Practical support sheet Ecological sampling

Why sample in ecology?

In an ideal world when investigating, say, the number of dandelions in two meadows, you would count every single dandelion in each. The problem is that this might take forever and become very, very boring. So, instead, you need to take a sample. You might estimate the number of dandelions in each meadow by counting the number in several small areas and then multiplying up to calculate a value for each meadow. The idea is to maximise the usefulness of your data while minimising the effort required to collect them.

Random sampling

Frequently, ecologists notice a distinct pattern that may be related to one or more factors at two sites. For example, the vegetation in one field may be very different to that in another field, or the species found under oak trees may be different to those under ash trees, or the species upstream and downstream of an outflow pipe discharging into a river may seem to differ. To make valid comparisons, samples need to be taken from both sites. If the investigator chooses where to sample, the sample will be subjective. Random sampling allows an unbiased sample to be taken.

Using a grid

In a habitat, such as a meadow or heathland, tape measures put on the ground at right-angles to each other can be used to mark out a sampling area (Figure 1). Using a pair of random numbers you can locate a position within the sampling area to collect your data. The random numbers can be pulled from a set of numbers in a hat, come from random number tables, or be generated by a calculator or computer. The two numbers are used as coordinates to locate a sampling position within the area. The first random number gives the position on the first tape and the second random number gives the position on the second tape.

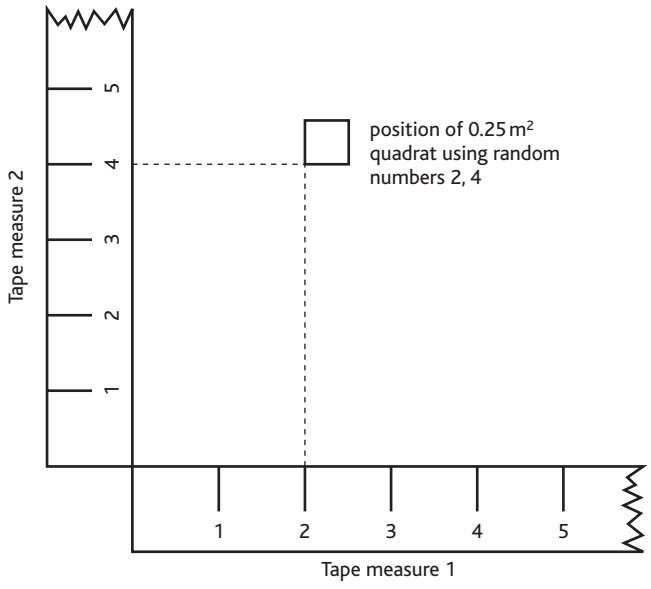

Figure 1 Using measuring tapes to define a sample area.

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If you are sampling fixed objects within an area, for example the area of *Pleurococcus* (an alga) on the shaded side of trees in a wood or the number of woodlice under rocks, you could number all the trees or rocks and then use random numbers to select which trees or rocks to sample.

This sampling idea is also used when measuring the number of cells in a culture. The culture is mixed to give a reasonably uniform distribution of cells and then a known volume is placed on a haemocytometer (a special cavity slide with a ruled grid in the centre). You then count the number of cells that occur in, say, 25 squares of the grid. Because you know the dimensions of the grid squares and the depth of the liquid above the square, you can work out the volume of culture in each square, and then calculate a mean number of cells per cm^3 of the culture.

Systematic sampling

Random sampling may not always be appropriate. If conditions change across a habitat, for example across a rocky shore or in a sloping meadow that becomes more boggy towards one side, then systematic sampling along a transect allows the changes to be studied. A transect is effectively a line laid out across the habitat, usually using a tape measure, along which samples are taken. The sample points may be at regular intervals, say every 2 m across a field, or they may be positioned in relation to some morphological feature, such as on the ridges and in the hollows in a sand dune system.

Sampling techniques

Quadrats

Quadrats are used for sampling plant communities and slow moving or stationary animals, for example many of those found on rocky shores. There are two types of quadrat: a frame quadrat and a point quadrat.

A frame quadrat is usually square; the most commonly used is 50 cm by 50 cm ($0.25\ m^2$) and may be subdivided into 25 smaller squares, each 10 cm by 10 cm. The abundance of organisms within the quadrat is estimated (see the section Methods of measuring abundance and Figure 3). Quadrats may be placed across the site to be sampled using random or systematic sampling methods. Throwing quadrats is not random and can be dangerous.

It is important to sample enough quadrats to be representative of the site, but why do 1000 quadrats if 10 will give almost as accurate a result? To find out the optimum number of quadrats required, record the number of species in each quadrat and plot the cumulative results against number of quadrats until sampling additional quadrats does not substantially increase the number of species recorded.

A point quadrat frame (Figure 2) enables pins to be lowered onto the vegetation below. Each species touched is recorded as a hit. The percentage cover for a particular species is calculated using the equation:

$$\%\ \text{cover} = \frac{\text{hits}}{\text{hits} + \text{misses}} \times 100$$

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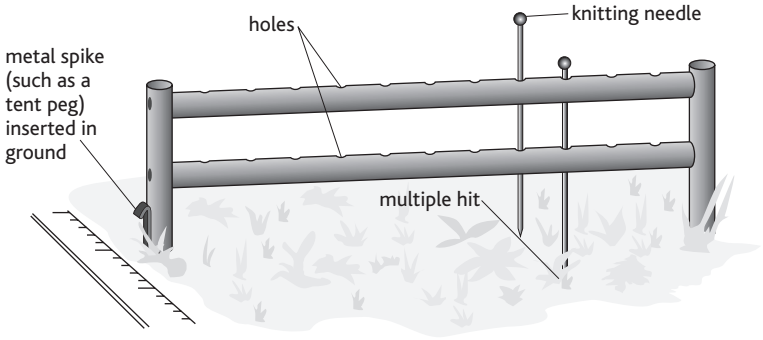

Figure 2 A point quadrat frame. Each plant species touched by the needle is recorded.

Methods of measuring abundance

Density

Count the number of individuals in several quadrats and take the mean to give number per unit area, for example per metre squared (m^{-2}). In many plant species (e.g. grasses) it is very difficult to distinguish individual plants, so measuring density is not possible.

Frequency

Frequency is the number or percentage of sampling units in which a particular species occurs. This avoids having to count the number of individuals. If clover was recorded in 10 of the 25 squares that make up a 0.25 m^2 quadrat frame, the percentage frequency would be 40%. You need to be consistent when determining presence or absence in a sampling unit. For example, you might decide that only plants rooted in the square are counted, or you might decide that any plant or animal in the quadrat is counted including any that touch or overhang the quadrat.

Percentage cover

This is the percentage of the ground covered by a species within the sampling unit. Count the number of squares within the quadrat that the plant completely covers, then count those that are only partly covered and estimate the total number of full squares that would be completely covered by that species.

Estimating animal populations

Quadrats cannot be used for mobile animals as these don't stay in the quadrats. A variety of different nets and traps need to be used. Animals that occur on the soil surface may be sampled using a pitfall trap (Figure 3). Those in vegetation can be sampled using a pooter directly or indirectly (after being knocked from the vegetation onto a white sheet). Insects and other small invertebrates found in leaf litter can be collected using a Tullgren funnel. Mark–release methods can also be used.

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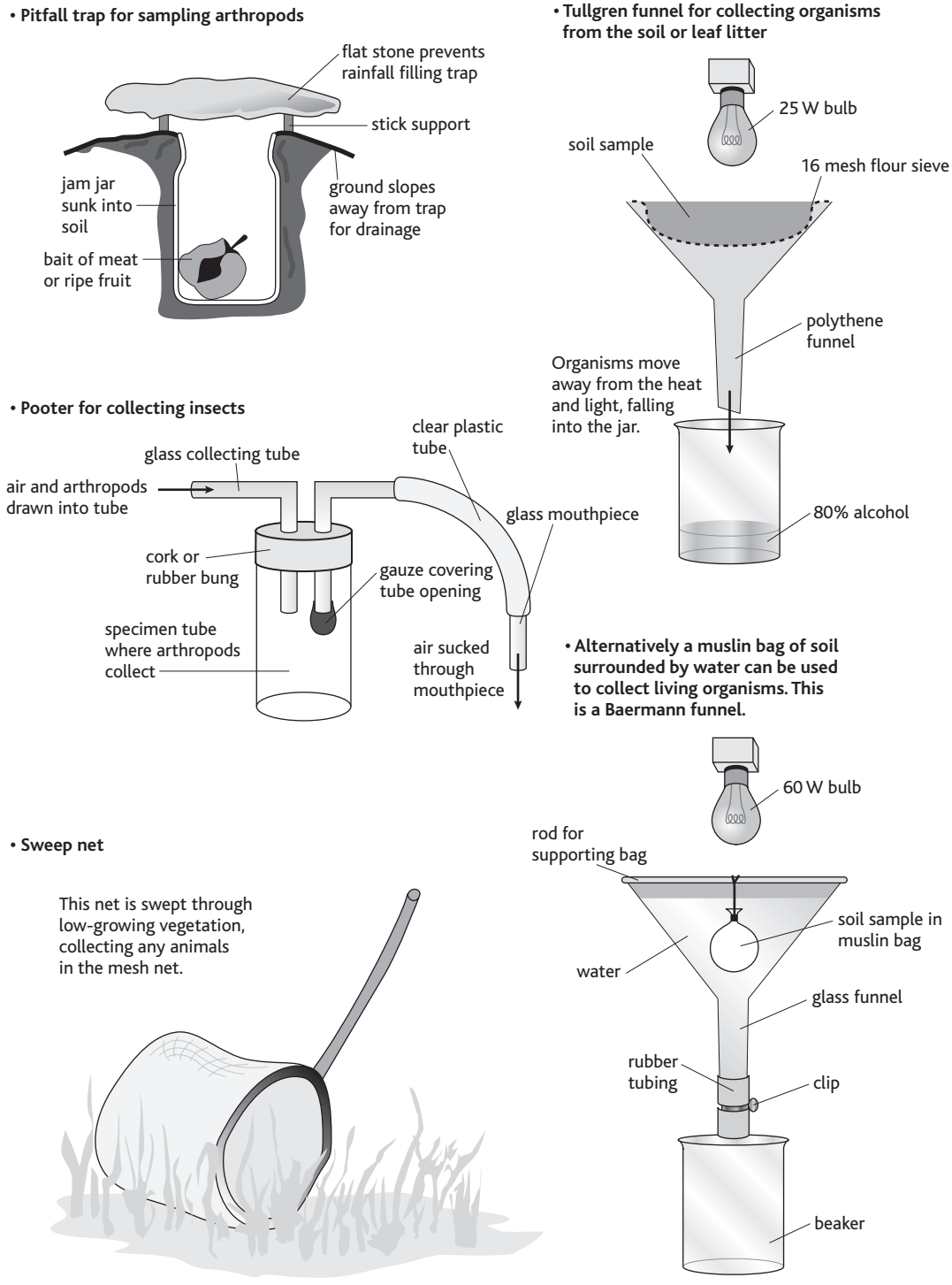

Figure 3 Net and traps for sampling animals.

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Measuring abiotic factors when sampling the environment

Angle of slope
Use a clinometer.

Aspect
Use a compass.

Temperature
Use a thermometer or temperature probe, but be aware that the time of day can influence the values obtained, as will cloud cover. The thermometer or probe should be placed in the same position each time a measurement is made to allow valid comparison of measurements.

Light
Use a light meter. Light readings can vary widely with time of day and cloud cover. It is better to take all measurements over a short period or take regular readings over extended periods using a datalogger.

Oxygen concentration
In aquatic systems, oxygen probes can be used to measure oxygen concentration.

Humidity
Relative humidity can be measured using a whirling hygrometer. It needs to be spun for 60 seconds just above the vegetation before readings are taken from the wet and dry thermometer and used to determine the humidity from a calibration scale.

Conductivity
The ability of a water sample to carry an electric current gives a measure of the dissolved mineral salts. The conductivity of pure water is zero; increasing ion concentration raises the conductivity.

Soil water
A sample of soil is dried at 110 °C until there is no further loss in mass. The % soil moisture can be calculated using the equation:

$$\%\ \text{soil moisture} = \frac{\text{mass of fresh soil} - \text{mass of dry soil}}{\text{mass of fresh soil}} \times 100$$

Soil organic matter
A dry soil sample of known mass is heated in a crucible for 15 minutes to burn off all the organic matter. The mass is re-measured after the soil sample has cooled. The % soil organic matter is calculated using the equation:

$$\%\ \text{organic matter in soil} = \frac{\text{mass of dry soil} - \text{mass of burnt soil}}{\text{mass of dry soil}} \times 100$$

pH
Universal Indicator or a pH meter can be used to test pH after mixing a soil sample with water. If using Universal indicator in the field, it is best to use a proper soil testing kit that contains some long glass tubes, with lines engraved on the sides, to show levels for adding soil and chemicals. First, 1 cm^3 of soil is shaken with distilled water before adding one spatula of barium sulphate (low hazard). This helps to flocculate (settle) the clay fraction, which is important as clay particles are very small and will otherwise cloud the water for days. Then 1 cm^3 of pH indicator solution is added and the pH recorded after the contents of the tubes have been allowed to settle.

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