

Ecosystems of the Planet 1

Ecosystems consist of interdependent components.

Term	Definition
ecosystem	A natural area in which plants, animals and other organisms are link to each other and the non-living elements of the environment.
biotic	All of the living elements of an ecosystem including plants, animals and bacteria.
abiotic	The physical, non-living parts of an ecosystem including temperature, water and light.
fauna	Another term for the animals in an ecosystem.
flora	Another term for the plants in an ecosystem.
interdependence	The reliance of every form of life on other living things and on the natural resources in its environment.
biome	Large-scale ecosystems that are spread across continents with unique animals and plants.

Ecosystems

Biotic elements are all living parts of the ecosystem:

- Animals include insects, birds and mammals.
- Plants include trees, flowers, grasses, mosses and algae. They provide food and shelter for animals.
- Micro-organisms like fungi and bacteria are decomposers. They breakdown dead plants and animals (decompose), releasing nutrients into the ecosystem so they can be recycled and taken up by new plants.. This is called nutrient cycling.

An ecosystem

Abiotic elements are all non-living parts of the ecosystem:

- Rocks help in the formation of soils and rock type is important. Weathering releases nutrients stored in rocks into the ecosystem.
- Soils store water and carbon nutrients which plants can use.
- Sunshine and rain are needed for photosynthesis, so they are essential to the ecosystem.
- Wind and frost also play a role.

The biotic factors and abiotic factors all rely upon each other (interdependence) – eg animals need plants, plants need nutrients from the soil, the soil needs the climate to weather the rock to give it new nutrients. A change to one part of an ecosystem has an impact on other parts because of this interdependence.

Example 1:

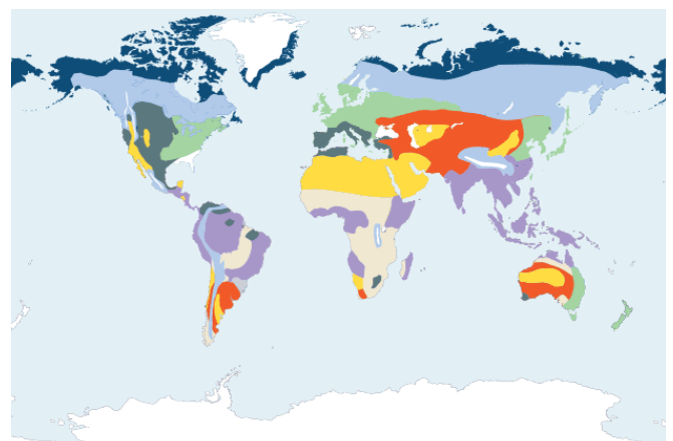
- Hot, dry summer.
- Reduced plant growth.
- Fewer berries for birds in winter.
- Numbers of birds falls.
- Fewer birds for birds of prey to hunt so their numbers fall too.

Example 2:

- Hedgerow trimmed.
- Fewer habitats for ladybirds and spiders so numbers fall.
- Birds have less to eat so numbers fall.

Biomes

- Large scale ecosystems are known as biomes.
- Each biome has animals and plants that are unique to it.
- Biomes are identified by their climate, soils, plants and other species.
- Climate and latitude (how far it is from the equator) are important factors in the location of biomes.
- Tropical biomes (tropical rainforests, coral reefs, tropical grasslands and deserts) are all nearest the equator and have hot weather.
- Temperate biomes (temperate forests and temperate grasslands) all have milder temperatures (neither hot nor cold).
- Polar biomes (polar regions) are furthest from the equator so have very cold weather.



Term	Definition
circumpolar winds	Flows of air around the Earth's poles.
herbivores	An animal that feeds on plants.
carnivores	An animal that eats other animals.
xerophytic	A type of plant that can survive on very little water.

Characteristics of Biomes

Biome and its Location	Climate	Flora	Fauna
Tropical rainforests Found between the Tropics of Cancer and Capricorn.	High and constant temperatures because the sun is always high in the sky. High temperatures mean high rainfall (over 2000mm) so they are hot and humid places.	The climate is ideal for plant growth. The growing season is all year round. Vegetation is mainly trees (mahogany, ebony and rosewood). Vine-like lianas grow round tree trunks.	Most animals and insects like in the canopy and include toucans, jaguars, monkeys, chameleons, frogs and snakes.
Coral reefs Found within 30°N/S of the equator in the tropical and sub-tropical oceans.	Ocean temperatures average 18°C. Water needs to be shallow (<30m) and clear. They are found on the continental shelf.	Relatively small range of plant life – algae grows on coral to provide it with energy. Sea grasses are flowering plants that provide shelter for reef animals.	Coral is an animal made up of thousands of polyps related to the jellyfish. 4000 species of fish including sarfish, clams, eels and parrot fish. Mammals include dugongs.
Tropical grasslands Known as savannah and found between 5 and 30°N/S of the equator.	Have low rainfall and high temperatures throughout the year. Have two seasons; a longer dry season and a short wet season due to migration of the ITCZ (a belt of low pressure that brings heavy rainfall once a year).	Grasses grow in summer rains and die back in winter to put nutrients back into the soil. The baobab tree has adapted to the dry conditions and has thick bark to reduce moisture loss and few leaves so little water lost through transpiration. Its roots are long to find water.	Herbivores include antelopes (eg gazelles, springbok, impala and oryx), elephants, zebra, rhinos and wildebeest. Carnivores include lions, hyenas and leopards.
Hot deserts Found between 5 and 30°N/S of the equator.	Very high temperatures during long days but temperatures plummet at night to below freezing. Annual rainfall is 40mm and unreliable.	Most plants are xerophytic so they can survive with very little water; eg cacti have thick, spiky, waxy leaves to reduce water loss and to stop animals from trying to eat them.	Lack of plants (food) makes it difficult for animals to survive here and most are nocturnal to avoid high temperatures. Animals include meerkats, camels and sidewinder rattlesnakes.
Temperate grasslands Found between 40 and 60°N/S of the equator.	Cold winters and hot summers. Average rainfall is 250-750mm and mostly falls in the summer growing season.	Trees and shrubs struggle to grow quickly; willow and oak grown along river valleys where there is more water. Grasses and small plants provide habitat and food for animals.	Mammals include gophers, rabbits, coyotes and wolves. Bison and wild horses are found in N America.
Temperate forests Found between 40 and 60°N/S of the equator.	Have four distinct seasons; summers are warm and winters are mild. Rainfall is very high (750-1500mm) and is all year round. Average temperature is 10°C	Forests are made up of broad-leaved trees that shed their leaves in winter (deciduous) and grow during the summer months; eg oak, elm and beech. Below the tree canopy are shrubs and on the forest floor are brambles, grasses, bracken and thorns.	Mammals have to adapt to cooler winters (some hibernate or migrate to warmer places) and warmer summers. Black bears are found in N America and hibernate in winter. Squirrels are widespread and owls and pigeons are found in most areas.
Polar regions Arctic = N Pole Antarctica = S Pole	Long, cold winters and short, cool summers and less than 250mm of rainfall each year.	Treeless area. Some evergreen shrubs, mosses and grasses that keep their leaves ready for the sun.	Mammals include polar bears, wolves, foxes and reindeer; all have thick fur for harsh winters.

Term	Definition
biomass	The total mass of plants and animals in an ecosystem.
litter	The total amount of organic matter on the ground including leaves and humus.
nutrient cycling	A set of processes whereby organisms extract minerals necessary for growth from the soil or water before passing them on through the food chain and ultimately back to the soil through decomposition.

Location of Tropical Rainforests



There are distinct layers to the vegetation of the tropical rainforest due to these cycles.

- Emergents – the tallest trees, up to 50m, that appear to stick out above the canopy. They have large buttress roots to support the thin and branchless trunk so it can grow tall enough.
- Canopy – most of the trees grow to a height of about 30m. This layer of trees receive 70% of the sunlight and 80% of the rainfall and creates a continuous blanket of leaves.
- Under canopy – where there is a gap in the canopy to give sunlight smaller trees can grow.
- Shrub layer – the lowest layer where only some species survive because it is very dark; less than 5% of sunlight reaches the forest floor.

Processes within Tropical Rainforests

The Water Cycle

As the rainforest heats up in the morning, the water evaporates to form clouds. The clouds then rain the next day. This is called convectional rainfall. Water is lost through the pores in leaves and then evaporated by heat through evapotranspiration. The roots of plants take up some water and then it is lost again through transpiration. The removal of trees means that there is less moisture in the atmosphere. This leads to less rainfall and can sometimes lead to drought.

The Carbon Cycle

Rainforests take in carbon dioxide from the air as they photosynthesise and grow. With their large leaves, plants and trees store a lot of carbon which means they have a role to play in reducing global warming and climate change. When trees and plants are burned the carbon is released back into the atmosphere and adds to the greenhouse effect.

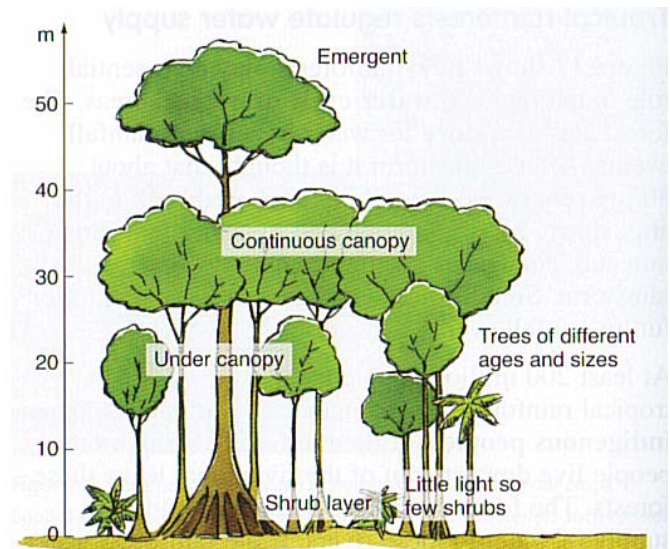


Figure 18 Typical structure of the tropical rainforest

Nutrient cycling

All parts of the rainforest (climate, water, soils, plants, animals and people) are all dependent on one another.

1. Trees are evergreen so dead leaves and other material fall all year round.
2. The warm and wet climate means dead plant material is decomposed quickly by fungi and bacteria on the forest floor. This makes the top of the soil high in nutrients so plants grow quickly; this is why many trees have their roots on the surface.
3. Plants pass on their nutrients when they are eaten by animals. Many plant and animal species have formed symbiotic relationships (where they depend on each other for survival).

Therefore, most nutrients are stored in the biomass with the rest stored in dead organic material and the soil.

Ecosystems of the Planet 4

Biodiverse ecosystems are under threat from human activity: tropical rainforest.

Key Term	Definition
Carbon sink	Natural systems that absorb and store carbon dioxide from the atmosphere
Ecotourism	Tourism which conserves the environment and culture whilst also improving the welfare of locals.

The Sumatran Rainforest: Gunung (Mount) Leuser National Park (GLNP)



is in the **North West** of the **Indonesian** island of Sumatra. The GLNP covers almost **8,000 km²** and it is a **biodiversity hotspot**; home to over **170 species** of mammals and **380 species** of birds, plus both the tallest and the largest flower in the world. Its location close to the Equator means the park receives **over 3,000 mm rainfall per year**, with temperatures ranging from **~20°C to 28°C**.

Interdependence: The different species are closely interlinked especially due to the rapid **cycling of nutrients** which occurs in the **humid climate**. The high levels of **solar radiation** and rapid **decomposition** of litter allow rapid **plant growth**. This can then support a **diverse range of animal species**. **Humans** can benefit from this biodiversity, however some types of human activity can **disrupt** this fine balance.

Value of the GLNP to People and the Planet:

<p>Biodiversity and environment- The GLNP is classed as a 'core ecoregion' as it has such a diverse and unique range of species. It is the only place in the world where you will find Sumatran tigers, rhinos, elephants and orang-utans living together. The rainforest is also a huge carbon sink which helps to absorb some of the excess CO₂ in the atmosphere.</p>	<p>Total economic value over 30 years is estimated to be >\$7 billion. Through tourism, fishery, agriculture, water supply and many other resources the park provides. Ecotourism is a growing industry. GLNP draws in ~30,000 visitors a year, this provides jobs and income for locals.</p>	<p>Timber- hardwood trees such as teak, one of the most valuable trees in Indonesia. One mature tree can be worth up to \$7,000. It is then exported and used to make furniture and flooring.</p>	<p>Medicinal plants- Many rainforest plants are used by local people for their medicinal qualities.</p>
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Threats to the GLNP	Mitigation attempts
<p>Deforestation: globally 50% of all rainforests have already been removed. In Indonesia the figure is similar, but it is experiencing the fastest rate of deforestation in the world. The main reasons for this are:</p> <p>Agriculture- Palm oil plantations: huge areas of natural forest are cleared (most often through cutting and burning the area) to make room for palm trees. In 2015 10,000 miles² of Indonesian forest were burnt. This destroys the natural ecosystem, releases CO₂ and creates a monoculture, thus reducing biodiversity. 54% of palm oil used globally is from Indonesia making it extremely important for the country's exports and GDP.</p> <p>Logging for timber - as the GLNP is a protected area, all logging that occurs within the park is illegal. However, the high value of timber is very tempting and the dense, mountainous rainforest is very difficult to police.</p> <p>Highways – new highways (e.g 1982) built through the centre of the park have allowed easier access into the previously remote parts of the rainforest. This has therefore led to an increase in illegal logging and palm oil plantations.</p>	<p>Encourage locals to gain income from alternative sources which don't require deforestation.</p> <p>Ecotourism: This provides locals with jobs in a range of activities such as; tour guides, working in eco-lodges, selling souvenirs, etc. As tourists are attracted to the park specifically for the wildlife and biodiversity, this will therefore encourage locals to help with conservation to protect their income in the future. In 2016 12 million people visited Indonesia, on average spending >\$1,100 per person. This money can benefit both locals and the government. Tourists who enter the GLNP have to pay £8.50 which can then be used to manage the park and help protect it for future generations to enjoy.</p> <p>REDD (Reducing Emissions from Deforestation and Degradation): aims to give countries carbon credits for helping to protect the rainforest which they can trade.</p> <p>Reforestation: Since 2008 the Orangutan Information Centre (OIC) has also been restoring damaged forests in the Leuser Ecosystem and have planted more than 1.5 million trees. These trees should be as close to the natural forest tree ecosystem as possible.</p>

Impacts of deforestation:

The loss of habitat and food sources for many animals has resulted in many species seeing significant drops in their population and many are now listed as critically endangered. **Sumatran orang-utans have seen an 80% drop** in their population and there are now **<400 Sumatran tigers and <80 Sumatran rhinos left in the wild.**

Wildlife conflict

This is a particular problem where wildlife comes into contact with farmers who are trying to make a living from their crops. Both orang-utans and elephants are known to raid and destroy crops leading to conflict.

Elephants and other animals are also vulnerable to poaching for their ivory, fur skins or to be kept as pets.

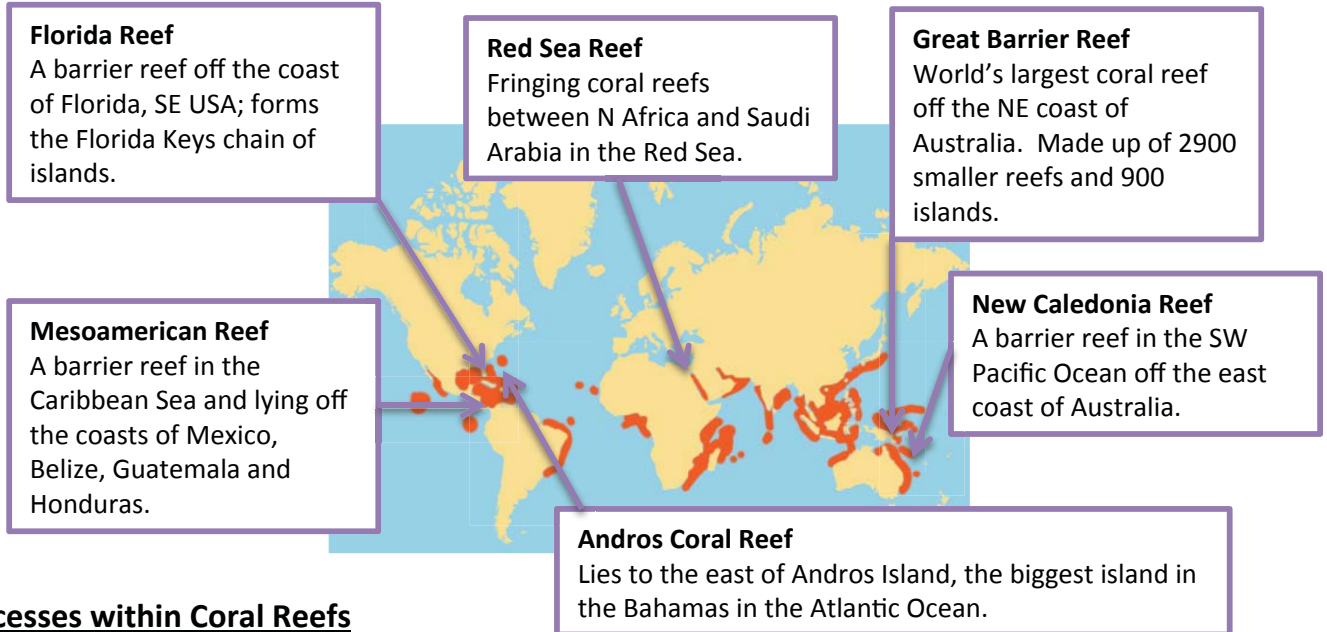
Law Enforcement: ensuring illegal activities are 'clamped down' on through fining and prosecuting illegal logging and illegal palm oil plantations. In 2015 the government prosecuted a major palm oil company for illegal plantations, issuing a fine of **over \$26 million** and a prison sentence for the company director.

The park became a **UNESCO world heritage site in 2004 and has National Park status:** help protect the rainforest from development and make logging illegal across the park.

Increased patrols and education: by patrolling the area for poachers and illegal activities park rangers and wildlife rangers can deter people and improve policing of the rainforest. Organisations such as the **OIC** also work with villages to explain the importance of the ecosystem for people's livelihoods, and develop local conservation action plans.

Term	Definition
symbiotic	Organisms that live together; one or both of the organisms can benefit from this.
zooanthellae	Plant-like algae that live on coral.

Location of Coral Reefs



Processes within Coral Reefs

Three main conditions are needed for coral reefs to form:

1. **Temperature:** they only live in seawater with an average temperature of 18°C and above. The ideal temperature for coral growth is 23-25°C.
2. **Light:** corals feed on tiny algae that need light to photosynthesise and grow – no algae means no food! This means coral is found in shallow waters where there is maximum light available for the algae.
3. **Clear water:** corals need clear, unpolluted water. Sediments and pollution means less light and affect the coral's ability to feed.

Nutrient Cycling

Corals live in very nutrient poor waters so they need very efficient nutrient recycling system to make use of the nutrients they do have.

There is a symbiotic relationship between coral and zooanthellae:

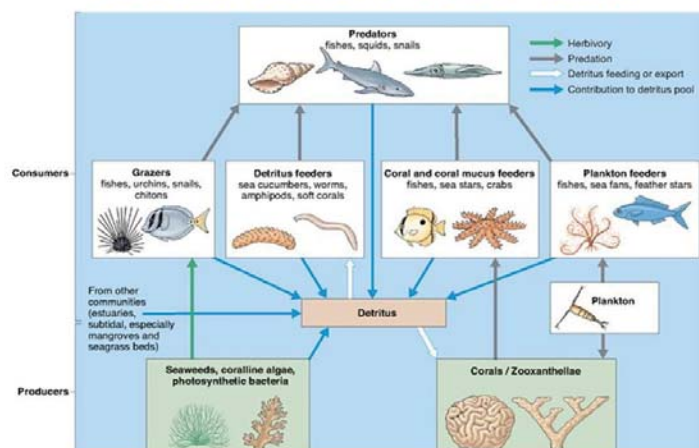
- Zooanthellae lives in the tissues of the coral polyp and feeds off the waste nitrogen and phosphorous from the coral.
- In exchange, as the zooanthellae photosynthesise they produce nutrients to feed the coral.

The most important part of this is that it means nitrogen is not lost as it just passes between the coral and the zooanthellae.

The coral and algae also get nutrients from other sources:

- They consume zooplankton. The zooplankton gets its nutrients from phytoplankton (which makes its own food from sunlight).
- They consume ammonia (dissolved nitrogen) that has been excreted from fish. In return the coral provides the fish with food and shelter.

Coral Reef Food Web



Ecosystems of the Planet 6

Biodiverse ecosystems are under threat from human activity: coral reefs.

Key Term	Definition
Coral bleaching	When coral expels the algae (zooxanthellae) living in its tissues causing the coral to turn completely white
Biodiversity	the variety of plant and animal life in a particular habitat

The Great Barrier Reef: *is in the Southern Hemisphere off the north east coast of Australia in the Coral Sea. It stretches 2300 km along the coast of Queensland. It is classed as a **biodiversity hotspot** with over **600 species of coral** and over **1,600 species of fish** and is the largest coral reef ecosystem in the world.*



Interdependence: The different species are closely interlinked as the fish benefit from the safety of the reef for breeding, whilst the coral depends on the nitrogen excreted by fish. Human activity can disrupt this balance.

Value:

Contributes \$5.6 bn per year to the Australian economy & 70,000 jobs	Protects the coast of Queensland from erosion from storms	Fish breeding grounds and a hotspot for biodiversity.
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The Great Barrier Reef Marine Park Authority (GBRMPA) oversees the management of the reef and has a 25 year management plan.

Threats to the Great Barrier Reef	Mitigation attempts
<p>Crown of Thorns starfish (COTS) is a predator of the coral. Estimates suggest it is responsible for 50% of coral loss on the GBR from 1985 - 2012. Tritons Trumpet is one of the starfish’s few predators – due to their beautiful shells they were collected and numbers of COTS exploded.</p>	<p>Managing Outbreaks of COTS Individual divers cull outbreaks by injecting them with salt solution (short term). In the long term, protecting the starfish’s natural predator the Triton’s trumpet snail.</p>
<p>Climate Change: Coral Bleaching – Resulted in loss of around 22% of the reefs coral in 2017. Increased sea temperatures cause corals to expel the zooxanthellae from the polyps, removing their colour and main food source. Ocean Acidification – pH levels in the ocean have fallen by 0.1 pH. CO₂ from burning fossil fuels has dissolved into the oceans making them more acidic. This reduces the ability for corals and other animals to build their calcium carbonate skeleton.</p>	<p>Reef zoning also allows fragile areas to be studied by scientists and protected from fishing and careless tourism. The GBRMPA are working with reef managers, researchers, industries and communities to build the health of the Great Barrier Reef so it can withstand the impacts of climate change. More than 250 projects since 2007 to help mitigate the impacts of climate change.</p>
<p>Pollution – 35 rivers bring agricultural run-off into the ocean. The run-off contains pesticides and fertilizers which can increase algal growth → blocks sunlight → coral can’t grow.</p>	<p>Monitoring of key species and chemistry to track, halt and reverse changes in water quality. The GBRMPA guidelines identify 'trigger' levels for managers to take action if conditions exceed them. They also work to educate and raise awareness of pollution and how to minimise land run-off.</p>
<p>Overfishing - Recreational fishing is an open access fishery, taking an estimated six million fish in 2007. Studies have found that in zones that permitted fishing, there are a disproportionate number of prey and not enough predators to keep them in check.</p>	<p>Reef zoning is managed by the GBRMPA which zoned the GBR into 19 mapped areas that contain 7 different uses. E.g. preservation zones for scientific study only. They also limit fishing quotas and police the area. 3000 tonnes annual limit for commercial fishers, 2500 tonnes limit for recreational fishing. 67% of the reef is open to fishing – number of operators licences restricted. Zoning also helps by ensuring fishing only happens in designated areas so fragile areas are protected.</p>