

Future of Life

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1 Diversity

1.1 Levels of Diversity

Genetic Diversity Genetic diversity is the total number of genetic characteristics in the genetic makeup of a species, it ranges widely from the number of species to differences within species and can be attributed to the span of survival for a species.

Species Diversity Species diversity is defined as the number of species and abundance of each species that live in a particular location. The number of species that live in a certain location is called species richness.

Ecosystem Diversity Ecosystem diversity deals with the variations in ecosystems within a geographical location and its overall impact on human existence and the environment. Ecosystem diversity addresses the combined characteristics of biotic properties (biodiversity) and abiotic properties (geodiversity).

1.2 Protecting Endangered Species

- State Level: California's Species of Special Concern
- Federal Level: Endangered Species Act of 1973
- International Level: CITES and IUCN

World Heritage Sites Important cultural or environmental sites that are protected by UNESCO.

The Extinction Vortex in Figure 1 Representation of how species go extinct over time. Inherent problems with small populations lead to even smaller populations.

1.3 Approaches to Conservation

1.3.1 Small Population Approach

The small population approach studies the processes that cause extinction once population sizes have been reduced, such as the extinction vortex. This relates to the ideas of the minimum viable population and the effective population size.

Definition. The *minimum viable population* is a lower bound on the population of a species, such that it can survive in the wild.

Definition. The *effective population size* is the number of individuals that an idealised population would need to have in order for some specified

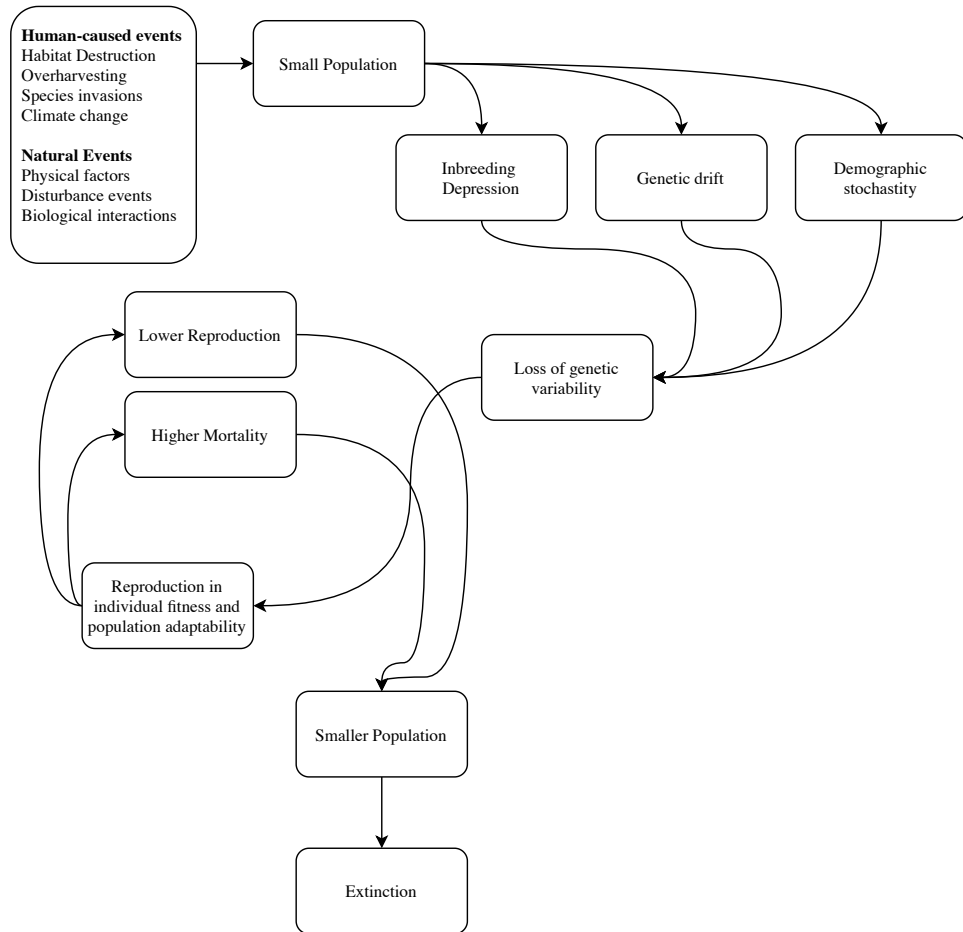


Figure 1: The extinction vortex

quantity of interest to be the same in the idealised population as in the real population. Takes into account different factors such as breeding population size and genetic diversity.

1.3.2 Declining Population Approach

The declining population approach focuses on threatened and endangered populations that show a downward trend, even if the population is above minimum viable population. This approach gives you a broader picture of ecosystem health, and helps you identify and counteract threats at an earlier stage.

1.4 How do we allocate resources to conservation?

Should we spend more resources on *Bufo* or *Rheobatrachidae*? Or something in the middle like *Rana*. Remember that:

- *Bufo* had a large number of species experiencing decline that represented a small portion of the overall group.
- *Rheobatrachidae* had a small number of species experiencing decline that represented the entire diversity of that group.
- *Rana* are in the middle. There are a middling number of species in decline that represent a relatively small portion of the group.

There is no single correct answer, but often we want to put our resources into groups that have a higher likelihood of success, rather than wasting money on a lost cause.

2 Threats and Solutions

2.1 Threats to Biodiversity

- Habitat Loss and Alteration
- Climate Change
- Over-exploitation

- Invasive Species
- Pollution

2.2 More Details

Habitat Loss and Alteration Habitat loss is the process by which a natural habitat becomes incapable of supporting its native species. The organisms that previously inhabited the site are displaced or dead, thereby reducing biodiversity and species abundance.

Effects of Fragmentation In addition to loss of habitat, the process of habitat fragmentation results in three other effects: increase in number of patches, decrease in patch sizes, and increase in isolation of patches. Fragmented habitats have lower species diversity.

Fragmentation and Conservation The Monarch Butterfly Biosphere Reserve features intentionally connected fragments to increase species diversity. Since fragmentation harms environments, wildlife corridors can help prevent fragmentation by allowing animals to pass over roads.

Over-Exploitation Overexploitation means harvesting species from the wild at rates faster than natural populations can recover. Overfishing and overhunting are both types of overexploitation. Currently, about a third of the world's endangered vertebrates are threatened by overexploitation.

Pollution: Superfund Superfund is a law that was passed in 1980: the goal was to identify and clean up toxic waste sites. Since 1980, 392 sites have been delisted.

COVID and Conservation Some animals benefitted from COVID:

- Less urban disturbance \Rightarrow urban population of porcupines increased.
- Less people on beaches \Rightarrow Shore birds population increased.
- Higher fertility rates in birds.
- Higher diurnal(daytime) activity in rabbits.

There were some negatives; mainly that conservation and restoration activities like invasive species management or endangered species support activities were halted during quarantine. In addition, there is less enforcement of rules, so people may steal/disturb endangered species more.

3 The Sixth Extinction

There have been 5 major extinctions: we covered them in the history of life lecture. This section discusses whether we are currently in a sixth major extinction. In order to satisfy the criteria, we need to have extinction rates higher than a certain “background rate”.

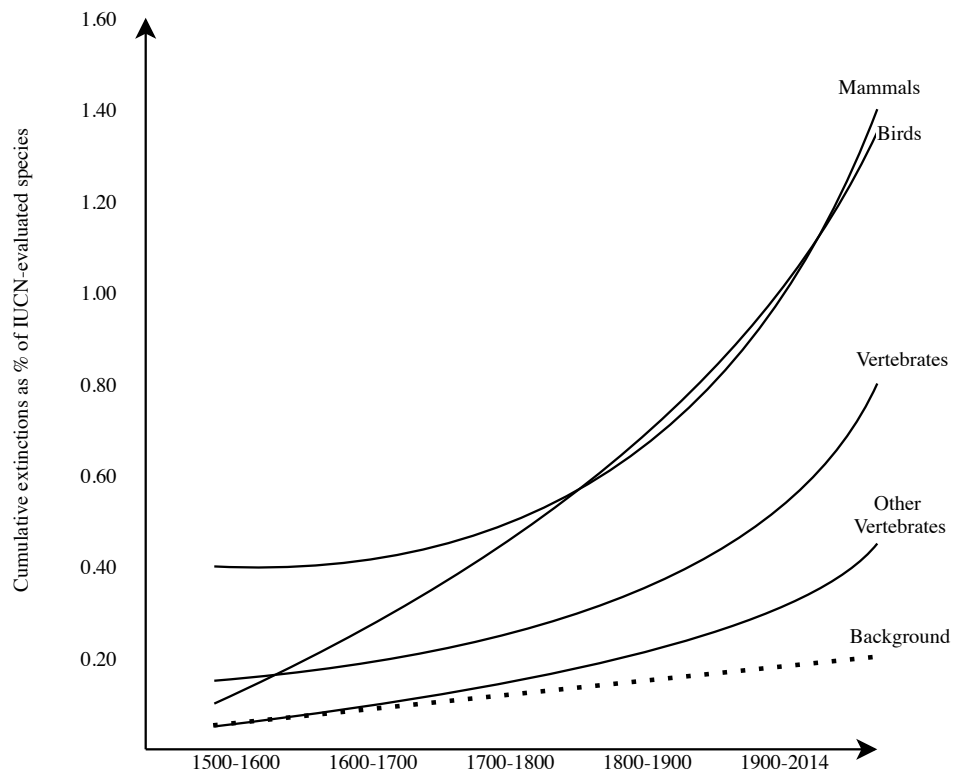


Figure 2: Earth’s sixth mass extinction

In order to be considered a mass extinction, we need at least 75% of species to go extinct. If currently threatened species go extinct, we still will

not reach mass extinction percentages: we are around 65% for some groups.

The True Silent Spring Since 1970, the population size of birds has decreased by about 3 billion birds. Nature is more silent now since the birds have gone quiet.

The Half-Earth Project Goal to have 50% of Earth's area to be protected.

- If we have 100% habitat loss, we can retain 0% species.
- If we have 90% habitat loss, we can retain 5% species.
- If we have 50% habitat loss, we can retain 85% species.