

# Chapter 4

This chapter covers Ecology and, as such, has a vocabulary all its own – which is often examined.

**Environment:** All the organisms (biotic) and the conditions (abiotic) which exist in an area

**Abiotic factors:** all the non-living factors in an environment, such as rainfall, temperature, soil.

**Biotic factors:** All the living organisms in an area – such as producers, predators and parasites.

**Population:** All the members of one species living in an area

**Community:** The total of **all** the populations living in an area (i.e. all the biotic factors)

**Ecosystem:** The community of living organisms and the abiotic factors affecting them in one area.

**Habitat:** The place where an organism lives

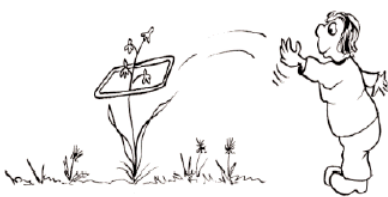
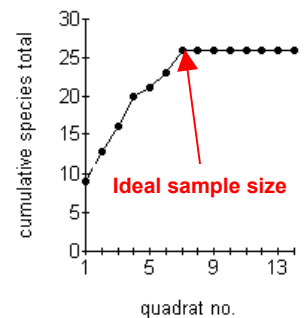
**Niche:** Where an organism fits into the community - covering feeding, nesting, and range of habitat.

## Counting populations

Because it is impossible to count all the members of a large community, some form of sampling has to be used. The **size of the sample depends on the area to be investigated**, but can be shown on a graph as shown (*right*):

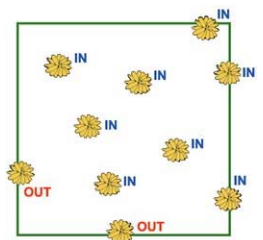
Beyond this point, more samples (= more work) does not increase the **reliability** of the results.

Section 3



AQA are very keen that you should know the importance of **random sampling**. This is essential **to avoid bias**. In fieldwork, this is done by:

1. **Lay out two tapes at right-angles**
2. **Use random number tables to pick co-ordinates**
3. **Place a quadrat (of suitable size) at that point and count the organisms within it**
4. **Repeat this process** until enough samples have been obtained (**30 or more**)
5. **The edge effect:** What to do with plants which touch the edge? The rule is **if they touch the right side or the top, count them "in"**. If they touch the bottom or the left side, count them "out".



**Quadrats** (= a frame of known size – typically 1m or ½m square, which may be divided into 100)



These can be used to estimate a population in an **area which is fairly uniform**. Examples include lawns, woods and open ground. They can produce three estimates of population size:

1. **Density** (organisms per m<sup>2</sup>);
2. **Frequency** (number of quadrats that contain the organism)
3. **Percentage cover** (estimated by the sampler)

**Transects** (= a straight line. Can be of any length, but samples are taken at uniform intervals along it)

These are used when **the abiotic factors gradually vary**, causing a change to the organisms living there. Examples include **seashores** (low → high tide); across streams; up hillsides. Can be used with a quadrat to sample in more detail, otherwise **population estimates are limited to frequency**. Useful to obtain a general 'overview' of an area before starting more detailed work with quadrats.



## Mark-release-recapture

Since animals are mobile, it is difficult to use quadrats or transects to count them. Instead, the mark-release-recapture technique is used.

1. A (large) sample group of the animal is caught (without injury)
2. They are **all** marked (usually underneath, with paint) such that their survival is not affected
3. They are released back **into the same area they were captured**
4. They are allowed time to mix with the rest of the population, but not to reproduce
5. A second, **unbiased**, sample group is captured and divided into
  - a. those that are marked (i.e. have been recaptured) and
  - b. those that are unmarked (i.e. have been caught for the first time).
6. The population is calculated from:

$$\text{Population} = \frac{\text{Overall total in second sample (5)} \times \text{Total number marked (2)}}{\text{Total number of marked individuals in second sample (5a)}}$$

This formula assumes that:

1. The population does not change between samples, due to migration, predation or breeding.
2. The marked individuals mix freely (and randomly) with the rest of the population
3. Marking does not affect the animal in any way.

## Diversity

This describes a community, both by the total number of species present and by the number of organisms present. The **index of diversity (d)** is given by:

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

Where:

- **N** = total number of organisms in the area (i.e. the community, or sum of the populations)
- **n** = total number of each organism (i.e. each individual population)
- $\Sigma$  = 'sum of' (i.e. calculate each value, and then add them together).

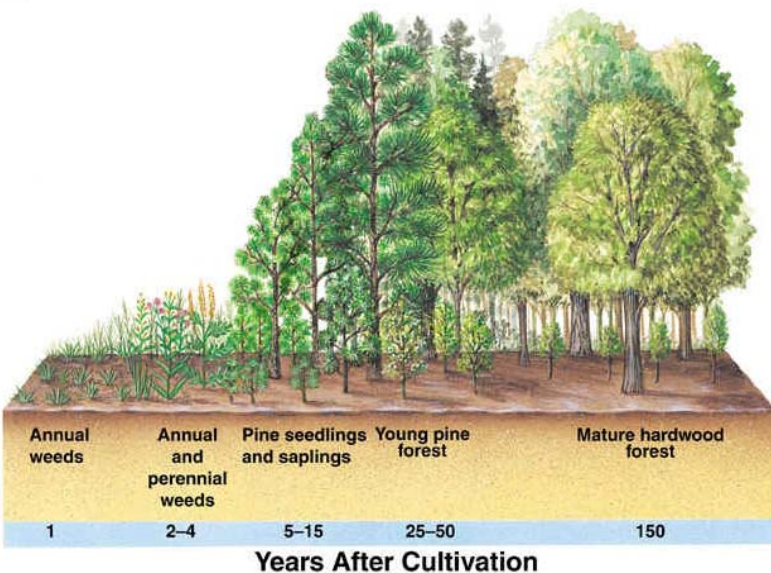
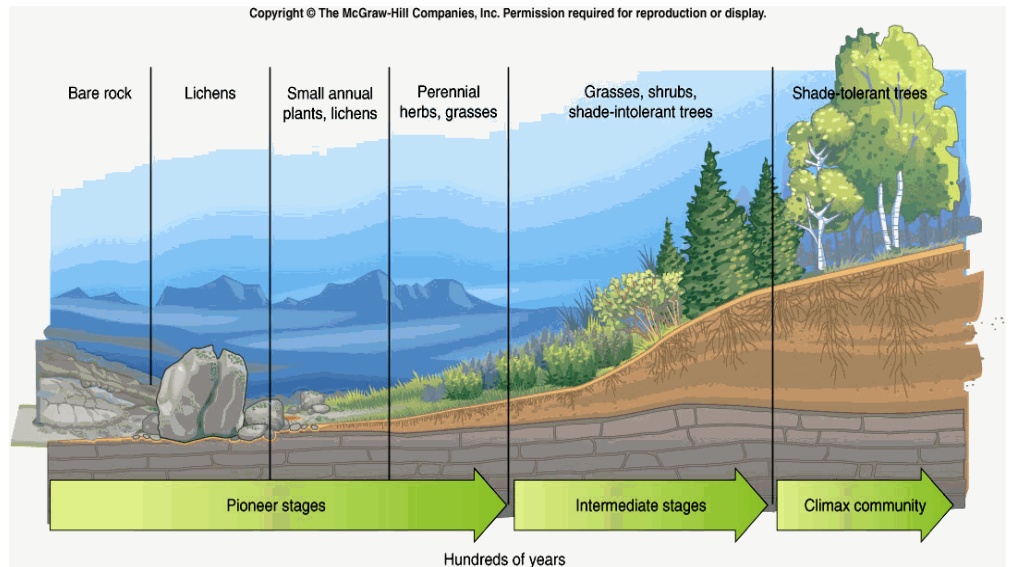
It follows that the bottom line can involve quite a lot of calculating! When looking at the final index of diversity total (the value is generally between 2 and 10), remember that:

- **The harsher the environment, the lower diversity. Abiotic factors dominate.**
- **The less harsh the environment, the greater the diversity and biotic factors dominate.**

## Succession

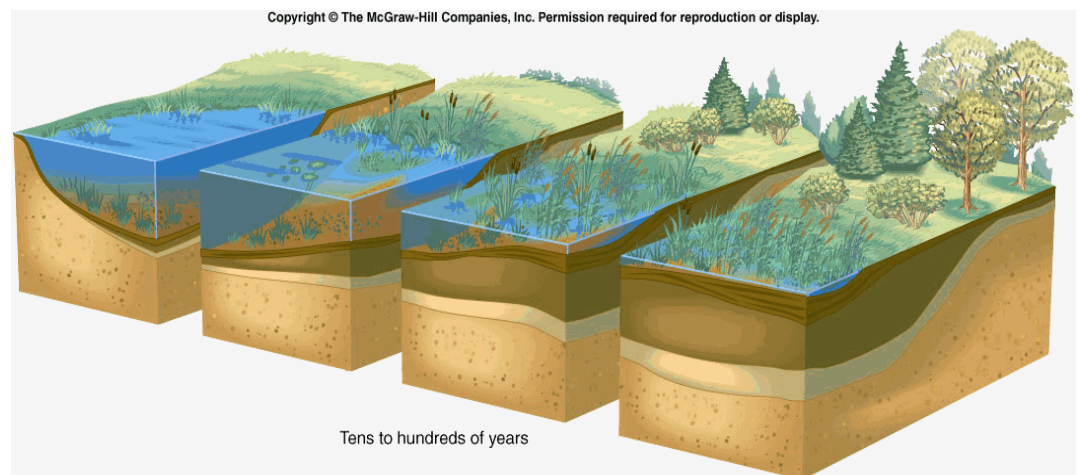
Some of the organisms in an area are gradually replaced over time by new species. This **succession** is a **result of the changes to the environment brought about by the organisms themselves**. Through succession, the **organisms tend to get bigger and more complex, whilst the biodiversity also rises**.

**Pioneer species** are those that first colonise bare soil or rock. They can withstand the harsh environment, and include lichens and mosses and Marram Grass on sand dunes. The process continues in stages (**seres**) until the **climax community** is reached, which will remain **stable until the abiotic factors change**.



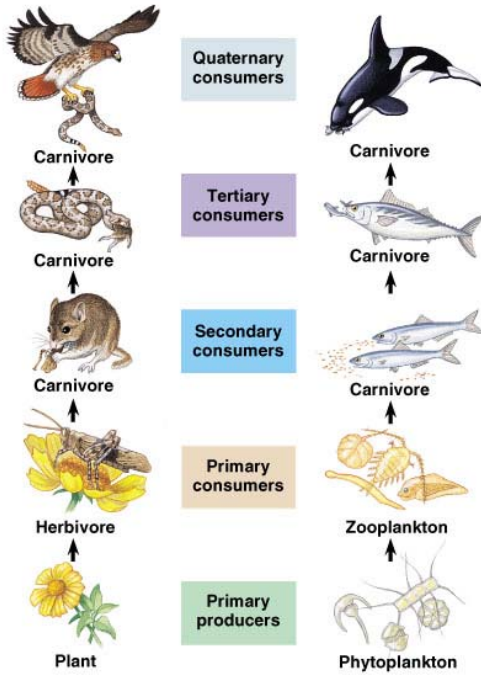
If succession is halted (e.g. by fire, flood or by Man's actions – such as ploughing), then a **secondary succession** will start. **This is much faster** than **primary succession** as there are many seeds in the soil from which new plants can grow, whilst animals readily colonise the area as soon as the plants appear.

Ultimately, it does not matter very much what the starting point for succession is - rock, bog or pond - as eventually the **climax community will be much the same**, since the climate is the main influence on it.





## Food Chains and Food Webs



**A terrestrial food chain**      **A marine food chain**  
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- Not all of the 'prey' organism is actually eaten
- Only the energy eaten, **assimilated and used for growth** by the 'prey' is available to the 'predator'. Most of the 'missing' 90% of energy is **lost in respiration**, but also in keeping warm, moving etc.

For these reasons, food chains are usually short and big, fierce animals are rare (thank goodness!)

Once again, a few terms need to be learned:

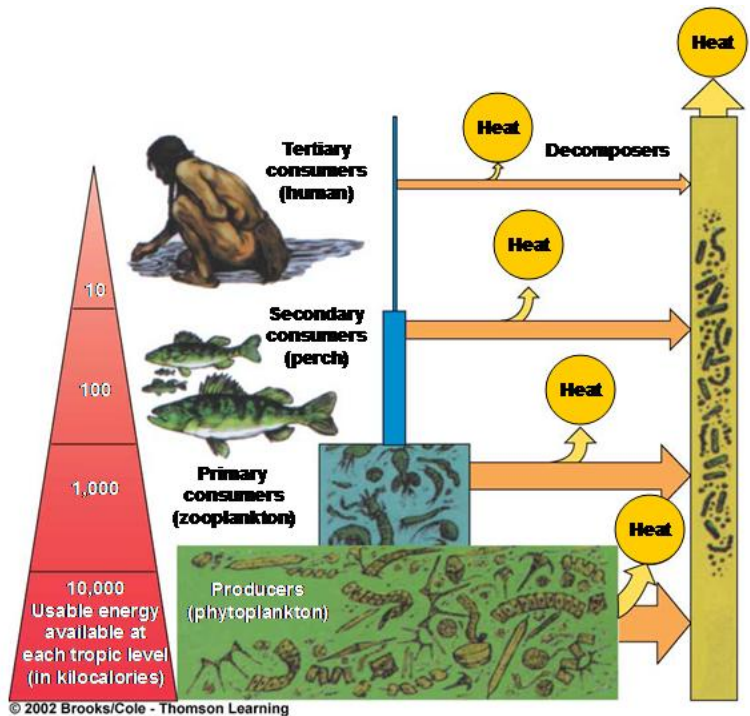
**Producer:** An **autotroph** i.e. it can make organic molecules from inorganic ones. Normally these are plants. **Only about 1% of the Sun's energy is trapped by photosynthesis in new organic matter**, so this, vital, stage of any food web is **by far the least efficient**.

**Primary consumer:** A herbivorous **heterotroph**

**Secondary consumer:** A carnivorous **heterotroph**

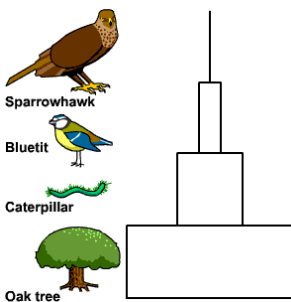
**Decomposer:** The microbes that respire the molecules in dead & waste matter and so recycle them.

Only about 10% of the energy at any level in a food chain is passed on to the next level. This is because:



## Ecological Pyramids

These have not changed since you did them at primary school. **Pyramids of Numbers** can be inverted (when a parasite is involved – *see right*);



**Pyramids of Biomass** and **Pyramids of Energy** are **never inverted** (*see left*). Thus, if one appears in the exam, it is because the **lower (smaller) level is reproducing very quickly** (and the figure used only shows one moment), **or there is another source of food that has been omitted** (usually that is dead material).

