Mesofauna biodiversity investigation

Can human impact affect the biodiversity of soils? How can Simpson's Index of Diversity help to determine the species richness of disturbed soils?

A healthy soil demonstrates high biodiversity with millions of mesofauna (microscopic invertebrates) and macrofauna (macro-invertebrates). Mesofauna are busy decomposing organic material and releasing key nutrients for plant use within the soil. Macrofauna play an important role in soil aggregation, porosity, and carbon accumulation within the soil. Healthy soils demonstrate high biodiversity. Human impact on soils due to construction, agricultural production, and lawn care can decrease soil biodiversity. Soil ecosystems can be altered as soil structure is changed and/or the loss of nutrients and/or erosion occurs.

Simpson's Index of Diversity is a tool used to measure the level of biodiversity present in each soil sample. It measures both the **species richness** (number of species per sample) and the **species evenness** (relative abundance of each individual species per sample) in a community. A community dominated by one or two species is considered to be less diverse than one in which several species have a similar abundance. The Simpson's Index of Diversity value (D) ranges between 0 and 1. In Simpson's Index of Diversity, 1 represents infinite diversity and 0, no diversity.

The Berlese funnel is commonly used to isolate small organisms. A sample is taken and put in the funnel with a wire or mesh screen below the litter. A bright light is placed above the funnel and a container with alcohol is placed below the funnel. As the leaf litter dries, from the top down, the organisms in the leaf litter will migrate downward, trying to stay in the moist litter, and will eventually fall into the alcohol, which will preserve them for later observation. They can then be sorted and classified and the diversity index can be determined.

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

Simpson's Index of Diversity

n = the total number of organisms of a particular species

N = the total number of organisms of all species

It is important to measure the volume of your sample in order to compare the Simpson's Index of Diversity of your sample to the entire ecosystem.

- 1 acre = 43,568 ft^2
- 1 inch of soil = .0833 ft

If your sample is two inches deep and measures 8 inches long by 10 inches wide, its volume (ft^3) equals:

.1667 ft deep × .6664 ft long × .833 ft wide = .0925 ft^3

Materials

- Mesofauna sample
- Gallon zip lock bags
- 2 L bottle or cardstock/tape to create Berlese funnel
- Scissors
- Heavy duty tape (duct tape or similar)
- Scale
- Ruler or tape measure
- Screen (wire, mesh, or cheesecloth)
- Isopropyl alcohol
- Dissecting microscope or magnifying glass
- Small jar with lid
- Petri dish
- Heat lamp

Content designed by educationprojects.org on behalf of the farmer board at Ohio Corn & Wheat.

Instructions

Day 1

1. Research different methods of human impact on soil structure (agricultural tillage practices, construction, lawn/flower bed, etc.) to better understand their impact on soil structure.
2. Brainstorm how these human impacts affect the Simpson's Index of Diversity values of a disturbed soil ecosystem compared to an undisturbed soil ecosystem. This can be done on Google Jamboard, using sticky notes, etc. Use this information to predict the Simpson's Index of Diversity for each human impact.
3. Get a plastic bag and go to your designated locations. Collect all of the leaf litter and soil on the top layer of humus (to the extent that you can remove it with your fingers) and place into your plastic bag.
4. Measure the area and depth of the soil sample and record. Determine how large the ecosystem is that your sample is taken from. If you are sourcing your sample from an agricultural field, ask the farmer and determine the acreage of the field.

Day 2

5. Create a Berlese funnel apparatus.
   a. Cut the top of a 2-L soda bottle off at about one third of the height. The top part will function as the funnel and will be inverted and inserted into the lower part of the bottle. *Alternatively, you can create a funnel out of heavy cardstock by creating a funnel and taping the edges together.*
   b. Pour the isopropyl alcohol into the small jar to a depth of 1.5 cm. Place the jar in the bottom of the 2-L bottle. *Alternatively: If you are using a cardstock funnel, place the jar of alcohol below the funnel on the table.*
   c. Invert the top part of the bottle and cut some mesh large enough to create a basket in the wide end of the funnel. To do this, you might need to fold up the corners of the mesh to make it fit inside the funnel part of the bottle. *Alternatively: If you are using a cardstock funnel, place the mesh in the funnel to prevent the mesofauna from falling through.*
   d. Tape the edges of the mesh to the inside of the container. *If you are using a small mesh (such as a window screen) create a loose pit in the middle that is deep enough to hold your soil and allow the fauna room to burrow down. Cut numerous slits into the screen first so that larger animals can crawl through.*
6. Carefully set the funnel on top of the bottom portion of the 2-L bottle, making sure it fits tightly in the bottom and does not tip over. The tip of your funnel should be close to the jar with alcohol but should not touch the liquid.
7. Place the mesofauna (leaf litter/soil) that you collected into the top of the funnel so that it rests on the mesh.
8. Put a light above your funnel apparatus to help dry out the sample.

Day 3

9. Gently pour the contents of the alcohol jar into the petri dish for observation.
   Keep the alcohol jar tightly covered when not in use.
10. Set up a dissecting microscope and place the petri dish under the microscope to identify the species of invertebrates. If you do not have a dissecting microscope, use a 10× magnifying lens.
11. Use Invertebrate classification charts to help with your species identification and record them in your data table. If you cannot determine their identity, count the number and name them Species A, B, etc.
12. Collect data following the steps below.
    a. Create a lab journal entry that includes the predicted Simpson's Index of Diversity ratings for human impact areas brainstormed in instructions number 2 and the following data collected during this lab.
    b. Determine the species abundance and species diversity of your sample locations. How do these samples compare

to the entire ecosystem? What is the diversity index of the ecosystem? *Draft the data tables needed to display raw data collection that is measured for your trial. You may want to use another piece of paper for this and the following requirements below. Here is an example.*

Species	**Number (n)**	**n(n–1)**	**Observations**
Total	**N =**	**∑ n(n–1) =**	

c. Determine the differences in the Simpson's Index of Diversity values for your location. Show your work.
d. Create a data table to demonstrate the calculated D values from other student groups to determine the mean for each location.
e. Graph your data. Be sure to include a scaled interpretation of the volume of the ecosystem that the sample was taken from. *Remember, the x-axis is the horizontal axis and always is the independent variable. The y-axis is the vertical axis and is the dependent variable.*

Reflection

Based on your findings from the lab, what conclusions can you draw? Write a conclusion to show your interpretation of the data and how it relates to the concepts studied in this lab.

1. Describe the location that your sample is taken from. Be sure to include: sample size, ecosystem size, physical description, and other observations.
2. What was your Simpson's Index of Diversity prediction for the location? Be sure to include what led you to make this prediction.
3. What is the calculated Simpson's Index of Diversity for your location? Be sure to include the calculations, data charts and graphs.
4. How did your data and calculations compare to your predicted Simpson's Index of Diversity?
5. Does there seem to be a relationship between the sample locations and the biodiversity calculated? If so, what is that relationship?