

The organism in the environment

Revision notes · Ecological terms, sampling populations with quadrats, biodiversity, and how abiotic and biotic factors affect where organisms live.

For Pearson Edexcel International GCSE Biology 4BI1 and Science (Double Award) 4SD0. **Biology only** is not in the Double Award and is only examined on Paper 2.

The organism in the environment Spec 4.1–4.5

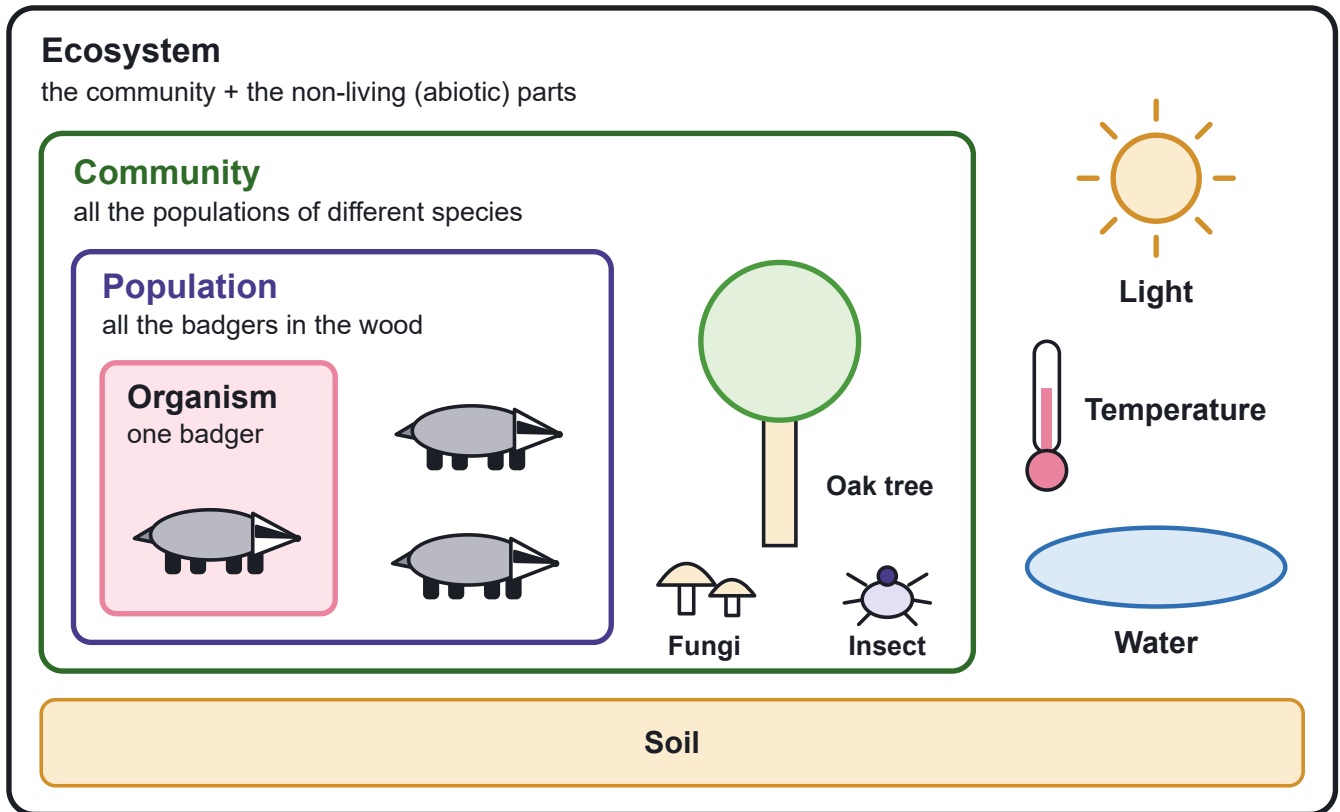
Population, community, habitat and ecosystem Spec 4.1

Ecologists use four key terms to describe living things and where they live. Each one covers a bigger scale than the one before.

Key ecological terms		
Term	What it means	Example
Population	All the organisms of one species living in the same area	All the badgers in a wood
Community	All the populations of different species living in the same area	The badgers, foxes, oak trees, insects and fungi in the wood
Habitat	The place where an organism lives	The woodland floor, or a pond
Ecosystem	A community together with the non-living (abiotic) parts of its environment	The wood, including its soil, water, light and temperature

An **ecosystem** is made of living (**biotic**) and non-living (**abiotic**) parts that interact with each other. Energy and materials move between them.

Common mistake: A population is one species only. If an answer mentions different species living together, it is describing a community.



Each level contains the one before it: **organism**, **population**, **community**, then **ecosystem** (the community plus its abiotic parts).

Practical: population size with quadrats Spec 4.2

To compare the population size of an organism in two different areas, you cannot count every individual. Instead you take samples using a **quadrat**, a square frame that marks out a small, known area.

Quadrat A square frame used to sample the organisms in a small, known area.

Method: comparing two areas

1. Choose the two areas to compare, for example a shaded area under a tree and an open, sunny area of the same lawn.
2. In the first area, lay two tape measures at right angles along two sides to make a grid.
3. Use a **random number generator** to pick two coordinates, one along each tape measure.
4. Place the quadrat at that point and count the number of the chosen species (for example daisies) inside it.
5. Repeat for at least 10 quadrats, then calculate the **mean number per quadrat**.
6. Repeat the same steps in the second area, using the same size of quadrat and the same number of quadrats.
7. Compare the two means.

Variables and safety

- **Independent variable:** the area (for example shaded or open).
- **Dependent variable:** the number of the chosen species per quadrat.
- **Control variables:** the size of the quadrat, the number of quadrats, the species counted, the person counting and the time of year.
- **Safety:** wear suitable footwear, wash hands after handling soil or plants, and do not touch plants you cannot identify.

Practical: Say that quadrats are placed randomly to avoid bias, and that using many quadrats makes the mean more reliable. The same number of quadrats must be used in each area for a fair comparison.

Typical result: if one area has more light or water, the mean number of a plant that needs these will be higher there. The mean from each area is then used to estimate the whole population, as shown in the next section.

Estimating population size Spec 4.2

You cannot count every organism in a large area, so you count the organisms in a sample of quadrats and scale up the mean to the whole area.

$$\text{estimated population} = \text{mean number per quadrat} \times (\text{total area} \div \text{area of one quadrat})$$

Estimating a population

A student counted daisies in five 0.25 m² quadrats placed randomly in a field of area 100 m². The counts were 3, 5, 4, 6 and 2. Estimate the number of daisies in the field.

1. Mean per quadrat = $(3 + 5 + 4 + 6 + 2) \div 5 = 20 \div 5 = 4$
2. Number of quadrat areas in the field = $100 \div 0.25 = 400$
3. Estimated population = $4 \times 400 = 1600$

Answer: 1600 daisies

Plants that are difficult to count individually, such as grass, can be measured by **percentage cover**: the percentage of the quadrat covered by the species.

- Take as many quadrats as possible, because a bigger sample is more representative and reduces the effect of anomalies.
- Place quadrats randomly, to avoid bias.
- Calculate a **mean** from the raw data. A bar chart or frequency table is useful for presenting the results.

Maths skill: Check the units. If the quadrat is 0.5 m by 0.5 m its area is 0.25 m², not 0.5 m². This is the most common slip in estimate questions.

Biodiversity Spec 4.3B Biology only

Biodiversity

The variety of all the different species of organisms in an ecosystem, habitat or on Earth.

Biodiversity depends on how many different **species** are present. A habitat with many species has **high biodiversity**. A habitat with only a few species has low biodiversity.

Biodiversity is about the number of different species, not the number of individuals. A field containing a million plants of one species has low biodiversity. A hedgerow with a dozen different plant species and the insects that feed on them has high biodiversity.

Exam tip: If asked for the meaning of biodiversity, mention the variety of different species. Do not write about the number of organisms.

Practical: distribution and biodiversity Spec 4.4B Biology only

The **distribution** of an organism is where it is found. Quadrats can be used to investigate how organisms are distributed in their habitats, and to measure the biodiversity of a habitat.

Distribution: a belt transect

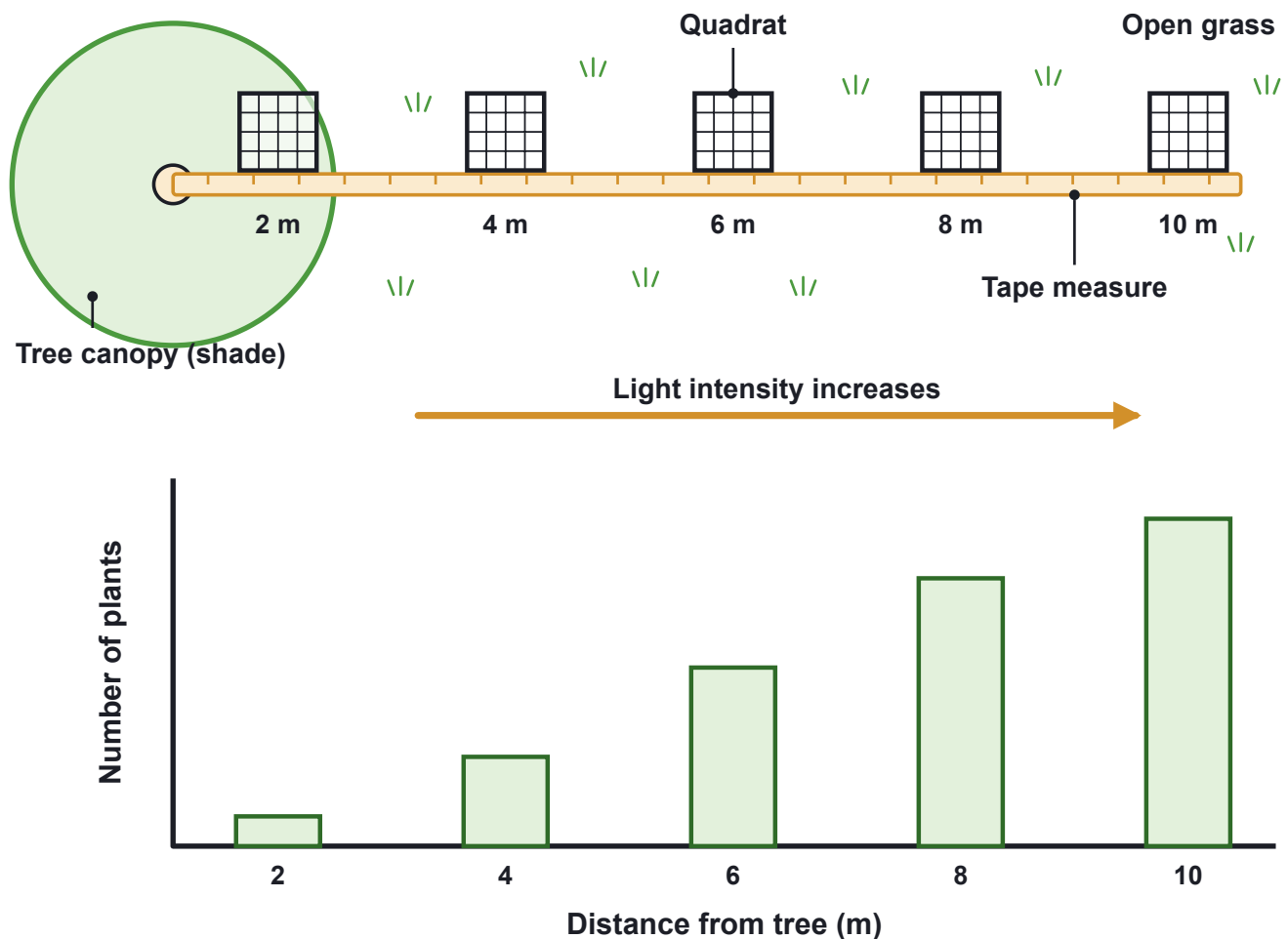
1. Lay a tape measure in a straight line (a **transect**) across the habitat, for example from under a tree out into open grass.
2. Place a quadrat at regular intervals along the tape, such as every 2 m.
3. At each position count the organisms of the species in the quadrat, and measure an environmental factor such as light intensity with a light meter.
4. Record both in a table and plot a graph to look for a pattern.

Typical result: plants that need a lot of light increase in number as you move from shade into open ground. A correlation like this does not prove that light intensity is the cause.

Measuring biodiversity

1. Place quadrats randomly in the habitat.
 2. In each quadrat, identify every species present, using a key if needed, and record how many different species there are.
 3. Repeat for many quadrats, then work out the **mean number of different species** per quadrat.
 4. Compare habitats: the one with the higher mean number of species has the higher biodiversity.
- **Independent variable:** position along the transect, or the habitat being compared.
 - **Dependent variable:** the number of the species, or the number of different species, per quadrat.
 - **Control variables:** quadrat size, number of quadrats and the person counting.
 - **Safety:** wear suitable footwear, wash hands after handling soil or plants, and do not touch plants you cannot identify.

Practical: Use a transect to show a change along a gradient. Use random quadrats to compare habitats. Biodiversity is measured by counting the number of different species, not the number of individuals.



A belt transect: quadrats at regular intervals along a tape measure, with the count from each quadrat plotted against distance.

Abiotic and biotic factors Spec 4.5

The population size and distribution of organisms are affected by **abiotic factors** (non-living) and **biotic factors** (living). Changes in either can change which species live in a place and how many there are.

Factors that affect populations		
Type	Factor	How it can affect population size and distribution
Abiotic	Temperature	Affects the rate of enzyme-controlled reactions, so growth and survival. Species survive only within a range of temperatures.
Abiotic	Light	Plants need light for photosynthesis. Less light means fewer plants, and so less food for the animals that depend on them.
Abiotic	Water	All organisms need water. In dry conditions only organisms adapted to save water survive, so numbers and variety fall.
Biotic	Competition	Organisms of the same or different species compete for the same limited resources, such as food, water, light and space.
Biotic	Predation	Predators eat prey, so predator and prey numbers affect each other.

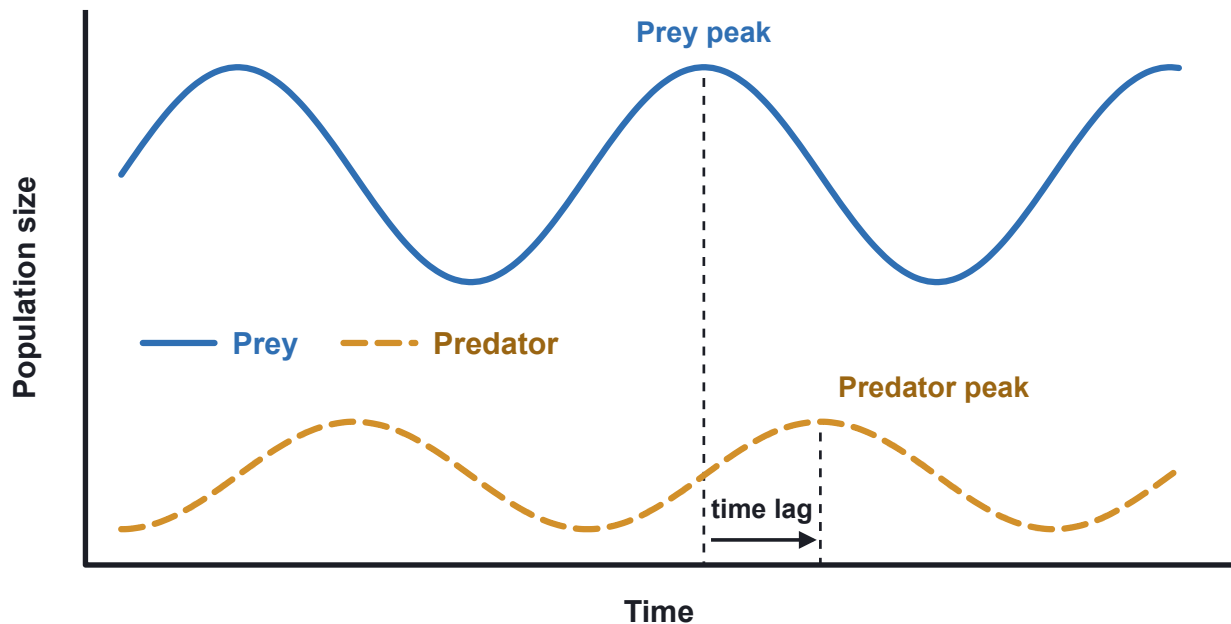
Competition

Competition happens when organisms need the same resource and there is not enough for all of them. Plants compete for light, water and mineral ions. Animals compete for food, water and territory. The better-adapted species gets more of the resource, so it survives and reproduces more, and the numbers of the other species may fall.

Predation

In a stable community, predator and prey numbers rise and fall in a repeating pattern. When prey numbers rise, predators have more food, so predator numbers rise. More predators eat more prey, so prey numbers fall. With less food, predator numbers then fall, and the prey can recover.

Exam tip: On a predator-prey graph, the predator peak comes after the prey peak, because predator numbers rise only once there is more food.



Predator and prey numbers cycle: the predator peak comes after the prey peak.

Quick check

1. What is a population?
2. What is an ecosystem?
3. Why are quadrats placed randomly?
4. **Biology only** What is biodiversity?
5. Name two biotic factors that affect population size.

Quick check answers

The organism in the environment

1. All the organisms of one species living in the same area.
2. A community together with the non-living (abiotic) parts of its environment.
3. To avoid bias.
4. The variety of different species in an ecosystem or habitat.
5. Competition and predation.