

Quadrats and belt transects

Investigate the relationship between organisms and their environment using field-work techniques, including quadrats and belt transects

For Edexcel GCSE Biology 1BI0 and Combined Science 1SC0. Teacher answers start on a new page.

Name

Date

Aim

To use quadrats and a belt transect to find out how the number of a plant species changes along a line from shade into open ground, and how this relates to light intensity.

Background

It is not possible to count every organism in a habitat, so ecologists take samples. A **quadrat** is a square frame (often 0.5 m × 0.5 m) that marks out a small area. The number of organisms in several quadrats is used to estimate the population in the whole area. To avoid bias, the quadrats are placed **randomly**, for example using random coordinates from a random number generator.

The environment changes across many habitats, for example from shade to open ground. A **belt transect** is a line (a tape measure) laid across the habitat, with quadrats placed at regular intervals along it. It shows how the number of organisms changes along an environmental gradient.

Abiotic factors such as light intensity, soil moisture and soil pH can be measured at each quadrat. A correlation between the number of a species and an abiotic factor suggests that the factor affects where the species lives, but it does not prove it. Other factors may also be changing along the transect.

Hypothesis

The number of plants of one species per quadrat will increase as the light intensity increases from the shade under a tree to open ground, because the species needs a lot of light for photosynthesis.

Variables

Independent	Distance along the transect from the tree (m), which changes the light intensity (lux)
Dependent	Number of plants of the chosen species in each quadrat
Control	• Size of the quadrat (always 0.5 m × 0.5 m) • The species being counted • The same person counting, using the same method (for example counting only plants rooted inside the quadrat) • Time of day and weather when light is measured • Same position of the light meter (at the height of the plants, pointing upwards)

Equipment

- Quadrat, 0.5 m × 0.5 m
- Two 30 m tape measures
- Random number table or calculator
- Light meter (measuring in lux)
- Identification key or chart for the plant species
- Clipboard, results table and pencil
- Suitable clothing and footwear
- Wet wipes or access to water for washing hands

Risk assessment

Hazard	Risk	Precaution
Uneven ground, holes and slippery grass	Trips and falls.	Wear suitable footwear and watch where you are walking. Stay with your group.
Poisonous or irritant plants, thorns and stinging plants	Skin irritation or poisoning if touched or eaten.	Do not touch or eat any plant you cannot identify. Wear gloves if asked. Wash your hands after the practical.
Soil, animal droppings and ticks	Infection from soil or droppings; tick bites in long grass.	Cover cuts with waterproof plasters, wear long trousers, wash hands before eating, and check for ticks afterwards.
Weather (sun, rain, cold)	Sunburn, heatstroke or getting too cold.	Wear suitable clothing, use sun cream and a hat, and bring water. Follow your teacher's weather guidance.
Hay fever and allergies	Allergic reactions to pollen or plants.	Tell your teacher about allergies and take any medication with you.

Method

1. Choose an area that changes from shade to open ground, for example from under a tree out into open grass. Decide on the plant species to count.
2. Part A, random sampling. Lay two tape measures at right angles along two sides of the area to be sampled.
3. Use a random number generator to pick two coordinates, one for each tape measure.
4. Place the quadrat at the point where the two coordinates meet.
5. Count the number of plants of the chosen species inside the quadrat. Count only plants rooted inside the quadrat, and record the number.
6. Repeat steps 3 to 5 for at least 10 quadrats. Calculate the mean number per quadrat.
7. Part B, belt transect. Lay a tape measure in a straight line from the base of the tree out into open grass, for a distance of at least 10 m.
8. Place the quadrat on the left of the tape at 0 m, with the tape along one edge, and count the plants of the chosen species.
9. Measure the light intensity with the light meter at ground level next to the quadrat, pointing upwards. Record the value in lux.
10. Move the quadrat along the tape to 2 m, 4 m, 6 m, 8 m and 10 m, repeating steps 8 and 9 at each point.
11. Record all results in a table.
12. Plot a graph of the number of plants against distance or against light intensity, and look for a pattern.

Results

Number of plants and light intensity along the belt transect		
Distance from tree (m)	Light intensity (lux)	Number of plants in quadrat
0		
2		
4		
6		
8		
10		

Graph

Draw a scatter graph with light intensity (lux) on the x-axis and number of plants per quadrat on the y-axis. Plot each quadrat as a point and draw a line of best fit. Alternatively, draw a bar chart with distance from the tree (m) on the x-axis and number of plants per quadrat on the y-axis.



Exam questions 9 questions · 25 marks

1 A student placed quadrats randomly in a field. Explain why quadrats are placed randomly. [2 marks]

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2 Describe how the student could place quadrats randomly in a field. **[2 marks]**

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3 A student used ten quadrats, each 0.5 m × 0.5 m (area 0.25 m²), to count daisies in a field. **[4 marks]**
 The numbers were 4, 7, 5, 6, 3, 8, 5, 6, 4 and 2. (a) Calculate the mean number of daisies per quadrat. (b) The field has an area of 200 m². Estimate the number of daisies in the field.

Answer =

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4 Explain why a belt transect was used, instead of random sampling, to investigate how the number of plants changes from the shade of a tree to open grass. **[2 marks]**

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5 The table shows the number of plants per quadrat along a belt transect from under a tree. **[3 marks]**
 Describe the pattern in the results and suggest an explanation.

Distance from tree (m)	Light intensity (lux)	Number of plants in quadrat
0	800	0
2	2100	2
4	4500	5
6	7600	9
8	9800	12
10	10 500	13

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Teacher answers

Core practical 8: Quadrats and belt transects. The example results are practice data, not real measurements.

Example results

Example results (practice data). One quadrat (0.5 m × 0.5 m) at each position.		
Distance from tree (m)	Light intensity (lux)	Number of plants in quadrat
0	800	0
2	2100	2
4	4500	5
6	7600	9
8	9800	12
10	10 500	13

Conclusion

The number of plants per quadrat increased from 0 at the base of the tree to 13 at 10 m, as the light intensity increased from 800 lux to 10 500 lux. This shows a positive correlation between light intensity and the number of plants of this species, which suggests that the species grows better where there is more light, because it needs light for photosynthesis. However, correlation does not prove that light is the cause. Soil moisture and soil nutrients also change along the transect (for example, tree roots take up water), and these could also affect the plants. The data are from only one quadrat at each point, so more repeats are needed to be confident.

Errors and improvements

Error	Effect on the results	Improvement
Only one quadrat was used at each position along the transect.	A single unusual quadrat could give a misleading picture, and anomalies cannot be spotted.	Use several quadrats at each position (for example three, along parallel lines) and calculate a mean.
Quadrats in the random sample were not placed truly randomly (for example, thrown or placed where plants were easy to see).	Sampling bias, so the estimate of the population is not representative.	Use a random number generator for coordinates, and place the quadrat exactly at those points.
Plants overlap or are hard to identify, so different people count differently.	Counts are inaccurate (random error) and may differ between people.	Use a clear rule for counting (for example plants rooted inside the quadrat) or percentage cover, and use the same person throughout.
The light meter reading changes with cloud cover, time of day and the angle of the meter.	Light intensity readings are not comparable between quadrats.	Take readings quickly in the same direction at the same height, in similar weather, and take several readings and calculate a mean.
Other abiotic factors, such as soil moisture, change along the transect.	The pattern may not be caused by light, so the conclusion is less valid.	Measure other factors (soil moisture, soil pH) at each quadrat and compare.

Mark scheme

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

1. [2]

- to avoid (sampling) bias (1) ignore 'to make it fair'
- so that the sample is representative of the whole area (1)

2. [2]

- lay two tape measures at right angles along two sides of the field (to make a grid) (1)
- use a random number generator / random number table to pick two coordinates and place the quadrat where they meet (1)
- do not accept 'throw the quadrat'

3. [4]

- (a) total = 50 (1)
- mean = $50 \div 10 = 5$ (daisies per quadrat) (1)
- (b) $5 \div 0.25 = 20$ daisies per m^2 (1) allow $200 \div 0.25 = 800$ quadrats
- $20 \times 200 = 4000$ daisies (1) allow $800 \times 5 = 4000$; allow error carried forward from (a)

4. [2]

- a belt transect samples along a line across an environmental gradient / from one area to another (1)
- so the change in the number of plants with distance or light intensity can be seen / random sampling would not show a pattern (1)

5. [3]

- the number of plants increases as the distance from the tree / light intensity increases (1)
- use of data, for example from 0 plants at 800 lux to 13 plants at 10 500 lux (1)
- because the plants need light for photosynthesis, so grow better where light intensity is higher (1)

6. [2]

- correlation does not show causation / other factors may also change along the transect (1)
- for example soil moisture / soil nutrients / soil pH / temperature (1)

7. [2]

- soil moisture / soil pH / temperature (1)
- matching instrument: moisture meter / pH meter or probe (allow indicator solution) / thermometer (1)

8. [2]

- use more than one quadrat at each position (1)
- repeat the transect in other places / along parallel lines (1)
- calculate a mean (1)
- Max 2

9. [6]

Level 3 5-6	A clear, logical method that includes the transect line, regular quadrat spacing, counting plants, measuring light intensity, and at least one control or way of improving reliability.
Level 2 3-4	A mostly complete method but with some steps missing, for example how light is measured or how the quadrats are spaced.
Level 1 1-2	Some correct steps but the method is incomplete or unclear.

Indicative content

- lay a tape measure in a straight line from the tree out into open grass
- place a quadrat at regular intervals along the tape (for example every 2 m)
- count the number of plants of the chosen species in each quadrat
- measure light intensity at each quadrat with a light meter
- controls: same size of quadrat, same species counted, same person counting
- repeat with more quadrats or repeat the transect and calculate a mean
- record in a table and plot a graph to look for a pattern

Exam tips

- Always give the reason for random placement: it avoids bias. Do not just say 'to be fair'.
- Use a belt transect when the question mentions a gradient or change across a habitat. Use random quadrats to estimate the population in a whole area.
- In population estimate calculations: find the mean per quadrat, convert to the number per m² using the quadrat area, then multiply by the total area.
- For correlation questions, say that a correlation does not prove one factor causes the other because other variables may also change.
- Name the instrument for each abiotic factor: light meter for light intensity, moisture meter for soil moisture, pH probe for soil pH.