

## ACTIVITY 4

# Investigating the effects of trampling

### Introduction

There is enough variation in the distribution of grasses and low-growing plants along the length of Gordon Square to form the basis for an investigation into the effects of trampling.



Figure 16. A heavily trampled area of grass.

### Learning objectives

*Through this activity pupils will:*

- consider how the distribution of organisms in different habitats is affected by environmental factors
- describe and explain the responses of plants to trampling
- evaluate the method of data collection

### Background information for teachers

Grassy areas such as the Squares are maintained as grassland by mowing and trampling. Mowing removes the upper portions of grassland plants above a certain height.

Many tall growing plants are killed when the upper parts of the plant are removed, either by grazing animals or mowers. Other plants have evolved a range of adaptations which enables them to survive in such conditions.

The key to a successful plant in closely mowed grassland lies in the position of the meristem. The meristem is a group of actively dividing cells forming the growing point of a shoot or a root. Most plants have an apical meristem: the growing point is located at the tip of the shoot (or root). If they are grazed or mown, plants with an apical meristem lose their growing points, and will probably die. Note that some plants can survive if they are able to produce a new side shoot from an axillary bud (the bud in the axil of a leaf).

The leaf blade of grass is long, narrow, and has its meristem near the point where it joins the stem. Even if the upper part of the leaf is broken off, perhaps by a lawnmower, the grass can continue to grow. The competitive advantage of having a growing point close to the ground is lost in longer vegetation, such as underneath shrubs and trees, where the leaves are in shade.



Figure 17. Rough hawkbit (*Leontodon hispidus*) adopts a rosette growth form in short grass.

Some common grassland plants, such as the daisy (*Bellis perennis*), dandelion (*Taraxacum officinale*), Rough hawkbit (*Leontodon hispidus*) and greater plantain (*Plantago major*), grow a rosette of leaves. This is a specific growth-form where the plant has very short leaf internodes, resulting in a circle of leaves lying flat against the ground in a spiral fashion to avoid overlapping. A strong straight root (the tap root) grows vertically down in the soil under the leaves. These adaptations give the plants a competitive advantage in short grassland which is mowed or trampled, such as the lawns of Gordon Square.

In longer vegetation, the rosette growth-form is less common, as the flat leaves are shaded out by surrounding plants. If rosette-forming plants (such as the dandelion) grow amongst taller plants the leaves tend to grow more upright as a clump rather than as the characteristic flat rosette. Both of the growth forms can survive mowing, as the shoot meristems are very close to the ground, though the plants may lose flowers on taller upright flower stems.



Figure 18. White clover (*Trifolium repens*) spreads with rooted runners in short grass.

Other plants adopt a trailing, creeping or prostrate growth form. White clover (*Trifolium repens*), silverweed (*Potentilla anserina*) and creeping buttercup (*Ranunculus repens*) spread vegetatively by means of stolons. These are stems that grow low against the ground, growing new roots and producing new offshoots of the same plant.

## Resources

### Worksheets

- 1. Obtaining your results
- 2. Recording your results
- 3. Analysis and evaluation of results

### Accompanying CD

- PowerPoint 'Sense of Place'
- All photos from this section

### Apparatus needed

50cm<sup>2</sup> quadrats  
20m tape measure  
Metal pins (e.g. knitting needles)

Metre rules  
*Playing field plants* fold-out chart

*The illustrations on this page are taken from the Playing Field Plants fold-out chart*

## Lesson sequence

### 1. Before fieldwork

Levels of trampling in Gordon Square do not form a clear pattern. Although the gravel paths are wide, and there is some seating, the grassy areas are used as shortcuts and as a place for sitting on sunny days. An alternative way to investigate the effect of trampling is to investigate whether there is a relationship between soil hardness and the frequency of a small number of plants. Soil hardness is used as a surrogate for the amount of trampling; it is assumed that soils become harder as trampling increases.

#### Introduction to quadrats

A quadrat is a square frame used for sampling an area. An appropriate size for the grassy areas of Gordon Square is 50cm x 50cm. Although ready-made quadrats can be purchased from educational suppliers, they can easily be constructed from canes or plastic tubes.

Quadrats can be used to sample an area either systematically or randomly. The sampling strategy chosen will depend on the hypothesis being investigated. Random sampling is particularly useful if two habitats are being compared. For random sampling, every point in the sample area has an equal chance of being sampled. Systematic sampling is used to investigate changes in a habitat caused by one environmental factor. The best way to measure these types of changes is to use a transect. This activity uses random sampling. Random sampling means that every part of the sample area has an equal chance of being sampled. If enough samples are taken, the results should be representative of the whole sample area.



Figure 19. A 0.5m<sup>2</sup> sized frame quadrat used for sampling short grassland.

#### Sampling within a quadrat

The simplest way for pupils to process the results of quadrat surveys is to count the number of plants that they find in each quadrat. Where each plant is a discrete individual, such as dandelions and daisies, this is acceptable. When all the results have been collected, pupils can calculate the mean number of plants per quadrat for each of the sample areas. For a greater challenge, pupils can transform the figure for mean number per quadrat into mean number of plants per square metre.

Many grasses and other grassland plants, such as white clover, speedwell and creeping buttercup, cannot easily be counted in this way, because the edges of each plant are not immediately obvious. Instead it is easier to calculate the local frequency of the plant in each quadrat. This is more challenging for pupils.

Frequency is easier to measure using a gridded quadrat. In the example shown to the left, the quadrat has been divided into 100 squares. Pupils count the number of squares in which the plant (or, in this case, red paper) is found. Since the red paper is found in 56 squares, the local frequency of red paper is 56%. Once the frequency of plants has been calculated for each quadrat, the mean frequency can then be calculated in the usual way for the whole sample area.



Figure 20. A gridded quadrat.

## 2. Fieldwork

Assuming a class of 8 groups of 3 or 4 pupils, if each group takes 10 random samples, the total number of samples taken by the class will be 80. If you choose a 20m x 20m area of Gordon Square, and pupils take samples using 0.5m<sup>2</sup> sized quadrats, this means that approximately 4%, or 20m<sup>2</sup> of the total sample area of 900m<sup>2</sup> is sampled.

### Using quadrats

The instructions for using quadrats with classes are notoriously variable. Throwing a quadrat is not truly random – pupils may aim for conspicuous patches of plants, and they are unlikely to sample ground close to their feet and areas immediately behind trees. You may also be conscious of the dangers of pupils throwing quadrats at each other. A useful strategy that we have used is outlined below.

1. Prepare two sets of numbered pieces of paper from 1-30. Put these into a bucket, or similar.
2. Put the pupils into groups of 3 or 4.
3. Lay two 20m measuring tapes perpendicular to each other in the study area.
4. Invite a pupil from one group to take a piece of paper out of the bucket. Once the paper has been replaced, he/she should walk along the tape until reaching the distance, e.g. if 14 is chosen, walk to 14m.
5. Invite a second pupil from the same group to do the same for the other tape.
6. Then they turn into the plot at a right angle to the tape and walk into the plot until they meet. They should place the quadrat here.
7. Instruct the pupils to wait in a queue for random numbers, and to return to the back of the queue when they have finished sampling.

## Measuring soil hardness

Soil hardness (or soil compaction) can be measured in the field by using a metal stake or pin. These can easily be made by using knitting needles. Hold the stake out at arm's length above the centre of the quadrat and let it fall through the fingers. Measure the depth of entry into the soil. This may seem unscientific, but it really does work if pupils take care to let the stake fall from the same height above the quadrat each time. Alternatively, after a dry period when the soil is hard, ask pupils to apply uniform pressure to the stake at each measuring site and measure the depth it reaches into the soil. Clean the stake of soil before it is used for the next measurement.

## Identifying plants

The fold-out chart *Playing Field Plants* can be used to help with identification. We have found that it is sometimes useful with classes to spend a few minutes creating a 'species board'. Choose the 5 commonest grassland plants (not grasses) growing at the time of sampling, and ask each group of pupils to attach with sticky tape a labelled sample of each plant (including flowers and leaves) to a wooden board. They can use this board for reference while collecting data from quadrats.

## 3. After fieldwork

### Analysing class data

Firstly pupils add together the frequency of the different species of rosette plants they found (plantains, daisy, dandelion, yarrow and others) to obtain a total rosette plant frequency. Secondly pupils add together the frequency of the different species of creeping plants they found (white clover, creeping buttercup and others) to obtain a total creeping plant frequency.

Pupils can display their data on a scattergraph, since this is an investigation into the relationship between soil hardness (as a measure of trampling intensity) and the growth of rosette and creeping plants. Use red dots to show the total frequency of rosette plants and blue dots to show the total frequency of creeping plants.

The prompt questions (sheet 3) help pupils to link their results to what they know about interspecific competition, and to speculate on how conditions might have changed while the Squares were closed to the public, and trampling was much reduced, during the restoration works in 2006.

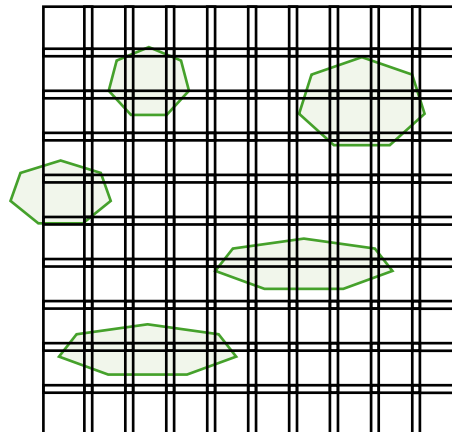
### Evaluation of the method

The prompt questions (sheet 3) help pupils to organise their evaluation of the method, and to make suggestions for possible improvements to improve the quality of the data collected.

# Investigating the effects of trampling

## SHEET 1 - OBTAINING YOUR RESULTS

1. Place the gridded quadrat on the ground.
2. For each plant count the number of squares the plant is found in. Use the *Playing Field Plants* chart to help you to find out the names of plants you find.
3. Use a metre rule to measure the height at rest of the highest plant in the quadrat.
4. To measure soil hardness
  - (a) Hold a metal pin at arm's length above the quadrat and let it fall through your fingers.
  - (b) Measure the depth of entry into the soil.



The plant is found in 39 of the grid squares of the quadrat, so its frequency is 39%.

Makes sure the same person takes all the soil hardness measurements. Be careful to hold the metal pin at the same height each time.

### Common grassland plants in Gordon Square



Yarrow



Rough hawkbit



Dandelion



Creeping buttercup



White clover

# Investigating the effects of trampling

## SHEET 2 - RECORDING YOUR RESULTS

Plant	Frequency					
	1	2	3	4	5	6
Quadrat						
<b>Rosette plants</b>						
Plantains						
Daisy						
Dandelion						
Yarrow						
Other rosette plants						
<b>TOTAL ROSETTE PLANTS</b>						
<b>Creeping plants</b>						
White clover						
Creeping buttercup						
Other creeping plants						
<b>TOTAL CREEPING PLANTS</b>						
Grass						
Bare earth						
SOIL PIN DEPTH (cm)						

# Investigating the effects of trampling

## SHEET 3 - ANALYSIS AND EVALUATION OF RESULTS

1. Draw a scattergraph with soil pin depth (cm) on the x-axis against the frequency of total rosette plants (use red dots) and the frequency of total creeping plants (use blue dots).

Draw best-fit lines for (a) the rosette plants and (b) the creeping plants.

2. Describe the trends shown on your graph.

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3. Using what you know about **competition between plants**, explain  
(a) why rosette plants are common in short grassland

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(b) why rosette plants are less common among longer grass

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4. Explain why the number of rosette plants might change if the Squares were closed to the public and were no longer mowed.

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5. Consider your method. List the difficulties that your group found. Suggest improvements that could be made so other groups will not encounter the same problems.

Difficulties found	Improvement

6. The level of trampling was investigated by using a soil pin to measure the hardness of the soil. How reliable is this method? Design another method for measuring the level of trampling that you could use if you had more time.

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