How does natural change occur in ecosystems?

Ecological succession describes the process of natural change in ecosystems.

Seasonal fluctuations in temperature, precipitation and light levels bring about short term change, for example in temperate climates, deciduous trees lose their leaves in winter in response to declining light levels and the increasing difficulty of extracting water from cold soils. By shedding their leaves they reduce transpiration to offset the effect of physiological drought. In spring, before the tree foliage is fully developed, light reaches the woodland floor stimulating primroses and then bluebells to flower and seed. After the ‘spring window’ closes the canopy becomes denser and only a few plants can flower.

Key Terms

Climatic climax The final stage of a plant succession, in which the vegetation is in balance with the environmental conditions (soil and climate). Providing the environmental conditions remain unchanged there will be no change in the vegetation once this stage is reached.

Deforestation The deliberate clearance of forest by cutting or burning.

Plagioclimax The plant community that exists when human interference prevents the climatic climax being reached.

Pioneers The first plants to colonise an area. Plants are small and have low nutrient requirements. Many are annuals and legumes (can fix atmospheric nitrogen).

Secondary succession Succession taking place on land that was formerly vegetated but has undergone loss of that vegetation.

Sere An individual stage in a plant succession.

Succession A series of changes that take place in a plant community over time.

The composition of vegetation depends on the interaction between all the components that make up the environment — the plants' habitat. These include natural factors such as climate, relief and soils, and human influence through clearance, fires and livestock grazing. Plants will survive under suitable conditions, depending on environmental factors and competition. Plant populations vary from one area to another and become more complex over time. The change in a plant community through time is called a succession.

If allowed to continue undisturbed, succession will reach its climatic climax, in which the plant species live in perfect balance with the current environmental conditions. Although climate is the major influence on vegetation at a global scale, on a local scale other factors such as drainage, geology and relief affect plant growth.

There are two basic types of succession:
• **Primary succession** occurs on surfaces that have had no previous vegetation. These include lava flows, bare rock and sand dunes. There are two main types of primary succession. **Xeroseres** are formed on dry land. This group can be subdivided into lithoseres on bare rock and **psammoseres** on sand dunes. **Hydroseres** are formed in water — haloseres in salt water and hydroseres in fresh water.

![Plants colonising bare lava on Mt Rangitoto, New Zealand: a primary succession](image)

• **Secondary succession** follows the destruction or modification of an existing plant community. This can occur naturally, perhaps after a landslide or a fire caused by lightning. It can also occur through human activity, such as deforestation to provide farmland (described later as a **plagioclimax**).

**Development of a succession**

As a succession develops it passes through a series of stages called **seres**. Here the processes of invasion, colonisation, competition, domination and decline operate to influence the composition of the vegetation.

When plants first invade bare ground (through the processes of dispersal and migration), groups of a particular species, or colonies of two or more species, become established. These **pioneer species** are extremely hardy plants, adapted to survive in harsh conditions. Long-rooted salt-tolerant marram grass growing on a sand dune is an example of a pioneer plant. Pioneers compete for available space, light, water and nutrients and, as they die, they help to modify the habitat, adding organic matter to the developing soil. They can affect the microclimate of the area (wind speed at ground level, shelter, temperature and humidity) and soil conditions (organic content, nutrient recycling, acidity and water retention). The roots of the pioneer plants help to break up and weather the surface and so aid soil formation.
As the ground is improved by the creation of an immature soil, other plants are able to colonise and change the existing balance of species. Each stage of the colonisation provides better conditions for plant growth than the previous one, so an increasing number of species is found. The addition of organic matter (from decaying vegetation) to the developing soil improves its structure and water-retention qualities. This allows the growth of taller and more aggressive plants that are more demanding of water, nutrients and anchorage. Taller plants also provide shelter from the sun and wind, which in turn allows other plants to become established. In each stage of a plant succession, there are dominant plants. These are the tallest plants and cover the most ground.

Over time, sometimes even thousands of years, a period of relative stability is reached in which the vegetation has reached its climax, with dominants excluding rivals less suited to the current environmental conditions. Once the major dominants are in place the number of species begins to decline. Climax is usually dominated by the tallest species that can grow in the given conditions. At this stage the community becomes ‘closed’ — saturation point has been reached with all potential niches occupied. This is known as the climatic climax community, the natural vegetation having reached a stable balance with the climate and soils of the area.

Some biogeographers believe that within one climate, local factors such as drainage, geology, relief and even microclimates can create variations in the climatic climax community. This idea is known as polyclimax theory.

Plant successions can be stopped from reaching the climatic climax, or deflected towards a different climax, by human interference. The resulting vegetation is known as a plagioclimax. Examples of human activity that create plagioclimaxes are deforestation or afforestation, animal grazing or trampling or fire clearance. A secondary succession is one that develops on land that has previously been vegetated. For example, an area might have been cleared for farming but later abandoned. This abandoned land becomes colonised in a secondary succession. The stages of secondary succession may be more rapid than those of primary succession because organic matter is already present in the soil. The pioneer stage may be short or absent altogether. Climatic climax might be reached in a much shorter time than if the succession had started on a new surface. Secondary
succession can also follow natural events such as a change in climate, a disease, a mudflow, a volcanic eruption or a spontaneous fire, which can be the result of lightning.

**A plagioclimax: heather moorland**

A good example of a plagioclimax in the UK is heather moorland. Many of the uplands in Britain were once covered by a climax vegetation of deciduous woodland, particularly oak forest. Heather (*Calluna vulgaris*) would have featured, but only in small amounts. Gradually the forests were removed, for a variety of purposes. As the soils deteriorated without the deciduous vegetation, hardy plants such as heather came to dominate the uplands. Sheep grazing became the major form of agriculture and the sheep prevented the regeneration of climax woodland by destroying young saplings. Many of these uplands have been controlled by managed burning to encourage new heather shoots. Burning has eliminated the less fire-resistant species, leading to the dominance of heather. One of the aims of burning heather is to ensure that as much as possible of the available nutrient fund is conserved in the ecosystem. In many areas, heather is burnt on average every 15 years. If a longer time elapses there is too much woody tissue, the fires burn too hot, and nutrients are lost in the smoke.

If the burning was not continued, the heather moorland would degenerate, eventually allowing the growth of trees and a succession to woodland. Much of the present vegetation of the UK is a plagioclimax, largely as a result of clearance from the Roman and Anglo-Saxon periods through to the eleventh century. By this time only about 10% of the original woodland remained in England and Wales.