Appendix A: Lego Ecology - Try It Yourself!

Holland, E.P. and Helgason, T. (2022). Abstract bricks: LEGO(R) as a conceptual tool for teaching experimental design. In: Nerantzi, C., and James, A. (2022) LEGO® for university learning: online, offline and elsewhere. 2nd edition. Open access publication

Background and Aims

Being able to estimate how many species are present in an ecological community is an important question in conservation ecology, as it underpins efficient and effective land management at a larger scale. For example, if you have a limited budget, how will you decide whether to designate area A or area B as a National Park?

In this session, you will learn how sampling effort and relative abundance of species (the 'shape' of the community) affects our ability to estimate how many species are present in a community.

Set up: You need two bags of around 200 LEGO bricks, each of which has a different combination of brick colours and sizes. One bag should have a relatively even spread of brick types (e.g. 10-20 each of 10-20 colour/shape combinations). The other bag should contain two or three ‘dominant’ brick types (30-50 of the same colour/shape combination) and a small number of as many other colour/shape bricks as you can find.

Learning objectives

By the end of this session, you should be able to:

- construct a species accumulation curve from sampling data;
- explain how the shape of the curve depends on the relative abundance of species in a community;
- explain why different sampling efforts might be appropriate for differently shaped communities.

Task

Take a sample of 6-8 individuals (bricks) from community A. Don't worry about exact numbers; just use a small handful that will give roughly the same number of individuals each time. We will use colour and shape as the distinguisher between 'species' in the sample, so for example a blue 2x2 brick is a different species from a blue 10x2 brick. How many unique species are there in your first sample? Let’s call this S_1. Do you think this is representative of the community as a whole?

Take a second sample, and keep it separate from the first. How many unique species are in this sample (S_2)? Is it the same number as before? Are they the same species?

A species accumulation curve is a graph with sampling effort along the x axis, and number of species along the y axis (see Figure 1 for an example). Mark the first sample on the graph, at $x = 1$ and $y = S_1$. For the second and subsequent samples, we must pool our samples to get a cumulative number of unique species (e.g. we still only count red 1x1 bricks once even if they appeared in two or more samples).

Keep taking more samples until you think you have found the number of species in the community. Why do you think you have got a good estimate?

When you have finished sampling community A, build a tower of bricks for each unique species from your samples. Line them up in rank order (most individuals per species to the least). What does this tell you about commonness and rarity of species in your samples?

Now repeat the exercise with community B. Draw a new line on the species accumulation chart, and build another set of species abundance towers. Why does the line look different?

If you had only taken one sample, which community would you have decided to conserve, to save the most species? Did this change with greater sampling effort? If you had taken the samples in a different order, would this change your answer? (This is called randomisation; see Figure 2.)

If you only counted colour, and not shape, when identifying species in these communities, how would your conclusions about the similarities and differences between A and B change?

Key points

- A species accumulation curve is a plot with sampling effort on the x axis, and number of unique species on the y axis.
- The relative abundance of individuals among species in the community affects the shape of the species accumulation curve. When the community is even (similar number of individuals in each species), the species accumulation curve is likely to reach a plateau relatively soon, and give a good estimate of the true species richness (number of species). When the community is dominated by one or a few species, and has a number of relatively rare species, the species accumulation curve may never reach a plateau, as new unique, rare species continue to turn up with increased sampling effort.
- The number of samples needed to be confident about an estimate of species richness is lower for an even community, and higher for a community with many rare species.

- Confidence intervals around the species accumulation curve can be drawn by randomising the order of samples and calculating the distribution of the number of species seen per *x* samples (e.g. after 4 samples, in one community we may have found 6-7 species, but in another it may be 4-8).

Figures

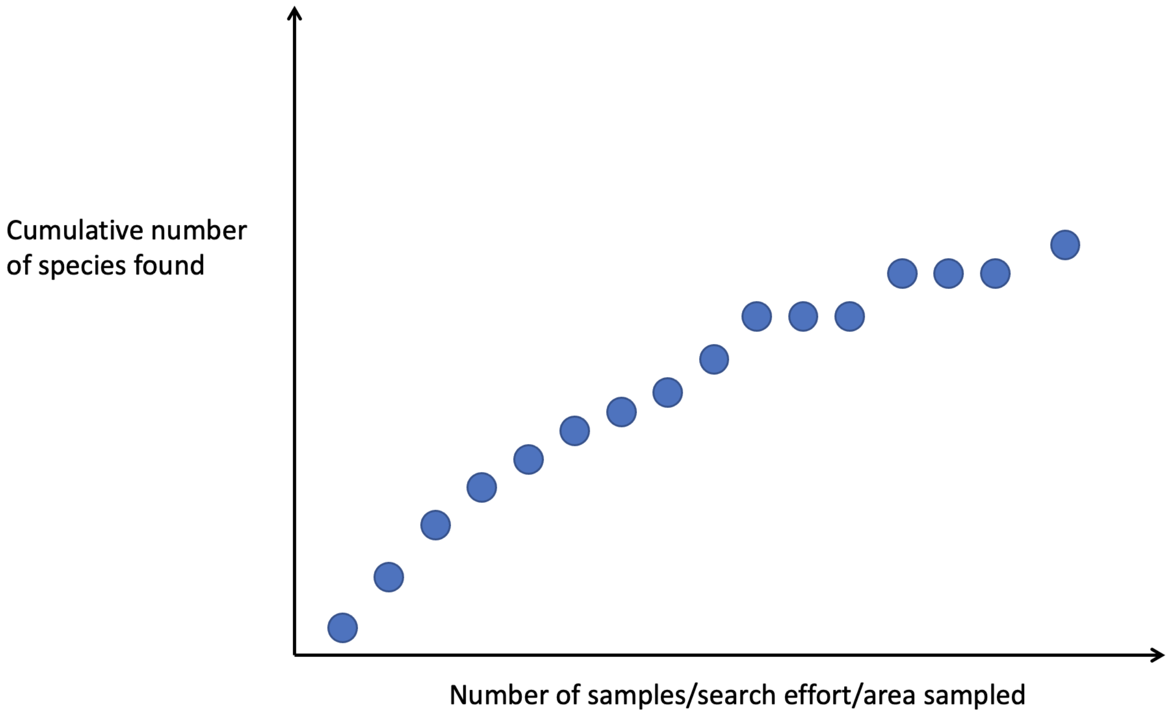

Figure 1. An example species accumulation curve, where the number of unique species increases over time, but the rate at which new species turn up slows down as the community becomes better represented in the cumulative sample.

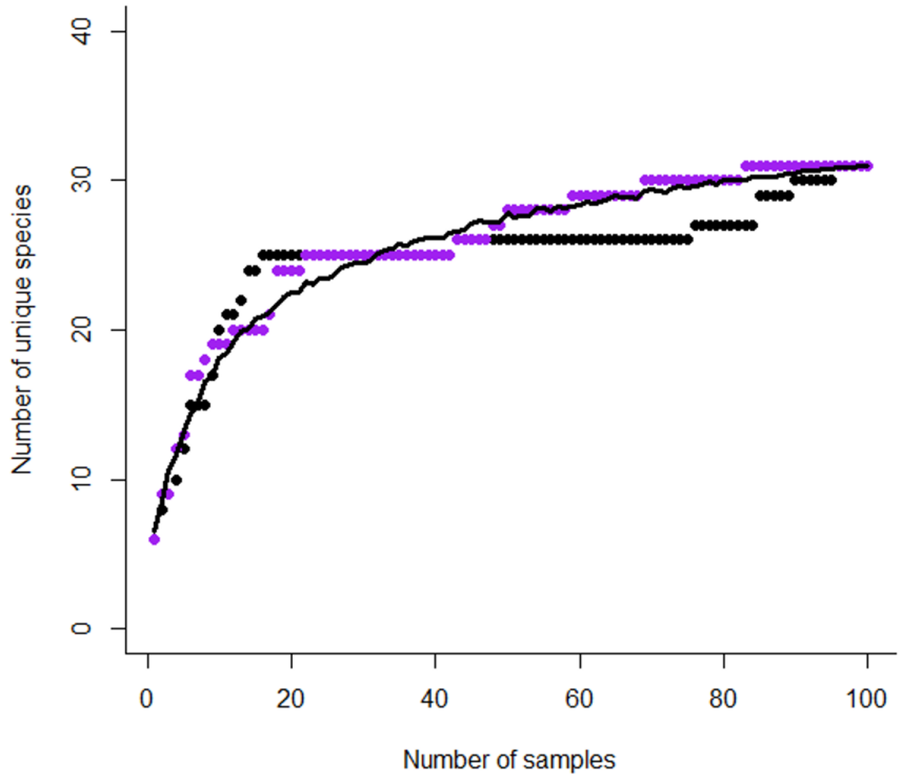

Figure 2. The order in which samples appear can change the species accumulation curve; for example the black line and the purple dots represent samples from the same data set, with individual samples in a different order. The solid black line shows the mean species accumulation curve, calculated from the same dataset with samples in many different random orders. This more clearly indicates that new species are still appearing (the line is not horizontal), so we can conclude that more sampling is needed to represent the community more fully.