Biodiversity and conservation

Topic 3 · SL

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

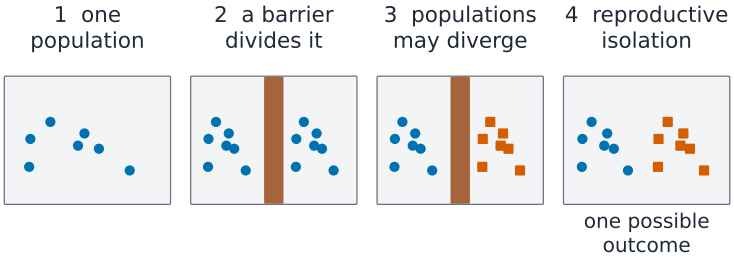
An index does not establish the cause of a difference or guarantee ecosystem resilience.

Natural selection

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

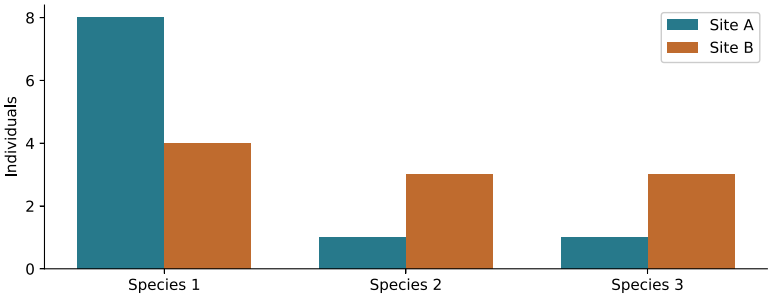
- Heritable variation and differences in reproductive success change populations.
- Fitness concerns contribution to later generations, not simply strength.

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

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.

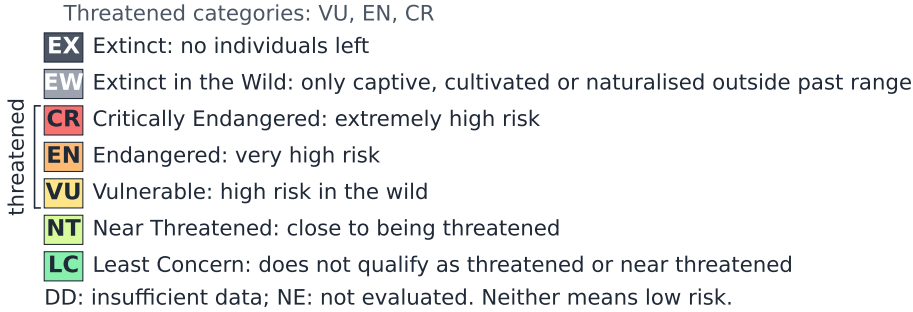
Who is most at risk?

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.

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.

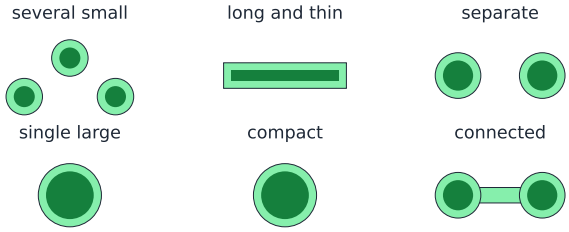
A **flagship species** raises support.

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.

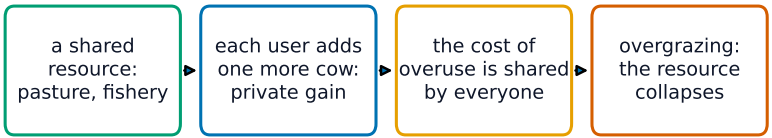
A shared fishery budget

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.

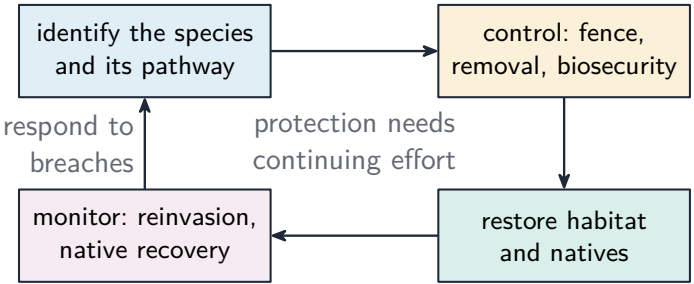
Evaluate a restoration comparison

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.

Managing an invasive species



Respond quickly to any reinvasion

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.