Levels of organisation

4.7.2.1 · Biology · revision notes

Food chains, the names of the feeding levels (producer, primary, secondary and tertiary consumer), predator–prey cycles, and how ecologists use quadrats and transects to measure the abundance and distribution of species. This includes a required practical, so expect planning, calculation and graph questions as well as recall.

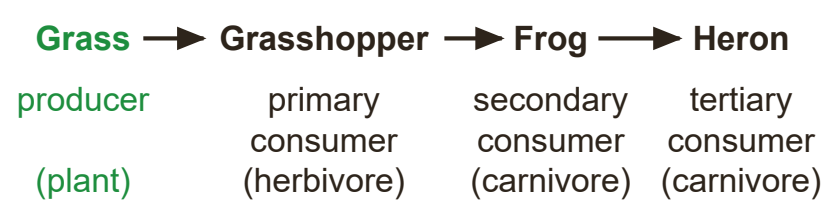
Key facts

- Food chain: producer → primary consumer → secondary consumer → tertiary consumer
- Arrows point towards the organism doing the eating
- Mean = sum of values ÷ number of values
- Population estimate = mean number per m² × total area in m²
- Producers make glucose by photosynthesis (usually green plants or algae)
- Predator–prey graph: predator peaks come after prey peaks
- Median = middle value when in order; mode = most common value
- Random quadrats → population size; transect → distribution along a gradient

Notes

Food chains

- Organisms that photosynthesise produce the biomass that all other life on Earth depends on.
- Every food chain begins with a **producer**: usually a green plant or an alga that makes glucose by photosynthesis.
- Next come the **primary consumers** (which eat producers), then the **secondary consumers** (which eat primary consumers), then the **tertiary consumers**.
- The arrows point from the organism that is eaten to the organism that eats it.

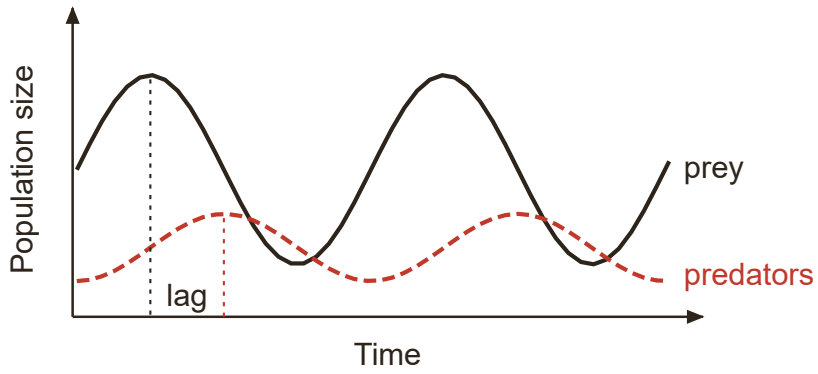


A food chain always starts with a producer. Arrows show what is eaten by what.

- A **predator** is a consumer that kills and eats other animals, which are its **prey**.

Predator–prey cycles

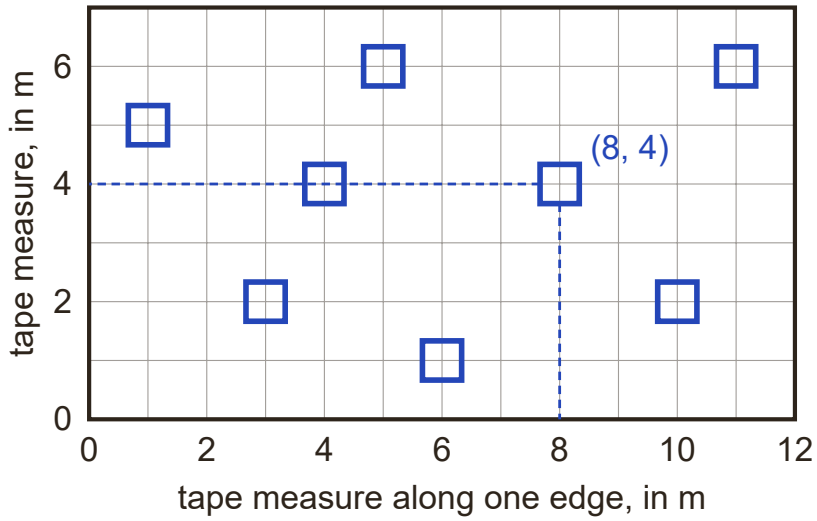
- In a stable community, the numbers of predators and prey rise and fall in cycles.
- More prey → more food for predators → more predators survive and breed.
- More predators → more prey eaten → prey numbers fall.
- Fewer prey → less food → predator numbers fall → prey numbers can rise again.
- On a graph, each predator peak comes **after** a prey peak, and there are usually fewer predators than prey.



Predator–prey cycle: the predator peak lags behind the prey peak.

Quadrats: how many?

- A **quadrat** is a square frame, e.g. 50 cm × 50 cm (0.25 m²).
- Place quadrats **randomly** (e.g. at coordinates from a random number generator on a grid) to avoid bias.
- Do not throw quadrats: a thrown quadrat is not placed randomly.

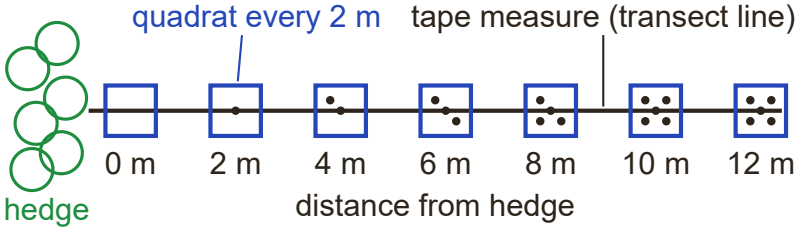


Random sampling: two tapes make a grid and random numbers give each quadrat's coordinates.

- Count the organisms in each quadrat and calculate the mean number per quadrat.
- **Mean** = total ÷ number of values; **median** = the middle value when the values are in order; **mode** = the most common value.
- Estimated population = (mean number per quadrat ÷ area of one quadrat) × total area of the habitat.
- The more quadrats you use, the more representative the estimate.
- To compare two areas (e.g. wet and dry soil), place equal numbers of same-sized random quadrats in each, count the species in each and compare the means.
- Measure the factor at each quadrat, e.g. with a soil moisture meter or light meter.

Transects: where?

- A **transect** is a line (e.g. a tape measure) across a habitat where a factor changes, such as from a hedge out into a field.
- Place a quadrat at regular intervals along the line. Count the organisms (or estimate percentage cover) and measure the abiotic factor at each point.



Transect: count the plants and measure the factor (e.g. light) in a quadrat at each point along the line.

- Plot the results to see how the distribution of the species changes with the factor.

How to answer each type of question

Name the feeding levels in a food chain

1 mark each | Grade 3

1. The first organism is the producer.
2. Count along the arrows: next is the primary consumer, then the secondary, then the tertiary.
3. A herbivore eats producers, so it is a primary consumer.

Example. Here is a food chain from a rocky shore:
seaweed → limpet → crab → herring gull
(a) Name the producer.
(b) Name the secondary consumer.
(c) Name the herbivore.

Model answer.

(a) Seaweed (1)
(b) Crab (1)
(c) Limpet (1)

Calculate a population estimate from quadrat data

2 to 3 marks | Grade 5

1. Calculate the mean number per quadrat (total ÷ number of quadrats).
2. Divide by the area of one quadrat to get the number per m².
3. Multiply by the total area of the habitat.
4. Show every step; each one can earn a mark.

Example. A student placed 10 quadrats randomly in a field. Each quadrat had an area of 0.25 m². The table shows the number of daisies in each quadrat.

Quadrat	1	2	3	4	5	6	7	8	9	10
Number of daisies	4	7	2	0	5	3	6	1	4	8

The field has an area of 1500 m². Estimate the number of daisies in the field. (3 marks)

Model answer.

Mean = 40 ÷ 10 = 4 daisies per quadrat (1)
Number per m² = 4 ÷ 0.25 = 16 (1)
Estimate = 16 × 1500 = 24 000 daisies (1)

Describe how to investigate the effect of a factor on distribution (required practical)

4 to 6 marks | **Grade 5**

1. Lay a tape measure (transect) from one area to another where the factor changes.
2. Place a quadrat at regular intervals, e.g. every 2 m.
3. Count the organisms or estimate percentage cover in each quadrat.
4. Measure the factor at each quadrat, e.g. light intensity with a light meter.
5. Repeat along more transects and calculate means.

Example. Plan an investigation to find out how the number of daisies changes with distance from a tall hedge at the edge of a school field. (4 marks)

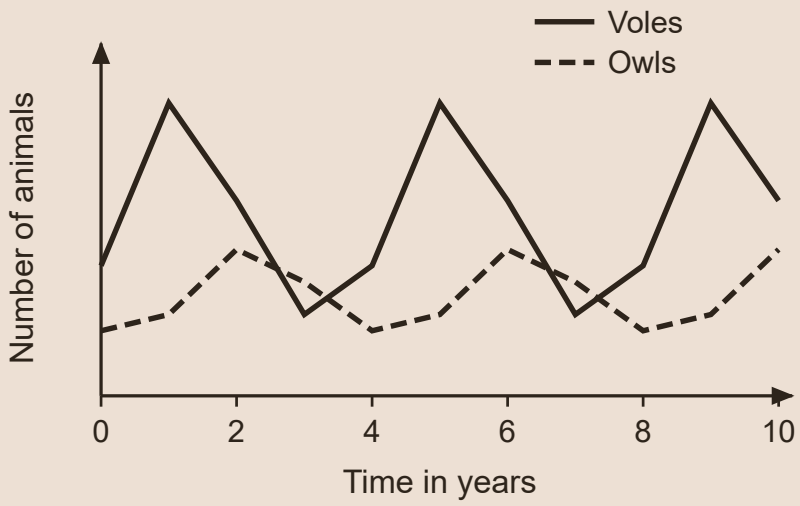
Model answer. Lay a tape measure from the hedge out into the field, at right angles to the hedge (1). Place a quadrat at regular intervals along the tape, e.g. every 2 m (1). Count the daisies in each quadrat (1). Repeat along several transects at different points along the hedge and calculate a mean for each distance (1). Also credit: measure the light intensity at each quadrat with a light meter.

Explain a predator–prey graph

3 to 4 marks | Grade 7

1. Describe the pattern: both populations rise and fall in cycles, with the predator peak after the prey peak.
2. Explain the rise in predators: more prey means more food, so more predators survive and breed.
3. Explain the fall in prey: more predators eat more prey.
4. Explain the fall in predators: less food.

Example. An ecologist recorded the numbers of voles and of owls (which feed mainly on voles) in a forest over 10 years. The graph shows the results. The owl numbers are drawn on a larger scale than the vole numbers.



Explain the pattern shown by the graph. (4 marks)

Model answer. When there are many voles there is plenty of food for the owls (1), so more owls survive and breed and their numbers rise (1). More owls eat more voles, so the number of voles falls (1). With fewer voles there is less food, so the owl numbers then fall; this is why the owl peaks come after the vole peaks (1).

Don’t lose marks

- Drawing food chain arrows the wrong way. They point towards the organism that does the eating.
- Forgetting to divide by the quadrat area when it is not 1 m².
- Placing quadrats where the organisms are, instead of randomly. This biases the estimate.
- Saying that predator and prey numbers peak at the same time.
- Using a transect to estimate the total population size. Transects show distribution; random quadrats estimate abundance.

More tips

Memory tricks

- Predators lag: on a cycle graph the predator line always peaks a little after the prey line.
- Quadrat check: dividing by 0.25 m² is the same as multiplying by 4. If a 0.25 m² quadrat holds 4 daisies, 1 m² holds 16.
- Random quadrats count 'how many'; a transect shows 'where'.
- Median: put the values in order first, then find the middle one.

Exam technique

- In practical questions, give the details that make a method repeatable: quadrat size, how positions were chosen, the interval along the transect and the number of repeats.
- Show every step of a population calculation.
- When describing a graph, give values (e.g. 'the prey peaked at 800 in year 3') before explaining.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Name producers and consumers in a food chain**
The producer comes first, then the primary, secondary and tertiary consumers.

Grade 4 — **State why food chains start with producers**
Producers (green plants and algae) make glucose by photosynthesis, so they produce the biomass for the rest of the chain.

Grade 4 — **Calculate a mean, median and mode**
Mean = total ÷ number of values; median = middle value when in order; mode = most common value.

Grade 5 — **Describe using quadrats to estimate population size**
Place quadrats randomly, count the organisms, find the mean per quadrat, then scale up to the whole area.

Grade 5 — **Estimate population size from quadrat data**
Mean number per m² × total area in m².

Grade 5 — **Use a transect to investigate distribution**
Place quadrats at regular intervals along a line and measure the factor at each point.

Grade 7 — **Explain predator–prey cycles from a graph**
Prey rise first, giving predators more food; predators rise and eat more prey, so prey fall, then predators fall.

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