Measuring physical factors in the environment

Do environmental conditions affect the distribution of plants?

Aim

To find out whether environmental conditions affect the distribution of plants by measuring the environmental conditions in three different areas on your school playing field and surveying the plants found in those areas.

Equipment

- measuring wheel or tape measure
- light sensor
- anemometer (to measure wind speed)
- datalogger
- compass
- rain gauge
- plant key

Safety

- Cover any cuts with waterproof dressings.
- Wash your hands after the lesson.

What you need to do

1 First you will need to think of a good question you can answer from a study of the distribution of plants on the field. It will need to be a question that you can gather data for, such as 'Is the distribution of plants affected by different exposure to wind and rain in different areas of the field?' or 'Is plant distribution affected by different amounts of trampling in different areas of the field?' You may need to look at the playing fields to help you think of something you can measure. When you have thought of a question, discuss it with your teacher.

2 Then write a plan for an investigation to gather data to answer your question. You will need to think about which conditions you will measure to answer your question. You will need to include all conditions that might affect plant distribution so that you can tell from your results whether the condition you are most interested in is the most important one for affecting where and how well different plants grow. Remember that the environment includes other organisms, such as humans, as well as rain and light.

3 You will also need to think about how you will measure these conditions and what equipment you will need. Some items of equipment you might consider are: compass, light sensor, rain gauge, anemometer (to measure wind speed), datalogger.

4 Decide how often you will take your measurements. Do conditions stay the same or will you need to record changes over several hours, days or weeks?

5 Decide how you will measure distribution of the plants, and what equipment you will need. You might need a metre rule or tape measure, trundle wheel, or plant key.

6 Decide whether there are any conditions that you will not be able to control that might affect your results. For example, if there are no matches played on the fields, will this reduce the amount of trampling?

7 Decide what you will record about the plants. For example, will you record how many of each kind, their size, etc.?

Using the evidence

1 Decide how you will record your data. Will a map of the area help? What kind of data table will you need? (*3 marks*)

2 Decide how you will analyse your data and how you might present your results. (*3 marks*)

Evaluation

3 Prepare a report for the rest of the class on the difficulties involved in collecting data about the effect of physical factors on the distribution of plants. (*3 marks*)

Extension

4 What conclusion can you make from your investigation about a link between your independent and your dependant variable? (*3 marks*)

5 If you could repeat your investigation, what changes would you make to your method? Explain your answer. (*4 marks*)

Analysing climate data

You need to be able to calculate mean and median for climate data.

Revise how to do this by reading the section on Analysing data in lesson B2 3.1 in the Student Book.

- Go to the Historic Station Data page on the Met Office website.
- Select the weather station nearest to your school.
- Select the latest complete year of data.
- Select data similar to that shown in the table below.

Year/Month	Maximum temperature/°C	Minimum temperature/°C	Rain/mm	Sun/hours
2009/1	5.7	0.8	56.9	46.8
2009/2	6.1	1.9	25.0	42.4
2009/3	10.0	3.3	29.6	141.4
2009/4	13.9	5.5	36.9	137.9
2009/5	15.4	7.6	76.2	187.7
2009/6	18.9	10.3	51.0	180.9
2009/7	19.4	12.4	150.7	158.1
2009/8	19.9	12.8	55.3	137.7
2009/9	16.9	10.6	27.4	127.4
2009/10	14.0	7.6	64.9	79.2
2009/11	10.0	5.3	215.2	55.9
2009/12	5.1	0.6	60.9	48.6

1 Using data from the website, calculate the mean and median monthly values for each of:

a maximum temperature (*4 marks*)

b minimum temperature (*4 marks*)

c rainfall (*4 marks*)

d sunshine. (*4 marks*)

Investigating the distribution of *Pleurococcus*

A green powdery growth is evidence of the presence of tiny single-celled plants called *Pleurococcus* growing on the trunk of a tree. Is the distribution of *Pleurococcus* on a tree trunk influenced by physical factors?

Aim

To find out whether the distribution of *Pleurococcus* is influenced by physical factors by using a quadrat to measure the percentage cover of *Pleurococcus* at different points around a tree trunk.

Equipment

- quadrat – 10 cm × 10 cm with 1 cm grid squares photocopied onto acetate
- compass
- string, long enough to fasten around a tree (1.5–2 m), marked in 10 cm intervals

Safety

- Wash your hands thoroughly after you have finished the activity.

What you need to do

1 Use your compass to find the direction of North.

2 Take your piece of string marked at 10 cm intervals. Fix it around the trunk of the tree about 1–1.5 m above the ground.

3 Place a 10 cm × 10 cm quadrat on the string at the north-facing point. Estimate percentage cover of *Pleurococcus* at this point.

4 Move the quadrat 10 cm along the string and repeat your estimation. Carry on until you have sampled the whole circumference of the tree.

5 Note which of your samples was taken from the trunk facing east, south and west respectively.

6 Display your results as a bar chart, plotting percentage cover against aspect (the direction in which that part of the trunk was facing).

Using the evidence

1 What conclusion can be drawn from your results? (*1 mark*)

2 What conditions do you think *Pleurococcus* needs to live? (*3 marks*)

3 How do environmental conditions, such as light and water, vary around the tree? (*3 marks*)

4 How might your answers to questions **1** and **2** explain the distribution of *Pleurococcus*? (*1 mark*)

Evaluation

5 **a** How could the method you used be made more reliable? (*1 mark*)

b How could the method you used be made more accurate? (*1 mark*)

Extension

6 **a** Write a hypothesis to explain the reason for the conclusion you made in question **1**. (*1 mark*)

b Design an investigation to test your hypothesis. (*6 marks*)

What affects the distribution of plants?

Sunita and Henry were investigating whether trampling affected the distribution of plants on the school playing fields. They decided to sample three areas of the football pitch: one near the goal, one near the centre of the pitch and one on the edge of the pitch. They made the hypothesis that there would be more grass and fewer daisies, dandelions and plantains where the area was more trampled. This was because they thought that plants with big leaves like daisies, dandelions and plantains can't cope with being trodden on.

1 **a** Why did Sunita and Henry make a hypothesis before starting their investigation? (*1 mark*)

b Do you think that their prediction is a good one? Explain your answer. (*1 mark*)

They chose to use a 50 cm × 50 cm quadrat. Preliminary work showed them that it was difficult to count individual grass plants. So they planned to record how much of the quadrat was covered by each kind of plant they found inside the quadrat each time.

2 **a** What is preliminary work? (*2 marks*)

b Explain why preliminary work can help to improve an investigation. (*2 marks*)

Sunita thought they should take five samples in each area, but Henry thought one in each area would be enough.

3 Which method would give more reliable results? Explain your answer. (*2 marks*)

When they were sampling, Sunita wanted to choose where to put the quadrat because she said it would give the best results. Henry said they should use a random method. (A set of random numbers is generated by a computer. The numbers are used as coordinates on a grid – see lesson B2 3.2b in the Student Book.)

4 Which method would give the best scientific results? Explain your answer. (*2 marks*)

Sunita and Henry recorded their results in a table. They then averaged the results to give one number for the percentage of the quadrat covered by each plant in each area. The table below shows their average results.

Plant	**Percentage of quadrat covered in each area**		
	Near goal	**Centre of pitch**	**Edge of pitch**
grass	50	40	40
daisy	20	10	30
dandelion	0	0	30
plantain	20	10	0

5 What would be the best way for Sunita and Henry to show these results graphically? Explain your answer. (*2 marks*)

6 Use the results in the table to calculate the percentage of bare ground:

a near the goal (*1 mark*)

b in the centre of the pitch (*1 mark*)

c at the edge of the pitch. (*1 mark*)

7 **a** Which plant is least affected by trampling? Explain your answer. (*2 marks*)

b Which plant is most affected by trampling? Explain your answer. *(2 marks)*

c Was Sunita and Henry's prediction correct? Explain your answer. (*3 marks*)

Estimating population size

A student estimated the population of clover plants growing in a field. The field was 80 m in length and 50 m wide.

The student used a quadrat which had an area of 1 m^2.

The student sampled 10 sites.

The table shows the student's results.

Quadrat number	Number of clover plants
1	3
2	3
3	6
4	2
5	1
6	2
7	0
8	3
9	2
10	0

1 What would be the best way of using the quadrat to sample the clover population? (*1 mark*)

2 Calculate the mean number of clover plants per quadrat. Show your working. (*2 marks*)

3 Use the mean you calculated in question **2** to estimate the number of plantain plants in the field. Show your working. (*3 marks*)

Extension

Another method of sampling populations is to use the ACFOR abundance scale, where:

A = abundant

C = common

F = frequent

O = occasional

R = rare.

The abundance scale can be made semi-quantitative, where:

A = 80–100% cover

C = 60–79% cover

F = 40–59% cover

O = 20–39% cover

R = 0–19% cover.

4 Give one advantage and one disadvantage of using the ACFOR scale rather than calculating percentage cover. (*2 marks*)

Using a transect

Physical factors affect the distribution of plants.

Aim

To investigate how trampling affects plants.

Equipment

- 50 cm × 50 cm quadrat
- tent peg
- measuring tape

Safety

- Cover any cuts with waterproof dressings.
- Wash your hands after the activity.

What you need to do

1 Find an area of grass where people have walked, creating an unofficial pathway of 'trampled' grass.

2 Place the measuring tape across the grass, so that it goes from the grassy area on one side of the trampled area to the grassy area on the other side.

3 Place your quadrat against the tape measure at one end. Record the percentage cover of each kind of plant you find. You can estimate the percentage cover of a plant by looking at the quadrat and estimating what proportion of the quadrat is filled with that plant. If there is bare soil, record this too. Remember the percentages for this quadrat should all add up to 100%.

4 Record your results in a table like the one shown below.

Quadrat number	% cover of each species				Depth tent peg went into soil (cm)
	Grass	Bare soil	Dandelion	Clover	
1					
2					
3					

5 Push the tent peg into the soil in your quadrat and measure how far it goes into the soil, using your ruler.

6 Turn the quadrat over and do the same for the next 50 cm along the measuring tape. Continue until you have reached the other side of the trampled area.

7 Using your results, make a bar chart showing percentage cover of each species and bare soil as you go across the transect. (*4 marks*)

8 Using your results, make a graph of the depth the tent peg went into the soil (*x*-axis) against percentage cover of grass (*y*-axis). (*4 marks*)

Using the evidence

1 Finding how deep the tent peg will go into the soil is a way of measuring trampling. Explain why (*2 marks*).

2 What effect does trampling have on the growth of grass? (*1 mark*)

3 What effect does trampling have on the number of different species that are able to grow? (*1 mark*)

Evaluation

4 How could you have obtained more reliable results? (*1 mark*)

5 Compare your results with those of others in your class. Explain why your results are not exactly the same. (*2 marks*)

6 Is 'pushing in' a tent peg a precise method of measuring the effect of trampling? Explain the reason for your answer. (*1 mark*)

7 Hold a discussion on what would happen to the plants on the transect if the environment changed, e.g. if the path was no longer used. What conclusion do you come to? (*2 marks*)

Extension

8 Suggest what physical factors in the soil are affected by trampling and explain how each of these factors might affect the populations of plants. (*6 marks*)

Collecting and analysing ecological data

1 Some students carried out a belt transect to analyse the distribution of daisy plants growing near a tree. Their results are shown in the table.

Distance from tree/m	Light intensity /arbitrary units	Number of daisy plants per m^2
1	1.0	4
2	2.5	7
3	3.5	10
4	7.5	11
5	5.5	12
6	6.0	13
7	6.5	14
8	6.5	14
9	6.5	14

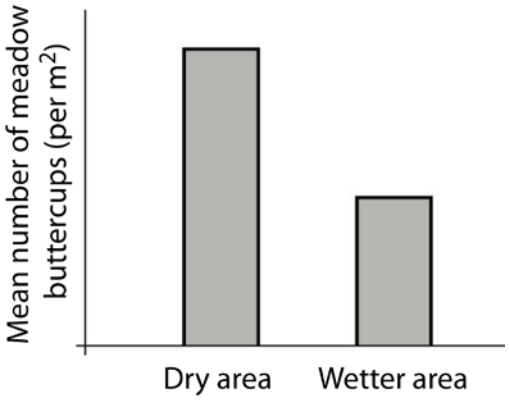
a Describe how the students would have carried out their investigation. (*4 marks*)

b Plot a graph of the results, with distance from tree on the *x*-axis and number of daisies per m^2 on the *y*-axis. (*4 marks*)

c Describe the results of this investigation. (*3 marks*)

d Suggest an explanation for these results. (*4 marks*)

2 A student wanted to investigate the number of meadow buttercups growing in a dry area and in a wetter area. She placed 10 quadrats in each area and counted the number of meadow buttercups per m^2. The graph shows her results.



a Explain why it was important that the student studied 10 quadrats in each area, and not only two or three. (*2 marks*)

b The student concluded that there were more meadow buttercups in the wetter area because there was more water present in the soil. Another student said there could be another reason for the difference. Which student do you think is right? Explain your answer. (*1 marks*)

The mark–release–recapture technique

Most animals are mobile so estimating population size can be difficult.

In the mark–release–recapture technique:

- a large sample of the population is captured
- the animals are marked
- the marked animals are released and allowed to mix with the rest of the population for a few days
- a second large sample of the population is then recaptured and the numbers that were previously caught is counted
- the population size is calculated by the formula:

$$P = \frac{S1 \times S2}{M2}$$

Where:

P = total number of animals in the population

S1 = number of animals in sample 1

S2 = number of animals in sample 2

M2 = number of marked animals in sample 2.

1 Suggest two precautions that should be used when marking the captured animals. (*2 marks*)

2 A student captured and marked 54 woodlice. She released them then, 48 hours later she captured 63 woodlice. Of these 63, 18 had been previously marked.

Use the above formula to estimate the population of woodlice. (*2 marks*)

Extension

3 Suggest four assumptions that are made when using this method to estimate the number of woodlice. (*4 marks*)