

7 • Ecology

AQA • GCSE • Biology

Ecology: communities, cycles and human impacts

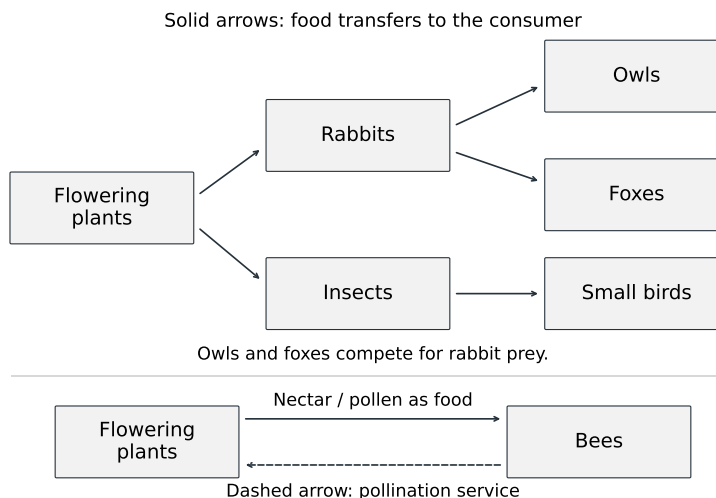
- The Sun's energy passes through ecosystems; carbon and water cycle between the living and non-living world.
- Communities compete and depend on each other; adaptations fit organisms to their conditions.
- Human activity – waste, land use, deforestation, global warming – threatens biodiversity, and trophic-level biology (bio only) explains why food chains are short.

Adaptations, interdependence and competition (4.7.1)

■ Levels, resources and interdependence

An **ecosystem** includes the interaction between a **community** of living organisms and the non-living parts of its environment. An individual is one organism; a population is organisms of one species in an area; a community includes the populations of different species there. **Worked, AQA 2023 Q01.1 [1]:** all organisms in the same habitat form a community. Add their interactions with soil, water, temperature and other abiotic surroundings to describe the ecosystem (sheet 7.1 Q2.1 [2]).

Competition occurs when organisms require the same limited resource. Plants compete for light, space, water and mineral ions. Animals compete for food, mates and territory. Two predator species can compete for the same prey; competition for mates usually concerns members of the same species. **Interdependence** includes food, shelter, pollination and seed dispersal. A removal can affect several populations; the size of the effect depends on the other available resources and relationships.



Worked, sheet 7.1 Q3.1 [4]. In the model, flowering plants provide food for bees and bees pollinate flowers. If bee numbers fall, bee-dependent flowers may receive less pollination, produce fewer seeds/fruits, and reproduce less successfully. Consumers may then have less plant food. This gives a named, linked explanation; it does not mean every plant depends on bees or every removal must destroy a community.

Worked, sheet 7.1 Q3.2 [4]. Suppose a new predator eats rabbits. More rabbits are eaten, so fewer survive and their population may fall (effect plus cause: 2). Existing rabbit predators face greater competition for the same prey, so less food may reduce their survival/reproduction (effect plus cause: 2). Alternatively, explain how fewer rabbits grazing could allow their food plants to increase. Give two developed effects, not four unexplained names.

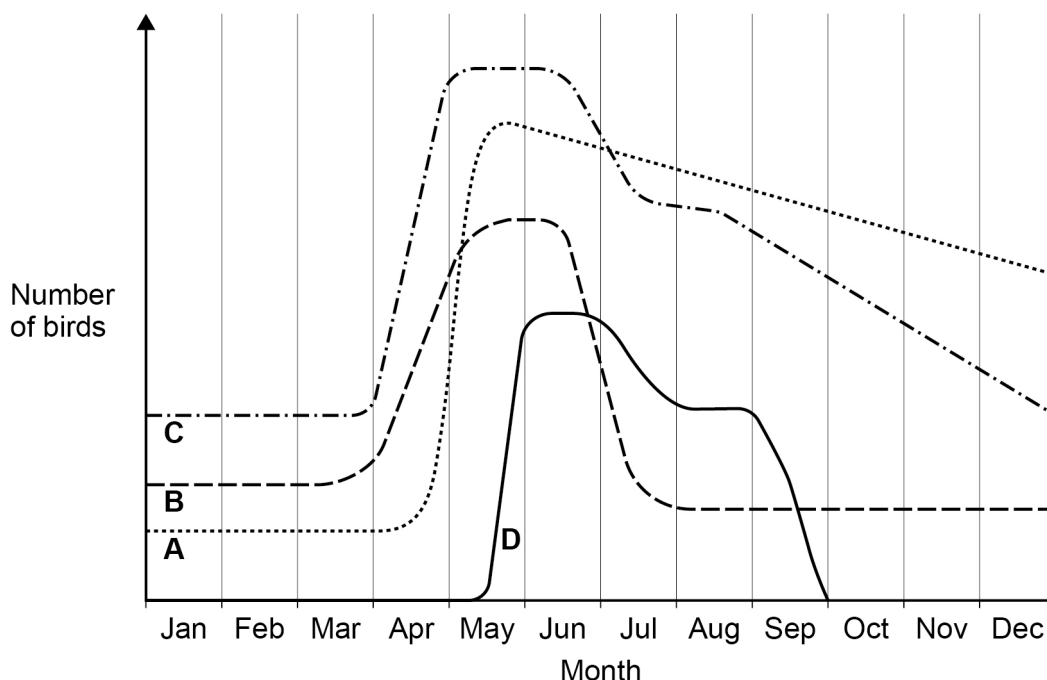
■ Abiotic and biotic factors in context

Abiotic factors are non-living conditions: light intensity, temperature, moisture, soil pH/mineral content, wind intensity/direction, carbon dioxide for plants and dissolved oxygen for aquatic animals. **Biotic factors** include food availability, new predators, pathogens and competition. Classify the factor, then explain its effect using the organism and conditions in the question.

Worked, AQA 2025 Q02.5 [3]. Daisies were more abundant further from a tree; the question asks for three abiotic factors other than soil water. Light intensity, soil pH and soil mineral-ion content are three accepted answers. Temperature, soil type, wind and soil oxygen are also accepted. Do not repeat water. Although carbon dioxide is a general syllabus example, the scheme ignores it here; “space” and vague “nutrients” are also ignored. Choose context-relevant factors rather than reproducing a memorised list.

Teacher-written causal example. Nitrate ions supply nitrogen for amino acids and proteins. Less nitrate can reduce protein synthesis and plant growth. Magnesium ions have a different role in chlorophyll. Do not say every mineral ion makes amino acids. Differing success in obtaining a limited resource can change the relative sizes of plant populations.

■ Reading community data



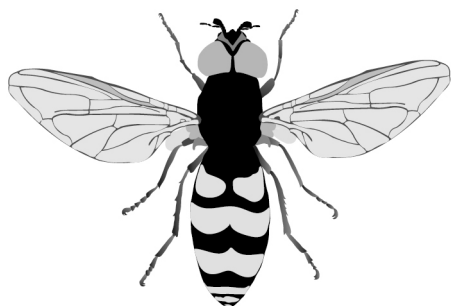
Worked, AQA 2023 Q01.4 [3]. Read the dotted A line: numbers are constant from January to March/early April; increase during April towards May; then decrease from May/June towards December. Name time intervals with each trend. The original vertical axis has no numbers, so exact counts and percentage decreases cannot be calculated from it.

Worked, Q01.5–.6 [1+1]. The question supplies a disease outbreak in June/July: B has the lowest resistance in that context. D is the migrating species because it is present for only part of the year, around May to September/October. The graph alone does not identify every cause of population change; use the supplied disease and migration information. “The line goes down” without the species/time context is inadequate.

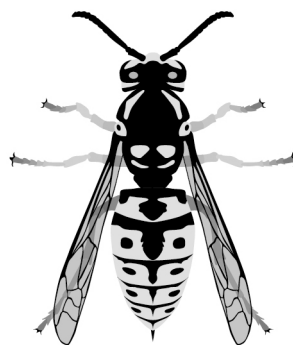
■ Adaptations and extreme environments

Adaptations enable survival in normal conditions. Structural features concern the body, such as insulating blubber; behavioural features are actions, such as migration; functional features are internal processes, such as venom production. Explain how a feature helps in the stated environment. A thick insulating layer reduces heat transfer in cold conditions; migration changes the conditions encountered; producing venom can help capture prey. An organism does not deliberately acquire a new inherited feature simply because it needs one.

Figure 1



Hoverfly



Wasp

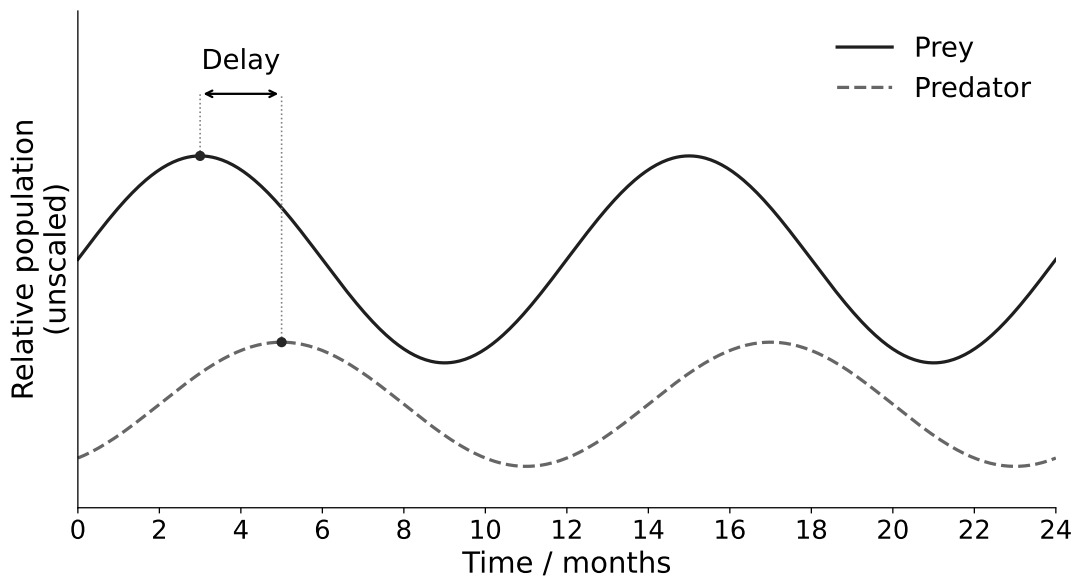
Worked adaptation, AQA 2024 Q01.4 [3]. Both insects have yellow/black markings and share a habitat; the wasp has a sting, the hoverfly does not. The hoverfly resembles the wasp (1); predators avoid wasps to avoid being stung (1); so predators are less likely to attack/eat the hoverfly (1). Similar appearance is the structural feature; the survival benefit needs the predator-response explanation. Do not just say a predator “thinks it is a wasp”.

Extremophiles live in conditions extreme for most organisms, such as very high temperature, pressure or salt concentration. Deep-sea vent bacteria are the named syllabus example. **Sheet 7.1 Q3.3 extension:** darkness prevents photosynthesis using sunlight, but some vent bacteria use energy released by chemical reactions to make organic food (chemosynthesis). This explains a possible energy source, not all bacteria’s metabolism. Chemosynthesis is supplied enrichment for this authored question, beyond the named extremophile knowledge required in 4.7.1.4.

Organisation of an ecosystem and material cycles (4.7.2, RP9/RP10)

■ Food chains and population cycles

A **producer** (green plant or alga) makes glucose by photosynthesis and builds biomass. A teacher-written chain is grass → rabbit → fox: the arrows show food transfer to the consumer, not the direction in which an animal moves. The rabbit is a primary consumer ; the fox is a secondary consumer in this chain.



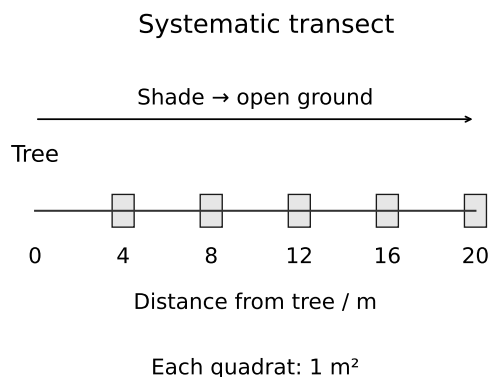
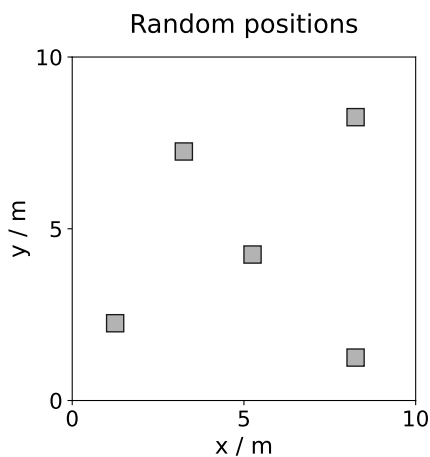
More prey can support predator survival and reproduction. More predators eat more prey; as prey decline, food becomes scarce and predator numbers fall. With fewer predators, prey can recover. The predator response takes time. Real populations are also affected by other factors, so do not assume every supplied graph is a perfect cycle.

Worked model reading: the first prey peak is at month 3; the corresponding predator peak is at month 5.

$$\text{peak delay} = t_{\text{predator}} - t_{\text{prey}}$$

$$\text{peak delay} = 5 \text{ months} - 3 \text{ months} = 2 \text{ months}$$

■ RP9: choose a sampling method



For a **population estimate**, use random coordinates over the defined area, not convenient or plant-rich positions. Keep quadrat size and counting rules consistent, sample sufficiently and calculate a mean. For **distribution along a gradient**, lay a transect from shade to open ground; sample at regular distances, count the species (or estimate cover) and measure light intensity at each position. Repeat transects and calculate means at comparable positions. A quadrat measures a local sample; a transect arranges those samples along a line. Record units and plot the measured factor against abundance using suitable labelled scales.

Worked teacher extension to sheet Q2.2: counts 4, 6, 6, 8, 11; assume random 0.25 m² quadrats in a 100 m² field. The ordered middle value and most frequent value are both 6.

$$\text{mean count} = \frac{\text{sum of counts}}{\text{number of quadrats}}$$

$$\text{mean count} = \frac{4 + 6 + 6 + 8 + 11}{5} = 7 \text{ plants per quadrat}$$

$$\text{density} = \frac{\text{mean count}}{\text{quadrat area}}$$

$$\text{density} = \frac{7 \text{ plants}}{0.25 \text{ m}^2} = 28 \text{ plants m}^{-2}$$

$$\text{estimated population} = \text{density} \times \text{total area}$$

$$\text{estimated population} = 28 \text{ plants m}^{-2} \times 100 \text{ m}^2 = 2800 \text{ plants}$$

This estimate assumes a representative sample. Do not treat one shaded-to-open transect as a random sample of the whole field.

■ **RP9: interpret original exam evidence**

Table 2

	Distance from the tree in metres				
	4	8	12	16	20
Mass of fresh soil in grams	250	266	260	248	252
Mass of dried soil in grams	225	234	209	184	181
Mass of water lost from soil in grams	25	32	51	64	71
Percentage of water in soil	10	12	20	26	X
Number of daisies per m ²	0	7	15	28	32

2025 Q02.1–Q02.4: students dried soil at 100°C, cooled and reweighed, repeating until mass stopped changing. Constant mass helps ensure **all water has been removed**. Subtract container mass if it is included in a weighing; this table already gives soil masses. At 20 m, fresh soil = 252 g and dry soil = 181 g.

$$\text{water mass} = \text{fresh soil mass} - \text{dry soil mass}$$

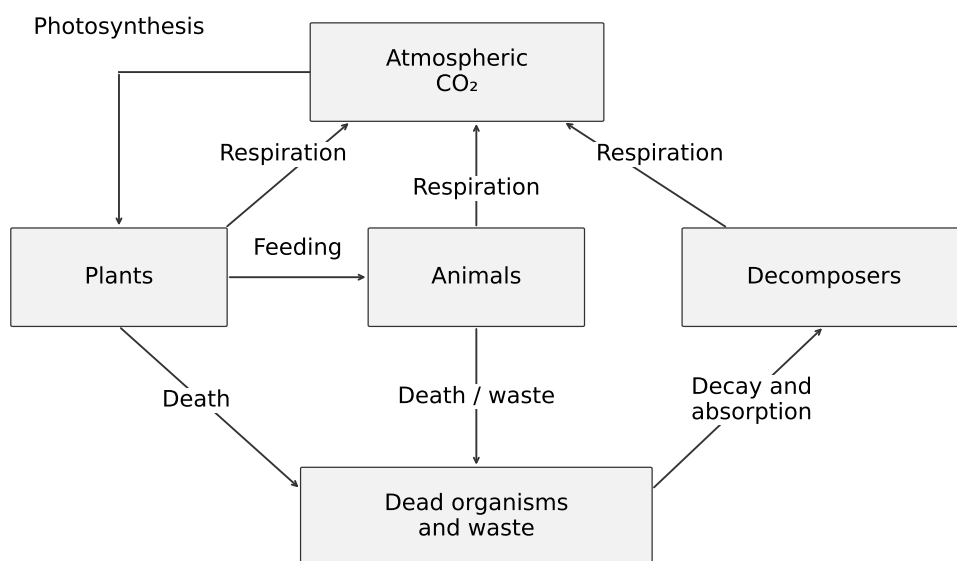
$$\text{water mass} = 252 \text{ g} - 181 \text{ g} = 71 \text{ g}$$

$$\text{water percentage} = \frac{\text{water mass}}{\text{fresh soil mass}} \times 100$$

$$\text{water percentage} = \frac{71 \text{ g}}{252 \text{ g}} \times 100 = 28.1746 \dots \% = 28\% \text{ (nearest whole number)}$$

Between 4 and 16 m, water percentage increases with distance (10% to 26%); this is not direct proportionality. To improve the conclusion about water and daisies, repeat at each distance and calculate means; sample more trees or directions, or add intermediate distances. Light and other factors may vary too: association alone does not establish that water caused the change.

■ Carbon, water and mineral recycling



Photosynthesis uses atmospheric CO₂ to make glucose. **Feeding** transfers carbon compounds; **respiration** by plants, animals and decomposers releases CO₂. Microorganisms secrete enzymes that break down large molecules in dead material; small soluble products are absorbed. Their respiration returns carbon to the atmosphere. **Combustion** of biomass or fossil fuels also releases CO₂: this is a separate process from respiration. Material is recycled; energy is transferred and eventually dissipated.

Water cycle: evaporation from water surfaces and transpiration from plants put water vapour into air. Cooling causes condensation into droplets; precipitation returns water to land and sea. Run-off and drainage return water to the sea. Evaporation leaves dissolved salts behind, helping provide fresh water over land.

Original 2023 Q04.1 [6] – response plan: decomposer bacteria/fungi use enzymes to break down fallen leaves. Respiration releases CO₂ into air; it enters leaves through stomata and is used in photosynthesis to make glucose and other plant material. Nitrogen in the leaves is recycled into soil nitrate ions; roots absorb these, including by active transport, and use nitrogen to make amino acids/proteins. Link breakdown to reuse for **both** carbon and nitrogen. The detailed nitrogen cycle is not required.

■ Decay, compost and biogas – Biology

During **decomposition**, bacteria and fungi use enzymes to break down dead material. Warmth towards the enzyme optimum increases activity; temperatures above the optimum can denature enzymes. Moisture supports microbial activity, but a waterlogged heap can lack oxygen. Turning compost adds oxygen for aerobic respiration. Compost is decomposed organic material used as a natural fertiliser. Anaerobic decay produces methane; a biogas generator collects this gas, which can then be burned for

heating or electricity generation. Gas production and combustion are different stages.

■ **RP10: milk decay and temperature**

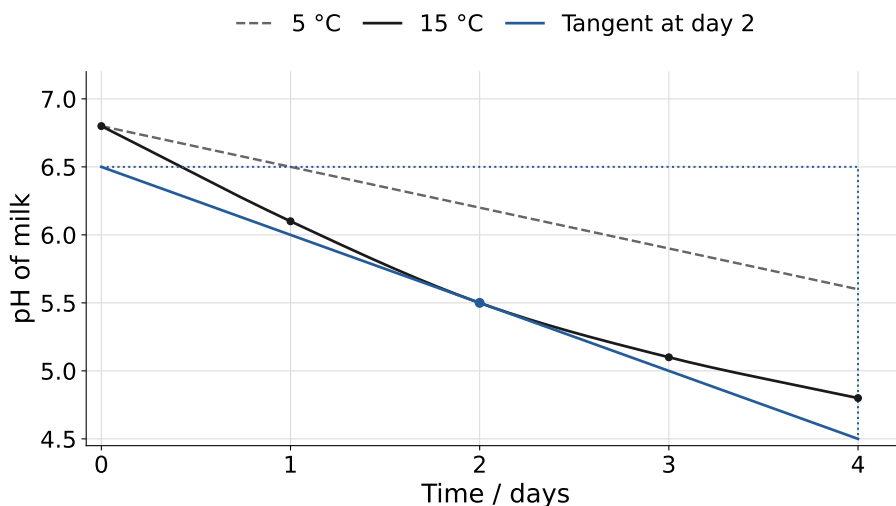
Original 2023 Q 04.2–Q 04.5: students used 25 cm³ fresh milk at 5°C, 15°C and 25°C, recording pH daily for four days. Keep volume/type of milk and measurement timing consistent; maintain the set temperatures. Repeat at each temperature and calculate means, or measure pH more frequently. These are improvements to a comparison, not evidence that all possible temperatures were tested.

Table 1

Time in days	pH of milk		
	5 °C	15 °C	25 °C
0	6.8	6.8	6.8
1	6.5	6.1	5.3
2	6.2	5.5	4.9
3	5.9	5.1	4.8
4	5.6	4.8	4.8

Q 04.3 [3]: plot all five 25°C points: (0,6.8), (1,5.3), (2,4.9), (3,4.8), (4,4.8). Draw a smooth curved best-fit line; one straight line is not suitable. The official scheme awards points for days 1–3 and the curve, but incorrect endpoint plots can still invalidate marks. Read labelled scales before plotting.

Teacher redraw: the following graph uses Table 1 data and an illustrative tangent matching the official example. It is not the original Figure 7.



Q 04.4 [4]: draw a tangent to the 15°C curve at day 2, then use well-separated points on that tangent. This measures the instantaneous rate; an endpoint-to-endpoint gradient on the curve is an average. The official example tangent uses pH 6.5 at day 0 and pH 4.5 at day 4.

$$\text{gradient} = \frac{\Delta \text{pH}}{\Delta t}$$

$$\text{gradient} = \frac{4.5 - 6.5}{4 \text{ days} - 0 \text{ days}} = -0.5 \text{ pH units per day}$$

The pH decreases; the rate of decrease has magnitude 0.5 pH units per day. The given rate at 5°C is 0.3 pH units per day.

$$\text{rate ratio} = \frac{\text{rate at } 15^\circ\text{C}}{\text{rate at } 5^\circ\text{C}}$$

$$\text{rate ratio} = \frac{0.5 \text{ pH units per day}}{0.3 \text{ pH units per day}} = 1.666 \dots \approx 1.67$$

The ratio is dimensionless: the 15°C rate is about 1.67 times as fast. A student's accepted tangent may give a slightly different gradient; use that tangent consistently.

Q 04.5 [3]: within the tested range, enzymes are more active at the higher temperature; lipids are broken down more quickly; fatty acids are produced faster, so pH falls faster. Do not write amino acids as lipid breakdown products. The 25°C curve levels off near pH 4.8; the graph alone does not show that all bacteria died, or that heating further would always speed decay.

(HT Bio) Environmental change: temperature, water availability, atmospheric-gas composition – changes may be **seasonal, geographic or human-caused** – shift the distribution of species.

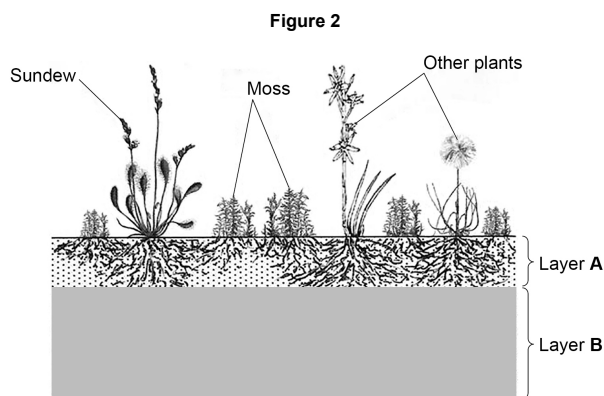
Biodiversity and human interactions (4.7.3)

■ Variety, stability and human pressures

Biodiversity means the variety of different species on Earth or within an ecosystem, not the number of individual organisms. A field with many plants of one crop can still have low species variety. Greater variety can reduce dependence on one particular species for food, shelter or maintaining the physical environment. This supports stability; it does not guarantee that disturbance has no effect. Human survival depends on maintaining biodiversity.

Population growth and rising living standards increase resource use and waste. If not properly managed, waste causes **pollution** : sewage, fertiliser and toxic chemicals in water; smoke and acidic gases in air; landfill and toxic chemicals on land. Pollution can kill organisms and reduce species variety. Building, quarrying, farming and waste disposal also remove habitat. Tropical forests are cleared for cattle, rice fields and biofuel crops: habitats are lost, fewer trees remove carbon dioxide by photosynthesis, and burning or decay releases carbon dioxide. Rising carbon dioxide and methane contribute to global warming. Changed temperature, rainfall or sea level can alter habitats, species distributions and migration, with possible species loss.

■ Peat: distinguish local loss from global effects



Layer **A** contains a lot of air.

Layer **B**:

- contains the dead remains of plants
- has a low pH
- contains very little oxygen
- contains carbon dioxide and methane.

Original 2024 Q02.1 [3]. Little oxygen in layer B limits aerobic respiration, so less energy is released for decomposer activity and decay is slow. Low pH can also reduce enzyme activity. Do not explain respiration of the dead plants themselves.

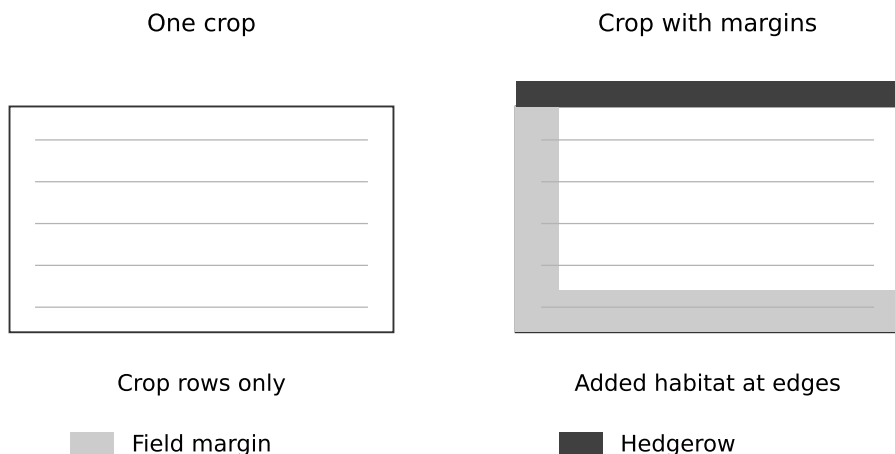
Original 2024 Q02.5 [4]. Removing peat can release trapped carbon dioxide and methane. Burning peat produces carbon dioxide; exposed peat can decay, with decomposer respiration releasing carbon dioxide. These gases trap heat, raising atmospheric temperature. In this question the scheme ignores methane attributed to burning/decay: name the stored methane released from the bog. Anaerobic decay producing methane is biologically valid and appears in the 2025 scheme; keep the process and question context clear.

Worked extended answer – original 2025 Q05.3 [6]. Locally, destroying a bog removes specialised habitat, food and shelter. Populations may die or migrate, reducing local biodiversity; loss of a local population does not automatically mean worldwide extinction. Globally, peat removal releases trapped greenhouse gases, while burning and decay release further gases. Increased warming changes rainfall, temperature or sea level, so habitats and food availability change elsewhere. Some species migrate; others may become extinct if they cannot survive the changed conditions. The level-based scheme requires explained local **and** global effects for Level 2, and detailed linked explanations at both scales for Level 3. Six disconnected facts are not a complete explanation.

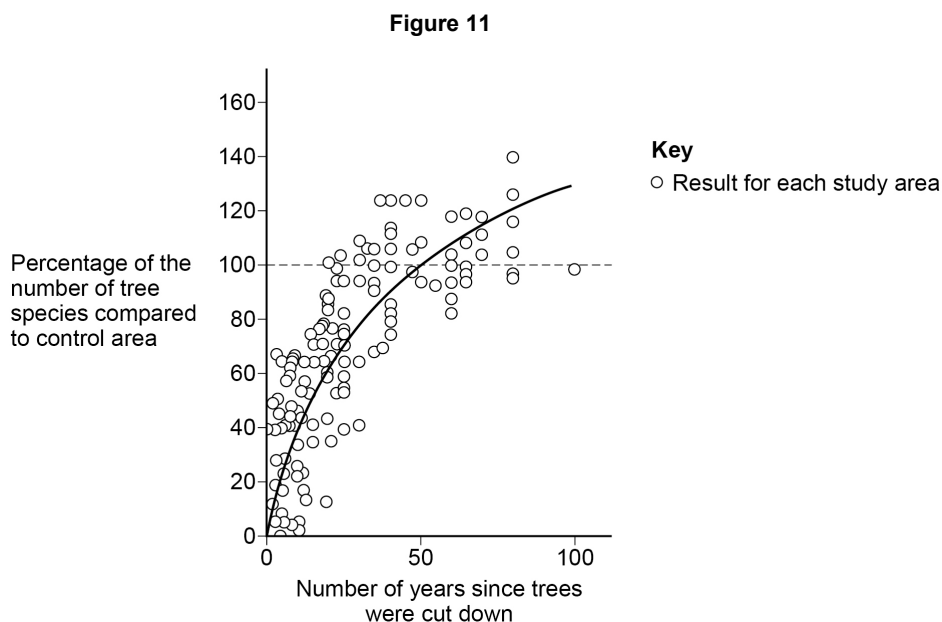
■ Maintain biodiversity and judge evidence

Programmes include: **breeding programmes** for endangered species; protection and **regeneration of rare habitats**; reintroducing **field margins and hedgerows** into single-crop farmland; reducing **deforestation and carbon dioxide emissions**; and **recycling** rather than landfill. Match the intervention to the threat and explain its mechanism.

Teacher schematic – not measured species counts.



Margins and hedgerows can supply different foods, shelter and nesting sites. Connected hedgerows can allow movement between habitats. More plant species may support a wider variety of animals; the outcome depends on establishment and management. Do not promise a particular numerical increase or guaranteed pest control from this schematic.



Original 2023 Q06.3–Q06.5. Percentages allow comparison because the areas began with different numbers of tree **species**, not necessarily different numbers of trees. Recovery is initially faster, then slower; results also vary between areas at similar times. Reaching 100% of the control’s species count does not establish recovery of the original species composition. Greater tree diversity can provide more **types** of food and habitat for animals; merely saying “more food” misses the variety required. Evaluate conflicting pressures using given evidence: habitat protection can compete with food production, housing or income. State a justified choice and its limitation rather than assuming every intervention has no cost.

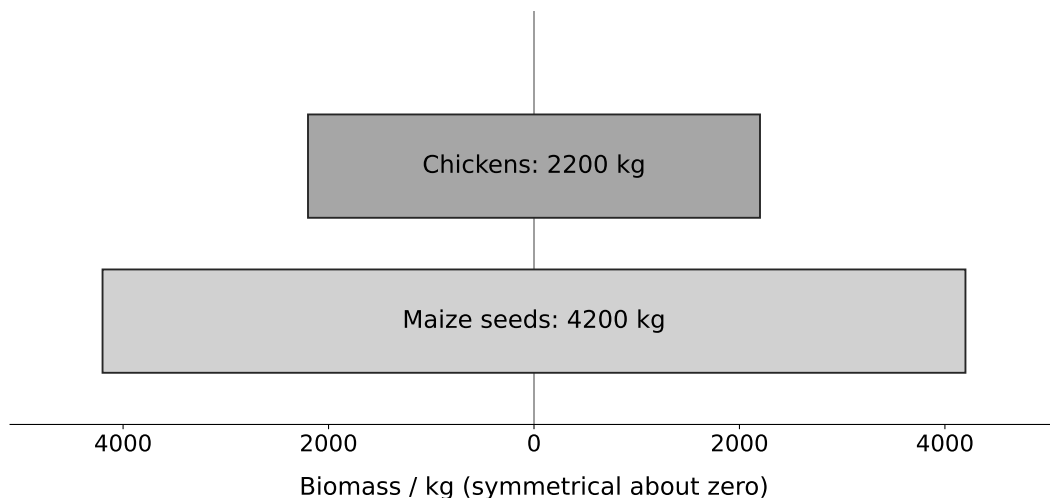
Trophic levels and food security – biology only (4.7.4–4.7.5)

Trophic levels are numbered from the producer: 1 plants/algae; 2 primary consumers (herbivores); 3 secondary consumers (carnivores eating herbivores); 4 tertiary consumers (carnivores eating carnivores). Apex predators have no predators. Decomposers secrete enzymes onto dead material; small soluble molecules diffuse into the microorganisms. They act on material from different levels, rather than forming a compulsory final link in every food chain.

■ Construct and calculate from biomass data

Put the producer at the bottom of a **pyramid of biomass** and use bar widths proportional to the supplied masses. Do not force every dataset to fit an exact 10% transfer.

Teacher answer drawing from original AQA 2024 Q07.2; not the original Figure 11.



Original Q07.2 [3]: 4200 kg maize seeds feed 1000 chickens of mean mass 2.2 kg. Total chicken biomass = $1000 \times 2.2 = \mathbf{2200 \text{ kg}}$. Use a suitable scale symmetrical around zero, label the horizontal axis **biomass / kg**, label both bars and plot 4200 and 2200 accurately. Bar height is not assessed; the relative width carries the biomass information.

Original Q07.3 [2]: chicken : maize = $2200 : 4200 = \mathbf{11 : 21}$. This is about 0.524 : 1; do not reverse the requested order. The percentage for these supplied masses is about 52.4%, not exactly 10%. The approximately 10% syllabus statement is a broad description, not a replacement for calculation with given data.

$$\text{transfer efficiency} = \frac{\text{biomass transferred}}{\text{biomass available}} \times 100\%$$

Worked example [2], authored: 200 kg of producers supports 18 kg of herbivores. Efficiency = $18/200 \times 100\% = \mathbf{9\%}$. One mark is for the method and one for the value; an extra explanation is not needed to earn the calculation marks. Sheet 7.4 Q2.2 uses $40/500 \times 100\% = \mathbf{8\%}$.

Producers transfer about 1% of incident light energy for photosynthesis. This is an **energy** percentage, distinct from biomass transfer between feeding levels. Much ingested material is not absorbed and is **egested as faeces**. Absorbed material can leave as carbon dioxide/water from respiration or water/urea in urine; glucose is used

in respiration. Only part becomes biomass available to the next level, so progressively less remains to support populations higher in the chain. In original 2024 Q07.4 [1], 80% is already available for respiration/growth: the remaining 20% is lost as **faeces**, not respiration, urine or heat. Identify which part of the budget the question asks about.

Original Q02.2 [1]: for moss producing $340 \text{ g/m}^2/\text{year}$, an approximate 10% transfer gives $340 \times 0.10 = \mathbf{34 \text{ g/m}^2/\text{year}}$. Preserve the rate units.

■ Food security and efficient production

Food security means enough food for a population. Pressures include increasing birth rate and demand; changing diets and transport of scarce food; new pests/pathogens damaging crops or animals; failed rains/environmental change reducing production; agricultural input costs; and conflict disrupting water or food availability. Explain how the named pressure changes supply or demand, rather than listing six words.

Restricting animal movement reduces muscle activity and associated energy transfer. Keeping surroundings at a suitable temperature reduces the need for extra respiration to maintain body temperature; it does **not** stop respiration. More of the food resource can contribute to growth. High-protein feed supplies material for growth. Evaluate production benefits against animal-welfare concerns, costs and the evidence provided.

Original 2024 Q07.1 [5], worked: 1000 chickens each require 46 MJ; maize supplies 16 MJ/kg and 80% is usable. One hectare produces 16.4 tonnes = 16 400 kg.

$$\text{required energy} = 1000 \times 46 = 46\,000 \text{ MJ}$$

$$\text{usable energy per hectare} = 16\,400 \times 16 \times 0.80 = 209\,920 \text{ MJ/ha}$$

$$\text{area} = \frac{46\,000}{209\,920} \times 10\,000 = 2191.3\dots \text{ m}^2 \approx 2190 \text{ m}^2 \text{ (3 s.f.)}$$

Apply the usable fraction before calculating land area. Keep intermediate values unrounded.

■ Fisheries and biotechnology

Larger **mesh** openings let young fish escape and potentially breed before capture. **Fishing quotas** limit catches, helping leave breeding adults. These measures aim to maintain stocks where breeding continues; recovery depends on appropriate limits and enforcement.

Fusarium is a fungus grown on glucose syrup in aerobic conditions. Its biomass is harvested and purified to produce mycoprotein, a protein-rich vegetarian food. GM crops can increase food supply or improve nutritional value; golden rice is a nutritional example, not a guarantee that all GM crops have higher yields. GM

bacteria produce human insulin, which is harvested/purified to treat diabetes. Insulin is a biotechnology example addressing health, **not a food or a direct solution to hunger**. The farming, fisheries and biotechnology sections here are Biology content for both tiers; the old worksheet's HT-only labels were incorrect.

Checklist before you call this topic done

- Definitions chain: ecosystem, community, abiotic/biotic factors with examples.
- Plant vs animal competition; interdependence consequences; three adaptation types + extremophiles.
- Food-chain vocabulary; predator–prey cycle read off a graph; RP9 sampling with mean/mode/median.
- Carbon and water cycles with decomposers' role; (bio) decay factors + biogas + RP10.
- Four human threats + five biodiversity programmes named.
- (Bio) Trophic levels, pyramid shape, 10 % rule with efficiency calculation.
- (Bio) Six food-security threats; efficiency farming, net size and quotas, mycoprotein, golden rice.