EXTINCTION

Content Statements:

A4.1.1 Biodiversity as the variety of life in all its forms, levels and combinations

A4.1.2 Comparisons between current number of species of Earth and past levels of biodiversity

A4.1.3 Causes of anthropogenic species extinction

A4.1.4 Causes of ecosystem loss

A4.1.5 Evidence for a biodiversity crisis

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BIODIVERSITY

Biodiversity describes the variation seen in living organisms at all levels of biological organisation. A higher level of diversity is vital for the integrity of ecosystems – making them more stable and resistant to change. Biological diversity can involve variation within a species (genetic), between species or within ecosystems.

Genetic Diversity
Variety of genes and traits available within a species

Species Diversity
Variety of different species found within an ecosystem

Ecosystem Diversity
Variety of habitats / niches in an area of land or water

MEASURING BIODIVERSITY

When assessing the level of biodiversity in a particular region, two key measures are typically investigated:

- **Species richness** describes the *number* of different species present in an area (more = greater richness)
- The *relative abundance* of different species describes **species evenness** (similar abundance = evenness)

Species richness and evenness can be quantitated by estimations such as percentage land coverage (plants) or by population sampling techniques such as the capture-mark-release-recapture method (lincoln index).

BIODIVERSITY CRISIS

The level of biodiversity is constantly changing. Random mutations, speciation and extinction all change the levels of biodiversity. Evidence from fossils suggest that there may be more species on Earth today than at any time in the remote past. However, there has also been a significant loss of biodiversity in recent times. Assessments of biodiversity are made by multinational agencies and are based on contributions from both expert scientists and civilians. The accuracy of diversity estimates is influenced by methods of classification:

- **Lumpers** will classify species according to *shared similarities* – resulting in lower biodiversity estimates
- **Splitters** focus more on the *differences* between organisms – resulting in higher biodiversity estimates

ANTHROPOGENIC CAUSES

The current biodiversity crisis is widely recognised to be **anthropogenic** (due to human activity). The overarching cause is the global growth of the human population, which is placing various strains on ecosystems:

- **Overexploitation** (overfishing and excessive / unnecessary hunting)
- **Climate Change** (greenhouse gases impact environment conditions)
- **Urbanisation** (leading to the direct loss or fragmentation of habitats)
- **Pollution** (damage to environment from microplastics and fertilisers)
- **Invasive Species** (spread of pests and diseases via global transport)
- **Deforestation** (the clearing of land for either industry or agriculture)

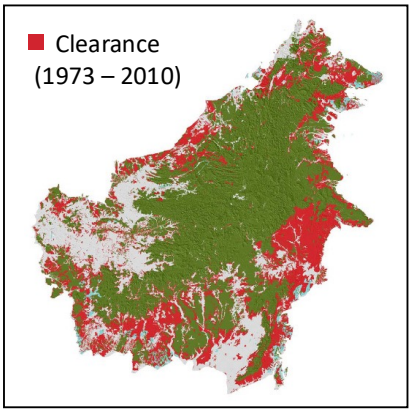
Mnemonic: O! CUPID

ECOSYSTEM LOSS

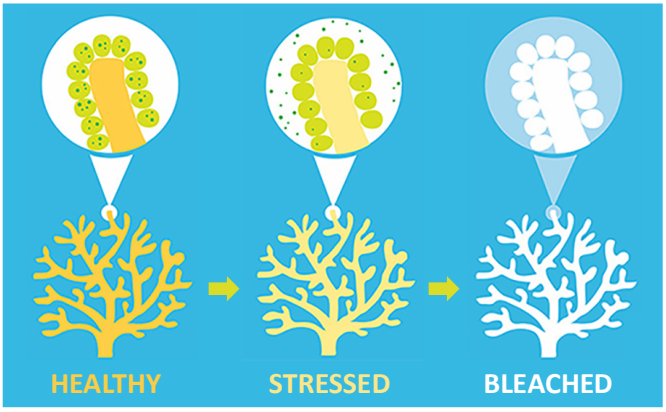
Ecosystems can become threatened by direct human activity or ecosystem loss can involve indirect activity.

An example of ecosystem loss due to **direct** activity is the extensive removal of **mixed dipterocarp forests** in South East Asia. Dipterocarps are a family of trees that function as a keystone species with rainforests – the trees provide an important habitat for native species and provide nutritional support (via fruits and nectar). These forests are being cleared for timber and to provide space for agriculture (palm oil plantations). This is endangering local species (like the orangutan) as well as threatening water security and food sovereignty.

An example of ecosystem loss due to **indirect** activity is the **mass bleaching** of the Great Barrier Reef off the coast of Australia. Coral polyps receive nutrition from photosynthetic algae (zooxanthellae) that live within the polyp's endodermis. Anthropogenic greenhouse gas emissions are increasing oceanic temperatures and decreasing pH (ocean acidification). This has caused the zooxanthellae to leave the coral polyp, resulting in bleaching. As a reef provides shelter and spawning grounds for marine life, this loss threatens biodiversity.



Deforestation (Borneo)



Stages of coral bleaching (algae expulsion)

Ecosystems

Ecosystems will consist of all the interactions that occur between *living organisms* (i.e. community) and their *abiotic environment*

EXTINCTION

Extinction is the total cessation of a species or higher taxon level, reducing the overall level of biodiversity. It can result gradually *(phyletic extinction)* as one population progressively evolves into something else, or it can occur rapidly *(abrupt extinction)* when one species does not leave any descendants and ceases to exist.

Mass extinction events are categorised by an unusually high number of species dying out in a short period. There have been five mass extinction events in the past history of the Earth, while human activity is causing a current sixth mass extinction (which is anthropogenic). It is estimated that Earth has experienced roughly a 73% decline in the average size of all monitored wildlife populations over the last 50 years *(source: WWF)*.

SPECIES EXTINCTIONS

Species that have been declared extinct as a consequence of anthropogenic activity (**overhunting**) include North Island giant moas (terrestrial megafauna), Caribbean monk seals and the Tasmanian tiger (thylacine).

The **giant moa** was a large flightless bird that occupied New Zealand's North Island. Prior to human colonisation, giant moas had few natural predators – making them extremely vulnerable to ecosystem disturbances. Following the arrival of humans in the 1200s, the giant moa was driven extinct by overhunting and the progressive destruction of habitat.

The **Caribbean monk seal** was a marine species that lived in the oceans around the Gulf of Mexico. Their docile nature made them easy prey to humans, who hunted them for their oil and blubber. Additionally, constant overfishing led to starvation. The species was officially declared extinct in late 2008 – with the last recorded sighting occurring in 1952.

Tasmanian tigers are extinct carnivorous marsupials that were once native to Australia. They died out on the mainland roughly 3,500 years ago (possible due to competition with dingoes), but continued to exist on Tasmania. Upon the arrival of European settlers, the Tasmanian tigers were rapidly hunted to extinction (the last one died in 1936 in captivity).

CONSERVATION

Conservation involves protection and maintenance of natural resources in order to preserve biodiversity. **In situ** conservation involves the preservation of plant and animal species *within* a natural habitat (on-site), while **ex situ** conservation is the preservation of plant and animal species *outside* natural habitats (off-site). In situ conservation allows wildlife to maintain normal behaviour and occupy their natural position in food webs, while ex situ conservation allows for greater control of conditions to improve the chances of survival.

In situ Conservation Techniques:

- Using legislation and funding to designate protected areas of land as **national parks** or nature reserves
- Actively or passively restoring a damaged ecosystem until it can become fully sustainable (**rewilding**)
- Repurposing areas used for human activity (**reclamation**) to restore previous ecosystems (e.g. quarries)

Ex situ Conservation Techniques:

- Captive breeding programs (**zoos**) involving animals raised and bred in containment to ensure survival
- **Botanical gardens** are areas devoted to collecting, cultivating and displaying a variety of plant species
- Biological samples are stored and catalogued at secure sites to preserve diversity (**seed** or **tissue banks**)

EDGE OF EXTINCTION PROGRAMME

The EDGE of Existence programme selects species for conservation prioritisation based on two conditions:

- Species have few close relatives and represent unique phylogenetic branches (**evolutionarily distinct**)
- Species are classed *'at risk'* according to the IUCN red list for threatened species (**globally endangered**)

The EDGE of Existence programme is used to inform stakeholders of priorities – it does not make decisions regarding interventions (keystone species and culturally significant species may require greater resources).