Measuring Biodiversity

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Overview: In this lesson, students learn a few key concepts associated with measuring biodiversity (here measured as species richness).

Lesson Concepts:

Your measure of species richness depends on your sampling effort. In general, when you spend more time looking, or cover a greater area, you find more species, until eventually you find all of them.

1. If you sample a greater diversity of habitats, you are likely to find greater number of species than if you sample only one kind of habitat/ecosystem. (greater ecosystem diversity leads to greater biodiversity)
2. The number of newly sampled species decreases with time/effort.

Review concepts to repeat:

1. Biodiversity is different kinds of living things.
2. We can measure biodiversity.
3. Different types of animals and plants live in different habitats.
4. We replicate our samples.
5. We take random samples to avoid bias.

Grade span: 6-8 or 9-12

Advanced preparation:

You will need:

- Variety of dried beans/grains (10+ kinds)
- Paper cups (Dixie cups or larger)
- The first paper cup per group should be almost full (if Dixie cups) with 6+ kinds (of varying proportions from very common to very rare) of beans to start. You'll need about half a cup of 4+ species for the second "stream" round.

Each group will need:

- A yardstick (or some straight-edge)

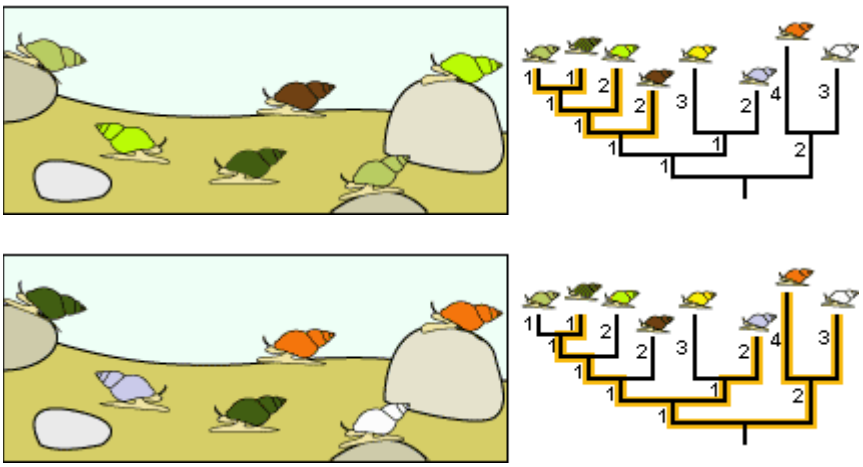
- A very large sheet of paper (at least 2 x 3ft or so)

Time: 50 minutes

Grouping: Divide the class into groups of 4-6 students.

Teacher background:

Biodiversity can be measured in a number of ways. Genetic diversity is a measure of the genes represented in the sample. For example, even though both snail samples below have four species, the sample on the bottom has more genetic diversity.

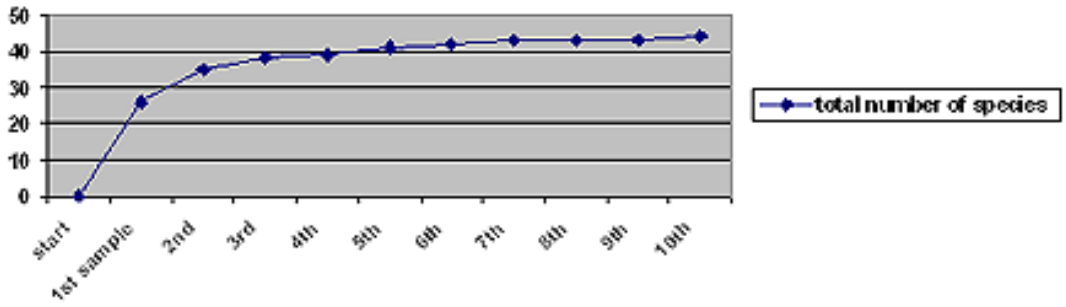


Graphic courtesy of Understanding Evolution http://evolution.berkeley.edu/evosite/relevance/IIIC3Scenario.shtml

Ecosystem diversity is sometimes used as a proxy for biodiversity since different types of animals/plants live in different habitats. If your sample encompasses different habitats/ecosystems, then in it should have a greater variety of plants/animals than if you sampled one ecosystem/ habitat.

Many people measure species richness, or the number of species in a given area. You collect most (common and abundant) species in the first samples, and then fewer and fewer additional (rarer) species as you continue your effort. Eventually, you might collect all species in the area, for example if you're collecting mammals in California. Sometimes, you might not realistically have the means to collect all species, such as insects in a rainforest. To get an idea of how much you know, vs. how much you don't know, it's useful to graph your data as you sample (x= sampling effort, such as unit search time or area; y= total number of species recorded). This is called a "species accumulation curve." If you graph your results and see you're still in a steep part of the curve, then you know that you will probably find more species with just a little more effort. If you're in the flatter part of the curve, then you've seen most or all species in the area, and it might take a lot more effort to find additional species. Sometimes, we don't have time to do a thorough sample (such as a rapid ecological assessment after an

environmental disaster, or quick ecosystem monitoring). Because of the nature of this curve, we know that we measure a lot of an area's biodiversity in the early samples. Thus, although incomplete, quick assessments can still be very helpful.



Teaching tips:

Write results on the board as you go, next to whatever change you introduced into that round.

Procedure:

1. Divide the class into groups of 4-6.
2. Give each group a very large sheet of paper, tell them that this is their grassland (or any other ecosystem). Pretend it's about an acre (or other large unit of area).
3. Give each group the initial cup of beans and tell them to scatter their "species" randomly around their habitat.
4. Ask them how they would measure the biodiversity of their grassland. What would they count? Would they be able to count everything? Lead them to: Counting species ("kinds"). Sample parts of the area, for example, by dividing it into a grid and counting smaller representative areas.
5. Have them draw a grid on their paper (depends on size of paper, but you'll want about 30 squares or so). Then sample (count the species) in three of the squares. They should close their eyes and point to find which squares they sample (review why).
6. Ask the class how many groups came up with the same number of species in all of the squares they sampled (only one of our groups did). Discuss why.
7. Now draw a stream across the page, should be at least a few inches wide. Remove any grassland species that are now in this stream.
8. Give them another Dixie cup with four+ species of beans to scatter along the stream (again, some very common, some rare).
9. Re-sample their first three squares, and then another random three.
10. Record and discuss the numbers. We now have greater habitat diversity, so more species can live on our paper, even though grassland diversity alone didn't change. Squares with a combination of stream and grassland have higher diversity (more species).

11. Now, as a class, count how many species are in the entire ecosystem. Write this number on the board. Give each group a pile of beans that includes one of each type ("extra beans").
12. Each group should then sample one (random) square at a time, recording how many ADDITIONAL species they get from each square. They can keep track by moving the "extra beans" from an "unsampled" to a "sampled" pile on the desk (not on the paper!). Do not move beans back to the unsampled pile. This helps students keep track of what they found in previous samples.
13. Have the students record these data in a table, left column: sample number (square1, 2, 3, etc for the rows); right column should be total number of beans/species in the "sampled" pile after that square/sample.
14. As a class, graph the data for the groups that reached the total species number in the fewest, and the most samples. Compare the shape of the curves.
15. As a class, discuss why we don't pick up all of the species in the first sample (animals have different distributions, some are more common, some are rare, some might "prefer" certain habitats, or areas on the paper). Discuss why the species accumulation curve is useful …see background info. It's important to know what we know, as well as what (and possibly how much) we don't know.