

Classification, biodiversity and conservation

A-Level Biology 9700 · Topic 18 revision notes

Everything from the 4 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. Species, domains and kingdoms

3. Transects and correlation

2. Sampling and measuring biodiversity

4. Extinction and conservation

1 Species, domains and kingdoms

Syllabus 18.1

A **species** can be defined in more than one way: by the ability to **interbreed to produce fertile offspring** (biological), by shared **physical features** (morphological) or by a shared **ecological niche** (ecological). All cellular life is placed in three **domains**: **Bacteria** and **Archaea**, which are both prokaryotes but differ in their **membrane lipids**, **ribosomal RNA** and **cell wall** composition, and **Eukarya**. Eukaryotes are classified into a hierarchy of **kingdom, phylum, class, order, family, genus and species**, with four kingdoms: **Protocista, Fungi, Plantae and Animalia**. Viruses are not in any domain; they are classified by whether their nucleic acid is **DNA or RNA** and whether it is **single-stranded or double-stranded**.

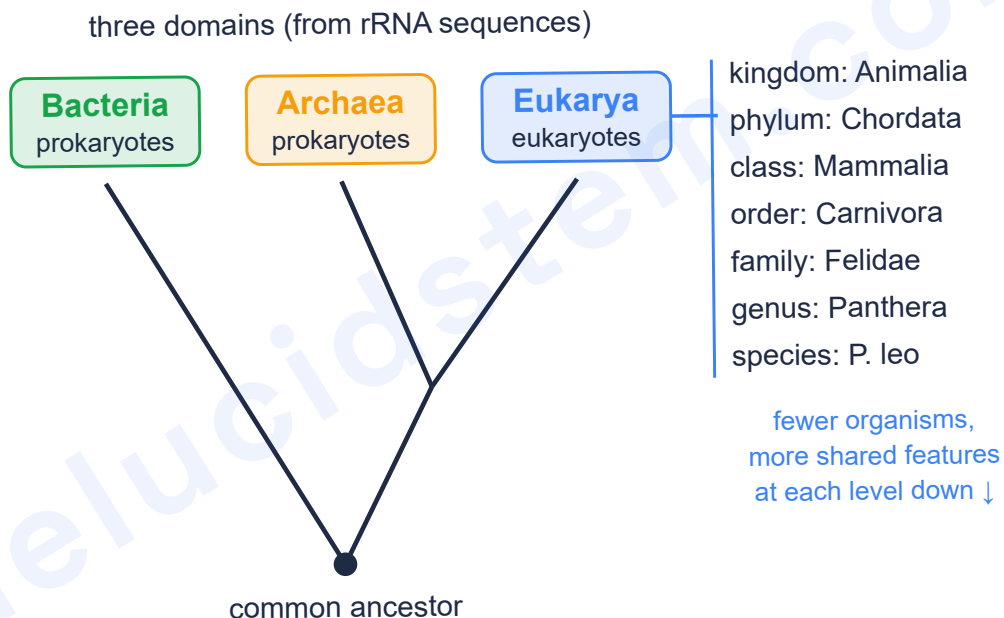


Fig. 1: the three domains share a common ancestor; within Eukarya the lion is classified through seven taxonomic ranks

Define, divide, rank.

- ✓ **Biological species:** interbreed to give **fertile** offspring.
- ✓ **Archaea vs Bacteria:** membrane lipids, rRNA, cell walls (no peptidoglycan in Archaea).
- ✓ **Ranks:** kingdom, phylum, class, order, family, genus, species.
- ✓ **Viruses:** DNA or RNA, single- or double-stranded; no domain.

Watch out!

Producing offspring is not enough for the biological species concept: the offspring must be **fertile**. A horse and a donkey produce a mule, but the mule is infertile, so they are two species.

Archaea are **not** a kind of bacteria, even though both are prokaryotes. They are a separate domain with different membrane lipids, different rRNA and no peptidoglycan in their cell walls.

2 Sampling and measuring biodiversity

Syllabus 18.2

An **ecosystem** is a community of organisms and its physical environment, interacting; a **niche** is the role of a species in its ecosystem, including what it feeds on, where it lives and how it interacts with other organisms and the environment. **Biodiversity** can be assessed at three levels: the **number and range of ecosystems and habitats**, the **number of species and their relative abundance**, and the **genetic variation within each species**. Samples must be **random** to avoid bias. **Frame quadrats** placed at random coordinates give density, frequency or percentage cover of plants and slow-moving animals, and **Simpson's index of diversity**, $D = 1 - \sum (n/N)^2$, combines richness and evenness on a scale of 0 to 1. Mobile animals are estimated by **mark-release-recapture** with the **Lincoln index**, $N = (n_1 \times n_2) \div m_2$.

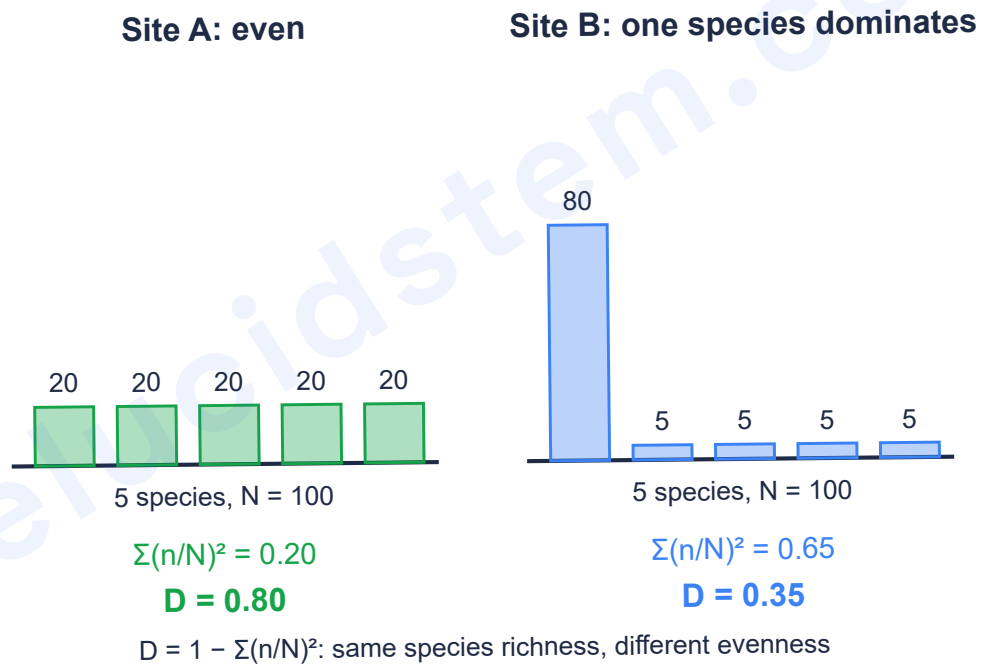


Fig. 1: two sites with the same five species and the same total; the even site has the higher Simpson's index

Random, square, divide.

- ✓ **Three levels:** ecosystems and habitats, species and abundance, genetic variation.
- ✓ **Random coordinates** on a grid remove sampling bias.
- ✓ **$D = 1 - \sum(n/N)^2$:** near 1 high diversity, near 0 low.
- ✓ **Lincoln:** $N = n_1 \times n_2 \div m_2$.

Watch out!

Square each n/N **before** adding, then subtract the total from 1. Adding the n/N values first always gives 1, and forgetting the final subtraction gives a number that falls as diversity rises.

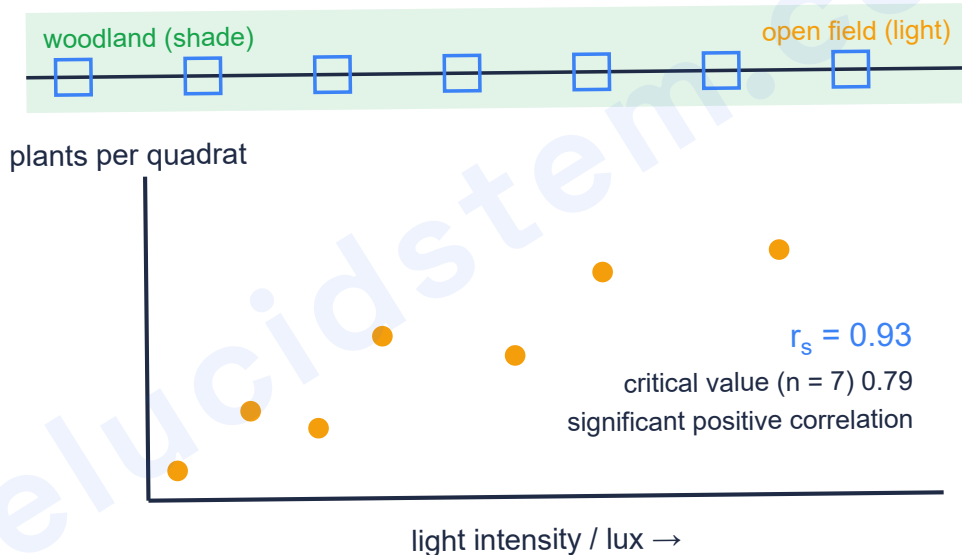
Put the **recaptured marked** number m_2 on the bottom. If marked animals are more likely to be caught a second time (trap-happy), m_2 is too large and the population is underestimated.

3 Transects and correlation

Syllabus 18.2

A **line transect** is a tape laid across a habitat, recording the organisms that touch it at regular intervals; a **belt transect** places **quadrats** at intervals along the line, giving abundance as well as presence. Measuring an **abiotic factor** (light, soil moisture, pH) or a **biotic factor** at each point lets you test for a **correlation** with a species' abundance. **Spearman's rank correlation**, $r_s = 1 - 6\sum D^2 \div (n^3 - n)$, works on ranks and suits data that are not normally distributed. **Pearson's correlation coefficient** r measures how close the points are to a straight line and needs both variables to be normally distributed. Both run from -1 to $+1$; the value is compared with a **critical value** at $p = 0.05$ to accept or reject the **null hypothesis** of no correlation. A correlation never proves cause.

belt transect: quadrats placed at intervals along a line across a gradient



correlation shows an association, not that light causes the change

Fig. 1: a belt transect from woodland into an open field, and the scatter graph of plant numbers against light intensity

Gradient, rank, critical value.

- ✓ **Belt transect** = quadrats along a line; gives abundance along a gradient.
- ✓ $r_s = 1 - 6\sum D^2 \div (n^3 - n)$; ties share mean ranks.
- ✓ **Compare with the critical value** at $p = 0.05$; reject the null if equal or greater.
- ✓ **Correlation is not causation**; Pearson needs normal, linear data.

Watch out!

A transect is **systematic**, not random sampling; it is used deliberately along a gradient. For estimating the overall diversity of a uniform area, use random quadrats instead.

A significant correlation does **not** show that one variable causes the other. Light might affect the plants, or both might depend on a third factor such as soil moisture or trampling.

4 Extinction and conservation

Syllabus 18.3

Populations and species become extinct when **climate change** shifts conditions faster than they can move or adapt, when a **competitor** uses their resources more efficiently, when **hunting by humans** removes individuals faster than they reproduce, and when **habitats are degraded or lost**. Small populations also lose genetic diversity. Biodiversity is worth maintaining for **ecosystem stability and services**, for **food, medicines and genes**, for **economic** value such as ecotourism, and for **ethical** reasons. Conservation protects species in **national and marine parks**, and away from their habitat in **zoos**, **botanic gardens**, **frozen zoos** and **seed banks**. Rare mammals can be bred by **IVF**, **embryo transfer** and **surrogacy**. **Invasive alien species** are controlled to protect native species, and internationally the **IUCN** assesses threat (the Red List) while **CITES** regulates trade.

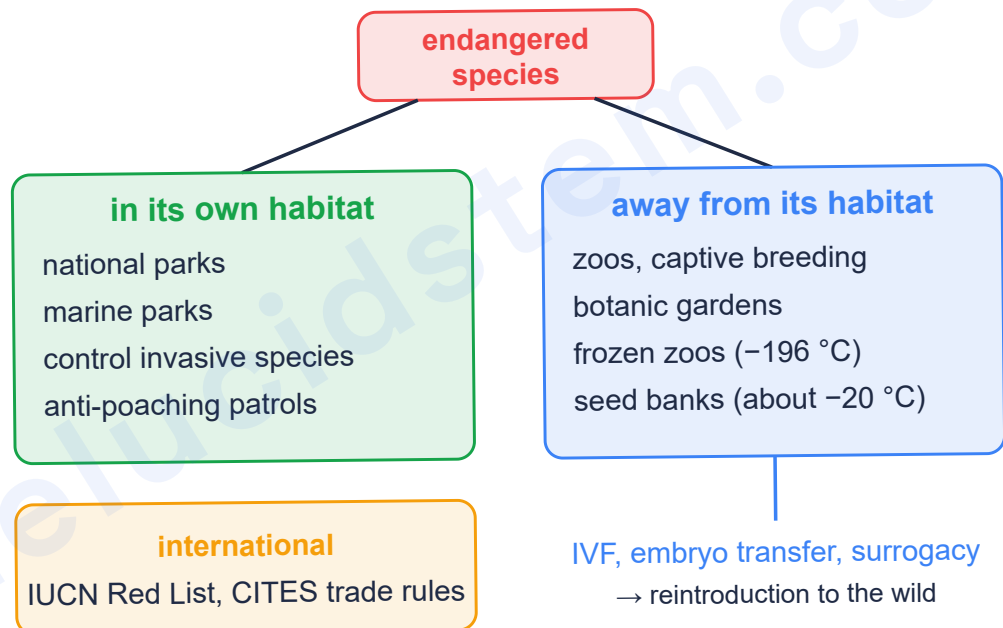


Fig. 1: conservation of an endangered species in its own habitat, away from it, and through international agreements

Explain the threat, name the tool.

- ✓ **Four threats:** climate change, competition, hunting, habitat loss; explain the effect on numbers.
- ✓ **In the habitat:** national and marine parks. **Away:** zoos, botanic gardens, frozen zoos, seed banks.
- ✓ **IVF, embryo transfer, surrogacy** multiply offspring from rare mammals.
- ✓ **IUCN** = Red List; **CITES** = trade rules.

Watch out!

Do not just name the threat: explain the effect on the **population**. For example, habitat loss reduces the food and breeding sites available, so the carrying capacity falls and fewer individuals survive and reproduce.

Seed banks and frozen zoos do not stop a species declining in the wild on their own. They store **genetic diversity**; the habitat must still be protected for any reintroduced organisms to survive.