

Distribution of organisms and biodiversity using quadrats

investigate the distribution of organisms in their habitats and measure biodiversity using quadrats

For Pearson Edexcel International GCSE Biology 4BI1 and Science (Double Award) 4SD0. **Biology only** This practical is not in the Double Award and is only examined on Paper 2. Teacher answers start on a new page.

Name

Date

Aim

To investigate how the distribution of a plant changes along a transect from shade into open ground, and to compare the biodiversity of two habitats using quadrats.

Background

The **distribution** of an organism is where it is found in a habitat. Distribution often changes gradually along a **gradient** in an environmental factor, such as light intensity from under a tree out into open grass. A **transect** (a line across the habitat) with quadrats at regular intervals is used to show this change.

Biodiversity is the variety of different species in a habitat. It is measured by counting the number of different species, not the number of individuals. To compare habitats, quadrats are placed randomly in each, the number of different species in each quadrat is recorded and the mean is calculated. The habitat with the higher mean number of species has the higher biodiversity.

A graph showing that an organism's numbers change with an environmental factor shows a **correlation**. It does not prove that the factor is the cause, because other factors may also change along the transect.

Hypothesis

The number of daisies will increase with distance from the tree as light intensity increases, and a meadow will have a higher mean number of species per quadrat than a mown lawn.

Variables

Independent	Part A: distance along the transect from the tree (m). Part B: the habitat (lawn or meadow)
Dependent	Part A: number of daisies per quadrat (and light intensity). Part B: number of different species per quadrat
Control	• Size of the quadrat (0.5 m × 0.5 m) • Number of quadrats (10 in each part, and 10 in each habitat) • The species counted in Part A (daisies) • The person counting and identifying the species • Time of day and weather (light meter readings taken at the same time) • Part B: quadrats placed at random in both habitats, on the same day

Equipment

- Quadrat, 0.5 m × 0.5 m
- 2 tape measures (10 m or longer)
- Light meter
- Random number table or random number generator

- Identification key or chart for the plants in the habitats
- Clipboard, pencil and recording table
- Calculator

Risk assessment

Hazard	Risk	Precaution
Uneven or wet ground and tape measures	Tripping or slipping	Wear suitable footwear, look where you are walking and keep tape measures tidy.
Plants, soil and animal droppings	Infection, stings or skin irritation	Do not touch plants you cannot identify, do not put hands near the mouth, and wash hands after the fieldwork.
Weather and sun	Sunburn or getting cold	Wear suitable clothing and sun cream if needed, and follow the teacher's instructions.

Method

1. Part A: lay a tape measure in a straight line (the transect) from the base of a tree out into open grass, for 9 m.
2. Place the quadrat at 0 m, with the tape measure along one edge. Then place it at every 1 m along the tape measure to give 10 quadrats.
3. At each quadrat, count the number of daisies.
4. At each quadrat, measure the light intensity with a light meter held at ground level, pointing upwards. Take all readings at the same time of day.
5. Record the distance, light intensity and number of daisies in the results table.
6. Part B: choose two habitats to compare, for example a regularly mown lawn and an uncut meadow.
7. In the first habitat, use random numbers as coordinates on a grid of two tape measures to place the quadrat in 10 different positions.
8. In each quadrat, identify every species of plant present, using a key if needed. Do not count how many of each, only how many different species.
9. Record the number of different species for each quadrat.
10. Repeat steps 7 to 9 in the second habitat, using the same size of quadrat and the same number of quadrats.
11. Calculate the mean number of different species per quadrat in each habitat.
12. Plot a graph of Part A to look for a pattern, and compare the means of Part B. Wash your hands.

Results

Results table: columns 2 to 4 are Part A (the transect); columns 5 and 6 are Part B (random quadrats in each habitat)					
Quadrat number	Distance from tree (m)	Light intensity (lux)	Number of daisies	Number of different species in lawn	Number of different species in meadow
1	0				
2	1				
3	2				
4	3				
5	4				
6	5				
7	6				
8	7				
9	8				
10	9				
Mean (Part B only)					

Graph

Part A: plot number of daisies (y-axis) against distance from the tree (m) (x-axis) as a bar chart or line graph, and plot light intensity (lux) against distance on the same x-axis (second y-axis, or a separate graph). Describe the pattern and whether the two change together. Part B: bar chart of the mean number of different species per quadrat (y-axis) for each habitat (x-axis, categoric).



Exam questions 10 questions · 26 marks

1 State what is meant by the term biodiversity. [2 marks]

.....

.....

.....

.....

2 State when it is better to use a transect and when it is better to use randomly placed quadrats. [2 marks]

.....

.....

.....

.....

- 3** A student recorded the number of different plant species in five random quadrats in two habitats. Calculate the mean number of species per quadrat in each habitat and state which habitat has the higher biodiversity. **[3 marks]**

Number of different species in each quadrat		
Quadrat	Habitat X	Habitat Y
1	3	7
2	2	8
3	4	6
4	3	9
5	3	5

Answer =

- 4** A student said, 'The habitat with 200 plants must have higher biodiversity than the habitat with 80 plants.' Explain why the student may not be correct. **[2 marks]**

- 5** Describe the trends shown in the data as the distance from the tree increases. **[3 marks]**

Daisies along a transect		
Distance from tree (m)	Light intensity (lux)	Number of daisies
0	900	0
3	3500	2
6	9000	6
9	11800	9

6 The student concluded that light intensity is the cause of the increase in daisies. Explain why this conclusion is not certain. **[2 marks]**

.....

.....

.....

.....

7 Explain why the quadrats were placed at regular intervals along the transect and why the same size of quadrat was used. **[2 marks]**

.....

.....

.....

.....

8 Describe one source of error when identifying the species in a quadrat and how it could be reduced. **[2 marks]**

.....

.....

.....

.....

.....

9 The mean number of species per quadrat was higher in a meadow than in a lawn that is mown every week. Suggest an explanation. **[2 marks]**

=====

=====

=====

=====

=====

10 Describe how you would use quadrats to compare the biodiversity of two habitats. **[6 marks]**

[illegible]

Teacher answers

Practical 13: Distribution of organisms and biodiversity using quadrats. The example results are practice data, not real measurements.

Example results

Example results (practice data)					
Quadrat number	Distance from tree (m)	Light intensity (lux)	Number of daisies	Number of different species in lawn	Number of different species in meadow
1	0	900	0	3	7
2	1	1200	0	2	8
3	2	1800	1	4	6
4	3	3500	2	3	9
5	4	5200	3	3	7
6	5	7400	5	2	8
7	6	9000	6	4	6
8	7	10500	8	3	7
9	8	11200	8	3	8
10	9	11800	9	3	6
Mean (Part B only)				3.0	7.2

Conclusion

Part A: the number of daisies rose from 0 at the base of the tree to 9 at 9 m, while light intensity increased from 900 to 11800 lux. Daisies were absent or rare in the shade and most common in open ground, so their distribution is correlated with light intensity. Daisies in the light can photosynthesise faster and grow and reproduce better. However, this does not prove that light is the cause, because soil moisture, leaf litter and competition from other plants also change with distance from the tree. Part B: the mean number of different species per quadrat was 3.0 in the lawn and 7.2 in the meadow, so the meadow has the higher biodiversity. Regular mowing stops many species from growing and flowering, whereas the uncut meadow provides conditions for more species.

Errors and improvements

Error	Effect on the results	Improvement
Only one transect is used, so it may not be representative of the whole habitat (random error)	The pattern may be due to chance or to a local feature, such as a patch of damp soil	Repeat with several transects at different positions and calculate the mean at each distance.
Light intensity changes with cloud, time of day and the shadow of the person taking the reading	Readings are not comparable, and the link between light and daisy numbers is less reliable	Take all readings at the same time, in one session, and avoid casting a shadow on the meter; repeat each reading and take a mean.
Misidentifying species, or missing small plants (systematic error)	The number of species is wrong, so biodiversity is over- or underestimated	Use a key or chart, have the same person identify the species in both habitats and check unknown plants with the teacher.
Quadrats in Part B are not placed randomly, or too few are used	The sample is biased, so the means may not represent the habitats	Use random numbers for coordinates and use more quadrats (at least 10 per habitat).
The two habitats differ in many ways (soil, size, drainage)	The difference in biodiversity cannot be put down only to mowing	Choose habitats that are as similar as possible, such as neighbouring areas, and measure the other factors.

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [2]

- the variety of different species (1)
- in a habitat or ecosystem / on Earth (1)

2. [2]

- transect: to investigate a change in distribution along a gradient, for example from shade to open ground (1)
- random quadrats: to compare habitats / to sample a whole area without bias (1)

3. [3]

- habitat X: $15 \div 5 = 3$ (1)
- habitat Y: $35 \div 5 = 7$ (1)
- habitat Y has the higher biodiversity (1)

4. [2]

- biodiversity is the number of different species, not the number of individuals (1)
- the habitat with 200 plants may contain only a few species / the habitat with 80 plants may have more different species (1)

5. [3]

- the number of daisies increases as the distance from the tree increases (1)
- from 0 at 0 m to 9 at 9 m (data quote) (1)
- light intensity also increases with distance (1)

6. [2]

- a correlation does not prove that one factor causes the other (1)
- other factors, such as soil moisture, leaf litter or competition, also change with distance from the tree (1)

7. [2]

- regular intervals give a fair sample of the whole gradient / changes can be compared at equal distances (1)
- the same size of quadrat so that counts are comparable (1)

8. [2]

- species may be misidentified or small plants missed (1)
- use an identification key or chart / use the same person in all quadrats (1)

9. [2]

- mowing stops many species growing / flowering / producing seeds (1)
- so only a few species that can survive being cut, such as grasses, remain; the meadow can support more species (1)

10. [6]

Level 3 5-6	A clear, ordered method with random placement of quadrats using coordinates, identification of every species in each quadrat, enough quadrats, a mean calculated for each habitat and a comparison, with variables controlled
Level 2 3-4	A method with random quadrats in both habitats and recording species in each, but with some detail or ordering missing
Level 1 1-2	A simple or partial method, for example placing quadrats and counting with little detail

Indicative content

- lay out a grid with two tape measures in each habitat
- use random numbers as coordinates to place the quadrat
- identify every species in the quadrat using a key
- record the number of different species, not the number of individuals
- use the same size and same number of quadrats (at least 10) in each habitat
- calculate the mean number of different species per quadrat for each habitat
- the habitat with the higher mean has the higher biodiversity

Exam tips

- Biodiversity is the number of different species. Counting how many individual plants there are is not a measure of biodiversity.
- Use a transect to show a change along a gradient (for example light intensity) and random quadrats to compare habitats.
- Quote data from the table or graph when you describe a trend, and mention both variables.
- A correlation does not prove cause. Suggest another factor that changes along the transect.
- In a sampling method, say how the positions are chosen (random numbers as coordinates) and that the same size and number of quadrats are used in each habitat.