color (continued)

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Activity Introduction *continued*

- Which habitat is the healthiest? Why are populations that are more diverse usually more stable? Why would a diverse population be more resistant to disease, predation, and invasion?
  - Which habitat seems to be dominated by one or two species of beads? What is the Diversity Index of that habitat? What kind of real-life habitat might this represent? (It might represent an area that has been planted for agriculture or an area that has been invaded by an invasive species.)
  - Assume two habitats have the same number of "species" of beads. One habitat is predominantly one species of bead with just a few beads of the other species. The other habitat has equal numbers of all the different species. Which will have the highest Diversity Index? (The habitat with equal numbers of each species will have the higher index. The number of different species (species richness) and the number of individuals of each species (species evenness) are both important measures of biodiversity.)
  - If you repeated the whole process with the same container of beads, do you think you would get the same results? (Probably not. This is why scientists often take several samples and average the results. Also, with *UrbanWatch* BUS surveys we generally tally data from every group and enter them into the online database. This assures a more accurate snapshot of the diversity for that green space.) If you have time, take three samples and average your results. You can also tally the entire container of beads and see how the Diversity Index of the whole compares with the Diversity Index of the sample.

Going Further

See the *UrbanWatch* "BUS Surveys" activity for instructions on how to set up and conduct a Biodiversity Urban Survey in a green space at or near your school. This is the outdoor application of the indoor biodiversity activity your class just completed. Environmental Educators from Fernbank Museum are available to assist with setting up and conducting these outdoor surveys, as well as with collected data submitted online. Their contact information is listed below.

Contact Us: *UrbanWatch Atlanta*
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Adapted from the Wisconsin Dept. of Natural Resources "Invaders of the Forest" program, updated by Fernbank Museum of Natural History.