Conditions for life on Earth

**Suitable abiotic factors**

Availability of water

Water is essential for life on Earth because:

* Water acts as a **transport medium**. Blood is mainly water with substances dissolved and cells suspended in it. Blood is essential to all higher animals for carrying substances, such as food and oxygen around the body. Plants have sap, which is mainly water, to carry their food and mineral salts between roots and leaves.
* Water helps to **maintain body temperature**. Animals sweat and plants transpire, and both of these processes help to take excess heat away from the body as the water evaporates.
* Water acts as a **solvent** and all chemical reactions in living things take place in water.
* Water has a **high** **specific heat capacity**. This means that it takes a lot of energy to heat up water and so it tends to maintain a constant temperature and resist changes in temperature. Aquatic organisms enjoy a much more even temperature throughout the year than many terrestrial organisms, which have to contend with very hot temperatures in the summer or during the day and very cold temperatures in the winter/at night.
* Water **protects** from the damaging effects of **ultraviolet radiation**, yet allows the wavelengths of light required for photosynthesis through.

Appropriate temperature range (0-40°C)

Warm temperatures are needed to sustain life because:

* Enzymes work best in a temperature range of 35-40°C and enzymes are essential to speed up the chemical reactions in all plants and animals’ bodies
* Enzymes will not work at all in temperatures below 0°C but they recover their activity when warmed up again
* Enzymes are denatured at temperatures over 60°C and permanently lose their ability to speed up reactions

Suitable ambient gases (oxygen, carbon dioxide and nitrogen)

* A balance of oxygen and carbon dioxide in the atmosphere is maintained by the processes of photosynthesis, carried out by all green plants in the light, and respiration, carried out by all living organisms all the time.
* Carbon dioxide is needed for photosynthesis and climate control, and nitrogen is needed for protein synthesis.

Light

* Light provides the energy for photosynthesis
* Radiation from the sun produces heat when it is absorbed – it is the source of energy for the hydrological cycle and warming of the Earth

**Atmospheric change**

* Carbon dioxide was dissolved in the oceans and deposited as carbonate rocks, and photosynthesis in primitive plants exchanged carbon dioxide for oxygen
* Water vapour condensed and turned to liquid water as temperatures fell, forming the seas
* Ammonia was oxidised to nitrates and then to nitrogen gas by denitrifying bacteria. Electrical storms also caused the nitrogen in the atmosphere to form carbon compounds, which then formed DNA and amino acids
* Oxygen was given off by early plants photosynthesising. Once oxygen levels had risen above 0.2%, aerobic respiration and more complex life forms appeared
* The oxygen released during photosynthesis reached the stratosphere, where it reacted with UV radiation to form the ozone layer. The ozone layer protects from UV radiation, allowing life to evolve on land

Reasons for conservation

Moral and Ethical reasons

* One reason for conserving species is because it is moral and ethical to do so. Many people believe that other organisms have a right to live and that it is wrong to kill unnecessarily
* In more affluent societies, it is not necessary to exploit wildlife for food, but in other societies it is an essential part of the diet e.g. bushmeat

Food

* Many species, particularly plant species, are used as a source of food – by conserving them, we maintain potential food sources
* Out of a known 250,000 species, 30 plants are used on a large scale

Educational reasons

* By studying wildlife we can learn about biomimetics – the knowledge of how other species are adapted to survive and the application of that knowledge to solve human engineering problems
* An example of this is that the bones of birds must have thin walls to make them light. Their strength is retained by having internal cross-trusses to prevent the bone bending and snapping. Similar trusses are used inside tubular bridges so that they can be strong but light

Medical reasons

* Very important medicines such as codeine, morphine and taxol have been derived from plant species
* We must conserve species because there may be many more medicines still undiscovered which could be lost

Aesthetic/Recreational reasons

* Nature is beautiful to look at and natural areas are nice to visit
* If we didn’t conserve species or their habitats, we wouldn’t be able to enjoy places such as woodlands and coastlines

Ecological reasons

* Plants and animals are important in balancing the atmosphere, completing food chains, and controlling water and nutrient cycles
* Species are also interdependent and plants depend on animals for pollination and seed dispersal
* In the same way, animals depend on plants for nutrients and oxygen

Industrial reasons

* We can gain many essential products from plants and animals such as paper, timber, dyes and oils
* If we want to continue to use them, we must conserve the species from which they are derived

**Interdependence of Species**

* Pollination
* Seed dispersal
* Food chains – producers (green plants), herbivores, carnivores
* Balance of the atmosphere – plants exchange CO2 for O2 in photosynthesis
* Habitat provision
* Decomposition – this releases nutrients

Examples of interdependence of species – Brazil nut trees

Brazil nut trees will not produce nuts when grown on plantations.

* Orchid flowers are needed to help the orchid bees produce offspring (male bees cover themselves in the scent to attract females).
* Brazil nut trees require female orchid bees to pollinate the flowers before the nuts can be formed.
* The only animal capable of breaking into the nut pods are agoutis. Agoutis are needed for seed dispersal.

How humans threaten wildlife

An **endangered species** is any species which is in danger of extinction throughout all or a significant portion of its range.

A **threatened species** is any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Unsustainable exploitation for human gain

* Food – bushmeat, wild bird’s eggs, fish etc
* Fashion – fur, skins, scales etc
* Pets and entertainment – exotic pets, SeaWorld etc
* Furniture and ornaments – mahogany, teak, ivory, coral, turtle shell etc
* Traditional medicines often use body parts from rhinos, bears, seahorses, tigers and other endangered species
* Industrial materials – paper, timber, dyes, oils etc

Inability to survive habitat alteration (change)

* Some species may be unable to survive habitat alteration
* Most species have particular habitat requirements which may be lost
* Competitor species may be more able to survive the changes
* Introduced species – predators, competitors, disease

Examples of habitat change

* Wetland drainage
* Logging (removing trees selectively)
* The creation of reservoirs (flooding)
* Pollution – pesticides, toxins, noise pollution (sounds from traffic and industry can interfere with the way animals hunt and communicate), litter

Deliberate habitat destruction

* Deforestation
* Expansion of farmland
* Urbanisation
* Mineral extraction
* Mono-cropping

Conservation methods

**Legal protection**

Trade controls

**CITES – Convention on International Trade in Endangered Species**

* CITES is an international agreement that controls and regulates trade in endangered species and their products.
* The agreement is enforced by strict customs controls, backed up by fines and even jail sentences. It is difficult to enforce because not all countries have signed up, and it is very difficult to police or catch the smugglers involved.

Banning damaging activities

**The Wildlife and Countryside Act**

This is a UK law that provides protection for many wildlife species, by legally protecting their habitats or by making the exploitation or harming of them illegal.

Designation of legally protected areas

Designated protected areas place restrictions on the activities that may be carried out there to provide protection for the community of species that live there, rather than particular species.

Examples of designated areas include:

* SSSI’s (Site of Special Scientific Interest)
* NNR’s (National Nature Reserve) and MNR’s (Marine Nature Reserve)
* SPA’s (Special Protected Area)
* SAC’s (Special Area of Conservation)
* Ramsar sites (these provide protection for the biodiversity of wetland areas)

**Sustainable management of exploitation**

IWC – International Whaling Commission

The IWC aims to control (not ban) whaling and ensure sustainable exploitation by conserving whale stocks.

**Captive breeding and release**

Problems with keeping species in captivity

* Some species are too large to be kept in captivity e.g. blue whales
* Some species have very specific requirements which cannot be easily met in captivity
* It may be difficult to provide enough food for the animals
* It may be difficult to provide food in the right way, e.g. insects for birds which catch insects in flight
* Keeping animals in zoos or plants in botanic gardens is expensive
* Some species have complicated species interactions, e.g. large blue butterfly caterpillars spend the winter in the nests of a certain species of ant

Problems with captive breeding programmes

* Some species do not breed in captivity. Not enough is known about the habitat requirements of each species to be able to provide the right conditions for successful breeding
* Some individuals may be stimulated to come into breeding condition by many factors such as day length, light level, temperature etc. If the factor that stimulates a particular species to breed is not understood, then it is difficult to provide it
* Captive breeding may cause inbreeding to occur. Inbreeding describes breeding between closely related individuals. Inbreeding increases the risk of recessive genes producing offspring with disadvantageous characteristics

Problems with seed banks

* The viability of the seeds declines with increasing periods of storage, and so the gene pool would be reduced
* It is easy to store enough small seeds in a seed bank, but to store enough large seeds or fruit such as coconuts would be hard
* Seeds that are naturally preserved by drying can be kept easily but seeds and fruit with a higher water content, such as coconuts, are harder to store

Methods of increasing the success of captive breeding

* **Cryopreservation** of eggs, sperm and embryos – eggs, sperm and embryos can be deep frozen by cryopreservation so that they can be used in captive breeding programmes in the future. Deep frozen sperm can be transported much more easily and for much longer distances than the male animal itself. Also, frozen sperm can be used long after the male animal has died.
* **Artificial insemination** – breeding by artificial insemination reduces the problems and risks of moving animals. Semen may be introduced into the uterus of the female animal when she has released eggs and can become pregnant, or the eggs may be removed from the female, fertilised with sperm and returned to her uterus.
* **Embryo transfer** – the transfer of fertilised embryos or embryos from a female of a rare species, into females of closely related more common species. This enables more young to be produced than could be achieved through normal breeding.
* **Micro-propagation** of plants – a tissue culture where many clusters of cells can be produced from a single young plant or tissue sample. Each cell cluster can be cultivated to produce an individual plant. In this way, many plants can be produced from a single original plant, all of which are genetically identical.

Problems with releasing captive-bred animals

* They may not recognise food species or poisonous foods because they would not have been familiar with them in captivity
* They may not have developed essential survival skills such as the ability to hunt for prey
* They may have no immunity to local diseases
* The threat to their habitat may still be present
* They may not be accepted by the indigenous population. This makes it harder to find a mate and they may be more likely to be killed by predators without the protection of living in a group

**Habitat conservation**

Habitat protection

* Nature reserves can be established by RSPB or Natural England to reduce disturbance or damage to the habitat.
* Designated protected areas include NNRs, SSSIs, SPAs and SACs.
* Grant aid or subsidies can also be used to support voluntary conservation schemes, such as the Environmental Stewardship Scheme (ESS) for farmers.

Habitat management

Many habitats in Britain are not completely natural, they are maintained by management practices for agriculture or human gain (if left alone, UK lowland would become deciduous woodland). For example, chalk grassland (grazing sheep), hay meadows (annual cutting) and hedgerows (regular cutting), are the result of human management and are examples of plagioclimaxes or deflected succession.

Management practices to maintain or enhance habitats include:

* Controlling succession
* Culling or removing undesirable or non-native species
* Providing suitable biotic and abiotic conditions
* Planting biological corridors e.g. hedgerows to link up habitats and combat forest fragmentation

Habitat creation

Human actions may create good wildlife habitats unintentionally while they are carrying out some other activity. Some examples of habitats created by humans that can benefit wildlife are:

* Roadside verges
* Forestry plantations
* Reservoirs
* Urban gardens

Conservation in the UK

Designated areas

**UK**

**SSSI** – Site of Special Scientific Interest. These are designated by Natural England to protect habitats of rare plants and animals, e.g. orchids and dormice. They are also designated to protect unusual geology or landforms, e.g. the Lugg Meadows.

**LNR** – Local Nature Reserve. These are designated by the local council for the protection of wildlife and also public enjoyment, e.g. Tupsley Quarry.

**NNR** – National Nature Reserve. These are designated by Natural England to protect complete habitats or communities which need conserving e.g. Claerwen National Nature Reserve.

**MNR** – Marine Nature Reserve. These are designated by Natural England to protect marine wildlife and plants e.g. Lundy Island or Skomer Island.

**EU**

**SAC** – Special Area of Conservation. These are designated under the Habitats Directive, e.g. Ben Nevis.

**SPA** – Special Protection Area. These are designated under the Birds Directive, e.g. the Severn Estuary.

**International**

**Ramsar sites.** These are designated by DEFRA for wetland birds e.g. Isles of Scilly.

Legislation

**UK**

**Act of Parliament (date)** – Wildlife and Countryside Act (1981 and 1984). This provides protection for many wildlife species and designated protected areas. Some features of the Wildlife and Countryside Act are the protection of many mammals such as otters and dormice, and the protection of badgers and their setts.

**EU**

**Directives** – Habitat Directive and Birds Directive. These have very high status.

**International**

International ‘law’ tends to consist of agreements.

**IWC** – International Whaling Commission. This is an agreement to restrict the capture and trade of whales.

**CITES** – Convention on International Trade in Endangered Species. This is an agreement that regulates the trade in endangered species of plants and animals, and their products.

**Agri-environmental systems**

The Environmental Stewardship Scheme (ESS)

The ESS provides financial support to farmers to steward and encourage environmentally beneficial development. Points are awarded for individual features of the farm that benefit wildlife.

The aims of the ESS are:

* To conserve wildlife (biodiversity)
* To maintain and enhance the landscape quality and character
* To promote public access and understanding
* To protect natural resources

The ESS does this through:

* Hedgerow management – gap infill and A shape trimming
* Ditch management
* Grassland management
* Building dry stone walls
* Planting in-field trees to provide shelter, perch sites, nest sites for birds and habitats for other animals and insects
* Creating riverbank buffer strips – these help to prevent pesticides and fertilisers from flowing into rivers
* Uncultivated field corners
* Beetle banks – these are strips of wild grass for beetles to live in. Beetles are natural predators and mean farmers are able to use fewer pesticides

**Royal Society for the Protection of Birds**

The aims of the RSPB are:

* To restore, create and enhance thousands of hectares of land to benefit both people and wildlife
* To protect and increase populations of key, threatened species (particularly birds)
* To improve wildlife law enforcement
* To protect and conserve birds living on the coast and marine environments
* To protect important wildlife sites
* To help farmland bird populations to recover by advising farmers and landowners to conserve priority farmland bird species and habitats
* To work with farmers to recover populations of lapwings, tree sparrows, corn buntings, turtle doves and other farmland birds, by creating suitable habitats using agri-environmental schemes

Examples of the work of RSPB

* Restoring, creating and enhancing a variety of habitats including reedbeds, heathland, chalk grassland and wetlands
* Protecting and increasing populations of key, threatened species
* Protecting important wildlife sites through campaigns
* Conserving coastal birds and coastal/marine environments

The RSPB is funded through the work of volunteers, donations and fundraising. The RSPB is a UK based charity. RSPB members volunteer thousands of hours working directly for birds, and are the charity’s biggest source of income.

**World Wide Fund For Nature**

WWF has three main aims: to save endangered species, to protect endangered habitats and to address global threats.

The aims of WWF are:

* To safeguard the natural world
* To tackle climate change
* To change the way we live
* To work with government and parliament
* To work with local authorities
* To work with schools and young people

Examples of the work of WWF:

* Conserving the world’s biological diversity
* Ensuring that the use of renewable natural resources is sustainable
* Promoting the reduction of pollution and wasteful consumption

WWF is funded through the government, donations and fundraising.

Management Practices to Maintain UK Habitats

Woodland management

* Coppicing – this is done for timber, fence posts and fuel. It increases biodiversity on the woodland floor by letting in more light.
* Pollarding – this means cutting at over 2m, often in towns or to prevent deer eating new shoots

Hunting and fishing

* Grouse moorland is burnt to encourage new growth of heather for the birds to feed on
* River management includes removal of vegetation on banks, and the keeping away of animals to make sure that the water is very clean for trout and salmon fishing

Agriculture

* Chalk grassland – sheep grazing. Sheep eat tree saplings and small plants, but low growing plants and grasses survive
* Hay meadows – annual cutting in June and July after plants have set seed
* Field boundaries – hedge laying

Conservation Abroad

**Conservation of the Amazon Rainforest**

Species in the Amazon Rainforest

Jaguars, Amazon River dolphins, anacondas, toucans and macaws

Threats to the rainforest

* Cattle ranching
* Subsistence agriculture
* Commercial agriculture
* Roads
* Logging
* Mining
* Hydroelectric dams (flooding)
* Deforestation for the timber industry/to clear land for farming

Reasons to conserve the rainforest

* Over half the world’s plant and animal species are found in the rainforest
* The Amazon rainforest releases 20 billion tonnes of moisture every day, helping to water crops thousands of miles away
* Deforestation releases more carbon dioxide into the atmosphere than all the ships, cars and planes put together
* Healthy rainforests absorb up to 10% of man’s carbon emissions each year
* Rainforests balance and stabilise the gases in the atmosphere
* Forests can be a huge source of wealth if they are managed sustainably

Stopping the destruction – 3 broad strategies

1. Expand protected areas and increase enforcement
2. Develop sustainable management of remaining forest and cleared areas
3. Reform of land ownership to give peasants a stake

Other conservation methods

* Development of ecotourism
* Developed countries paying Brazil for Amazon biodiversity conservation
* Increasing the productivity of cleared land e.g. develop GM crops that can survive in nutrient poor soils
* Replanting forests to help conserve species
* Replanting areas to link up existing areas – biological corridors

**Conservation in Antarctica**

Species in Antarctica

Fur seals, emperor penguins and blue whales

Threats to Antarctica

* Climate change – Antarctica’s biological community is greatly sensitive to environmental change
* Mineral exploitation – valuable natural resources such as oil have been found in Antarctica
* Scientific exploration – e.g. Lake Vostok is a vast subglacial lake in the centre of Antarctica which has been isolated for millions of years
* Overfishing – humans currently harvest about 100000 tonnes of krill per year, which removes food for seals, penguins and whales
* Uncontrolled tourism – almost 1000 tourists visit each summer. Most tourists arrive on huge cruise ships, each with a capacity of almost 3000 people. This causes disturbance of wildlife, oil pollution, litter etc.

Reasons to conserve Antarctica

* High albedo reflects solar radiation, preventing too much global warming
* Ice stores water – if it all melted, sea levels would rise by 75m
* The dead bodies and faeces of animals contain carbon compounds. These sink to the ocean floor, locking away carbon

How Antarctica is conserved

* The 1961 Antarctic Treaty designates Antarctica as a reserve devoted to peace and science
* The International Association of Antarctica Tour Operators (IAATO) promotes and practices sustainable travel and tourism
* Military activity, nuclear weapons and the dumping of nuclear waste is prohibited

**Conservation of Coral Reefs**

Typical coral reef species

Octopus, sea urchin, reef sharks, starfish, lobsters, clams, seahorses, sponges, fish and sea turtles

Conditions required for coral reefs to form

Coral reefs form in shallow, warm tropical seas. Corals also need high amounts of sunlight for algal photosynthesis, low turbidity in water to avoid physical damage by sediments landing on the coral and killing the polyps, constant salinity, a hard substrate for polyp attachment and warm, stable temperatures ideally between 23 and 29°C.

Where coral reefs are found

Coral reefs are found along the edges of shallow, submerged ocean banks or along shelves in warm, shallow tropical seas. Coral reefs are found at 30° N and S of the equator, around South Africa, Queensland Australia, Brazil, Miami Florida and Okinawa.

Why it is important to conserve coral reefs

* Corals remove and recycle carbon dioxide – excessive amounts of carbon dioxide contribute to global warming
* Coral reefs are valuable marine habitats
* Many drugs are being developed from coral reef animals and plants as possible cures for cancer, arthritis, human bacterial infections, viruses and other diseases – we may continue to find the answers to medical problems in the coral reefs, so long as we can keep them healthy
* Coral reefs break the power of the waves during storms, hurricanes, typhoons, and even tsunamis
* By helping to prevent coastal erosion, flooding, and loss of property on the shore the reefs save billions of dollars each year
* If properly managed, reefs can yield around 15 tonnes of fish and other seafood per square kilometre each year
* Sustainably managed coral reef-based tourism can also provide significant alternative or additional sources of income to poorer coastal communities in developing countries

Threats to coral reefs

* Shrimp farming
* Recreation – damage by swimmers, surfers and oil pollution from boats
* Over-fishing
* Reef mining for building materials & production of lime, mortar and cement
* Fishing with explosives and cyanide
* Coral harvesting for tourist souvenirs
* Untreated sewage and agricultural runoff
* Logging e.g. in Papua New Guinea resulting in sedimentation
* Global warming increases sea water temperature causing coral bleaching, and if sea levels increase the algae within the coral polyps won’t be able to photosynthesise

How to conserve coral reefs

* Ban dynamite, chlorine bleach and cyanide fishing
* Greater enforcement of CITES appendix II
* Greater control of over-fishing of reef species
* Ban most destructive fishing techniques
* Developed nations must pay for developing nations to protect their reefs
* Greater control of extraction of species and rock for aquaria

**Life Processes in the Biosphere**

Adaptation to the environment

Range of tolerance

Range of tolerance is the upper and lower limits of an abiotic factor which permit survival of a species. The young usually have a narrower range of tolerance than the adults.

**Abiotic factors**

The survival and distribution of species is largely controlled by abiotic factors. Being able to survive extreme conditions to which few species are adapted may avoid competition with other species that won’t be able to live there, but it may also limit the areas that will be suitable for that species and make it vulnerable to environmental change.

Temperature

* No organisms can survive where low temperatures cause the cells to freeze or high temperatures denature their proteins.
* Within this range a species will be able to survive if their proteins, including enzymes, are functional. Even within this range of temperatures that is generally suitable for life, each enzyme will function within a particular temperature range.
* This is a problem for organisms that live where temperatures fluctuate a lot, but the problem can be overcome if the body’s internal temperature can be kept constant.
* Bacteria around volcanic vents have evolved to survive at temperatures over 110°C.

Light

* Light that is absorbed during photosynthesis is the source of energy for most food chains.
* Plants have evolved pigments to absorb light in particular habitats. Many woodland floor plants have red or blue pigments to make use of the green light that passes through the canopy vegetation. These plants often cannot survive continual bright sunlight.
* UV light damages living cells and is particularly dangerous to animals with thin skins, such as amphibians.

pH

* Organisms with exposed living tissues are particularly susceptible to enzyme damage caused by high or low pH.
* Many plants can only survive if the soil is within a certain pH range. Outside the range their root cell enzymes may not function or they will be unable to absorb nutrients. For example, most lichens cannot survive in acidic conditions.
* Animals with exoskeletons cannot survive very acidic conditions because it dissolves the skeleton. For example freshwater crustaceans such as crayfish cannot survive in acidic water.

Water

* All organisms require water, but some species have particular requirements, often for breeding or because they do not have the ability to reduce water loss.
* For instance, frogs have thin skin that must remain moist. If it dries out then the living skin cells die and absorption of oxygen is reduced. Although they spend most of their lives out of water, they live in moist areas and must return to water to lay their eggs. Toads have a thicker skin that reduces water loss so they can live in drier habitats.

Mineral nutrients

* Animals get their mineral nutrients in their food or water, but most plants can only absorb them from their surroundings via their roots.

Turbulence and physical damage

* Some species are well adapted to surviving conditions of turbulence without being seriously damaged.
* For example, brown seaweeds on rocky shores are very flexible and coated with mucus that reduces wear against rocks.

Species interdependence and control of abiotic factors

The abiotic factors that affect a species may be controlled or modified by other species living in the same habitat, so the survival of one organism may indirectly depend upon the presence of another species.

Altered abiotic factors in a woodland:

* Light levels on the woodland floor may be lowered because of shading
* Humidity will be higher because of transpiration by the canopy vegetation
* Wind velocities will be reduced because trees act as windbreaks
* There will be an increase in nutrient availability because of the decomposition of dead leaves and branches

**Biotic factors**

If a species is not adapted to the abiotic factors then it cannot survive. It must also be adapted to biotic factors, which involve other species, especially obtaining food and avoiding becoming food. Other biotic factors include disease, nutrient supply, and interrelationships for breeding such as pollination and seed dispersal.

Feeding

* All heterotrophs have to get their food energy from other living organisms. Depending on their particular food, they may need to have adaptations for catching, eating and digesting their food.
* In harsh environments where food may be scarce or unreliable, it may be an advantage to eat a wide variety of foods.
* Tropical rainforests have abiotic conditions that are ideal for plant growth so productivity is high and food supplies are very abundant and reliable. This allows many animals to survive, with enough food for different species to exist with specialised feeding mechanisms to avoid competition. Birds’ bills vary in shape to allow them to eat different types of food.
* A feeding mechanism requiring specific habitat protection is that most woodpeckers find insect larvae by pecking into rotten wood. Habitat management must include enough old rotting trees.

Avoiding predators

* The large number of herbivores and predators in rainforests make it important to have defence mechanisms such as a bad taste, toxins or thorns.
* Animals may also use camouflage to avoid being found.
* Tree-living animals may be more prone to predation if they come down to the ground.

Symbiotic nutrition

* In some cases, different species have evolved to assist each other with nutrition.
* An example: the algae that live inside coral polyps on coral reefs are provided with a safe habitat and supplies of nutrients, while the polyps are provided with carbohydrates.

Disease

* Diseases naturally control populations, when the population density is high.
* While individuals may become ill or die, the overall population may benefit by ensuring the weaker individuals do not survive, but if a population is already threatened then losses due to disease may cause it to decline.

Pollination

* Plants with a low population density where individuals are spaced well apart need a pollen delivery system, so they have evolved flowers that attract animals, such as bees, beetles, moths or bats that transfer pollen from flower to flower.
* Particular plants have evolved to attract specific animal groups using scent, colour, shape or time of opening.

Seed dispersal

* Wind dispersal of seeds only works for small seeds and plants in windy areas. Larger seeds cannot be carried by the wind and neither can those produced in sheltered areas such as beneath the forest canopy.
* Plants often produce seeds that are intended to attract animals. Some seeds may be carried away and eaten, but some may be dropped and can then grow into plants. For example, grey squirrels bury acorns as food stores for the winter. Many are never dug up again and will germinate to produce new oak trees.
* Some seeds are enclosed in edible fruit that attracts the animals. The seeds may be discarded or pass through the gut undigested. For example, tropical fruit bats eat fruit. The seeds are then dispersed in their faeces.

Nutrient supply

* Nutrients from dead organic matter are released during the break-up by detritivores and subsequent breakdown by decomposers.
* Plants can then utilise the nutrients again, which ensures future food supplies for the detritivores and decomposers.

Grouping organisms and environments

**Species:** A group of similar organisms which resemble one another and can breed together to produce fertile offspring

(E.g. humans, lions and oak trees)

**Population:** All the individuals of a species living in a particular area at a particular time

(E.g. all of the oak trees in deciduous woodland)

**Community:** The populations of all the species living in a particular area at a particular time

(E.g. the sum of all the plants and animals: such as oak trees, ash trees, holly bushes, hazel bushes, grasses, mosses, sparrow hawks, sparrows, blue tits, voles, earthworms, fungi etc in a woodland)

**Ecosystem:** The community of organisms, their inter-relationships with each other and interactions with their abiotic environment

(E.g. the community of species in a woodland, their inter-relationships and interactions with energy, water and nutrient cycles)

**Habitat:** The place where a particular organism lives, which provides a particular set of environmental conditions

(E.g. a rocky shore, human skin, the mole lives in the soil within a grassland)

**Niche:** That part of a habitat which is inhabited by an organism and the role which it plays within the ecosystem, e.g. what it feeds on, the temperature range it can tolerate.

(E.g. the tawny owl is a nocturnal carnivore, nesting in holes in hollow trees, feeding on small mammals and birds, crabs are scavengers of rocky shores)

**Biome:** A large geographical region, with a characteristic climate, in which certain types of plants and animals (a community of species) live, usually named from the dominant vegetation.

(E.g. deciduous broadleaf woodlands of Western Europe, tropical rainforest, savanna)

**Biosphere:** The part of the planet which provides conditions suitable for life and is inhabited by living organisms (i.e. the soils of the lithosphere, liquid water and the troposphere).

Changes in ecosystems

**Succession**

Succession is a series of changes in plant community, leading to a climax community (deciduous woodland for lowland UK).

**Primary succession** starts with no living organisms or dead organic matter from: bare rock (lithosere), water (hydrosere) or sand.

Hydrosere Succession

1. Floating plants are able to photosynthesise and obtain nutrients from the water. Plants add organic matter to the water.
2. Rooted plants e.g. water lilies appear. Leaves float on the surface to intercept sunlight for photosynthesis. Roots obtain nutrients from sediment at the bottom of the pond.
3. Emergent species, those that grow partially submerged, establish as the lake becomes shallower e.g. yellow iris and reeds. Death and decay of these plants add nutrients and increase the sediment layer.
4. Water levels recede further and the swamp becomes a marsh. Species adapted to very wet conditions die out.
5. Trees that tolerate boggy conditions establish e.g. willow, as do trees that are able to fix nitrogen e.g. Alder. These tree species shade out some of the marsh species. Transpiration by trees further dries out the swamp. As soil dries out, aerobic decomposition rapidly adds organic matter to the soil. Called a willow carr.
6. Slow growing oak and ash trees develop and a climax community of deciduous woodland becomes established.

The first colonising plants are called pioneers. They are adapted to quite harsh abiotic conditions.

Lithosere Succession

1. There is no soil; there are extremes of temperature and water availability. The first colonisers are simple autotrophs, such as algae and lichens. Weathered rock fragments and dead organic matter gradually build up.
2. Mosses colonise and gradually a thin layer of soil builds up.
3. Grasses and ferns colonise.
4. As soil builds up and plants get larger the abiotic factors become less extreme. It never gets as hot or cold or wet or dry as when the rock was exposed. The soil makes plant nutrients available. Seedlings of less hardy plants can survive under the shade of the larger plants.
5. Flowering plants colonise and survive once the insects that pollinate them are established.
6. When the soil is deep enough and the edaphic factors (soil factors) are suitable, trees can colonise. The first species usually have wind-blown seeds while later ones have seeds that are dispersed by animals.

Areas that have water available all year round usually become woodland. The temperature controls the type of woodland: tropical rainforest, temperate deciduous woodland or boreal conifer forest.

Areas with seasonal rain usually become grassland: tropical savanna or temperate grassland.

Secondary Succession

* Secondary succession refers to the changes that occur in an area that has already reached the climax state.
* Natural events such as forest fires, hurricanes, volcanic eruptions and flooding, or human activities such as deforestation, grazing, mowing and burning interrupt the sequence of events in succession and can remove the climax community.
* Succession starts again but happens more quickly than primary succession, because there is already organic matter e.g. soil, present.

Plagioclimaxes and Deflected Succession

* If the human activity that produced a plagioclimax stops, then secondary succession will eventually re-establish the climax community. So if the plagioclimax community includes species that are considered to be important, then it is necessary to continue the activities that maintained the plagioclimax.
* Examples of plagioclimaxes in the UK are hay meadows, maintained by mowing, and hedgerows, maintained by cutting.

Diversity and ecological stability

The assessment of species diversity is important in monitoring environmental change, damage and the success of conservation efforts.

* Higher diversity in less abiotically extreme environments results in more stable ecosystems. Populations are dominated by biotic factors, such as in tropical rainforests and coral reefs.
* Lower species diversity in more abiotically extreme environments results in less stable ecosystems. Populations are dominated by abiotic factors and may fluctuate dramatically.

High biodiversity = high ecological stability

Estimating of the total number of species that exist

Predictions can be made based on the past rate of discovery and how much harder it is getting to find new species. In relatively unexplored ecosystems such as the deep ocean, it is fairly easy to find new species and this suggests that most species that actually exist have yet to be discovered.

There is evidence that the number of extinctions is increasing and this has prompted countries to sign up to agreements to maintain biodiversity and the gene pool of each species.

**Population dynamics**

An understanding of the factors that influence population change is important in monitoring species’ survival, the success of conservation strategies and also in assessing the maximum sustainable yields of exploited species.

The actual size of a population is controlled by the numbers of births and deaths and movements in and out of the area:

Population size = starting population + births + immigrants

– deaths – emigrants

Factors affecting birth rates

* The number of births is controlled by the natural reproductive potential of the species (biotic potential). This has evolved over long time periods to produce sufficient offspring to replace the individuals that die.
* There must be a surplus of young to ensure the survival of the population in bad years, without wasting time and resources that could threaten the survival of them all.
* Species such as herring produce many young because the chances of dying are high. In contrast, species such as elephants produce few young because the chances of dying are low. These species can be particularly vulnerable to an increase in the death rates.

Factors affecting mortality (death) rates

* The number of deaths (mortality rate) is mainly controlled by environmental factors that prevent some of the individuals that are born from surviving.
* A range of environmental factors affects the likelihood of dying: **density independent factors** such as drought, flood and volcanic eruption, and **density dependent factors** such as food supply and disease.
* Density dependent factors become more important as the population density increases, until the mortality rate forms a long-term balance with the birth rate.

**Homeostatic regulation of population size**

Carrying capacity

* Carrying capacity is the maximum population that can be supported indefinitely without damaging or over-exploiting the environment.
* If the population rises above the carrying capacity then density dependent factors become stronger, so mortality increases and the population decreases.
* If the population drops below the carrying capacity then density dependent factors become weaker, so mortality decreases and the population increases.
* The mortality rate changes if the population is above or below the carrying capacity to return the population to the carrying capacity.

Artificial population control

Culling (selective killing) of a population may be necessary to conserve species or habitats where natural control mechanisms no longer exist, e.g. the culling of red deer in Scotland where wolves no longer exist.

Land Resources

The conservation of landscape for informal public enjoyment

Since communities of plants and associated animals are an important part of the landscape, landscape conservation often results in wildlife conservation.

**Landscape protection**

* Conserving the aesthetic appeal of the environment involves the maintenance of features that are natural or have been produced by human activities and give the countryside its character, e.g. woodlands, hedgerows, stone walls, in-field trees, ditches, banks, ponds and river features.
* Some of these features can be protected simply by preventing any damaging activities. Others need active management to counteract natural processes such as ecological succession.

**Landscape enhancement**

Restoration and development of countryside features can enhance its character such as planting small woodland areas, replacing conifers with mixed indigenous species, ‘soft’ riverbank management and the restoration of river meanders.

**Visitor management**

* Visitor management should involve the careful provision of facilities that do not damage the character of the countryside, for example paths, car parks, information and recreational facilities.
* They can be designed to fit into their surroundings by the use of traditional designs and local materials. Paths may be made of sand, gravel or stone, buildings and signs may be made of rough wood and the use of grass with protective matting produces a more natural surface than tarmac.
* Providing good facilities and publicising them will attract the public and help keep them away from sites where their presence would cause problems. These are often called Honeypot sites. The extra facilities provided could include a visitor centre, toilets, café, guided walks and other events.

**Governmental organisations**

**Natural England**

* The organisation Natural England is responsible for designating areas for landscape conservation.
* It sets up controls and regulations which must be followed by landowners and other users to protect them from undesirable change.
* Damaging changes such as the clearance of natural woodland or urban expansion are prevented. Beneficial management activities are carried out such as the grazing of meadows and moorland to stop ecological succession and maintain the plagioclimax.

**National Parks**

National Parks are designated areas for informal public recreation, wildlife conservation and maintenance of the rural economy. In the UK they are designated by Natural England, but each National Park is managed by its own National Park Authority (NPA). An example of a National Park is Dartmoor.

The aims of National Parks:

* To conserve and enhance the natural beauty of the landscape
* To provide public access for quiet recreation
* To maintain the rural economy (farming, quarrying, tourism etc)

**Areas of Outstanding Natural Beauty (AONBs)**

AONBs are designated for their landscape qualities for the purpose of conserving and enhancing their natural beauty (which includes landforms and geology, plants and animals, landscape features and the rich history of human settlement over the centuries). They are designated by Natural England but administered by the relevant City Council. An example of an AONB is the Scilly Isles.

**Country Parks and Urban Parks**

Country Parks are areas of countryside managed for public enjoyment. Most are near urban areas and are run by local authorities. Many country parks are abandoned or redeveloped derelict industrial sites or have other uses such as plantations and reservoirs.

Urban Parks are areas of semi-natural land in an urban area used for public recreation and relaxation. They can provide a valuable facility for those who may rarely see the countryside.

**DEFRA (Department for Environment, Food and Rural Affairs)**

* Agri-environmental schemes set up under DEFRA, such as the Environmental Stewardship Scheme, could potentially influence all farmland and therefore have a big impact on the aesthetic appeal of the countryside.
* Some aspects are intended to maintain historically important features of the landscape such as dry stone walls and archaeological features.
* Other features are mainly intended to protect wildlife but also affect the landscape such as in-field trees and hedgerows.
* The higher level scheme also includes footpaths and educational access.

**Non-governmental organisations (NGOs)**

**The National Trust**

* The National Trust was set up to protect threatened coastline, countryside (including forests, farmland and moorland), and buildings from uncontrolled development for public enjoyment.
* Important habitats are managed or created for wildlife, often using traditional techniques, including organic farming.
* National Trust areas encourage use of public transport and sell local produce in their cafés. An example of a National Trust area is Lundy Island, Devon.

Land Use Conflicts

The competition for land resources in the UK leads to conflicts involving proposed, adjacent or multiple land uses and their possible or actual impacts on the environment.

Major causes of land use conflicts

**Urban Expansion**

Increased demand for housing land has caused development to encroach on greenfield sites. Neighbouring towns may merge into one another.

Example: London and its satellite towns.

**Transport developments**

Road schemes – new/enlarged roads

Congestion caused by increased car ownership and transport of goods by lorry has led to schemes to build new roads to provide quicker transport links. They spoil the landscape and destroy habitats.

Example: M6 toll road

New/enlarged airports

Airport extensions result in loss of farmland, habitats and rural communities. Noise and congestion problems also extend over a larger area.

Example: proposed third runway at Heathrow Airport

Port development

Ports, to allow trade, must be built in sheltered sites e.g. estuaries, which destroy sensitive habitats, such as mud flats and salt marshes.

Example: oil terminals at Milford Haven in Wales

**Mining/quarrying**

In lowland areas, mineral extraction can clash with agricultural use. In upland areas, it can spoil the landscape but economic activities are allowed in National Parks.

Example: China clay quarry in Dartmoor

**Energy generation**

Power stations

People must have electricity but power stations can look very unattractive and must be reasonably near demand. Hydroelectric power stations are also usually located in upland areas of scenic beauty.

Example: Drax coal fired power station in Yorkshire

Wind farms

Wind farms are often in areas of scenic beauty where bird strikes are likely and there may be noise or radio interference.

Example: a wind farm in an upland area in a National Park

Tidal barrages

A tidal barrage would cause disruption to habitats, cut off shipping lanes and use huge amounts of resources.

Example: barrage at La Rance in France

**Tourism and recreation**

Traffic

Bank holiday weekends bring large amounts of traffic into National Parks, where roads and car parks may be inadequate. At peak times most National Parks experience traffic congestion and thoughtless or illegal parking.

Walking

Increased numbers of visitors to National Parks and beauty spots has increased footpath erosion.

Example: footpath erosion on Pennine Way

**Landfill sites**

Landfill sites take up large areas of land, attract vermin and release methane, a powerful greenhouse gas.

Example: landfill site for Hereford and Worcester at Hill and Moor

**Incinerators**

Incinerators are unpopular with local people, who fear toxic emissions and argue that reducing and recycling would be a better use of resources.

Example: new incinerator near Stoke City football ground

Methods of resolving land use conflicts

**Planning controls**

* Most developments are only permitted if permission is granted. The process starts with a planning application being made to the local planning authority.
* If the proposed development is controversial or large then a public inquiry is held, such as for major roads, airports, ports or power stations. All interested groups have the opportunity to present their cases to an independent inspector.
* The inspector compiles a report that is submitted to the Secretary of State for the Environment, who usually accepts the inspector’s recommendation, but may overrule it if there is some greater national priority.
* Planning applications are normally granted if they are appropriate within local and national planning strategies of the local planning authority and the Government.

Areas with very strict planning controls are National Parks and Green Belts.

National Parks

Virtually no new urban developments are permitted unless they are essential or very desirable for the existing local community or the local economy. New housing may be restricted to the needs of the local community and buildings must be appropriate, probably using local materials and traditional architectural designs.

Green Belts

* Green Belts have been established around some urban areas to stop the unrestricted sprawl of urban areas.
* Green Belts are administered by DEFRA and local authorities through planning legislation.
* Planning permission is not normally granted for developments within the Green Belt unless refusing it would cause greater problems, such as the widening of a road to prevent serious congestion.

The aims of Green Belts are:

* To protect the surrounding countryside from further encroachment
* To stop neighbouring areas from merging to form conurbations
* To reduce congestion and the loss of character of each urban area
* To encourage urban regeneration of brownfield sites within the enclosed urban area that might have been abandoned, as it is cheaper than to develop greenfield sites in the surrounding countryside

**Land use zoning**

Space zoning and time zoning

* Space zoning involves allocating different parts of an area to activities that would conflict if they occurred in the same place, e.g. walking and mountain biking in country parks, and wildlife conservation areas and areas accessible to visitors.
* Time zoning involves allocating different time periods to activities that would conflict if they took place at the same time, e.g. military activities on parts of the Brecon Beacons on weekdays, and public access on weekends.

**Assessment of environmental impacts**

Leopold Matrix

* The Leopold Matrix provides a method of comparing the overall impacts of a proposal by considering each aspect separately and assessing the severity of the impact caused. These can then be combined to produce an assessment of the total impact.
* All the physical, biological and social impacts of the environment are assessed and each is given a value from one to ten for its importance. Each part of the proposal is given a value between one and ten depending on the magnitude of its impact on each aspect of the environment.
* This system prevents too much importance being put on a single harmful effect when a medium impact on many aspects of the environment may actually be worse.

Environmental Impact Assessments

* An EIA is a procedure that must be followed for major developments before they are granted development consent.
* This is an EU scheme that ensures that the possible environmental impacts of a project are considered in the planning process before the planning authority decides whether to grant permission.
* It also includes possible modifications or alternatives to the development that would reduce its impact.
* EIAs often involve the use of the Leopold Matrix.

Cost Benefit Analysis

* A cost benefit analysis analyses the financial costs and benefits of a proposed development.
* If the financial benefits outweigh the financial costs, the development will go ahead. If the financial costs outweigh the financial benefits, the development will not go ahead.