

Field investigations: quadrats and transects

Measure the population size of a common species in a habitat. Use sampling techniques to investigate the effect of a factor on the distribution of this species.

For AQA GCSE Biology 8461 and Combined Science: Trilogy 8464. Teacher answers start on a new page.

Name

Date

Aim

To estimate the population size of a common plant in a habitat using random quadrats, and to find how a factor such as light affects its distribution along a transect.

Background

An ecologist cannot usually count every organism in a habitat. Instead, a **sample** is taken and used to estimate the **population size** (the total number of a species) and the **distribution** (where the species is found).

A **quadrat** is a square frame, usually 0.25 m^2 ($50 \text{ cm} \times 50 \text{ cm}$) or 1 m^2 . The number of organisms inside it is counted. Placing quadrats at **random** positions avoids bias and gives a sample that represents the whole habitat.

A **transect** is a line, such as a tape measure, laid across a habitat where a factor changes, for example from shade into open ground. Quadrats are placed at regular intervals along the line, so you can see how the number of organisms changes with the factor.

Environmental factors that may affect distribution include light intensity, soil moisture, soil pH, temperature, and trampling. The species you choose must be easy to identify and count.

Hypothesis

The number of plants per quadrat will increase with distance from the hedge, because light intensity increases with distance from the shade of the hedge, and the plant needs light for photosynthesis.

Variables

Independent	Part A: none (random sampling). Part B: distance along the transect from the hedge (m), which changes the light intensity
Dependent	Number of plants of the chosen species in each quadrat
Control	• Same species counted each time (and the same rule for counting plants on the edge of the quadrat) • Same size of quadrat • Same person counting • Same time of day and same weather when measuring light • Same transect line direction for each repeat • Same habitat and similar soil along the transect

Equipment

- Quadrat (0.25 m^2 , $50 \text{ cm} \times 50 \text{ cm}$)
- Two 30 m measuring tapes

- Random number generator or calculator (or random number table)
- Light meter
- Identification key or guide for the chosen species
- Clipboard, results table and pencil
- Gloves
- Stakes or markers (optional)

Risk assessment

Hazard	Risk	Precaution
Harmful or irritant plants (for example nettles, giant hogweed)	Skin irritation, burns or allergic reactions	Learn which plants to avoid. Wear gloves and long trousers. Do not touch unknown plants.
Uneven ground and weather	Tripping, sunburn or getting cold	Wear sensible footwear, dress for the weather, use sun cream and stay within the marked area.
Ticks, insects and animal faeces	Bites, stings or infection	Check clothes afterwards, cover skin and wash your hands thoroughly after the practical.
Water, roads or fences near the site	Falling into water or getting hurt	Stay away from water edges and roads, work in groups and follow the teacher's boundary.

Method

1. Choose a habitat (for example a field) and a common species that is easy to identify, such as daisies or dandelions, in an area you can measure.
2. Lay two tape measures at right angles along two sides of the sampling area to make a pair of axes.
3. Part A, population size: use a random number generator to pick two numbers, one for each tape measure, to give coordinates.
4. Place the quadrat with its corner at that coordinate and count the plants of the species inside the quadrat. Record the number in a separate Part A table with the headings Quadrat number and Number of plants in quadrat.
5. Repeat at least 10 times with new random coordinates. Using many quadrats makes the sample more representative.
6. Calculate the mean number of plants per quadrat. Divide by the area of the quadrat to find the mean per m².
7. Measure the total area of the habitat in m². Estimate the population: mean number per m² × total area of the habitat in m².
8. Part B, distribution: lay a tape measure across the habitat, in a straight line from the shade of a hedge into open ground. This is the transect.
9. Place a quadrat on the line at 0 m, touching the hedge side of the tape, then every 2 m along the transect up to 10 m.
10. At each position, count the plants of the species inside the quadrat.
11. At each position, measure the light intensity at ground level with a light meter, held at the same angle each time.
12. Record the results in a table. Repeat on one or two other transects if time allows, and calculate the mean for each distance.

L3 . Plot a graph of number of plants against distance from the hedge, and describe the pattern in distribution.

Results

Transect: number of plants in a 0.25 m² quadrat at each distance from the hedge		
Distance from hedge (m)	Light intensity (lux)	Number of plants in quadrat
0		
2		
4		
6		
8		
10		

Graph

Line graph of number of plants per quadrat (y-axis) against distance from the hedge in m (x-axis). The independent variable goes on the x-axis. Plot a point for each distance and join the points with straight lines, because the data are continuous along a transect. Use more than half the grid and equal scale steps.



Exam questions 10 questions · 26 marks

1 A student places quadrats at random positions in a field. Explain why the positions are chosen at random. **[2 marks]**

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2 Explain why many quadrats should be used, instead of just two or three. **[2 marks]**

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3 A student counted daisies in ten 0.25 m² quadrats and recorded: 3, 5, 4, 6, 2, 4, 5, 3, 4, 4. **[2 marks]**
Calculate the mean number of daisies per quadrat.

Answer =

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4 The field has an area of 400 m². Use your answer to question 3 to estimate the population of daisies in the field. **[3 marks]**

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5 Calculate the mode and the median of the counts in question 3. **[2 marks]**

Answer =

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- 6** The student wants to investigate how the number of plants changes from the shade of a hedge to an open field. Explain why a transect is better than random sampling for this investigation. **[2 marks]**

- 7** Use the sample results to describe how the number of plants changes with distance from the hedge, and suggest a reason. **[3 marks]**

Number of plants per quadrat		
Distance from hedge (m)	Light intensity (lux)	Number of plants in quadrat
0	2000	2
2	4500	5
4	8000	9
6	11000	13
8	12000	14
10	12500	14

- 8** A student says that the results prove that light intensity is the only factor that affects the distribution of the plant. Explain why the student cannot be sure. **[2 marks]**

- 9** Name two variables that should be controlled when using quadrats along a transect. **[2 marks]**

10 Describe how you would use quadrats to estimate the population of a plant species in a school field. Include how you would reduce errors in your estimate. **[6 marks]**

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Teacher answers

Required practical 9: Field investigations: quadrats and transects. The example results are practice data, not real measurements.

Example results

Example results (practice data) for one transect, plants counted in a 0.25 m ² quadrat		
Distance from hedge (m)	Light intensity (lux)	Number of plants in quadrat
0	2000	2
2	4500	5
4	8000	9
6	11000	13
8	12000	14
10	12500	14

Conclusion

The number of plants per quadrat increased from 2 at the hedge to 14 at 10 m, and the increase was greatest between 0 and 6 m, where light intensity also rose most quickly. Beyond 8 m the number levelled off at 14. This suggests that the **distribution** of this species is affected by light intensity: it is more abundant where there is more light. This fits with the idea that the plant needs light for photosynthesis. However, other factors, such as soil moisture and the roots of the hedge, also change with distance from the hedge, so the results show a **correlation**, not proof that light is the cause. The data come from a single transect, so more transects would be needed for a firm conclusion.

Errors and improvements

Error	Effect on the results	Improvement
Too few quadrats in the random sample (random error).	The mean may not be representative, especially if the plants are clumped, so the population estimate could be too high or too low.	Take more quadrats (at least 10, ideally 20 or more) and calculate the mean.
Quadrats not placed randomly, for example choosing places where plants are easy to see (bias, a systematic error).	The sample is not representative, so the population estimate is wrong.	Use a random number generator to pick coordinates.
Difficulty in deciding whether to count plants on the edge of a quadrat, or in identifying the species.	Counts differ between people, giving inconsistent data.	Agree a rule (for example count plants touching the top and left edges only), use an identification guide and have the same person counting.
Only one transect is used, and other factors change along it.	The pattern may be due to a different factor or to chance, so the conclusion is weak.	Repeat on two or more transects at the same distances, calculate the mean and measure other factors such as soil moisture.
Light intensity changes with cloud and time of day.	Readings taken at different times are not comparable.	Take all the light meter readings within a short time, or repeat at the same times and on a day with steady weather.

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 bias (1)
- so the sample is representative of the whole habitat / area (1)

2. [2]

- so the results are more representative of the whole habitat / area (1)
- to reduce the effect of anomalies / chance / of an unusual quadrat (1)

3. [2]

- total = 40 (1)
- $40 \div 10 = 4$ (daisies per quadrat) (1)

4. [3]

- mean per $\text{m}^2 = 4 \div 0.25 = 16$ (1)
- 16×400 (1)
- = 6400 (daisies) (1) allow ecf from a different answer to question 3

5. [2]

- mode = 4 (1)
- median = 4 (1) (ordered: 2, 3, 3, 4, 4, 4, 4, 5, 5, 6, middle values are 4 and 4)

6. [2]

- a transect samples at regular intervals along the line where the factor changes (1)
- so the change in number of organisms can be linked to distance / the factor (1) allow random quadrats would not show the pattern along the gradient

7. [3]

- the number of plants increases with distance from the hedge (1)
- then levels off at 14 beyond 8 m (1)
- light intensity increases with distance, and plants need light for photosynthesis (1)

8. [2]

- other factors may also change with distance from the hedge (1)
- for example soil moisture / soil pH / competition from the hedge roots (1) allow only one transect was used

9. [2]

- size of quadrat (1)
- same species counted / same rule for plants on the edge (1)
- same person counting (1)
- same time of day / same weather (1)
- same distance between quadrats (1)
- Max 2

10. [6]

Level 3 5-6	A clear, logical method including random placement of the quadrat (for example with a random number generator and two tape measures), counting the species in each quadrat, repeating many times, calculating the mean per quadrat, and the calculation of the population estimate using the total area. At least two ways of reducing error are given. The method could be followed by another person.
Level 2 3-4	A mostly clear method with the main steps. The calculation of the estimate or the random placement is missing, or only one way of reducing error is given.
Level 1 1-2	A few simple points, for example 'put a quadrat down and count the plants', with little detail.

Indicative content

- lay out two tape measures at right angles along two sides of the field
- use random numbers as coordinates to place the quadrat
- count the plants in the quadrat and repeat at least 10 times
- calculate the mean per quadrat, then per m^2
- measure the area of the field; population = mean per $m^2 \times$ area
- reduce error by using many quadrats, same counting rule for edge plants and the same person counting

Exam tips

- If asked why quadrats are placed at random, say 'to avoid bias'. For why many are used, say 'to make the results more representative'.
- Be careful with units in population estimates. Work out the number per m^2 first (divide by the quadrat area), then multiply by the area of the habitat.

- Use a transect when the question mentions a change in a factor, such as ‘from the shade into the open’. Use random quadrats to estimate the population of a whole area.
- A correlation does not prove a cause. Say ‘this suggests’ and name another factor that could also change.
- Describe a graph with data: give the values for the highest and lowest points as well as the trend.