DP IB Environmental Systems & Societies (ESS): SL

Your notes

Threats to Biodiversity

Contents

The Number of Species on Earth


Your notes

Estimating Numbers of Species

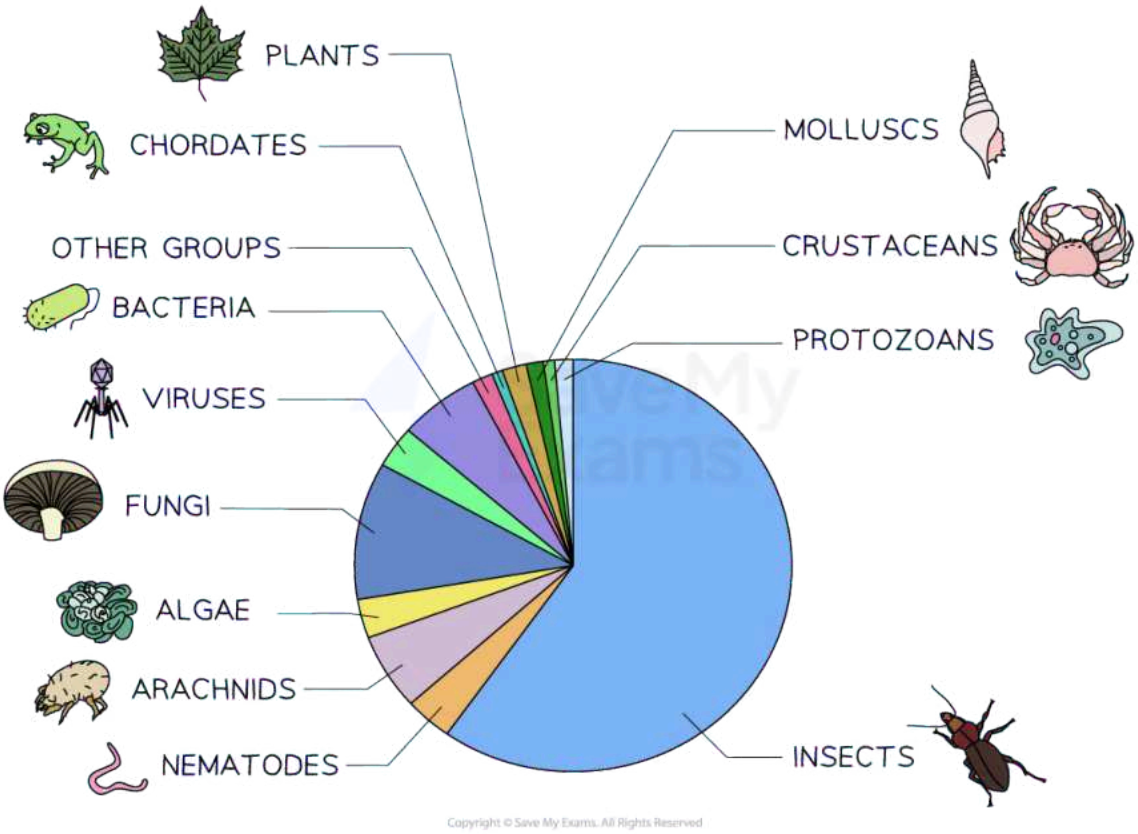
- Current global species estimates vary, but it is generally accepted that there are between 5 and 10 million species on Earth
- As of December 2022, just over 2.16 million species have been described and classified
- However, the actual number of species could be higher or lower depending on a variety of factors, including classification issues, under-sampling of certain groups, and differences in taxonomic opinions

Challenges of Estimating Species Numbers

- Estimates of the total number of species on the planet vary considerably due to a number of factors, including:
  - Classification issues
  - Lack of funding for scientific research
  - Limited access to remote and inaccessible habitats
- The classification of species is not always clear-cut, and different taxonomists may have different opinions on what constitutes a species
  - As a result, there may be significant variation in the number of species recognised within a particular group
  - Additionally, the discovery of new species can lead to changes in classification, which can further complicate the process of estimating the total number of species
- Another factor that contributes to the variation in global species estimates is the limited funding for scientific research
  - Many areas of the world remain relatively unexplored, and new species are still being discovered in remote and inaccessible habitats
  - Without adequate funding for research and exploration, many of these species may go undiscovered and unrecorded, making it difficult to estimate the total number of species on the planet
- In addition, some groups of organisms are more difficult to study than others, which can result in a significant underestimation of the total number of species within those groups

Your notes

- For example, the diversity of microorganisms is poorly understood, and many species have yet to be discovered and described
- Similarly, deep-sea organisms are significantly under-sampled



Pie chart showing the estimated proportions of different groups of organisms on Earth today, by numbers of species

Current Species Loss

- Current rates of species loss are far greater now than in the recent past, due to increased human influence
- The human activities that cause species' extinction include:
  - Habitat destruction
  - Introducing invasive species
  - Pollution

- Overharvesting
- Hunting

- The loss has been compounded by rapid human population growth on Earth since the 18th Century because:
  - Humans are highly intelligent and can colonise many types of habitat
  - Humans have developed the ability to travel across continents and transport other species with them
  - Industrialisation has led to the more rapid consumption of natural resources by humans
  - Humans need food, space for infrastructure (eg. houses, roads), grazing land for livestock, clean water, and natural resources (eg. fossil fuels, rocks, wood)
- This has created selection pressures on many other species, which are being outcompeted
  - For many species, the inevitable outcome is extinction


Your notes

Habitat Destruction

- Natural events such as hurricanes, landslides and tsunamis can cause major damage to habitats; however, it is often only temporary and habitats can recover
- Over the past 1000 years humans have made major advances in agriculture, construction and industry but it has had major permanent consequences for habitats
- Causes of aquatic habitat loss include: destructive fishing techniques, dredging of wetlands, damage from ships, tourism and pollution
- Causes of terrestrial habitat loss include: inland dams, deforestation, desertification, agriculture and pollution
- When a species' habitat is destroyed or degraded then they no longer have the support systems and resources they need to survive

Introducing invasive species

Your notes

Photo by Shannon Kunkle on Unsplash

Purple loosestrife is considered an invasive species in North America and New Zealand where it can out compete native species and cause disruption to the ecosystem in canals and rivers

- When humans travel between countries and continents, they often exchange (either intentionally or unintentionally) animal and plant species between their home country and the foreign country
  - These introduced species are non-native
  - Non-native species can be highly problematic as they often have no natural competitors, predators or pathogens that help limit population growth
  - Without these natural population checks, non-native species can massively increase in number
  - The large numbers of non-native species can negatively affect the native species through factors such as competition and disease

- For example, grey squirrels have led to the decimation of the native red squirrel population in the UK
  - Grey squirrels were introduced to the UK in 1876
  - They quickly grew in numbers
  - The larger grey squirrels compete with red squirrels for food
  - They also carry and transmit a disease known as squirrelpox which is fatal to red squirrels

Your notes

Pollution

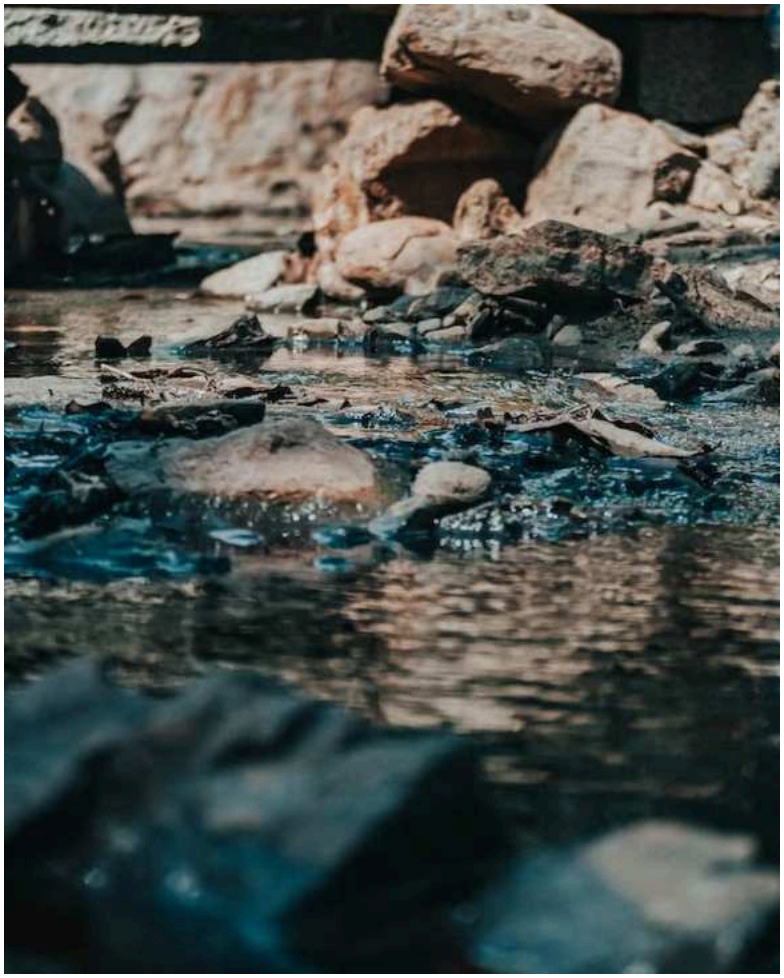


Photo by Nithin Sameer on Unsplash

Oil spills cause devastating impacts on ecosystems

- Pollution is the addition of contaminants into a natural environment that negatively impact that environment
- Fertilisers, fossil fuels and non-biodegradable plastics are all examples of pollution that can seriously harm ecosystems
  - For example, many species within aquatic ecosystems have been negatively affected by large crude oil spills
  - The oil doesn't break down for many years and it can kill thousands of birds and fish
- Sewage and runoff from factories can contaminate the soil and upset the nutrient balance in terrestrial and aquatic ecosystems


Your notes

Overharvesting

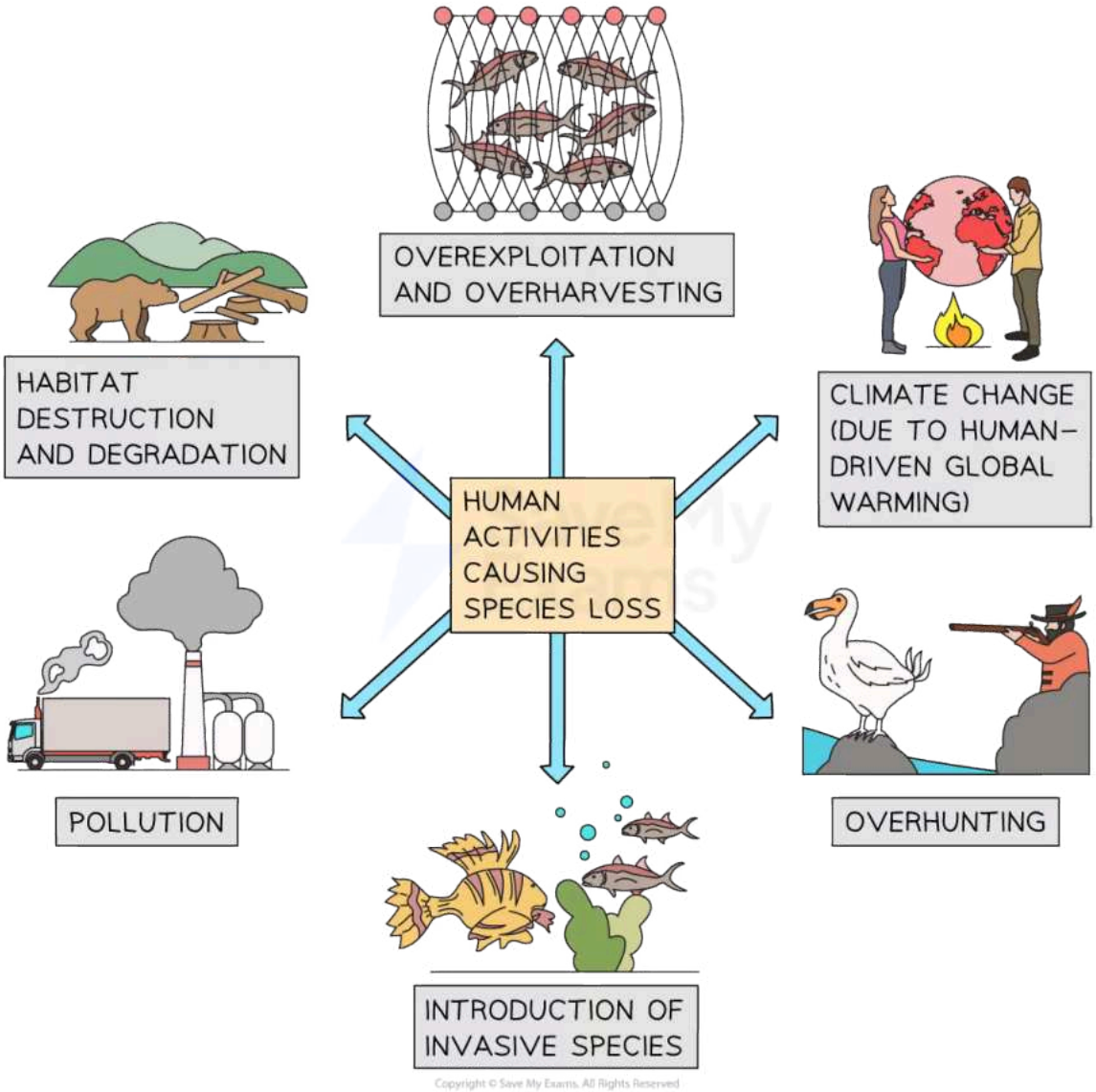
- Humans harvest many plant and animal species
- When humans remove individuals from a natural population at a rate greater than the population's natural growth rate, overexploitation is occurring
- Continued overexploitation of a species can drive it to become extinct
  - For example, the popular commercial fish tuna has seen a dramatic decline in numbers in Europe due to overfishing
  - To combat this, the Council of Fisheries in the European Commission has introduced total allowable catches (TACs) or catch limits (measured by weight or number of fish)
- Many tropical rainforests are under threat from overexploitation
  - They have major ecological and economic value
  - The trees are being cut down and harvested at a rate much faster than reforestation takes place
  - There are many initiatives and organisations around the world with the aim of protecting tropical rainforests

Hunting

- In the past humans would have hunted, killed and eaten wild animal species in order to survive
- Nowadays most of the meat that humans consume comes from domesticated livestock like cattle, sheep and chicken
  - The development of livestock and the food processing industry has negated the need for many humans to hunt wild animals
- Some humans in underdeveloped countries still have to hunt animals for survival

- The hunting of wild animals is still common and has become a sport for some individuals
  - The rarer and more vulnerable species are often more desirable for a sport hunter
- If too many individuals within a species are killed then the population will become so small that it is no longer able to survive

Your notes



Human activities that lead to a loss of biodiversity

Worked Example

Describe the threats to biodiversity from human activity in a given natural area of biological significance or conservation area.

Answer

Snowdonia is an area of mountains in the north of Wales in the United Kingdom, popular for its scenery and designated as a National Park. Snowdonia is renowned for its heathlands and woodlands of oak, ash, and birch that harbour a wide variety of mosses, liverworts and lichens. The Snowdon Lily (*Gagea serotina*) is a unique species to this area.

However, the non-native species *Rhododendron ponticum* was introduced into Snowdonia by humans in the mid-18th century. *R. ponticum* is an attractive, pink-flowering shrub that grows to around 5 metres in height and originally comes from Spain, Portugal and Turkey.

Although it was originally planted for ornamental use in parks and gardens, *R. ponticum* has become a pest species that has colonised Snowdonia aggressively since its introduction by humans. It outcompetes, smothers and shades native species, such as oak and birch, by forming a thick understorey in which tree saplings cannot capture enough light. The soil also becomes acidic and mature trees die and are not replaced by new growth. Associated species such as soil fungi also die out in line with the reduced diversity of plant species.

Authorities in Snowdonia are carrying out a programme of eradication, but this has been very difficult. Climate change helps *R. ponticum* as UK temperatures rise to become more like those in the Mediterranean and the Middle East.


Your notes

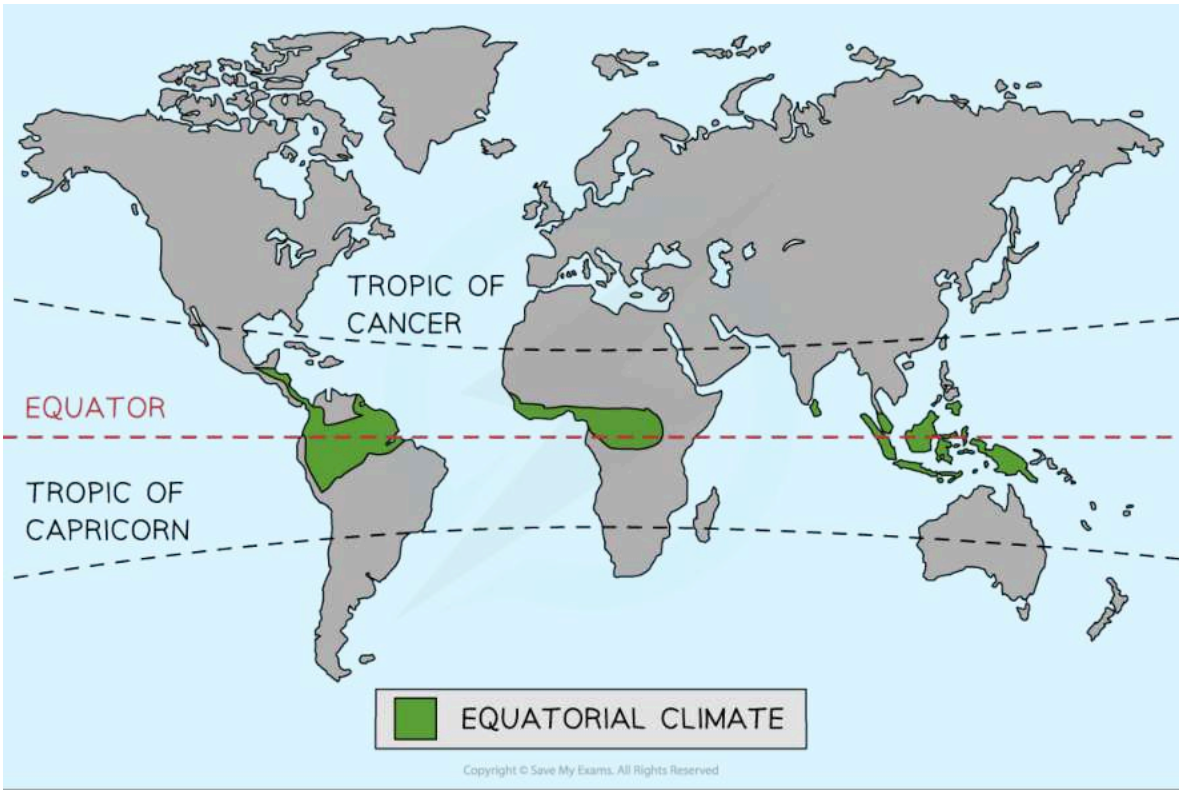

Your notes

Tropical Biomes & Sustainable Development

Tropical Biomes

- Tropical biomes are mainly found in a band between 15° north and 15° south of the equator within the equatorial climate zone
- Covering only 6% of the Earth's surface, the main areas covered by tropical ecosystems are in the following countries:
  - **Amazon** - the largest remaining rainforest on Earth usually associated with Brazil but covers parts of seven other countries in South America
  - **Central America** - including parts of Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama
  - **Central Africa** - including Cameroon, the Central African Republic, the Republic of Congo, the Democratic Republic of Congo (DRC), Equatorial Guinea and Gabon
  - **Indo-Malaysia** - including Malaysia, Indonesia and a number of other countries in South-East Asia

Your notes



Distribution of the equatorial climate

Characteristics of Tropical Biomes

Characteristics	**Equatorial Climate**
Location	Low latitudes Within the Tropics 23.5° north and south of the equator Amazon in South America, New Guinea, South-east Asia, Zaire Basin
Annual Precipitation	Over 2000 mm

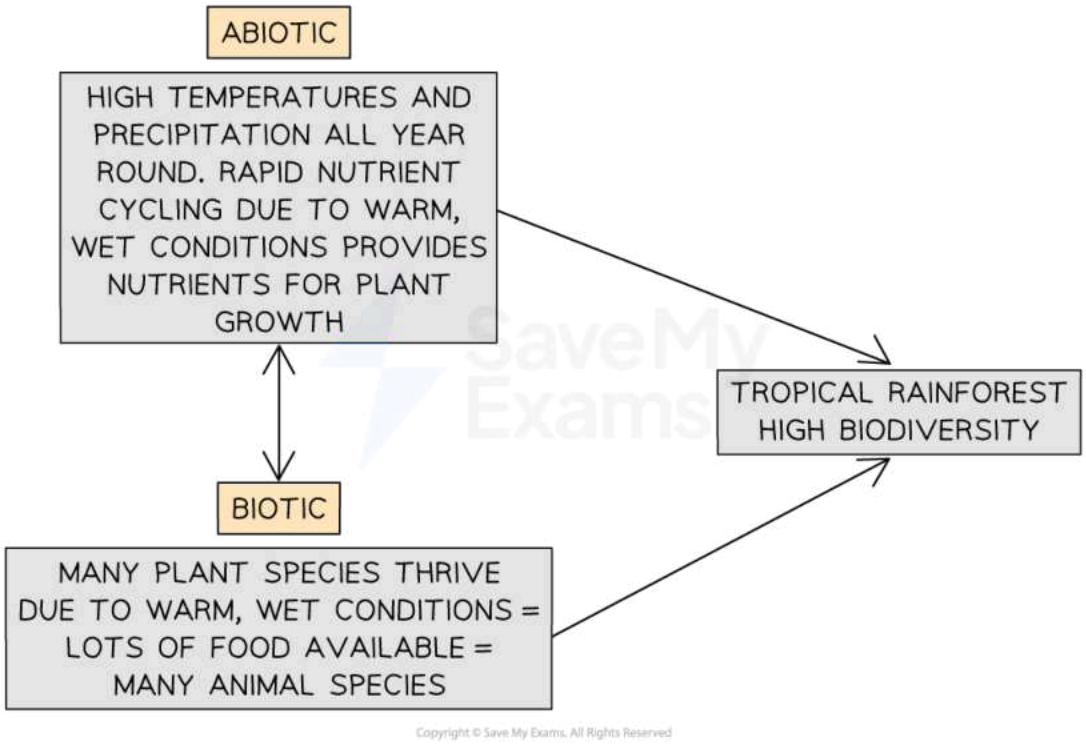
Temperature Range	Small range of mean monthly temperatures (26–28℃) Constant high temperatures **Diurnal Range** is about 7℃
Seasons	No seasons - hot and wet all year round
Humidity	High, usually over 75–80%
Soils	Many of the soils in the rainforest are **latosols** Due to **leaching** and rapid uptake of nutrients by plants the soils are actually not very fertile Nutrients are concentrated in the upper topsoil
Biodiversity	Tropical biomes contain the highest biodiversity of plants and animals on Earth Estimates range from 50% to 80% of the world's plant and animal species For example, 10 km^2 of tropical rainforest can contain up to 1,500 flowering plants, 750 species of trees, 400 species of birds and 150 species of butterflies


Your notes

Exploitation in Tropical Biomes

- Tropical biomes (particularly tropical rainforests) have some of the highest levels of biodiversity of any ecosystem
  - The wet and warm climate means there is year-round growth
  - Wide variety of plants provides a range of habitats and food
  - Rapid nutrient cycling increases plant growth
  - Lack of human activity in the past meant that plants and animals have remained undisturbed
- The abiotic and biotic components in tropical rainforests are all interlinked and changes in one can lead to changes in the others - this is known as interdependence

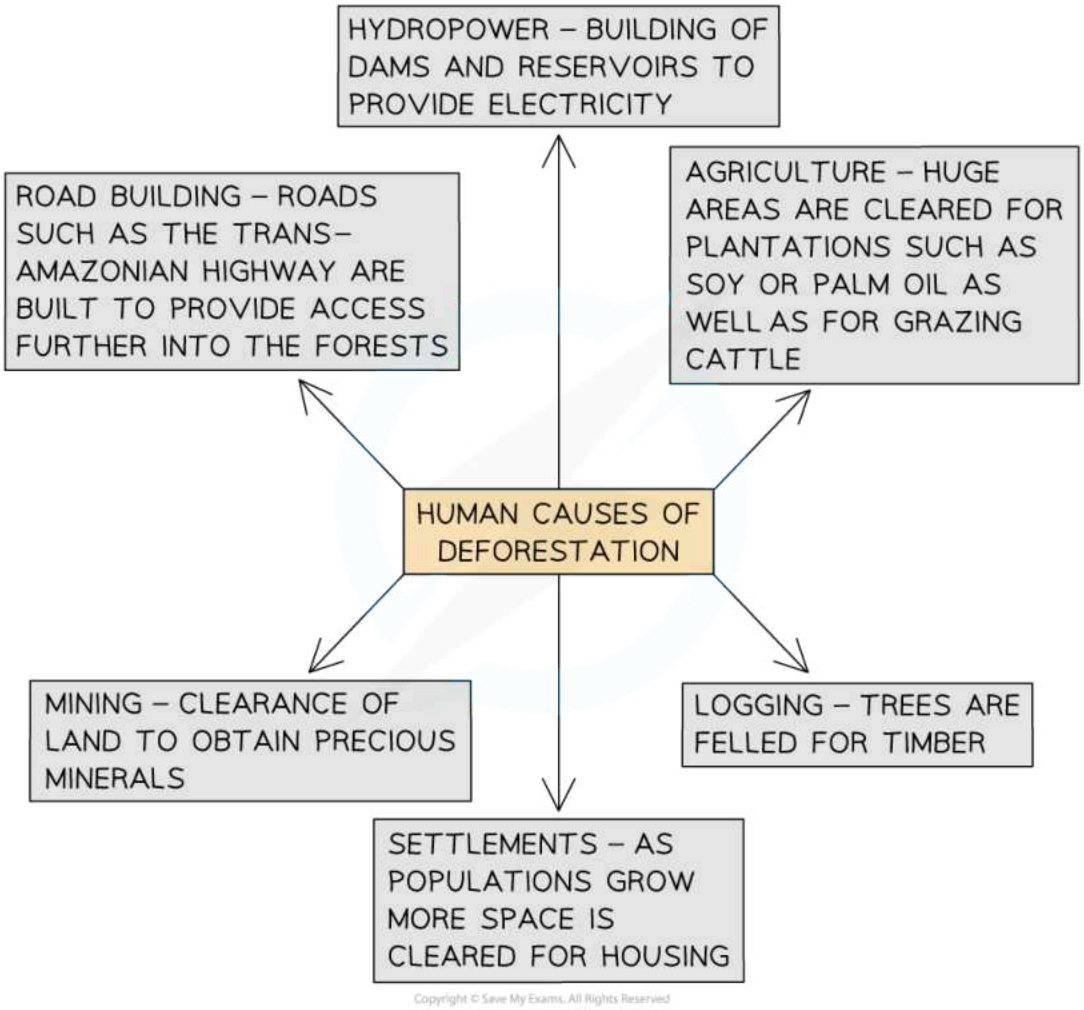
Your notes



Factors contributing to high biodiversity in tropical rainforests

- Most tropical biomes occur in LEDCs and therefore there is a conflict between exploitation, sustainable development and conservation
- Current threats in tropical biomes mainly revolve around the removal and degradation of rainforest ecosystems. This deforestation is due to human activities, including:
  - Agriculture, particularly large scale **slash and burn**
  - Mining
  - Hydroelectric power
  - Logging
  - Road building and settlements
  - Wildfires (although natural, increasing frequency and severity is linked to climate change)

Your notes



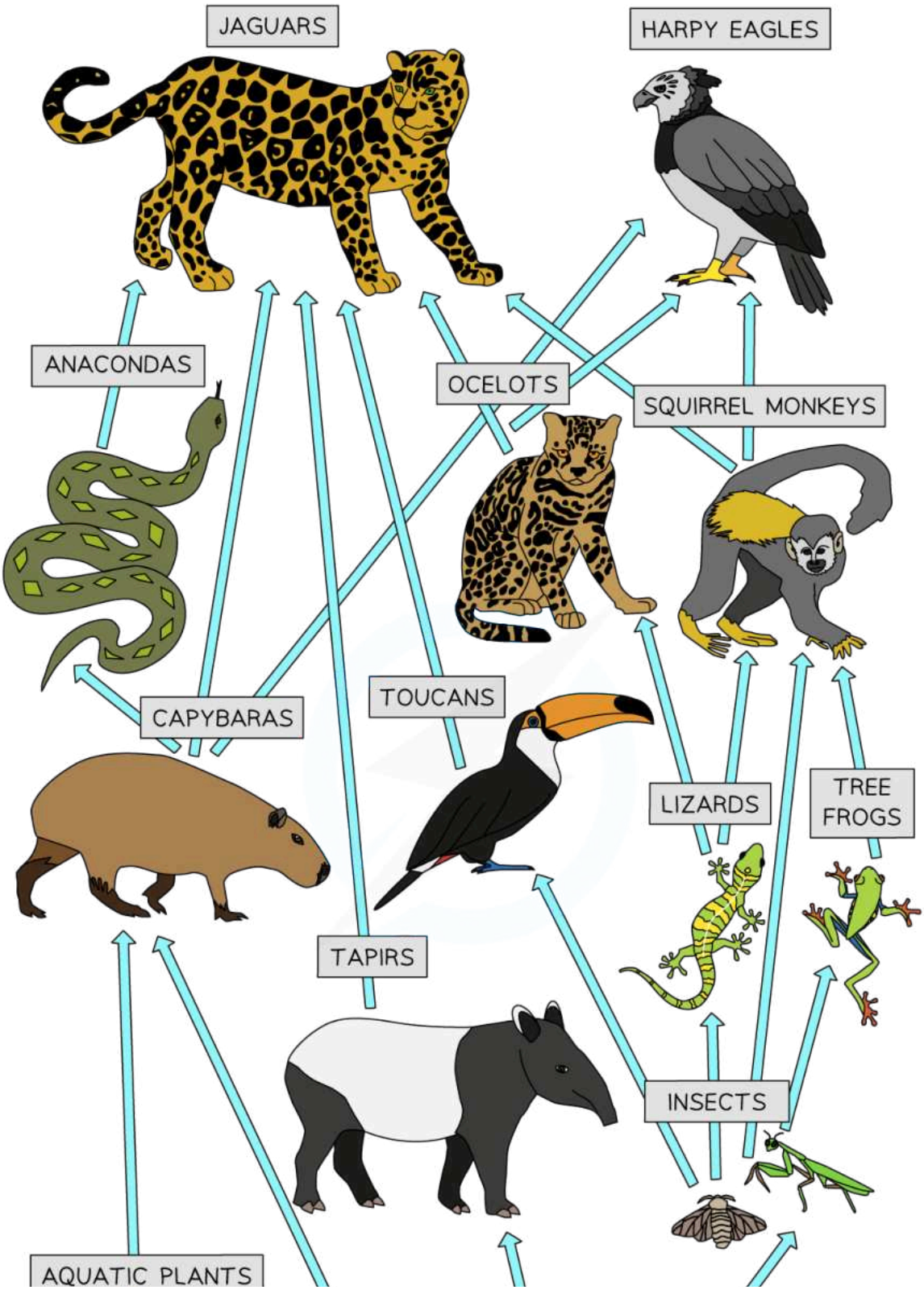
Human causes of deforestation

- The interdependence of the rainforest components means that when one element is affected it then impacts all the other components
  - For example, a decline in one species (especially if it is a **keystone species**) can lead to a decline in other species
  - The Zam tree produces seeds which are food for agouti, who disperse the seeds
  - The agouti is hunted for meat reducing their populations this means fewer seeds are dispersed
  - Fewer new Zam trees will germinate and so there is less food for leaf cutter ants which in turn means less food for the tree frogs and the snakes which prey on the frogs

- The Zam tree is pollinated by a particular species of butterfly. Without the flowers the numbers of the butterfly species will decline - this also affects the beetles which lay their eggs in the butterfly faeces

- Plant and animal species may become extinct - this may happen to some before they are even discovered
- Important medicinal plants and potential medicinal plants may become extinct
- Indigenous communities may be forced to abandon their traditional lifestyle due to the lack of food to hunt and gather
- In summary, unsustainable exploitation in tropical biomes results in massive losses of biodiversity and their ability to perform globally important ecological services, such as carbon sequestration and climate regulation


Your notes



Your notes

Tropical rainforest food webs are highly complex with high interdependence amongst species

Your notes

Threats to Areas of Biological Significance

Coral Reefs of Southeast Asia

Photo by yang wewe on Unsplash

Coral reefs are ecosystems under threat

- An example of an area of great biological significance that has been impacted by human activity is the coral reefs of Southeast Asia, particularly the reefs surrounding Indonesia and the Philippines
  - These coral reefs are some of the most diverse ecosystems on the planet, providing habitat for thousands of species of fish, invertebrates, and other marine organisms
  - However, human activity in the form of overfishing, pollution, and climate change is causing significant damage to these fragile ecosystems
- Overfishing is a major threat to the biodiversity of coral reefs in Southeast Asia, with many species of fish and other marine organisms being overexploited for food and other uses
  - This has led to declines in populations of many important species and disruptions to the ecological balance of the reef ecosystem
- Pollution from land-based activities, such as agricultural runoff and sewage discharge, is also a significant threat to coral reefs
  - This is leading to reduced water quality and increased stress on the corals
- Finally, climate change is causing the ocean to warm and become more acidic
  - This is leading to coral bleaching and death
- The conflict between exploitation, sustainable development, and conservation in the coral reefs of Southeast Asia is complex and challenging
  - Economic interests in the form of tourism and fishing drive the exploitation of these ecosystems, while conservation efforts seek to protect them
  - Sustainable development seeks to balance economic growth with environmental protection, but it is often difficult to achieve in practice
- One approach to addressing this conflict is through the establishment of marine protected areas (MPAs)
  - MPAs can help to protect coral reef ecosystems by limiting fishing and other human activities, allowing damaged reefs to recover and promoting biodiversity
  - However, the success of MPAs depends on effective management and enforcement, which can be difficult to achieve in practice

Eastern Himalayas


Your notes

Photo by Uriel Soberanes on Unsplash

Snow leopards are vulnerable species found in the Eastern Himalayas that are threatened by illegal hunting

- Another example of an area of biological significance is the Eastern Himalayas, which is home to a vast array of plant and animal species found nowhere else in the world
- The following are some of the ways human activity has affected the biodiversity of this region:
- **Deforestation:**
  - The Eastern Himalayas have experienced significant deforestation, primarily for agriculture, timber, and fuelwood
  - Deforestation has led to habitat loss and fragmentation, which can lead to the displacement or extinction of species
- **Poaching and hunting:**
  - The Eastern Himalayas are also home to many endangered and vulnerable species, including tigers, snow leopards, and rhinoceroses

Your notes

- Poaching and hunting of these animals for their meat, hides, and other body parts have put many of these species at risk of extinction

- **Climate change:**
  - Many species in the Eastern Himalayas are highly adapted to the specific temperature ranges and other climatic conditions in this area
  - This means they are vulnerable to climate change, which can affect the growth and survival of many plant and animal species in the region
- The conflict between exploitation, sustainable development, and conservation in the Eastern Himalayas is highly complex
  - Economic development and poverty reduction are important goals, and the region's resources can contribute to these goals
  - However, this often comes at the expense of environmental protection and conservation
  - Sustainable development seeks to balance economic growth with environmental protection, but it can be challenging to achieve in practice
- The governments of the countries that share the Eastern Himalayas have made efforts to protect the region's biodiversity, including the establishment of protected areas and the implementation of policies to reduce deforestation and illegal poaching
  - However, these efforts have been met with resistance from powerful interest groups, including logging companies and poachers


Your notes

Your notes

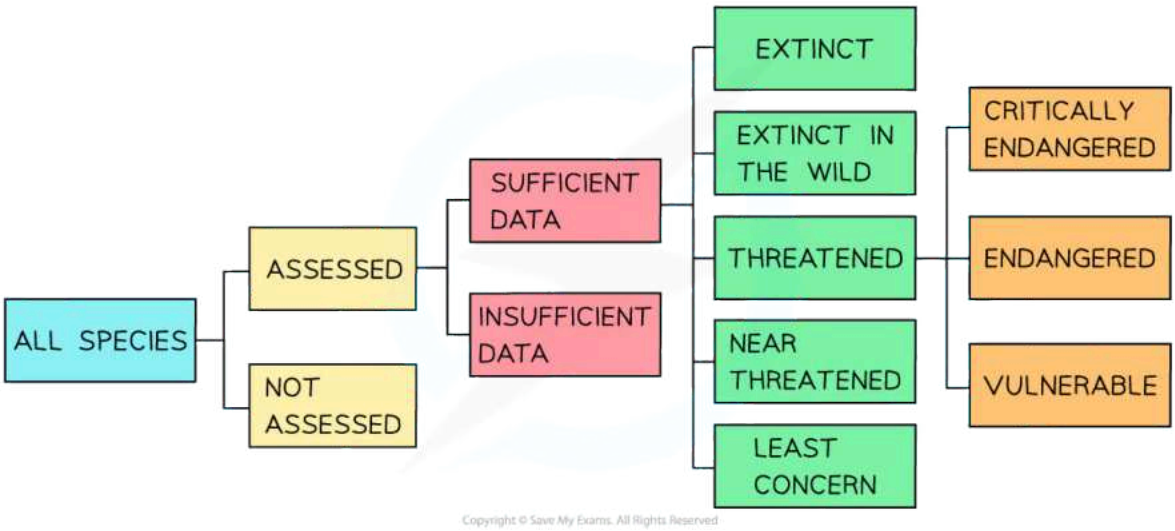
Determining Conservation Status

- International cooperation is essential if conservation is to be successful
- There are several agreements and authorities that exist within and between countries with the aim of protecting and conserving species worldwide

IUCN

- The International Union for the Conservation of Nature (IUCN) is the global authority on the status of the natural world and the measures needed to safeguard it
- One of the duties that the IUCN carries out is assessing the conservation status of animal and plant species around the world
  - Scientists use data and modelling to estimate the category each species should be in
- Factors used to determine the conservation status of a population include:
  - Population size (smaller populations are usually at a greater risk of extinction)
  - Degree of specialisation
  - Distribution
  - Reproductive potential and behaviour
  - Geographic range
  - Degree of endemicity (i.e. if the species is only found in a single specific area)
  - Degree of habitat fragmentation
  - Quality of habitat
  - Trophic level (animals in higher trophic levels are usually at a greater risk of extinction)
  - Probability of extinction
- The IUCN has their own classification system
  - There are several different categories and levels that a species can fall into depending on its population numbers and the threats and risks to those populations
- Animals that are on the IUCN Red List of Threatened Species™ can be seen online as this list is made public

Your notes



The IUCN classification system of species - scientists are continually updating and reviewing the conservation status of species

Your notes

Extinct, Critically Endangered & Improving Species

Extinct Species

James St. John, CC BY 2.5, via Wikimedia Commons

The passenger pigeon is now only seen in museums

- **Passenger Pigeon** (*Ectopistes migratorius*):
  - The Passenger pigeon was once one of the most abundant bird species in North America, with flocks numbering in the billions

- However, due to overhunting and habitat destruction, the passenger pigeon went extinct in the early 20th century
- The hunting of these birds for meat, as well as the destruction of their forest habitats, led to a sharp decline in their numbers
- By the late 1800s, the species was in serious decline, and despite some attempts at conservation, it went extinct in 1914

- **Tasmanian Tiger** (*Thylacinus cynocephalus*):
  - The Tasmanian tiger, also known as the thylacine, was a carnivorous marsupial that once inhabited the Australian island of Tasmania
  - Human activity such as hunting, habitat loss, and disease transmission by introduced species caused their population to decline, and the last known Tasmanian tiger died in captivity in 1936, marking the extinction of the species

Your notes

Critically Endangered Species

The sumatran orangutan is critically endangered

- **Sumatran Orangutan** (*Pongo abelii*):
  - The Sumatran orangutan is one of three species of orangutan and is found only on the Indonesian island of Sumatra
  - Habitat destruction and fragmentation due to logging, conversion of forests to agriculture, and infrastructure development have been the primary causes of its decline
  - In addition, illegal hunting and capture of orangutans for the pet trade have also contributed to their decline
  - The Sumatran orangutan is now critically endangered, with only around 14,000 individuals remaining in the wild
- **Black rhinoceros** (*Diceros bicornis*):
  - The black rhinoceros is a large mammal native to Africa and is critically endangered due to poaching for their horns, habitat loss, and civil unrest in the countries of their range
  - Their population has declined by over 90% since the 1960s, and there are currently only around 5,500 individuals remaining in the wild
  - Conservation efforts such as anti-poaching patrols, habitat restoration, and captive breeding programs are underway to try to save this species from extinction

An Improving Species


Your notes

Becker1999 from Grove City, OH, CC BY 2.0 by/2.0 via Wikimedia Commons

The southern white rhino is a success story in conversation having been brought back from the brink of extinction

- **Southern white rhinoceros** (*Ceratotherium simum*):
  - The Southern white rhinoceros was once on the brink of extinction due to poaching for their horns, with only a handful of individuals surviving in the wild in South Africa in the early 20th century
  - However, conservation efforts including increased law enforcement, habitat protection, and captive breeding programs have helped their population recover to over 18,000 individuals today
  - While they are still threatened by poaching and habitat loss, the Southern white rhinoceros' conservation status has greatly improved thanks to human intervention
- **Bald eagle** (*Haliaeetus leucocephalus*):
  - The bald eagle is a bird of prey native to North America and was once on the brink of extinction due to habitat destruction, hunting, and pesticide use, which caused eggshell thinning and reproductive failure
  - Conservation efforts such as habitat protection, captive breeding programs, and the banning of harmful pesticides like DDT have helped their population recover from less than 500 pairs in the 1960s to over 10,000 pairs today
  - The bald eagle's conservation status has greatly improved thanks to human intervention

Your notes