🌲 # DP IB Environmental Systems & Societies (ESS): SL

✏️ **Your notes**

3.2 Human Impact on Biodiversity

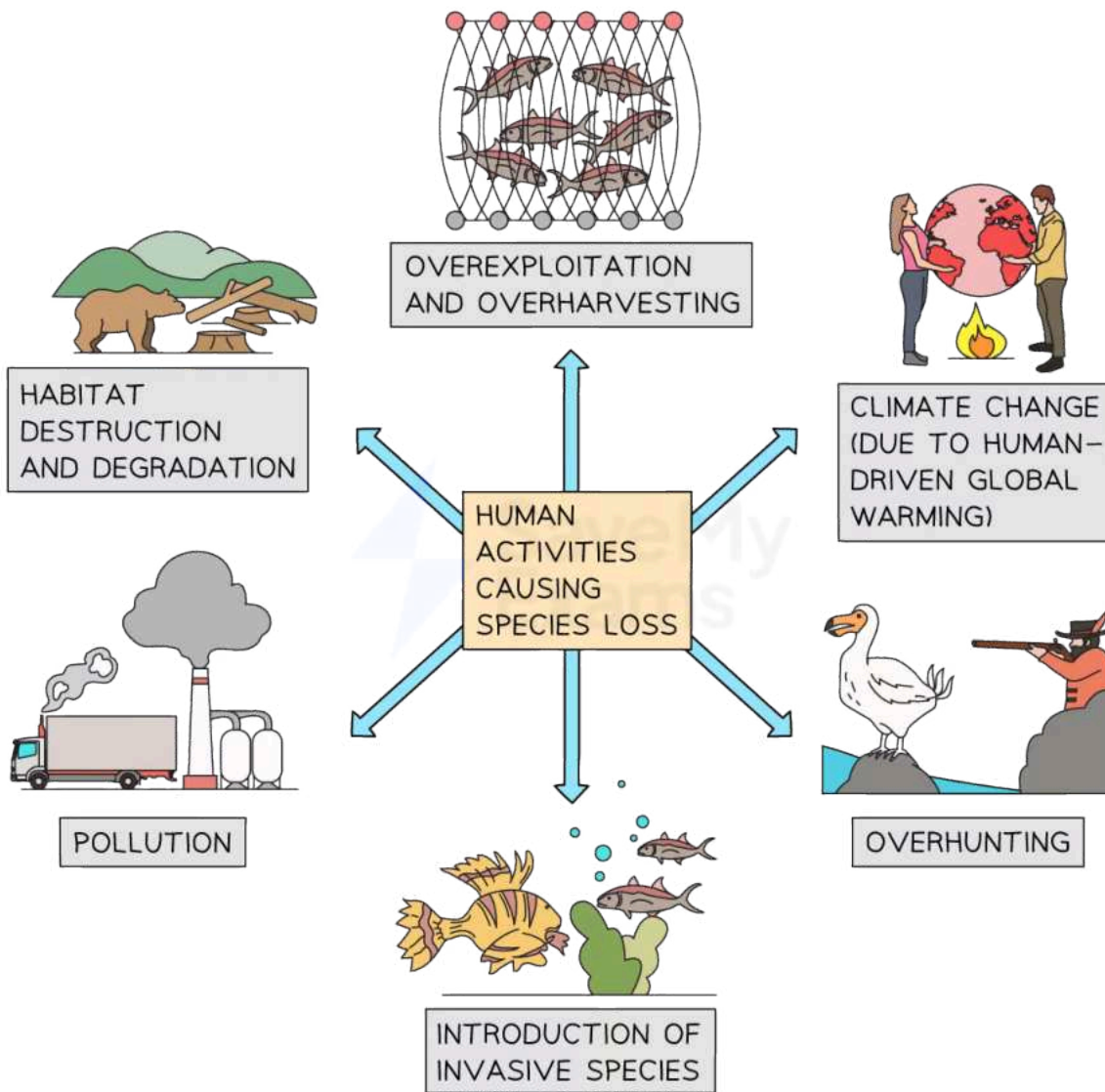## Contents

Threats to Biodiversity

Threats to Biodiversity

- Biodiversity is crucial for ecosystem stability, resilience and functioning

  - However, biodiversity is being negatively affected by both **direct** and **indirect** human influences

Human activities that lead to a loss of biodiversity

Direct threats

- **Overharvesting**:

  - Harvesting of species at a rate faster than their natural reproduction, leading to **population decline**

    - For example, overfishing of Atlantic cod in the North Sea, leading to **population collapse**

    - Many tropical rainforests are also 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

  - Continued overexploitation of a species can drive it to become **extinct**

- **Poaching**:

  - Illegal hunting or capturing of wildlife, often for **trade** or **consumption**

    - For example, poaching of African elephants for their tusks, leading to a decline in elephant populations

  - If too many individuals within a species are killed then the population will become so small that it is no longer able to survive and the species may go extinct

- **Illegal pet trade**:

  - Trafficking of live animals for the exotic pet market

Indirect threats

- **Habitat loss**:

  - Destruction or fragmentation of natural habitats due to human activities such as **deforestation**, **urbanisation**, or **agricultural expansion**

    - For example, clearing of rainforests in the Amazon for cattle ranching

  - 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, they no longer have the support systems and resources they need to survive

- **Climate change**:

Your notes

- The change in global climate patterns due to greenhouse gas emissions, leading to habitat disruption, shifts in species distributions and increased frequency of extreme weather events

  - For example, melting of polar ice caps, threatening species like polar bears

- **Pollution**:

  - Introduction of harmful substances or contaminants into the environment, including air, water and soil pollution

    - For example, plastic pollution in oceans, endangering marine species

- **Invasive alien species**:

  - Non-native species introduced into an ecosystem that **disrupt native species** and ecosystems

    - For example, Japanese knotweed in the UK, which outcompetes native plants and causes damage to buildings

  - 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 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

CASE STUDY

Grey Squirrel Invasion in the UK

- **Alien species**:

  - Grey squirrels (*Sciurus carolinensis*) were introduced to the UK from North America in the 19th century
  - Originally brought over as ornamental additions to estates, they have since become a major invasive species

- **Impact**:

  - Grey squirrels outcompete native red squirrels (*Sciurus vulgaris*) for resources such as food and habitat
  - They also carry the squirrelpox virus, which is fatal to red squirrels but does not affect grey squirrels

- **Management strategies**:

Your notes

- **Culling programs**: some areas have introduced culling programs to reduce grey squirrel populations, aiming to protect red squirrels and restore native biodiversity
- **Forest management**: habitat management practices such as selective tree planting and creating corridors for red squirrels help to create more favourable conditions for the native species, as they are more arboreal than grey squirrels
- **Research and monitoring**: continual research and monitoring of squirrel populations and their impacts can help to develop effective management strategies over time

Combined impacts

- Most ecosystems face **multiple** human impacts **simultaneously**

  - This leads to **cumulative effects**

  - This is when negative effects are amplified when different threats act together, reducing ecosystem resilience

    - For example, in a coral reef ecosystem, overfishing by human populations weakens the resilience of the coral reef to coral bleaching caused by climate change, making ecosystem collapse more likely

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EXAM TIP

Make sure you understand the difference between direct and indirect threats to biodiversity. It would be a good idea to learn at least one specific example of each threat to illustrate its impact.

It is possible to investigate the impact of human activity on biodiversity in an ecosystem using **transect surveys**.

For example, you could study the change in species diversity along a transect laid perpendicular to a site of human interference (i.e. to determine how species diversity changes as you **move away** from the site where human-disturbance has occurred).

Or you could randomly sample within transects **before** and **after** the human activity.
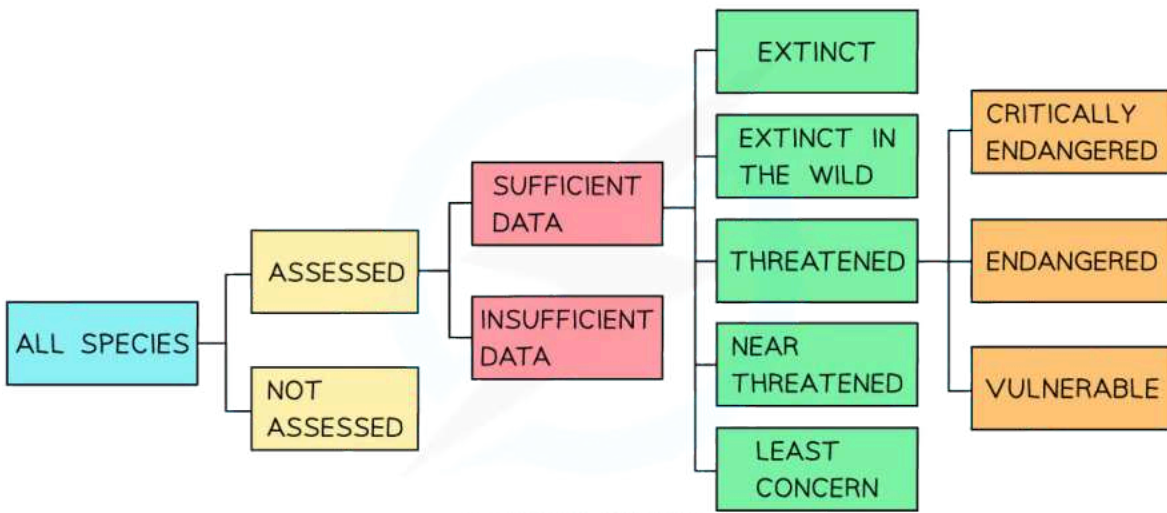
Assessing Conservation Status

- 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)

  - Rate of increase or decrease of the population

  - Degree of specialisation

  - Distribution (geographic range)

  - Reproductive potential and behaviour (breeding potential)

  - 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)
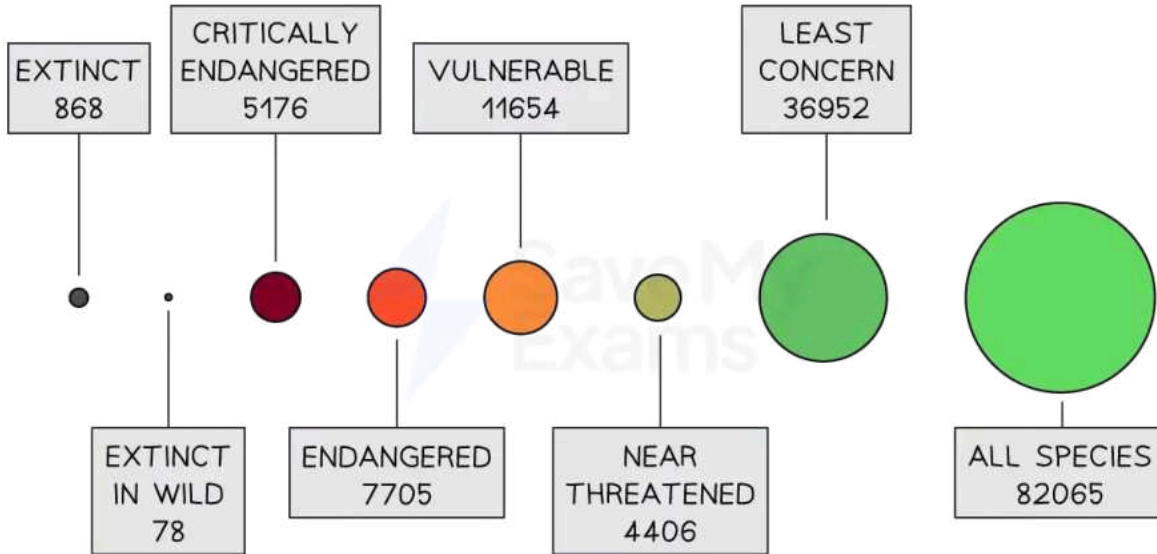
  - Known threats

Your notes

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

- 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
  - Species that have been assessed are categorised by the IUCN as:
    - LC = least concern
    - NT = near threatened
    - VU = vulnerable
    - EN = endangered
    - CR = critically endangered
    - EW = extinct in the wild
    - EX = extinct
  - Species can also be classed as DD (data deficient) when there is not enough data on which to base a category choice, or as NE (not evaluated)
- Animals that are on the **IUCN Red List of Threatened Species™** can be seen online as this list is made public
- Giving a global conservation status highlights how vulnerable certain species are

Your notes

- This helps governments, NGOs and individuals to select appropriate conservation priorities and management strategies

| EXTINCT 868 | CRITICALLY ENDANGERED 5176 | VULNERABLE 11654 | LEAST CONCERN 36952 |

| EXTINCT IN WILD 78 | ENDANGERED 7705 | NEAR THREATENED 4406 | ALL SPECIES 82065 |

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The IUCN categorises species on the basis of their risk of extinction; this 2016 data can be represented visually to give an immediate picture of the level of risk being faced by many species

- Although the data shown above is from 2016, the number of species assessed is **increasing** every year and in 2023, this figure reached almost double the amount from 2016, with just under 160 000 species assessed

  - However, this means that extinction risk has still only been evaluated for **less than 5% of the world's described species**

Conservation Case Studies

Extinct, Critically Endangered & Improving Species

Extinct species

- **Passenger Pigeon** (*Ectopistes migratorius*):

  - The Passenger pigeon was once one of the most abundant bird species in North America, numbering in the billions of individuals

  - 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

Your notes

Mounted male passenger pigeon, Field Museum of Natural History (James St. John, Wikimedia Commons, CC BY-SA 4.0 DEED)

- **Tasmanian Tiger** (*Thylacinus cynocephalus*):

  - The Thylacine, also known as the Tasmanian Tiger or Tasmanian Wolf, 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

  - The last known Tasmanian tiger died in captivity in 1936, marking the extinction of the species
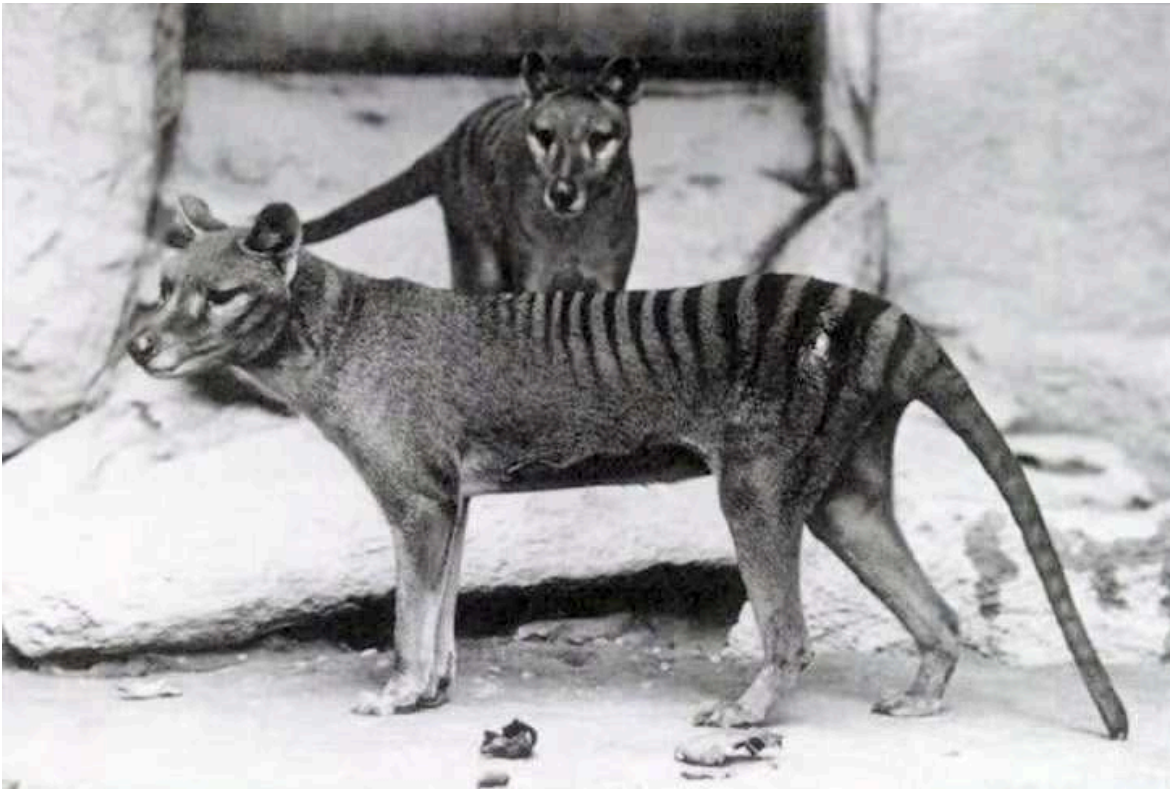
A female Thylacine and her juvenile offspring (male) in the National Zoo in Washington, D.C., c. 1903 (Baker; E.J. Keller, Wikimedia Commons, CC BY–SA 4.0 DEED)

Critically endangered species

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

Your notes

Close-up of an adult male Sumatran orangutan, Tierpark Hagenbeck, Hamburg (Aiwok, Wikimedia Commons, CC BY-SA 4.0 DEED)

- **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 3 000 mature 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
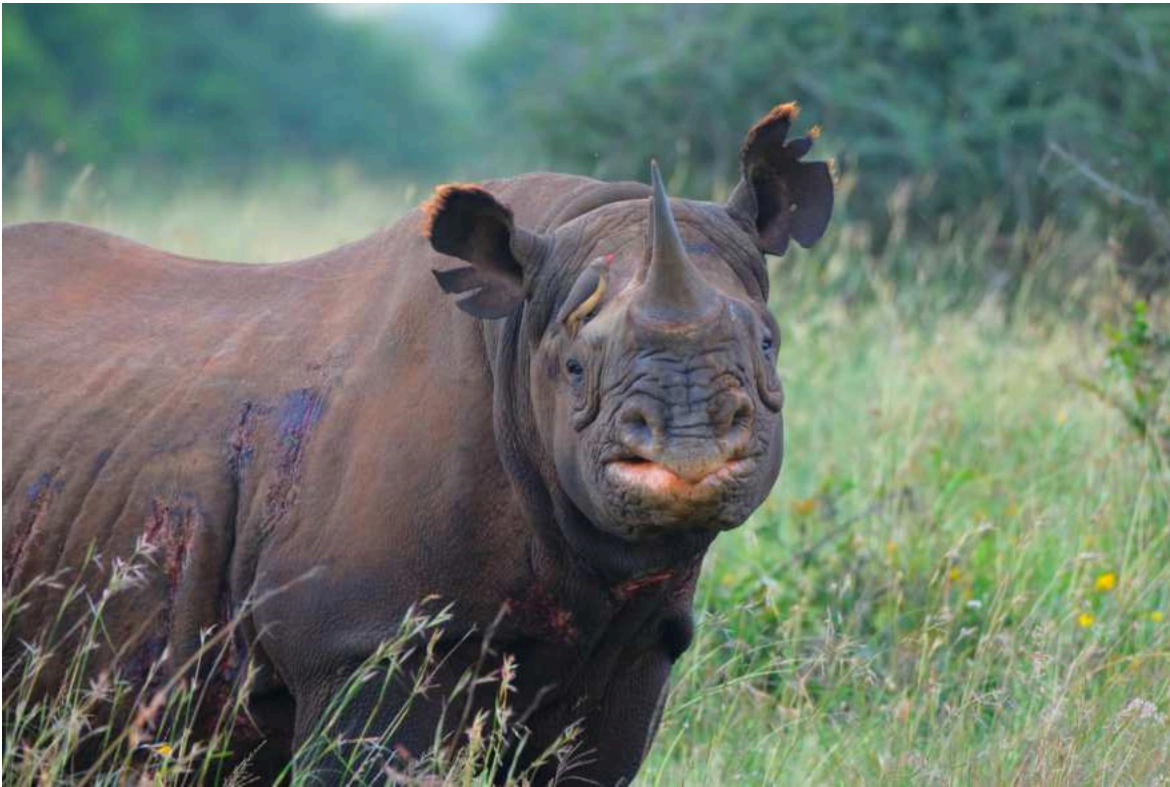
Black rhinoceros female, with an oxpecker and scratches on skin, in Nairobi National Park, Kenya (Zammerman, Wikimedia Commons, CC BY–SA 4.0 DEED)

Improving species

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

A southern white rhino mother with calf in Namibia (Zigomar, Wikimedia Commons, CC BY–SA 4.0 DEED)

- **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

Bald eagle about to fly in Kachemak Bay, Alaska (Andy Morffew, Wikimedia Commons, CC BY-SA 4.0 DEED)

EXAM TIP

In preparation for your exams, you should learn at least one example, in detail, of an extinct species, a critically endangered species, or an improving species. You do not need to use the examples given here.

For the three different named species, consider the factors that contributed to their decline and the impacts of their decline or extinction on ecosystems and societies. Consider the conservation strategies that were used, and whether they were successful or not.
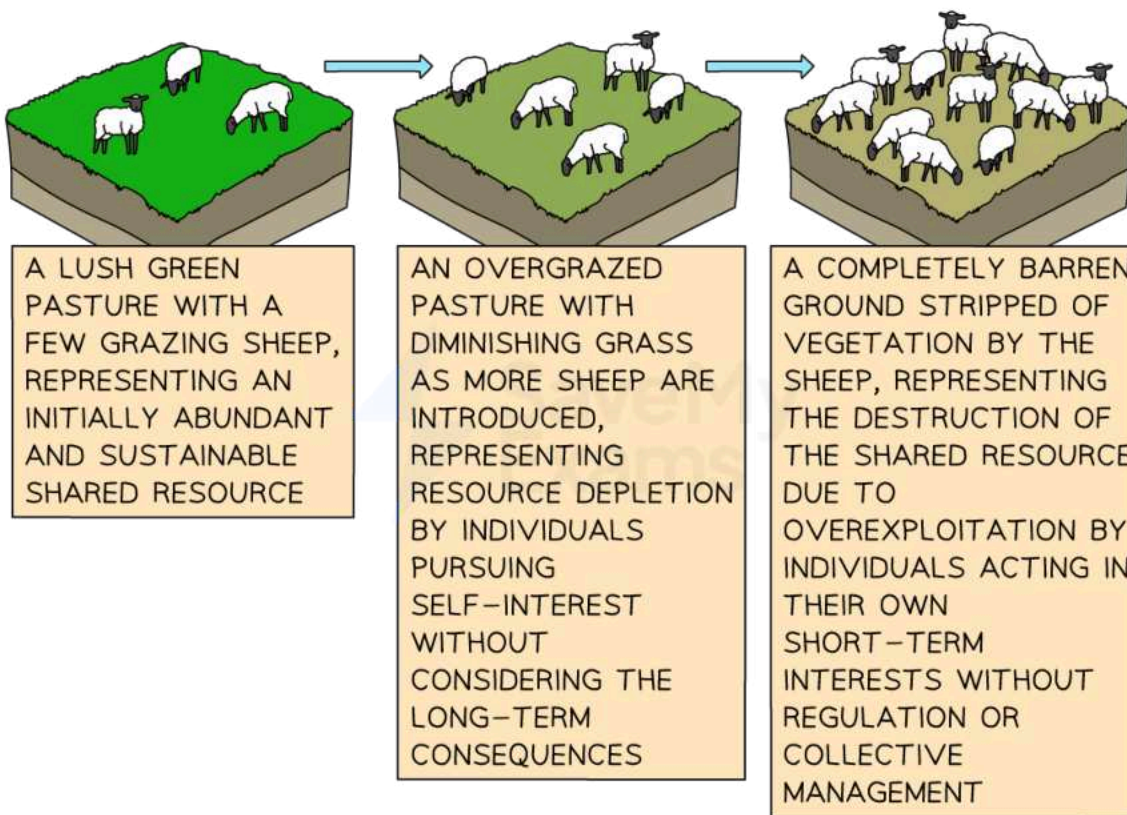
Tragedy of the Commons

Tragedy of the Commons

- The tragedy of the commons describes the **overuse** and **depletion** of a **shared resource**

  - It occurs when individuals act in their own self-interest rather than considering the common good

  - It leads to the **degradation** of the resource, making it **unavailable** for future use

| A LUSH GREEN PASTURE WITH A FEW GRAZING SHEEP, REPRESENTING AN INITIALLY ABUNDANT AND SUSTAINABLE SHARED RESOURCE | AN OVERGRAZED PASTURE WITH DIMINISHING GRASS AS MORE SHEEP ARE INTRODUCED, REPRESENTING RESOURCE DEPLETION BY INDIVIDUALS PURSUING SELF-INTEREST WITHOUT CONSIDERING THE LONG-TERM CONSEQUENCES | A COMPLETELY BARREN GROUND STRIPPED OF VEGETATION BY THE SHEEP, REPRESENTING THE DESTRUCTION OF THE SHARED RESOURCE DUE TO OVEREXPLOITATION BY INDIVIDUALS ACTING IN THEIR OWN SHORT-TERM INTERESTS WITHOUT REGULATION OR COLLECTIVE MANAGEMENT |

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A non-human example demonstrating the tragedy of the commons

Implications for sustainability

- **Overexploitation**:

  - Many natural resources are used faster than they can be replenished

Your notes

- This is resulting in **resource depletion** and could eventually lead to the **collapse** of certain ecosystems
- **Impact on biodiversity**:

  - Result in the loss of **habitats** and **species**

  - It can also lead to reduced **genetic diversity**

    - These factors can weaken ecosystem resilience, threatening biodiversity

CASE STUDY

Overfishing of Fish Stocks on the Grand Banks

- **Location**:

  - Grand Banks, off the coast of Newfoundland, Canada
- **Natural resource affected**:

  - Cod fish
- **Problem**:

  - Intensive fishing by local and international fleets
  - Advanced fishing technologies and no effective regulation
- **Consequences**:

  - Dramatic decline in cod populations
  - Economic collapse of the fishing industry in the region
  - Long-term ecological damage
- **Current situation**:

  - Strict regulations and moratoriums on cod fishing
  - Slow recovery of cod stocks but these are still a long way below historical levels

- The tragedy of the commons does not only apply to situations where a natural resource is overharvested

  - It also applies to the **contamination** and **degradation** of **ecosystems** by humans

CASE STUDY

Plastic Pollution in Ocean Gyres

- **Location**:

  - Various ocean gyres, including the North Pacific Gyre, home to the Great Pacific Garbage Patch
- **Natural resource affected**:

Your notes

- Marine environment and marine biodiversity
- **Problem**:

  - Accumulation of plastic debris from land-based and marine sources
  - Plastics are non-biodegradable and persist for hundreds of years
- **Consequences**:

  - Marine animals ingest plastics, leading to injury and death
  - Plastics break down into microplastics, entering the food chain
  - Damage to marine ecosystems and decline in marine biodiversity
- **Current situation**:

  - Efforts to reduce plastic use and increase recycling
  - International agreements and clean-up initiatives