Edexcel GCSE Biology

Your notes

The Organism in the Environment

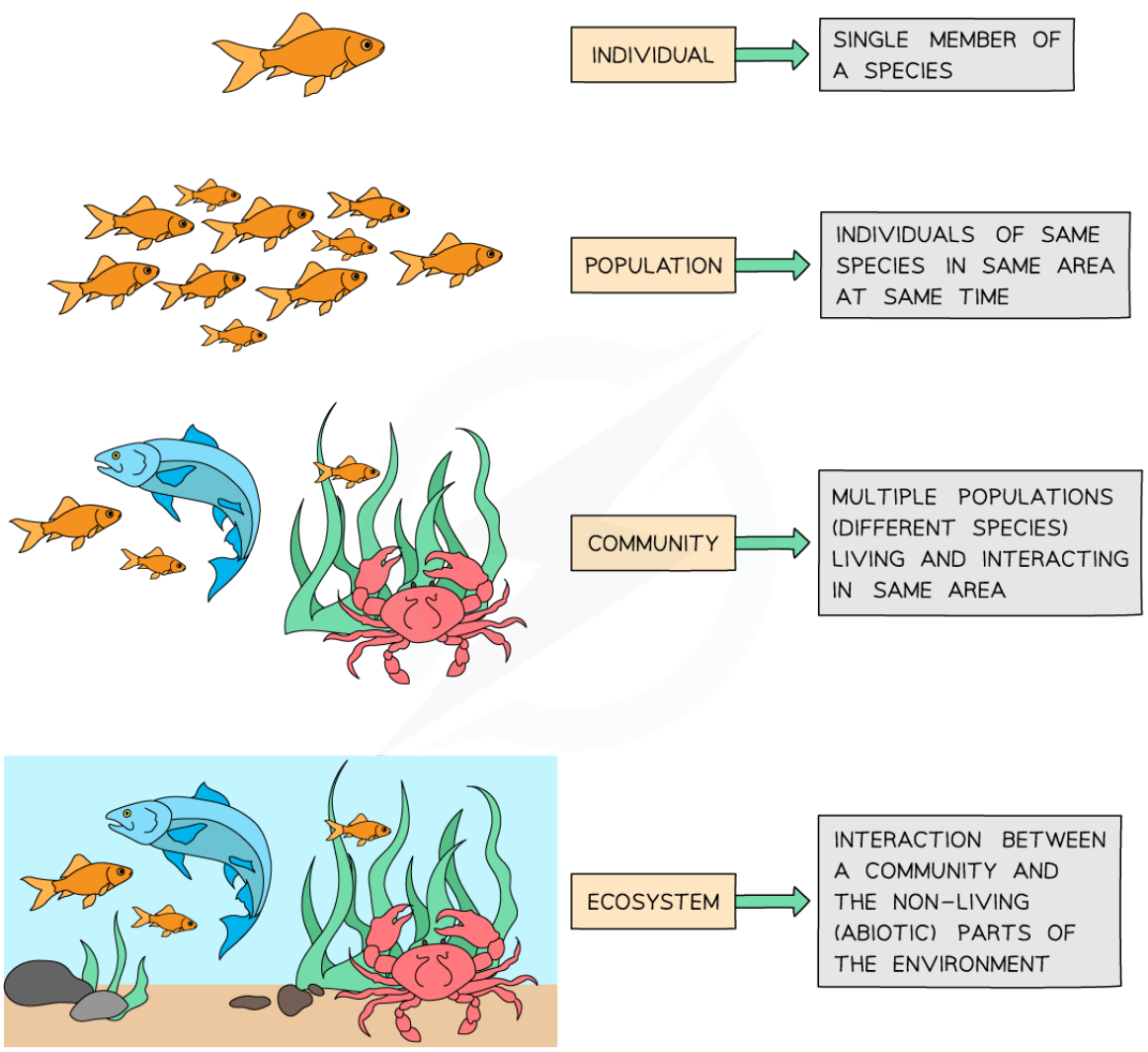
Contents

Your notes

Key Terms in Ecology

- There are several key terms that we use when referring to the various different components of an ecosystem and their levels of organisation:
  - **A population** is defined as a group of organisms of the **same species** living in the **same place** at the **same time**
  - **A community** includes **all** of the **populations** living in the **same area** at the **same time**
    - Within a community, each species depends on other species for food, shelter, pollination, seed dispersal etc
    - If one species is removed it can affect the **whole community**
    - This is called **interdependence**
  - **A habitat** is the place where an **organism lives**
    - E.g. badgers, deer, oak trees and ants are all species that would live in a woodland habitat
  - **An ecosystem** is defined as all the **biotic factors** and all the **abiotic factors** that interact within an area at one time
    - Biotic factors includes all the **living** components such as plants and animals
    - Abiotic factors includes all the **non-living** components such as light intensity, mineral ions, water availability
    - Ecosystems can **vary greatly in size and scale**
      - A small ecosystem might be a garden pond
      - A large ecosystem might be the whole of Antarctica

Your notes



Levels of organisation in an ecosystem

Your notes

Abiotic & Biotic Factors

- The environment in which communities of plants and animals live is **changing all the time**
- These changes are caused by **abiotic** (non-living) and **biotic** (living) **factors**
- These factors affect communities in different ways, for example:
  - For some species, certain factors may cause their **population size** to **increase**, whereas for other species their population size may **decrease**
  - For some species, certain factors may cause the **distribution** of their populations (i.e. where they live) to **change**

Abiotic factors

- In Biology, 'abiotic' means non-living
- An **abiotic** factor is a **non-living** factor within an environment such as temperature, light intensity and water availability
- The table below explains how these abiotic factors may affect a community of organisms
  - One abiotic factor not included in this table is the **presence and levels of pollutants**, which can change the size and distribution of populations of certain species
  - For example, **lichen** are very sensitive to **air pollution** and are not able to grow if the concentration of **sulphur dioxide** (an air pollutant) gets above a certain level

Abiotic Factors that Affect Communities Table

Your notes

ABIOTIC FACTOR	HOW ABIOTIC FACTOR AFFECTS COMMUNITY
LIGHT INTENSITY	LIGHT IS NEEDED BY PLANTS FOR PHOTOSYNTHESIS. MORE LIGHT LEADS TO AN INCREASE IN RATE OF PHOTOSYNTHESIS AND AN INCREASE IN PLANT GROWTH RATE
TEMPERATURE	AFFECTS THE RATE OF PHOTOSYNTHESIS IN PLANTS
MOISTURE LEVELS	PLANTS AND ANIMALS REQUIRE WATER TO SURVIVE
SOIL pH AND MINERAL CONTENT	DIFFERENT SPECIES OF PLANTS ARE ADAPTED TO DIFFERENT SOIL pH LEVELS AND NUTRIENT CONCENTRATION LEVELS
WIND INTENSITY AND DIRECTION	WIND SPEED AFFECTS TRANSPIRATION RATE IN PLANTS. TRANSPIRATION AFFECTS THE RATE OF PHOTOSYNTHESIS AS IT ENSURES WATER AND MINERAL IONS ARE TRANSPORTED TO THE LEAVES
CARBON DIOXIDE LEVELS FOR PLANTS	CO_2 IS REQUIRED FOR PHOTOSYNTHESIS IN PLANTS. CO_2 CONCENTRATION AFFECTS THE RATE OF PHOTOSYNTHESIS
OXYGEN LEVELS FOR AQUATIC ANIMALS	SOME AQUATIC ANIMALS (SUCH AS FISH) CAN ONLY SURVIVE IN WATER WITH HIGH OXYGEN CONCENTRATIONS

Biotic factors

- In Biology, 'biotic' means living

- A **biotic** factor is a **living** factor in the environment such as competition, predation and disease

Biotic Factors that Affect Communities Table


Your notes

Your notes

BIOTIC FACTOR	HOW BIOTIC FACTOR AFFECTS COMMUNITY	EXAMPLE
AVAILABILITY OF FOOD	MORE FOOD MEANS ORGANISMS HAVE A HIGHER CHANCE OF SURVIVING AND REPRODUCING. THIS MEANS THEIR POPULATIONS CAN INCREASE	RAINFOREST ECOSYSTEMS HAVE A RICH FOOD SUPPLY AND THIS ALLOWS MANY SPECIES TO LIVE THERE. DESERTS HAVE A POOR FOOD SUPPLY AND THIS ALLOWS FEWER SPECIES TO LIVE THERE
NEW PREDATORS	IN BALANCED ECOSYSTEMS, PREDATORS CATCH ENOUGH PREY TO SURVIVE BUT NOT SO MANY THAT THEY WIPE OUT THE PREY POPULATION. IF A NEW PREDATOR IS I NTRODUCED TO THE ECOSYSTEM, IT MAY BECOME UNBALANCED	RED FOXES WERE INTRODUCED FOR RECREATIONAL HUNTING IN AUSTRALIA IN THE 1800S BUT HAVE SINCE CAUSED THE DECLINE OF MANY NATIVE SPECIES THAT THEY FEED ON, SUCH AS SMALL MAMMALS AND BIRDS. THIS HAS ALSO REDUCED THE FOOD SUPPLY FOR NATIVE PREDATORS
NEW PATHOGENS	IF A NEW PATHOGEN ENTERS AN ECOSYSTEM, THE POPULATIONS LIVING THERE WILL HAVE NO IMMUNITY OR RESISTANCE TO IT AND THE POPULATION MAY DECLINE OR BE WIPED OUT	CORONAVIRUS CAUSED A GLOBAL PANDEMIC AND A DECLINE IN MANY HUMAN POPULATIONS AROUND THE WORLD BECAUSE IT WAS A NEW PATHOGEN
COMPETITION	IF TWO SPECIES COMPETE FOR THE SAME RESOURCE(S) AND ONE	NORTH AMERICAN GREY SQUIRRELS WERE INTRODUCED TO THE UK

	IS BETTER ADAPTED TO TAKE ADVANTAGE OF THESE RESOURCES, THEN THAT SPECIES WILL OUTCOMPETE THE OTHER. THIS MAY CONTINUE UNTIL THERE ARE TOO FEW MEMBERS OF THE LESSER ADAPTED SPECIES TO BREED SUCCESSFULLY	IN THE 1800S AND HAVE SINCE CAUSED THE DE-CLINE IN OUR NATIVE RED SQUIRREL POPULATION. GREY SQUIRRELS HAVE OUTCOMPETED RED SQUIRRELS FOR RESOURCES SUCH AS FOOD AND NEST-SITES. THEY ALSO CARRY A VIRUS (A NEW PATHOGEN) THAT RED SQUIRRELS HAVE NO RESISTANCE TO

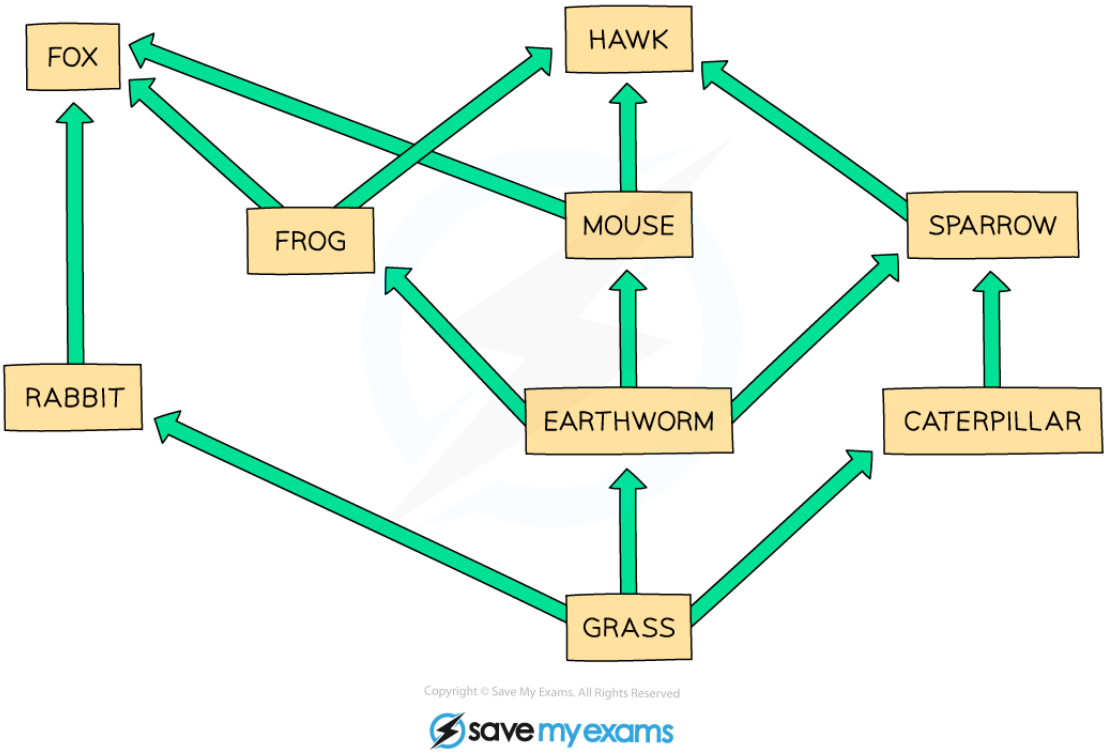
Your notes

Your notes

Interdependence

- In order to survive and reproduce (have offspring), organisms need certain resources from their surroundings (from the ecosystem they are living in)
- This means that members of a species will often **interact** with members of its own species or other species
- Some examples of these **interactions** include:
  - Predators (carnivores) eating prey
  - Herbivores eating plants
  - Plant species being pollinated by bees
- Within a community, each species depends on other species for food, shelter, pollination, seed dispersal etc.
  - This means that a **change** in the **population** of **one species** can have significant **knock-on effects** for **other species** in the same community
  - If one species is **removed** it can also affect the **whole community**
- This is called **interdependence**
- A **stable** community is one where all the species and environmental factors are in balance so that population sizes remain fairly constant

Your notes



A food web shows the interdependence of organisms

- For example, in the food web above, if the **population of earthworms decreased**:
  - The population of **grass plants would increase** as there are now fewer species feeding off them
  - The populations of **frogs and mice would decrease significantly** as earthworms are their only food source
  - The population of **sparrows would decrease slightly** as they eat earthworms but also have another food source to rely on (caterpillars)

Examiner Tips and Tricks

Questions about interdependence in food webs are common and simple to gain marks on if you answer them fully and correctly.Do not say an animal or plant would 'die out' as this is unlikely to happen – stick to using the words **decrease** or **increase** (in the population of a species). If in doubt, always give your reason for the increase or decrease in population.

Parasitism & Mutualism

- The survival of some organisms in a community is **dependent** on **other species** within the **same community**
  - This is known as **interdependence**
- Two examples of **interactions** that can create **interdependence** within a community include:
  - **Parasitism** (parasitic relationships)
  - **Mutualism** (mutualistic relationships)

Parasitic relationships

- Parasites are organisms that are adapted to live **very closely with another species**, known as the **host** (or the **host species**)
  - The parasite lives either **in or on the body of the host species**
- The parasite gains **resources** (i.e. what it needs in order to survive) from the host
  - This can include, food, shelter and a suitable location to reproduce (where offspring can feed and grow)
- However, **the host doesn't get any benefits from this relationship**
  - In fact, parasites often **harm** the host in some way
- An example of a parasitic relationship is **fleas** being a parasite to **mammals** (e.g. dogs)
  - The fleas **feed on the host's blood** but don't provide anything to the host in return

Mutualistic relationships

- A mutualism is a type of relationship between two species within a community, where **both organisms benefit** in some way
- For example, **bees** and many species of **flowering plants** have a mutualistic relationship
  - **Bees gain nectar** (i.e. food to provide them with energy) from flowers
  - When bees visit flowers, pollen is transferred to their bodies
  - As bees visit multiple different flowers, they spread the pollen to these flowers, pollinating them
  - In this way, the flowers **gain help in reproducing**

Your notes

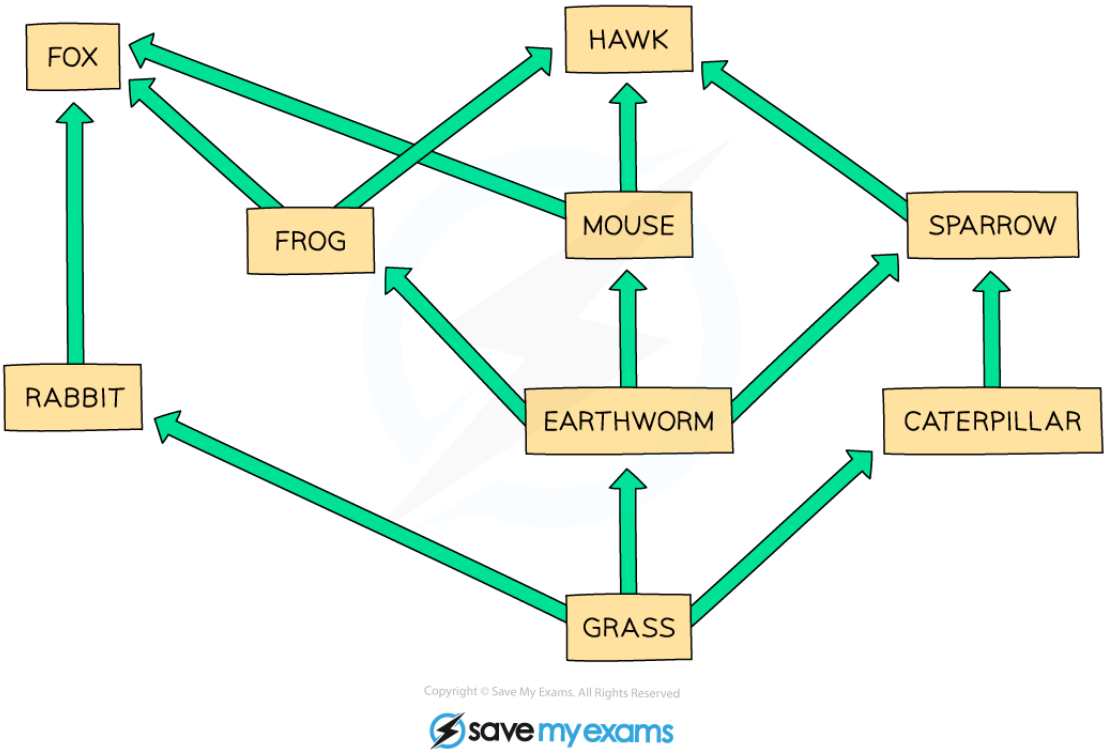
Biodiversity

- Biodiversity is the **range and variety of different species of organisms within a given area (e.g. on Earth or within an ecosystem**)
- It considers not only the **species richness**, but also the **variation** within each species including the relative abundance (i.e. the population size) of each species present
  - For example, a **high biodiversity** would be found in an environment with **lots of different species** which show **a lot of variation** and are all **evenly distributed** across the study area

The importance of biodiversity

- Different species depend on each other for many things, including:
  - **Food**
  - **Shelter** (e.g. birds nesting in trees)
  - **Maintenance of the physical environment** (e.g. tree roots provide stability for soils, ensuring they do not get washed away. This, in turn, provides a stable habitat for other plant species)
- High biodiversity ensures the **stability** of ecosystems by **reducing** the **dependence** of one species on another for these three things
- **Populations** with high levels of diversity are also more likely to be **resilient** to sudden **environmental impacts or diseases**
- Consider the food web below:
  - If the mouse population was suddenly wiped out, the fox and the hawk populations might decrease but would not be wiped out as mice are **not their only food source**
  - This example ecosystem has **sufficient biodiversity** to **support** the fox and hawk populations
  - The fox population can still **depend on** the rabbit and frog populations for food
  - The hawk population can still **depend on** the frog and sparrow populations for food

Your notes



A food web demonstrates the importance of biodiversity within an ecosystem

Sampling Organisms

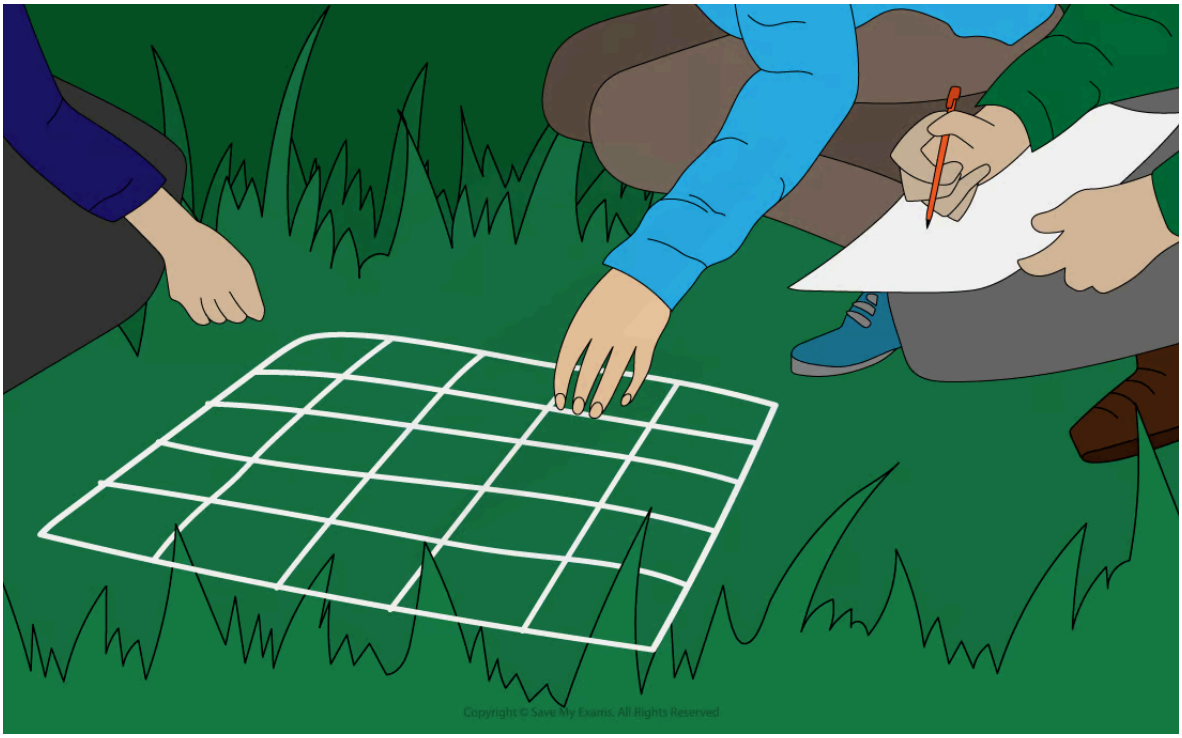
Your notes

Determining the Abundance & Distribution of an Organism

- **Ecology** is the branch of biology that studies:
  - **abundance** of species
  - the **distribution** of species in their habitats
  - the **interactions between species**
  - the **interactions** between **species** and their **abiotic** environment
- The distribution and abundance of a species in an area can be assessed using practical methods, including:
  - quadrats
  - belt transects

Quadrats

- Measuring all the different levels of biodiversity within an ecosystem is very **time consuming**
  - Finding out which species live in an ecosystem and the size of the populations requires the **identification and cataloguing** of all organisms present to build a **species list**
  - In large and complex ecosystems it is impossible to find, identify and count every individual organism
- To simplify things, **sampling** is often used to estimate the **distribution** and **abundance** of species
  - Sampling involves assessing **multiple small areas** within a larger habitat and using these results to **represent** the habitat as a whole
- When carrying out sampling, square frames called **quadrats** can be used to mark off the area being sampled
  - Quadrats are **square frames** made of wood or wire
  - They can be a variety of sizes, e.g. 0.25 m^2 or 1 m^2
- Quadrats are placed on the ground and the organisms within them are recorded
  - Quadrats are useful for investigating species that **do not move around**, e.g. plants or sessile animals, such as limpets on a rocky shore



Using a quadrat to investigate population size or distribution

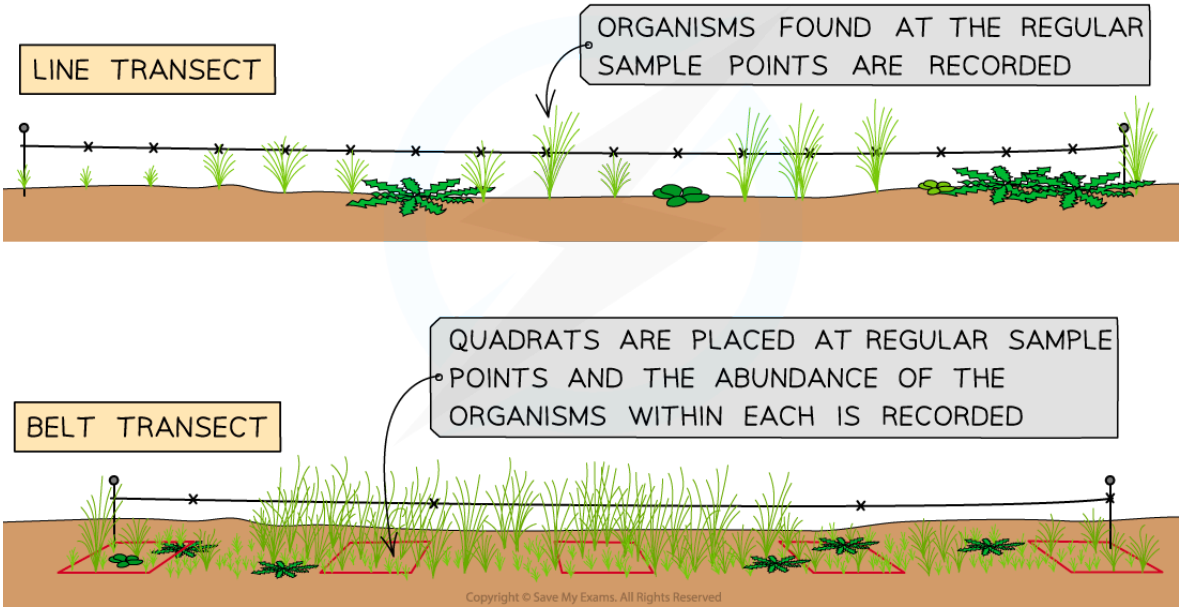
- Quadrats must be laid **randomly** in the area to avoid **sampling bias**
  - This random sampling can be done by converting the sampling area into a **grid format** and labelling each square on the grid with a number
  - Then a random number generator is used to pick the sample points
- Once the quadrat has been laid on the chosen sample point the **abundance** of the **different species** present can be recorded
  - The abundance of a species is the total number of individuals of a species within a given area

Belt transects

- Throughout some areas, there can be **changes in the physical conditions**
  - For example, there may be changes in altitude, soil pH or light intensity
- When investigating the species distribution in these kinds of areas **sampling** is appropriate
- Methods using **transects** can help show how species distribution changes with the different physical conditions in the area

Your notes

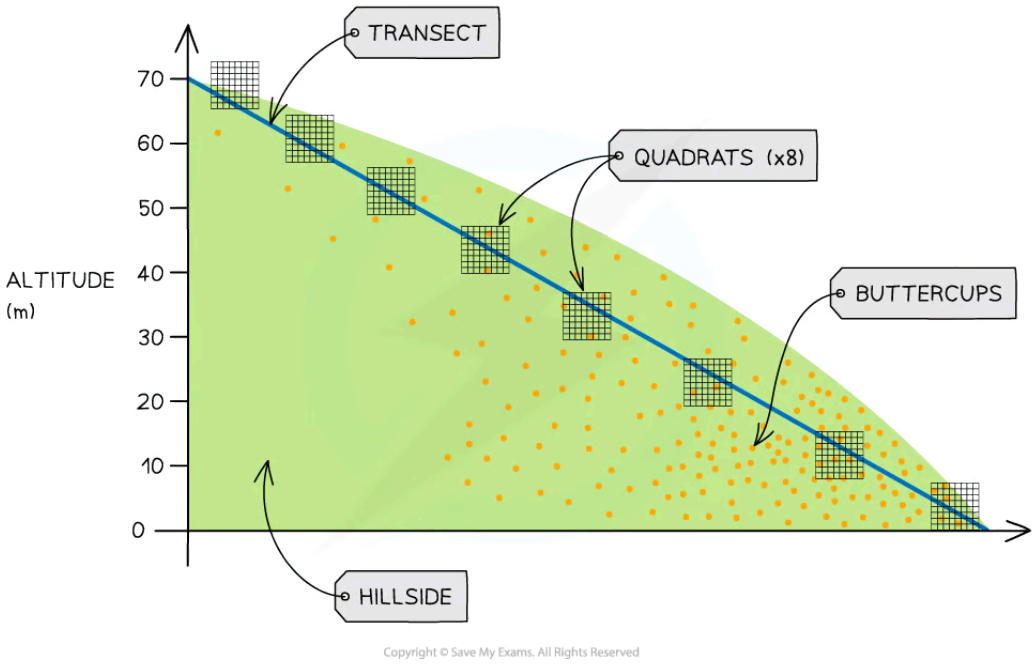
- A transect is a line (usually formed by a measuring tape), along which samples are taken
- One form of transect is a **belt transect**. For a belt transect:
  - Lay out a measuring tape in a straight line across the sample area
  - Place quadrats at **regular intervals** along the tape and **record the abundance of each species within each quadrat**
- Another simpler form of transect is a **line transect**. For a line transect:
  - Lay out a measuring tape in a straight line across the sample area
  - At **equal distances** along the tape record the identity of the organisms that **touch the line**
  - This method only measures **which species are present** in the area and should not be used to measure the **abundance** (number of individuals) of a particular species



A line transect and belt transect is carried out in the field

Your notes

Your notes



An example of a belt transect on a hillside. A quadrat is placed at regular intervals (every 10m of altitude gained) and the number of individuals (of the species being investigated e.g. buttercups) in each quadrat is recorded.

Examiner Tips and Tricks

Take care with your spelling of the word '**quadrat**' - it is commonly written as '**quadrant**' by students in examinations.

Practical: Determining the Abundance & Distribution of an Organism

- It is possible to investigate the **relationship between organisms and their environment** using field-work techniques, including quadrats and belt transects
- There are two practical scenarios you need to be aware of:
  - Investigating the **population size** (of a particular species) in **two different areas** using **quadrats**

- Investigating the **distribution** (of a particular species) **across an environmental gradient** using a **belt transect**


Your notes

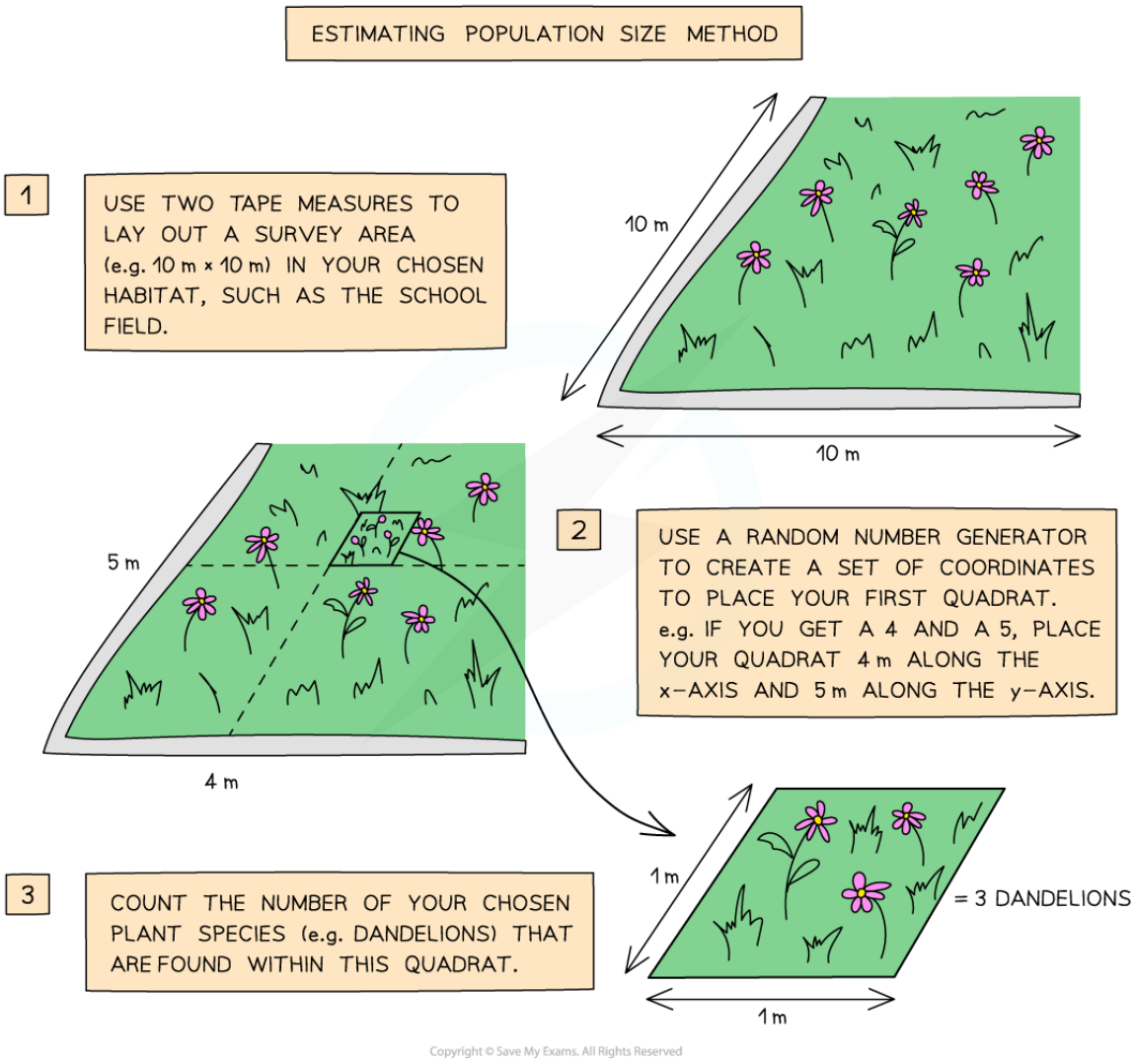
Practical scenario 1: Investigating population size in two different areas using quadrats

Apparatus

- 2 tape measures
  - These are used to lay out a survey area
- Quadrat
  - This is used to sample your chosen species
- Random number generator
  - This is used to generate random sets of coordinates (locations within the survey area where you will place the quadrat)
- Species identification guide
  - This is used to help accurately identify and count individuals of your chosen species

Method

Your notes



Your notes

Quadrat	Number of dandelions
1	3
2	4
3	2
4	1
5	0
6	0
7	2
8	5
9	3
10	1
Total	**21**

4 RECORD THIS NUMBER IN A RESULTS TABLE AND REPEAT STEPS 1–3 UNTIL YOU HAVE RECORDED THE NUMBER OF YOUR CHOSEN PLANT SPECIES IN 10 QUADRATS.

5 ESTIMATE THE POPULATION OF DANDELIONS IN YOUR SURVEY AREA USING THE EQUATION:

$$\text{ESTIMATED POPULATION SIZE} = \frac{\text{TOTAL AREA}}{\text{AREA SAMPLED}} \times \text{TOTAL NUMBER OF DANDELIONS COUNTED}$$

TOTAL SURVEY AREA WAS 10 m × 10 m

$$= \frac{100}{10} \times 21$$

$$= 210$$

EACH QUADRAT IS 1 m × 1m AND 10 QUADRATS WERE PLACED

How to estimate the population size of a plant species in a survey area. You must repeat steps 1–5 in the second study area.

Results

- Once the results have been collected and the averages calculated, we can **compare the abundance of the study species** in each survey area
- Species abundance is likely to be influenced by **biotic factors** such as:
  - Competition
  - Predator-prey relationships
  - Interactions with other organisms within the food chain or food web
- The abundance will also be influenced by **abiotic factors** such as:
  - Light intensity
  - Mineral availability
  - Water availability
  - pH
  - Temperature
  - Salinity


Your notes

Limitations

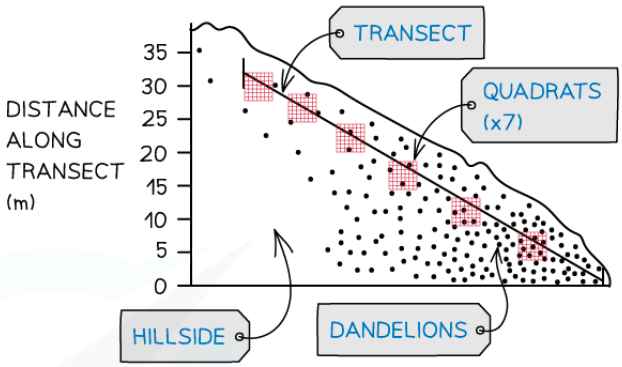
- It can be easy to **miss individual organisms** when counting in a quadrat, especially if they are covered by a different species
  - Solution: Use a pencil or stick to carefully **move leaves out of the way** to check if there is anything else underneath
- **Identifying species** may be tricky
  - Solution: Use a **species identification guide** to identify the species

Practical scenario 2: Investigating the effect of a factor on the distribution of a species

Your notes

INVESTIGATING THE EFFECT OF A FACTOR ON THE DISTRIBUTION OF A SPECIES METHOD

1 SET YOUR TRANSECT UP THROUGH THE AREA YOU ARE INVESTIGATING. IN THIS CASE, A 30 m TAPE MEASURE IS PLACED UP A HILLSIDE. PLACE A QUADRAT AT EQUAL INTERVALS (e.g. EVERY 5 m) ALONG THE TRANSECT.

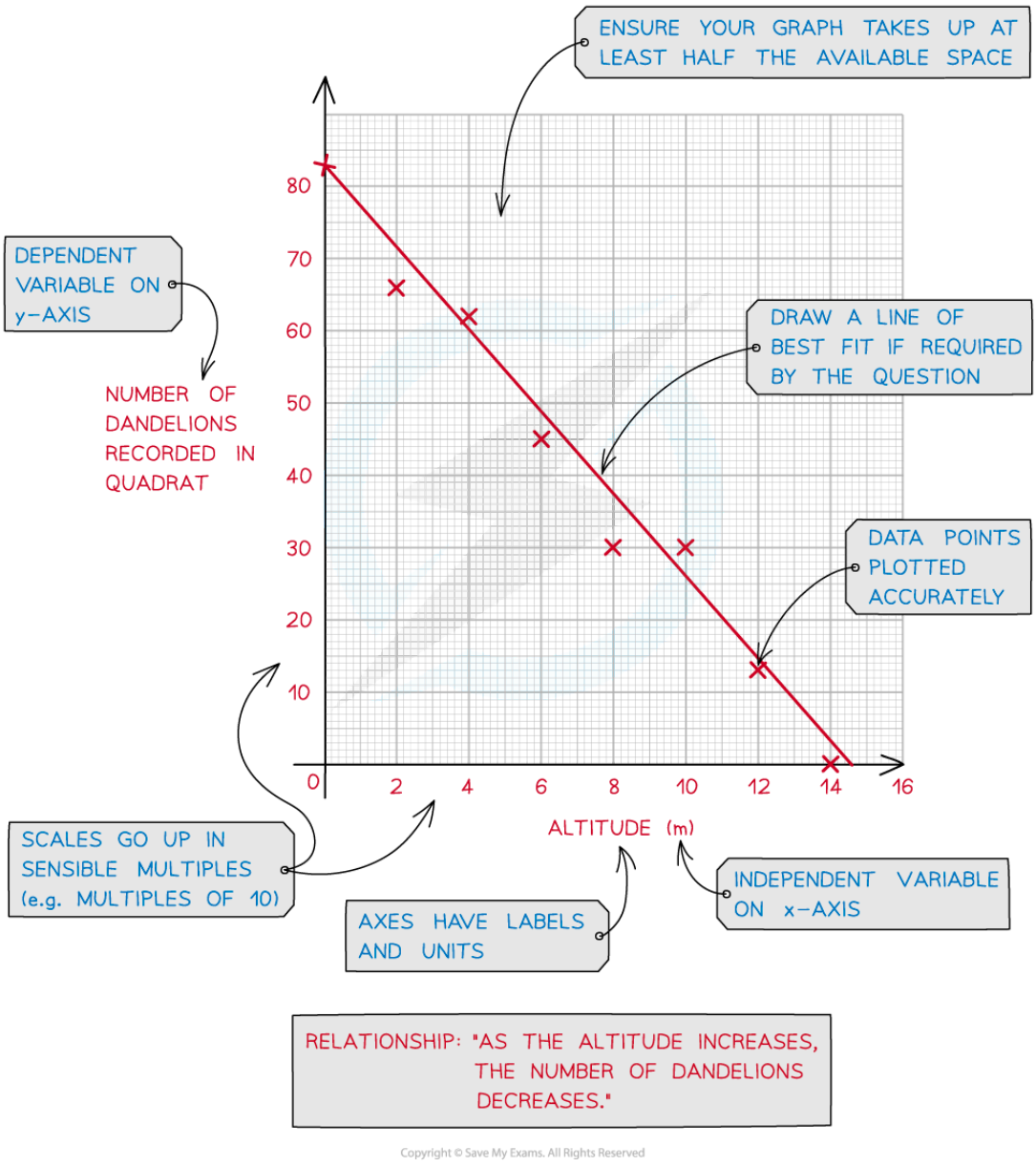


Distance along transect (m)	Number of dandelions	Attitude (m)
0	84	2
5	66	4
10	62	6
15	45	8
20	30	10
25	30	12
30	13	14

2 RECORD THE NUMBER OF YOUR CHOSEN PLANT SPECIES INSIDE EACH QUADRAT. RECORD YOUR ABIOTIC FACTOR (e.g. ALTITUDE) AT EACH QUADRAT. RECORD YOUR RESULTS IN A TABLE.

Your notes

3 PLOT YOUR DATA IN A GRAPH AND DESCRIBE ANY RELATIONSHIP THAT CAN BE OBSERVED.



How to investigate the effect of a factor on the number of plants across a survey area

Examiner Tips and Tricks

When completing an ecological study, we must ensure that the data collected is **random** and **representative** of the survey area. We do this by selecting the position of the quadrat randomly and taking a minimum of 10 readings in each survey area.

Your notes