Biodiversity and conservation

Topic 3 · SL and HL

Non-detection is serious evidence

> Possibly Extinct and a confirmed Extinct category are different assessment claims.

- Baiji: cited IUCN assessment, Critically Endangered (Possibly Extinct).
- Yangtze finless porpoise: dated 2022 estimate 1249; uncertainty and future threats remain.

Three levels of biodiversity

Level	Meaning
Genetic diversity	Inherited variation within a species
Species diversity	Variety of species, by richness and **evenness**
Habitat diversity	Variety of habitats or ecosystems in an area

Same richness, different evenness

1. **Given and formula.** Invented A: 8, 1, 1; B: 4, 3, 3. Both N=10. $D = N(N-1)/\sum n(n-1)$.
2. **Calculate.** $D_A = 90/56 = 1.607$; $D_B = 90/24 = 3.75$.
3. **Interpret.** Same richness; B is more even. This finite-sample convention can exceed observed richness.

Decision

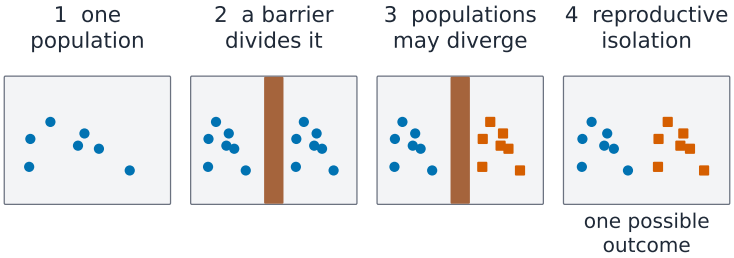
An index does not establish the cause of a difference or guarantee ecosystem resilience.

Natural selection

> Selection is not a deliberate response to a need; **evolution** need not create a new species.

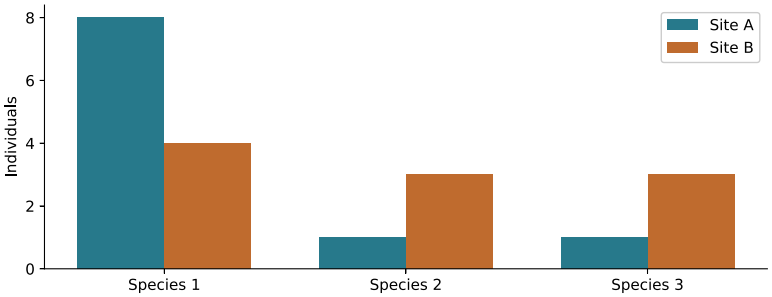
- Heritable variation and differences in reproductive success change populations.
- Fitness concerns contribution to later generations, not simply strength.

Speciation



- A barrier can reduce gene flow; divergence may follow through selection, mutation and drift.
- Reproductive isolation requires evidence; geographical separation alone is not a guarantee.

Richness is not the whole story



B is more even, so more diverse

AHL: Plate tectonics

Splitting and building

Isolation can allow divergence; not every barrier creates species.

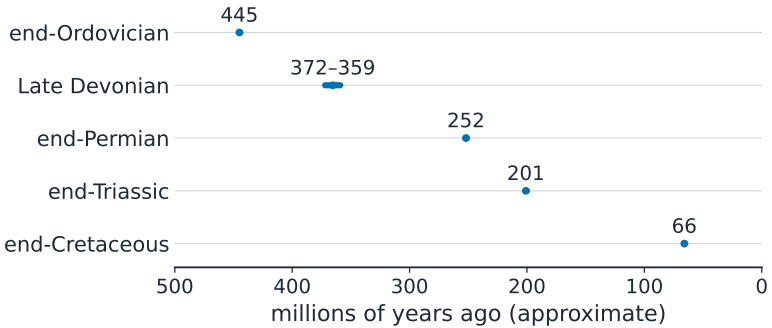
Mountains create new habitats.

Joining and moving

Connections permit dispersal and new interactions.

Continents move into new climates.

AHL: Extinction intervals



Different events and fossil records do not justify one uniform percentage-loss census.

Causes of loss (HIPPO)

Cause	Example
Habitat loss	Rainforest cleared for cattle, soya, oil palm
Invasive species	Cane toads in Australia
Pollution	Fertiliser runoff and eutrophication
Population and consumption	More demand for land and water
Overharvesting	Overfishing of cod; rhino poaching

Fragmentation and edge effects

Fragmentation changes geometry and connectivity; the biological effect needs a species and mechanism.

- Edge conditions and response depth depend on the habitat boundary and species.
- Restricted movement and gene flow can add risks for small populations.

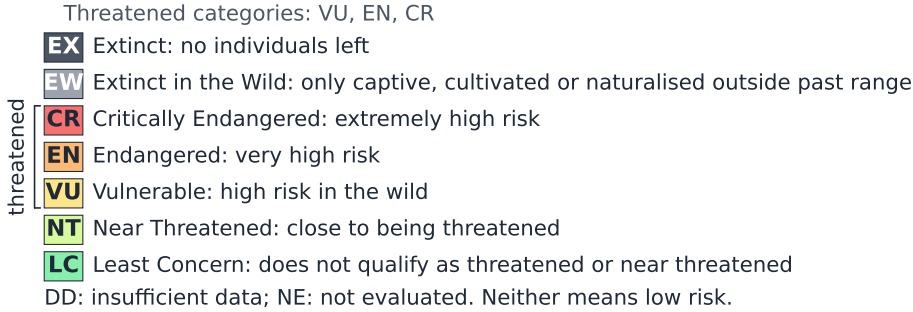
Who is most at risk?

Your turn

Which species is most vulnerable to extinction?

A. A weed with many seeds and a wide range
B. A mouse that eats many foods
C. A large slow-breeding eagle with a small range
D. A common insect with a short life

The IUCN Red List



> DD and Not Evaluated do not establish low risk; listing alone does not protect habitat.

Three case histories

Protecting habitat and stopping the threat can turn a decline around.

- The passenger pigeon, billions in the 1800s, extinct in 1914.
- Yangtze finless porpoise, critically endangered; fishing ban since 2021.
- Giant panda, reserves and corridors; moved to Vulnerable in 2016.

AHL: Prioritise conservation

> Specify the qualifying evidence, threat and response rather than equating richness with guaranteed value.

- Hotspot definition: at least 1500 endemic vascular plants and at least 70% original-vegetation loss.
- KBA, hotspot, biosphere reserve and legal **protected area** are different designations.

AHL: Two key biodiversity areas

Kakadu Savanna, Australia

Confirmed; assessment 2018.

Savanna biodiversity; fire timing and introduced species matter.

Tanjung Puting, Indonesia

Confirmed legacy site; assessment 2001.

Peat-swamp/heath forest; historical logging, conversion and fire pressures.

Why conserve?

Intrinsic value

Every species has a right to exist.

An ecocentric view.

Instrumental value

Food, medicines, timber.

Pollination, clean water, flood control.

Who conserves?

Government and international

National agencies can enforce applicable rules.

UNEP coordinates; it does not enforce every national wildlife law.

Non-governmental

Fieldwork, funding, campaigning and legal challenges.

Powers, resources and independence vary.

Species-based conservation

Strengths

Saves species on the edge.

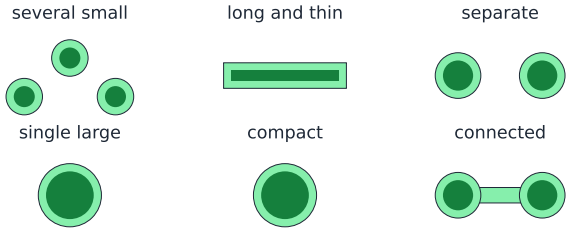
A **flagship species** raises support.

Limits

Expensive; few species.

Threats and habitat conditions still need action.

Designing protected areas



Size/shape pairs have equal total area; corridor adds area.
Dark green: interior under an assigned edge-depth model; trade-offs vary.

Compare equal areas and stated threats: no geometry is universally best.

Habitat-based conservation

> Habitat protection can help many species; it does not guarantee every population is safe.

- Protected areas, **ecological restoration**, **rewilding**.
- The panda programme combines reserves with **captive breeding**.

Model interior habitat

1. **Given.** Invented square side 1000 m; assigned uniform edge depth 100 m.
2. **Interior dimensions.** Side $= 1000 - 2(100) = 800$ m.
3. **Interior share.** $800^2/1000^2 \times 100 = 64\%$.

Decision

An assigned edge depth is a geometry model, not a universal measured ecological boundary.

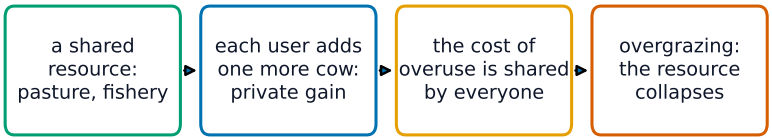
A shared fishery budget

1. **Given.** Invented annual stock growth 120 tonnes, combined catch 150 tonnes; other flows ignored.
2. **Balance.** Stock change $= 120 - 150 = -30$ tonnes.
3. **Decision.** Rules, monitoring and changing recruitment matter; shared ownership need not mean unrestricted access.

Decision

A single growth estimate is not a guaranteed safe harvest.

The tragedy of the commons



solutions: regulation, quotas, fees, private or community ownership

> Without rules, the shared resource is overused

Agreements and the area target

CITES and CBD

Trade regulation differs from habitat management.

CBD: conservation, sustainable use and genetic-resource benefit sharing.

Target 3 by 2030

At least 30% terrestrial/inland water and 30% marine/coastal areas.

Effective, connected, representative and equitable conservation; respect rights.

Evaluate a restoration comparison

1. **Given.** Invented breeding pairs: restored 40→60; comparison 50→55.
2. **Changes.** Restored +20; comparison +5.
3. **Additional change.** Difference-in-changes $= 20 - 5 = 15$ pairs.

Decision

Comparable trends and other design assumptions are needed; subtraction alone is not causal proof.

In-situ and ex-situ conservation

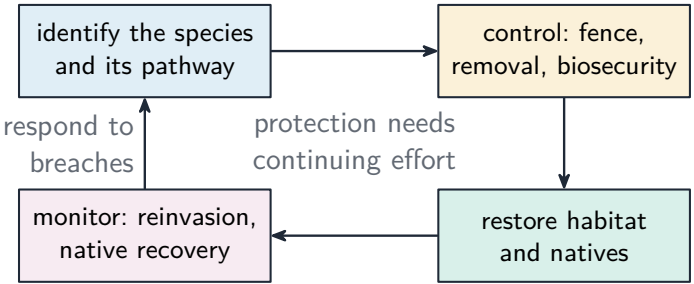
two ways to conserve a species

in-situ (in the wild)
national parks,
marine reserves

ex-situ (away from the wild)
zoos, botanic gardens,
seed banks,
frozen zoos

> In situ protects the whole habitat

Managing an invasive species



Respond quickly to any reinvasion

AHL: New alleles and reproductive isolation

Variation

Mutation can create alleles; sex makes new combinations.

Selection and drift can change frequencies.

Isolation evidence

Big Bird finch lineage: observed hybrid ancestry and isolation.

Rhagoletis host races: partial isolation during ongoing divergence.

AHL: Selection under human pressures

Unintended selection

Gorongosa poaching selected among heritable variants.

Tusklessness did not evolve by deliberate need.

Artificial selection

Choosing few breeders can narrow variation.

Diverse lines and wild relatives retain options.

AHL: Human signatures and geological names

Potential records

Artificial radionuclides, fly ash, plastics and altered sediments.

Markers need dates, preservation and correlation.

Formal classification

Anthropocene proposal rejected in 2024.

Human impacts remain observable regardless of a naming decision.

AHL: Management and justice

Kakadu

Cultural burning plus contemporary management.

Access, knowledge, grasses and climate affect feasibility.

Rights and evidence

Assess who decides, loses access and receives benefits.

Ngorongoro: distinguish dated allegations, findings and outcomes.

AHL: Feedback and rewilding

Reinforcing loop

More trees → seed/shelter → recruitment → more trees.

Positive means amplification, not a welcome outcome.

Constraints

Water, grazing, neighbouring farms and food production.

Measure functioning and social outcomes, not just activity.

AHL: Tourism receipts and costs

1. **Given.** Invented 8000 visits at 20 currency units; operating costs 110000.
2. **Gross receipts.** $8000 \times 20 = 160000$.
3. **Remaining before omitted costs.** $160000 - 110000 = 50000$.

Decision

Trace actual conservation funding and local benefits; gross revenue is not profit.

Exam tips

> In evaluate questions, weigh species-based against habitat-based approaches.

- Name all three levels when you define biodiversity.
- Distinguish isolation, divergence and evidence of reproductive isolation.
- Link each cause of loss to a mechanism and an example.

Check yourself

Try these

Site X has 12, 4 and 4 individuals; site Y has 7, 7 and 6. Which is more diverse?

Explain how fragmentation reduces biodiversity.

Explain four principles of protected-area design.